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A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.*

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Read, in abstract, before the Canadian Institute, December 5th, 1859.

INTRODUCTORY NOTICE.

In attempting to convey to the general reader a practical or really useful knowledge of the Minerals and Geology of Canada, it is advisable to consider the subject under the following heads:

1. How minerals are distinguished from one another.
2. The minerals and metallic ores met with in Canada.
3. How rocks are classified and distinguished.
4. Organic Remains: their use and teachings.
5. Subdivisions and distribution of Canadian rocks.

The term "Geology" comprises, strictly, a knowledge of the physical history of the Earth, as revealed to us by the study of the rock-

* The object of the series of papers to be published under this title, is twofold: First, to enable our surveyors, farmers, and others, to determine the Canadian minerals that may come under their observation; and, secondly, to serve as an introduction to the valuable reports and other publications issued by our Geological Survey.

masses which lie around and beneath us; and by a comparison of the results of ancient phenomena, with the forces and agencies still at work in modifying the surface of the globe. As geology is thus essentially based on the study of rocks and their contents, and as rocks are made up of a certain number of simple minerals, it is necessary, or at least advisable, to obtain a knowledge of these latter (so as to be able to recognize them when met with), before proceeding to the discussion of the rocks into which they enter. With these minerals, also, it is convenient to consider a few others of economic application and common occurrence, including the more important metallic ores. In this consideration, the characters or properties by which minerals are distinguished from one another will first be explained, introductory to a Tabular Distribution of Canadian minerals. The latter will be so arranged as to enable the reader to make out the name of any one of the included species, with great facility.

I. How Minerals are distinguished from one another.

Minerals are distinguished from one another by certain characters or properties which they possess: such as form, degree of hardness, fusibility, &c. Hence, it is to these characters that our attention must be first directed.

Mineral characters are of two kinds: *physical* or *external* characters, and *chemical* characters. The former are exhibited by the mineral under ordinary conditions; the latter, only when the mineral is exposed to the action of heat or mineral acids, by which, in general, a certain degree of chemical decomposition is effected. Hence the term "chemical" as applied to these latter characters.

The physical properties of minerals are somewhat numerous; but many, although of the highest interest in indicating the existence of natural laws, and in their relations to physical science generally, are not readily available as a means of mineral discrimination. These, consequently, will be omitted from consideration in the following pages; and the other characters will be discussed only in so far as they admit of direct application to the end in view—namely, the practical discrimination of minerals one from another.*

* In the explanation of these various characters, it is occasionally necessary to refer, as examples, to a few substances of foreign occurrence. The reader will therefore understand, that the present Part of this Essay makes no special mention of the minerals of Canada, but is simply an Introduction to Part II, in which these minerals will be found arranged together.

The following are the characters in question :

1. Aspect or Lustre.
2. Colour.
3. Streak.
4. Form.
5. Structure.
6. Hardness.
7. Specific Gravity.
8. Relative Malleability.
9. Magnetism.
10. Taste, &c.

1. *Aspect or Lustre.*—We have here to consider, first: the *kind ;* and, secondly, the *degree* or *intensity* of the lustre, as possessed by the mineral under examination. The kind of lustre may be either *metallic*, as that of a piece of copper, silver, &c.; or *sub-metallic,* as that of most kinds of anthracite coal; or *non-metallic,* as that of stones in general. Of the non-metallic lustre there are several varieties, as, more especially : the *vitreous* or glassy lustre—example : rock-crystal ; the *resinous* lustre—ex. : native sulphur ; the *pearly* lustre—ex.: talc; the *silky* lustre (usually accompanying a fibrous structure)—ex. ; fibrous gypsum ; the *stony* aspect ; the *earthy* aspect, &c. These terms sufficiently explain themselves. Occasionally, two kinds of non-metallic lustre are simultaneously present, as in obsidian, which exhibits a "resino-vitreous" aspect ; and the lustre in some zeolites is pearly within, and vitreous externally. In mica, and some few other minerals, there is frequently a *pseudo-metallic* lustre. This may be distinguished from the metallic lustre properly so-called, by being accompanied by a degree of translucency, or by the powder of the mineral being white or light-colored : minerals of a true metallic aspect being always opaque, and their powder being always black or dark-colored. So far as regards the metallic and the non-metallic lustres, there are very few minerals which exhibit (in their different varieties) more than one kind. Thus, galena, the common ore of lead, copper pyrites, &c., always present a metallic lustre ; whilst, on the other hand, quartz, feldspar, calc-spar, gypsum, &c., are never found otherwise than with a non-metallic aspect. Hence, by means of this easily-recognized character, we may divide all minerals into two broad groups ; and thus, if we pick up a specimen

and wish to ascertain its name, we need only look for it amongst the minerals of that group with which it agrees in lustre. The first step towards the determination of the substance will in this way be effected.

The *degree* of lustre may be either splendent, shining, glistening, glimmering, or dull; but the character is one of comparatively little importance.

2. *Colour.*—When combined with a metallic aspect, colour becomes a valuable character in the determination of minerals, because it then remains constant as regards a given substance. Thus galena, the common ore of lead, is always lead-grey; copper pyrites, always brass-yellow; native gold, always gold-yellow; and so forth. When accompanied, however, by a vitreous or other non-metallic lustre, colour is, practically, a character of no value; as in that case, the mineral may present, in its different varieties, every variety of colour. Thus, we have colourless quartz, amethystine or violet quartz, red quartz, yellow quartz, &c., just as in the vegetable kingdom, we have red, white, and yellow roses; and dahlias, &c., of almost every shade. When combined with a metallic aspect, the colour is said to be metallic; and of metallic colours we may enumerate the following:

White	Silver-white	ex. Native silver.
	Tin-white	ex. Pure tin; cobalt ore.
Grey	Lead-grey	ex. Galena.
	Steel-grey	ex. Specular iron ore.
Black	Iron-black (usually with sub-metallic lustre)	ex. Magnetic iron ore.
Yellow	Gold-yellow	ex. Native gold.
	Brass-yellow	ex. Copper-pyrites.
	Bronze-yellow (a brownish-yellow)	ex. Magnetic pyrites.
Red	Copper-red	ex. native copper.

These metallic colours are often more or less obscured by a black, brownish, purple, or iridescent *surface-tarnish*. Hence, in noting the colour of a mineral, a newly-fractured surface should be observed. The non-metallic colours comprise, white, grey, black, blue, green, red, yellow, and brown, with their various shades and intermixtures; as orange-yellow, straw-yellow, reddish-brown, greenish-black, &c. In minerals of a non-metallic aspect, the colour is sometimes uniform; and at other times, two or more colours are present together, in spots, bands, &c., as in the varieties of quartz, called agate, bloodstone, jasper, and so forth. In Labradorite, or Labrador feldspar, a beautiful play or change of colour is observed in certain directions. The finer varieties of Opal also exhibit a beautiful and well-known iridescence.

3. *Streak.*—Under this technical term is comprised the *colour of the powder* produced by drawing or "streaking" the mineral under observation, across a file or piece of unglazed porcelain. The character is a valuable one on account of its uniformity; as, no matter how varied the colour of a mineral may be in different specimens, the streak will remain of one and the same colour throughout. Thus, blue, green, yellow, red, violet, and other specimens of fluor spar, quartz, &c., exhibit equally a white or "uncoloured" streak. The streak is sometimes "unchanged," or of the same tint as the external colour of the mineral; but far more frequently it presents a different colour. Thus, Cinnabar, the ore of mercury, has a red colour and red streak; realgar, or sulphide of arsenic, has a red colour and orange-yellow streak; copper pyrites, a brass-yellow colour, and greenish-black streak; and so forth. In certain malleable and sectile minerals, whilst the colour remains unchanged in the streak, the lustre is increased. The streak is then said to be "shining." Finally, it should be remarked, that in trying the streak of very hard minerals, we must crush a small fragment to powder, in place of using the file; because otherwise, a greyish-black streak, arising from the abrasion of the file, might very possibly be obtained, and so conduce to error. It may be observed, however, that all minerals of a non-metallic aspect, and sufficient hardness to resist the file, have a white streak.

4. *Form.*—The forms presented by minerals, may be either *regular* or *irregular*. Regular forms are called *crystals,* whether the minerals which present them be transparent or opaque. The term "crystal" was first applied to transparent vitreous specimens of quartz or rock-crystal; but, as it was subsequently found that opaque specimens of quartz presented exactly the same forms, and that opaque as well as transparent forms of other minerals existed, the term gradually lost its original signification, and came to be applied to all regular forms of minerals, whether transparent, translucent, or opaque. Minerals of a metallic lustre are always opaque; and many of these, as iron pyrites and galena, occur frequently in very regular and symmetrical

crystals. Crystals originate in almost all cases in which matter pas se from a gaseous, or liquid, into a solid state; but if the process take place too quickly, or the matter solidify without free space for expansion, crystalline masses, in place of regular crystals, will result. If a small fragment of arsenical pyrites, or native arsenic, be heated at one end of an open glass tube (five or six inches long and one-fourth of an inch in diameter), the arsenic, in volatilizing, will combine with oxygen, and form arsenious acid, which will be deposited at the other end of the tube, in the form of minute octahedrons (Fig. 3, below). In like manner, if a few particles of common salt be dissolved in a small quantity of water, and a drop of the solution be evaporated gently (or suffered to evaporate spontaneously) on a piece of glass, numerous little cubes and hopper-shaped cubical aggregations will result. Boiling water, again, saturated with common alum, will deposit octahedral crystals on cooling: the cooled water not being able to retain in solution the full amount of alum dissolved by the hot water. In like manner, sugar, sulphur, and other bodies crystallise by slow cooling from the molten state.

The study of crystal-forms constitutes the science of Crystallography. To enter into the details of this science would extend our present discussion beyond its proposed limits, and carry us altogether beyond the object in view—the simple determination of the names of commonly-occurring minerals—and hence we shall confine ourselves to the general statement, that crystals admit of being arranged in six groups, or "systems;" the forms of each individual group passing into one another by simple transitions, but having no relations to the forms of the other groups.* The names of these respective groups,

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* The reader desirous to take up the study of Crystallography in a more extended manner, may attend the author's special courses of lectures which include that subject. In these, the use of crystallographic instruments is shewn, and the lectures are illustrated by numerous wood and porcelain models, drawings, and natural crystals. The following is extracted from the syllabus of the advanced course on Mineralogy:

CRYSTALLOGRAPHY, PART I.—Crystals, how defined. Formation of Crystals. Elements of Crystals: planes, edges, angles; diagonals, axes. Forms and combinations. Replacing planes. General nomenclature of Forms and simple Crystals. Law of constant Angles. Measurement of Angles. Laws of Symmetry: Holohedral, Hemihedral, and Tetartohedral Forms. Classification of Crystals. Dimorphism. Isomorphism. Compound Crystals. Distortions. Pseudomorphs.

PART II.—The six systems of Crystallization. The Monometric system. The Dimetric system. The Hexagonal system. The Trimetric system. The Monoclinic system. The Triclinic system. Method of ascertaining the system of a given Crystal.

PART III.—Optical and other physical relations of Crystallography.

with figures of a few of their more common forms and combinations, are given in the annexed tabular view.

The Monometric or Regular System.—This group includes the cube (Fig. 1), the rhombic dodecahedron (Fig. 2), the regular octahedron (Fig. 3), trapezohedrons or leucitoids (Fig. 4), pentagonal dodecahedrons (Fig. 5), &c. Fig. 6 is a combination of the cube and

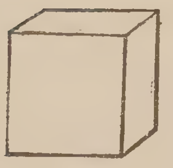
FIG. 1.

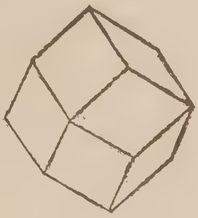
FIG. 2.

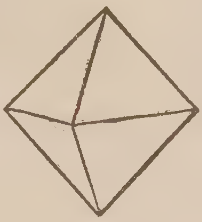
FIG. 3.

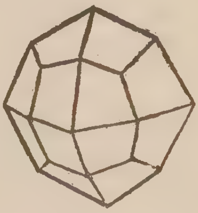
FIG. 4.


FIG. 5.

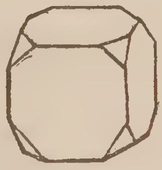
FIG. 6.

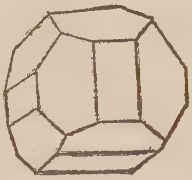
FIG. 7.

octahedron ; Fig 7, a combination of the cube and pentagonal dodecahedron. Native gold, silver, copper, iron pyrites, galena, magnetic iron ore, garnet, fluor spar, rock salt, and numerous other minerals, crystallize in this system.

The Dimetric or Square-Prismatic system.—This includes, principally, square-based prisms and pyramids (or octahedrons), and their combinations. Figures 8 and nine are examples of Dimetric crystals.

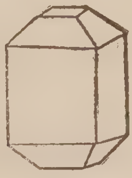
FIG. 8.


FIG. 9.

Amongst minerals, Copper Pyrites, Tin-stone, Zircon, and Idocrase, may be cited as belonging to the group.

The Hexagonal system.—Regular six-sided prisms (Fig. 10) and pyramids (Fig. 11), combinations of these (Fig 12), rhombohedrons

(Figs. 13 and 14), and scalenohedrons (Fig. 15), are included under this system. Graphite, Red Silver ores, Cinnabar, Specular Iron Ore, Corundum, Quartz, Beryl, Apatite or phosphate of lime, Cal-

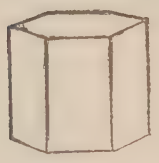

FIG. 10.

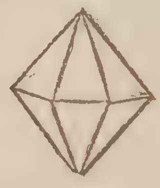

FIG. 11.

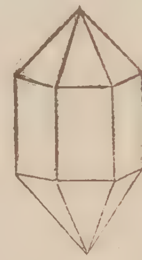

FIG. 12.

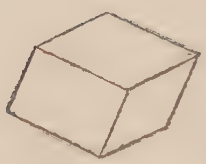

FIG. 13.

FIG. 14.

FIG. 15.

careous Spar, Dolomite, and Carbonate of Iron, are some of the principal minerals which belong to it.

The Trimetric or Rhombic system.—This system includes right-rhombic prisms, rectangular prisms, rhombic octahedrons, &c., and their combinations. Fig. 16 is a rhombic prism ; figs. 17 and 18 are

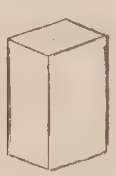

FIG. 16.

FIG. 17.

FIG. 18.

combinations belonging to this system. White iron-pyrites, mispickel or arsenical pyrites, native sulphur, topaz, staurolite, arragonite, heavy spar, celestine, and Epsom salt, are some of the principal minerals which belong to this group.

The Monoclinic or Oblique Rhombic system.—Rhombic prisms and pyramids, and rectangular prisms and pyramids, with *oblique or sloping base*, belong to this system. Figs. 19 and 20 are monoclinic combinations. The principal minerals comprise: Augite, Hornblende, Epidote, Orthoclase, or potash feldspar, Stilbite, and Gypsum.

FIG. 19.

FIG. 20.

The Triclinic, or Doubly Oblique system.—The forms of this system are oblique (or they incline) in two directions. The crystals in general are more or less flat and unsymmetrical in appearance. No two planes meet at right angles; and there are never more than two similar planes present in any crystal belonging to the group. Axinite, Albite or soda feldspar, Labradorite or lime feldspar, and sulphate of copper, are the principal triclinic minerals.

Such is a brief exposition of the six crystal systems. For present purposes it will only be necessary for the student to impress upon his memory the following forms, so as to be able to recognize them when met with. The cube (Fig. 1), the regular octahedron (3), the rhombic dodecahedron (2), the pentagonal dodecahedron (5), the cubo-octahedron (6), the regular six-sided prism (10), a combination of a six-sided prism and pyramid (12) a rhombohedron (13 and 14), a scalenohedron (15), a rhombic prism (16).

The *irregular* forms presented by minerals are of very subordinate importance; so that a few of the more common need only be mentioned. Most of the terms used in reference to these, explain themselves.

Irregular mineral forms:—Globular or *nodular*, ex. quartz, iron pyrites; reniform or kidney-shaped, ex. quartz, &c.; botryoidal mammillated: a form made up of a series of rounded elevations and depressions, or otherwise exhibiting a surface of this character, ex. red and brown iron ore, calcedony, &c.; stalactitic, ex. calc spar, &c.; coralliform, resembling certain branching corals, ex. arragonite; dendritic or arborescent, a branching form, often made up of small aggregated crystals, ex. native silver, native copper, &c.; filiform or wire-like, ex. native silver; acicular, in needle-like crystallizations, ex. many varieties of augite, hornblende, epidote, &c. When a mineral has a perfectly indefinite shape it is said to be "massive" or "amorphous."

Structure :—In the majority of minerals, a certain kind of structure, or, in other words, the shape as well as the mode of aggregation of the smaller masses of which they are composed, is always observable. Structure in minerals may be either *lamellar, laminar* or *foliated, prismatic, fibrous, granular*, or *compact*. When the mineral, as in most varieties of calc-spar, heavy-spar, feldspar, and gypsum, for example. is made up of broad tabular masses producing a more or less stratified appearance, the structure is said to be lamellar. When the tabular masses (whether straight, wavy, or curved,) become extremely thin or leafy, as in mica more especially, the structure is said to be laminar, or foliated, or sometimes micaceous. The scaly structure is a variety of this, in which the laminæ are of small size. When the component masses are much longer than broad or deep, as in many specimens of tourmaline, beryl, calc-spar, &c., the structure is said to be prismatic or columnar. When the prismatic concretions become very narrow, the fibrous structure originates. Fibrous minerals may have either: a straight or parallel-fibrous structure, as in many specimens of gypsum, calc-spar, &c.; a confusedly-fibrous structure, as in many specimens of augite and hornblende; or a radiated-fibrous structure, as in the radiated varieties of iron pyrites, in natrolite, wavellite, &c.,—the fibres radiating from one or more central points. Minerals made up of small grains or granular masses are said to have a granular structure; ex. granular or saccharoidal limestone, granular gypsum, &c. Finally, when the component particles are not apparent, the mineral is said to have a compact structure, as in the native malleable metals, obsidian, and most varieties of quartz. Hard and vitreous minerals of a compact structure (ex. obsidian), generally show when broken, a *conchoidal fracture*, or a series of circular markings resembling the lines of growth on the external surface of a bivalve shell.

Almost all minerals, especially those of a lamellar structure, separate more readily in certain directions than in others. This peculiarity is called *cleavage*. The fragments resulting from "cleavage" have often a perfectly regular or definite form. Thus the purer specimens of calc-spar, no matter what their external form, break very readily into rhombohedrons, which measure 105°5' over their obtuse edges. Galena, the common ore of lead, yields rectangular or cubical cleavage forms; whilst the cubes of fluor-spar break off most readily at the corners or angles, and yield regular octahedrons, fig. 3.

Hardness.—The hardness of a mineral is its relative power of resisting abrasion, not that of resisting blows: many of the hardest minerals being exceedingly brittle. Practically, the character is of great importance. By its aid gypsum may be distinguished in a moment from calc-spar or limestone, calc-spar from feldspar, and copper pyrites from iron pyrites, not to mention other examples.* The degree of hardness in minerals is conventionally assumed to vary from 1 to 10 (1 being the lowest) as in the following scale drawn up by a German mineralogist, *Möhs*, and now generally adopted:

Scale of Hardness—Möhs' Scale.

1. Foliated Talc.
2. Rock Salt, a transparent cleavable variety.
3. Calcareous Spar, a transparent variety.
4. Fluor Spar.
5. Apatite.
6. Feldspar.
7. Rock Crystal.
8. Topaz.
9. Corundum.
10. The Diamond.

In order to ascertain the hardness of a mineral by means of this scale, we attempt to scratch the substance under examination, by the different specimens belonging to the scale; beginning with the hardest, in order not to expose the specimens to unnecessary wear. Or, we take a fine file, and compare the hardness of the mineral with that of the individual members of the scale, by drawing the file briskly across them. The comparative hardness is estimated by the resistance offered to the file; by the noise produced by the file in passing across the specimens; and by the amount of powder so

* Gypsum may be scratched by the finger nail. Calc-spar and copper pyrites may be scratched easily by a knife; whilst feldspar and iron pyrites are hard enough to scratch window-glass. Not long ago, as mentioned by Sir William Logan, a farmer in the Ottawa district was put to much expense and annoyance by mistaking feldspar for crystalline limestone, and attempting to burn it into lime.

obtained. The degree of hardness of the mineral is then said to be equal to that of the member of the scale with which it agrees the nearest. Thus, if the mineral agrees in hardness with Fluor-spar we say, in its description, H (or hardness) =4. If, on the other hand, it be somewhat softer than fluor-spar, but harder than calcareous spar, we say, H=3.5. Finally, if, as frequently happens, the hardness of a mineral vary slightly in different specimens, the limits of the hardness are always stated. Thus, if in some specimens, a mineral agree in hardness with calc-spar, and in others with fluor-spar, we say, H = 3 to 4; or, more commonly, H = 3 — 4. If the hardness be very rigorously tested, it will frequently be found to differ slightly on different faces of a crystallized specimen, or on the broad faces and the edges of the laminæ of foliated specimens,—but this, so far as regards the simple determination of minerals, is practically of little moment.

As the minerals of which the scale of Möhs consists, may not be in all places obtainable, or always at hand when required, the author of this paper contrived some years ago another scale, agreeing closely enough for practical purposes with that of Mohs, and exacting for its application only such objects as are always to be met with. The following is the scale in question; its use explains itself:

Chapman's Convenient Scale of Hardness, to correspond with that of Möhs.

1. Yields easily to the nail.
2. Does not yield to the nail. Does not scratch a copper coin.
3. Scratches a copper coin, but is also scratched by one, being of about the same degree of hardness.
4. Not scratched by a copper coin. Does not scratch glass (ordinary window-glass).
5. Scratches glass very feebly. Yields easily to the knife.
6. Scratches glass easily. Yields with difficulty to the knife.
7. Does not yield to the knife. Yields with difficulty to the edge of a file.

8, 9, 10. Harder than flint or rock-crystal.

Convenient terms of comparison for degrees of hardness above No. 7 cannot be easily obtained; but that is of little consequence, as there are but few minerals of common occurrence which exhibit a higher degree; and these are readily distinguished by other characters. Where, in the above scale, two terms of comparison are employed, both must of course be attended to in the determination of the hardness.

Specific Gravity.—This is also a character of great value in the determination of minerals. The specific gravity of a body is its weight compared with the weight of an equal bulk of pure water. In order to ascertain the specific gravity of a mineral we weigh the specimen first in air and then in water. The loss of weight in the latter case exactly equals the weight of the displaced water, or, in other words, of a volume of water equal to the volume of the mineral. Now, the specific gravity of pure water, at a temperature of about 62°, being assumed to equal 1, or unity, it follows that the specific gravity of a mineral is obtained by dividing its weight in air by its loss of weight in water. Thus, if $a =$ the weight in air, and $w =$ the weight in water, G, or $sp.\ gr. = \frac{a}{a-w}$.

Example.—A piece of calcareous spar weighs 66 grs. in air, and 42 grs. when immersed in rain or distilled water. Hence its sp. gr. $= \frac{66}{66-42} = \frac{66}{24} = 2.75$.*

The weight of the mineral may be ascertained most conveniently and with sufficient exactness for general purposes, by a pair of small scales such as are commonly called "apothecaries' scales." These may be purchased for a couple of dollars, or even less. A small hole must be made in the centre of one of the pans for the passage of a horse-hair or silken fibre, about four inches in length, and furnished at its free end with a "slip-knot" or running noose, to hold the specimen whilst it is being weighed in water. The strings of the perforated pan may also be somewhat shortened, but the balance must in this case be brought into equilibrium by a few strokes of a file on the under side of the other pan, or by attaching thinner strings to it. If grain weights be used with this balance, the following will be required : 50 grs., 30, 20, 10, 5, 3, 2, 1, 0.5, 0.3, 0.2, 0.1.

The specific gravity bottle often recommended in mineralogical works, is too heavy to be carried by the scales described above. Bottles of the smallest capacity, weigh, when filled with water, at least 500 grains; and these scales will not carry more than 200, or 250 grains at the most. They are not very sensitive, indeed, when

* This is the maximum specific gravity of calcareous spar.

loaded with more than 50 or 60 grains in each pan, although often of great delicacy when carrying lesser weights. The use of the sp. gr. bottle requires a chemical balance, costing, at the very lowest, some twenty-five or thirty dollars, besides being of difficult portability; and hence its employment for general purposes is scarcely available.

Relative Malleability.—Some few minerals, as native gold, native silver, sulphide of silver, native copper, &c., are *malleable* or *ductile*, flattening out when struck, instead of breaking. A few other minerals, as talc, serpentine, &c., are *sectile*, or admit of being cut by a knife; whilst the majority of minerals are *brittle*, or incapable of being cut or beaten out without breaking. In testing the relative malleability of a mineral, a small fragment should be placed on a little anvil, or block of steel polished on one of its faces,* and struck once or twice by a light hammer. To prevent the fragment from flying off when struck, it may be covered by a strip of thin paper, held down by the forefinger and thumb of the left hand. Thus treated, malleable bodies flatten into discs or spangles, whilst brittle ones break into powder.

Magnetism.—Few minerals attract the magnet in their natural condition, although many do so after exposure to the blowpipe. (See below.) In trying if a mineral be magnetic, we chip off a small fragment, and apply to it a little horse-shoe magnet, such as may be purchased anywhere for a quarter of a dollar; or otherwise we apply the specimen to a properly suspended magnetic needle In this manner the black granular masses which occur frequently in our gneissoid or Laurentian rocks, and in the boulders derived from them, may easily be recognised as magnetic iron ore.† Many specimens of magnetic iron ore (and also of magnetic pyrites) exhibit "polarity," or attract from a given point, one end of the needle, and repel the other.

Taste.—This is a very characteristic although limited property, being exhibited only by a few soluble minerals. In these, the taste may be saline, as in rock salt; or bitter, as in Epsom salt; or metallic, as in sulphate of iron, and so forth.

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* The little anvils called "Watch-makers' anvils," are very suitable for this purpose. They may be purchased (where Watch-makers' tools are sold) for half-a-dollar, or even less.

† The other dark-coloured cleavable masses in these rocks consist of mica or more rarely of hornblende.

Chemical Characters.*—These, so far as regards the determination of mineral species, comprise the results produced by the action of acids; and the relative fusibility, &c., of minerals, as ascertained by the employment of the blow-pipe.

Action of Acids.—The acid-test is resorted to, chiefly for the purpose of distinguishing the *carbonates* from other mineral substances. The majority of carbonates, as carbonate of lime, carbonate of oxide of copper, &c., when touched with a drop of diluted hydrochloric acid (the "spirit of salt" of the shops), produce a more or less vigorous effervescence. This reaction is still more marked, if a small fragment of the mineral be dropped into a test-tube containing a little of the acid. The effervescence arises from the escape of carbonic acid. Some carbonates, as carbonate of iron, dissolve very slowly, and scarcely produce any effervescence, unless employed in a pulverised state, or unless the acid be gently heated. Sulphate of lime and various other minerals dissolve in hydrochloric acid, but without causing effervescence. Quartz, feldspar, &c., on the other hand, are quite insoluble. Certain silicates, and more especially those named "zeolites" dissolve partially in hot hydrochloric acid, leaving the undissolved silica in the form of a gelatinous mass. Gold and platinum are not attacked by strong nitric acid, which dissolves copper, silver, &c., very readily. Cupreous acid-solutions have always a green or blue colour. Red copper ore dissolves with effervescence in nitric acid producing a coloured solution; by which characters it may be readily distinguished from the red silver ores.

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* The Chemical Characters of minerals are discussed in the present paper in the briefest terms. To have entered fully into these characters, would have carried us altogether beyond the object in view: the simple determination of the names of Canadian minerals. The advanced lectures given daily during the Michaelmas Term in University College, Toronto, by the author, are open to all students desirous of obtaining more ample information on the subject. The annexed extract is taken from the author's syllabus to this course of lectures:

"THE CHEMICAL RELATIONS OF MINERALOGY.

"*The Chemical Constitution of Minerals.*—1, Chemical Nomenclature as applied to Mineralogy; 2, The Laws of Combination; 3, The Atomic Theory: 4, Chemical Notation: 5, Construction of Chemical Formulæ; 6, Isomorphism, or Law of Substitution; 7, Atomic Volumes.

"*The Chemical Examination of Minerals.*—1, Action of Acids, &c. 2, Employment of the Blow-pipe, comprising: *a*, Instruments and Appliances; *b*. Reagents; *c*, Operations; *d*, Reactions; and *e*, Plan of Analysis in the examination of an unknown substance."

Students attending these lectures, are strongly advised to go through, also, a course of Practical Chemistry, in the Laboratory of University College, under the direction of Professor Croft.

The acids used in these experiments may be conveniently kept in small glass bottles furnished with a long glass stopper, reaching to the bottom of the bottle, and with a glass cap to prevent the escape of corrosive fumes. For geological purposes (testing calcareous rocks, &c.,) strong hydrochloric acid diluted with half its bulk of pure water, is principally used. The "specimen basket" may be provided near its upper edge with a little nest, or wicker-work pocket, for the reception of the acid bottle.

Action of the Blow-pipe.—The blow-pipe in its simplest form is merely a narrow tube of brass or other metal, bent round at one extremity, and terminating at that end in a point with a very fine orifice (*a:* fig. 21). If we place the pointed end of this instrument just within the flame (and a little above the wick) of a lamp or common candle, and then blow gently down the tube, the flame will be deflected into a horizontal position, and its heating powers will be wonderfully increased. Many minerals when held in the form of a thin splinter at the point of the blow-pipe flame, melt with the greatest ease; and some are either wholly or partially volatilized. Other minerals, on the contrary, remain unaltered; and thus, by the aid of the blow-pipe, we are often enabled to distinguish from one another, in a moment, various minerals which in external characters may be closely alike.*

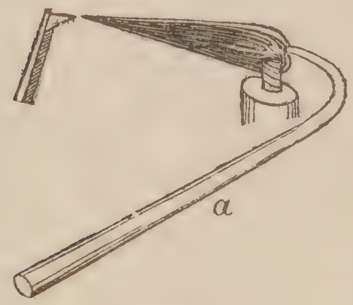

FIG. 21.

The blow-pipe has, strictly, a three-fold application. It may be employed, as just pointed out, to distinguish minerals from one another; some of these being fusible, whilst others are infusible; some attracting the magnet after exposure to the blow-pipe, whilst others do not exhibit that reaction; some imparting a colour to the flame, others volatilizing, and so forth. Secondly, the blow-pipe may be employed to ascertain the general composition of a mineral, or the presence or absence of some particular substance in it, as copper, lead, iron, cobalt, manganese, sulphur, arsenic, and the like. Thirdly, the blow-pipe may be used to determine in certain special

* More convenient forms of blow-pipe will be found described in special works on the use of that instrument, but the common form described above is quite sufficient for the simple experiments required in the determination of our ordinary minerals.

cases the actual amount of a metallic or other ingredient previously ascertained to be present in the substance under examination.*

In the employment of the blow-pipe (in conjunction with external characters) in the simple determination of our Canadian minerals, we are never compelled to resort to more than two experiments: the *fusion-trial*, and the *water-test*. The student will find it of advantage, however, to study in addition the reactions of the more common metals and metallic oxides as given in special works on the Blow-pipe. To describe these reactions in the present essay would extend the subject much beyond its allotted limits.

The Trial of Fusibility.—In order to ascertain the relative fusibility of a substance, we chip off a small particle (the smaller the better) and expose the point of this to the extremity of the blow-pipe flame —holding the test-fragment in a small pair of tongs or forceps with platinum tips;† or supporting it, if it be of a metallic aspect or of a certain weight and exhibit at the same time a coloured streak, on a piece of well-burnt pine charcoal. The particle thus exposed to the flame ought not to be larger than a small carraway seed. If it be fusible, its point, in the course of ten or fifteen seconds, will become rounded into a bead or globule. The proper method of blowing can be acquired by half-an-hour's practice. The cheeks are to be filled with air, and this is to be urged *gently* and continuously down the tube by the compression of the cheek muscles, the operator breathing at the same time (if he require to do so) through his nose. By a little practice this becomes exceedingly easy; and the blowing need never be kept up (at least in experiments of this kind) for more than a quarter of a minute at a time. A *thin splinter* will exhibit signs of fusion in ten or twelve seconds, or not at all. The use of the instrument, therefore, is easily acquired, and is in no way injurious to the health.

Thus treated:

(*a*) The test-fragment may "decrepitate" or fly to pieces. Example, most specimens of galena. In this case, a larger fragment

* See, for example, a paper by the author "on the Assaying of Coals by the Blow-pipe," first published in this Journal: Vol. III., page 208. Also Plattner's "Probirkunst mit dem Lothröhre."

† These forceps may be obtained from any dealer in chemical apparatus. For simple experiments they may be replaced by a strip of thin sheet iron bent into the form of a pair of nippers or tongs. Some twine or silk must be twisted round the middle part to prevent the fingers from being burned.

must be heated in a test-tube over a small spirit lamp, and after decrepitation has taken place, one of the resulting fragments may be exposed to the blow-pipe flame as already explained.

(*b*) The test-fragment may change colour (with or without fusing) and become attractable by a magnet. Example, carbonate of iron. This becomes first red, then black, and attracts the magnet, but does not fuse. Iron pyrites on the other hand becomes black and magnetic, but fuses also.

(*c*) The test-fragment may colour the flame. Thus, most copper compounds impart a rich green colour to the flame; compounds containing baryta, and many phosphates and borates, with the mineral molybdenite, colour the flame pale green; sulphur, selenium, lead, and chloride of copper colour the flame blue of different degrees of intensity; compounds containing strontia and lithia impart a crimson colour to the flame; some lime compounds impart to it a paler red colour; soda compounds, a deep yellow colour; and potash compounds, a violet tint.

(*d*) The test-fragment may become caustic. Example, carbonate of lime. The carbonic acid is burned off, and caustic lime remains. This restores the blue colour of reddened litmus paper. It also imparts if moistened, a burning sensation to the back of the hand or other sensitive part.

(*e*) The test-fragment may take fire and burn. Example, native sulphur; common bituminous coal, &c.

(*f*) The test-fragment may "volatilize," or dissipate in fumes, either wholly or partially, and with or without an accompanying odor. Thus, grey antimony ore volatilizes with dense white fumes; arsenical pyrites volatilizes in part, with a strong odor of garlic; common iron pyrites yields an odour of brimstone, and so forth.

(*g*) The test-fragment may fuse, either wholly, or only at the point and edges; and the fusion may take place quietly, or with bubbling, and with or without a previous "intumescence" or expansion of the fragment. Most of the so-called zeolites, for example, (minerals abundant in Trap rocks), swell or curl up on exposure to the blow-pipe, and then fuse quietly. Lepidolite fuses with great bubbling, and colours the flame red. Feldspar only melts on the edges, at least, in ordinary cases.

(*h*) The test-fragment may remain unchanged. Example, Quartz, and various other infusible minerals.

The Water-test.—Many solid minerals contain a considerable amount of water, or the elements of water, in some unknown physical condition. Gypsum, for example, contains 20.93 per cent. of water. In order to ascertain if a substance yield water, we chip off a fragment (of about the size of a small pea) and heat this in a common test-tube (or better, in a small "bulb-tube" or glass tube closed and expanded at one end, as shown in the accompanying figure) over the flame of a little spirit lamp. If water be present, it will rise and condense in the form of a thin film, or in small drops, on the cold neck or upper part of the tube. When the moisture begins to appear, the tube must be held in a more or less horizontal position, otherwise a fracture may be occasioned by the water flowing down and coming in contact with the hot glass. A small spirit lamp may be made by fitting a piece of glass tubing an inch long (to serve as a wick holder) into the cork of any short, stout bottle. A proper lamp, however, with a glass cap to prevent the evaporation of the spirit when the lamp is not in use, can be purchased for a quarter of a dollar.

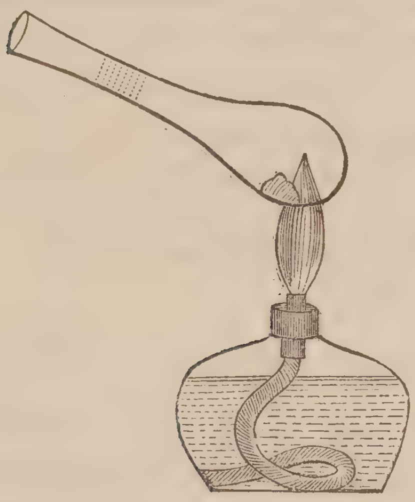

FIG. 22.

This concludes our review of the more common characters possessed or exhibited by mineral bodies. The application of these characters to the actual determination of Canadian minerals, by means of an original Tabular Distribution or Arrangement, will be shewn in the next number of the *Journal*.

ERRATA.

Figure 7 (on page 7) has been accidentally printed in a reversed position.

Page 5, line 17, *for* "realgar, or sulphide of arsenic," *read* "realgar, a sulphide of arsenic."

Page 15, line 5 from bottom, *for* "which," *read* "whilst this."

RESOLUTION OF ALGEBRAICAL EQUATIONS.

Proof of the impossibility of representing in finite algebraical functions, in the most general case, the roots of algebraical equations of degrees higher than the fourth; with methods for finding the roots of equations of the 5th, 6th, 7th, &c., degrees, in those cases where the coefficients in the given equations involve a general or variable quantity, but where, in consequence of relations subsisting between the coefficients, the roots of the equations happen to admit of being exactly represented in finite algebraical functions.

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Read before the Canadian Institute, 19*th February*, 1859.

Definitions.

Def. 1. In the functions which are to be considered, a variable is involved; and, when quantities are spoken of as rational or irrational, the meaning always is, rational or irrational *with respect to the variable.* Thus, c being constant, and p variable, the former of the expressions, $c + \sqrt{p}$, $\sqrt{c + p}$, is surd or irrational; and the latter, rational.

Def. 2. Surds may be distinguished as *of different orders.* The n^{th} root of a rational expression, n being a prime number, distinct from unity, is a surd of the first order. But the n^{th} root of a rational expression, when $n = n_1 n_2 n_3 \ldots n_s$, each of the numbers, n_1, n_2, &c., being a prime number distinct from unity, is a surd of the s^{th} order. Again, the n^{th} root of an expression involving surds of the s^{th} order, but of no higher order, when $n = n_1 n_2 n_3 \ldots n_t$, each of the numbers, n_1, n_2, &c., being a prime number distinct from unity, is a surd of the $(s+t)^{th}$ order, and so on. Thus, the first of the expressions,

$$(c+p)^{\frac{1}{12}},\ \left\{(c+p)^{\frac{1}{12}}+p\right\}^{\frac{2}{3}},\ c^{2}+\left[\left\{(c+p^{\frac{1}{6}})^{\frac{1}{2}}+p^{\frac{1}{16}}\right\}^{\frac{1}{3}}+\sqrt{p}\right]^{\frac{1}{33}},$$

is a surd of the third order; the second, of the fourth order; and the third, of the seventh order.

Def. 3. Every surd of a certain order is formed by the extraction of some root, (as the n^{th}), of an expression involving only surds of the order immediately inferior, n being a prime number, When we speak of *the index of the surd* so formed, the fraction $\frac{1}{n}$ is meant. For instance, if we regard $(c+p)^{\frac{1}{15}}$ as generated by the extraction of the fifth root of $(c+p)^{\frac{1}{3}}$, it is a surd of the second order, with the index $\frac{1}{5}$. From another point of view, it might be described as a surd of the second order, with the index $\frac{1}{3}$.

Def. 4. In the case of a surd of a certain order, we may distinguish *the principal surd* from its *subordinates*. Thus, under the principal surd, $(c+\sqrt{p})^{\frac{1}{3}}$, is involved the subordinate $\sqrt{p}$. Under the principal surd,

$$\left[\left\{c+(1+p^2)^{\frac{5}{7}}\right\}^{\frac{1}{8}}+(2+p)^{\frac{2}{5}}\right]^{\frac{1}{2}},$$

c being a constant quantity, are involved the subordinates,

$$(1+p^2)^{\frac{1}{7}},\ (2+p)^{\frac{1}{5}},\ \left\{c+(1+p^2)^{\frac{5}{7}}\right\}^{\frac{1}{2}},$$
$$\left\{c+(1+p^2)^{\frac{5}{7}}\right\}^{\frac{1}{4}},\ \left\{c+(1+p^2)^{\frac{5}{7}}\right\}^{\frac{1}{8}};$$

the first appearing in the principal surd only in its fifth power; and the second only in its second power. A surd which is a subordinate of the surd Y, but is not a subordinate of any surd which is itself subordinate to Y, may be termed a *chief subordinate* of Y; while those surds which are subordinates of surds subordinate to Y may be called *secondary subordinates* of Y.

Def. 5. An *integral function* of a variable is one in which no surd, principal or subordinate, occurs as the denominator, or a term in the denominator, of a fraction. For instance, c being constant, and p variable, the first of the expressions,

$$\frac{\sqrt{p}}{\sqrt{c}},\quad \left(c^2+\frac{1}{c+\sqrt{p}}\right)^{\frac{1}{3}},\quad c+\frac{1}{\sqrt{p}},$$

is an integral function of p; but the two last are not.

Cor. A given algebraical function $f(p)$ of a variable p always admits of being exhibited as an integral function. For, reduce the function to the form $\frac{N}{D}$; where each of the quantities N and D is the sum of a rational expression, which may be zero, and of a finite series of terms, each of them the product of a rational coefficient by some power of an integral surd, or by the continued product of several such powers. Take Y, one of the surds of highest order present in any of its powers in the function; and arrange the terms in N and D according to the powers of Y not exceeding the $(m-1)^{\text{th}}$, $\frac{1}{m}$ being the index of the surd Y. Then

$$f(p)=\frac{a+a_1 Y+a_2 Y^2+\ldots+a_{m-1} Y^{m-1}}{b+b_1 Y+b_2 Y^2+\ldots+b_{m-1} Y^{m-1}};$$

where the coefficients, b, a, b_1, a_1, &c., may involve powers of any surd in $f(p)$, except Y. No powers of Y higher than the $(m\text{-}1)^{\text{th}}$ are written; because, for instance, if there were a term AY^{m+2} in the numerator, A being an expression clear of the said Y, it might be written, $(AY^m)Y^2$. But Y^m may be written so as to involve only the subordinate surds of Y; and hence the term AY^{m+2} may be considered as contained in the term, $a_2 Y^2$. Assume

$$\frac{a+a_1 Y+\&c.}{b+b_1 Y+\&c.}=c+c_1 Y+\ldots\ldots+c_{m-1} Y^{m-1};$$

and, when the expressions, $b+b_1 Y+\&c.$, $c+c_1 Y+\&c.$, are multiplied by one another, let the product, arranged according to the powers of Y not exceeding the $(m\text{-}1)^{\text{th}}$, be, $d+d_1 Y+\&c.$; where d, d_1, &c., are clear of the surd Y. Then

$$a+a_1 Y+\&c=d+d_1 Y+\ldots\ldots+d_{m-1} Y^{m-1}.$$

Determine the m unknown quantities, $c, c_1, \ldots\ldots, c_{m-1}$, by the m simple equations,

$$d=a,\ d_1=a_1, \ldots\ldots,\ d_{m-1}=a_{m-1}.$$

Then the function may be written,

$$f(p)=c+c_1 Y+c_2 Y^2+\&c.;$$

where the coefficients, c, c_1, &c., are clear of the surd Y. Again, let a surd of the highest order present in any of its powers in the coefficients c, c_1, &c., be V; and its index $\frac{1}{n}$. By the process already exemplified, we may find, for each of the coefficients, c, c_1, &c., an equivalent expression such as

$$h+h_1 V+h_2 V^2+\ldots\ldots+h_{n-1} V^{n-1};$$

where h, h_1, &c., are clear of the surds V and Y. Let it be remarked, that, in consequence of our having commenced with Y, a surd of the highest order in $f(p)$, it is impossible, after Y has once been disposed of, as above, that it can ever return upon our hands, as it might do, if it were a subordinate of any of the principal surds in c, c_1, &c. From the same consideration we selected V, a surd of the highest order in c, c_1, &c. We may obviously go on in the manner described, till we have exhausted all the surds that need to be disposed of, in order to make the expression for $f(p)$ altogether an integral function of p.

Def. 6. Let $f(p)$ be an algebraical function of a variable p. Instead of Y_1, a surd of the lowest order in f (p), having the index $\frac{1}{m}$, write z_1Y_1 in every place where Y_1 occurs in $f(p)$ in any of its powers, z_1 being an indefinite m^{th} root of unity. Do in like manner with all the other surds of the lowest order. Again, Y_2 being a surd of the order next to the lowest in $f(p)$ thus altered, having $\frac{1}{n}$ for its index, and z_2 being an indefinite n^{th} root of unity, write z_2Y_2 for Y_2 in every place where Y_2 occurs in the function in any of its powers. Proceed in this way, till modifications of the kind described have been made upon all the surds in the function, including those of the highest order; and let the function, after having suffered all these changes, become $\phi(p)$. Denote by ϕ_1, ϕ_2, ϕ_3,......, ϕ_λ, the values of $\phi(p)$, not necessarily all unequal, that result from taking all the possible values of the indefinite numerical quantities, z_1, z_2, &c., which have been introduced into the function. These expressions, ϕ_1, ϕ_2, &c., may be termed the *cognate functions* of $f(p)$.

As it is important that a clear apprehension be formed of the manner in which we understand the terms ϕ_1, ϕ_2, &c., we subjoin illustrative examples. Let

$$f(p)=(1+\sqrt{p})^{\frac{1}{3}}+(1+\sqrt{p})^{\frac{2}{3}}.$$

$$\text{Then, } \phi(p)=z_2(1+z_1\sqrt{p})^{\frac{1}{3}}+z_2(1+z_1\sqrt{p})^{\frac{2}{3}}.$$

Here there are, including $f(p)$, six cognate functions;

$$f(p)=\phi_1=(1+\sqrt{p})^{\frac{1}{3}}+\quad(1+\sqrt{p})^{\frac{2}{3}};$$

$$\phi_2=z\ (1+\sqrt{p})^{\frac{1}{3}}+z^2(1+\sqrt{p})^{\frac{2}{3}};$$

$$\phi_3=z^2(1+\sqrt{p})^{\frac{1}{3}}+z\ (1+\sqrt{p})^{\frac{2}{3}};$$

$$\phi_4 = (1-\sqrt{p})^{\frac{1}{3}} + (1-\sqrt{p})^{\frac{2}{3}};$$
$$\phi_5 = z(1-\sqrt{p})^{\frac{1}{3}} + z^2(1-\sqrt{p})^{\frac{2}{3}};$$
$$\phi_6 = z^2(1-\sqrt{p})^{\frac{1}{3}} + z(1-\sqrt{p})^{\frac{2}{3}};$$

where z is a definite third root of unity, distinct from unity. In the three first of these equations, in order that ϕ_1, ϕ_2, and ϕ_3, may be definite, we must take a definite value of $\sqrt{p}$, and then also a definite value of $(1+\sqrt{p})^{\frac{1}{3}}$. As a new surd, $(1-\sqrt{p})^{\frac{1}{3}}$, occurs in the three last equations, we must fix upon some definite value of this surd, retaining the definite value already assigned to $\sqrt{p}$; and then ϕ_4, ϕ_5, and ϕ_6, will be definitely determined. Had we assumed

$$f(p) = (p+\sqrt{p^2-1})^{\frac{1}{3}} + (p-\sqrt{p^2-1})\,(p+\sqrt{p^2-1})^{\frac{2}{3}},$$

we should have got six cognate functions; but three of them merely a repetition of the other three; for the three which result from taking $\sqrt{p^2-1}$ with the negative sign are the same as those which result from taking it with the positive sign.

Def. 7. Suppose that we form the cognate functions of $f(p)$, as described in the previous definition, with this difference, that we now proceed as though certain surds, Y_1, Y_2, &c., (in such a series all the subordinates of any surd mentioned are necessarily included), were rational. In other words, attach no indefinite numerical multipliers, (as z_1, z_2, &c.,) to any of the surds, Y_1, Y_2, &c.; but consider each of these surds as having a single definite value. The cognate functions of $f(p)$, so obtained, may be termed the cognate functions of $f(p)$, *taken without reference to the surd character of the surds* Y_1, Y_2, &c. For instance, let

$$f(p) = (2+p^{\frac{1}{5}})^{\frac{1}{7}} + (1+\sqrt{p})^{\frac{1}{3}} + (1+\sqrt{p})^{\frac{2}{3}} + \sqrt{p};$$

then the cognate functions of $f(p)$, taken without reference to the surd character of the surds, $\sqrt{p}$, $p^{\frac{1}{5}}$, $(2+p^{\frac{1}{5}})^{\frac{1}{7}}$, are,

$$\phi_1 = (2+p^{\frac{1}{5}})^{\frac{1}{7}} + (1+\sqrt{p})^{\frac{1}{3}} + (1+\sqrt{p})^{\frac{2}{3}} + \sqrt{p};$$
$$\phi_2 = (2+p^{\frac{1}{5}})^{\frac{1}{7}} + z(1+\sqrt{p})^{\frac{1}{3}} + z^2(1+\sqrt{p})^{\frac{2}{3}} + \sqrt{p};$$

$$\phi_3=(2+p^{\frac{1}{5}})^{\frac{1}{7}}+z^2(1+\sqrt{p})^{\frac{1}{3}}+z\,(1+\sqrt{p})^{\frac{2}{3}}+\sqrt{p};$$

z being a definite third root of unity.

Def. 8. Let $f(p)$ be an integral function of a variable p; and suppose, that, if Y be any surd whatever, principal or subordinate, occuring in the function in its c^{th} power, and having (see Def. 3) the index $\frac{1}{s}$, c is less than s. Also, the form of the function being,

$$f(p)=A+A_1Y_1+A_2Y_2+\ldots\ldots+A_mY_m,$$

where the coefficients A, A_1, &c., are (see Def. 1) rational, and each of the terms Y_1, Y_2, &c., is either some power of an integral surd, or the continued product of several such powers, suppose that no two of the terms, Y_1, Y_2, &c., are identical. Finally, if V be any surd, principal or subordinate, occurring in the function in its n^{th} power, and if the form of V^n be,

$$V^n=(B+B_1Y_1+B_2Y_2+\ldots\ldots+B_cY_c)^{\frac{n}{r}},$$

where the coefficients, B, B_1, &c., are rational, and each of the terms, Y_1, Y_2, &c., is either some power of an integral surd, or the continued product of several such powers, the index of the surd V being $\frac{1}{r}$, suppose that no two of the quantities, Y_1, Y_2, &c., are identical. When these conditions are satisfied, the function $f(p)$ may be described as satisfying the conditions of Def. 8.

Cor. Any given algebraical function $f(p)$ of a variable p admits of being exhibited so as to satisfy the conditions of the Definition. For should a surd Y, principal or subordinate, with the index $\frac{1}{s}$, occur in the function in its c^{th} power, c not being less than s, let ws be the greatest multiple of s in c; the excess of c above ws, (which may be zero), being k. Then we may replace Y^c by $(Y^{ws})\,Y^k$; and, since the index of the surd Y is $\frac{1}{s}$, Y^{ws} may be written out so as to involve only the subordinate surds of Y. Thus the violation of the first condition of the Definition, involved in the term Y^c, is got quit of. For instance,

$$Y^c=(1+\sqrt{p})^{\frac{8}{5}}=(1+\sqrt{p})^{\frac{3}{5}}+\sqrt{p}\,(1+\sqrt{p})^{\frac{3}{5}}.$$

Next, should any such quantities as Y_1, Y_2, &c., (see above), be identical, the terms containing the identical quantities, as described, may be combined into a single term. For instance,

$$f(p)=p+\left\{1+p\sqrt{p}+p^{2}\sqrt{p}\right\}^{\frac{1}{3}}+p\left\{1+p\sqrt{p}+p^{2}\sqrt{p}\right\}^{\frac{1}{3}}$$

$$=p+(1+p)\left\{1+(p+p^2)\sqrt{p}\right\}^{\frac{1}{3}}.$$

Def. 9. An irrational function, $f(p)$, of a variable p, is said to be *in a simple form*, when no equation such as,

$$A+BU+CV+\ldots\ldots+DY+\ldots\ldots+ET=0, \ldots\ldots\ldots\ldots(1)$$

can subsist; where the coefficients, B, C, ..., E, all of them distinct from zero, are (see Def. 1) rational; A likewise being rational; and each of the terms, U, V, ..., T, is either some power of an integral surd occurring in $f(p)$, or the continued product of several such powers; the expression on the left hand side of the equation satisfying the conditions of Def. 8. Let it be observed, that, in this paper, when we speak of a surd occurring in a function, we mean that the surd appears in the function, as a principal or subordinate surd, in some one or more of its powers, but not necessarily in the first power. Thus, the surds which occur in the function,

$$p+\sqrt{7}+(p-\sqrt{p^2-1})^{\frac{2}{7}}+(p-\sqrt{p^2-1})^{\frac{5}{7}},$$

are, $\sqrt{p^2-1}$, and, $(p-\sqrt{p^2-1})^{\frac{1}{7}}$. The first occurs in its first power; the second, in its second and fifth powers. This being kept in view, we may instance, as violating the condition above mentioned, the function,

$$f(p)=(p+\sqrt{p^2-1})^{\frac{1}{3}}+(p-\sqrt{p^2-1})^{\frac{1}{3}} \ldots\ldots\ldots\ldots(2)$$

For the equation, of the form (1), subsists:

$$(p-\sqrt{p^2-1})^{\frac{1}{3}}-(p+\sqrt{p^2-1})^{\frac{2}{3}}(p-\sqrt{p^2-1})=0.$$

Hence $f(p)$, as exhibited in (2), is not in a simple form.

Cor. 1. The Definition implies, that, should an irrational function of a variable p, in a simple form, and equal to zero, present itself in the form,

$$f(p)=A+BU+CV+\ldots\ldots+ET,$$

where U, V, &c., are terms of the same kind as in equation (1), and

A, B, &c., are rational, the coefficients A, B, &c., must vanish separately. Also, should $f(p)$ be of the form,

$$f(p) = A + A_1 V_1 + A_2 V_2 + \ldots\ldots + A_c V_c,$$

where each of the terms, V_1, V_2, &c., no two of them identical with one another, is either some power of an integral surd, or the continued product of several such powers, while the expressions A, A_1, &c., involve only surds distinct from those whose powers constitute the factors of the terms V_1, V_2, &c., then [it being understood, as before, that $f(p)$ is in a simple form and equal to zero] the cofficients A, A_1, &c., must vanish separately.

Cor. 2. If $f(p)$, a function of a variable p, be in a simple form, and if

$$A + A_1 Y_1 + A_2 Y_2 + \ldots + A_c Y_c = B + B_1 U_1 + B_2 U_2 + \ldots + B_m U_m ; \ldots (3)$$

where A_1, B_1, A_2, B_2, &c., none of them being zero, are rational; A and B also being rational; and each of the expressions, Y_1, U_1, Y_2, U_2, &c., is either some power of an integral surd occuring in $f(p)$, or the continued product of several such powers; the expressions, $A + A_1 Y_1 +$ &c., $B + B_1 U_1 +$ &c., having been arranged so as severally to satisfy the conditions of Def. 8; then the surd parts,

$$Y_1, Y_2, \ldots\ldots\ldots, Y_c, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

are identical, taken in same order, with the surd parts,

$$U_1, U_2, \ldots\ldots\ldots, U_m ; \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

and, U_1 being the part identical with Y_1, the rational coefficient B_1 is equal to the rational coefficient A_1. What we mean by *identical with*, as distinguished from *equal to*, may be shown by an example. The surd $\sqrt{p^2-1}$ is equal to the product of the two surds, $\sqrt{p+1}$, $\sqrt{p-1}$. But the expressions, $\sqrt{p^2-1}$, $\sqrt{p+1}$ $\sqrt{p-1}$, are not identical; because the only surd which appears in the former is not found in the latter; and the surds which constitute the factors of the latter do not appear in the former. The truth of the Corollary may thus be shown. Should any term in (4), as Y_1, be identical with a term in (5), as U_1, let the two terms, A_1Y_1 and B_1U_1, in (3), the latter removed to the left hand side of the equation, be written as one term, $Y_1(A_1 - B_1)$. No other term in (5) can be identical with Y_1, for then it would also be identical with U_1; but since the expression, $B + B_1U_1 +$, &c., satisfies the conditions of Def. 8, no two terms in

(5) are identical. If U_2 be identical with a term in (4), necessarily distinct from Y_1, let that term be Y_2; and let the two terms, $A_2 Y_2$ and $B_2 U_2$, in (3), the latter removed to the left hand side of the equation, be written, $Y_2 (A_2 - B_2)$. Make all other such modifications as are possible. Then equation (3) becomes,

$$(A - B) + Y_1(A_1 - B_1) + \ldots\ldots + A_a Y_a - B_n U_n + \&c. = 0 ; \ldots\ldots (6)$$

where all the terms, Y_1, Y_a, U_n, &c., are distinct; so that the expression on the left-hand side of equation (6) satisfies the conditions of Def. 8. Therefore, by Cor. 1, the coefficients, $A_1 - B_1, \ldots\ldots, A_a, B_n$, &c., vanish separately. But, since the terms A_1, B_1, &c., are all (by hypothesis) distinct from zero, this shows that there are, in fact, no such terms in (6) as those which we have written, $A_a Y_a$, $- B_n U_n$. Hence the terms in (4) are identical, taken in same order, with those in (5). Also, Y_1 being identical with U_1, we have seen that A_1 is equal to B_1.

Proposition I.

If $f(p)$ be an integral function of a variable p, not in a simple form, then an equation,

$$Y_c = P Y_1^{\lambda_1} Y_2^{\lambda_2} \ldots\ldots Y_a^{\lambda_a} \ldots\ldots\ldots\ldots (1)$$

must subsist; where Y_c, Y_1, &c., are surds, principal or subordinate, occurring in $f(p)$, of the same order, and with a common index $\frac{1}{s}$; λ_1, λ_2, &c., being whole numbers, less than s; while P is an expression involving only such surds, occurring in $f(p)$, as are of lower orders than the surds Y_c, Y_1, &c.

For, since $f(p)$ is not in a simple form, an equation such as (1), Def. 9,

$$A + BU + CV + \ldots\ldots + DY + \ldots\ldots + ET = 0, \ldots\ldots (2)$$

subsists; all the surds involved in the equation being surds present in $f(p)$. Let

$$Y_c = P Y_1^{\lambda_1} Y_2^{\lambda_2} \ldots\ldots Y_a^{\lambda_a} \ldots\ldots\ldots\ldots (3)$$

be an equation such as (1), with this difference, that the indices of the surds Y_c, Y_1, &c., are not assumed to be equal to one another; but λ_1 is less than the denominator of the index of Y_1, λ_2 less than the denominator of the index of Y_2, and so on. Of the terms, U, V, ……, T, in (2), let those which involve among their factors surds of the highest order in equation (2), be, U, V, ..., Y; and let the sum of A and of those terms, such as E T, in (2), which do not involve surds of the highest order present in (2), be H. Then

$$H + BU + CV + \dots\dots\dots + DY = 0.$$

Again, let

$$U = H_1 X_1, V = H_2 X_2, \dots\dots\dots, Y = H_a X_a;$$

where X_1 is the continued product of those factors of U, which are powers of surds of the highest order in (2); X_2, the continued product of those factors of V, which are powers of surds of the highest order in (2); and so on. Then, putting

$$H + BH_1 X_1 + CH_2 X_2 + \dots\dots + DH_a X_a = 0, \dots\dots\dots\dots (4)$$

let us suppose, if possible, that no such equation as (3) can subsist; and, in connection with this supposition, let us make the hypothesis, that the terms, X_1, X_2, &c., are all distinct from one another. By differentiating (4) with regard to p, we get

$$H \frac{d\{\log(H)\}}{dp} + BH_1 X_1 \frac{d\{\log(BH_1 X_1)\}}{dp} + \&c. = 0 \;\dots\dots\; (5)$$

Multiply (4) by the coefficient of $BH_1 X_1$ in (5), and subtract the product from (5). Then

$$hH + h_2 C H_2 X_2 + \dots\dots\dots + h_a D H_a X_a = 0; \dots\dots\dots\dots\dots\dots (6)$$

where the values of h, h_2, &c., are

$$h = \frac{d\left\{\log\left(\frac{H}{BH_1X_1}\right)\right.}{dp}$$

$$h_2 = \frac{d\left\{\log\left(\frac{CH_2X_2}{BH_1X_1}\right)\right.}{dp}$$

and so on. None of the factors of the coefficient of X_2 in (6) vanish. For C (by hypothesis) is not zero. The equation, $H_2 = 0$, is virtually of the form (3), which we have supposed inadmissible. And, if h_2 were zero, we should have, by integrating the value of h_2,

$$BH_1 X_1 = kCH_2 X_2, \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (7)$$

k being a constant quantity, that is, a quantity independent of p. But since X_1 and X_2 are not identical, there must be one factor of

X_1, as $M^{\frac{c}{\lambda}}$, such that X_2 either has no power of the surd $M^{\frac{1}{\lambda}}$ as one of its factors, or a power of $M^{\frac{1}{\lambda}}$ distinct from the c^{th}. Both of these alternatives are included in the assumption that $M^{\frac{r}{\lambda}}$ is a factor of X_2, r being a whole number, which is not equal to c, but may be zero. Hence, if equation (7) subsist, we have

$$BH_1 X' M^{\frac{c-r}{\lambda}} = k\, CH_2 X'', \ldots\ldots\ldots\ldots (8)$$

where X' is what X_1 becomes when the factor $M^{\frac{c}{\lambda}}$ is rejected; and X'' is what X_2 becomes on the rejection of the factor $M^{\frac{r}{\lambda}}$. Since c and r are whole numbers, different from one another, and each less than the prime number λ, we can choose whole numbers, m and n, such that $m\,(c-r) = n\lambda + 1$. Then

$$(BH_1 X')^m M^n M^{\frac{1}{\lambda}} = (k\, CH_2 X'')^m.$$

$$\therefore M^{\frac{1}{\lambda}} = (BH_1 X')^{-m} M^{-n} (k\, CH_2 X'')^m. \ \ldots\ldots\ldots (9)$$

But this equation will be readily seen, when the expression on its right hand side is rendered (Cor. Def. 5) integral, and made to satisfy the conditions of Def. 8, to be of the inadmissible form (3). Consequently h_2 cannot be zero; and therefore the coefficient of X_2 in (6) is not zero. In like manner it can be shown that the coefficients of all the other terms, such as X_2, in (6), are distinct from zero. Again, the coefficients of the terms, H, X_2, X_3, &c., in (6), when rendered integral functions, and made to satisfy the conditions of Def. 8, involve no surd of so high an order as those whose powers constitute the factors of X_2, X_3, &c. This will be plain if it be considered that the differential coefficient of the logarithm of any power of a surd does not involve, when arranged so as to satisfy the conditions of Def. 8, the surd in question. For instance,

$$\frac{d\left\{\log (1+\sqrt{p})^{\frac{2}{3}}\right\}}{dp} = \frac{\sqrt{p}-p}{3p(1-p)},$$

where the differential coefficient obtained is clear of the surd

$(1+\sqrt{p})^{\frac{1}{3}}$. Since therefore the coefficients of the terms, H, X_2, ..., X_a, in (6), when arranged so as to satisfy the conditions of Def. 8, involve only surds of lower orders than those whose powers constitute the factors of X_2, X_a, &c., and since the coefficients of the terms, X_2, ..., X_a, in (6), are all distinct from zero, it follows that equation (6) is of the same character as equation (4). But equation (6) contains one term less than equation (4), X_1, having been eliminated. Therefore, in the same way in which equation (6) was derived from (4), we may deduce from (6) another equation of the same character as (6), but with a term fewer. And so on, till ultimately we get

$$b\,H + l\,X_a = 0\,;$$

where l and b, the former not zero, involve no surds of so high an order as those whose powers constitute the factors of X_a. But [compare the reasoning by which equation (9) was deduced from (8)] this is virtually an equation of the inadmissible form (3). Hence, in consistency with the hypothesis that equation (3) cannot subsist, it cannot be supposed that the terms, X_1, X_2, ..., X_a, in (4), are all distinct from one another. Should X_a then be identical with X_1, let the two terms, $BH_1\,X_1$, $DH_a\,X_a$, be combined into the single term, $X_1\,(BH_1 + DH_a)$. Make all other such modifications on equation (4) as are possible. Ultimately we get

$$H + X_1\,(BH_1 + DH_a + \&c.) + X_2\,(CH_2 + \&c.) + \&c. = 0 \ldots (10)$$

where no two of the terms, X_1, X_2, &c., are identical. But, by what has been proved, this is impossible, except upon condition that the coefficients of X_1, X_2, &c., vanish separately. Put therefore

$$BH_1 + DH_a + \&c. = 0 \ldots\ldots\ldots\ldots\ldots\ldots (11)$$

If we compare this equation with (2), we perceive that it is of the same character as (2), with this difference, that there is no surd in equation (11) of so high an order as some of the surds in equation (2). But, in the same manner in which we derived (11) from (2), we may deduce from (11) another equation bearing the same relation to (11) as (11) bears to (2). And so on, till ultimately one of the equations, such as (10), at which we arrive, contains only one term such as X_1, with no more than a single term, such as BH_1, for its coefficient: from which it follows that B must be zero; whereas all the coefficients, B, C,........., E, in (2), were supposed (see Def. 9) to be distinct from zero. Hence some equation such as (3) must of necessity admit of being formed. Now suppose that the indices of the surds, Y_e, Y_1, &c , in (3), are, $\frac{1}{s}$, $\frac{1}{s_1}$, &c ; and that s_1 is not equal to s. By raising both sides of equation (3) to the s_1^{th} power, we may easily [compare the manner in which equation (9) was deduced from (8)] transform (3) into an equation, not involving the surd Y_1,

$$Y_e = P_1 \, Y_2^{\beta_2} \, Y_3^{\beta_3} \, \ldots\ldots\ldots Y_a^{\beta_a} ,$$

where P_1 is an expression such as P; β_2 being a whole number less than the denominator of the index of Y_2; β_3, a whole number less than the denominator of the index of Y_3; and so on. By continuing this process of reduction as far as necessary, we ultimately arrive at an equation such as (1).

Cor. Let each of the terms, Y_1, Y_2, &c., be either some power of an integral surd, or the continued product of several such powers; while A_1, A_2, &c., are algebraical expressions, distinct from zero; and A is an algebraical expression not assumed to be distinct from zero. Then, if

$$A + A_1 \, Y_1 + A_2 \, Y_2 + \ldots\ldots + A_e \, Y_e = 0, \ldots\ldots (12)$$

an equation of the form,

$$Y_1 = P \, Y_n^m \, , \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (13)$$

must subsist; where P is an expression involving only such surds as are present in the coefficients A, A_1, &c., or are subordinates of some of the surds whose powers constitute the factors of Y_1, Y_2, &c.; and Y_n is a term in the series, Y_2, ..., Y_e; m being either unity or zero. For, in the same way in which we eliminated X_1 from equation (4), we may proceed to eliminate successively the terms Y_2, ..., Y_e, from (12). The result of the elimination of Y_2 is,

$$\ldots\ldots + A_1 \, Y_1 \, \frac{d \left\{ \log \left(\frac{A_1 \, Y_1}{A_2 \, Y_2} \right) \right\}}{dp} + \&c. = 0 \ldots\ldots (14)$$

Here (see remarks in the Proposition) the coefficient of Y_1, when made to satisfy the conditions of Def. 8, involves no surds except such as are found in A_1 or A_2, or are subordinates of the surds whose powers constitute the factors of Y_1 and Y_2. Hence the coefficient of Y_1 in (14) is an expression such as P in (13). Should this coefficient vanish, we have $A_1 \, Y_1 = k \, A_2 \, Y_2$, k being a constant; which equation is of the form (13). Suppose that the coefficient of Y_1 in (14) does not vanish; and let equation (14), for the sake of simplicity, be written,

$$B + B_1 Y_1 + B_3 Y_3 + \ldots\ldots + B_c Y_c = 0 \ldots\ldots\ldots\ldots (15)$$

In the same manner in which we proved B_1 to be an expression such as P, it can be shown that all the other terms, B, B_3, &c., are expressions such as P. Eliminate Y_3 from equation (15), as Y_2 was eliminated from (12). The result of the elimination is

$$\ldots\ldots + B_1 Y_1 \frac{d\left\{ \log \left(\frac{B_1 Y_1}{B_3 Y_3} \right) \right\}}{dp} + \&c. = 0 \ldots\ldots (16)$$

As above, the coefficient of Y_1 here is an expression such as P. Also, if that coefficient vanish, we have $B_1 Y_1 = k B_3 Y_3$, k being a constant quantity. And this equation is of the form (13). Should the coefficient of Y_1 in (16) not vanish, we may proceed to eliminate another of the terms, Y_2, Y_3, ..., Y_c; and it will be found that the coefficient of Y in the equations that result from such eliminations can never at any stage become zero, unless such an equation as (13) subsist. Suppose then that all the terms, Y_2, Y_3, ..., Y_c, can be eliminated in the manner described, without the coefficient of Y_1 at any stage becoming zero. Then ultimately we get

$$H A + K A_1 Y_1 = 0,$$

where H and K, the latter (and consequently also the former) not zero, are expressions such as P. And this is an equation of the form (13), m being taken equal to zero. Hence an equation such as (13) must necessarily subsist.

Proposition II.

In $f(p)$, an integral function of a variable p, in a simple form, satisfying the conditions of Def. 8, let Y be a surd which is not subordinate to any other in the function, its index being $\frac{1}{s}$. Arrange $f(p)$ as follows:

$$f(p) = A + A_c \overset{c}{Y} + A_n \overset{n}{Y} + A_m \overset{m}{Y} + \&c.,$$

where A_c, A_n, &c., are expressions distinct from zero, and clear of the surd Y; A being also clear of the surd Y; and $\overset{c}{Y}$, $\overset{n}{Y}$, &c., being distinct powers of Y, not exceeding the $(s-1)^{th}$. Let the surd T be a chief (see Def. 4) subordinate of Y, but not a subordinate of any other surd in $f(p)$; its index being $\frac{1}{r}$; and, by changing T, wherever it occurs in $f(p)$ in any of its powers, into zT, z being an r^{th} root of unity, distinct from unity, let $f(p)$, A, Y, A_c, &c., be transformed into F (p), B, U, B_c, &c.; so that

$$F(p) = B + B_c U^c + B_n U^n + \&c.$$

Then, if $F(p) = f(p)$, the terms,

$$A, A_c Y^c, A_n Y^n, \&c., \ldots\ldots\ldots\ldots (1)$$

taken in same order, are equal to the terms,

$$B, B_c U^c, B_n U^n, \&c., \ldots\ldots\ldots\ldots (2)$$

each to each; A being equal to B.

For, since $F(p) = f(p)$, we have

$$(A-B) + A_c Y^c + A_n Y^n + \&c. - B_c U^c - \&c. = 0 \ldots\ldots\ldots\ldots (3)$$

Hence (Cor. Prop. I) one or other of the following equations must subsist:

$$\left.\begin{aligned} A_c Y^c &= D(A-B), \\ A_c Y^c &= D A_m Y^m, \\ A_c Y^c &= D B_m U^m; \end{aligned}\right\} \ldots\ldots\ldots\ldots (4)$$

where D is an expression involving only such surds as occur in the expressions A, B, A_c, B_c, &c., or are subordinates of Y or of U; Y^m being a term in the series, Y^c, Y^n, &c., distinct from Y^c; and U^m representing some term in the series, U^c, U^n, &c. But, since T is not a subordinate of any surd in $f(p)$ except Y, the coefficients B, B_c, &c., involve no surds different from those which enter into the coefficients A, A_c, &c.; and therefore involve only surds which are found in $f(p)$. Also, since T is not subordinate to any of the subordinates of Y, it follows that the subordinates of U are the same with those of Y. Hence D involves only such surds as occur in $f(p)$. Therefore (Cor. 1, Def. 9,) the first and second of equations (4) are inadmissible; and the third must subsist. Adopting then the equation, $A_c Y^c = D B_m U^m$, we say that no other term in (1) than $A_c Y$ can be equal to the product of $B_m U^m$ by an expression such as

D; for, should $A_n Y^n = D_1 B_m U^m$, where D_1 involves only such surds, exclusive of Y, as occur in $f(p)$, this would give us,

$$D_1 A_c Y^c = DA_n Y^n. \quad \text{.............................} \quad (5)$$

Now D cannot be zero, else $A_c Y^c$ would vanish; but A_c is (by hypothesis) not zero; and the equation, $Y = 0$, is impossible by Def. 9. Hence, since D is not zero, equation (5) is (Cor. 1, Def. 9) inadmissible. Therefore we cannot have $A_n Y^n = D_1 B_m U^m$. Consequently, as we established the third of equations (4), we can establish similar equations for all the terms in (1), after the first:

$$A_n Y^n = D_1 B_r U^r,$$
$$A_m Y^m = D_2 B_a U^a,$$

and so on; the terms, $A_c Y^c$, $A_n Y^n$, $A_m Y^m$, &c., being all different from one another, on the one hand; and the terms, $B_m U^m$, $B_r U^r$, $B_a U^a$, &c., being all different from one another, on the other hand. Hence equation (3) becomes,

$$(A-B) Y^c (1-D^{-1}) A_c + Y^n (1-D_1^{-1}) A_n + \&c. = 0;$$

where (Cor. 1, Def. 9) the coefficients, $A-B$, $A_c(1-D^{-1})$, &c., vanish separately. That is, the terms in the series (1), taken in some order, are equal to those in the series (2), each to each; A being equal to B.

Proposition III.

Let $f(p)$ be an algebraical function of a variable p, in a simple form; and let Y_c, Y_1, &c., certain surds, with the common index $\frac{1}{s}$, no one of them a subordinate of any of the others, be such that all their subordinates occur in $f(p)$. Suppose that

$$Y_c = PY_1^{\lambda_1} Y_2^{\lambda_2} \ldots\ldots Y_a^{\lambda_a},$$

or, as the equation may be written,

$$Y = P, \quad \text{...........................} \quad (1)$$

where Y is merely a symbol used (for the sake of simplicity) to denote the continued product of the expressions Y_c, $Y_1^{-\lambda_1}$, $Y_2^{-\lambda_2}$, ...,

$Y_a^{\frac{\lambda_a}{}}$; and P is an expression involving only such surds as occur in $f(p)$; the whole numbers λ_1, λ_2, &c., being less than s. Take ϕ, the general expression which includes (see def. vi.) all the cognate functions of $f(p)$; one of its particular forms, distinct from $f(p)$, being ϕ_1. In passing from $f(p)$ to ϕ, let P and Y become respectively Q and y; and, in passing from ϕ to ϕ_1, let Q and y become respectively P_1 and y_1. Then the equation,

$$y_1 = k\,P_1\,, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

subsists; k being an s^{h} root of unity.

Explanatory remark.—When we speak of Y becoming y in passing from $f(p)$ to ϕ, we do not assume that the expression Y is present in $f(p)$; but we mean that all the surds which occur in $f(p)$, and are also found in Y, must, in order that Y may be transformed into y, undergo the same changes which they require to suffer in order that $f(p)$ may become ϕ.

We proceed with the proof of the Proposition. In the first place, should P be zero, $Y_c = 0$. Let Y_c be of the form,

$$Y_c = (a + a_1 S_1 + a_2 S_2 + \ldots\ldots + a_n S_n)^{\frac{1}{s}};$$

where the coefficients, a, a_1, &c., are rational; and each of the terms S_1, S_2, &c., is either some power of an integral surd, or the continued product of several such powers; the expression, $a + a_1 S_1 + $ &c., satisfying the conditions of Def. 8. Then, since $Y_c = 0$, we have

$$a + a_1 S_1 + a_2 S_2 + \text{\&c.} = 0.$$

Now all the surds present in this equation, being subordinates of Y_c, are (by hypothesis) surds occurring in $f(p)$, a function in a simple form. Therefore (Cor. 1, Def. 9) the coefficients, a, a_1, &c., vanish separately. But, if Y_c' be what Y_c becomes in passing from $f(p)$ to ϕ, and Y_c'' be what Y_c' becomes in passing from ϕ to ϕ_1, we have

$$Y_c'' = (a + a_1 S_1' + \ldots\ldots + a_n S_n')^{\frac{1}{s}},$$

where S_1', &c., are what S_1, &c., become in passing from $f(p)$ to ϕ_1. Therefore $Y_c'' = 0$. But, in the same way in which, from the fact that Y_c is zero, we have deduced the conclusion that Y_c'' is zero, we may, from the fact that P is zero, deduce the conclusion that P_1 is zero. Also, since $\overset{\prime\prime}{Y}_c$ is a factor of y_1, y_1 must be zero. Therefore $y_1 = k\,P_1$.

In the next place, should P not be zero, the expressions y^s, $\overset{s}{Y}$, y_1^s, developed by the ordinary process of involution, rendered integral, and made to satisfy the conditions of Def. 8, are of the forms,

$$\left.\begin{aligned} y^s &= A + A_1\,v + A_2\,t + \&c., \\ Y^s &= A + A_1\,V + A_2\,T + \&c., \\ y_1^s &= A + A_1\,V_1 + A_2\,T_1 + \&c.; \end{aligned}\right\} \cdots\cdots\cdots (3)$$

where A, A_1, &c., are rational; and each of the expressions, v, t, &c., is either some power of an integral surd, or the continued product of several such powers; the expressions V, T, &c., being what v, t, &c., become in passing from ϕ to $f(p)$; and V_1, T_1, &c., what v, t, &c., become in passing from ϕ to ϕ_1. In like manner, the expressions, $\overset{s}{Q}$, $\overset{s}{P}$, $\overset{s}{P}_1$, satisfying the conditions of Def. 8, are of the forms,

$$\left.\begin{aligned} Q^s &= B + B_1\,m + B_2\,l + \&c., \\ P^s &= B + B_1\,M + B_2\,L + \&c., \\ \overset{s}{P}_1 &= B + B_1\,M_1 + B_2\,L_1 + \&c.; \end{aligned}\right\} \cdots\cdots\cdots (4)$$

where B, B_1, &c., are rational; and each of the expressions, m, l, &c., is either some power of an integral surd, or the continued product of several such powers; M, L, &c., being what m, l, &c., become in passing from ϕ to $f(p)$; and M_1, L_1, &c., what m, l, &c., become in passing from ϕ to ϕ_1. From (1), (3), and (4), we have,

$$A + A_1\,V + A_2\,T + \&c. = B + B_1\,M + B_2\,L + \&c\ldots\ldots (5)$$

But the surds occurring in the expression on the left hand side of this equation, being necessarily subordinates of some of the surds, Y_c, Y_1, ..., Y_a, are all present in $f(p)$. Those occurring in the expression on the right hand side of the equation are likewise all present in $f(p)$. Therefore, since equation (5) subsists, the surd parts, V, T, &c., are (Cor. 2, Def. 9) severally identical, taken in some order, with the surd parts, L, M, &c.; which also (Cor. 1, Def. 9) implies, that, if V be the surd part identical with M, A_1 is equal to B_1; and so on. But since V is identical with M, and A_1 equal to B_1, and T is identical with (we may suppose) L, and A_2 equal to B_2, and so on, the equation,

$$A + A_1\,V_1 + A_2\,T_1 + \&c. = B + B_1\,M_1 + B_2\,L_1 + \&c, \ldots\ldots (6)$$

must subsist; because, in passing from $f(p)$ to ϕ_1, V becomes V_1, and M becomes M_1, so that V_1 and M_1 are identical, and hence $A_1 V_1$ is equal to $B_1 M_1$: and so of the other terms. Therefore from (6), (3), and (4),

$$\overset{s}{y_1} = \overset{s}{P_1} \therefore y_1 = k\, P_1 .$$

Proposition IV.

If $f(p)$, an integral function of a variable p, be in a simple form, each of its cognate functions is in a simple form.

It is self-evident that the Proposition is true for all functions which involve only surds of the first order. Suppose the law to have been found to hold for all functions which do not involve surds above the $(n-1)^{\text{th}}$ order: it may then be proved true for a function, $f(p)$, involving surds of the n^{th}, but of no higher, order.

For take ϕ, the general expression which includes all the cognate functions of $f(p)$; one of its particular forms, distinct from $f(p)$, being ϕ_1; and suppose, if possible, that ϕ_1 is not in a simple form. Then an equation such as (1). Prop. I,

$$Y_c = P\, Y_1^{\lambda_1}\, Y_2^{\lambda_2} \ldots\ldots Y_a^{\lambda_a} ,$$

must (Prop. I.) subsist; all the surds involved in the equation being surds which occur in ϕ_1. We may write this equation in the form,

$$y_1 = P, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where y_1 denotes the continued product of the expressions Y, $Y_1^{-\lambda_1}$, &c. Let y_1 in ϕ_1 correspond to y in ϕ, and to Y in $f(p)$: that is to say, y is what Y becomes in passing from $f(p)$ to ϕ, and y_1 is what y becomes in passing from ϕ to ϕ_1. In like manner, let P in ϕ_1 correspond to Q in ϕ, and to R in $f(p)$. Let the the surds Y_c, Y_1, &c., in ϕ_1, correspond to Y_c', Y_1', &c., in $f(p)$; and since the surds Y_c', Y_1', &c., have the common index $\frac{1}{s}$, let their forms be,

$$Y_c' = V_1^{\frac{1}{s}}, \; Y_1' = V_1^{\frac{1}{s}}, \ldots\ldots, Y_a' = V_a^{\frac{1}{s}} .$$

Take $F(p)$, a function involving all the surds which occur in the expressions R, V_c, V_1, ..., V_a; and let the particular cognate function of $F(p)$, obtained by making the same changes in the surds involved in $F(p)$ as require to be made in order to pass from $f(p)$ to

ϕ_1, be $F_1(p)$. Then the surds occurring in $F(p)$ are all of lower orders than Y_c', Y_1', &c.; hence they are all of lower orders than the n^{th}. But we are at present reasoning on the hypothesis that the law sought to be established in the Proposition holds for all functions which do not involve surds above the $(n-1)^{th}$ order. Therefore, since $F(p)$, containing only surds which occur in $f(p)$, is in a simple form, it follows that the function $F_1(p)$ also is in a simple form. Now, if we refer to equation (1), we find that the surds involved in P, and all the subordinates of those surds whose powers constitute the factors of y_1, occur in the function $F_1(p)$. Therefore, by Prop. III, we can deduce from (1) the equation,

$$Y = k\,R,$$

k being a constant quantity. But this is an equation such as (1), Prop. I.; all the surds appearing in the equation being surds which occur in $f(p)$. Such an equation, however, is directly at variance with the hypothesis that $f(p)$ is in a simple form. And hence ϕ_1 cannot but be in a simple form. Consequently the law sought to be established in the Proposition holds good for all functions which do not involve surds above the n^{th} order.

Since, therefore, the law holds good for functions involving only surds of the first order, and since, on the hypothesis of its holding good for functions involving only surds of orders not higher than the $(n-1)^{th}$, we have shown that it must hold good for functions involving only surds of orders not higher than the n^{th}, it holds good universally.

Proposition V.

If $f(p)$, an integral function of a variable p, in a simple form, be a root of the algebraical equation, $F(x) = 0$, in which the coefficients of the powers of x are rational functions of p, then ϕ_1, any one of the cognate functions of $f(p)$, is a root of the same equation.

For take ϕ, the indefinite expression which includes all the cognate functions of $f(p)$; and let $F(\phi)$, $F\{f(p)\}$, $F(\phi_1)$, developed by the ordinary process of involution, and arranged so as to satisfy the conditions of Def. 8, be,

$$F(\phi) = A + A_1 Y_1 + A_2 Y_2 + \ldots\ldots + A_c Y_c,$$
$$F\{f(p)\} = A + A_1 V_1 + A_2 V_2 + \ldots\ldots + A_c V_c,$$
$$F(\phi_1) = A + A_1 U_1 + A_2 U_2 + \ldots\ldots + A_c U^c;$$

where A, A_1, &c., are rational; and each of the terms, Y_1, Y_2, &c., is either some power of an integral surd, or the continued product of several such powers; V_1, V_2, &c., being what Y_1, Y_2, &c., become in passing from ϕ to $f(p)$; and U_1, U_2, &c., what Y_1, Y_2, &c., become in passing from ϕ to ϕ_1. The expression for $F\{f(p)\}$ can only involve such surds as are present in some of their powers in $f(p)$. And $f(p)$, by hypothesis, is in a simple form. Therefore $F\{f(p)\}$, as exhibited above, is in a simple form. It also satisfies the conditions of Def. 8. But, since $f(p)$ is a root of the equation, $F(x) = 0$, $F\{f(p)\}$ is equal to zero. Therefore, in the expression for $F\{f(p)\}$, the coefficients A, A_1, &c., must (Cor. 1, Def. 9) vanish separately. Hence, $F(\phi_1) = 0$; and consequently ϕ_1 is a root of the equation, $F(x) = 0$.

Cor.—Let $f(p)$ be an integral function of p, in a simple form; and let certain surds in $f(p)$, viz.: y_1, y_2, &c., (in which series of terms, as was noticed in Def. 7, all the subordinates of any surd mentioned are necessarily included), have definite values attached to them; and let the cognate functions of $f(p)$, taken according to the manner described in Def. 7, without reference to the surd character of y_1, y_2, &c., be

$$\phi_1, \ \phi_2, \ \phi_3, \ \ldots\ldots, \ \phi_n.$$

Also let $F(x) = 0$, be an equation in which the coefficients of the powers of x are rational as far as all surds except y_1, y_2, &c., are concerned; that is, the coefficients contain no surds besides y_1, y_2, &c. Then, if $f(p)$ be a root of the equation, $F(x) = 0$, any one of the terms, ϕ_1, ϕ_2, ..., ϕ_n, (the definite values of y_1, y_2, &c., being adhered to), is a root of the same equation. For, in this case, in the same manner in which the expressions for $F\{f(p)\}$ and $F(\phi_1)$ in the Proposition were formed, we get

$$F\{f(p)\} = A + A_1 V_1 + A_2 V_2 + \&c.$$
$$F(\phi_1) = A + A_1 U_1 + A_2 U_2 + \&c.;$$

where A, A_1, &c., are rational as far as all surds except y_1, y_2, &c., are concerned; and each of the expressions, V_1, V_2, &c., is either some power of a surd in $f(p)$, not contained in the series, y_1, y_2, &c., or the continued product of several such powers; U_1, U_2, &c., being what V_1, V_2, &c., become in passing from $f(p)$ to ϕ: the expressions for $F\{f(p)\}$ and $F(\phi_1)$ satisfying the conditions of

Def. 8. In passing from $f(p)$ to ϕ, no change is made on A, A_1, &c., because the surds entering into these expressions are the same in $f(p)$ as in ϕ_1. But since $F\{f(p)\}$ is equal to zero, the coefficients A, A_1, &c., must (Cor. 1, Def. 9) vanish separately. Therefore $F(\phi_1) = 0$; and ϕ_1 is a root of the equation, $F(x) = 0$.

(*To be continued.*)

ON THE GEOLOGY OF BELLEVILLE AND THE SURROUNDING DISTRICT.

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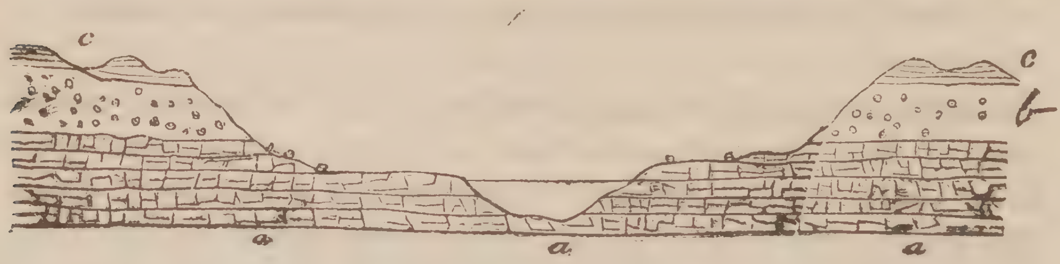
Read before the Canadian Institute, December 17*th*, 1859.

For the information of distant readers, it may be observed that the town of Belleville, in Canada West, is situated at the mouth of the River Moira near the western or closed extremity of the Bay of Quinté. The Trent, a broad and important river, enters this bay at the upper end, about ten miles west of the Moira, or rather constitutes by its ex-extension, the bay itself. The Salmon River or Shannon on the other hand flows into the same waters some eight or nine miles to the east of Belleville. The observations contained in the present paper apply almost exclusively to the tract of country thus bounded respectively on the east and west by the Salmon River and the Trent; and extending from a short distance along the shore of Prince Edward's County (south of the Bay of Quinté,) to some ten or twelve miles inland or to the north of the Bay. A few remarks, however, furnished by a hasty visit to the back township of Elzevir, are also incorporated in this paper—leaving the geological details of the iron district of Belmont, Madoc, &c., for a future communication.

Throughout this tract of country (as indeed almost everywhere within the Province,) the eye is at once struck by evidences of ancient denuding forces of an action both prior and subsequent to the deposition of the Drift; and, as a corollary to this action, of the much lower level of the land, relative to the water, at a comparatively recent period of geological history. The shores of the Bay of Quinté in very many places, and the high banks or terraces which run, with more or less of interruption, a short distance inland along the course of the above-named rivers, and which were evidently washed at one time by waters either salt or fresh, afford abundant proofs of this earlier physical condition of the district. The foundation rock, so to say, of this locality, is the well-known Trenton Limestone. This, although exposed in numerous places, is generally capped by a considerable thickness of Drift clay, sand, and gravel, with boulders of limestone and various gneissoid rocks, such as lie more or less immediately along the northern confines of the tract in question. Around Belleville itself, more particularly, the upper portion of the Drift consists of very finely stratified sand and light-coloured plastic clay, overlying gravel and other coarser materials with boulders of various kinds. The accompanying sketch-section across the River Moira will serve to convey an idea of the extensive denudation to which the Drift has been here subjected. In



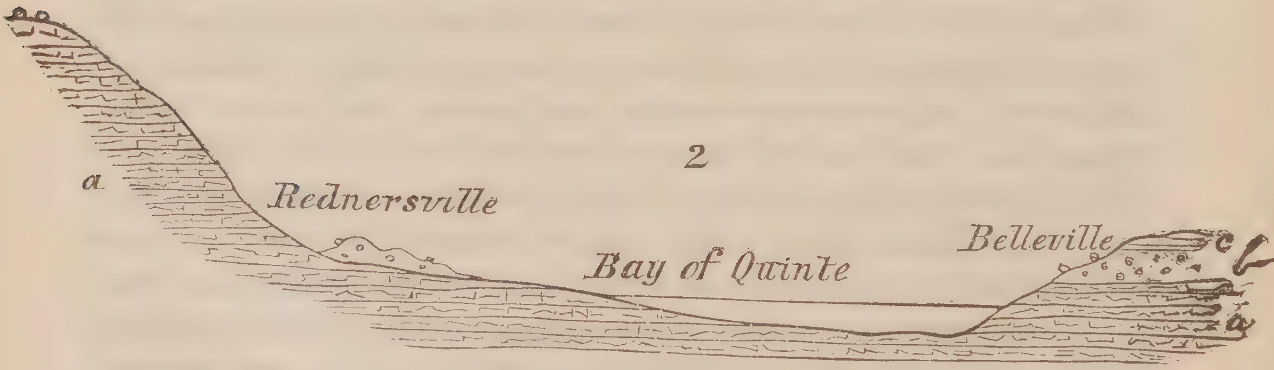
this section, *a* is the upper thin-bedded portion of the Trenton limestone, and *b* and *c* are the Drift beds. In consequence of this denudation the beds *c* are only of partial occurence, but I remarked them in several places at considerable distances apart. They are especially well shewn on the side of a hill or steep bank through which a street is cut, in the vicinity of the Court-house, Belleville.

A deposit of calcareous tufa derived in great part from minute fresh-water shells belonging to *cyclas*, *planorbis*, and other genera, constitutes a comparatively recent formation extending over a considerable area on the top of the drift bank or high ground on the west side of the river. It marks the site of an old swamp, now drained off. The same modern calcareous formation occurs still more extensively along the foot of the so-called " mountain " at Trenton, (where it was kindly pointed out to me by the Rev. Mr. Bleasdell of that village,) and undoubtedly in many other places ; although the above were the only spots in which it came under my personal observation. It may be stated, as a general rule, that a deposit of calcareous tufa or shell-marl will be found under the vegetable mould around the margins of almost all our smaller lakes, these having occupied at one period a larger extent of surface than that included within their present areas. As a mineral manure, this calcareous deposit ought to possess considerable value, but I did not find any particular importance attached to it either at Belleville or Trenton, and it seemed to be very little used.

The limestone surface immediately under the Drift appears throughout the entire district to have been polished and grooved by glacial action; but it is only here and there, and more especially where a recent removal of the Drift deposit has taken place, that the results of this action are now visible. At the period of my visit to Belleville (June 1859) a beautiful example of polished and striated rock had just been laid bare in some drain excavations on the south side of Bridge Street, west of the Moira; and I observed the same effects on the exposed faces of limestone at "The Plains," between the Moira and the Shannon; and, still more distinctly, opposite the Shannonville Station, on the north side of the Grand Trunk Railway. At the latter locality, large slabs of rock exhibited a polished surface equal to that of plate-glass, with fine striæ running across it in a general N.W. and S.E. direction. By the effect of weathering, however, these results of ancient glacial action become more or less rapidly obliterated.

The Trenton limestone of the district in question is lithologically divisable into two distinct sets of beds. Of these, the upper are thin-bedded (passing indeed into shales,) and are exceedingly fossiliferous; whilst the lower are thick-bedded and almost destitute of fossils. These lower beds are well displayed at the quarries on Ox Point, and at other places eastward along the Bay of Quinté. They form a most excellent building stone. The upper or thin-bedded limestones crop out extensively along the banks of the Trent, Moira, and Salmon rivers, and are exposed in most of the road cuttings of the district, and along the line of the Grand Trunk Railway. They literally teem with the more common fossils of the Trenton group. A list of those actually collected, is given below. These beds lie apparently in horizontal layers, but at Ox Point and other places some low anticlinals or undulations are visible, and a careful examination of the district shows a slight but general dip towards the south-west. A road cutting near the west bank of the Moira exposes a bed of calcareous clay about a foot in thickness interstratified with the shaly limestones of the upper part of the Trenton series. This bed, pointed out to me, by Campbell Wallbridge, Esq., of Belleville, contains numerous impressions of *strophomena alternata* and other Trenton forms, and is thus (as shown moreover by its position amongst the shaly limestones) a true member of the group. It is the first example of this kind of association that I have met with in the Trenton series, but a similar interstratification of clay and limestone beds has been seen, I believe, in other places.

About Belleville, the most prolific fossil localities are the river banks, and an old cutting for a mill-race on the east bank of the river, a little north of the Railway Station. The banks of the river (the Salmon) at Shannonville, and a cutting on the Railway at that place, about half a mile west of the Station, are also good localities; whilst around Trenton village many excavations and small quarries will be found exceedingly rich in fossils. On the steep side also of the high land at Rednersville in Prince Edward's County, some good specimens may be procured. This is the highest position occupied by the Trenton Limestone immediately around Belleville. I was led to understand by persons residing in Belleville, that the rock was not limestone; but it consists simply of the same shaly limestone as that seen on the banks of the Moira, as shewn in the following section (lettered as in figure 1), from which moreover, an idea may be gleaned of the vast amount of denudation which must have taken place in that neighbourhood, both before and after the deposition of the Drift.



At some of the above mentioned localities, and especially in the old mill-race near the Railway Station at Bellevile, I found *Columnaria alveolata*, until recently considered typical of the Black River Limestone, associated with ordinary Trenton fossils; and near the Episcopalian Church at Shannonville, I found the same coral with *Stromatocerium rugosum*, also accompanying Trenton species. These types therefore, (as already shewn by Sir William Logan and others, from the examination of other localities) although highly characteristic of the Black River Limestone, are not absolutely peculiar to that formation (or sub-formation) as was formerly thought to be the case. The subjoined Table gives an enumeration of the fossils collected, during my visit, at Belleville and in the surrounding district.

PLANTS:

Indistinct fucoids, and at Rednersville an undescribed form presenting a thick primary stem-mass, with numerous dichotomous branchings.

CORALS and CRINOIDS:

Stromatocerium rugosum (Shannonville). *Stenopora fibrosa* (the *Chætetes lycoperdon* of Hall, &c.): Variety 1, *ramosa*, the branched form, most abundant on the surfaces of the flat layers along the banks of the Moira; Variety 2, *concava*, the flattened or salver-shaped form concave above, abundant everywhere, more especially at the Railway cutting near Shannonville; Variety 3, *globosa*, the true "puff-ball" form, rather uncommon. *Columnaria alveolata* (Belleville, Shannonville). *Petraia (Streptelasma) cornicula*. *Glyptocrinus ramulosus?* (stem fragments only.

BRYOZOONS:

Ptilodictya (Stictopora) acuta, common at most of the fossiliferous localities, with a few other (indeterminable) forms.

BRACHIOPODS:

Lingula quadrata. *Rhynconella increbescens* (not common). *Strophomena alternata* and *S. filitexta* (both exceedingly abundant). *Leptæna sericea*. *Orthis testudinaria* (also very abundant); *O. tricenaria* (beautifully preserved); *O. pectinella*; *O. lynx* (only observed by me at Trenton).

CONCHIFERS:

Of this Class I did not meet with any determinable forms.

GASTEROPODS:

Pleurotomaria lenticularis, *Murchisonia gracilis*; *M. bellicincta*; *M. sub-fusiformis* (?) *Subulites elongata*.

PTEROPODS (?):

Conularia Trentonensis (not very common).

CEPHALOPODS:

Orthoceras (*Endoceras*) *proteiforme*; *O. bilineatum*; *O.* ——— (undetermined species); *O. tenuifilum*, or a related species with beaded siphuncle.

TRILOBITES:

Asaphus platycephalus (= *Isotelus gigas*, exceedingly common in a fragmentary state); *A. megistos* (rare). *Ceraurus pleurexanthemus* (very abundant). *Calymene Blumenbachii* (tolerably common, and well preserved). *Trinucleus concentricus* (two fragments only, found at Shannonville).

In the above list it will be seen that I have placed the coral commonly known as *Chætetes lycoperdon*, under the genus *Stenopora*, of Lonsdale. D'Orbigny's *Monticulipora*, to which genus the branched form has been referred, appears to agree in all essential respects with *Stenopora*, and to be thus an unnecessary addition to the list of Favositian genera. *Calamopora* of Goldfuss (including amongst others, *Favosites*, *Stenopora* and *Chætetes*) can scarcely be employed without risk of misconception, and is therefore now almost universally abandoned. *Favosites* differs essentially from *Stenopora* and *Chætetes* in possessing perforated cell-walls. The imperforate favositoidean corals fall into two series: the one exhibiting fissiparous and the other gemmiparous reproduction. The former show in the fracture the *interior* of the tubes, and constitute the genus *Chætetes*. The latter show the *outside* of the cell-walls (reproduction taking place by the lateral interpolation of new tubes) and they form the genus *Stenopora*. To this genus, if the above definition as given by McCoy and others, hold good, our so called *Chætetes* undoubtedly belong. This admitted, our common forms, the *Calamopora fibrosa* of Goldfuss, may be legitimately placed under McCoy's *Stenopora fibrosa*, and conveniently sub-divided into three varieties: the branching form (variety *ramosa*); the flat, cup-shaped or salver-shaped hemispherical form (variety *concava*); and the globular or true "puff-ball" form (variety *globosa* or *lycoperdon*). It often happens that whilst one variety is exceedingly abundant at a special locality, the other two are altogether absent. McCoy ("British Palæozoic Fossils," p. 24,) makes but two varieties: *lycopodites* and *regularis*, the latter including the branched and polymorphous forms; but those given above, so far as regards Canadian examples, will be found I think of more convenient adoption.

The "petites saillies coniques," the distinguishing character of d'Orbigny's *Monticulipora*, appear to be a necessary consequence of the mode of reproduction exhibited by *Stenopora*.*

On proceeding north of Belleville, the thin-bedded limestone gives place to the lower or thick beds, and these in turn merge into a silicious limestone, the probable equivalent of the Black River subdivision; although the country is so thickly covered by Drift, that sections are only observable here and there. At the village of Hungerford, in the township of that name, the grey silicious limestone is seen to overlie a series of thin flat layers of a reddish calcareous sandstone with pale green spots distributed irregularly through its mass. This rock is apparently an abnormal form of the Potsdam sandstone, or, perhaps a bed of passage between the Potsdam sandstone and the Calcareous sand rock, as it contains from 40 to 50 per cent. of dolomitic carbonate of lime. I found no traces of organic remains in it. I should be inclined to look upon it as the calcareous sand rock, were it not for its agreement, in certain of its physical characters, with the Potsdam sandstone as recognised elsewhere. From this part of the country however, westward to Georgian Bay, the beds between the base of the Trenton and the outcrop of the Laurentian series, are more or less obscure—thinning out altogether, or merging, as it were, one into the other. About three miles north of Hungerford village (or perhaps less, the intermediate space being greatly obscured by Drift) the Laurentian or Gneissoid rocks begin to crop out, dipping at a high angle to the north-east, or in a contrary direction to the slight dip of the Silurian strata. Close to the southern limit of the Laurentian outcrop a fine band of crystalline limestone occurs, interstratified with dark grey and reddish beds of gneiss. This may be conveniently examined at the village of Bridgewater in Elzevir Township on the property of Billa Flint, Esq., to whose enterprising spirit, that part of the country owes so much. The specimens of crystalline limestone obtained at this spot, form a marble of excellent quality. I have to regret that from want of time I was unable to examine the run of the band, and its quality at other points. A few fragments of galena and some impure steatite were shown to me, as having been met with near at hand.

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* These remarks were written several months ago. In the last number of the *Canadian Naturalist*, we were gratified to find the identity of the so-called *Chætetes lycoperdon* with *Stenopora fibrosa* also adopted by Mr. Billings.

The accompanying sketch-section across the little River Scoot, was taken near Mr. Flint's village. It may serve to convey an idea of the relative positions of the various beds which occur there. In this section, *A* represents the Gneissoid strata, with the band of crystalline limestone *b*; *C* denotes the Lower Silurian beds (limestone above, and, by inference, the reddish sand-rock below, as seen farther south); and *D*, denotes the Drift deposit.

3

Iu concluding this brief notice of the more salient geological features of Belleville and its vicinity, I am anxious to express my obligations to the family of Lewis Wallbridge, Esq., M. P. P., for mnch information respecting points of interest to be visited, and for the presentation of many fossils obtained in the neighbourhood.

REVIEWS.

Galbraith and Haughton's Scientific Manuals. Experimental and Natural Science Series: Manual of the Animal Kingdom; Protozoa. By Professor J. Reay Greene.

This small volume has a double title; we have chosen that which presents it as the commencement of an extended series of manuals, because we thus give most information to our readers. Those who obtain it alone from curiosity respecting its particular subject, would make use of the other.

It is a beautifully printed, carefully illustrated, and neatly got up volume, containing only 88 pages, with a Bibliography of the subject, questions for examination, and an index; to this are prefixed 30 pages of general introduction. Of course there is, within such limits, no attempt to characterise or enumerate genera and species. The object aimed at, is a general view of structure, arrangement and distribution. In the case of the Protozoa, this may be all that most people need or could profit by, but as we rise in the animal kingdom, such a manual would appear very meagre. We see announced as forthcoming, another Zoological volume from the pen of the author of that which lies before us, and a Botanical one from that of Professor Harvey of Dublin. We are curious to see whether the present manual is to be a model as to size, and if so, how the learned authors will acquit themselves in such trammels; but our present business is with Professor Greene's manual of the sub-kingdom, Protozoa. It must in the first place be conceded that in this department of zoology, accessible and trust-worthy information is greatly needed, and would be gladly received by a large class of readers. Professor Greene appears to be well acquainted with what has been written on the subject, and has laudably exerted himself, to give a clear, though much compressed account of what is known, in relation to these elementary forms of animal life. We are not satisfied with his mode of treating their classification. He regards them as being as yet too little understood for the limits of classes and orders to be well determined, and therefore only gives under the titles of the several groups which have been proposed, the subdivisions recommended by the authors who have chiefly studied them, accompanied by such structural and physiological particulars respecting at least some typical species as seem to be established by sufficient authority. For practical usefulness we should have preferred some attempt, even if confessedly only provisional, to harmonise what we seem to have learned from various investigators into a consistent system whose parts are brought into proper relation to each other and tò the whole; and we confess we have no such ideas as to the necessary foundations and limits of what are entitled to be called *classes* and *orders*, as would deter us from applying these terms to the greater and secondary divisions, which, though liable to modification by increasing knowledge, seem now to express the relations of the creatures, which we agree with the author in regarding as a distinct, well established sub-kingdom of the animal kingdom. He indeed complains of the characters of PROTOZOA being almost wholly negative, but this may perhaps appear to be almost unavoidable in a *lowest* division of any large collection of objects. In the vegetable kingdom, the method we prefer, separates as a sub-kingdom, those plants which are without Vascular tissue—the mode of diposing that tissue when present, giving characters to the remaining sub-kingdoms,—and so in the animal kingdom, the development and disposition of the nervous system characterise the four higher divisions, whilst Protozoa are animals consisting of an animated jelly, (Sarcodium) with little differentiation of parts and no perceptible nervous system. We are aware indeed that there may possibly not be one of the sub-kingdoms, certainly none excepting the highest, in which there are not instances, where no nervous system can be demonstrated; but in all such instances there is a manifest conformity to a type of structure, which directs our judgment as to the position of the object, whilst in Protozoa, wherever we have a tolerable acquaintance with the life history of the creature we recognise not only the absence of the characteristics of another sub-kingdom, but the presence of certain features properly belonging to that we are considering. If we have materials in our hands which really justify us in establishing a sub-kingdom of Protozoa, they can hardly fail to suggest some opinion as to the mode of sub-dividing it. If groups of creatures have been examined and intelligibly described, the question of their relation to other known groups, and the comparative importance of their distinctive marks will arise, and should be solved to the best of our ability.

It seems to us, that the possession of a mouth, and consequently of an alimentary sac, with a somewhat definite figure, and an outer covering, differing in some degree from the mass of the body, characterise *Infusoria* (in the now received limited sense,) as the highest class of Protozoa. From them, *Rhizopoda* are distinguished, by having no difference, so far as is known, or only a slight difference in certain parts, in their external covering from the mass of their bodies, and by their power of protruding portions of their substance, in the form denominated Pseudopodia. Possibly the naked Rhizopoda, the Arcellina, the Foraminifera, and the Polycystina may be so many good orders in this class. Thalassicollida may be nearer akin to Sponges: of Gregarinida, nothing can as yet be satisfactorily decided, until a full history of at least some species, removes the doubts which at present are unavoidable respecting their nature.

Sponges for which we may adopt the name of *Amorphozoa*, form a third distinct class. Since no protrusion of pseudopodia is attributed to Thalassicollida and in some of them at least, cellæform bodies, seeming to contain germs are surrounded by spicules, not unlike the peculiar ovarian spicules of some sponges; we may perhaps regard these organisms as one order of Amorphozoa. Without waiting for the expression of Dr. Bowerbank's views, we would not decide on the subdivision of the class, but would temporarily employ one of the existing arrangements to afford us that aid of system without which we can hardly proceed a step usefully in the study of nature. Whatever may be its defects, that founded on the nature of the skeleton, may serve the purpose, and at least exhibits remarkable analogies with the arrangement of Rhizopoda; Thalassicollida representing naked Rhizopoda, the horny sponges having a certain correspondence with Arcellina—those with Silicious spicula being the analogues of Polycystina, and those with Calcareous spicula of Foraminifera. Did our space permit, we should endeavour to ascertain the proper arrangement of Infusoria also, being well convinced, that all other information is in a great degree thrown away, if not connected with an intelligible system, and that methods which are necessarily only provisional and in which we may be sensible of great defects, are yet far preferable to any attempts at communicating anatomical, physiological, or descriptive matter independently of systems, which never carry the student beyond insulated facts, and barren, because unconnected observations.

Although Professor Greene may not exactly see these things in the same light that we do, we are by no means insensible to the merits of his book. The Introduction is excellent and useful, and its extent can hardly deter the idlest reader. His accounts of the low, and generally minute organisms of which he treats are highly interesting, and cannot fail to diffuse information, and lead to the increase of knowledge, by enlisting a host of new inquirers. The proprietors of the series have done their part well, and their first number holds out a favourable promise for those which are to follow; if what is more important is not sacrificed to over-anxiety after compression.

W. H.

The Old Glaciers of Switzerland and North Wales. By A. C. Ramsay, F.R.S. and G.S. London: Printed by Spottiswood and Co. 1859.

Amongst the various records of a by-gone condition of things presented by Nature's archives to the interpretation of the geologist, few can compete in interest, and perhaps in difficulty of solution, with those belonging to the great Drift or Glacial epoch: that period in the history of the earth's mutations, which immediately preceded, and gradually passaged into, the present or historic age. Broadly spread across the entire northern hemisphere, southward to a mean latitude (on this continent) of about 40° N., and again extending many degrees northwards from the southern pole, lie vast beds of clay, and sand, and gravel, mixed up with and overlaid by heaps of travelled stones or boulders; stones that have been brought by natural agencies, often across intervening seas and valleys, and over mountain ridges, miles and miles away from their original localities. Where hard and compact rocks lie underneath this boulder formation, or rise up amongst it, their surfaces are almost always found to be rounded, or smoothed and polished, and marked likewise in long and straight lines with narrow grooves and scratches. If these peculiarities be not always observable on exposed rock surfaces, their absence is chiefly due to the disintegrating action of the atmosphere, as they necessarily become obliterated, sooner or later, by the effects of weathering.

In Canada the drift formation is largely developed; and in many places the underlying limestone and other rocks exhibit the polished surfaces and the long lines of grooving just alluded to. But it is in mountainous countries that the phenomena of the drift epoch are portrayed to us in their grandest outlines. There, in many localities within the limits of latitude already pointed out, the hill-sides present their rounded contours, smoothed, polished, and striated; the hill-tops bear their loads of boulder stones, balanced one upon another, or perched, perhaps, on isolated points of rock; and the valleys show their excavated hollows and lake-basins, their barriers of heaped up boulders, their high and furrowed walls, with other memorials of abrading agencies belonging, it may be there, to an older time, but which are still in action amongst the frozen solitudes of the remote north, and in the higher valleys of the Alps and other mountain chains. In these valleys the broad ice-rivers still slowly push their way amidst the surrounding rocks, wearing and abrading them, and piling up at lower levels their stony burdens in the form of huge moraines.* This however leaves the tale half told. To complete our view of the phenomena under which the drift accumulations took place, we must

* In many glaciers the formation of a terminal moraine is prevented it should be observed by the action of the stream which results from the melting of the ice.

picture in addition the likeness of a northern sea, girt with protruding glaciers from which drift off the floating icebergs with their freight of rock and stone. This rocky freight, as the icebergs melt in lower latitudes, is necessarily scattered over the hill-tops, the plains, and valleys of the deep sea-bottom. We must picture also, over broad areas, vast sinkings and upheavals of the land, going grandly on through the slow lapse of centuries; the stranding and piling up of icebergs on shoals and coasts; the southern migration and subsequent retrogression of northern organisms; and the gradual dawn of softening climatic influences, coupled with the shrinking back of glacial forces to within their present limits.

It was thus by observations conducted in northern lands and seas, and in Alpine valleys, that the true nature of our drift phenomena became gradually elucidated. Professor Ramsay, in the attractive essay now before us, has placed in striking parallel—not from the descriptions of others, but from personal observation and research—some of the glacier valleys of Switzerland, with the romantic Pass of Llanberis and other valleys of North Wales. Commencing with the Swiss valleys, he lays before us a rapid but graphic sketch of the glaciers of the Aar: shewing how incontestible is the fact, that, vast as are these glaciers now, they shrink into insignificance when compared with their extension in former times. The same fact is observable, indeed, with regard to almost all the glaciers of these Alpine valleys. On this subject, after mentioning some modern instances of the advance and retreat of glaciers, Professor Ramsay remarks:—"But all such historical variations in the magnitude of glaciers are trifling compared with their wonderful extension in pre-historic periods. There is perhaps scarcely a valley in the High Alps in which the traveller, whose eye is educated in glacial phenomena, will not discern symptoms of the former presence of glaciers where none now exist; and in numerous instances, far from requiring to be searched for, these indications force themselves on the attention by signs as strong as if the glacier had disappeared but a short time before the growth of the living vegetation. So startling, indeed, are these revelations that for a time the observer scarcely dares to admit to himself the justness of his conclusions, when he finds in striations, moraines, *roches moutonnées*, and *blocs perchés*, unequivocal marks of the former extension of an existing glacier, a long day's march beyond its present termination; and further, that its actual surface of to-day is a thousand feet and more beneath its ancient level."

With regard to the Aar valley, the glaciers of which are taken as type-forms in relation to this inquiry, our author observes in addition: "Below the lower glacier of the Aar, the stream winds through one of those gravelly flats, so frequent in old glacier valleys, and at its lower end, where this plain narrows towards the Grimsel, a boss of granitic gneiss, well *moutonnée*, nearly bars the valleys across which the path leads. It is partly covered by striations, well marked on the slope that looks up the valley, telling the observer not only of the previous extension of the glacier thus far, but also that the ice which filled the plain pressed strongly on the higher side of the boss, and was forced upwards till it fairly slid over the rock, the lower part of the ice being quite unchecked by the opposing bar. I mention this especially, because similar phenomena were often pointed out by Buckland in describing the old glaciers of North Wales. On either hand, all the way from the glacier to this point, the mountain sides show the same mammillated contours that mark the rock above the ice, and a little further down the valley, the signs of glacial action become even unusually obtrusive. A large hill rises from the valley on the right, up which the road winds to the Hospice of the Grimsel. On the left is the narrow gorge of the Aar, and on the other side of the hill the sullen lake of the Grimsel half encircles it far above the level of the river. At its outflow the lake is partly dammed up by a little moraine-like dêbris; but it requires no soundings to tell that the rounded rocks close by, passing under the rubbish, form the chief retaining barrier of the water. On both banks, except when weather-worn, the rocks are ice-worn, and the lake is nearly looped into two by *roches moutonnées* that project from either bank toward the centre, like Llyn Idwal above Nant Francon, and the lakes of Llanberis, if these were undivided by the alluvial strip below Dolbadarn Tower. At its farther end a long, narrow, high, rounded barrier of solid rock (over which the glacier formerly poured) crosses the valley, damming up the lake in that direction; and here so great has been the pressure, that I found proof of the ice having been forced into a narrow transverse fissure, which it polished and striated quite out of the direction of its general flow. The lake is a complete rock basin similar to some of the tarns of North

Wales, and such as I only know in regions where glaciers once have been.

"On the hill that rises behind the Hospice, the glacial striations on the rocks gradually circle round to the further end of the lake, following the sweep of the valley; and it soon becomes apparent that this hill itself, is but a gigantic *roche moutonnée,* mammilated and striated all over, on which erratic blocks were left by the decrease of the glacier of the Aar after a period in which it rose so high, that it not only filled the hollow of the lake, and pressed upward over the ridgy barrier at its further end, but actually overflowed the entire hill. If from its polished side you survey the opposite ridge of the Aar valley, the vast size of the old glacier becomes still more strongly impressed upon the mind. A great wall of rock rises sharply above the river course, and on its side the striations which cover it, have been deflected upwards, at a low angle, the effect of the intense jamming to which the thick ice was subjected in its downward course, when obstructed by the great *roche moutonnée* that rises in the middle of the valley between the lake and the mountains on the opposite side of the Aar. Above this wall, the mountain is moutonnée almost to the very summit, where at length the serrated peaks of the highest ridge rise sharply above the ice-worn surfaces. The valley has been filled with ice almost to the very brim."

After thus discussing in their past and present bearings, the glacial phenomena of these Swiss valleys, our author turns to the valleys of Cænarvonshire that lie around the majestic Snowden, and traces out, in these, step by step, the former existence of immense glaciers, whose dimensions rivalled in grandeur the great ice-rivers of the ancient Alps. He then considers the question of identity of time with respect to the extinct glacial phenomena of Wales and the ancient extension of the Alpine glaciers. "But these things being true, [the former existence, &c., of glaciers in the valleys around Snowden], what relation in time is there between the old glaciers of Switzerland and those of Wales? The elements from which to attempt a solution of this question are few. First, it may be said that the signs of glaciation in the former extension of still existing Swiss glaciers, are not only identical in all respects with those of the extinct glaciers of Wales, but also that in many an Alpine valley all the ice marks remain, even when no diminished glacier still holds its place amid its uppermost recesses. These in all respects may be compared to the ancient glaciers of the neighbouring Jura, the Vosges, or of Wales. Again, when we consider that the great old glaciers of the Oberland apparently opened out on the broad drift-covered territory that extends northward to the Jura, there is another point of resemblance. So similar in general structure and in all its adjuncts is this Drift with that of the north of Europe, that I see no reason whatever to doubt their identity. To add weight to this opinion, I may quote the high authority of Mr. Smith of Jordan Hill, who informed me, that he recollects seeing in the museum at Berne, a neglected collection of *Swiss shells*, arctic in their grouping, and subfossil, like those of our Newer Pliocene beds; and in the museum at Geneva a similar collection, among which was *Mya Udivalensis.* Further, it is well known that in the superficial deposits associated with these, the bones of the great hairy elephant (E. primigenius), and other mammalian remains, occur by the Lake of Geneva, at Winterthur, and in other places; and though no one that I know of, has yet attempted to prove the ploughing of drift out of the mouths of Swiss valleys by the older and larger glaciers, yet in every other respect the conditions are so identical, that I am prepared to expect that this also will be proved, and I cannot resist the conclusion that, when glaciers filled the valleys of Wales, it was at that very time (the Newer Pliocene epoch) that the glaciers of Switzerland attained their great original extension.

Further, in spite of the modern fact that far south of the equator, the cold is greater than in equivalent northern latitudes, it is difficult not to speculate on the probable existence of a climate perhaps colder for the whole world, during what is often called the glacial period; a period when not only the Alps, but all Scandinavia, were full of great rivers of ice descending to the sea; when the White Mountains of North America also had their glaciers, (as I was informed in 1857, in conversation with Agassiz,) and when the great glaciers of the Himalayah, as described by Dr. Joseph Hooker, descended 5000 feet below their present levels, the older moraines being in one instance only 9000 feet above the sea, whereas the present end of the glacier lies at a height of 14,000 feet.

Another point often occurs to my mind,—what relation have these extinct glaciers to the human period? This is a subject on which we still are in the dark, but considering that in Newer Pliocene bone-caves, flint knives have been found,—there is reason to believe, coeval with elephants, rhinoceroses, and other Mammalia, partly extinct;—and that in France, at Abbeville and Amiens, well formed flint hatchets of an old type occur in fresh-water and marine strata of so-called *Upper Tertiary* date; and also, that a human skull was dug out of the so-called Pliocene volcanic ashes of Auvergne, it is possible, and perhaps even probable, that, long after the Drift was raised above the sea, the eyes of men may have looked upon the glaciers of Wales, when in their latter days, the ice had shrunk far up into the highest recesses of the mountains."

In calling the attention of our readers to this ably-written essay, we must not forget to mention, that its author has added much to the interest of his descriptions by a number of charming little vignette illustrations, and by a valuable map of the country around Snowden. In the latter, the directions of the rock-striæ, with the moraines and other vestiges of the ancient glaciers of North Wales, are indicated from Professor Ramsay's personal explorations.

E. J. C.

The Family Herald. John Lovell, Montreal.

A periodical of a somewhat novel and attractive character has been added to our Canadian Literature under this name. Issued in the form of a Newspaper sheet, and embracing scientific, literary and general news; it partakes in some respects of the united characteristics of *Chamber's Journal*, and the *London Athenæum.* A tale or novel runs through a series of chapters, in successive numbers; well selected stories, poems, and literary gleanings occupy other of its columns; and a good space is devoted in each number to Reviews. Its news columns are severally set apart to "Canada and the Lower Provinces," "England," "Scotland," "Ireland," and The "United States." The only thing omitted is party politics;—and, without any disparagement to the uses and value of our free press, as one of the elements of our social life and freedom, we believe that to many fair and young readers, *The Family Herald* will be none the less welcome for the omission.

The Editor of this new Canadian periodical is Mr. G. P. Ure, a gentleman long connected with the press; and the character of the earlier numbers of his new serial, show that he is making the best use of his opportunities and experience. When the great influence of the daily press is considered, not on politics only, but in forming the tastes, and training the minds of so large a portion of the community, to whom, such constitutes their most frequent reading, it cannot but be acknowledged that a periodical thus combining somewhat of the attractiveness and accessible brevity of the newspaper, with the careful literary characteristics of the scientific periodical, or monthly magazine, supplies one of the great wants of our industrious and advancing community. If the *Family Herald*, is conducted with the same good taste and judiciousness in the selection of its materials, which have been manifested in its earlier numbers, it cannot fail to meet with the success it merits. D. W.

On the Classification and Geographical Distribution of the Mammalia —being the lecture on Sir Robert Reade's foundation, delivered before the University of Cambridge,, in the Senate-house, May 10, 1859,—*to which is added an appendix, on the Gorilla, and on the extinction and transmutation of species.* By Richard Owen, F.R.S. &c. &c. London: John W. Parker and Son, West Strand. 1859.

Everything which proceeds from the pen of Professor Owen will be received with lively interest and with respectful attention. The present lecture is a pretty full exposition of his views respecting the Classification of Mammalia according to the cerebral system, which he has derived from a long series of dissections, and a diligent use of such opportunities as have perhaps never before been possessed by a comparative anatomist. That his system is an important improvement on that of Cuvier, can hardly be denied.

Every unprejudiced observer of nature will feel favourably disposed towards a method which brings *Edentata*, [Bruta] *Cheiroptera, Insectivora* and *Rodentia* into close relationship. We cannot help looking a little suspiciously at the multiplication of orders, and are disposed to anticipate still further improvements. In the meantime, all honour is due to Professor Owen's labours; and his present explanation of the characters of the various tribes is to be highly valued. In connection with this lecture, the author has published two papers which form an appropriate and valuable supplement to it. Appendix A is a note on the extinction of species, "being the conclusion of the Fullerian course of lectures on Physiology for 1859." Appendix B is on the Orang, Chimpansee, and Gorilla, in reference to the transmutation of species, and runs to a considerable extent. Our present limits forbid extracts, or analysis, but in naming the subjects we excite the curiosity of our readers to know the opinions of the chief of comparative anatomists, and they can readily satisfy it, by having recourse to the work itself, which deserves the careful study of all who are interested in these pursuits. W. H.

Archaia; Or Studies of the Cosmogony and Natural History of the Hebrew Scriptures. By J. W. Dawson, LL.D., F.G.S., Principal of McGill College, &c. Montreal: B. Dawson and Son. 1860.

Dr. Dawson's recent contribution to the literature of the Bible—for in such light must his *Archaia* be chiefly regarded,—has reached us just as we are going to press; and, hence, we are unable to devote to it the space to which it is so justly entitled, both by the distinguished name of its author and by its own intrinsic merits. As the issue, moreover, of a Canadian publisher, it has further claims upon us: ill met, we are afraid, by this too scanty and too hurried notice. Archaia is essentially composed of a series of critical essays or discourses founded on the opening chapter of Genesis; but the author enlarges his field of inquiry by various references to other passages of the sacred writings; more especially in the bearings of these on the Mosaic record of creation, and in their connexion with the study of nature generally. For the successful composition of a work of this kind, the author possesses many peculiar qualifications: a ready command of language, a clear and logical method of discussion, an intimate acquaintance with the discoveries and researches of modern science, and, above all, an evidently sincere and strong faith in the divine truths of Revelation. With these qualifications, although preceded on the same path by many active investigators, he has produced, as might be expeccted, an interesting and popularly written book; and one, moreover, containing various subordinate points of a novel character. The very nature of the subject renders, however, a work of this description more or less unsatisfactory to many readers. Perhaps to the scientific investigator, and to those whose thoughts have long dwelt on these questions, more especially; but if the work before us, leave the mind in some respects unsatisfied, we cannot but admit that in its expansive treatment of the subject it has gone far beyond its predecessors. The author, in his preface, hopes that his work may aid in some degree in redeeming the subject from the narrow views which are unhappily too prevalent: and of this, if those who entertain such views can be led to read the book, we have but little doubt. In this respect alone, therefore, apart from its general value, we may fairly welcome it, and urge its perusal upon those who still blindly look upon geology, and upon natural science generally, as antagonistic in some undefined manner to the spirit of Revelation.

It is difficult to extract a passage, sufficiently independent of the context for quotation, without occupying a larger space than our limits permit; but the following from one of the introductory chapters, in which the author claims for the Holy Scriptures a deeper insight into natural phenomena than many have hitherto foreseen, may serve as an example of the style and general expression of the work:

"The law of type or pattern in nature is distinctly indicated in the Bible. This is a principle only recently understood by naturalists, but it has more or less dimly dawned on the minds of many great thinkers in all ages. Nor is this wonderful, for the idea of type is scarcely ever absent from our own conceptions of any work that we may undertake. In any such work we anticipate recurring daily toil, like the returning cycles of nature. We look for progress, like that of the growth of the universe. We study adaptation both of the several parts to subordinate uses and of the whole to some general design. But we also keep in view some pattern, style, or order, according to which the whole is arranged, and the mutual relations of the parts are adjusted. The architect must adhere to some order of architecture, and to some style within that order. The potter, the calico printer, and the silversmith, must equally study uniformity of pattern in their several manufactures. The Almighty Worker has exhibited the same idea in his works. In the animal kingdom, for instance, we have four leading types of structure. Taking any one of these—the vertebrate, for example—we have a uniform general plan, embracing the vertebral column constructed of the same elements; the members, whether the arm of man, the limb of the quadruped, or the wing of the bat or the bird, or the swimming paddle of the whale, built of the same bones. In like manner all the parts of the vertebral column itself in the same animal, whether in the skull, the neck or the trunk, are composed of the same elementary structures. These types are farther found to be sketched out,—first in their more general, and then in their special features—in proceeding from the lower species of the same type to the higher, in proceeding from the earlier to the later stages of embryonic development, and in proceeding from the more ancient to the more recent creatures that have succeeded each other in geological time. Man, the highest of the vertebrates, is thus the archetype, representing and including all the lower and earlier members of the vertebrate type. The above are but trite and familiar examples of a doctrine which may furnish and has furnished the material of volumes. There can be no question that the Hebrew Bible is the oldest book in which this principle is stated. In the first chapter of Genesis we have specific type in the creation of plants and animals after their kinds or species, and in the formation of man in the image and likeness of the

Creator ; and, as we shall find in the sequel, there are some curious ideas of higher and more general types in the grouping of the creatures referred to. The same idea is indicated in the closing chapters of Job, where the three higher classes of the vertebrates are represented by a number of examples, and the typical likeness of one of these—the hippopotamus—to man seems to be recognised. A late able writer has quoted, as an illustration of the doctrine of types, a very remarkable passage from Psalm cxxxix.:—

> "'I will praise Thee, for I am fearfully and wonderfully made.
> Marvellous are thy works,
> And that my soul knoweth right well.
> My substance was not hid from Thee
> When I was made in secret,
> And curiously wrought in the lowest parts of the earth:
> Thine eyes did see my substance yet being imperfect,
> And in Thy book all my members were written,
> Which in continuance were fashioned when as yet there was none of them.'

"It would too much tax the faith of exegists to ask them to believe that the writer of the above passage, or the spirit that inspired him, actually meant to teach—what we now know so well from geology, that the prototypes of all the parts of the archetypal human structure may be found in those fossil remains of extinct animals which may, in nearly every country, be dug up from the rocks of the earth. No objection need, however, be taken to our reading in it the doctrine of embryonic development according to a systematic type.

"In that spiritual department which is the special field of scripture, the doctrine of type has been so extensively recognised by expositors, that I need only refer to its typical numbers, its typical personages, its typical rites and ceremonies, and lastly, to its recognition of the Divine Redeemer as the great archetype of the spiritual world, as man himself is of the natural. In this last respect the New Testament clearly teaches that, in the resurrection, the human body formed after Adam as its type, is to be sublimated and reformed after the heavenly body of the Son of God, rising to some point of perfection higher than that of the present earthly archetype.

"It is more than curious that this idea of type, so long existing in an isolated and often despised form, as a theological thought in the imagery of scripture, should now be a leading idea of natural science; and that while comparative anatomy teaches us that the structures of all past and present lower animals point to man, who, as Prof. Owen expresses it, has had all his parts and organs 'sketched out in anticipation in the inferior animals,' the Bible points still farther forward to an exaltation of the human type itself into what even the comparative anatomist might perhaps regard as among the 'possible modifications of it beyond those realized in this little orb of ours,' could he but learn its real nature."

The passage given above, even if we cannot go with the author to the full extent of his argument, will shew the suggestive, thought-creating character of Dr. Dawson's work. As such, it will shew also, the value of the work itself to the biblical or theological student, who, shaking off the trammels of a too narrow school, is willing to allow a place in his philosophy to the teachings of the great cosmic harmony which circles around him, and which proclaims through all its changes, I, too, am of God.

E. J. C.

SCIENTIFIC AND LITERARY NOTES.

PROFESSOR GEORGE WILSON, M.D., F.R.S.E.

Death has of late thinned the ranks of Edinburgh's men of science and letters. Some of the last veterans of the old *Edinburgh Review*, the foremost of Scottish Metaphysicians, and one eminent in her ranks of native Geologists, have rapidly followed one another to the tomb; but a sense of sorrow not less intense than that which was felt on the painful and sudden loss of Hugh Miller, has been occasioned by the death of Dr. George Wilson, the first Regius Professor of Technology in the University of Edinburgh. Dr. Wilson is widely known as the biographer of Cavendish and Reid; the author of "Researches on Colour Blindness," and other scientific works; besides numerous valuable papers contributed to scientific periodicals, and to the Transactions of the Royal Society and other learned bodies of which he was a member. His researches embraced a great variety of subjects, and included many discoveries of interest and value; among which may be noted his investigations into the history of medical electricity, and his discovery of fluorine in sea-water and in blood.

Dying, however, in his forty-first year, when, to those who knew him best, he seemed only to be ripening for the works of his matured genius: the best of his productions very partially indicate the wide range of thought and the original capacity of his mind. He has left incomplete the biography of his old friend and colleague, Professor Edward Forbes; and many of his papers furnish mere glimpses of the original views in his favourite science of Chemistry which he had purposed to work out in the leisure of later years he was never destined to see.

In addition to his professorship, Dr. Wilson was Director of the Scottish Industrial Museum. Of this national Institution a writer in the *Athenæum*, has justly remarked: "Dr. George Wilson was in no small degree the originator of that museum; he gave to it his heart, his genius, and his hopes of success and fame." It would not, indeed, be unjust to say that his life was in some degree the sacrifice made by his devotion to that favourite object. Of a warm and generous nature, and with the well-tempered enthusiasm of true genius, he threw his whole heart into whatever he did; and his loss is mourned in his native city with demonstrations of public grief rarely manifested with like intensity. His remains were followed to the grave by the City Magistrates, the professors of the University, and the representatives of scientific societies and public bodies: and the day of his funeral was observed as one of public mourning. Such an expression of general grief, was due perhaps even more to the worth of a singularly upright and genial Christian man, than to the admiration excited by his rare eloquence as a lecturer, and the fascination of a peculiarly winning and attractive manner, alike in public and private. To those who knew him in the intimate relations of private life, his loss creates a blank that nothing can replace. To a wider circle it may suffice to say, the world has lost in him,—at the early age of forty-one,—a most faithful and conscientious servant of science, and a singularly honest and painstaking searcher after its truths. What he has done will give his name a place among the honoured ranks of our scientific discoverers,—but what he was capable of doing, had life been granted to him, would have rendered all he has done of little account.

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

The twenty-ninth Annual Meeting of the British Association for the advancement of Science, which opened its proceedings under the presidency of His Royal Highness Prince Albert at Aberdeen, on Wednesday, September 14th, 1859, appears to have fully equalled in general interest the most successful of its predecessors. The attendance was much beyond the average; and so numerous were the papers communicated to the various Sections, that a mere enumeration of their titles, alone, would occupy many pages of our Journal. In the first Section, for example, comprising Mathematical and Physical Science, nearly eighty papers were read; and the total number of communications and Reports brought forward at the Meeting, is not far short of four hundred. Some of these papers are of the highest value: but a considerable number are of merely local interest, and many, indeed, appear to be entirely destitute of any special novelty or importance. Considering the undesirable manner in which really valuable communications, on account of the limited duration of the Meetings, are obliged to be hurried through, and their discussion greatly shortened, it would seem advisable to restrict the reading of the papers to such only as contain new facts or practical demonstrations, or which refer to questions of a debatable nature bearing on the philosophy of Science. Mere details of local geology (however useful in their way), with descriptions of ordinary fossils, analyses of river-waters, ordinary meteorological observations, and other papers of a similar character, *that neither clear up doubtful points nor open out new paths of inquiry*, might surely be forwarded with equal profit to some of the numerous scientific journals, in which, if worthy of regard, they would readily receive insertion. Some plan, at least, will have to be adopted sooner or later, to keep down the formidable array of papers, brought forward, in increasing numbers, at each successive meeting of the Association.

We give below (from copies of the Aberdeen *Herald*, kindly placed at our disposal by Professor Wilson,) a Report of the President's Address, and a few of the more important or generally-interesting papers communicated at this Meeting.

THE PRESIDENT'S ADDRESS.

GENTLEMEN OF THE BRITISH ASSOCIATION,—

Yonr kind invitation to me to undertake the office of your President for the ensuing year could not but startle me on its first announcement. The high position which science occupies, the vast number of distinguished men who labour in her sacred cause, and whose achievements, while spreading innumerable benefits, justly attract the admiration of mankind, contrasted strongly in my mind with the consciousness of my own insignificance in this respect. I, a simple admirer, and would-be student of science, to take the place of chief and spokesman of the scientific men of the day, assembled in furtherance of their important objects—the thing appeared to me impossible. Yet, on reflection, I came to the conclusion, that, if not as a contributor to or director of your labours, I might still be useful to you, useful to science, by accepting your offer. Remembering that this Association is a popular Association, not a secret confraternity of men jealously guarding the mysteries of their profession, but inviting the uninitiated, the public at large, to join them, having as one of its objects to break down those imaginary and hurtful barriers which exist between men of scienee and so-called men of practice—I felt that I could, from the peculiar position in which Providence had placed me in this country, appear as the representative of that large public, which profits by and admires your exertions, but is unable actively to join in them; that my election was an act of humility on your part which to reject would have looked like false humility, that is like pride, on mine. But I reflected further, and saw in my acceptance the means, of which necessarily so few are offered to her Majesty, of testifying to you, through the instrumentality of her husband, that your labours are not unappreciated by your Sovereign, and that she wishes her people to know this as well as yourselves. Guided by these reflections, my choice was speedily made, for the path of duty lay straight before me.

If these, however, are the motives which have induced me to accept your flattering offer of the Presidency, a request on my part is hardly neccessary that you will receive my efforts to fulfil its duties with kind indulgence.

If it were possible for anything to make me still more aware how much I stand in need of this indulgence, it is the recollection of the person whom I have to succeed as your President—a man of whom this country is justly proud, and whose name stands among the foremost of the naturalists in Europe for his patience in investigation, conscientiousness in observation, boldness of imagination, and acuteness in reasoning. You have no doubt listened with pleasure to his parting address, and I beg to thank him for the flattering manner in which he has alluded to me in it.

The Association meets for the first time to-day in these regions, and in this ancient and interesting city. The poet, in his works of fiction, has to choose, and anxiously to weigh, where to lay his scene, knowing that, like the painter, he is thus laying in the background of his picture, which will give tone and colour to the whole. The stern and dry reality of life is governed by the same laws, and we are here living, feeling, and thinking under the influence of the local impressions of this northern seaport. The choice appears to me a good one. The travelling philosophers have had to come far, but in approaching the Highlands of Scotland they meet nature in its wild and primitive form, and nature is the object of their studies. The geologist will not find many novelties in yonder mountains, because he will stand there on the bare backbone of the globe, but the primary rocks which stand out in their nakedness, exhibit the grandeur and beauty of their peculiar form, and in the splendid quarries of this neighbourhood are seen to peculiar advantage the closeness and hardness of their mass, and their inexhaustible supply for the use of man, made available by the application of new mechanical powers. On this primitive soil the botanist and zoologist will be attracted only by a limited range of plants and animals, but they are the very species which the extension of agriculture and increase of population are gradually driving out of many parts of the country. On those blue hills the red deer, in vast herds, holds undisturbed dominion over the wide heathery forest, until the sportsman, fatigued and unstrung by the busy life of the bustling town, invades the moor, to regain health and vigonr by measuring his strength with that of the antlered monarch of the hill. But, notwithstanding all his efforts to overcome an antagonist possessed of such superiority of power, swiftness, caution, and keenness of all the senses, the sportsman would find himself baffled, had not science supplied him with the telescope, and those terrible weapons which seem daily to progress in the precision with which they carry the deadly bullet, mocking distance, to the mark.

In return for the help which science has afforded him, the sportsman can supply the naturalist with many facts which he alone has opportunity of observing, and which may assist the solution of some interesting problems suggested by the life of the deer. Man also, the highest object of our study, is found in vigorous healthy developement, presenting a happy mixture of the Celt, Goth, Saxon, and Dane, acquiring his strength on the hills on the sea. The Aberdeen whaler braves the icy regions of the Polar Sea, to seek and do battle with the great monster of the deep: he has materially assisted in opening these icebound regions to the researches of Science; he fearlessly aided in the search after Sir John Franklin and his gallant companions, whom their country sent forth on this mission, but to whom Providence, alas! has denied the reward of their labours, the return to their homes, to the affectionate embrace of their families and friends, and the acknowledgments of a grateful nation. The City of Aberdeen itself is rich in interest for the philosopher. Its two lately united Universities make it a seat of Learning and Science. The Collection of Antiquities, formed for the present occasion, enables him to dive into olden times, and, by contact with the remains of the handiwork of the ancient inhabitants of Scotland, to enter into the spirit of that peculiar and interesting people, which has attracted the attention and touched the hearts of men accessible to the influence of heroic poetry. The Spalding Club, founded in this city for the preservation of the historical and literary remains of the north-eastern counties of Scotland, is honourably known by its important publications.

Gentlemen!—This is the 29th Aniversary of the foundation of this Association; and well may we look back with satisfaction to its operation and achievements, throughout the time of its existence. When, on the 27th September, 1831, the Meeting of the Yorkshire Philosophical Society took place at York, in the theatre of the Yorkshire Museum, under the presidency of the late Earl Fitzwilliam, then

Viscount Milton, and the Rev· W. Vernon Harcourt eloquently set forth the plan for the formation of a British Association for the promotion of Science, which he showed to have become a want for his country, the most ardent supporter of this resolution could not have anticipated that it would start into life full-grown as it were, enter at once upon its career of usefulness, and pursue it without deviation from the original design, triumphing over the oppositions which he had to encounter in common with everything that is new and claims to be useful. Gentlemen, this proved that the want was a real, and not an imaginary one, and that the mode in which it was intended to supply that want was based upon a just appreciation of unalterable truths. Mr. Vernon Harcourt summed up the desiderata in graphic words, which have almost identically been retained as the exposition of the objects of the Society, printed at the head of the annually-appearing volume of its Transactions:—" to give a stronger impulse and more systematic direction to scientific inquiry—to promote the intercourse of those who cultivate Science in different parts of the Empire, with one another and with foreign Philosophers—and to obtain a more general attention to the objects of Science, and a removal of any disadvantages of a public kind which impede its progres."

To define the nature of Science, to give an exact and complete definition of what that Science, to whose service the Association is devoted, is and means, has as it naturally must, at all times occupied the Metaphysician. He has answered the question in various ways, more or less satisfactorily to himself or others. To me, Science, in its most general and comprehensive acceptation, means the knowledge of what I know, the consciousness of human knowledge. Hence, to know, is the object of all Science; and all special knowledge, if brought to our consciousness in its separate distinctiveness from, and yet in its recognised relation to the totality of our knowledge, is scientific knowledge. We require, then, for Science—that is to say, for the acquisition of scientific knowledge—those two activities of our mind which are necessary for the acquisition of *any* knowledge—analysis and synthesis; the first, to dissect and reduce into its component parts the objects to be investigated, and to render an accurate account to ourselves of the nature and qualities of these parts by observation; the second to recompose the observed and understood parts into a unity in our consciousness, exactly answering to the object of our investigation. The labours of the man of Science are therefore at once the most humble and the loftiest which man can undertake. He only does what every little child does from its first awakening into life, and must do every moment of its existence; and yet he aims at the gradual approximation to divine truth itself If then, there exists no difference between the work of the man of Science and that of the merest child, what constitutes the distinction? Merely the conscious self-determination. The child observes what accident brings before it, and unconsciously forms its notion of it; the so-called practical man observes what his special work forces upon him, and he forms his notions upon it with reference to this peculiar work. The man of Science observes what he intends to observe, and knows why he intends it. The value which the peculiar object has in his eyes is not determined by accident, nor by an external cause, such as the mere connexion with work to be performed, but by the place which he knows this object to hold in the general universe of knowledge, by the relation which it bears to other parts of that general knowledge.

To *arrange* and *classify* that universe of knowledge becomes therefore the first and perhaps the most important, object and duty of Science. It is only when brought into a system, by separating the incongruous and combining those elements in which we have been enable to discover the internal connexion which the Almighty has implanted in them, that we can hope to grapple with the boundlessness of His creation, and with the laws which govern both mind and matter. The operation of Science then has been, systematically to divide human knowledge, and raise, as it were, the separate groups of subjects for scientific consideration, into different and distinct sciences. The tendency to create new sciences is peculiarly apparent in our present age, and is perhaps inseparable from so rapid a progress as we have seen in our days; for the acquaintance with and mastering of distinct branches of knowledge enables the eye, from the newly-gained points of sight, to see the new ramifications into which they divide themselves in strict consecutiveness and with logical necessity. But in thus gaining new centres of light, from which to direct our researches, and new and powerful means of adding to its ever-increasing treasures, science approaches no nearer to the limits of its range, although travelling further and further from its original point of departure. For God's world is infinite; and the boundlessness of the universe, whose confines appear ever to retreat before our finite minds, strikes us no less with awe when, prying into the starry crowd of heaven, we find new worlds revealed to us by every increase in the power of the telescope, than when the microscope discloses to us in a drop of water, or an atom of dust, new worlds of life and animination, or the remains of such as have passed away.

Whilst the tendency to push systematic investigation in every direction enables the individual mind of man to bring all the power of which he is capable to bear on the specialities of his study, and enables a greater number of labourers to take part in the universal work, it may be feared that that consciousness of its unity which must pervade the whole of science, if it is not to lose its last and highest point of sight, may suffer. It has occasionally been given to rare intellects and the highest genius, to follow the various sciences in their divergent roads, and yet to preserve that point of sight from which alone their totality can be contemplated and directed. Yet how rare is the appearance of such gifted intellects! And if they be found at intervals, they remain still single individuals, with all the imperfections of human nature.

The only mode of supplying with any certainty this want, is to be sought in the combination of men of science representing all the specialities, and working together for the common object of preserving that unity and presiding over that general direction. This has been, to some extent, done in many countries by the establishment of academies embracing the whole range of the sciences, whether physical or metaphysical, historical or political. In the absence of such an institution in this country, all lovers of science must rejoice at the existence and activity of this Association, which embraces in its sphere of action, if not the whole range of the sciences, yet a very large and important section of them, those known as the *inductive sciences*, excluding all that are not approached by the inductive method of investigation. It has, for instance (and, considering its peculiar organisation and mode of action, perhaps not unwisely), eliminated from its consideration and discussions those which come under the description of moral and political sciences. This has not been done from undervaluing their importance and denying their sacred right to the special attention of mankind, but from a desire to deal with those subjects only which can be reduced to positive proof, and do not rest on opinion or faith. The subjects of the moral and political sciences involve not only opinions but feelings; and their discussion frequently rouses passions. For feelings are "subjective," as the German metaphysician has it—they are inseparable from the individual being—an attack upon them is felt as one upon the person itself; whilst facts are "objective," and belong to everybody—they remain the same facts at all times and under all circumstances: they can be proved; they have to be proved; and when proved, are finally settled. It is with facts only that the Association deals. There may, for a time, exist differences of opinion on these also, but the process of removing them and resolving them into agreement is a different one from that in the moral and political sciences. These are generally approached by the *deductive* process; but if the reasoning be ever so acute and logically correct, and the point of departure, which may be arbitrarily selected, is disputed, no agreement is possible; whilst we proceed here by the *inductive* process, taking nothing on trust, nothing for granted, but reasoning upwards from the meanest fact established, and making every step sure before going one beyond it, like the engineer in his approaches to a fortress. We thus gain ultimately a roadway,—a ladder by which even a child may, almost without knowing it, ascend to the summit of truth, and obtain that immensely wide and extensive view which is spread below the feet of the astonished beholder. This road has been shown us by the great Bacon; and who can contemplate the prospects which it opens, without almost falling into a trance similar to that in which he allowed his imagination to wander over future ages of discovery!

From amongst the political sciences it has been attempted in modern times to detach one which admits of being severed from individual political opinions, and of being reduced to abstract laws derived from well-authenticated facts. I mean political economy, based on general statistics. A new Association has recently been formed, imitating our perambulating habits, and striving to comprehend in its investigations and discussions even a still more extended range of subjects, in what is called "social science." These efforts deserve our warmest approbation and good-will. May they succeed in obtaining a purely and strictly scientific character! Our own Association has, since its meeting in Dublin, recognized the growing claims of political economy to scientific brotherhood, and admitted it into its statistical section. It could not have done so under abler guidance and happier auspices than the Presidency of the Archbishop of Dublin, Dr. Whately, whose efforts in this direction are so universally appreciated. But even in this section, and whilst statistics alone were treated in it, the Association, as far back as 1833, made it a rule that, in order to ensure positive results, only those classes of facts should be admitted which were capable of being expressed by numbers, and which promised, when sufficiently multiplied, to indicate general laws.

If, then, the main object of science—and I beg to be understood, henceforth, as speaking only of that section which the Association has under its special care viz., inductive science—if I say, the object of science is the discovery of the laws which govern natural phenomena, the primary condition for its success is:—Accurate observation and collection of facts in such comprehensiveness and completeness as to furnish the philosopher with the necessary material from which to draw safe conclusions.

Science is not of yesterday. We stand on the shoulders of past ages, and the amount of observations made, and facts ascertained, has been transmitted to us, and carefully preserved in the various storehouses of science; other crops have been reaped, but still lie scattered on the field; many a rich harvest is ripe for cutting, but waits for the reaper. Economy of labour is the essence of good husbandry, and no less so in the field of science. Our Association has felt the importance of this truth, and may well claim, as one of its principal merits, the constant endeavour to secure that economy. One of the latest undertakings of the Association has been, in conjunction with the Royal Society, to attempt the compilation of a classified catalogue of scientific memoirs, which, by combining under one head the titles of all memoirs written on a certain subject, will, when completed, enable the student who wishes to gain information on that subject to do so with the greatest ease. It gives him, as it were, the plan of the house, and the key to the different apartments in which the treasures relating to his subject are stored, saving him at once a painful and laborious search, and affording him at the same time an assurance that what is here offered contains the whole of the treasures yet acquired.

While this has been one of the latest attempts, the Association has from its very beginning kept in view that its main sphere of usefulness lay in that concentrated attention to all scientific operations which a general gives to the movements of his army, watching and regulating the progress of his impetuous soldiers in the different directions to which their ardour may have led them, carefully noting the gaps which may arise from their independent and eccentric action, and attentively observing what impediments may have stopped, or may threaten to stop, the progress of certain columns. Thus it attempts to fix and record the position and progress of the different labours, by its reports on the state of sciences published annually in its transactions;—thus it directs the attention of the labourers to those gaps which require to be filled up, if the progress is to be a safe and steady one —thus it comes forward with a helping hand, in striving to remove those impediments which the unaided efforts of the individual labourer have been or may be unable to overcome.

Let us follow the activity of the Association in these three different directions. The Reports on the state of Science originate in the conviction of the necessity for fixing, at given intervals, with accuracy and completeness, the position at which it has arrived. For this object, the General Committee of the Association entrusts to distinguished individuals in the different branches of science the charge of becoming, as it were, the biographers of the period. There are special points in different sciences in which it sometimes appears desirable to the different sections to have special reports elaborated; in such cases the General Committee, in its capacity of the representative assembly of all the sciences, reserves to itself the right of judging what may be of sufficient importance to be thus recorded

The special subjects which the Association points out for investigation, in order to supply the gaps which it may have observed, are—either such as the philosopher alone can successfully investigate, because they require the close attention of a practised observer, and a thorough knowledge of the particular subject; or they are such as require the greatest possible number of facts to be obtained. Here science often stands in need of the assistance of the general public, and gratefully accepts any contribution offered, provided the facts be accurately observed. In either case the Association points out *what* is to observed, and *how* it is to be observed. The first is the result of the same careful sifting process which the Association employs in directing the issue of special reports. The investigations are entrusted to specially-appointed committees or selected individuals. They are in most cases not unattended with considerable expense, and the Association, not content with merely suggesting and directing, furnishes by special grants the pecuniary means for defraying the outlay caused by the nature and the extent of the inquiry. If we consider that the income of the Association is solely derived from the contributions of its members, the fact that no less a sum than £17,000 has, since its commencement, been thus granted for scientific purposes, is certainly most gratifying. The question *how* to observe, resolves itself into two,—that of the scientific method which is to be employed in approaching a problem or making an observation, and that of the philosophical instruments used in the observation or experiment. The Association brings to bear the combined knowledge and experience of the scientific men not only of this but other countries, on the discovery of that method which, while it economises time and labour, promises the most accurate results. The method to which, after careful examination, the palm has been awarded, is then placed at the free disposal and use of all scientific investigators. The Association also issues, where practicable, printed forms, merely requiring the different heads to be filled up, which, by their uniformity, become an important means for assisting the subsequent reduction of the observations for the abstraction of the laws which they may indicate. At the same time most searching tests and inquiries are constantly carried on in the Observatory at Kew, given to the Association by Her Majesty, the object of which is practically to test the relative value of different methods and instruments, and to guide the constantly progressive improvements in the construction of the latter. The establishment at Kew has undertaken the further important service of verifying and correcting to a fixed standard the instruments of any maker, to enable observations made with them to be reduced to the same numerical expression. I need hardly remind the inhabitants of Aberdeen that the Association, in one of the first years of its existence, undertook the comparative measurement of the Aberdeen standard scale with that of Greenwich—a research ably carried out by the late Mr. Baily.

The impediments to the general progress of science, the removal of which I have indicated as one of the tasks which the Association has set for itself, are of various kinds. If they were only such as direction, advice, and encouragement would enable the individual, or even combined efforts of philosophers, to overcome, the exertions of the Association which I have just alluded to might be sufficient for the purpose. But they are often such as can only be successfully dealt with by the powerful arm of the State, or the long purse of the nation. These impediments may be caused either by the social condition of the country itself, by restrictions arising out of peculiar laws, by the political separation of different countries, or by the magnitude of the undertakings being out of all proportion to the means and power of single individuals of the Association, or even the voluntary efforts of the public. In these cases the Association, together with its sister Society, "the Royal Society," becomes the spokesman of Science with the Crown, the Government, or Parliament—sometimes, even, through the Home Government, with Foreign Governments. Thus it obtained the establishment, by the British Government, of magnetic and meteorological observatories in six different parts of the globe, the beginning of a network of stations which we must hope will be so far extended as to compass, by their geographical distribution, the whole of the phenomena which throw light on this important point in our tellurian and even cosmical existence. The Institute of France, at the recommendation of M. Arago, whose loss the scientific world must long deplore, cheerfully co-operated with our Council on this occasion. It was our Association which, in conjunction with the Royal Society, suggested the Antarctic Expedition, with a view to further the discovery of the laws of terrestrial magnetism, and thus led to the discovery of the southern polar continent. It urged on the Admiralty the prosecution of the tidal observations, which that Department has since fully carried out. It recommended the establishment, in the British Museum, of the conchological collection, exhibiting present and extinct species, which has now become an object of the greatest interest.

I will not weary you by further examples, with which most of you are better acquainted than I am myself, but merely express my satisfaction that there should exist bodies of men who will bring the well-considered and understood wants of science before the public and the Government, who will even hand round the begging-box, and expose themselves to refusals and rebuffs to which all beggars are liable, with the certainty besides, of being considered great bores. Please to recollect that this species of bore is a most useful animal, well adapted for the ends for which nature intended him. He alone, by constantly returning to the charge, and repeating the same truths and the same requests, succeeds in awakening attention to the cause which he advocates, and obtains that hearing which is granted him at last for self-protection, as the minor evil compared to his importunity, but which is requisite to make his cause understood. This is more particularly the case in a free, active, enterprising, and self-determining people like ours, where every interest works for itself, considers itself the all-important one, and makes its way in the world by its own efforts. Is it, then, to be wondered at, that the interests of science, abstract as science appears, and not immediately showing a return in pounds, shillings, and pence, should be postponed, at least, to others which promise immediate tangible results? Is it to be wondered at, that even our public men require an effort to wean themselves from other subjects, in order to give their attention to science and men of science, when it is remembered that science, with the exception of mathematics, was, until of late, almost systematically excluded from our school and university education;—that the traditions of early life are those which make and leave the strongest impression on the human mind, and that the subjects with which we become acquainted, and to which our energies are devoted in youth, are those for which we retain the liveliest interest in after years, and that for these reasons the effort required must be both a mental and a moral one? A deep debt of gratitude is therefore due to bodies like this Association, which not only urges the wants of science on the

Government, but furnishes it at once with well-matured plans how to supply them with the greatest certainty and to the greatest public advantage.

We may be justified in hoping, however, that by the gradual diffusion of science, and its increasing recognition as a principal part of our national education, the public in general, no less than the Legislature and the State, will more and more recognise the claims of science to their attention; so that it may no longer require the begging-box, but speak to the State, like a favoured child to its parent, sure of his parental solicitude for its welfare; that the State will recognise in science one of its elements of strength and prosperity, to foster which the clearest dictates of self-interest demand.

If the activity of this Association, such as I have endeavoured to describe it, ever found or could find its personification in one individual—its incarnation, as it were—this had been found in that distinguished and revered philosopher who has been removed from amongst us, in his ninetieth year, within these last few months. Alexander von Humboldt incessantly strove after dominion over that universality of human knowledge which stands in need of thoughtful government and direction to preserve its integrity; he strove to tie up the *fasces* of scientific knowledge, to give them strength in unity. He treated all scientific men as members of one family, enthusiastically directing, fostering, and encouraging inquiry, where he saw either the want of, or the willingness for, it. His protection of the young and ardent student led many to success in their pursuit. His personal influence with the Courts and Governments of most countries in Europe, enabled him to plead the cause of science in a manner which made it more difficult for them to refuse than to grant what he requested. All lovers of science deeply mourn for the loss of such a man. Gentlemen, it is a singular coincidence, that this very day on which we are here assembled, and are thus giving expression to our admiration of him, should be the anniversary of his birth.

To return to ourselves, however. One part of the functions of the Association can receive no personal representation—no incarnation. I mean, the very fact of meetings like that which we are at present inaugurating. This is not the thoughtful direction of one mind over acquired knowledge, but the production of new thought by the contact of many minds, as the spark is produced by the friction of flint and steel; it is not the action of the monarchy or a paternal government, but the republican activity of the Roman Forum. These meetings draw forth the philosopher from the hidden recesses of his study, call in the wanderer over the field of science to meet his brethren, to lay before them the results of his labours, to set forth the deductions at which he has arrived, to ask for their examination, to maintain in the combat of debate the truth of his position and the accuracy of his observations. These meetings, unlike those of any other society, throw open the arena to the cultivators of all sciences, to their mutual advantage: the Geologist learns from the Chemist that there are problems for which he had no clue, but which that science can solve for him; the Geographer receives light from the Naturalist, the Astronomer from the Physicist and Engineer, and so on. And all find a field upon which to meet the public at large, invite them to listen to their reports, and even to take part in their discussions; show to them that philosophers are not vain theorists, but essentially men of practice—not conceited pedants, wrapped up in their own mysterious importance, but humble inquirers after truth, proud only of what they may have achieved or won for the general use of man. Neither are they daring and presumptuous unbelievers—a character which ignorance has sometimes affixed to them—who would, like the Titans, storm heaven, by placing mountain upon mountain, till hurled down from the height attained by the terrible thunders of outraged Jove; but rather the pious pilgrims to the Holy Land, who toil on in search of the sacred shrine, in search of truth—God's truth—God's laws as manifested in His works, in His creation.

[A very interesting communication, laid before the Geological Section, by Sir Charles Lyell, "On the Results of some Observations in France, in reference to the Antiquity of the Human Race," appeared in the last number of the *Canadian Journal*, Vol. IV. p 497. In the present Number we give two additional papers: one of great value, "On Fossil and Recent Reptilia," by Professor Owen; and a communication of much general interest, "On Japan;" by Lawrence Oliphant, Esq.]

ON THE ORDERS OF FOSSIL AND RECENT REPTILIA, AND THEIR DISTRIBUTION IN TIME.* BY PROF. OWEN, F.R.S., ETC.

Professor Owen began by remarking that, with the exception of Geology, no collateral science had profited so largely from the study of organic remains as Zoology. The catalogues of animal species had received immense accessions from the determination of the nature and affinities of those which had become extinct, and much deeper and clearer insight had been gained into the natural arrangement and subdivision of the classes of animals since Palæontology had expanded our survey of them. Of this the class Reptilia, or cold-blooded air-breathing Vertebrates, afforded a striking example. In the latest edition of the 'Règne Animal,' of Cuvier, 1829, as in the 'Elémens de Zoologie' of M. Edwards, 1834–37, and the still more recent monograph on American Testudinata, by Agassiz, 4to, 1857, the quadruple division of the class, proposed by Brongniart in 1802, was adhered to, viz., Chelonia (tortoises, turtles), Sauria (crocodiles, lizards), Ophidia (serpents), Batrachia (frogs, newts); only the last group is made a distinct class by the distinguished Professor of the United States:—"After this separation of the Batrachians from the true Reptiles we have only three orders left in the class of Reptiles proper,—the Ophidians, the Saurians, and the Chelonians," l. c. p. 239. In Prof. Owen's Reports on British Fossil Reptiles, to the British Association, in 1839 and 1841, it was proposed to divide the class into eight orders, viz., Enaliosauria, Crocodilia, Dinosauria, Lacertilia, Pterosauria, Chelonia, Ophidia, and Batrachia, which were severally characterized. Subsequent researches had brought to light additional forms and structural modifications of cold-blooded air-breathing animals now extinct, which had suggested corresponding modifications of their distribution into ordinal groups. Another result of such deeper insight into the forms that have passed away, has been the clearer recognition of the artificiality of the boundary between the classes Pisces and Reptilia of modern zoological systems. The conformity of pattern in the arrangement of the bones of the outwardly well-ossified skull in certain

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* From *The Athenæum* of October 1, 1859.

fishes with well developed lung-like air-bladders (Polypterus, Lepidosteus, Sturio), and in the extinct reptiles, Archegosaurus and Labyrinthodon: the persistence of the notochord (*chorda dorsalis*) in Archegosaurus as in Sturio: the persistence of the notochord and branchial arches in Archegosaurus and Lepidosiren: the absence of occipital condyle or condyles in Archegosaurus as in Lepidosiren: the presence of teeth with the labyrinthic interblending of dental tissues in Dendrodus, Lepidosteus, and Archegosaurus, as in Labyrinthodon: the large median and lateral throat-plates in Archegosaurus as in Megalichthys, and in the modern fishes Arapaima and Lepidosteus:—all these characters, as the author had urged in his Lectures at the Government School of Mines (March, 1858), pointed to one great natural group, remarkable for the extensive gradations of development, linking and blending together fishes and reptiles within the limits of such group. The salamandroid (or so-called "sauroid") Ganoids—Lepidosteus and Polypterus—are the most ichthyoid, the Labyrinthodonts the most sauroid, of the great group: the Lepidosiren and Archegosaurus are intermediate gradations, one having more of the piscine, the other more of the reptilian, character. Archegosaurus conducts the march of development from the fish proper to the Labyrinthodont type; Lepidosiren conducts it to the perennibranchiate, or modern batrachian, type. Both forms expose the artificiality of the ordinary class-distinction between Pisces and Reptilia, and illustrate the naturality of the cold-blooded Vertebrates, or "Hæmatocrya" (αιμα, blood, κρυος, frost: the correlative group is the "hæmatotherma.") Reptiles are defined as "cold-blooded, air-breathing Vertebrates;" but the Siren and Proteus chiefly breathe by gills, as did most probably the Archegosaurus. The modern naked Batrachia annually mature, at once, a large number of small ova. The embryo is developed with but a small allantoic appendage, and is hatched with external gills. These are retained throughout life by a few species; the rest undergo a more or less degree of metamorphosis. Other existing reptiles have comparatively few and large eggs; and the embryo is inclosed in a free amnios, and is more or less enveloped by a large allantois. It undergoes no marked transformation after being hatched. On this difference the Batrachia have been by some naturalists separated as a distinct class from the Reptilia. But the number of ova simultaneously developed in the viviparous land salamanders is much less than in the siren, and not more than in the turtle; and, save in respect of the external gills, which disappear before or soon after birth, the salamander does not undergo a more marked transformation, after being hatched, than does the turtle or crocodile.* It depends, therefore, upon the value assigned to the different proportions of the allantois in the embryo of the salamander and lizard, whether they be pronounced to belong or not to distinct classes of animals. This embryonic, or developmental, character, is unascertainable in the extinct Archegosaurus and Labyrinthodon. The affinity of Labyrinthodon to Ichthyosaurus, and those structures which have led the ablest Germans palæontologists to pronounce the Labyrinthodonts to be true Saurians, under the names of Mastodonsaurus, Trematosaurus, Capitosaurus, &c., may well support the conjecture that modifications more "reptilian" than those in Salamandra may have attended the development of their young. Characters derived

* The Cæcilia may probably depart still further from the type-batrachian mode of development, and approach more to the type-reptilian mode.

from the nature of the cutaneous coverings equally fail to determine the class-characters of Batrachia as contra-distinguished from Reptilia. It is true that all existing Batrachia have a scaleless skin, or very minute scales (Cæcilia), but not all existing reptiles have horny scales. The crocodiles and certain lizards show a development of dermal bones similar to that in certain placoid and ganoid fishes. This development is greater, and the resemblance is closer, in those ancient forms of Reptilia which exhibit in their endo-skeleton unmistakeable signs of their affinity to ganoid fishes and Batrachia. In a survey, therefore, of the present known forms of cold-blooded, air-breathing Vertebrates, recent and fossil, Prof. Owen could not define any real and adequate boundary for dividing them primarily into two distinct classes of Batrachians and Reptiles. As little was he able to point out a character dividing the air-breathing from the water-breathing Hæmatocrya—the reptiles from the fishes. In the present communication the author drew an arbitrary line between Lepidosiren and Archegosaurus, and proposed to begin his review of the ordinal groups of Reptilia, or air-breathing Hæmatocrya, with that of which the Archegosaurus was the type.

Order I. *Ganocephala.*—For this group or order he proposed the name of Ganocephala (γανος, lustre, κεφαλη, head), in reference to the sculptured and externally-polished or ganoid bony plates with which the entire head was defended. These plates include the "*postorbital*" and "*supertemporal*" ones, which roof over the temporal fossæ. No occipital condyles. The teeth have converging inflected folds of cement at their basal half. The notochord is persistent; the vertebral arches and peripheral elements are ossified; the pleurapophyses are short and straight; pectoral and pelvic limbs, which are natatory and very small; large median and lateral "throat-plates;" scales small, carinate, sub-ganoid; traces of branchial arches. The above combination of characters gives the value of an ordinal group in the cold-blooded Vertebrata. The extinct animals which manifest it were first indicated by certain fossils discovered in the sphærosideritic clay-slate forming the upper member of the Bavarian coal-measures, and also in splitting spheroidal concretions from the coal-field of Saarsbruck, near Treves; these fossils were originally referred to the class of fishes (*Pygopterus Lucius*, Agassiz.) But a specimen from the "Brandschiefer" of Münster-Appel presented characters which were recognised by Dr. Gergens to be those of a Salamandroid reptile.* Dr. Gergens placed his supposed "Salamander" in the hands of M. Hermann von Meyer for description; who communicated the result of his examination in a later number of the under-cited journal.† In this notice the author states that the Salamander-affinities of the fossil in question, for which he proposes the name of *Apateon pedestris*, "are by no means demonstrated."‡ "Its head might be that of a fish, as well as of a lizard, or of a batrachian." "There is no trace of bones of limbs." M. von Meyer concludes by stating that, "in order

* "Mainz, Oktober, 1843.—In dem Brandschiefer von Münster-Appel, in Rhein-Baiern, habe ich in vorigen Jahre einen Salamander aufgefunden. Gehört dieser Schiefer der Kohlen-formation? in diesene falle wäre der Fund auch in anderen Hinsicht interressant." Leonhart und Bronn, Neues Jahrbuch für Mineralogie, &c., 1844. p. 49.

† Ibid. 1844, p. 336.

‡ "Ob das—Apateon pedestris—ein Salamander-artiges Geschöpf war, ist keineswegs ausgemacht."

to test the hypothesis of the Apateon being a fossil fish, he has sent to Agassiz a drawing, with a description of it." Three years later, better preserved and more instructive specimens of the problematical fossil were obtained by Prof. von Dechen from the Bavarian coal-fields, and were submitted to the examination of Prof. Goldfuss, of Bonn; he published a quarto memoir on them, with good figures, referring them to a Saurian genus, which he calls Archegosaurus, or "primeval lizard,"—deeming it to be a transitional type between the fish-like Batrachia and the lizards and crocodiles.* The estimable author, on the occasion of publishing the above memoir, transmitted to Prof. Owen excellent casts of the originals therein described and figured. These casts were presented by the Professor to the Museum of the Royal College of Surgeons, London, and were described by him in his 'Catalogue of the Fossil Reptiles,' in that Museum, (4to. 1854). The conclusions which Prof. Owen formed thereupon, as to the position and affinities of the Archegosaurus in the reptilian class, are published in that Catalogue, and were communicated to and discussed at the Geological Society of London (see the 'Quarterly Journal of the Geological Society,' Vol. iv., 1848). One of the specimens appeared to present evidence of persistent branchial arches. The osseous structure of the skull, especially of the orbits, through the completed zygomatic arches, indicated an affinity to the Labyrinthodonts; but the vertebræ and numerous very short ribs, with the indications of stunted swimming limbs, impressed the writer with the conviction of the near alliance of the Archegosaurus with the Proteus and other perennibranchiate reptiles. This conclusion of the affinity of Archegosaurus to existing types of the reptilian class is confirmed by the subsequently discovered specimens described and figured by M. von Meyer, in his 'Palæontographica' (Bd. vi., 2te Hef. 1857),—more especially by his discovery of the embryonal condition of the vertebral column†—*i. e.*, of the persistence of the notochord, and the restriction of ossification to the arches and peripheral vertebral elements. In this structure the old carboniferous Reptile resembled the existing Lepidosiren, and afforded further ground for regarding that remarkable existing animal as one which obliterates the line of demarcation between the fishes and the reptiles. Coincident with this non-ossified state of the basis of the vertebrate bodies of the trunk is the absence of the ossified occipital condyles, which condyles characterize the skull in better developed Batrachia. The fore part of the notochord has extended into the basi-sphenoid region, and its capsule has connected it, by ligament, to the broad, flat ossifications of expansions of the same capsule, forming the basi-occipital or basi-sphenoid plate. The vertebræ of the trunk in the fully developed full-sized animal present the following stages of ossification. The neurapophyses coalesce at the top to form the arch, from the summit of which was developed a compressed, subquadrate, moderately high spine, with the truncate, or slightly convex, summit, expanded in the fore and aft direction, so as to touch the contiguous spines in the back: the spines are distinct in the tail. The sides of the base of the neural arch are thickened and extended outwards into diapophyses, having a convex articular surface for the attachment

* "Archegosaurus: Fossile Saurier aus dem Steinkohlengebirge die den Uebergang des Ichthyoden zu den Lacerten und Krokodilen bilden," p. 3. 'Beitrage zur vorweltlichen Fauna des Steinkohlengebirges,' 4to. 1847,

† 'Reptilien ausder Steinkohlen Formation in Deutschland,' Sechster Band, p. 61.

of the rib: the fore part is slightly produced at each angle into a zygapophysis looking upward and a little forward; the hinder part was much produced backwards, supporting two-thirds of the neural spine, and each angle developed into a zygapophysis, with a surface of opposite aspects to the anterior one. In the capsule of the notochord three bony plates were developed, one on the ventral surface, and one on each side, at or near the back part of the diapophysis. These bony plates may be termed "cortical parts" of the centrum, in the same sense in which that term is applied to the element which is called "body of the atlas" in man and Mammalia, and "sub-vertebral wedge-bone" at the fore part of the neck in Enaliosauria. As such ventral or inferior cortical elements co-exist with seemingly complete centrums in the Ichthyosaurus, thus affording ground for deeming them essentially distinct from a true centrum, the term "hypapophyses" had been proposed by Prof. Owen for such independent inferior ossifications in and from the notochordal capsule, and by this term may be signified the sub-notochordal plates in Archegosaurus, which co-exist with proper "hæmapophyses," in the tail. In the trunk they are flat, subquadrate, oblong bodies, with the angles rounded off; in the tail they bend upwards by the extension of the ossification from the under to the side parts of the notochordal capsule; sometimes touching the lateral cortical plates. These serve to strengthen the notochord and support the intervertebral nerve in its outward passage. The ribs are short, almost straight, expanded and flattened at the ends, round and slender at the middle. They are developed throughout the trunk and along part of the tail, co-existing there with the hæmal arches, as in the menopome.* The hæmal arches, which are at first open at their base, become closed by extension of ossification inwards from each produced angle, converting the notch into a foramen. This forms a wide oval, the apex being produced into a long spine; but towards the end of the tail the spine becomes shortened, and the hæmal arch is reduced to a mere flattened ring. The size of the canal for the protection of the caudal blood-vessels indicates the powerful muscular actions of that part; as the produced spines from both neural and hæmal arches bespeak the provision made for muscular attachments, and the vertical development of the caudal swimming organ. All these modifications of the vertebral column demonstrate the aquatic habits of the Archegosaurus; the limbs being in like manner modified as fins, but so small and feeble, as to leave the main part of the function of swimming to be performed, as in fishes and perennibranchiate batrachia, by the tail. The skull of the Archegosaurus appears to have retained much of its primary cartilage internally, and ossification to have been chiefly active at the surface; where, as in the combined dermo-neural ossifications of the skull in the sturgeons and salamandroid fishes, *e.g.*, Polypterus, Amia, Lepidosteus, these ossifications have started from centres more numerous, than those of the true vertebral system in the skull of Saurian reptiles. The teeth are usually shed alternately. They consist of osteo-dentine, dentine, and cement. The first substance occupies the centre, the last covers the superficies of the tooth, but is introduced into its substance by many concentric folds extending along the basal half. These folds are indicated by fine longitudinal straight striæ along that half of the crown. The section of the tooth at that part gives the

* "Principal Forms of the Skeleton," Orr's 'Circle of the Sciences,' p. 187, fig. 11.

same structure which is shown by a like section of a tooth of the *Lepidosteus oxyurus*.* The same principle of dental composition is exemplified in the teeth of most of the ganoid fishes of the Carboniferous and Devonian systems, and is carried out to a great and beautiful degree of complication in the old red Dendrodonts. The repetition of the same principle of dental structure in one of the earliest genera of Reptilia, associated with the defect of ossification of the endoskeleton and the excess of ossification in the exa-skeleton of the head, decisively illustrate the true affinities and low position in the Reptilian class of the so-called Archegosauri. For other details of the peculiar and interesting structure of the animals representing the earliest or oldest known order of Reptiles, Prof. Owen referred to the article "Palæontology" in the 'Encyclopædia Britannica.' This order is "carboniferous."

Order II.—*Labyrinthodontia*.—Head defended, as in the Ganocephala, by a continuous casque of externally sculptured and unusually hard and polished osseous plates, including the supplementary "postorbital" and "supertemporal" bones, but leaving a "foramen parietale."† Two occipital condyles. Vomer divided and dentigerous. Two nostrils. Vertebral centra, as well as arches, ossified, biconcave. Pleurapophyses of the trunk, long and bent. Teeth rendered complex by undulation and side branches of the converging folds of cement, whence the name of the order. Osseous scutes in some. The reptiles presenting the above characters have been divided, according to minor modifications exemplified by the form and proportions of the skull, by the relative position and size of orbital, nasal and temporal cavities, &c., into the several genera; as *e. g.* Mastodonsaurus. Trematosaurus, Metopias, Capitosaurus, Zygosaurus, Xestorrhytias. The relation of these remarkable reptiles to the Saurian order has been advocated as being one of close and true affinity, chiefly on the character of the extent of ossification of the skull and of the outward sculpturing of the cranial bones. But the true nature of some of these bones appears to have been overlooked, and the gaze of research for analogous structures has been too exclusively upward. If directed downward from the Labyrinthodontia to the Ganocephali, and to certain ganoid fishes, it suggests other conclusions, which had been worked out by Prof. Owen, in his article on "Palæontology," above referred to. There is nothing in the known structure of the so-named Archegosaurus or Mastodonsaurus that truly indicates a belonging to the Saurian or Crocodilian-order of reptiles. The exterior ossifications of the skull and the canine-shaped labyrinthic teeth are both examples of the Salamandroid modification of the ganoid type of fishes. The small proportion of the fore-limb of the Mystriosaurus in nowise illustrates this alleged saurian affinity; for though it be as short as in Archegosaurus, it is as perfectly constructed as in the Crocodile, whereas the short fore-limb of Archegosaurus is constructed after the simple type of that of the Proteus and Siren. But the futility of this argument of the sauroid affinities is made manifest by the proportions of the hind-limb of Archegosaurus; it is as stunted as the fore-limb. In the Labyrinthodonts it presented larger proportions, which, however, may be illustrated as naturally by these proportions of the limbs in certain Batrachia, as in the Teleosaurus.

* Wyman, 'American Journal of the Natural Sciences,' October, 1843.

† The corresponding vacuity is larger in some ganoid fishes.

Order III.—*Ichthyopterygia.*—The bones of the head still include the supplementary "post-orbitals" and "supra-temporals," but there are small temporal and other vacuities between the cranial bones: a "foramen parietale," a single convex occipital condyle,* and one vomer which is edentulous. Two antorbital nostrils. Vertebral centra, ossified, biconcave. Pleurapophyses of the trunk long and bent the anterior ones with bifurcate heads. Teeth with converging folds of cement at their base; implanted in a common alveolar groove, and confined to the maxillary, premaxillary, and premandibular bones. Premaxillaries much exceeding the maxillaries in size. Orbit very large: a circle of sclerotic plates. Limbs natatory; with more than five multi-articulate digits; no sacrum. With the retention of characters which indicate, as in the preceding orders, an affinity to the higher Ganoidea, the present exclusively marine Reptilia more directly exemplify the Ichthyic type in the proportions of the premaxillary and maxillary bones; in the shortness and great number of the biconcave vertebræ; in the length of the pleurapophyses of the vertebræ near the head; in the large proportional size of the eyeball, and its well-ossified sclerotic coat, and especially in the structure of the pectoral and ventral fins. The skin is naked. The order ranges from the lias to the chalk.

Order IV.—*Sauropterygia.*—No post-orbital and supra-temporal bone:† large temporal and other vacuities between certain cranial bones; a foramen parietale; two antorbital nostrils; teeth simple, in distinct sockets of premaxillary, maxillary, and premandibular bones, rarely on the palatine or pterygoid bones; maxillaries larger than premaxillaries. Limbs natatory; not more than five digits. A sacrum of one or two vertebræ for the attachment of the pelvic arch in some, numerous cervical vertebræ in most. Pleurapophyses with simple heads; those of the trunk long and bent. In the Pliosaurus the neck vertebræ are comparatively few in number, short and flat. The sauropterygian type seems to have attained its maximum dimensions in this genus: the species of which are peculiar to the Oxfordian and Kimmeridgian divisions of the Upper Oolitic system. M. von Meyer regards the number of cervical vertebræ and the length of neck as characters of prime importance in the classification of Reptilia, and founds thereon his Order called Macrotrachelen, in which he includes Simosaurus, Pistosaurus and Nothosaurus, with Plesiosaurus. No doubt the number of vertebræ in the same skeleton bears a certain relation to ordinal groups; the Ophidia find a common character therein; yet it is not their essential character; for the snake-like form, dependent on multiplied vertebræ, characterizes equally certain Batrachians (Cæcilia) and fishes (Muræna). Certain regions of the vertebral column are the seats of great varieties in the same natural group of Reptilia. We have long-tailed and short-tailed lizards: but do not, therefore, separate those with numerous caudal vertebræ, as "Macrourau," from those with few or none. The extinct Dolichosaurus of the Kentish chalk, with its procœlian vertebræ, cannot be ordinally separated, by reason of its more numerous cervical vertebræ, from other shorter-necked procœlian lizards. As little can we separate the short-necked and, the big-headed amphicœlian Pliosaur from the Macrotrachelians of Von Meyer-

* This character is retained throughout the rest of the class, save in Batrachia, and will not afterwards be expressed in their characters.

† These bones do not reappear in the subsequent orders.

with which it has its most intimate and true affinities. There is much reason, indeed, to suspect that some of the Muschelkalk Saurians, which are as closely allied to Nothosaurus as Pliosaurus is to Plesiosaurus, may have presented analogous modifications in the number and proportions of the cervical vertebræ. It is hardly possible to contemplate the broad and short-snouted skull of the Simosaurus, with its proportionably large teeth, without inferring that such a head must have been supported by a shorter and more powerful neck than that which bore the long and slender head of the Nothosaurus or Pistosaurus. The like inference is more strongly impressed upon the mind by the skull of the Placodus, still shorter and broader than that of Simosaurus, and with vastly larger teeeh, of a shape indicative of their adaptation to crushing molluscous or crustaceous shells. Neither the proportions and armature of the skull of Placodus, nor the mode of obtaining the food indicated by its cranial and dental characters, permit the supposition that the head was supported by other than a comparatively short and strong neck. Yet the composition of the skull, its proportions, cavities and other light-giving anatomical characters, all bespeak the close essential relationship of Placodus to Simosaurus and other so-called Macrotrachelian reptiles of the Muschelkalk beds. Prof. Owen continued, therefore, as in his Report of 1841, to regard he fin-like modification of the limbs as a better ordinal character than the number, of vertebræ in any particular regoin of the spine. Yet this limb-character is subordinate to the characters derived from the structure of the skull and of the teeth. If, therefore, the general term Enaliosauria may be sometimes found convenient in its application to the natatory group of Saurian Reptiles, the essential distinctness of the orders Sauropterygii and Ichthyopterygii, typified by the Ichthyosaurus and Plesiosaurus respectively, should be borne in mind. The Plesiosaurus. with its very numerous cervical vertebræ, sometimes thirty in number may be regarded as the type of the Sauropterygii, or pentadactyle sea-lizards. Of all existing reptiles, the lizards, and, amongst these, the Old World monitors, (*Varanus*, Fitz.), by reason of the cranial vacuities in front of the orbits, most resemble the Plesiosaur in the structure of the skull; as in the division of the nostrils, the vacuities in the occipital region between the exoccipitals and tympanics, the parietal foramen, the zygomatic extension of the post-frontal, the palato-maxillary, and pterygo-sphenoid vacuities in the bony palate; and all these are lacertian characters as contradistinguished from crocodilian ones. But the antorbital vacuities, between the nasal, prefrontal, and maxillary bones, are the sole external nostrils in the Plesiosaurs. The zygomatic arch abuts against the fore part of the tympanic and fixes it: a much greater extent of the roof of the mouth is ossified than in lizards, and the palato-maxillary and pterygo-sphenoid fissures are reduced to small size. The teeth, finally, are implanted in distinct sockets. That the Plesiosaur had the "head of a lizard" is an emphatic mode of expressing the amount of resemblance in their cranial conformation. The crocodilian affinities, however, are not confined to the teeth, but are exemplified in some particulars of the structure of the skull itself. In the simple mode of articulation of the ribs the lacertian affinity is again strongly manifested; but to this vertebral character such affinity is limited. All the others exemplify the ordinal distinction of the Plesiosaurs from known existing reptiles. The shape of the joints of the centra; the number of vertebræ between the head and tail, especially of those of the neck;

the slight indication of the sacral vertebræ; the non-confluence of the caudal hæmapophyses with each other, are all "plesiosauroid." In the size and number of abdominal ribs and sternum may perhaps be discerned a first step in that series of development of the hæmapophyses of the trunk, which reaches its maximum in the plastron of the Chelonia. The connexion of the clavicle with the scapula is common to the Chelonia with the Plesiosauri; the expansion of the coracoids—extreme in Plesiosauri—is greater in Chelonia than in Crocodilia; but is still greater in some Lacertia. The form and proportions of the pubis and ischium, as compared with the ilium, in the pelvic arch of the Plesiosauri, find their nearest approach in the pelvis of marine Chelonia; and no other existing reptile now offers so near, although it be so remote, a resemblance to the structure of the paddles of the Plesiosaur. Both Nothosaurus and Pistosaurus had many neck-vertebræ, and the transition from these to the dorsal series was effected, as in Plesiosaurus, by the ascent of the rib-surface from the centrum to the neurapophysis; but the surface, when divided between the two elements, projected further outwards than in most Plesiosauri. In both Nothosaurus and Pistosaurus the pelvic vertebra developes a combined process (par- and di-apophysis). but of relatively larger, vertically longer size, standing well out, and from near the fore part of the side of the vertebra. This process with the coalesced riblet indicates a stronger ilium, and a firmer base of attachment of the hind limb to the trunk than in Plesiosaurus. Both this structure and the greater length of the bones of the fore-arm and leg show that the Muschelkalk predecessors of the liassic Plesiosauri were better organized for occasional progression on dry land. The Sauropterygii extend from the Trias to the chalk inclusive.

Order V.—*Anomodontia* (*ανομος*, lawless, *οδους*, tooth).—This order is represented by three families, all the species of which are extinct, and appear to have been restricted to the triassic period. Teeth wanting, or confluent with tusk-shaped premaxillaries, or confined to a single pair in the upper jaw, which have the form and proportions of canine tusks. A foramen parietale and two nostrils, tympanic pedicle fixed. Vertebræ biconcave; pleurapophysis of the trunk long and curved the anterior ones with bifurcate heads; a sacrum of four or five vertebræ forming with broad iliac and pubic bones, a large pelvis. Limbs ambulatory.——Family Dicynodontia. A long ever-growing tusk in each maxillary bone; premaxillaries connate, and forming with the lower jaw a beak-shaped mouth, probably sheathed with horn. This includes two genera—Dicynodon and Ptychognathus—all the known species of which are founded on fossils from rocks of probably triassic age in South Africa.——Family Cryptodontia. Upper as well as lower jaw edentulous. The genus Oudenodon closely conforms to the dicynodont type, and the species are from the same rocks and localities.——Family Gnathodontia. Two curved tusk-shaped bodies holding the place of the premaxillaries, and consisting of confluent, dentinal and osseous substance, descending in front of the symphysis mandibulæ. These bodies are homologous with the pair of confluent premaxillary teeth and bones in the existing New Zealand amphicœlian lizard Rhynchocephalus; they are analogous to the tusks in the Dicynodonts, and must have served a similar purpose in the extinct reptiles of the New Red (Trias) Sandstone of Shropshire (Rhynchosaurus), in which alone this structure, with an otherwise edentulous beak-shaped mouth, has hitherto been met with. To this order belongs the Rynchosauroid reptile, from the Elgin sandstone, with palatal teeth, called Hyperodapedon, by Prof. Huxley.

Order VI. *Pterosauria.*—Although some members of the preceding Order resembled birds in the shape or the edentulous state of the mouth, the reptiles of the present order make a closer approach to the feathered class in the texture and and pneumatic character of most of the bones, and in the modification of the pectoral limbs for the function of flight. This is due to the elongation of the antebrachial bones, and more especially to the still greater length of the metacarpal and phalangial bones of the fifth or outermost digit, the last phalanx of which terminates in a point. The other fingers were of more ordinary length and size, and were terminated by claws, the number of their phalanges progressively increasing to the fourth, which had four joints. The whole osseous system is modified in accordance with the possession of wings: the bones are light, hollow, most of them permeated by air-cells, with thin, compact outer walls. The scapula and coronoid are long and narrow, but strong. The vertebræ of the neck are few but large and strong,—for the support of a large head with long jaws, armed with sharp-pointed teeth. The skull was lightened by large vacuities, of which one was interposed between the nostril and the orbit. The vertebræ of the back are small as are those of the sacrum, which were from two to five in number, but combined with a small pelvis and weak hind-limbs, bespeaking a creature unable to stand and walk like a bird; the body must have been dragged along the ground like that of a bat. The vertebral bodies were united by ball-and-socket joints, the cup being anterior, and in them we have the earliest manifestation of the "procœlian" type of vertebra. The Pterosauria are distributed into genera according to modifications of the jaws and teeth. In the oldest known species, from the lias, the teeth are of two kinds: a few, at the fore part of the jaws, are long, large, sharp-pointed, with a full elliptical base, in distinct and separated sockets; behind them is a close-set row of short, compressed, very small, lancet-shaped teeth. These form the genus Dimorphodon, Ow. In the genus Ramphorynchus, V. M., the fore par- of each jaw is without teeth, and may have been incased by a horny beak; but behind the edentulous production there are four or five large and long teeth followed by several smaller ones. The tail is long, stiff, and slender. In the genus Pterodactylus, Cuv., the jaws are provided with teeth to their extremities; all the teeth are long, slender, sharp-pointed, set well apart. The tail is very short. *P. longirostris*, Ok., about ten inches in length. From lithographic slate at Pappenheim, *P. crassirostris*, Goldf., about one foot long, *P. Sedgwickii*, Ow., from the greensand, with an expanse of wing of twenty feet, exemplify the Pterodactyles proper. The oldest well-known Pterodactyle is the *Dimorphodon macronyx* of the lower lias; but bones of Pterodactyle have been discovered in coeval lias of Wirtemberg. The next in point of age is the *Dimorphodon Banthensis*, from the "Posidonomyen-Schiefer" of Banz in Bavaria, answering to the alum shale of the Whitby lias. Then follows the *P. Bucklandi*, from the Stonesfield oolite. Above this come the first-defined and numerous species of Pterodactyle from the lithographic slates of the middle oolitic system in Germany, and from Cirin on the Rhone. The Pterodactyles of the Wealden are, as yet, known to us by only a few bones and bone fragments. The largest known species are the *P. Sedgwickii* and *P. Fittoni*, from the upper greensand of Cambridgeshire. Finally, the Pterodactyles of the middle chalk of Kent, almost as remarkable for their great size constitute the last forms of flying reptile known in the history of the crust of this earth.

Order VII. *Thecodontia.*—Vertebral bodies biconcave: ribs of the trunk long and bent, the anterior ones with a bifurcate head: sacrum of three vertebræ: limbs ambulatory, femur with a third trochanter. Teeth with the crown more or less compressed, pointed, with trenchant and finely serrate margins: implanted in distinct sockets. This order is represented by the extinct genera Thecodontosaurus and Palæosaurus of Riley and Stutchbury, from probably triassic strata, near Bristol: by the Cladyodon of the New Red Sandstone of Warwickshire, with which, probably, the Belodon of the Keuper Sandstone of Wirtemberg is generically synonymous. The Bathygnathus, Leidy, from New Red Sandstone of Prince Edward's Island, North America, is probably, a member of the present order: which seems to have been the forerunner of the next.

Order VIII. *Dinosauria.*—Cervical and anterior dorsal vertebræ, with par- and di-apophyses, articulating with bifurcate ribs: dorsal vertebræ with a neural platform; sacral vertebræ from four to six in number. Articular ends of the free vertebræ, more or less flat; but in the cervical becoming convex in front and concave behind, in some species. Limbs ambulatory, strong, long and unguiculate. Femur with a third trochanter in some. The species of this order were of large bulk, and were eminently adapted for terrestrial life; some, *e. g.*, Iguanodon and, probably, Hylæosaurus, were more or less vegetable feeders; others, *e. g.*, Megalosar, were carnivorous. The Dinosauria ranged, in time, from the lias (Scelidosaurus Ow., from Charmouth) to the upper greensand (Iguanodon). The Megalosaurus occurs in the lower oolite to the Wealden inclusive. The latter formation is that in which the Dinosauria appear to have flourished in greatest numbers and of hugest dimensions.

Order IX. *Crocodilia.*—Teeth in a single row, implanted in distinct sockets, external nostril single and terminal or subterminal. Anterior trunk; vertebræ with par- and di-apophyses, and bifurcate ribs; sacral vertebræ two, each supporting its own neural arch. Skin protected by bony, usually pitted, plates.

Sub-Order Amphicœlia (αμφι, both; κοιλος, hollow; the vertebræ being hollowed at both ends).—Crocodiles, closely resembling in general form the long and slender-jawed kind of the Ganges, called Gavial, existed from the time of the deposition of the lower lias. The teeth of the liassic forms were similarly long slender, and sharp, adapted for the prehension of fishes, and their skeleton was modified for more efficient progress in water, by both the terminal vertebral surfaces being slightly concave, by the hind limbs being relatively larger and stronger, and by the orbits forming no prominent obstruction to progress through water. From the nature of the deposits containing the remains of the so-modified crocodiles they were marine. The fossil crocodile from the Whitby lias, described and figured in the *Philosophical Transactions*, 1758, p. 638, is the type of these Amphicœlian species. They have been grouped under the following generic heads:—Teleosaurus, Mystriosaurus, Macrospondylus, Massospondylus, Pelagosaurus, Acolodon, Suchosaurus, Goniopholis, Pœcilopleuron, Stagonolepis, (?) &c.* Species of the above genera range from the lias to the chalk inclusive.

Sub-Order Opisthocœlia (οπισθος, behind, κοιλος, hollow: vertebræ concave behind, convex in front).—The small group of Crocodilia, so-called, is an artificial one based upon more or less of the anterior trunk vertebræ being united by ball and-socket joints, but having the ball in front, instead of, as in modern crocodiles, behind. Cuvier first pointed out this peculiarity† in a crocodilian from the Oxfordian beds at Harfleur and the Kimmeridgian at Havre. Prof. Owen had described similar Opisthocœlian vertebræ from the Great Oolite at Chipping Norton, from the Upper Lias of Whitby, and, but of much larger size, from the Wealden formations of Sussex and the Isle of Wight. These specimens probably belonged, as suggested by him in 1841,‡ to the fore part of the same vertebral column as the vertebræ, flat at the fore part, and slightly hollow behind, on which he founded the genus Cetiosaurus. The smaller Opisthocœlian vertebræ described by Cuvier have been referred by Von Meyer to a genus called Streptospondylus. In one species from the Wealden, dorsal vertebræ, measuring eight inches across, are only four inches in length, and caudal vertebræ nearly seven inches across are less than four inches in length. These characterize the species called *Cetiosaurus brevis.* Caudal vertebræ, measuring seven inches deep and five and a half inches in length, from the Lower Oolite at Chipping Norton, and the Great Oolite at Enstone, represent the species called *Cetiosaurus medius.* Caudal vertebræ from the Portland Stone at Garsington, Oxfordshire, measuring seven inches nine lines across and seven inches in length, were referred by the author to the *Cetiosaurus longus.* The latter, he remarked, must have been the most gigantic of crocodilians.

Sub-Order Prœlia (προς, front, κοιλος, hollow: vertebræ with the cup at the fore part and the ball behind). Crocodilians with cup-and-ball vertebræ, like those of living species, first make their appearance in the greensand of N. America (*Croc. basifissus* and *C. basitruncatus*, Ow.)‖ In Europe their remains are first found in the tertiary strata. Such remains from the plastic clay of Meudon have been referred to *Crocodilus isorhynchus*, *C. cœlorhyncus*, *C. Becquereli.* In the 'Calcaire Grossier' of Argenton and Castelnaudry have been found the *C. Rallinati*, and *C. Dodanii.* In the coeval eocene London clay, at Sheppy Island, the entire skull and characteristic parts of the skeleton of *C. toliapicus* and *C. champsoides* occur. In the somewhat later eocene beds at Bracklesham occur the remains of the Gavial-like *C. Dixoni.* In the Hordle beds have been found the *C.*

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* This was referred to the present order by the author, after inspection of the specimens brought to the British Association Meeting, at Leeds, by Sir R. Murchison, but with a note on the greater relative breadth of the coracoid, as shown by the part of the bone then exposed.—(Encyclo. Brit. Art. 'Palæontology'). Prof. Huxley, to whom the specimens were subsequently consigned for description, together with others directly transmitted to him, confirms the general crocodilian character of Stagonolepis. I regard the modifications of the limb-bones as indications of affinity with the Thecodontia; but the structure of the cranium must be ascertained to determine this point. The associated fossils, especially those allied to Rynchosaurus, in the Elgin sandstones, have a triassic character.

† 'Annales du Muséum,' tom. xii, p. 83, pl. x. xi.

‡ 'Report on British Fossil Reptiles,' *Trans. British Association*, for 1841, p. 96.

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Hastingsiæ, with short and broad jaws; and also a true alligator (*C. Hantoniensis*). It is remarkable that forms of procœlian Crocodilia, now geographically restricted, the gavial to Asia and the alligator to America, should have been associated with true crocodiles, and represented by species which lived, during nearly the same geological period, in rivers flowing over what now forms the south coast of England. Many species of procœlian Crocodilia have been founded on fossils from miocene and pliocene tertiaries. One of these, of the gavial sub-genus (*C. crassidens*), from the Sewalik tertiary, was of gigantic dimensions.

Order X. *Lacertilia.*—Vertebræ, in most, procœlian, with a single transverse process on each side, and with single-headed ribs; sacral vertebræ, not exceeding two. Small vertebræ of this type have been found in the Wealden of Sussex. They are more abundant, and are associated with other and more characteristic parts of the species in the cretaceous strata. On such evidence have been based the *Rhapiosaurus subulidens*, the *Coniasaurus crassidens*, and the *Dolichosaurus longicollis*. But the most remarkable and extreme modifications of the lacertian type, in the cretaceous period, is that manifested by the huge species of which a cranium, five feet long, was discovered in the upper chalk of St. Peter's Mount. near Maestricht, in 1780. This species, under the name Mosasaurus, is well known by the descriptions of Cuvier. Allied species have been found in the cretaceous strata of England and North America. The Leiodon anceps of the Norfolk chalk was a nearly-allied marine Lacertian. The structure of the limbs is not yet well-understood; it may lead to a sub-ordinal separation of the Mosasauroids from the land lizards, most of which are represented by existing species, in which a close transition is manifested to the next order.

Order XI. *Ophidia.*—Vertebræ very numerous, procœlian, with a single transverse process on each side; no sacrum; no visible limbs. The earliest evidence, at present, of this order is given by the fossil vertebræ of the large serpent (Palæophis, Ow.) from the London clay of Sheppy and Bracklesham. Remains of a poisonous serpent, apparently a Vipera, have been found in miocene deposits at Sansans, south of France. Ophidiolites, from Œningen, have been referred to the genus Coluber.

Order XII. *Chelonia.*—The characters of this order, including the extremely and peculiarly modified forms of tortoises, terrapenes and turtles, are sufficiently well known. The chief modifications in oolitic Chelonia known to Prof. Owen were the additional pair of bones, interposed between the hyosternals and hyposternals of the plastron, in the genus Pleurosternon from the Upper Oolite at Purbeck. It would be very hazardous to infer the existence of reptiles, with the characteristic structure of the restricted genus Testudo, from the foot-prints in the triassic sandstone of Dumfries-shire. But Prof. Owen concurred in the general conclusions based upon the admirable figures and descriptions in the splendid monograph by Sir Wm. Jardine, Bart., F.R.S., that some of those foot-prints most probably belonged to species of the Chelonian order. As enormous species of true turtle (*chelone gigas*), the skull of which measured one foot across the back part, had left its remains in the eocene clay at Sheppy. The terrestrial type of the order had been exemplified on a still more gigantic scale by the Colossochelys of the Sewalik tertiaries.

Order XIII. *Batrachia.*—Vertebræ biconcave (*Siren*), procœlian (*Rana*), or opisthocœlian (*Pipa*): pleurapophyses short, straight. Two occipital condyles and two vomerine bones, in most dentigerous: no scales or scutes. Larvæ with gills, in most deciduous. Representatives of existing families or genera of true Batrachia have been found fossil, chiefly in tertiary and post-tertiary strata. Indications of a perennibranchiate batrachian had recently been detected by Prof. Owen, in a collection of minute Purbeck fossils. Anourous genera (*Palæophrynus*), allied to the toad, occurred in the Œniugen tertiaries, and here also the remains of the gigantic Salamander (*Andrias Schewzeri*) were discovered.

Summary of the above defined Orders.

Province—Vertebrata.
Class—Hæmatocrya.
Sub-Class—Reptilia.

Orders.

I. Ganocephala.
II. Labyrinthodontia.
III. Ichthyopterygia.
IV. Sauropterygia.
V. Anomodontia.
VI. Pterosauria.
VII. Thecodontia.
VIII. Dinosauria.
IX. Crocodilia.
X. Lacertilia.
XI. Ophidia.
XII. Chelonia.
XIII. Batrachia.

NOTES ON JAPAN. BY LAWRENCE OLIPHANT, F.R.G.S.

The following Notes are the results of personal observation during the recent mission of Lord Elgin to the Empire of Japan.

The three ports of the Empire visited by the mission, and which fell more immediately under our observation, were Nagasaki, situated in the Island of Kinsin; Simioda, a port opened by Commodore Perry on the Promontory of Idsa; and Yeddo, the capital city of the Empire. Of these Nagasaki is the one with which we have been for the longest period familiar. In former times it was a fishing village situated in the Principality of Omura. It is now an imperial demesne, and the most flourishing port in the Empire. It owes its origin to the establishment, at this advantageous point, of a Portuguese settlement in the year 1569; and its prosperity, to the enlightened policy pursued by the Christian Prince of Omura, in whose territory it was situated. Its transference to the Crown property was the result of political intrigues on the part of the Portuguese settlers, in consequence of which the celebrated Tageo Sama included it among the lands appertaining to the Crown. Situated almost at the westernmost extremity of the Empire, at the head of a deep land-locked harbour, and in convenient proximity to some of the wealthiest and most productive Principalities, Nagasaki possesses great local advantages, and will doubtless continue an important commercial emporium, even when the trade of the Empire at large is more fully developed, and has found an outlet through other ports. The town is pleasantly situated on a belt of level ground which intervenes between the water and the swelling hills. These, with their slopes terraced with rice fields; their wooded valleys and gushing streams; and their projecting points crowned with temples or frowning with batteries, form an amphitheatre of great scenic beauty; and the whole aspect of the place produces a most favourable impression on the mind of the stranger visiting Japan for the first time.

The Empire of Japan is stated, according to native authority, to consist of upwards of three thousand islands. The majority of these, however, are uninhabited rocks. The principal island is known to the natives as Dai Nipon. The word Nipon is, doubtless, the origin of the term Japan, now applied to the whole group. The Chinese have called Nipon, "Jipun, the Empire proceeding from the sun." Marco Polo calls it Jypanger, but all these words have clearly a common origin. Yesso, Kinsin, and Sikok complete the group of larger islands, which contain a territorial superficies, roughly estimated at 160,000 square miles. To these must be added the Japanese settlements in the neighbouring island of Tarakai, where the boundary which divides them from Russia, and marks the limit of that spreading Empire in this direction, remains yet undecided.

The city itself contains a population of about fifty thousand, and consists of between eighty and ninety streets, running at right angles to each other—broad enough to admit of the passage of wheeled vehicles, were any to be seen in them—and kept scrupulously clean. A canal intersects the city, spanned by thirty-five bridges, of which fifteen are handsomely constructed of stone. The Dutch factory is placed upon a small fan-shaped island about two hundred yards in length, and connected with the mainland by a bridge. Until recently, the members of the factory were confined exclusively to this limited area, and kept under a strict and rigid surveillance. The old *regime* is now however,rapidly passing away; and the history of their imprisonment, of the indignities to which they were exposed, and the insults they suffered, has already become a matter of tradition.

Kinsin, or "the Island of Nine," in which Nagasaki is situated, is so called because it is divided into nine provinces. It contains an area of about sixteen thousand miles, being in extent nearly equal to Sardinia. The provinces of which it is composed are—Fizen, Tsikuzen, Tsikugo, Buzen, Bungo, Figo, Oosom, Fingo, and Satsuma. I have enumerated these by name, not so much for the purpose of information as to convey some idea of the words and names in the Japanese language. All these provinces are divided among many princes, who are vassals of the empire. The supremacy, however, in each is generally vested in a single family, whose hereditary position among the aristocracy of the country confers upon it a recognized ascendancy.

In Kinsin, the most important of these Principalities, are Fizen and Satsuma. The largest city in the island, Saga, is the capital of Fizen and residence of its

Prince. Attached to this province there are no fewer than 1016 islands. One of these, Firando, is interesting to us, from the fact that, in the year 1613, an English factory was established there, which however, after a brief existence, failed, in consequence of a combination of adverse circumstances to which it is not necesary here to allude, more especially as we have no reason to anticipate that they will again arise to nip in the bud the commerce that is rapidly growing in those regions. Simabarra is another port of this province possessing historical interest. Its siege forms a celebrated but melancholy episode in the history of Christianity in Japan. Thirty-five thousand Roman Catholic Christians, who had taken refuge within its waters were bombarded by the Dutch at the behest of the Japanese Government, and utterly exterminated.

In former days Nagasaki was comprised within the limits of Fisen, and even now the defence of the city, in time of war, devolves upon the prince. The revenue of this high dignitary is stated to amount to about £360,000 a-year. His territory is one of the most productive in the empire, which will account for this enormous revenue. Besides rice, and various descriptions of grain, it produces tea, tobacco, and cotton, with fruit of divers sorts. Among the most important of its products, however, should be mentioned the vegetable tallow, one cargo of which has already reached this country, and been disposed of at a large profit. Among its mineral productions are iron, sulphur, cinnabar, and marble. There is a coal mine at Wukumote which some of the Dutch Mission have descended. They describe the mine as being well and judiciously worked, and the coal as being bituminous in its nature, and made into coke for use. Old Kainipfer tells a story (by way of illustrating the volcanic nature of the country) of a coal mine in this province which, through the carelessness of the miners, took fire, and has been burning ever since. The nearest coal mine is not more than seven miles from Nagasaki. Another very extensive one is situated in Tsekugen, about one hundred miles distant. A very excellent description of porcelain clay is also found here, and the European demand for eggshell China, which is sold in great quantities at Nagasaki, is chiefly supplied by the subjects of the princes of Ligon and Satsuma. The ruler of Ligon is, so far as we could learn from our Dutch informants at Nagasaki, a man of tolerably advanced views, and favourably disposed towards foreigners. He has already adopted many of our wisest inventions, but has not succeeded in thoroughly divesting himself of old prejudices. This was illustrated a short time prior to our visit, by his refusal to allow the Dutch to enter his territory to put up a steam engine which he himself had ordered out from Europe, to pump water out of one of his coal mines. But the Prince who has distinguished himself most notably by his progressive views is his Highness of Satsuma. Unfortunately, since our return to this country, we have received intelligence of the death of this most enlightened nobleman. A man of the highest rank, of enormous wealth, of great political influence, the Prince of Satsuma was ever ready to advance the interests of foreigners, and to introduce into his own State their arts and inventions. I was informed by a Dutch gentlemen who had visited him that he had established an electric telegraph between his castle and Hagosima, the chief city of his province, a distance of about three miles. He has also extensive glass factories, and cannon foundries, in which 800 workmen are employed.

Some idea may be formed of the scale upon which his establishment was conducted, from the fact that he possessed nine town houses in Yedo, and always travelled to that city with an escort of several thousand men. He was nearly connected with the Royal Family, his daughter being married to the late Tycoon, or Temporal Emperor, whose demise took place about the period of our arrival at Yedo.

A former Prince of Satsuma, was the conqueror of the Lewchew Islands. The Province of Satsuma contains great quantities of sulphur, which may form an mportant item in our trade with Japan. At its southern extremity is situated the Island of Loogasina, or Sulphur Island, which is said to burn incessantly. We did not pass within sight of it however. The mines of the island yield the Prince of Satsuma an annual revenue of 200 chests of silver.

The whole of the Island of Kinsin is eminently volcanic, notwithstanding its general fertility and varied products. Parts of it are wild and barren; the aspect of its shores and general character of its mountains would betray its origin, even did not incessant volcanic action exist to put the matter beyond a doubt. There are no less than five volcanoes active in this island—they are, Mitake, in the Province of Satsuma; Kirisima Yamma, in Fingo; Asoyammo, in Figo; Wunzler, in Fizen; and Tsurminyanma, in Bungo.

The most celebrated of these are the Kirisma Yamma and Wunzler, or the "High Mountain of Warm Springs." I find, on referring to the Chinese Repository, that in 1793 the summit of the mountain sunk entirely down; torrents of boiling water issued from all parts of the deep cavity which was thus formed, and the vapour arose like thick smoke. In one of its eruptions, it is recorded to have destroyed the ill-fated city of Simabara, when 35,000 persons are said to have perished There are also many hot and sulphurous springs, which are used as baths, and accounted to have great medical qualities. To some of these, curious superstitions are attached. They are considered departments for punishment in the infernal regions. To one which is covered at the top with a white cream like froth, are consigned pastry-cooks and confectioners who practised adulteration while in life; while deceitful brewers pass a miserable existence in a spring as thick and muddy as the beer and sakee they sold their customers. The Island of Kinsin is well watered; a hardy and industrious population inhabits its fertile valleys; its lofty mountain ranges contain scenes of great grandeur and sublimity, while its shores, indented with deep aud secure harbours and feathered with wood, owe much of their picturesque beauty to the numerous islands which stud those inland waters.

It is separated from the Island of Nipon by the narrow Straits of Vander Capellen or Simonerki, which connect the Straits of the Corea with the Purvonadei Sea. It was originally the intention of Lord Elgin to have explored on his retnrn voyage this most remarkable sheet of water, never yet traversed by foreign keel, and which must afford a most interesting field for surveys of scientific character, as also for general observation. Unfortunately, however, our time did not admit of his putting this design into execution. The South sea is thickly covered with islands, and was reported to us by the Japanese as navigable for ships of large draught. The large and important island of Sikok intervenes between it and the North Pacific Ocean with which this sea is connected, by the Straits of Bangon on the west, and the narrow Channel of Kind on the east. Sikok is, as its name implies, divided into four provinces; as, however, we did not even sight its shores we had no opportunity of obtaining any information about it. It is about 150 miles long, with an average breadth of 70 miles, and is computed to contain about 10,000 square miles.

With the Suwonda Sea, however we are more closely interested, for upon its margin is the Port of Hiogo, opened by the late treaty to the commerce of the west.

This port is situated in the Bay of Othosaka, opposite to the celebrated city of that name, from which it is ten or twelve miles distant. The Japanese Government have expended vast sums in their engineering efforts to improve its once dangerous anchorage. A break water, which was erected at a prodigious expense, and which cost the lives of numbers of workmen, has proved sufficient for the object for which it was designed. There is a tradition that a superstition existed in connection with this dyke, to the effect that it would never be finished, unless an individual could be found sufficiently patriotic to suffer himself to be buried in it. A Japannese Curtius was not long in forthcoming, to whom a debt of gratitude will be due in all time to come, from every British ship that rides securely at her anchor behind the breakwater.

Hiogo has now become the port of Ghosaken and Miaco, and will in all probability, be the principal port of European trade in the empire. The city is described as equal in size to Nagasaki. When Kainipfer visited it, he found 300 junks at anchor in its bay.

The Dutch describe Ohosaka as a more attractive resort even than Yedo. While this latter city may be regarded as the London of Japan, Ohosaka seems to be its Paris. Here are the most celebrated theatres, the most sumptuous tea-houses, the most extensive pleasure-gardens. It is the abode of luxury and wealth, the favourite resort of fashionable Japanese, who come here to spend their time in gaiety and pleasure. Ohosaka is one of the five Imperial cities, and contains a vast population. It is situated on the left bank of the Jedogawa, a stream which rises in the Lake of Oity, situated a day and a-half's journey in the interior. It is navigable for boats of large tonnage as far as Miaco, and is spanned by numerous handsome bridges.

The port of Hiago and the city of Osaca will not be opened to Europeans until the 1st of January, 1863. The foreign residents will then be allowed to explore the country in any direction, for a distance of twenty-five miles, except towards Miaco, or, as it is more properly called, Kioto. They will not be allowed to approach nearer than twenty-five miles to this far famed city.

As the Dutch have constantly been in the habit of passing through Kioto, it is probable that before very long this restriction will be removed, and Europeans will be permitted to visit, what is, without question, the most interesting spot in the Empire. If Yedo is the London, and Othosaka the Paris, Kioto is certainly the Rome of Japan. It is here that the spiritual Emperor resides, and that enormous ecclesiastical Court by which he is surrounded, and which is called the Dairie, is permanently fixed. It is here that the celebrated tomb of the Great Sayco Sena, the most famous of Japanese temporal Emperors is situated; and here are to be seen the most magnificient and imposing temples of which the Empire can boast. The population of Kioto is said to be half a million, and it has had the reputation of being the principal manufacturing town in the Empire. It is situated as nearly as possible in the centre of Dai Nipon, the largest and most important island in the Japanese group, and which now demands a brief descriptive notice. According to Kainipfer, its length measured along the middle of the island exceeds 900 miles, and its average width may be estimated at more than 100 miles—its surface may, therefore cover an area of about 100,000 square miles. It is traversed in its whole length by a chain almost of uniform elevation, and in many places crowned with peaks covered with perpetual snow. This chain divides the streams which flow to the south and east, and which fall into the Pacific Ocean, from those which pursue a northerly course to the sea of Japan. Very many of its peaks are volcanic—among the most important of these is the Fusyanuner, the highest mountain in Japan. Its elevation is estimated at about 11,000 feet above the sea level. It has been quiescent for upwards of a century; its summit was sheathed with snow when we saw it at midsummer. The volcanoe of Pries, situated on an island under which we passed, was in action. Nipon is divided into upwards of 50 separate provinces, and contains the capital city of the Empire: Yedo. The first point in it at which we touched was the port of Simoda, situated on the promontory of Idsu, and opened to foreign trade by Commodore Perry in 1852.

As this port is under the new treaty to be closed to foreigners, it is scarcely necessary to allude to it. At no time favourably situated for trade, and under all circumstances a dangerous harbour, the anchorage was totally destroyed by an earthquake, which took place in December, 1854. Placed at the extreme end of a mountainous promontory, to pass from which into the interior of the island it is necessary to cross a mountain range 6000 feet high, and inhabited by a poor population of fishermen, Simoda can never offer attractions to the merchant, or give us cause to regret that it is no longer available for commercial purposes. The promontory of Idsu forms the eastern shore of the Bay of Yedo The distance from Simoda to that city is about eighty miles. At Uraga the opposite shores approach to within ten miles of each other, and the straits which are thus formed afford scenery of much picturesque beauty. Eighteen miles from Yedo, and situated in a curvature of the western shore, lies the new port of Kanagawa, affording secure anchorage within half-a-mile of the land. Connected with Yedo by an excellent road, practicable for wheeled vehicles, and containing a considerable population already, Kanagawa possesses many advantages as a focus of trade. As, however, we did not land here, I do not venture to describe it further, the more especially as it has now been open to Europeans for upwards of two months, and we shall doubtless ere long have a full account of it from some of the pioneers of commercial enterprise who have already gone to establish themselves there. Foreigners are permitted by treaty to go into the interior for a distance of twenty-five miles, except toward Yedo. The Logos river, distant about ten miles from this city, is their limit in that direction.

Fortunately, no such restriction applied to us, and we were enabled, during a residence of ten days in that most interesting capital, to acquire some information with reference to the manners and customs of the singular race who inhabit it, of their mode of government, and of the resources of the country generally.

Situated at the head of a bay, or rather gulf, so extensive that the opposite shores are not visible to each other, Yedo spreads itself in a continuous line of houses along its partially undulating, partially level margin, for a distance of about ten miles. Including suburbs, at its greatest width it is probably about seven miles across, but for a portion of the distance it narrows to a mere strip of houses. Any rough calculation of the population of so vast a city must necessarily be very vague and uncertain ; but, after some experience of Chinese cities, two millions does not seem too high an estimate at which to place Yedo.

In consequence of the great extent of the area occupied by the residences of the Princes, there are quarters of the town in which the inhabitants are very scarce. The citadel, or residence of the temporal Emperor, connot be less than five or six miles in circumference, and yet it only contains about 40,000 souls. On the other hand, there are parts of the city in which the inhabitants seem almost as closely packed as they are in Chinese towns.

The streets are broad and admirably drained, some of them are lined with peach and plum trees, and when these are in blossom must present a gay and lively appearance. These which traverse the Prince's quarter are for the most part as quiet and deserted as aristocratic thoroughfares generally are. Those which pass through the commercial and manufacturing quarters are densely crowded with passengers on foot, in chairs, and on horseback, while occasionally but not often, an ox waggon rumbles and creaks along. The houses are only of two stories, sometimes built of freestone, sometimes of sunburnt brick, and sometimes of wood ; the roofs are either tiles or shingles. The shops are completely open to the street ; some of them are very extensive, the show rooms for the more expensive fabrics being up stairs as with us. The eastern part of the city is built upon a level plain, watered by the Toda Gawa, which flows through this section of the town, and supplies with water the large moats which surround the citadel. It is spanned by the Nipon ; has a wooden bridge of enormous length, celebrated as the Hyde Park Corner of Japan, as from it all distances throughout the empire are measured. Towards the western quarter of the city the country becomes more broken, swelling hills rise above the housetops, richly clothed with foliage, from out the waving masses of which appear the upturned gables of a temple, or the many roofs of a Pagoda.

It will be some satisfaction to foreigners to know that they are not to be excluded for ever from this most interesting city. By the treaty concluded in it by Lord Elgin, on the first of January, 1862, British subjects will be allowed to reside there, and it is not improbable that a great portion of the trade may be transferred to it from Kanagawa. There is plenty of water and a good anchorage at a distance of about a mile and a half from the western suburb of Linagawa.

The only other port which has been opened by the late Treaty in the Island of Nipon is the Port of Nee-e-gata, situated upon its western coast. As this port has never yet been visited by Europeans, it is stipulated that if it be found inconvenient as a harbour, another shall be substituted for it, to be opene l on the first of January, 1860.

It will thus be seen that we have one port in Kinsin, Nagasaki; three in Nipon, Hiogo, Kanagawa, and Nee-e-gata. In the remaining large Island of the Japanese group—viz., Yesso, we have secured Hakodadi. It was opened to foreign trade on the 1st of last July. Our ships of war have recently visited Hakodadi frequently. It is described as a beautiful spot, situated in a country resembling England in its climate, productions, and natural features.

The limits of this paper will not, unfortunately, admit of my adverting, at any length, to the singular political and social institutions of this most remarkable people—otherwise, it might have been interesting to have described the spiritual Emperor passlng a sub-celestial existence at Miaco, reminded only of his humanity by twelve wives, who are not spiritual; and the temporal Emperor, confined within the massive walls of his handsome palace, little better than a State prisoner. We cannot now speculate upon the power and influence wielded by the Council of State, composed of five feudal nobles ; or discuss the share which an ancient and powerful aristocracy possess in the administration of public affairs. That most striking feature in the social government of Japan, which consists of an elaborate system of espionage, exercised alike upon prince and beggar, and retaining all within the thraldrom of its iron grasp, would be a fertile theme for a paper in itself; while the celebrated Hara Kiri, or happy despatch, already so familiar to all, that it is scarcely necessary to allude to it as the resource alike of the unsuccessful politician, the detected criminal, and the injured member of society. It may not, however, be so well known that the old practice of ripping open the abdomen has been extinguished in favour of a less disgusting method of immolation, by which the duty of terminating the existence of the victim falls not upon himself but upon his friend, who decapitates him in the presence of his family and relations.

Still less can we now venture upon a discussion of the various creeds which obtain in Japan, of the old national religions of the Empire, known as the Sinsyn religion or faith of the gods, or of the extent to which it has become modified by those more recently introduced dogmas of Bhuddism (now a faith widely diffused throughout the Empire,) or of the influence exercised upon both, by the more Confucian tenets practised by those who follow Suitoo, or the way of the philosophers.

Having, thus enumerated and briefly discussed, so far as our limited information will admit, the five ports of Japan recently opened by treaty to the commerce and enterprise of the West, it may not be uninteresting to glance at the probable nature and extent of that commerce which is likely to spring up at them.

From the little we know of the internal resources of Japan, it is probable that we shall find a more profitable source of trade in its mineral than its vegetable productions. Unless we have been totally misinformed, these former are of vast extent and great value.

We know that the principal profits of the early Portuguese settlers were derived from the export of gold and silver. So lucrative was it that Kainipfer remarks—" It is believed that, had the Portuguese enjoyed the trade of Japan but twenty years longer, upon the same footing as they did for some time, much riches would have been transported out of this Ophir to Macao, and there would have been such a plenty and flow of gold and silver in that town, as sacred writ mentions there was at Jerusalem in the time of Solomon. At a later period, the Dutch carried on this same traffic to so great an extent that a native political economist, writing in 1708 on the subject, computes the annual exportation of gold at about 150,000 cobaugs, so that in ten years the empire was drained of 1,500,000 cobaugs, or about two millions and a half sterling.

The gold is found in various localities. That procured from Sado has the reputation of being the finest, and it is stated that the ore will yield from one to two oz. of fine metal per 1¼ lb. The copper mines in Garonga are stated to be very rich, the copper ore raised also being impregnated with gold. The ore from Satsuma yields from 4 to 6 oz. per 1¼ lb. These are the principal mines. Gold dust is found in some of the streams. Copper is superabundant, as is evident from the lavish use made of it for ornamental purposes.

For a long period the Dutch received at Nagasaki (in exchange for their merchandize) Japan copper. This however, as well as the sale of gold, has been stopped for many years. The Government allows no more copper to be produced now than is absolutely necessary for home consumption, which is comparatively very small. It will be for us to develope more fully one of the most important elements in the wealth of this vast empire.

By the treaty recently concluded, gold and silver coins may be exported from Japan, but not as cargo; the exportation of copper coin, as well as copper in bars, is prohibited, but the government engages to sell from time to time at public auction, any surplus quantity of copper that may be produced.

Iron abounds in various parts of Japan. The mines of iron are extensively worked, much more so at present than those of copper. Judging from articles of casting of their own construction, the ores must be of excellent quanlity. Specimens of wrought iron, cast and blister steel, have been examined with very satisfactory results. The wrought iron is usually hammered, and in small flat bars varying from 12 to 20 lbs. each. This is probably to be attributed to a want of proper machinery for heavier bars, and its being suited to their purposes. The steel of which the swords were composed which we procured at Yedo, was of admirable temper and quality.

I have already alluded to the coal mines which exist in the Island of Kinsiu—one of them is distant only seven miles from Nagasaki. They are a Government monopoly. Hitherto the coal brought for sale since the opening of trade at Nagasaki has been surface coal, and consequently inferior in quality; it is described as small. It burns slaty, leaving considerable ash, and is very light. There can be little doubt that good coal is to be found in the island, when the mines begin to be properly worked. By the treaty of Yedo, coals, zinc, lead, and tin, are to be exported, at a duty of five per cent.

The vegetable productions of Japan, which are most probably destined to become articles of commerce, are camphor, vegetable tallow, rice, wheat, drugs, seaweed, &c. Among manufactured articles we may mention lacquer ware and porcelain, but it is almost impossible at this early stage of our commercial relations to predict either their character or extent. Immediately on our return from Japan, some merchant ships went out to Nagasaki—not altogether strictly in accordance with international law—to open trade at that port. Since November last we have an actual experience to refer to; but we must beware of drawing conclusions rashly from it. That the result has not equalled the anticipations formed at the commencement is due to the fact that trade has not been carried on under the provisions of the treaty concluded at Yeddo, but under that now obsolete system formerly pursued by the Dutch, in which the foreign merchant was compelled to deal with and through Government alone. The consequence was, that after the first few Government contracts were completed, the trade could only be carried on under those restrictions and disadvantages which have rendered it so little profitable to the Dutch throughout this long course of years Now, however that those restrictions are removed, and a currency established, which will once more enable merchants to enter upon extensive commercial transactions under favorable conditions, instead of confining them to a paltry barter trade, carried out under Government regulations, I have no doubt that we shall receive very different accounts of our mercantile prospects in this quarter. When we hear that between November, 1858, and March, 1859, no less than 15,000 tons of British and American shipping have left Shanghae for Nagasaki, a port the annual trade of which had been carried on by two Dutch ships, and that upwards of 11,000 tons have returned thence, many of the vessels being announced to go back again, we are driven to suppose either that the British merchant is more than usually blind to his own interest, or that there really is a trade worth engaging in. About fourteen hundred bales of silk in all have been procured and exported at Nagasaki, since the trade began last November. It is expected that the supply of this article will increase materially, the climate being suitable for the growth of the mulberry, and the habits of the people well adapted to the manipulation of silk.

Among the imports into Japan, produce from the Straits and China naturally forms a large proportion. This is for the most part composed of drugs and what is technically termed Chow-chow cargo—viz., spices and condiments of various sorts; also Sandal and Sapan wood. We have contributed damasks, cottons, muslins, velvets, woollens, &c; while American piece goods have found a ready market. As yet, however, our merchants are only feeling their way, and some time must elapse before it will be possible for us to predict with any certainty either the nature or extent of that trade which is capable of being created in this most interesting quarter of the globe. Meantime, a heavy responsibility will rest alike upon the merchants engaged in developing commerial relations in this country, and on our own official agents employed in supporting them and at the same time in protecting the Government to which they are accredited in due exercise of their treaty rights.

We are ignorant of the political considerations which induced the Japanese Government to relinquish that system of exclusiveness which had for many years distinguished it among the nations of the East. We do know, however, that this result was not arrived at without much angry discussion and violent opposition on the part of some of the most influential members of the aristocracy; and we can have little doubt that a strong feeling adverse to intercourse with foreigners or the establishment of commercial relations with them, exists throughout a large important class in Japan.

At present, this party is in the minority, but whether it will remain so or not, must depend upon the skill and tact with which our political relations are conducted, and upon the impression which the foreign mercantile community will create upon the people generally. Of a haughty and independent spirit, the Japanese are also suspicious and vindictive, and it is possible that, unacustomed to contact with Europeans, they may grow restive under the annoyances and evils which follow in the wake of civilization, and manifest a temper calculated to irritate the nation with which they have so recently entered into a friendly compact. It will be at this juncture that we shall be called upon to exercise that forbearance and moderation which it is ever becoming in the strong to display towards the weak

It would be well to remember that while we have achieved a great result in thus opening to the world this prosperous and happy community, we have also incurred serious obligations towards them, and are bound not to take advantage of their ignorance and inexperience in their dealings with western nations. We can only hope to commend our civilization to them by maintaining a high moral standard, both in our commercial and political intercourse. They are sufficiently enlightened to appreciate a policy influenced by higher considerations than those involved in the accumulation of wealth. Unless we follow such a policy, it is not too much to predict that we shall lose alike their confidence and respect, and involve ourselves in complications disastrous to our commerce, and discreditable to our national character. Of all the nations of the east, the Japanese are the most susceptible to civilizing influences, and I quote the words of an eminent Chinese and Japanese scholar in saying that, in one respect, they are far in advance of their ancient neighbours the Chinese, in that their attention is directed to obtain a knowledge of other nations Their own efforts in this way will form their greatest security. Their soldiers once formed the bodyguard of the King of Siam, their Consuls once examined Spanish ships in Acapulco, their sailors once took a Dutch Governor out of his house in Formosa, and carried him prisoner to their rulers, their princes once sent an embassy to the Pope, their Emperor once defied the vengeance of Portugal, by executing her Ambassadors. The knowledge of these historical events remains among them. We may reasonably hope for a great preponderance of good results from an extension of an intercourse which has recommenced peacefully. Let us indulge in the expectation that the land of the rising sun may not only soon be fitted to take her place among nations, but also among Christian nations, with all the institutions, and liberty, and purity, of the best of these.

ERRATUM.

Vol. IV., page 442, line 10, *for* "procis," *read* "proboscis."

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—SEPTEMBER, 1859.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Days.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Average	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Result.	ME'N	Rain in Inches.	Snow in Inches.
					°	°	°	°	°												°							
1	29.549	29.385	29.390	29.4335	48.0	64.6	55.9	56.52	— 6.52	.287	.404	.288	.323	.86	.66	.64	.70	W N W	S S W	W N W	S 83 W	1.2	9.8	15.4	6.41	8.47	0.075	...
2	.478	.571	.604	.5550	48.7	61.3	52.7	54.83	— 7.90	.234	.208	.298	.256	.68	.37	.75	.61	W S W	W b N	Calm.	N 84 W	10.4	12.6	0.0	7.70	8.77	......	...
3	.481	.329	.474	.4308	56.3	64.6	54.5	58.45	— 3.98	.359	.428	.307	.370	.79	.71	.72	.75	S S E	S S W	N N W	S 44 W	9.5	10.6	8.8	3.75	6.52	0.395	...
4	.634	.731	—	—	46.9	61.7	—	—	—	.263	.265	—	—	.81	.48	—	—	N N W	W N W	N W b N	N 61 W	2.9	8.2	5.0	6.00	6.35	......	...
5	.865	.847	.932	.8895	43.3	58.4	47.2	51.07	—10.77	.275	.320	.258	.289	.82	.65	.79	.77	N W b W	S S W	N W b N	N 76 W	1.5	10.5	0.5	3.84	4.77	0.117	...
6	30.005	.996	30.001	30.0045	44.7	58.8	51.2	52.97	— 8.47	.234	.303	.244	.260	.79	.61	.65	.65	N W b N	S S W	N	N 67 W	4.8	9.8	3.5	2.01	4.79	......	...
7	30.008	.974	29.963	29.9815	47.6	60.6	48.7	53.43	— 7.72	.224	.335	.300	.286	.68	.63	.87	.70	N	S S W	S b W	S 77 W	1.2	7.8	0.2	1.82	3.68	......	...
8	30.004	.973	.957	.9758	42.2	62.8	52.3	54.23	— 6.50	.211	.261	.325	.279	.78	.45	.82	.67	W b N	S b E	S S E	S S E	0.4	7.5	0.5	1.84	2.14	......	...
9	29.966	.905	.823	.8990	49.4	66.4	58.4	59.10	— 1.25	.292	.258	.389	.317	.82	.39	.80	.65	S E	E b N	E N E	E	4.4	6.0	1.6	3.44	3.81	0.665	...
10	.703	.607	.582	.6217	58.8	67.1	64.2	63.27	+ 3.22	.465	.593	.583	.551	.94	.89	.97	.94	N E	S S W	S W	S 26 W	0.5	4.2	4.4	4.39	4.80	0.100	...
11	.384	.249	—	—	62.8	73.3	—	—	—	.542	.415	—	—	.95	.50	—	—	S W b S	W b N	W b N	S 87 W	9.0	23.0	15.0	12.40	13.34	0.038	...
12	.314	.065	.079	.1432	52.3	72.4	62.4	63.02	+ 3.78	.319	.334	.396	.367	.81	.42	.70	.65	S W b W	W S W	S W b W	S 64 W	3.5	19.2	6.0	10.67	12.03	......	...
13	.169	.327	.354	.2838	52.7	52.3	46.5	50.52	— 8.33	.197	.243	.212	.211	.48	.61	.66	.57	W N W	N W	S W b S	N 67 W	25.0	21.5	9.6	16.76	18.00	Inap	...
14	.458	.669	.886	.6950	40.4	50.1	37.8	43.17	—15.17	.191	.109	.157	.130	.76	.29	.69	.50	W	N W b W	W N W	N 55 W	11.5	22.0	3.0	12.94	13.82	......	...
15	30.018	.988	.970	.9963	35.7	46.5	44.0	43.08	—14.83	.122	.068	.198	.138	.58	.20	.69	.50	N N E	E	E N E	N 74 E	6.5	6.6	4.2	5.24	5.65	......	...
16	29.842	.770	.653	.7477	45.8	53.4	53.4	51.12	— 6.40	.195	.259	.331	.268	.64	.62	.81	.70	N E b E	E N E	N E b E	N 63 E	8.5	13.0	3.4	8.30	8.46	......	...
17	.639	.591	.650	.6277	53.4	58.4	50.9	53.93	— 3.07	.365	.400	.345	.362	.89	.82	.92	.86	N E b N	E b S	S E b E	N 79 E	3.5	5.8	2.2	1.86	2.62	......	...
18	.666	.641	—	—	46.2	59.9	—	—	—	.242	.379	—	—	.78	.73	—	—	N E b N	E b S	E b N	N 86 E	2.8	8.6	3.0	2.88	3.15	......	...
19	.419	.351	.357	.3782	50.9	60.3	59.5	57.97	+ 1.85	.345	.423	.470	.422	.92	.81	.89	.87	E N E	E	N N W	N 14 E	3.2	2.5	0.5	3.80	5.02	0.110	...
20	.510	.668	.676	.6028	51.6	51.9	53.8	52.07	— 3.53	.303	.362	.284	.294	.79	.94	.68	.75	N b E	N E b N	N E b N	N 37 E	13.8	8.0	6.0	7.02	7.18	0.008	...
21	.633	.576	.511	.5740	48.7	53.4	54.8	51.90	— 3.22	.311	.359	.379	.352	.90	.87	.88	.90	N E b N	E N E	E N E	N 64 E	5.6	10.8	19.5	13.66	13.80	1.185	...
22	.509	.522	.612	.5563	55.2	61.0	53.8	56.82	+ 2.18	.407	.482	.381	.425	.94	.90	.92	.92	E N E	E b N	Calm.	N 78 E	12.6	8.5	0.0	3.61	3.69	0.250	...
23	.670	.657	.675	.6662	53.7	62.4	57.7	58.68	+ 4.47	.393	.444	.432	.424	.95	.79	.91	.86	Calm.	Calm.	Calm.	S 35 W	0.0	0.0	0.0	0.15	0.15	Inap	...
24	.644	.630	.664	.6442	57.0	66.2	58.8	60.70	+ 6.95	.436	.457	.431	.447	.94	.70	.86	.85	Calm.	S E b S	E N E	N 16 E	0.0	3.4	3.0	1.25	2.61	......	...
25	.655	.628	—	—	57.0	64.6	—	—	—	.407	.485	—	—	.87	.79	—	—	N b W	S S W	Calm.	S 43 W	4.5	1.0	0.0	0.40	0.65	......	...
26	.646	.593	.571	.5980	51.2	65.0	60.6	58.87	+ 6.13	.341	.473	.455	.428	.90	.76	.86	.86	S S W	S W b S	S S W	S 44 W	0.5	1.2	1.5	1.60	1.76	0.045	...
27	.506	.536	.619	.5573	60.2	65.3	60.2	61.67	+ 9.45	.465	.496	.499	.477	.89	.79	.96	.87	S b W	N W	N N W	N 21 W	0.5	6.5	9.2	5.30	7.62	0.007	...
28	.744	.818	.910	.8300	57.0	64.9	50.1	57.47	+ 5.63	.441	.424	.334	.393	.95	.69	.92	.83	N b W	W N W	S W	N 2 E	8.0	4.0	3.0	3.48	5.88	......	...
29	.934	.993	.926	.9582	50.9	54.8	49.1	51.23	— 0.08	.292	.270	.285	.290	.77	.63	.81	.77	E b N	S E b S	N E b E	N 85 E	5.8	6.0	2.0	4.08	4.25	......	...
30	.864	.749	.624	.7347	48.3	61.9	62.4	58.62	+ 7.80	.316	.389	.470	.413	.93	.69	.84	.83	E	E	S E	S 88 E	1.5	10.4	6.2	3.16	7.02	0.530	...
M	29.6761	29.6550	29.6717	29.6686	50.35	60.18	53.88	55.18	— 2.31	.308	.350	.348	.337	.82	.65	.81	.75	....	....	....	....	5.44	8.97	4.57	......	6.36	3.525	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR SEPTEMBER.

Highest Barometer.......................... 30.049 at 8 a. m., on 15th } Monthly range=
Lowest Barometer .... 29.038 at 4 p. m. on 12th } 1.011 inches

Self-regist'ing Thermom.:
Maximum Temperature .... 75°4 on p. m. of 11th } Monthly range=
Minimum Temperature .... 35°7 on a. m. of 15th } 39°7
Mean maximum Temperature .... 62°68 } Mean daily range=
Mean minimum Temperature .... 49°32 } 13°36
Greatest daily range .... 22°8 from a. m. to p. m. on 1st.
Least daily range................. 4°6 from a. m. to p. m. on 13th.

Warmest day......... 10th ... Mean temperature......... 63.27 } Difference = 20°19.
Coldest day........... 15th ... Mean temperature......... 43°08 }
Maximum Radiation. { Solar.............................. 89°8 on p. m. of 11th } Monthly range=
{ Terrestrial........................ 23°1 on a. m. of 15th } 66°7.
Aurora observed on 8 nights, viz., on 1st, 2nd, 3rd, 4th, 5th, 14th, 27th, and 28th.
Possible to see Aurora on 17 nights; impossible on 13 nights.
Raining on 15 days,—depth 3.525 inches; duration of fall 36.4 hours.
Mean of cloudiness = 0.65.
Most cloudy hour observed, 4 p. m., mean = 0.72; least cloudy hour observed, 6 a. m., mean, = 0.61.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1607.37	784.62	1305.27	2110.21.

Resultant direction N. 44° W.; Resultant Velocity 1.60 miles per hour.
Mean velocity.......................... 6.36 miles per hour.
Maximum velocity .... 31.0 miles, from 1 to 2 a. m. on the 14th.
Most windy day....................... 13th...Mean velocity 18.00 miles per hour.
Least windy day .... 23rd...Mean velocity 0.15 ditto.
Most windy hour......noon to 1 p. m............ Mean velocity 9.36 ditto. } Difference
Least windy hour ....9 to 10 p. m............ Mean velocity 4.15 ditto. } 5.21 miles.

1st. Double Rainbow at 5 p. m.
3rd. Great magnetic disturbance and brilliant auroral display from 7 p. m. to 3 a. m. of 4th.
6th. Hoar Frost at 5.30 a. m., (first of the season.)
10th. Fog 7 to 11 a. m. Thunderstorm from 11.30 p. m.
13th. Corona round the moon at midnight.
15th. Thin Ice at 6 a.m., (first of the season.) Solar Halo 8 to 9.30 a. m.
17th. Dense ground Fog from 7 p. m.
18th. Ground Fog and very heavy Dew at 6 a. m.
19th. Very heavy Dew 6 a. m. Slight Thunderstorm 8.30 to 10 p. m.
24th. Distant Thunder at 4 p. m.
28th. Ground Fog at 7 p. m.
30th. Ground Fog at 6 a. m.

Heavy dew recorded on 9 mornings during the month.

The Resultant Direction and Velocity of the Wind for the month of September, from 1848 to 1859 inclusive, were respectively N 59° W, and 0.99 miles.

The month of September, 1859, was comparatively cold, dry, and windy; the Mean Temperature was 2°.80 below the average of 20 years, being the coldest September save two (1840 and 1848) during that period. The depth of rain recorded was 0.574 inches on the surface less than the average of 19 years, and the mean velocity of the wind 0.95 miles per hour above the average of 12 years.

COMPARATIVE TABLE FOR SEPTEMBER.

YEAR.	Temperature.					Rain.		Snow.		Wind.		
	M'n.	Diff. from Aver.	Max ob'd.	Min. ob'd.	Range.	No. of days.	Inch's.	No. of days.	Inch's.	Resultant Direction.	Resultant V'y.	Mean Force or Velocity.
1840	54.0°	−4.0°	70.2°	29.4°	40.8°	4	1.380	...	...	...	...	....
1841	61.3	+3.3	79.9	37.5	42.4	9	3.340	...	...	...	...	0.26 lbs.
1842	55.7	−2.3	83.5	28.3	55.2	12	6.160	...	...	...	...	0.45
1843	59.1	+1.1	87.8	33.1	54.7	10	9.760	...	...	...	...	0.57
1844	58.6	+0.6	81.5	29.6	51.9	4	*	...	...	...	...	0.26
1845	56.0	−2.0	78.8	35.3	43.5	16	6.245	...	...	...	...	0.34
1846	63.6	+5.6	84.0	39.0	45.0	11	4.595	...	...	...	...	0.33
1847	55.6	−2.4	74.8	38.1	36.7	15	6.665	...	...	...	...	0.33
1848	54.2	−3.8	80.9	29.5	51.4	11	3.115	...	...	N 71° W	2.38	5.81 mls.
1849	58.2	+0.2	80.6	33.5	47.1	9	1.480	...	...	N 75° W	0.69	4.23
1850	56.5	−1.5	76.0	31.7	44.3	11	1.735	...	...	S 65° W	1.02	4.78
1851	60.0	+2.0	86.3	33.4	52.9	9	2.665	...	...	N 14° E	1.03	5.45
1852	57.5	−0.5	81.8	36.1	45.7	10	3.630	...	...	N 77° W	0.53	4.60
1853	58.8	+0.8	85.4	36.1	49.3	12	5.140	...	...	N	1.06	4.33
1854	61.0	+3.0	93.1	36.3	56.8	14	5.375	...	...	N 22° W	1.33	4.04
1855	59.5	+1.5	81.7	36.1	45.6	12	5.585	...	...	N 20° E	1.29	7.61
1856	57.1	−0.9	77.3	37.4	39.9	13	4.105	...	...	S 79° W	1.98	6.53
1857	58.6	+0.6	81.4	34.1	47.3	11	2.640	...	...	N 68° W	1.61	5.55
1858	59.1	+1.1	80.1	36.8	43.3	8	0.735	...	...	S 74° W	1.53	5.69
1859	55.2	−2.8	73.8	35.7	38.1	15	3.525	...	...	N 44° W	1.60	6.36
M	57.98	...	80.94	34.35	46.59	10.8	4.099	...	...	....	...	5.41 Mls.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—OCTOBER, 1859.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 m. 33 s. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	Mean.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Average	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N
1	29.685	29.663	29.641	29.6493	55.9	59.2	56.3	56.95	+ 6.53	.398	.395	404	.388	.89	.78	.89	.84
2	.482	.560	—	—	52.7	54.8	—	—	—	.299	.199	—	—	.75	.46	—	—
3	.714	.542	.478	.5663	40.4	62.8	63.5	56.33	+ 6.80	.234	.413	.369	.336	.95	.72	.62	.73
4	.526	.538	.562	.5463	57.9	68.0	55.5	60.40	+11.37	.377	.461	.404	.408	.78	.67	.92	.78
5	.516	.409	.657	.5373	51.6	68.4	44.0	53.70	+ 5.08	.356	.410	.263	.333	.93	.59	.91	.81
6	.678	.677	.722	.7020	36.8	51.9	43.3	44.35	— 3.87	.196	.268	.180	.217	.89	.69	.63	.74
7	.696	.602	.648	.6420	40.0	55.9	42.5	44.95	— 2.90	.197	.309	.218	.235	.79	.70	.80	.78
8	.611	.664	.766	.6900	40.4	43.3	37.5	39.88	— 7.57	.208	.216	.144	.178	.83	.77	.64	.72
9	.870	.834	—	—	32.1	45.8	—	—	—	.111	.156	—	—	.61	.50	—	—
10	.824	.772	.772	.7897	32.1	52.7	44.3	44.07	— 2.60	.142	.238	.230	.208	.78	.59	.79	.71
11	.808	.828	.940	.8678	40.7	55.9	44.7	47.50	+ 1.25	.223	.319	.179	.220	.87	.71	.60	.67
12	.958	.844	.695	.8228	36.4	51.6	50.1	46.58	+ 0.62	.167	.230	.312	.251	.77	.60	.86	.77
13	.619	.468	.417	.4933	48.0	63.1	58.4	57.42	+11.85	.300	.380	.400	.367	.89	.65	.82	.78
14	.425	.463	.591	.5053	51.9	59.2	43.3	50.73	+ 5.47	.362	.184	.216	.246	.94	.35	.77	.68
15	.682	.753	.892	.7922	37.5	45.4	33.5	38.92	— 5.93	.177	.188	.170	.178	.79	.62	.88	.76
16	.962	.902	—	—	34.1	49.8	—	—	—	.170	.205	—	—	.87	.56	—	—
17	.623	.472	—	—	50.9	52.3	—	—	—	.271	.352	—	—	.73	.89	—	—
18	.018	.446	.651	.4132	58.8	46.2	37.9	46.37	+ 2.33	.362	.160	.147	.198	.72	.50	.65	.59
19	.666	.560	.489	.5652	35.3	41.5	33.9	37.43	— 6.35	.138	.151	.180	.158	.67	.57	.92	.71
20	.587	.638	.690	.6523	29.5	37.8	31.7	32.12	—11.45	.121	.106	.095	.105	.74	.47	.53	.59
21	.720	.630	.600	.6477	26.3	39.1	29.5	31.82	—11.43	.123	.075	.136	.119	.86	.30	.83	.70
22	.514	.479	.563	.5255	29.5	37.1	33.5	33.75	— 9.22	.129	.192	.176	.163	.78	.86	.92	.83
23	.695	.786	—	—	27.7	43.3	—	—	—	.113	.197	—	—	.74	.70	—	—
24	.729	.650	.572	.6418	37.1	46.5	44.0	42.73	+ 0.23	.209	.220	.252	.223	.94	.69	.88	.81
25	.509	.426	.547	.4948	38.2	41.5	32.4	37.18	— 5.10	.151	.118	.109	.131	.65	.44	.58	.59
26	.514	.365	.338	.3987	22.7	30.3	29.5	27.87	—14.12	.103	.103	.144	.111	.85	.61	.87	.72
27	.356	.344	.386	.3703	22.3	38.2	33.2	32.37	— 9.42	.685	.117	.166	.128	.71	.50	.87	.69
28	.404	.438	.560	.4828	31.7	44.5	36.4	37.52	— 3.97	.139	.113	.148	.139	.77	.37	.69	.63
29	.652	.720	.836	.7458	33.9	40.6	35.3	36.52	— 4.75	.143	.137	.170	.146	.74	.54	.83	.68
30	.883	.853	—	—	31.4	40.6	—	—	—	.135	.146	—	—	.76	.57	—	—
31	.826	.800	.84J	.8226	34.6	40.7	37.5	37.25	— 3.50	.190	.136	.186	.169	.95	.53	.83	.77
M	29.6095	29.5888	29.6342	29.6146	38.78	48.86	41.27	42.99	— 2.05	.209	.226	.216	.214	.82	.59	.78	.72

Day.	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resul't. Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Result'.	ME'N	Rain in inches.	Snow in inches.
1	N W	S S W	S W	S 37 W	3.5	12.4	5.0	6.61	6.93	...	...
2	S W b S	W N W	W N W	N 78 W	12.0	31.0	3.5	10.57	10.97	inap.	...
3	W b S	S S W	S W	S 30 W	0.5	15.5	7.5	7.46	7.70	...	...
4	S W	S b W	S W	S 30 W	3.0	4.8	0.5	4.14	4.20	...	...
5	S W b S	W N W	N W b W	N 80 W	0.5	17.5	4.2	8.08	11.72	...	...
6	W N W	W b N	W b N	N 78 W	3.2	22.0	5.8	8.06	8.44	inap.	...
7	N W	N b W	N b E	N 2 E	2.0	7.2	1.0	4.82	5.99	0.115	...
8	N E b N	N E	N	N 22 E	10.0	8.5	7.8	7.95	8.53	0.050	...
9	N	S b E	S b E	N 50 E	12.0	5.8	3.0	0.81	4.53	...	...
10	W N W	S	S W	S 21 W	2.0	9.5	0.5	3.93	4.60	...	...
11	S W	W N W	N b W	N 34 W	3.2	4.2	5.2	3.58	4.56	...	...
12	N	E	E	N 72 E	6.0	5.2	2.0	2.19	2.88	...	...
13	E	S S W	S W	S 32 W	0.4	20.4	9.6	8.48	10.09	0.397	...
14	N b W	W b N	W	N 77 W	3.8	18.5	8.0	10.98	11.37	...	...
15	W N W	N b W	Calm.	N 57 W	7.2	6.2	0.0	4.35	4.58	inap.	...
16	Calm.	E b S	E b S	S 71 E	0.0	10.5	4.0	5.15	5.65	inap.	...
17	S E b S	S S W	S W b S	S 40 W	3.5	9.8	2.3	6.43	7.31	0.318	...
18	W	W	W	N 84 W	29.0	27.0	10.2	2?.49	20.73	0.010	...
19	W N W	N W b N	N	N 36 W	4.6	5.8	3.8	6.56	7.43	0.040	inap.
20	N N W	N N W	N W b N	N 56 W	12.6	28.2	15.6	18.63	18.90	...	inap.
21	N W b N	N W	W b S	N 49 W	10.5	19.8	8.0	11.88	12.25	...	...
22	W N W	Calm.	W N W	N 73 W	1.2	0.0	4.0	1.73	1.73	...	inap.
23	W N W	S S W	S W b W	S 55 W	1.5	6.5	5.0	4.22	4.73	...	...
24	S W b W	W b S	W S W	N 88 W	5.4	13.8	4.0	5.95	7.13	0.010	melt-
25	N W b N	N N W	N	N 23 W	3.5	11.8	16.0	10.61	11.31	...	ing
26	N b E	E b N	N	N 8 E	2.0	3.8	5.8	3.23	4.11	...	as it
27	N b W	N W	W b N	N 62 W	4.4	19.5	10.0	10.68	11.27	...	fell.
28	W	W N W	N W b W	N 53 W	5.0	17.8	10.2	12.53	12.73	...	...
29	N W b W	N W	N W	N 44 W	6.6	12.5	9.0	8.36	8.51	...	...
30	W N W	W b N	N W	N 58 W	3.0	10.0	1.5	4.40	4.52	...	...
31	N W	W N W	W	N 77 W	7.5	12.0	8.4	6.22	6.30	...	...
M	....	....	....	....	5.47	12.82	5.85	......	8.12	0.940	inap.

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR OCTOBER, 1859.

Highest Barometer . . . . 29.962 at 6 a. m. on 16th, } Monthly range=
Lowest Barometer . . . . 29.018 at 6 a. m. on 18th, } 0.944 inches.

Self-registering Ther.
- Maximum temperature . . . . 69°8 on p.m. of 4th } Monthly range=
- Minimum temperature . . . . 22°3 on a.m. of 27th } 47°5
- Mean maximum temperature . . 50°38 } Mean daily range = 13°33.
- Mean minimum temperature . . 37°05 }
- Greatest daily range . . . . . . 26°0 from a. m. to p.m. on 3rd.
- Least daily range . . . . 4.7 from a. m. to p. m. on 25th.

Warmest day . . 4th ... Mean Temperature . . . 60°40 } Difference=32°53.
Coldest day . . . . 26th ... Mean Temperature . . . 27°87 }

Maximum Radiation { Solar . . . . 81°8 on p. m. of 4th } Monthly range=
{ Terrestrial . . . . 12.0 on a. m. of 27th } 69°8.

Aurora observed on 5 nights, viz.: 2nd, 3rd, 18th, 20th, and 21st; possible to see Aurora on 18 nights; impossible on 13 nights.
Snowing on 4 days; depth inappreciable: duration of fall 4.0 hours.
Raining on 11 days; depth, 0.940 inches; duration of fall, 25.8 hours.
Mean of cloudiness=0.64; most cloudy hour observed, 8 a. m., mean=0.77: least cloudy hour observed, midnight, mean=0.48.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
2449.20	1072.30	349.17	3837.12

Resultant direction, N 68° W; Resultant Velocity, 5.04 miles per hour.
Mean velocity of the wind 8.12 miles per hour.
Maximum velocity . . . 35.2 miles per hour, from 11 a.m. to noon on 18th.
Most windy day . . 18th—Mean velocity, 20.73 miles per hour. } Difference
Least windy day . . 22nd—Mean velocity, 1.73 do } 19.00 miles.
Most windy hour, 2 to 3 p. m.—Mean velocity, 13.45 do } Difference
Least windy hour, 1 to 2 a. m.—Mean velocity, 5.08 do } 8.37 miles.

7th. Solar Halo during the forenoon.
11th. Lunar Halo from 10.30 p. m.
15th. Slight Rain and Hail at 4 p. m.
17th. Sheet Lightning in N. W. 7.50 to 8.30 p. m.
18th. Very Stormy day, and rapid descent of temperature from 6 a. m.
19th. First Snow of the season, from 10 p. m. Depth inappreciable.
20th. 22nd. and 24th. Slight particles of Snow, melting as it fell.

Great change of temperature, from 4 p. m. of 5th = 68°5 to a. m. of 6th = 36°5
Range in 14 hours = 32°0.
Fog on 5th, at 6 a. m., and 13th at 6 a. m. Heavy Dew on 2nd and 11th at 6 a. m.
Hoar Frost recorded on 6 mornings. Thin Ice registered on 10 mornings.

The Resultant Direction and Velocity of the Wind for the month of October from 1848 to 1859 inclusive, were respectively N. 60° W., and 1.76 miles.

The mean Temperature of October, 1859, was 2°28 below the average of 20 years. The depth of Rain, 1.617 inches on the surface, also less than the mean of 20 years. The mean velocity of the Wind. 2.36 miles per hour greater than the average of 12 years, and the depth of Snow which averages about one inch, was recorded inappreciable. The month was therefore, comparatively cold, dry, and windy.

COMPARATIVE TABLE FOR OCTOBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant Direction.	Resultant Velocity.	Mean Velocity
	°	°	°	°	°					°		
1840	44.4	— 0.9	68.5	23.9	44.6	13	1.860	3	...	...	...	...
1841	41.6	— 3.7	58.3	20.3	38.0	6	1.360	2	...	...	...	0.41 lbs
1842	45.1	— 0.2	68.5	30.0	38.5	8	5.175	0	...	...	...	0.35 "
1843	41.8	— 3.5	65.7	24.5	41.2	12	3.790	4	2.5	...	...	0.54 "
1844	43.3	— 2.0	69.6	17.8	51.8	7	imper	4	12.0	...	...	0.43 "
1845	46.4	+ 1.1	62.7	20.0	42.7	11	1.760	1	inap.	...	...	0.26 "
1846	44.6	— 0.7	69.7	20.7	49.0	14	4.180	2	inap.	...	...	0.45 "
1847	44.0	— 1.3	65.0	20.3	44.7	13	4.390	2	inap.	...	...	0.19 "
1848	46.3	+ 1.0	62.2	26.4	35.8	11	1.550	0	0.0	N 54 W	1.24	4.60ms.
1849	45.3	0.0	59.2	25.5	33.7	13	5.965	1	inap.	N 12 W	1.27	4.76 "
1850	45.4	+ 0.1	66.6	24.8	41.8	10	2.085	0	0.0	N 66 W	1.10	5.30 "
1851	47.4	+ 2.1	66.1	25.0	41.1	10	1.680	2	0.3	S 72 W	1.06	4.39 "
1852	48.0	+ 2.7	70.7	29.8	40.9	12	5.280	0	0.0	N 5 E	1.19	4.47 "
1853	44.4	— 0.9	64.7	25.5	39.2	10	0.875	2	inap.	S 88 W	1.74	4.77 "
1854	49.5	+ 4.2	74.2	29.8	44.4	15	1.495	3	inap.	N 45 W	1.52	4.57 "
1855	45.4	+ 0.1	64.3	28.0	36.3	14	2.485	5	0.8	N 82 W	4.91	9.88 "
1856	45.3	0.0	70.1	23.3	46.8	10	0.875	2	0.1	N 76 W	2.15	6.07 "
1857	45.4	+ 0.1	63.5	27.7	35.8	10	1.040	2	0.2	N 19 W	2.93	6.24 "
1858	48.8	+ 3.5	76.3	34.2	42.1	17	1.797	1	inap.	N 34 W	0.36	5.96 "
1859	43.0	— 2.3	68.4	22.3	46.1	11	0.940	4	inap.	N 68 W	5.04	8.12 "
Mean	45.27	...	66.71	24.99	41.72	11.3	2.557	2.0	0.94	...	...	5.76

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—NOVEMBER, 1859.

Latitude—43 deg. 39.5 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Days.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above average.	Ten. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't Direc-tion.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M	10 P. M.	ME'N		6 A. M	2 P.M.	10 P.M.	M'N	6 A. M	2 P.M.	10 P.M.	M'N	6 A.M.	2 P. M.	10 P.M.		6 A.M	2 P.M	10 P.M.	Re-sult'.	ME'N		
1	29.813	29.690	29.704	29.7327	34.2	40.7	36.0	37.27	—3.20	.177	.136	.180	.159	.89	.53	.85	.72	w b n	s w b s	w s w	n 55 w	1.8	12.5	9.0	6.72	7.21	...	inapp.
2	.730	.698	.908	.7882	31.0	43.3	30.3	35.03	—5.23	.155	.148	.150	.145	.89	.52	.89	.73	w	n w	w b n	n 71 w	3.2	21.5	1.8	8.68	8.95	...	...
3	30.068	30.084	.932	30.0257	27.7	41.5	41.8	37.00	—3.00	.127	.182	.190	.167	.84	.68	.72	.75	w b n	s b e	e	s 74 e	2.8	6.6	10.8	3.59	5.41	...	inapp.
4	29.751	29.626	.627	29.6713	41.1	58.4	53.4	51.15	+11.38	.199	.400	.239	.279	.77	.82	.58	.72	e b n	s w b s	s w	s 41 w	1.6	11.4	8.0	7.21	7.40	...	...
5	.611	.736	30.084	.8373	53.4	61.0	37.1	49.07	+9.58	.219	.189	.115	.170	.53	.35	.52	.49	s w	w b n	nw b w	n 65 w	10.6	20.0	10.5	10.37	11.98	...	...
6	30.208	30.221	—	—	30.3	37.8	—	—	—	.127	.113	—	—	.75	.50	—	—	n b e	e	e	n 74 e	3.9	7.5	11.0	7.82	8.73	...	...
7	30.048	29.949	29.904	.9630	38.6	45.4	40.4	41.05	+2.05	.189	.189	.200	.194	.80	.62	.80	.75	e n e	e b n	e b n	n 80 e	8.4	3.8	2.0	3.13	3.14	inap	...
8	29.886	.787	.711	.7908	36.8	51.6	45.4	44.90	+6.22	.203	.273	.253	.242	.93	.71	.83	.81	e b n	e b n	e b s	s 78 e	3.5	4.0	3.4	2.40	2.47	...	...
9	.662	.679	.635	.6567	45.4	49.0	42.6	45.90	+7.50	.234	.292	.234	.249	.77	.84	.85	.80	Calm.	n n w	n b w	n 1 w	0.5	6.0	10.4	6.98	7.97	0.360	...
10	.462	.261	.346	.3523	38.9	36.8	32.8	35.72	—2.37	.216	.191	.171	.191	.91	.87	.91	.91	n e	n b e	n n w	n 14 w	9.2	6.2	10.2	6.61	8.58	0.405	0.2
11	.653	.712	.657	.6810	29.2	29.9	33.5	30.80	—6.98	.132	.124	.156	.134	.81	.74	.81	.78	nw b n	n	e	......	5.0	2.2	20.0	—	—	...	0.2
12	.449	.212	.067	.2307	36.0	41.8	48.0	41.82	+4.32	.206	.241	.320	.250	.97	.90	.95	.93	e b n	e	s w b s	......	15.0	7.0	11.5	—	—	1.135	...
13	.138	.199	—	—	36.8	29.9	—	—	—	.203	.096	—	—	.93	.57	—	—	w s w	w b s	w b s	s 72 w	9.7	23.5	11.5	18.31	18.80	inap.	0.1
14	.475	.632	.762	.6415	29.2	33.5	28.8	29.83	—7.07	.116	.125	.144	.123	.72	.65	.89	.74	sw b w	w b s	Calm.	s 72 w	15.9	20.0	0.0	9.76	9.84	...	inapp.
15	.835	.913	.945	.9157	29.2	36.1	35.7	33.70	—2.80	.147	.153	.159	.154	.90	.73	.76	.80	nw b w	nw b w	s e	s 59 e	2.2	2.0	2.0	1.82	2.77	...	...
16	.894	.817	.738	.8162	36.4	44.7	44.2	41.73	+5.53	.183	.207	.209	.195	.85	.69	.71	.73	s s e	e b s	Calm.	s 43 e	5.0	3.8	0.0	1.69	1.82	...	...
17	.721	.706	.773	.7417	41.5	48.7	46.3	45.23	+9.43	.212	.239	.260	.238	.80	.69	.83	.78	s s e	s s w	s s w	s 20 w	0.4	10.2	1.2	4.11	4.15	...	...
18	.744	.676	.540	.6385	41.8	49.4	50.5	46.62	+11.13	.208	.281	.328	.269	.78	.79	.90	.83	s b e	e s e	n e b n	n 33 e	3.0	4.2	11.4	7.67	9.16	1.470	...
19	.225	.047	.366	.2235	47.6	42.5	32.8	39.82	+4.73	.315	.244	.134	.222	.95	.89	.72	.86	n b e	n b w	n w	n 29 w	18.0	15.6	27.2	17.38	18.79	0.435	inapp.
20	.712	.849	—	—	27.7	32.4	—	—	—	.139	.138	—	—	.92	.75	—	—	nw b n	n w	n e b n	n 10 w	11.4	11.6	4.5	7.52	9.15	...	...
21	.956	.756	.544	.7270	28.8	32.4	37.8	33.14	—1.25	.144	.169	.208	.173	.90	.91	.91	.90	e n e	e b n	e	e	11.2	22.2	21.4	15.60	17.28	0.570	...
22	.384	.478	.612	.4995	43.6	44.0	39.3	41.95	+7.87	.248	.202	.219	.220	.88	.70	.91	.83	s	w b s	w	s 80 w	5.0	22.0	12.6	12.85	13.43	0.038	...
23	.779	.837	30.034	.9025	36.4	39.3	30.3	34.73	+1.07	.183	.179	.135	.163	.85	.75	.79	.80	w	w b n	n n w	n 60 w	12.4	21.2	15.4	12.93	14.81	...	...
24	30.154	30.166	30.156	30.1557	27.4	30.3	24.1	27.37	—5.90	.131	.148	.100	.127	.88	.88	.77	.84	n b w	n b e	n e b n	n 26 e	4.8	9.0	4.5	4.09	6.58	...	...
25	29.965	29.534	29.030	29.4635	30.6	33.2	43.5	36.35	+3.38	.152	.166	.252	.196	.89	.87	.90	.89	e s e	e b s	s e b e	s 42 e	14.5	18.2	8.4	7.33	17.39	0.410	0.1
26	.186	.335	.484	.3605	41.8	42.2	37.5	40.12	+7.55	.166	.156	.203	.172	.61	.57	.90	.69	w b s	w s w	w	s 77 w	20.6	15.0	23.2	17.31	17.50	inap.	...
27	.579	.478	—	—	33.2	37.5	—	—	—	.151	.161	—	—	.80	.71	—	—	sw b w	s w	s	s 75 w	7.5	13.2	5.0	9.07	9.98	...	inapp.
28	.547	.534	.667	.5893	30.6	35.0	32.4	32.30	+0.42	.152	.142	.095	.131	.89	.70	.51	.72	w n w	w	w b n	n 86 w	11.5	22.0	11.5	12.09	12.32	...	...
29	.698	.570	.530	.5945	31.4	38.2	38.2	36.30	+4.80	.139	.168	.165	.161	.78	.73	.71	.74	w s w	s w	s w b w	s 45 w	3.4	11.6	6.8	8.15	8.37	...	...
30	.490	.536	.568	.5392	38.6	47.6	41.8	42.43	+11.35	.197	.234	.236	.218	.84	.71	.89	.80	w s w	s w b w	s w	s 54 w	9.8	8.8	1.0	6.16	6.30	0.370	...
M	29.6995	29.6527	29.6663	29.6746	36.43	42.17	38.63	38.90	+2.75	.183	.199	.194	.190	.83	.72	.80	.78	...	...	...	......	7.23	12.09	9.21	...	9.65	5.193	0.6

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR NOVEMBER, 1859.

Highest Barometer .... 30.252 at 10 a. m. on 6th }
Lowest Barometer .... 28.881 at 0.30 a. m. on 26th } Monthly range = 1.371 inches.

Self-registering Ther.:
- Maximum temperature.............. 62°6 on p. m. of 5th }
- Minimum temperature.............. 21°8 on a. m. of 21st } Monthly range = 40°8.
- Mean maximum temperature...... 43°95 }
- Mean minimum temperature...... 32°77 } Mean daily range = 11°19.
- Greatest daily range .... 32°4 from p.m. of 5th to a.m. of 6th.
- Least daily range .... 2°4 from a.m. to p.m. of 10th.

Warmest day 4th; Mean temperature.......... .... 51°15 }
Coldest day 24th; Mean temperature................. 27.37 } Difference = 23°78.

Maximum Radiation { Solar................................ 69°8 on p.m. of 4th }
{ Terrestrial .... 14.0 on a.m. of 26th } Monthly range = 55°8

Aurora observed on 2 nights, viz.: 5th and 13th; possible to see Aurora on 9 nights; impossible on 21 nights.

Snowing on 9 days; depth 0.6 inches; duration of fall 12.8 hours.
Raining on 12 days; depth 5.193 inches; duration of fall 94.1 hours.

Mean of cloudiness = 0.81; most cloudy hour observed 2 p.m., Mean = 0.86; Least cloudy hour observed 8 a.m., Mean = 0.78.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1732.22	1381.97	1402.78	3650.46

Resultant direction, N 81° W; Resultant velocity, 3.39 miles per hour.
Mean velocity 9.65 miles per hour; Maximum 31.2 miles, from 3 to 4 a.m. on the 25th.
Most windy day 13th: Mean velocity 18.80 miles per hour. }
Least windy day 16th; Mean velocity 1.82 miles per hour. } Difference 16.98 miles.
Most windy hour 2 to 3 p.m.; Mean velocity 12.86 miles per hour. }
Least windy hour 5 to 6 a.m.; Mean velocity 7.60 do do } Difference 5.26 miles.

Indian Summer, from 3rd to 9th inclusive (well marked).
Large Meteor on 5th at 7 h. 50 m., p.m., falling from 10° W. of zenith to within 15° of western horizon.
First measurable Snow of the season, a.m. of 11th.
Solar Halos on 16th during the forenoon, and on the 17th during the forenoon (imperfect).
Lunar Halos on 4th from 8 p.m., on 7th from 10 p.m., and 8th from 7.30 p.m.
Lunar Corona on 4th from 8.30 p.m.

The Barometer at 6 a m. on 25th, corrected..................... 29.965
at midnight do 28.903

Range in 18 hours 1.062

The resultant direction and velocity, and mean velocity of the wind on the 11th and 12th, are not complete, the Anemometer having been out of repair.

The resultant direction and velocity of the wind for the month of November from 1848 to 1859 inclusive, were respectively, N. 75° W., and 2.13 miles.

November, 1859, was comparatively *Dark, Mild, Wet* and *Windy*. The mean temperature having been 2°25. The rain 2.084 inches on the surface. The wind 2.45 miles per hour, and the clouded sky .08; each in excess of their respective averages,

COMPARATIVE TABLE FOR NOVEMBER, 1859.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean	Difference from Average.	Maximum observed.	Minimum observed.	Range.	No. of d'ys	Inches.	No. of days	Inches.	Resultant. Direction.	Resultant. Velocity.	Mean Velocity
1840	35.9	— 0.7	54.4	20.5	33.9	5	1.220	8	...	...	...	...
1841	35.0	— 1.6	63.2	7.6	55.6	8	2.450	5	...	...	...	0.91lbs
1842	33.3	— 3.3	50 6	7.6	43.0	9	5.316	10	...	...	...	1.22 "
1843	33.5	— 3.1	51.2	14.4	36.8	10	4.765	7	1.2	...	...	0.59 "
1844	34.9	— 1.7	49.8	12.0	37.8	8	...	4	8.0	...	...	0.48 "
1845	36.8	+ 0.2	58.8	7.6	51.2	7	1.105	4	5.0	...	...	0.53 "
1846	41.3	+ 4.7	55.5	18.2	37.3	12	5.805	2	0.4	...	...	0.64 "
1847	38.6	+ 2.0	58.2	7.8	50.4	14	3.155	3	inap	...	...	0.36 "
1848	34.5	— 2.1	49.3	16.5	32.8	9	2.020	3	1.4	N 81 W	1.81	4.81ms.
1849	42.6	+ 6.0	56.7	28.4	28.3	10	2.815	2	1.0	N 39 W	1.55	4.78 "
1850	38.8	+ 2.2	62.3	18.1	44.2	7	2.955	1	inap.	N 42 W	1.43	5.27 "
1851	32.9	— 3.7	50.1	16.5	33.6	5	3.885	6	6.7	N 50 W	1.25	4.70 "
1852	36.0	— 0.6	50.4	18.7	31.7	7	1.775	3	2.0	N 59 W	1.53	6.50 "
1853	38.7	+ 2.1	54.1	14.4	39.7	15	2.425	6	2.7	N 9 W	0.55	5.52 "
1854	36.8	+ 0.2	54.9	15.1	39.8	13	1.115	4	1.3	W	3.44	7.54 "
1855	38.6	+ 2.0	54.1	18.7	35.4	8	4.590	6	3.0	N 66 W	3.18	10.81 "
1856	37.4	+ 0.8	56.4	22.8	33.6	10	1.375	9	9.5	S 85 W	2.95	8.75 "
1857	33.5	— 3.1	57.8	-2.3	60.1	14	3.235	9	6.9	S 61 W	5.45	9.25 "
1858	34.2	— 2.4	52.0	20.5	31.5	12	3.879	13	4.0	N 25 W	3.14	8.87 "
1859	38.9	+ 2.3	61.0	24.1	36.9	12	5.193	9	0.6	N 81 W	3.39	9.65 "
MEAN	36.65	...	55.04	15.36	39.68	9.2	3.109	5.7	3.16	...	...	7.20

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—AUGUST, 1859.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Velocity in miles per hour.			Mean direction of Wind.	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.				6 A.M.	2 P.M.	10 P.M.
1	29.719	29.780	29.784	66.1	72.3	69.0	.536	.631	.642	.84	.81	.92	S E	S E	S	0.05	4.81	1.30	...	Inap	...	Cu. Str. 8.	Cu. Str. 10.	Str.2. Dst. Lg.
2	836	795	824	68.8	86.2	66.3	548	564	536	79	46	84	S S W	S S W	S S W	4.47	4.42	1.98	...	...	...	Clear.	Clear.	Clear.
3	827	779	752	68.8	90.6	75.1	550	616	686	82	43	83	S	S E b E	S E b E	0.11	0.05	0.01	...	...	...	Do.	Do.	Cu. Str. 10.
4	543	481	601	68.9	70.6	70.3	648	688	688	95	92	92	S E b S	W N W	S S W	0.26	5.13	1.11	...	4.223	...	Rain.	Cu, Str.8. Th.	Clear.
5	656	569	656	69.1	78.6	59.7	606	550	439	88	58	88	W S W	W S W	W S W	3.51	6.97	6.26	...	0.180	...	Light Cir. 2.	C. C. Str. 9.	Cu. Str. 8.
6	771	700	791	59.0	70.4	67.2	358	323	496	73	44	77	W N W	W S W	S W	8.82	9.80	7.35	...	...	...	Clear.	Cirr. 4.	Do. 9.
7	506	535	684	68.3	67.0	58.2	516	310	423	77	48	88	S W	W	W N W	14.42	12.12	12.56	...	0.070	...	Cu. Str. 8.	C. C. Str. 8.	Do. 6.
8	775	784	798	60.1	74.7	61.0	403	463	419	79	56	86	S W b W	S W b W	S	1.26	0.60	0.83	...	...	...	Clear.	Clear.	Clear.
9	980	946	30.011	63.2	84.6	66.8	510	590	529	88	51	82	S W b S	S W b S	S	0.15	1.08	0.01	...	...	...	Do.	Do.	Do.
10	900	887	29.892	62.0	90.5	72.3	523	671	631	94	48	81	S S E	S S W	S E	0.18	0.18	0.00	...	...	...	Do.	Do.	Do.
11	866	748	778	64.9	88.4	71.6	563	650	572	93	47	76	S E	S b E	S b E	0.22	0.97	1.72	...	...	...	Do.	Do.	Do.
12	728	814	871	70.0	81.4	70.4	665	664	695	92	62	95	S b E	S S W	S W	1.08	1.75	0.73	...	Inap	...	C. C. Str. 10.	Cu. Str. 10.	C Str. 10. thun
13	741	530	720	68.7	86.2	69.0	648	719	599	95	85	85	W S W	S S W	S W b W	0.36	1.01	3.80	...	0.186	...	Do. 10.	Do. 4.	Clear.
14	707	680	800	70.0	87.7	69.1	523	623	571	72	48	82	E b S	E S E	S E b E	0.20	1.91	0.21	...	...	...	Clear.	Clear.	Cirri 4.
15	817	896	905	63.0	85.1	69.0	510	570	599	88	47	85	N E b E	E b N	E	4.00	6.18	5.21	...	...	...	Do.	Do.	Clear.
16	910	977	929	63.2	82.9	65.9	510	721	509	88	53	81	N E b E	N E b E	N E b E	6.54	4.02	4.05	...	...	...	Do.	Do.	Do.
17	959	916	845	65.0	89.7	65.8	483	637	509	78	47	81	N E b E	S E b E	S E	0.20	1.65	0.06	...	...	...	Do.	Do.	Do.
18	864	653	628	60.1	87.6	67.0	456	664	529	88	52	82	S E b E	S S W	S W b W	0.00	0.65	0.80	...	...	...	Do.	Do.	Do.
19	632	645	763	56.2	72.0	60.5	420	462	338	94	60	65	N N E	N N E	N	9.53	6.36	4.02	...	0.590	...	Rain.	Cumulus 4.	Cl. Ft. Au. Bo.
20	845	851	877	62.0	79.4	60.3	376	465	433	69	47	85	W S W	W	S W	2.15	0.67	0.66	...	...	...	Clear.	Clear.	Clear.
21	882	846	910	64.4	85.0	68.0	464	691	542	77	77	87	W S W	W S W	W S W	1.07	5.33	3.01	...	...	...	Do.	Do.	Str. 2. Dst. Lg.
22	904	835	899	68.6	84.5	68.2	549	590	612	89	51	90	N E	N E b E	N E b E	2.00	1.50	3.36	...	...	...	C. C. Str. 8.	Cu. Str. 8.	Clear.
23	932	844	884	63.8	84.3	67.0	416	545	502	72	47	78	N E b E	S E b E	S E	4.97	5.50	2.41	...	...	...	Clear.	C. C. Str. 6.	Cl. Ft. Au. Bo.
24	806	731	706	69.0	65.5	63.1	606	549	543	88	89	94	S E b E	S E b E	S W b S	2.03	8.78	0.70	...	1.100	...	C. C. Str. 8.	Rain.	Cu. Str. 4.
25	643	604	689	64.7	77.9	68.4	536	671	577	92	71	85	S S W	S W	S S W	0.05	0.02	3.11	...	...	...	Cu. Str. 10.	Cu. Str. 6.	Do. 4.
26	716	650	688	64.2	78.1	66.1	471	588	570	81	62	89	S W	S W	W S W	1.32	5.70	2.33	...	...	...	Do. 10.	Cirri Str. 4.	Cu. St. 4. Dt. lg.
27	614	600	738	63.0	71.1	57.0	485	429	329	86	55	72	W S W	W b N	W N W	0.00	6.26	12.80	...	...	...	Clear.	Cirr. Cum. 4.	Cu. Str. 6.
28	737	689	753	50.7	59.2	51.7	290	242	302	82	48	82	W N W	W N W	W N W	11.63	5.06	10.51	...	...	...	Cu. Str. 6.	Do. 4.	Cu. St. 10. Sp. A.
29	700	714	791	50.6	66.4	50.1	301	431	258	71	66	71	W	W	W	25.11	6.30	20.26	...	...	...	Str. 2. Frost.	Clear.	Clear. Aur. Bo.
30	730	701	670	41.4	59.7	56.0	169	235	385	65	46	84	W S W	W S W	S b W	1.20	1.80	0.82	...	0.076	...	Clear.	C. Str. 6.	Rain.
31	540	517	586	57.0	59.9	54.0	400	354	355	84	68	89	S b W	N W	W b S	12.13	5.90	0.87	...	0.231	...	Cu. Str. 10.	Do. 4.	Cu. Str. 2.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—SEPTEMBER, 1859.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 *deg.* 32 *min. North. Longitude*—73 *deg.* 36 *min. West. Height above the Level of the Sea*—118 *feet.*

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Velocity in miles per hour.			Rain in Inches.	Snow in Inches.	Weather, &c. A clondy sky is represented by 10; A cloudless sky by 6.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	5 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.			6 A.M.	2 P.M.	10 P.M.
1	29.660	29.698	29.493	49.8	65.9	55.1	.265	.319	.376	.75	.47	.87	W S W	W S W	S b E	5.83	4.46	2.30	...	...	Clear.	Cu. Str. 4.	Rain.
2	347	484	680	50.1	59.6	52.3	335	342	323	93	78	85	W S W	W N W	W S W	14.01	15.13	14.95	0.136	...	Rain.	Do. 6.	Clear. Aur.Bo.
3	738	667	623	50.0	57.0	52.9	309	350	361	85	75	93	S W	S b W	S E	5.41	1.96	3.64	0.301	...	C. Cum. 4.	Rain.	Rain.
4	658	713	876	50.4	60.9	51.2	309	325	296	85	61	79	W S W	W b S	W S W	8.01	12.21	10.05	0.800	...	Cu. Str. 8.	C. C. Str. 6.	Cu. Str. 3.
5	837	968	987	50.6	61.0	53.0	328	310	348	89	60	86	S W	W	W S W	3.63	2.08	4.17	Inap	...	C. C. Str. 4.	Cu. Str. 9.	Clear.
6	30.050	30.064	30.113	50.8	58.2	49.1	265	255	297	75	53	85	N W	N W	S W b S	0.61	6.26	4.53	...	...	Clear.	C. C. Str. 6.	Do.
7	054	000	077	45.7	65.0	54.6	211	296	335	72	44	80	S S W	W S W	S W b W	0.21	4.00	1.77	...	...	C. C. Str. 4.	Cu. Str. 4.	Cir. Cum. 4.
8	072	067	092	47.2	69.4	54.0	291	529	335	89	75	80	W S W	S S W	S S W	0.00	1.31	2.15	...	...	Cirr. 4.	Clear.	Clear.
9	124	006	001	58.9	76.4	68.2	275	498	571	56	55	85	S W	S W	S	5.07	2.90	1.51	...	...	C. C. Str. 4.	Do.	Do.
10	29.922	29.821	29.754	52.9	61.5	61.2	354	498	530	90	91	97	S E	S S E	S	0.27	0.51	2.85	0.330	...	C. Str. 8.	Rain.	Rain.
11	543	243	359	64.8	64.6	61.3	590	529	478	97	89	88	N	N E	S W	1.27	8.57	3.98	3.890	...	Rain and th.	Do.	Clear.
12	314	138	167	60.3	74.1	63.3	489	568	453	90	67	80	S W	S W	S W	3.30	2.80	7.55	...	...	Cu. Str. 9.	C. C. Str. 6.	Cu. Str. 9.
13	214	262	319	60.8	59.0	46.1	393	289	262	76	57	84	W	W	W	10.27	10.16	19.26	...	...	Do. 10.	Cu. Str. 10.	Do. 4.
14	267	594	850	39.5	47.8	38.1	180	150	186	77	45	81	W	W N W	W	11.98	19.13	17.01	0.773	...	Sw. with hail.	Do. 4.	Clear. Aur.Bo.
15	30.083	30.107	30.154	37.2	50.0	38.4	178	139	165	81	39	72	W N W	W b N	S W	24.86	14.15	3.70	...	...	Clear Frost.	Clear.	Cirri 4.
16	120	044	29.998	34.2	61.3	44.6	144	249	241	75	47	84	S E	E S E	E S E	0.01	0.78	0.66	...	...	C. C. Str. 8.	Do.	Clear.
17	29.856	29.789	834	42.0	58.2	52.2	228	387	361	87	80	93	E	E b N	N E b E	0.40	1.30	4.38	...	...	Cu. Str. 10.	Cu. Str. 10.	Cu. Str. 10.
18	840	862	848	48.0	75.7	50.4	303	574	290	89	70	82	W	S	S b W	1.92	0.07	0.01	...	...	Do. 10.	Clear.	Cl. Ft. Au. Bo.
19	640	629	610	45.2	77.0	61.7	211	534	442	72	59	83	E	S b E	S E b E	0.00	0.17	0.15	...	...	Clear.	Do.	Cu. Str. 9.
20	632	814	973	55.5	62.4	46.3	405	429	238	94	77	77	N	N E	E N E	3.92	7.61	11.66	0.930	...	Rain.	Cu. Str. 10.	Clear. Aur.Bo.
21	30.008	943	986	43.0	47.0	48.0	215	291	316	79	89	96	E N E	N E b E	N E b E	17.87	2.26	17.18	0.771	...	Do.	Rain.	Slight rain.
22	29.940	880	887	45.2	54.3	53.6	294	396	397	99	96	95	N E b E	N E b E	N E b E	15.76	7.65	9.18	1.409	...	C. Str. 8.	Do.	C. Str. 10.
23	840	844	887	50.0	55.2	52.6	341	383	361	96	90	93	N E b E	N E b E	N E b E	15.17	11.13	4.92	1.970	...	Rain.	Do.	Do. 10.
24	834	800	791	50.9	63.2	55.2	348	429	383	92	77	90	N	N E b E	N E b E	0.25	0.43	1.26	Inap	...	Cu. Str. 9.	Cu. Str. 6.	Cu. Str. 10.
25	870	864	869	53.0	62.3	59.6	354	436	462	90	80	90	E S E	E S E	S S W	0.36	3.16	0.01	...	...	Do. 10.	Do. 9.	Do. 10.
26	780	840	792	56.0	71.1	61.5	413	544	498	90	73	91	S S W	S W	S W	0.70	0.50	0.09	...	...	Do. 4.	Do. 4.	Do. 8.
27	761	749	765	57.8	68.2	62.3	436	543	534	90	79	92	S S W	S W	S W	0.35	2.43	1.83	Inap	...	C. C. Str. 6.	Do. 8.	Do. 10.
28	874	972	30.024	56.7	56.2	50.8	336	357	283	75	78	78	N E b E	N N E	N b W	8.80	6.12	4.04	Inap	...	Cu. Str. 8.	Do. 9.	Do. 10.
29	30.179	30.169	201	42.7	62.0	43.2	239	311	248	89	56	88	N E b E	E	E S E	1.95	4.67	0.09	...	...	Clear.	Cirr. 2.	Cl. Ft. Au. Bo.
30	179	003	29.961	40.3	70.6	53.2	225	423	348	91	59	86	E b N	S E	S S E	0.57	1.67	2.60	...	...	Cu. Str. 4.	Clear.	Clear.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR AUGUST, 1859.

Barometer	Highest, the 9th day	30.011
	Lowest, the 4th day	29.481
	Monthly Mean	29.760
	Monthly Range	0.530
Thermometer	Highest, the 3rd day	90°9
	Lowest, the 30th day	36°2
	Monthly Mean	68°72
	Monthly Range	54°7

Greatest intensity of the Sun's Rays .... 110°8
Lowest point of Terrestrial Radiation .... 25°2
Amount of evaporation .... 3.17 inches.
Mean of Humidity .... .742

Rain fell on 10 days amounting to 6.666 inches; it was raining 42 hours 55 minutes, and was accompanied by thunder and lightning on 2 days.

Most prevalent wind, S. W.

Least prevalent wind, N.

Most windy day the 29th day; mean miles per hour 17.22.

Least windy day the 10th day; mean miles per hour 0.12.

Frost occurred on the 30th day.

Aurora Borealis visible on 4 nights.

The electrical state of the atmosphere has indicated high intensity.

Ozone was present in rather large quantity.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR SFPTEMBER, 1859.

Barometer	Highest, the 29th day	30.201
	Lowest, the 12th day	29.138
	Monthly Mean	29.771
	Monthly Range	1.063
Thermometer	Highest, the 9th day	78°4
	Lowest, the 16th day	29°2
	Monthly Mean	54°31
	Monthly Range	49°2

Greatest intensity of the Sun's Rays .... 101°6
Lowest point of Terrestrial Radiation .... 18°2
Mean of Humidity .... .799
Amount of evaporation .... 1.42 inches

Rain fell on 14 days, amounting to 11.310 inches; it was raining 112 hours 17 minutes, and was accompanied by thunder on 1 day.

Most prevalent wind, N. E. b E.

Least prevalent wind, N.

Most windy day, the 14th day; mean miles per hour, 16.04.

Least windy day, the 19th day; mean miles per hour, 0.10.

Aurora Borealis visible on 5 nights.

The electrical state of the atmosphere has indicated rather feeble intensity.

Ozone was present in rather large quantity.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—OCTOBER, 1859.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Velocity in miles per hour.			Rain in Inches.	Snow in Inches.	Weather, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.			6 A.M.	2 P.M.	10 P.M.
1	29.894	29.758	29.786	50.6	60.4	55.7	.328	.487	.405	.89	.94	.94	s	s b w	s w	0.46	0.76	2.16	0.187	...	Rain.	Rain.	Cu. Str. 8.
2	642	525	616	51.1	52.3	47.2	348	375	298	93	93	92	s s w	s b w	s b w	2.35	10.22	8.11	0.556	...	Clear.	Cu. Str. 8.	Str. 4. Aur. B.
3	800	701	620	40.3	52.9	51.6	208	354	321	82	90	86	w s w	s w	s w	15.81	12.27	6.30	...	...	Do.	Do. 10.	Cu. Str. 2.
4	584	686	807	54.8	71.1	55.8	362	544	335	87	73	80	s w	w	E	1.53	7.61	1.48	...	...	Do.	Clear.	Clear.
5	748	613	520	45.1	79.2	67.2	275	574	362	92	58	89	N E	s w b w	w s w	4.51	1.50	7.53	...	...	Do.	Do.	C. Str. D. Ltg
6	722	633	764	41.9	48.6	40.0	197	165	188	78	49	77	w b s	w b N	w	10.48	3.45	15.02	Inap.	...	Rain.	C. C. Str. 6.	Clear.
7	776	758	846	34.1	50.2	42.0	175	309	184	89	85	70	s w	w b s	w	7.51	7.12	0.11	...	...	Clear.	Cu. Str. 4.	Cu. Str. 4.
8	900	851	916	30.6	48.7	36.2	130	165	170	78	49	80	N b w	E S E	N E b E	0.06	1.43	0.51	...	...	Cu. Str. 6.	Clear.	Clear. L. Halo.
9	30.005	30.006	30.129	34.0	51.0	36.3	126	123	170	65	30	80	N E	N N W	S S E	7.43	13.70	1.52	...	...	Clear.	Do.	Clear.
10	060	29.942	29.963	28.9	55.1	40.9	111	168	197	71	39	78	N N E	w b s	s b w	0.06	1.00	1.73	...	...	Do.	Do.	Do.
11	29.920	997	30.065	39.4	60.1	40.3	216	338	182	91	65	73	s w b w	w s w	w N w	16.01	0.62	0.63	...	...	Do.	Cu. Str. 3.	Do.
12	30.160	30.082	29.984	31.1	56.1	41.9	185	211	206	89	48	78	N N W	s w	s b E	0.83	1.17	1.48	...	...	Do.	Cirri 2.	Clear. L. Halo.
13	29.789	29.668	622	42.7	68.8	62.9	237	443	392	87	68	69	S S E	s w	s w	3.03	5.73	4.33	...	...	C. C. Str. 8.	C. C. Str. 8.	Rain.
14	514	466	562	51.5	59.7	49.8	341	323	290	59	68	82	s w	w s w	w s w	14.00	22.60	2.11	0.406	...	Ni. 10.	Cu. Str. 4.	Cu. Str. 10.
15	694	799	940	34.2	54.2	32.1	169	256	143	84	61	79	N N E	N W	N W	0.93	5.57	17.21	...	...	Sleet.	Do. 4.	Clear.
16	30.134	30.148	977	25.7	43.0	37.8	111	137	151	81	48	67	w b N	s w b w	s s w	3.35	12.86	0.71	...	...	Clear.	Do. 8.	Cu. Str. 2.
17	29.901	29.806	708	36.2	59.4	52.1	184	296	282	87	59	73	S E b E	s s w	s s w	0.10	0.57	0.01	...	...	Str. 2.	Do. 10.	C. Str. 10.
18	405	241	419	50.2	57.0	38.0	335	413	201	93	77	86	s	w s w	N W	0.21	1.10	11.45	0.580	...	Cu. Str. 10.	Do. 10.	Clear. Au. Bo.
19	654	669	700	31.0	44.6	32.2	130	189	107	74	64	56	w N w	w N w	N W	11.61	21.23	32.61	...	...	Clear.	Do. 4.	Str. 4. Aur. Bo.
20	510	500	601	29.8	35.0	29.0	136	162	123	83	80	77	w N w	w b N	w N w	19.00	26.81	14.31	...	0.50	Cu. Str. 10.	Do. 10.	Snhw.
21	487	484	520	24.2	30.5	28.2	111	142	135	87	84	86	w N w	w b N	w b N	27.00	17.17	8.00	...	2.30	Snow.	Snow.	Snow.
22	564	571	701	30.0	42.9	34.1	136	209	175	83	78	89	w b N	w b N	w s w	5.68	15.26	3.41	...	...	Cu. Str. 10.	Str. 4.	Str. 2. Ft. A.B.
23	781	799	870	30.0	45.0	38.2	142	101	186	84	34	81	w s w	w s w	w b s	1.35	6.80	9.52	...	...	C. C. Str. 6.	Clear.	C. Str. 10.
24	774	710	760	39.2	40.2	29.3	192	160	128	82	64	77	s s w	w N w	N E b E	0.00	11.02	8.61	Inap.	...	Do. 10.	Cu. Str. 8.	Do. 4.
25	764	650	647	24.1	31.8	25.0	094	130	094	73	74	68	S E	w	w N w	3.35	0.70	16.21	...	Inap.	Cirri Str. 4.	Do. 10.	Snow.
26	674	450	480	21.0	32.0	27.2	069	119	111	63	64	78	w N w	w N w	w	6.90	12.30	8.60	...	...	Clear.	Do. 2.	Cu. Str. 4.
27	254	251	320	23.9	33.2	32.2	089	131	143	72	70	79	w b N	w N w	w	10.16	4.60	14.36	...	...	C. C. Str. 4.	Dc. 10.	Do. 10.
28	351	397	554	34.1	39.1	31.2	158	178	149	79	73	84	w	w	w b N	19.23	13.50	32.30	...	...	Cu. Str. 6.	Do. 10.	Clear.
29	660	710	860	31.5	41.0	36.1	136	147	177	78	57	85	w N w	w N w	N W	7.96	14.41	10.82	...	...	Do. 8.	Do. 6.	C. Str. 9.
30	900	897	926	32.6	41.9	36.2	156	190	170	85	74	80	w b N	w b N	w s w	8.02	2.32	6.20	...	...	Do. 8.	Do. 4.	Do. 10.
31	900	874	960	31.6	38.9	34.1	149	180	158	84	77	79	w N w	w N w	w	0.56	14.40	2.47	...	...	Do. 10.	Do. 6.	Do. 10.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—NOVEMBER, 1859.

(NINE MILES WEST OF MONTREAL,)

BY CHARLES SMALLWOOD, M.D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Velocity in miles per hour.			Rain in inches.	Snow in inches.	Weather, &c. A Cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A. M.	2 P. M.	10 P. M.	6 A. M.	2 P. M.	10 P. M.	6 A. M.	2 P. M.	10 P. M.	6 A. M.	2 P. M.	10 P. M.	6 A. M.	2 P. M.	10 P. M.	6 A. M.	2 P. M.	10 P. M.			6 A. M.	2 P. M.	10 P. M.
1	30.004	29.901	29.924	32.0	41.0	38.1	.142	.190	.186	.84	.74	81	S W	S S W	S W	0.36	1.03	4.05	...	...	Cu. Str. 9.	Cu. Str. 10.	Cu. Str. 10.
2	29.870	864	860	37.0	46.2	33.3	199	238	168	90	77	89	W S W	S W	E b S	5.95	3.12	0.90	Inap.	...	Do. 10.	Do. 2.	Ni. 10.
3	30.124	30.249	30.304	28.1	33.8	24.2	117	126	094	76	75	73	N W	N W	N E b E	4.80	37.96	26.42	...	0.53	Do. 10.	Do. 4.	Cirri 4.
4	312	29.925	29.930	30.5	32.1	31.6	142	162	168	84	89	94	S S E	E N E	E N E	1.54	6.36	3.11	0.297	1.80	Snow.	Rain.	Verglose.
5	29.820	768	951	31.0	34.3	42.0	155	190	177	89	97	66	E S E	S E	W N W	11.05	0.00	5.40	Inap.	...	Cu. Str. 10.	Cu. Str. 10.	Clr. Dst. th. n.
6	30.374	30.382	30.434	26.1	37.0	26.2	099	157	094	69	70	68	W N W	W N W	W	17.93	3.42	1.05	...	...	Clear.	Clear.	Clear.
7	439	324	270	22.0	34.2	28.1	084	125	135	71	69	88	E	N E b E	N E b E	2.31	4.27	9.46	...	...	Cu. Str. 10.	C. C. St. 10.	Cu. Str. 10.
8	183	009	042	30.0	52.5	36.0	148	257	191	88	66	89	E	S	S	6.43	0.20	0.32	...	...	Do. 8.	Hazy.	Hy. L.H. 8p.m
9	29.901	29.804	29.824	33.0	53.2	47.5	144	304	290	70	76	82	S E b E	W	S S W	0.21	0.57	3.80	0.100	...	Hrzy.	Cu. Str. 10.	Rain.
10	800	521	499	33.4	33.7	30.2	182	182	154	95	94	94	N E b E	N E b E	N E b E	15.90	8.40	20.91	0.630	...	Rain.	Verglose.	C. Str. 10.
11	634	984	30.100	24.0	31.9	19.2	100	144	087	79	80	85	N W	N W b W	N E b E	14.15	8.02	0.00	...	0.70	Cu. Str. 10.	Cu. Str. 4.	Clear.
12	30.114	701	29.600	20.0	32.1	33.4	091	143	184	85	79	96	N E b E	N E b E	N E b E	0.00	7.06	5.51	...	3.70	Clear.	Snow.	Rain.
13	29.230	180	220	33.0	34.9	31.2	174	190	142	94	95	84	N E b E	S W	W S W	4.75	2.77	18.37	2.157	...	Rain.	Cu. Str. 9.	C. Str. 2.
14	559	520	827	24.0	30.1	22.1	111	130	064	87	78	86	S S W	W S W	W S W	24.70	1.52	23.88	...	...	C. Str. 2.	Do. 2.	Clear.
15	30.132	30.229	30.317	17.0	23.0	21.0	068	089	085	75	72	78	N E b E	E N E	S E	0.82	1.28	0.00	...	...	Do. 10.	Do. 10.	C. C. 2.
16	341	260	239	16.0	28.2	22.3	065	129	195	74	82	79	N E b E	N E b E	N E b E	6.41	4.92	4.72	...	...	C. C. 9.	Clear.	Clear.
17	081	048	090	30.1	49.1	12.2	136	278	206	84	81	78	S E	S E	E S E	0.81	2.90	8.23	...	...	Cu. Str. 9.	Cu. Str. 9.	Cu. Str. 10.
18	092	29.952	29.989	40.0	54.5	42.5	210	328	244	86	77	91	E S E	S E b E	N E b E	2.87	0.08	0.88	0.262	...	C. C. Str. 9.	Do. 10.	Do. 10.
19	29.611	406	219	41.4	42.3	40.6	251	261	241	96	98	96	N E b E	N E b E	N E b E	4.72	15.60	9.81	3.746	...	Rain.	Rain.	Do. 10.
20	700	901	30.232	28.2	27.1	20.1	241	093	075	98	68	72	W	N W b N	N	26.56	11.63	14.91	0.630	Inap.	Cu. Str. 10.	Cu. Str. 9.	Do. 8.
21	30.435	30.301	224	16.3	25.0	23.2	074	100	186	85	74	86	N E b E	N E b E	N E b E	7.22	6.35	6.21	...	...	Do. 9.	Do. 4.	Do. 10.
22	29.904	29.840	29.750	23.1	32.9	31.4	107	168	168	87	89	96	N E b E	N E b E	N E b E	21.66	7.20	6.90	...	4.10	Snow.	Snow.	Snow.
23	842	909	30.054	25.2	31.0	25.2	113	161	129	84	85	98	W	S W	W S W	7.80	2.01	8.93	...	2.70	Do.	Do.	Do.
24	30.254	30.270	378	22.2	26.9	17.3	102	117	063	98	82	67	S W	W S W	W S W	9.86	6.66	6.00	...	0.50	Do.	Cu. Str. 10.	Clear.
25	345	224	29.910	7.1	22.4	21.5	042	079	196	66	68	88	W S W	E b N	N E b E	4.03	0.36	6.63	...	1.40	Clear.	Do. 10.	Snow.
26	29.214	29.462	464	34.2	42.0	31.8	190	199	162	95	74	89	N E b E	S b W	S W	15.44	10.31	13.00	0.114	2.10	Snow.	Do. 8.	Cu. Str. 6.
27	661	679	600	30.6	35.6	30.0	148	162	154	88	84	89	S W	S W	S S E	2.80	0.00	2.23	...	...	Cu. Str. 4.	Do. 10.	Clear.
28	678	720	657	21.1	27.4	27.1	080	105	126	74	70	88	S	S W	S S W	11.17	2.28	3.92	...	Inap.	Do. 10.	Snow.	Cu. Str. 8.
29	30.104	30.019	30.047	8.0	22.0	11.9	048	084	060	77	71	80	N E b E	N E b E	N E b E	8.36	1.90	2.03	...	0.50	C. Str. 8.	Su. Str. 6.	Snow.
30	29.814	29.800	29.804	12.1	31.1	21.0	061	118	075	81	68	73	N N W	E	S S E	10.61	0.57	0.00	...	...	Do. 10.	Cirri 2.	Clear.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR OCTOBER, 1859.

Barometer	Highest, the 12th day	30.160
	Lowest, the 27th day	29.251
	Monthly Mean	29.779
	Monthly Range	0.909
Thermometer	Highest, the 5th day	83°1
	Lowest, the 25th day	19°4
	Monthly Mean	42°42
	Monthly Range	63°7

Greatest Intensity of the Sun's Rays .... 105°8
Lowest point of Terrestrial Radiation .... 14°2
Mean of Humidity .... .754
Amount of evaporation 1.27
Rain fell on 6 days, amounting to 1.629 inches; it was raining 20 hours and 15 minutes, and was accompanied by thunder on 1 day.
Snow fell on 3 days, amounting to 2.30 inches; it was snowing 24 hours.
First snow of the season fell on the 20th day.
Most prevalent wind, the W. N. W.
Least prevalent wind, E.
Most windy day, the 19th day; mean miles per hour, 21.81.
Least windy day, the 17th day; mean miles per hour, 0.29.
Aurora Borealis visible on 4 nights.
Lunar Haloes visible on 2 nights.
The electrical state of the atmosphere has indicated high and constant tension.
Ozone was present in moderate quantity.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR NOVEMBER, 1859.

Barometer	Highest, the 7th day	30.439
	Lowest, the 13th day	29.180
	Monthly Mean	29.940
	Monthly Range	1.259
Thermometer	Highest, the 18th day	57°6
	Lowest, the 25th day	4°6
	Monthly Mean	29°38
	Monthly Range	43°0

Greatest intensity of the Sun's rays .... 96°7
Lowest point of terrestrial radiation .... 5°1
Mean of Humidity .... .819
Rain fell on 10 days, amounting to 7.936 inches; it was raining 76 hours 55 minutes.
Snow fell on 12 days, amounting to 17.83 inches; it was snowing 76 hours 20 minutes.
Most prevalent wind, N. E. by E.
Least prevalent wind, E.
Most windy day, the 3rd day; mean miles per hour, 23.06.
Least windy day, the 27th day; mean miles per hour. 1.72.
Aurora Borealis visible on — nights.
Snow Birds ("Phlectorphanes nivalis,") first seen on 3rd day.
Lunar Halo visible on 1 night.
The Electrical state of the atmosphere has indicated moderate intensity.
Ozone was present in large quantities.

THE CANADIAN JOURNAL.

NEW SERIES.

No. XXVI.—MARCH, 1860.

THE PRESIDENT'S ADDRESS.

BY DANIEL WILSON, LL.D.,

PROFESSOR OF HISTORY AND ENGLISH LITERATURE, UNIVERSITY COLLEGE, TORONTO.

Read before the Canadian Institute, January 7th, 1860.

GENTLEMEN OF THE CANADIAN INSTITUTE,

Once more we assemble here to renew the work of another Session, as a body specially inviting its members to devote their energies to the investigation of the laws of nature, the advancement of science, and the discovery of new truths. The position in which you have placed me as your President was altogether unexpected by me, and I had anticipated a very different choice; but it would be as ungracious as unseemly for me now to cavil at a deviation from precedents indicated in the distinguished series of occupants of this chair, when I owe to it so honorable a distinction, conferred on me in so cordial and gratifying a manner.

The functions of this Institute are of a peculiarly important kind, and claim for it a generous encouragement from all who desire the true welfare and advancement of this Province. Of its future progress I entertain no doubt; for it is impossible that Canada can attain to true greatness apart from such elements of mental and moral vigor as it is the special object of the Canadian Institute to develop. And when that greatness has been achieved, and this young Institute has advanced with it to maturity, I doubt not that among the earnest thinkers and intellectual workers of Canada, the honors of this chair will be esteemed among the most coveted distinctions that this Province has to bestow. Meanwhile, however, I experience somewhat of the same difficulty which I believe some of my predecessors have felt, with an Annual Presidential Address to deliver, and nothing very definite to address you about.

I might enlarge upon the steady progress of the Institute, and in a special manner congratulate you, that—thanks to the zeal and wise courage of my predecessor in this chair,—our roll has been purged of an accumulation of defaulters, mere men of buckram and straw to us,—a source of weakness instead of strength; but a very thorn in the side of our too forbearing and courteous Treasurer. It is a duty which all societies, constituted as we are, find it necessary from time to time to perform; and it is due to the neglect of this unwelcome duty by former Councils, until forbearance had become almost culpable, that my predecessor has had the opportunity of signalizing his close of office by a stern execution of rigorous justice, which confers no slight boon on his successor and on the Institute at large. These, however, and other facts connected with the history of our progress, have already been fully set forth in the Annual Report; and I must turn to other themes for the subject of your Annual Address.

A resumé of the progress of Science and Literature in the Province would be peculiarly suitable to this occasion, but we are scarcely yet in such a condition as to furnish fresh materials for any very elaborate annual report of scientific progress. Our position as Canadians is a very peculiar one, when we consider that only sixty-two years have elapsed since Colonel Bouchette described the site of this capital of Upper Canada as a scene of dense trackless forests, where the wandering savage had constructed his ephemeral habitation beneath the luxurious foliage, while the bay and the neighbouring marshes were the haunts of such multitudes of wild-fowl as to destroy the stillness of night by their cries. But while we reflect with just pride on the changes which have been wrought on that untamed wilderness within the memory of some of our number, we are not forgetful that we are a part of the British empire, claiming our share in her greatness, and seeking to assume our part in her inherited duties; and in proof of this we can point at least to two Canadian Institutions worthy of a people sprung from the old stock that gave a Bacon and a Newton to the world.

The Provincial Geological Survey continues its valuable labours, under the guidance of Sir William Logan, whose former occupancy of this chair reflects an honor on any one who succeeds to it ; and during the past year two of the illustrated decades of Canadian Organic Remains have been issued, in a style peculiarly creditable to our young Province. The head quarters of the Geological Survey and its Provincial Museum, are established in the commercial capital of Lower Canada ; while in Toronto, the Provincial Magnetic Observatory, originated under your first President, Captain Lefroy, continues in full activity, and the data of another year's magnetic and meteorological phenomena have been recorded by its director, Professor Kingston, for future publication.

Perhaps no more striking illustrations of the changes which a century has wrought on this Province could be selected, than are embodied in those two evidences of Anglo-Canadian enterprise and intellectual activity. That on the old trail of the Missassauga and the Huron, the wild forest and the swamp have given way to the busy marts and the crowded thoroughfares of an industrious and thriving city, is no trifling evidence of the healthful revolution which has been effected ; and this change has all been wrought by the busy hands and the hardy endurance of the Anglo-Saxon and Celtic supplanters of the Aboriginal Indians,—by those to whom, as colonists, the well-known language of Burke is still applicable : "A people but in the gristle, and not yet hardened into the bone of manhood."

That in this essentially practical age a race so thoroughly energetic and progressive as that from which the colonists of Canada have sprung, should clear the forest, drain the swamps, pave the roads, and rear costly marts and dwellings where so recently the rude birch-bark wigwam stood, is no slight triumph. Yet we scarcely need to be reminded that such material triumphs are neither the highest nor the most enduring monuments of a nation's progress. That great city Nineveh, and the mighty Babylon, that once queened it so proudly on the banks of the Tigris and the Euphrates, are now but heaps of reedy clay, above which the wandering Arab feeds his flocks ; while Athens lives for us still, far more by the pen of Sophocles and Socrates, Plato and Aristotle, than by the marbles of Phidias, or the columns of Callicrates and Ictinus. Even so, among the commercial marts and capitals of the civilized world, both Toronto and Montreal must still be content to claim a very secondary place ; while in their relation to those two great departments of scientific labour on which this Province has hitherto chiefly concentrated its intellectual energies: the Geological Survey and the Magnetic Observatory, Montreal and Toronto are named with pride wherever science is cultivated and knowledge revered. There is something grand and ennobling in reflecting on the patient labors of the Magnetic, as of the Astronomical observer. In that little building which rears its modest tower in the University Park, apart from all our busy thoroughfares, on a spot so recently hewn out of the forest wilderness, observers are patiently noting, day by day, the minutest phenomena connected with the elements of terrestrial magnetic force, the laws of periodicity, the number, diversity of forms, and intensity of auroral manifestations, and the indications of a solar magnetic influence on the earth, dependent, as it seems, on the changes which the luminous envelope of the sun undergoes. A larger series of magnetic phenomena completes its cycle of variations from the ordinary mean within a decennial period, which coincides with a similar one observed in the solar spots; and a variation of the magnetic declination has also been traced, chiefly by means of our own Toronto observations, to lunar influence; while it has been conclusively established that the elements of the earth's magnetic force are subject to regular diurnal, annual, and decennial ranges of variation from maximum, through minimum, to maximum again. By such observed data glimpses of novel truths of the most remarkable and unexpected kind are being obtained. Through a source so unlikely as our observation of the phenomena of terrestrial magnetism, we are learning somewhat of the constitution of the central luminary of our system. Towards the close of last century, amidst an absolute ignorance of any known data to reason upon, much ingenious speculation was indulged in relative to the nature and constitution of the sun. In seeking to interpret observed solar phenomena, Sir William Herschell was led to the conclusion that the central body of our system is probably an opaque globe, surrounded by a luminous atmosphere, the disturbance of which he accounted for by the emission of an elastic fluid, ascending from the solid body, and producing by its currents those solar spots, to which our attention has been recently drawn by a series of interesting communications from one of our own number.

The recent ingenious application of photography by Sir John Herschell, for following up the speculations of his father, and making the sun record for us the daily changes wrought on its own luminous surface, is another means whereby materials for further philosophical induction are being accumulated; and meanwhile the beautiful reasoning of Arago that solar light corresponds to that emitted by gaseous bodies, in being unpolarized, establishes on indisputable scientific grounds that the sun is no longer to be regarded as a solid incandescent body.

Thus slowly, yet surely, does science widen the range of our knowledge, and also the area wherein fancy may freely speculate. The question of a plurality of inhabited worlds has engaged the inductive reasoning, as well as the fanciful speculations of eminent philosophers in recent years; and that of an inhabited central sun cannot therefore be considered as beyond the pale of such far-reaching thought. That solar luminary may inclose within its glowing atmosphere a world of wondrous compass and beauty. Pure and glorious beings may dwell there, that "lie immortal in the arms of fire;" or, tempered by an intermediate cloudy vail, it may be that there, beings nobler and higher in the scale of intelligence than we are, bask in an endless summer, and a nightless day. For there is no night there, and fancy may anticipate the light which shall yet make clear to us the revelations of even greater mysteries than these.

But from such speculations I return to the fact that they have been suggested by the daily work going on in our own Provincial Magnetical Observatory. The results of such daily observations, entered in a few columns of figures, or pencilled by the sun's own rays, through the wonderful agency of photography, seem of little apparent value; yet, meanwhile at Washington, Greenwich and Kew, at Paris, Brussels, Berlin, Vienna, Rome, Christiana, Moscow, St. Petersburg, and other European cities; at Bombay, Travancore, and Mauritius, and at British Guiana, Melbourne, and other Colonial sites, similar observations prove the simultaneous occurrence of such phenomena in the most distant parts of the earth, and thus reveal to us glimpses, at least, of the operations of an unknown force acting with corresponding results on the whole globe. Thus the space controlled and brought within the direct range of our knowledge by the records of magnetic observations comprehends not only the earth as a whole, but the distant central sun, and the bounds of the solar system. But great as is this range in space, the range in time is probably still more important. The phenomena of terrestrial magnetism take hold in many ways of other laws, and disclose irregular, or at least seemingly irregular changes, also simultaneous in their manifestations in the most distant parts of the earth, but embraced as a whole it may be within periods too great to have yet been comprehended in the range of time over which the longest series of magnetic observations have extended. It may be that the full significance of the phenomena now being recorded in the Toronto Magnetic Observatory will only be understood when their normal progression completes a larger cycle, not of years but generations; and other centuries shall, by our aid, perceive the compass of great general laws. The relations already traced between magnetism, electricity, light, heat, and mechanical force, and all the singular glimpses of thermodynamics reducible to well-established laws by known mechanical principles, manifestly point to future disclosures of some comprehensive truth, as simple, yet perhaps even more wide-embracing than Newton's law: a grand law of the universe that shall indicate long concealed relations between that vital force which is controled by mental volition and animal instincts, and the mechanical forces which control inorganic matter, and bind suns, and planets, and systems into one.

Thus do those little-heeded labors of our magnetic observers unite us as fellow-workers with the noble phalanx of intellectual toilers, whose far-reaching thoughts and speculations wander through unillumined vistas of the coming centuries, and search for revelations of truths which the angels desire to look into; and the full significance of which, I doubt not, the spirits of just men made perfect rejoice to employ their renovated powers in mastering. But, while thus standing on

> "This narrow isthmus 'twixt two boundless seas,
> The past, the future, two eternities,

man—unconsciously stimulated by his immortal destiny,—desires to look into the unseen truths of a great future; it is also with no less characteristic zeal that he indulges in a wise retrospection; and in this also we have our indefatigable Provincial phalanx of workers. The two Decades illustrative of Canadian palæontology, issued during the past year by the Geological Survey of Canada, minutely illustrate and describe evidences of life pertaining to formations dating within that primary palæozoic period in which the Geologist recognises the oldest traces of organic structure, at an epoch, the remoteness of which he dimly guesses at by hundreds of thousands of years. And of what use is it for us to learn of those long-perished crinoids and foraminifera, intombed in rocky sepulchres, grander and more lasting than the pyramids and catacombs of the Pharaohs? In this, too, Canada is doing her appointed share in the world's search into the hidden truths of that book of nature, which is no less a divine revelation to us than the sacred volume of revealed moral truth: no less divine, though of inferior moment in the bearings of the truths it discloses, as revealing to us the Creator travelling in the greatness of his might through the silences of that infinite which lies behind us. In this, Canada claims to take her part among the world's thinkers. She will hew her lumber, raise her wheat, mine her copper, lead the tracks of her railways ever westward, conquering the savage wilderness, and make the wilds of our vast pine forests the happy settlements of a free, industrious, and progressive people; but she aspires to something more than to be the mere lumberer and wheat-grower of the world; and in so far as Canada does so, her material progress will not be the less, but greatly the more, for the intellectual vigor developed in thus claiming her place in that grand intellectual arena to which only the world's most gifted races find admission.

I might indeed dwell here, with justice, on the practical results of science; on the certainty that the mastery of the laws of nature increase the power of man; on the wondrous consequences that have followed from its least heeded beginnings; on the rubbed amber, ἤλεκτρον,—the *electron* of the Greeks—lifting straws: or the convulsions of the dead frog in the kitchen of the famed Bolognese Professor, Galvani: from whence we trace all our magnetical observatories, our new determinations of longitudes, our electric telegraphs, and the world-embracing project of our Atlantic cable. Or, again, on Newton's Apple; Jansen, the Dutch Optician's toy glasses; Watt's tea-kettle; or—apter for our present purpose,—Franklin's old key, which served him, with a silk-thread, sealing-wax, and a sheet of paper, to discover the identity of lightning and electricity: these, or a thousand other germs of thought, insignificant, and barren as the sand-grains sown by the east wind, when presented to the dull common eye; but pregnant as the thousand-fold seed which the Master Sower let fall into good ground, when they drop like the dews of summer on the fostering intellect of ripened genius. But here at least, such a defence of the sciences is unneeded. In the Canadian Institute it may be presumed that we pursue science from the pure delight which springs from the discovery of its secret truths; that we climb the steeps of knowledge, as the traveller ascends the mountain's unexplored cliffs, gladdened at every pause in his ascent with new grandeur and beauty in the widening horizon which opens on his delighted gaze.

But, while in thus leaving out of our present consideration the direct commercial and utilitarian results of Canadian science, our chief field of operation in Canada, and the immediate evidences of her scientific progress, are presented to us in the illustration of unknown gasteropods, crinoids, and foraminifera, discovered among the fossil forms of our older palæozoic rocks: we must not overlook the comprehensive generalizations to which the accumulation of such minute and seemingly isolated facts in ancient organic structure are leading.

With the original area of observation so immensely widened to the zoologist and naturalist by the comprehensive disclosures of palæology, all former conclusions are being subjected to revision and testing by such new evidence. The reality of the existence of very clearly discriminated specific forms, and the proofs of a continuous system of organization, development, displacement, and extinction, seem all more evident and indisputable. Yet the immediate result appears in the removal of many old land-marks of scientific faith, whereby we witness some of those conditions of ruin, which mark all transitional and revolutionary eras,—whether of thought or action. The old has been shaken, or thrown down, the new is still to build; and the casual and hasty observer is too apt to regard the indispensable clearing away of old and worn-out fabrics as the index only of ruin and desolation; while in reality it is the inevitable stage towards a higher replacement: like the ragged log-piles, the girdled-trees, and charred stumps of the pioneers of civilization in our Canadian wilderness, which are the needful precursors of the clearing, the farm-house, and the happy village homes.

In this light, I conceive, we must look upon that comprehensive question which now challenges revision in the hearing of new witnesses: *What is Species?* It is a question which forces us back to first principles, and equally affects the sciences of Palæontology, Zoology, and Ethnology; while it has also been made to bear in no unimportant degree on the relations of Science and Theology: involving as it does the questions:—In what forms has creative power been manifested in the succession of organic life? and, Under what conditions has man been introduced into the most diverse and widely separated provinces of the animal world? It is to the comprehensive bearings of the latter indeed, that the former owes its origin; for what is the use of entertaining the question, prematurely forced upon us: Are all men of one and the same species? while authorities in science are still so much at variance as to what species really is; and writers who turn with incredulous contempt from the idea that all men are descended from Adam, can nevertheless look with complacency on their probable descent from apes! One revolutionary class of thinkers, having its representatives among the ablest men of science on this continent, incline to the belief that species is a mere logical invention of the systematiser, and that the older naturalists have converted convenient definitions and the necessary formulæ of classification, into assumed realities. On the other hand, the extreme phalanx of their opponents invent a series of catastrophes, by which each geological period is closed,—the finished act, as it were, of a grand cosmic tragedy,—and all existing life is swept away, to give place to the creation of new species for the succeeding epoch of a renovated earth. This mysterious question of the origin of species is accordingly trammelled in part by that most dangerous of all hindrances to free inquiry and unbiased scientific judgment: The foregone popular conclusions relative to the supposed terms in which alone it can be answered, consistently with the inspired history of creation. Hence, on the one hand, development theories and transmutation of species; and on the other the more consistent idea not only of permanency of species, but also, along with it, of the recognition of the same great general laws which now govern the natural world having been in operation throughout all the countless ages of organic being which geology reveals to us.

Such inquiries into first principles necessarily bring about a collision between the conservative and the progressive ranks of thought; but in the conflict—whatever dust and heat arise,—the inevitable destruction of some long cherished error is of itself a clear gain. The course and tendency of thought may meanwhile be indicated to us by some of its most striking aspects:—*e. g.*, by the startling propositions of Agassiz relative to supposed relations between the different types of man, and the geographical distribution and local circumscription of species in the world of inferior animal life. On the other hand, Professor Dana has produced his "Thoughts on

Species," illustrated by highly ingenious analogies, and not only suggesting clearer definitions, but also supplying some very comprehensive bases of thought. The problem, however, is not one of easy solution. After various oscillations in the phases of expressed opinion, Professor Baden Powell, has boldly taken up the enquiry in the whole comprehensive bearings of "The Philosophy of Creation," and in this work, among other profound questions, he gives special importance to that of the immutability or transmutation of species, as one of the most significant in relation to all the final deductions on which the disclosures of geology, and the scientific foundations of cosmo-theology, compel us to render our verdict anew.

Still more recently an eminent English Naturalist: Charles Darwin, has in his elaborate introductory treatise: "On the origin of species by means of natural selection," carried to undisguised conclusions, and with systematic details of evidence and results, some of those opinions which Professor Powell has only left to be surmised. According to Mr. Darwin, the essential differences of genera are only the product of the same powers of nature through a greatly protracted epoch, which within a less prolonged period had sufficed to produce species; and under our own limited observation are seen to give rise to permanent varieties in animals and plants. From observation of phenomena occurring within our own cognizance he has arrived at the conclusion that there is in reality no essential distinction between individual differences, varieties, and species. The well-marked variety is an incipient species; and by the operation of various simple physical causes, and comparatively slight organic changes, producing a tendency towards increase in one direction of variation, and arrestment, and ultimate extinction in another, that law of *natural selection*, as Darwin terms it, results, which leads to his "preservation of favoured races in the struggle for life." He thus establishes, as he conceives, a principle in nature, akin to that which man consciously sets in operation, when he effects changes on domesticated animals and on plants, by altered conditions of life, and then perpetuates such as he selects by preference for his own use. The element of time—so limited in man's operations,—is for practical purposes unlimited in relation to the operation of natural causes on the development of variations in organic being in diverse directions; and as the great physical changes to which geology bears witness, supply all the means requisite for producing individual variations on a scale immensely exceeding any change observable on organic life under domestication, Mr. Darwin, conceives, and produces many illustrations in confirmation of his idea, that not only the origin of species, but the wider differences which distinguish genera, and all higher divisions of the organic kingdom may be accounted for by the same prolonged processes of variation and natural selection. His " Origin of Species," is no product of a rash theorist, but the result of the patient observation and laborious experiments of a highly gifted naturalist, extending over a period of upwards of twenty years, and—like the *Reliquiæ Diluvianæ* of Buckland,—it will be found to embody thoughts and facts of great permanent value, whatever be the final decision on its special propositions. From the high authority of the writer, his well-established character as an accurate observer, and the bold and startling nature of his views, it cannot be doubted that his work—with the promised additions to the evidence now produced,—will tend to re-open the whole question, and give courage to other assailants of those views of the permanency of species, which have seemed so indispensable alike to all our preconceived ideas in natural science, and to our interpretations of revealed cosmogony. Before Mr. Darwin's " Origin of Species" appeared from the press, Sir Charles Lyell—himself no hasty or incautious doubter,—had remarked of it: " he appears to me to have succeeded by his investigations and reasonings, in throwing a flood of light on many classes of phenomena, connected with the affinities, geographical distribution, and geological succession of organic beings, for which no other hypothesis has been able, or has even attempted to account." In relation to opinions advanced on questions of such profound interest and difficulty, by a distinguished naturalist, as results of the experience and observations of many years, our attitude ought clearly to be that of candid and impartial jurors. We must examine for ourselves, not reject, the evidence thus honestly given. The experience of the past shows how frequently men have contended for their own blundering interpretations, while all the while believing themselves the champions and the martyrs of truth. All truth is of God, alike in relation to the natural and the moral law, and of the former, as truly as of the latter may we say: " if this counsel or this work be of men, it will come to nought; but if it be of God, ye cannot overthrow it; lest haply ye be found even to fight against God."

But meanwhile in another, though allied direction, truth is the gainer by this widening of the scientific horizon. In 1857 our greatest English naturalist, Prof. Owen, set forth his remarkable new system of classification of mammals, based on the form and complexity of the brain. In this novel and ingenious system he separates man, on clearly defined grounds of cerebral structure and proportions, into a distinct and crowning order of ARCHENCEPHALA; thereby supplying by anticipation, a scientific antidote to one at least of the fallacies of Professor Powell, which may be thus stated: regarding the duration of time and the number of species as equally unlimited, he argues:—"While the number of species thus tends to become infinitely great, the extreme difference between man at one end and a zoophyte at the other end of the scale is constantly finite; hence the average difference between any two species tends to become infinitely small; multiplied by the number of species, it must still be equal to a finite quantity; and the product being finite, if the first factor be infinity the second must be zero."

It is scarcely necessary to observe that the tendency of species to an infinite multiplication of intermediate links, which is implied here, is a perfectly gratuitous assumption. The duration of time and the multiplication of species may be equally infinite; that it will be so we assuredly have no right to assume; but in that case the analogies which palæontology reveals do not suggest the idea that such prolonged manifestations of the Creator's power to produce an infinite series of new forms will be exercised intermediately between those two fixed points of zoophyte and man. What if creative power should go on beyond the latter, into still higher manifestations of the divine image? Man cannot be demonstrated to be an absolute finality in organic creation. Apart, however, from any question of future creations, we look in vain among organic fossils for any such gradations of form as even to suggest a process of transmutation. Above all, in relation to man, no fossil form adds a single link to fill up the wide interval between him and the most anthropoid of inferior animals, when viewing him purely in those salient physical aspects to which the observation of the palæontologist is limited. The Archencephale of Owen stands as the crowning masterpiece of organic creation, separated from the highest type of inferior animal organization by as well defined and broad a line of demarkation as an insular kingdom from the states, republics, and confederacies of a neighbouring continent; and if the difference between man and the inferior animals, not only in mere physical organization, but still more in all the higher attributes of animal life, be not relative but absolute, then no multiplication of intermediate links can lessen the obstacles to transmutation. One true antidote therefore to such a doctrine, and to the consequent denial of primary distinctions of species, seems to offer itself in such broad and unmistakeable lines of demarkation as Professor Owen indicates, between the cerebral structure of man and that of the most highly developed of anthropoid or other mammals.

Thus the widening range of observation is leading to other, yet related questions and discoveries of no slight importance. The whole compass of that latter one has been embraced in one aspect, in the remarkable introductory essay of Prof. Agassiz, "On Classification," which accompanies the first portion of the great American work now issuing by him under the title of "Contributions to the Natural History of the United States." Like all that comes from the gifted pen of Louis Agassiz, the Essay is bold, comprehensive, and valuable; but also it is not free from conclusions akin to those which in others of that distinguished naturalist's writings have been open to the charge of rash and hasty deductions from imaginary or defective premises. A more recent contribution to the same department of science is Prof Owen's communication to the Zoological section of the British Association, "On the Orders of Fossil and Recent Reptilia, and their distribution in time." In introducing his subject Professor Owen remarked, that, "with the exception of geology no collateral science had profited so largely from the study of organic remains as zoology. The catalogues of animal species have received immense accessions from the determination of the nature and affinities of those which have become extinct, and much deeper and clearer insight has been gained into the natural arrangement and sub-division of the classes of animals since palæontology has expanded our survey of them." The result of such study in the hands of the great comparative anatomist, has not accordingly been to ignore species, but to reconsider their classifications. The boundary which modern zoological systems maintained between the classes *Pisces* and *Reptilia* is shown to be untenable, and a new group is discerned, within which extensive gradations of development link and blend together fishes, amphibia, and reptiles in one great natural series. No more important contribution has recently been made to zoological science ; illuminating, as it does, our knowledge of existing orders by the deeper insight acquired into forms of organic life that have long been extinct, it is a collateral contribution to scientific truth, analogous in kind, though not in degree, to that comprehensive demonstration of the typical skeleton, by which it is traced in all its details, from the highest to the lowest vertebrate forms. Such grand generalizations, based, not on theory, but on laborious and exhaustive induction, reveal to us the plan of the Creator, wrought out in His unchangeable purpose, through all the countless ages during which our planet has been the theatre of life. They tell us, moreover, in unmistakeable language, that even to work out one single idea of the Divine mind, it has required the unmeasurable duration of time since that initial act in which God said let there be light, and called into being this well-ordered material world. "Lo these are parts of his ways; but how little a portion is heard of him; but the thunder of his power who can understand?"

In the fossil radiata and mollusca of our Canadian palæozoic formations, illustrated and described in the recently published Decades of our Geological Survey, we are aided in the investigation of life as it existed in that primary geological period in which the earliest traces of organic form appear ; but an altogether different interest has been recently excited by discoveries at the very opposite end of the geological scale. It is now nearly ten years since M. Boucher de Perthes announced the discovery of the traces of human art in the same undisturbed gravel of the north of France, in which the bones of the fossil elephant and other extinct mammals are found. More recently fresh discoveries have tended to show that the statements set forth in the "*Antiquités Celtiques et Antediluviennes*" merited greater attention than, on various accounts, they received ; and the testimony of Mr. Prestwick, Sir Charles Lyell, and other thoroughly trustworthy observers appears to place the fact beyond all controversy that artificially wrought weapons and implements of flint have been found both in France and England, in such contiguity with the extinct fossil mammals of the drift, as to leave little room for question that at a period long anterior to the earliest indications of history or tradition, the north of Europe was occupied by a human population in a condition not less rude than the Indian aborigines of our own American Forests.

Purposing as I do, to take up the comprehensive inquiries to which such discoveries point, in greater detail than could be permitted in this address, I shall only remark, meanwhile, that those who appear to be most startled with the apparent bearings of such discoveries, overlook the nearly analogous evidence we already possessed of the antiquity of the primeval colonization of the British Isles. Fully ten years since, and before the publication of M. Boucher de Perthes' work, in discussing the prehistoric traces of British population, I based one important line of argument for its antiquity on the discovery of artificial lances and harpoons, found beside the gigantic Balænopteræ of the Scottish drift in the Carse of Stirling. These extinct fossil mammals—one of them seventy-two feet long,—lay stranded at the base of the Ochills, twenty-one feet above the present tide level, and from seven to twenty miles distant from the nearest ocean reach. Whatever difficulties may seem to arise from the recent disclosures at Abbeville and Amiens, or the older ones at Hoxne in Suffolk, in relation to the age of man, the chronology which suffices to embrace the ancient Caledonian whaler of the valley of the Forth within the period of human history will equally answer for the more recently discovered allophylian of the French diluvium. Meanwhile it may not be unprofitable to note here also the changing phases of scientific theology. The difficulty now is to reconcile the discovery of works of human art alongside of the fossil mammals of the drift. But when, in 1712, certain gigantic fossil bones,—which would now most probably be refered to the Mastodon,—were found near Cluverach, in New England, the famous Dr. Increace Mather communicated the discovery to the Royal Society of London; and an abstract in the Philosophical Transactions duly sets forth the comforting opinion of the New England divine, of the confirmation thereby afforded to the Mosaic Narrative, that there were giants, or at least "men of very prodigious stature," in the Antediluvian world: for one of their teeth, *a grinder*, weighed four pounds and three-quarters, and a thigh bone measured seventeen feet long! Let it suffice for the present that geology in all its trustworthy and well established evidence still affirms that it is only in the latest post-tertiary, or modern strata, that the traces of man and his arts are found: ancient indeed when compared with the times of authentic history or tradition, but only "of yesterday" when placed alongside of the Silurian organisms of our Canadian Decades, or even of the vertebrates of Geology's comparatively modern Tertiary formations.

From the epoch of Silurian crinoids to the era of the drift and its included traces of human arts, is a transition as vast in point of time as the distances in space which the astronomer reduces to definite figures, but which the mind in vain attempts to realize. Compared with such a transition, the lapse of time from the earliest traces of human art to our modern nineteenth century is brief enough; yet the contrast seems scarcely so great between the organic forms of our lower silurian rocks, and the mammals of the drift, as that which separates the first rude evidences of human ingenuity in the latter formation, from such triumphs of mechanical skill as the "Great Eastern" of the Thames, or the "Victoria Tubular Bridge" of our own St. Lawrence. The great achievement of mechanical science and fearless enterprise embodied in the gigantic structure which now spans the wide waters of the St. Lawrence, and has been opened for traffic since last we assembled here, is the crowning feature of that arterial system of railways which well nigh annihilates for us the impediments of time and space and is already revolutionizing our whole relations of commercial and social life.

It is impossible, however, to revert to either of those wonderful triumphs of mechanical science, without also recalling the painful coincidence that, alike in the Great Eastern Steam Ship and the Victoria Bridge, the inventive genius that had planned and directed each, throughout all the stages of its progress towards completion, was snatched away when seemingly on the eve of realizing his most cherished hopes. The death of Robert Stephenson, at the too early age of fifty-one, only a few weeks before the completion of that colossal creation of his genius which constitutes, not for Canada only, but for the world at large, one of the fittest memorials of the great Engineer, has already been referred to in the Annual Report of the Council: for, honored by ranking him among our Honorary Members, the Canadian Institute claims her share in the loss occasioned by the death of him whose remains have been laid amid the royal and noble dead of Westminster Abbey, with marks of distinction and tokens of public sorrow, rarely accorded but to such combinations of genius and great personal worth.

Your attention has been recalled by the interesting communication of Dr. Rae, to the latest results of Arctic discovery, which, while clearing up all mystery as to the fate of the lamented Franklin, ranks him in one sense among those whose loss we have anew mourned during the past year. Permit me, in thus referring to the honored name of Franklin, to couple with it that of a personal friend, Mr. Henry Goodsir, formerly Curator of the Royal College of Surgeons of Edinburgh, who volunteered his services as Naturalist of the Franklin Expedition, and has doubtless perished, like his chief, though we lack the poor consolation of even learning his fate. I have watched with liveliest interest each detailed account of the relics of that ill-fated expedition, in the hope of recognising traces of one, not the least gifted or worthy among those whom Britain justly mourns. A young, enthusiastic, and highly gifted student of science: Henry Goodsir has fallen on a field more honorable, and striving in a nobler cause than most of those which furnish the laurels of heroes. Yet it is impossible not to revert with mournful regret to the ardent, sanguine votary of science, thus perishing before one desire had been accomplished, or one hope realized; going forth with the accumulated knowledge that constituted his weapons for that dread field, like the young soldier ardent for the strife:

"And lost to life, and use, and name, and fame."

It is a duty which generally devolves on the President of a Society like this, to commemorate on such occasions, those whose loss we have to lament during the past year; for, alas, no year passes over us, in which we have not to mourn some blank which death has made in our own numbers, or in that great Commonwealth of Science and Letters in which we claim to take our humble part. Among the ranks of our own members death has removed some who were wont to take a lively interest in our proceedings; and all of us, I doubt not, have deeply sympathised in the very painful circumstances which attended the loss of one of our number, the only son of His Excellency, Sir Edmund Head: a youth of great promise, and of rare enthusiasm in his early devotion to science. And when we look abroad on that wider circle which our sympathies embrace, we see that the Old World and the New have shared with an impartial equality in death's irrevocable bereavements. Hallam and Prescott, Brunel and Stephenson, De Quincy and Washington Irving, have, during the past year, followed one another to the grave; and it will not, I trust, be deemed an intrusion on the special duties of this occasion, if I turn aside for a moment to refer to another loss which science has recently sustained, but in which I claim a larger personal share. Death has been busy of late among Edinburgh men whom I counted my personal friends. Dr. Samuel Brown, Professor Edward Forbes, and Hugh Miller, have followed one another to the grave within a brief period, and ere the past year drew to a close, Dr. George Wilson was added to the number of those who live only in honored memory. Dying at the early age of forty-one, when a career full of rich promise appeared only opening before him, and his mind seemed to be ripening in many ways for a great life-work: those who knew his capacity and his genius regard all that he had accomplished as insignificant indeed when compared with what he would have done if spared to those years in which men chiefly fulfil the promises of youth. Yet what he did accomplish, amid many and sore impediments to progress, is neither poor nor of small amount. Nor is it a light thing now to remember that one whose years of public life have been so few, and even these encroached on by the ever increasing impediments of failing health, has been laid in his grave amid demonstrations of public sorrow such as have rarely indeed been accorded, in that native city of his, to Edinburgh's greatest men. This was due even more to the genial kindliness and worth of a noble Christian man, than to the unwearied zeal of a popular public teacher, and an enthusiastic student of science. His loss to his university is great, but to his friends it is irreparable. In him the faith of science, and the nobler faith of the Christian, were blended into perfect harmony; for no doubt springing from half-revealed truths of science ever marred the serene joy of his faith while looking at the things which are not seen. Prejudice and falsehood, ignorance and vice, were felt by him to be the common foes of both; and pardon me, if I add, that no man I have ever known carried more genially and unobtrusively, yet more thoroughly, his earnest Christian faith into all the daily business and the duties of life.

When a man of such genuine kindliness and worth is suddenly called away in his prime, with still so much of his life-work seemingly waiting its accomplishment, it is as when a brave vessel founders in mid-ocean. The wild eddy of the troubled waters gathers around the fatal gulf, and a cry of sympathetic sorrow rises up as the news is borne along to distant shores. But the ocean settles back to its wonted flow where that gallant bark went down, and the busy world soon returns to its old absorbing occupations. But there are those to whom that foundered bark has been the shipwreck of a life's hopes; and to me the loss of my life-long friend and brother will make life's future years wear a shadow they could never wear before.

But, Gentlemen, I trespass on the privileges of this chair. Let it be my apology to you that the event I mourn is—from accidental circumstances,—peculiarly associated with this meeting and your choice of me as your President. Permit me, in closing an address already too protracted, in which I have aimed at indicating some of those lines of abstract thought whereby science is enlarging our views and widening our sphere of knowledge, to invite you, as in a sense the self-constituted acolytes in this temple of Canadian science, to enter with renewed energy and devotion on the work of another year : remembering, each one of us, that we know not how few our years of work may be. We may indeed—in a far more absolute and literal sense than Newton could,—say, after all our work is accomplished, that we "seem to have been only like a boy playing on the sea-shore, and diverting himself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before us." But yet let us remember this at least, that that great ocean of truth does lie before us, and even those pebbles which our puerile labours gather on its shore, may include here and there a gem of purest ray; and meanwhile the search for truth, and even the play along the pleasant shores of its great unexplored ocean, will bring to each one of us his own exceeding great reward.

RESOLUTION OF ALGEBRAICAL EQUATIONS.

(Continued from the last Number of the Journal.)

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PROPOSITION VI.

If all the cognate functions (not necessarily unequal) of $f(p)$, an integral function of a variable p, be,

$$\phi_1,\ \phi_2,\ \phi_3,\ \ldots\ldots,\ \phi_m; \qquad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

and if

$$X = (x-\phi_1)(x-\phi_2)\ \ldots\ldots\ (x-\phi_m)$$
$$= x^m + A_1 x^{m-1} + A_2 x^{m-2} + \ldots\ldots + A_m; \quad \ldots \ (2)$$

then the coefficients A_1, A_2, &c., may be exhibited as rational expressions, that is, (see Def. 1), rational functions of p.

For take ϕ, the general symbol under which are included all the particular terms in the series (1); and let the n^{th} power of ϕ, (n being a whole number), arranged so as to satisfy the conditions of Def. 8, be,

$$\phi^n = a + a_1 t_1 + a_2 t_2 + \&c. ; \quad \ldots\ldots\ldots\ldots \quad (3)$$

where the coefficients, a, a_1, &c., are rational; and each of the terms, t_1, t_2, &c., is either some power of an integral surd, or the continued product of several such powers. Suppose y_1^r to be one of the factors of t_1; the index of the surd y_1 being $\frac{1}{\lambda}$; and let the several λ^{th} roots of unity be, 1, z, z^2, ..., $z^{\lambda-1}$. Then, from (3),

$$\phi_1^n = a + a_1 v_1 + a_2 v_2 + \&c.,$$
$$\phi_2^n = a + a_1 u_1 + a_2 u_2 + \&c.,$$
$$\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots$$
$$\phi_m^n = a + a_1 w_1 + a_2 w_2 + \&c. ;$$

where v_1, u_1, &c., are what t_1 becomes in passing from ϕ to ϕ_1, ϕ_2, &c.; and so of the other terms. Therefore,

$$\Sigma(\phi^n) = \phi_1^n + \phi_2^n + \ldots + \phi_m^n = \ldots + a_1(v_1 + u_1 + \ldots + w_1) + \&c.,$$
$$= \ldots\ldots + a_1 \Sigma(t_1) + \&c. ; \quad \ldots\ldots\ldots\ldots \quad (4)$$

where, just as $\Sigma(\phi^n)$ represents the sum of the terms, ϕ_1^n, ϕ_2^n, ..., ϕ_m^n, so $\Sigma(t_1)$ represents the sum of the terms, v_1, u_1, ..., w_1. Now, in the series, v_1, u_1, &c., if any term v_1 be fixed upon, there are λ terms, including v_1, of the forms,

$$v_1, \; z v_1, \; z^2 v_1, \; \ldots\ldots, \; z^{\lambda-1} v_1 .$$

The sum of these is zero. Strike these λ terms out of $\Sigma(t_1)$; and then, in the same manner, whatever term among those remaining in $\Sigma(t_1)$ be considered, it may be demonstrated to be one of a group whose sum is zero. And so on. Therefore $\Sigma(t_1)$ is zero. In like manner all the terms on the right hand side of equation (4), except the first, or $m\,a$, must vanish. Consequently, $\Sigma(\phi^n)$ is rational. If now we put

$$S_1 = \phi_1 + \phi_2 + \ldots\ldots + \phi_m,$$
$$S_2 = \phi_1^2 + \phi_2^2 + \ldots\ldots + \phi_m^2,$$
$$S_3 = \phi_1^3 + \phi_2^3 + \ldots\ldots + \phi_m^3,$$

and so on, the expressions S_1, S_2, &c., are (by what we have proved) rational. But, by Newton's Theorem for the sums of the powers of the roots of an equation, (*see equation* (2),

$$S_1 + A_1 = 0. \quad \text{Therefore } A_1 \text{ is rational}$$
$$S_2 + A_1 S_1 + 2 A_2 = 0. \quad \text{Therefore } A_2 \text{ is rational.}$$

And in the same way all the terms A_1, A_2, &c., may be exhibited as rational expressions.

Cor. 1.—Should the terms in (1) not be all unequal, let the unequal terms be,

$$\phi_1, \ \phi_2, \ \ldots\ldots \ \phi_s \ldots\ldots\ldots\ldots\ldots\ldots\ldots \ (5)$$

Then if $f(p)$ be in a simple form, and X_1 be the continued product of the terms, $x-\phi_1$, $x-\phi_a$, ..., $x-\phi_c$, where ϕ_1, ϕ_a, ..., ϕ_c, are a number of terms in (1), fewer than s, X_1 cannot have the coefficients of the various powers of x rational. For suppose, if possible, that X_1 has the coefficients of the various powers of x rational. Then ϕ_1 is a root of the equation, $X_1 = 0$. And since, by the hypothesis made in the Corollary, $f(p)$ is in a simple form, ϕ_1 also (Prop. IV.) is in a simple form. Therefore (Prop. V.) all the terms in (5) are roots of the equation, $X_1 = 0$; and they are all unequal: which, since the equation is of a degree lower than the s^{th}, is impossible. Therefore X_1 cannot have the coefficients of the powers of x rational.

Cor. 2. If (See 5) we put

$$(x-\phi_1)(x-\phi_2)\ldots\ldots(x-\phi_s) = x^s + b_1 x^{s-1} + b_2 x^{s-2} + \&c.,$$

the coefficients, b_1, b_2, &c., may be exhibited as rational expressions; and, if $f(p)$ be in a simple form, each of the terms, ϕ_1, ϕ_2, ..., ϕ_s, recurs in (1) the same number of times. For let ϕ_1 occur λ times in (1); ϕ_2, β times; and so on. Then

$$(x-\phi_1)^{\lambda}(x-\phi_2)^{\beta}\ldots(x-\phi_s)^{\delta} = (x-\phi_1)(x-\phi_2)\ldots(x-\phi_m) = X \ldots\ldots (6)$$

The equation, $X = 0$, has one group of λ equal roots, another group of β equal roots, and so on. There is therefore a common measure, X_2, of X and $\frac{dX}{dx}$, of the form,

$$(x-\phi_1)^{\lambda-1}(x-\phi_2)^{\beta-1}\ldots\ldots(x-\phi_s)^{\delta-1} = X_2 \ \ldots\ldots\ldots\ldots\ldots \ (7)$$

The expression X_2 resembles X in having the coefficients of the various powers of x rational; for it is the H. C. M. of X and $\frac{dX}{dx}$. Hence, denoting $\frac{X}{X_2}$ by X_3, we have, from (6) and (7),

$$(x-\phi_1)(x-\phi_2)\ldots\ldots(x-\phi_s) = X_3\,, \quad \ldots\ldots\ldots\ldots \quad (8)$$

where X_3, being the quotient of X by X_2, must have the coefficients of the various powers of x rational. Hence b_1, b_2, &c, may be exhibited as rational expressions. Thus the former of the two points to be proved in the Corollary is established. Next, should $f(p)$ be in a simple form, and should the numbers λ, β, &c., not be all equal to one another, let λ be less than δ, and not greater than any of the others. Then, from (8) and (6), we have, putting X_4 to denote the quotient of X by X_3^{λ},

$$(x-\phi_2)^{\beta-\lambda}\ldots\ldots(x-\phi_s)^{\delta-\lambda} = X_4\,, \quad \ldots\ldots\ldots\ldots \quad (9)$$

X_4 being rational. Should the numbers, $\beta-\lambda$, $\delta-\lambda$, &c., not be all equal to one another, then, exactly as we reduced equation (6) to equation (9), on the left hand side of which no power of $(x-\phi_1)$ appears as a factor, we can reduce equation (9) to an equation bearing the same relation to (9) that (9) bears to (6). And so on, till we arrive at an equation, such as (9), in which the indices, such as, $\beta-\lambda$, &c., are all equal to one another. Let the result obtained when this point is reached be,

$$(x-\phi_a)^{l-h}(x-\phi_c)^{k-h}\ldots\ldots(x-\phi_s)^{\delta-h} = X_5\,.$$

From this, since the numbers, l, k, ..., δ, are equal to one another, we get, by continuing the reduction,

$$(x-\phi_a)(x-\phi_c)\ldots\ldots(x-\phi_s) = X_6\,;$$

X_6 being a rational expression: which, since the number of its factors, $x-\phi_a$, $x-\phi_c$, &c., is less than s, and since $f(p)$ is supposed to be in a simple form, is (Cor. 1) impossible. Hence λ, β, &c., in (6), are all equal to one another; and therefore each of the terms, ϕ_1, ϕ_2, ..., ϕ_s, must recur in (1) the same number of times.

Cor. 3. In $f(p)$ let certain surds, y_1, y_2, &c., (in which series of terms, as was pointed out in Def. 7, all the subordinates of any surd mentioned are included), have definite values assigned to them; and let the cognate functions of $f(p)$, obtained without departing from such definite values, (obtained, in other words, by proceeding without reference to the surd character of y_1, y_2, &c.,) be,

$$\phi_1, \phi_2, \ldots\ldots, \phi_n \ldots\ldots\ldots\ldots \text{(10)}$$

Then if

$$(x-\phi_1)(x-\phi_2)\ldots(x-\phi_n) = x^n + B_1 x^{n-1} + B_2 x^{n-2} + \&c.,$$

the coefficients, B_1, B_2, are equal to expressions which are rational as respects all surds except y_1, y_2, &c. In other words, no surds not included in the series y_1, y_2, &c., enter into these coefficients. The proof is the same as in the Proposition.

Cor. 4. In the case supposed in the preceding Corollary, it may be shown, as in Cor. 1, that, if the unequal terms in (10), (the definite values of y_1, y_2, &c., being understood to be adhered to), be,

$$\phi_1, \phi_2, \ldots\ldots\ldots, \phi_t,$$

and if $f(p)$ be in a simple form, and we write

$$(x-\phi_1)(x-\phi_a)\ldots\ldots(x-\phi_c) = X_1,$$

where the number of terms, ϕ_1, ϕ_a, ..., ϕ_c, is less than t, these terms being terms in (10), X_1 cannot involve, in the coefficients of the powers of x, merely the surds y_1, y_2, &c. For, if X_1 did involve merely these surds, ϕ_1 would be a root of the equation, $X_1 = 0$; and therefore (Cor. Prop. V.) all the expressions, ϕ_1, ϕ_2, ..., ϕ_t, would be roots of that equation; the definite values given to y_1, y_2, &c., being adhered to in all the expressions, ϕ_1, ϕ_2, ..., ϕ_t. But these expressions are, by hypothesis, unequal. Therefore the equation, $X_1 = 0$, has t unequal roots: which, since the equation is of a degree lower than the t^{th}, is impossible. Therefore X_1 cannot involve, in the coefficients of the powers of x, merely the surds y_1, y_2, &c.

Cor. 5. In the case supposed in Cor. 3, let the unequal terms in the series (10), be, ϕ_1, ϕ_2, ..., ϕ_t; and let

$$(x-\phi_1)(x-\phi_2)\ldots\ldots(x-\phi_t) = x^t + b_1 x^{t-1} + b_2 x^{t-2} + \&c.$$

Then the coefficients b_1, b_2, &c., are equal to expressions involving no surds which do not occur in the series y_1, y_2, &c.; and, if $f(p)$ be in a simple form, each of the unequal terms, ϕ_1, ϕ_2, ..., ϕ_t, recurs the same number of times in (10) The proof is the same as in Cor. 2.

Cor. 6. If the equation, $F(x) = 0$, be an equation in which the coefficients of the powers of x are rational functions of p; and if $F(x)$ cannot be broken into rational factors, (by which expression we mean, factors having the coefficients of the powers of x rational), then, $f(p)$, an integral function of p, in a simple form, being a root of the equation, $F(x) = 0$, the roots of that equation are identical with the terms of the series (5), that is, with the unequal cognate functions of $f(p)$. For (Prop. V.) every term in (5) is a root of the equation, $F(x) = 0$. Also (Cor. 2) the expression,

$$(x-\phi_1)(x-\phi_2)\ldots\ldots\ldots(x-\phi_s),\ldots\ldots\ldots\ldots\ldots\ldots \quad (11)$$

when multiplied out, and arranged according to the powers of x, has the coefficients of the powers of x equal to rational expressions. Therefore, unless the expression (11) were identical with $F(x)$, $F(x)$ would have a rational factor, of less dimensions, as respects x, than $F(x)$: which is contrary to supposition. Therefore the expression in (11) is identical with $F(x)$; and the roots of the equation, $F(x) = 0$, are the terms in the series (5).

Proposition VII.

Let $f(p)$ be an integral function of a variable p, in a simple form. Denote by $\phi_1, \phi_2, \ldots\ldots, \phi_n$, all the unequal cognate functions of $f(p)$, obtained by assigning definite values to certain surds, y_1, y_2, &c., and proceeding (according to Def. 7) without reference to the surd character of y_1, y_2, &c. Let

$$F_1(x) = (x-\phi_1)(x-\phi_2)\ldots\ldots\ldots(x-\phi_n)$$
$$= x^n + A_1 x^{n-1} + A_2 x^{n-2} + \ldots + A_n;$$

the coefficients A_1, A_2, &c., satisfying the conditions of Def. 8, and not involving (Cor. 5, Prop. VI.) any surds not found in the series, y_1, y_2, &c. Let y_1 be a surd occurring in $F_1(x)$, that is, in the coefficients, A_1, A_2, &c., but not a subordinate of any surd in $F_1(x)$, its index being $\frac{1}{r}$; and, when we substitute for y_1 in A_1, A_2, &c., the successive values, $zy_1, z^2 y_1, \ldots\ldots, z^{r-1}y_1$, z being an r^{th} root of unity, distinct from unity, let $F_1(x)$ become in succession $F_2(x)$, $F_3(x)$, &c. Then, if

$$F = F_1(x) \times F_2(x) \times F_3(x) \times \ldots\ldots\ldots \times F_r(x)$$
$$= (x-\phi_1)(x-\phi_2)\ldots\ldots(x-\phi_n)(x-\phi_{1+n})\ldots(x-\phi_{2n})\ldots(x-\phi_{nr}),$$

the terms, $\phi_1, \phi_2, \ldots\ldots, \phi_{nr}$, are all the unequal cognate functions of $f(p)$, obtained by giving definite values to all the surds in $f(p)$ which are present in the coefficients of the powers of x in F, and forming the cognate functions without reference to the surd character of the surds thus rendered definite: F being understood to be generated directly by the multiplication together of the factors, $F_1(x)$, $F_2(x)$, &c., and to have the coefficients of the various powers of x arranged so as to satisfy the conditions of Def. 8.

For, all the terms in the series,

$$\phi_1, \phi_2, \ldots\ldots\ldots, \phi_n, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

are (by hypothesis) unequal. Suppose, if possible, that the terms,

$$\phi_{n+1}, \phi_{n+2}, \ldots\ldots\ldots, \phi_{2n}, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

which are the roots of the equation, $F_2(x) = 0$, are not all unequal. Then, $F_2(x)$, having equal factors, has a measure, H, of less dimensions, as respects x, than $F_2(x)$, and yet involving, in the coefficients of the powers of x, merely such surds as occur in $F_2(x)$. But the surds in $F_2(x)$ are identical with those in $F_1(x)$. [For instance, let $F_1(x) = (1 + \sqrt{p})^{\frac{1}{3}}$, and, $F_2(x) = z(1 + \sqrt{p})^{\frac{1}{3}}$, where z is a third root of unity, distinct from unity. The presence of z in $F_2(x)$ does not affect the surds in the expression]. Therefore the expression H, of less dimensions as respects x than $F_1(x)$, involves in the coefficients of the powers of x merely such surds as appear in $F_1(x)$: which, [since $F_1(x)$ is the product of the terms, $x-\phi_1, \ldots\ldots, x-\phi_n$, where $\phi_1, \phi_2, \ldots \phi_n$, are all the unequal cognate functions of $f(p)$ obtained by assigning definite values to certain surds in $f(p)$], is (Cor. 4, Prop. VI.) impossible. Therefore all the terms in (2) are unequal. Next suppose, if possible, that some term in (2) is equal to a term in (1). Then $F_2(x)$ and $F_1(x)$ have a common measure; and their H. C. M. involves only such surds as appear in $F_1(x)$ or $F_2(x)$; that is, only such as appear in $F_1(x)$: which, as above, is (Cor. 4, Prop. VI.) impossible, unless $F_1(x)$ and $F_2(x)$ are identical. Suppose then, if possible, that $F_1(x) = F_2(x)$. The coefficients of like powers of x must be equal. Let the coefficient of a certain powers of x in $F_1(x)$, arranged according to the powers of y_1, (we choose a coefficient where y_1 occurs in some of its powers), and satisfying (as, by hypothesis, it does) the conditions of Def. 8, be,

$$b + b_1 y_1 + b_2 y_1^2 + \ldots\ldots + b_{r-1} y_1^{r-1},$$

where b, b_1, &c., are clear of the surd y_1. The corresponding coefficient in $F_2(x)$ is

$$b + b_1 z y_1 + b_2 z^2 y_1^2 + \&c.$$

Therefore, $b_1(z-1)y_1 + b_2(z^2-1)y_1^2 + \&c. = 0.$

Since the surds present in this equation are surds occurring in $f(p)$, and $f(p)$ is in a simple form, the coefficients, $b_1(z-1)$, $b_2(z^2-1)$, &c., must (Cor. 1. Def. 9) vanish separately. But, since z is an r^{th} root of unity, distinct from unity, r being a prime number, none of the expressions, $z-1$, z^2-1, &c., vanish. Therefore b_1, b_2, &c., must all be zero: which is inconsistent with the assumption that the surd y_1 is present in the coefficient selected. Therefore $F_1(x)$ is not equal to $F_2(x)$; and we proved that it has no common measure with $F_2(x)$. Therefore no term in (1) is equal to a term in (2); and all the terms, ϕ_1, ϕ_2, ..., ϕ_{2n}, are unequal. In the same way it appears that all the terms, ϕ_1, ϕ_2, ..., ϕ_{nr}, are unequal.

The terms, ϕ_1, ϕ_2, ..., ϕ_{nr}, thus proved unequal, are the unequal cognate functions of $f(p)$, obtained by giving definite values to the surds in F, [which, from the manner in which F was generated, are necessarily surds occurring in $f(p)$], and framing the cognate functions without reference to the surd character of these surds. For, in framing the cognate functions, ϕ_1, ϕ_2, ..., ϕ_{nr}, all the surds in $F_1(x)$, except y_1, were considered as definite; and no numerical multipliers (such as z_1, z_2, &c., in Def. 6) were affixed to them. If F contained all the surds in $F_1(x)$, except y_1, our point would be easily established. It may happen, however, that F does not contain all the surds in $F_1(x)$ except y_1. Other surds may have disappeared from it, along with y_1. Let t be one of these, if there be such: and let its index be $\frac{1}{s}$. Then, in virtue of the s values that may be given to t, the cognate functions of $f(p)$, taken on a non-recognition of the surd character of those surds alone which appear in F, must include s groups of such terms as

$$\phi_1,\ \phi_2,\ \ldots\ldots\ \phi_{nr}, \ \ldots\ldots\ldots\ldots\ldots \quad (3)$$

In general, if t, t_1, &c., be the surds in $F_1(x)$, besides y_1, which are not in F; and if $\frac{1}{s}$, $\frac{1}{s_1}$, &c., be the indices of the surds t, t_1, &c.,

there will be $s s_1$ .... groups of such terms as (3). Still further, without having respect to the surds t, t_1, &c., there may be (Cor. 5, Prop. VI.: see more particularly the explanation presently to be given) m distinct groups such as (3): only (as has been proved) the $n r$ functions in (3) are the only unequal terms in all the m groups On the whole, the series of cognate functions of $f(p)$, taken on a non-recognition of the surd character of those surds alone which are present in F, will embrace $m n r s s_1$ .... terms, or $m s s_1$ .... lines of terms such as (3), of which the following may serve as examples:

$$\left.\begin{array}{l}\phi_1, \phi_2, \ldots\ldots\ldots\ldots, \phi_{nr};\\ \psi_1, \psi_2, \ldots\ldots\ldots\ldots, \psi_{nr};\\ \phi'_1, \phi'_2, \ldots\ldots\ldots\ldots, \phi'_{nr};\\ \psi'_1, \psi'_2, \ldots\ldots\ldots\ldots, \psi'_{nr}.\end{array}\right\} \ldots\ldots\ldots\ldots \quad (4)$$

The first of these lines is (3). The second is a cluster of terms, in addition to the nr terms of the first line, obtained without having respect to t, t_1, &c., and being a repetition of the values of the terms in the first line; for, in the mnr terms, obtained without reference to t, t_1, &c., the unequal terms which constitute the series (3) are all repeated (Cor. 5. Prop. VI.) the same number of times. The third line of (4) contains the terms in the first line, transformed by changing t into $z_1 t$; z_1 being an s^{th} root of unity, distinct from unity. And those in the last line contain the terms of the second line, transformed by a similar change of t into $z_1 t$. Now it can be shown that the terms of the third line are equal, in some order, to those of the first, each to each. For, since t, present in $F_1(x)$, disappears from F, it follows that the continued product of the factors of F, viz.: $F_1(x)$, $F_2(x)$, &c., remains the same when $z_1 t$ is substituted for t. That is, the factors,

$$x - \phi_1,\ x - \phi_2, \ldots\ldots\ldots, x - \phi_{nr},$$

are the same, taken in some order, with the factors,

$$x - \phi'_1,\ x - \phi'_2, \ldots\ldots\ldots\ldots, x - \phi'_{nr}.$$

Hence the terms in the third line of (4) are, in some order, equal to those in the first line, each to each. In the same way it may be proved that all the $mnrss_1$ .... cognate functions above described, are merely repetitions of the values of the functions in (3). Hence the terms in (3) are all the unequal cognate functions of $f(p)$, obtained by giving definite values to the surds in F, and taking the cognate functions without reference to these surds.

Proposition VIII

Let an equation of the m^{th} degree, whose coefficients are rational functions of a variable p, be, $X = 0$; X having no rational factors; and let an algebraical root of this equation, in a simple integral form, arranged also so as to satisfy the conditions of Def. 8, be $f(p)$. Take u_1, a surd in $f(p)$, not a subordinate of any other surd in the function, with the index $\frac{1}{n}$; and let the cognate functions of $f(p)$, obtained by successively changing u_1, wherever it occurs in $f(p)$ in any of its powers, into u_1, $z_1 u_1$, $z_1^2 u_1, \ldots\ldots, z_1^{n-1} u_1$, z_1 being an n^{th} root of unity, distinct from unity, be,

$$\phi_1 \text{ or } f(p),\ \phi_2,\ \phi_3, \ldots\ldots\ldots, \phi_n.$$

Let $F_1(x)$ denote the continued product of the terms, $x - \phi_1$, $x - \phi_2$, $\ldots\ldots\ldots$, $x - \phi_n$. The coefficients of the various powers of x in $F_1(x)$, made to satisfy the conditions of Def. 8, are (Cor. 3, Prop. VI.) clear of the surd u_1; and the terms, ϕ_1, $\phi_2, \ldots\ldots\ldots, \phi_n$, constitute (Prop. VII.) the series of the unequal cognate functions of $f(p)$, obtained by affixing definite values to all the surds in $F_1(x)$, [which are necessarily surds in $f(p)$], and taking the cognate functions without reference to the surd character of the surds so made definite. Should $F_1(x)$, which is clear of the surd u_1, not have the coefficients of the powers of x rational, let u_2, a surd in $F_1(x)$, not a subordinate of any other surd in $F_1(x)$, with the indev $\frac{1}{r}$, be successively replaced by u_2, $z_2 u_2$, $z_2^2 u_2, \ldots\ldots\ldots, z_2^{r-1} u_2$; z_2 being an r^{th} root of unity, distinct from unity; and, in consequence of these alterations, let $F_1(x)$ become successively $F_1(x)$, ${}^2F_1(x)$, ${}^3F_1(x), \ldots\ldots\ldots, {}^rF_1(x)$; the functions which are ϕ_1, $\phi_2, \ldots\ldots\ldots, \phi_n$, in $F_1(x)$, becoming ϕ_{n+1}, ϕ_{n+2}, $\ldots\ldots \phi_{2n}$, in ${}^2F_1(x)$, and becoming ϕ_{2n+1}, &c., in ${}^3F_1(x)$; and so on. Denote the continued product of the terms, $F_1(x)$, ${}^2F_1(x), \ldots\ldots$, ${}^rF_1(x)$, when the result is made to satisfy the conditions of Def. 8, by $F_2(x)$, which is (Cor. 3. Prop. VI.) an expression clear of the surd u_2, and such (Prop. VII.) that the functions, ϕ_1, $\phi_2, \ldots\ldots, \phi_{nr}$, [the

nr factors of $F_2(x)$ being $x-\phi_1, x-\phi_2, \ldots\ldots, x-\phi_{nr}$], constitute the series of the unequal cognate functions of $f(p)$, obtained by assigning definite values to all the surds which are found in $F_2(x)$, [these being surds of necessity present in $f(p)$], and taking the cognate functions without reference to the surd character of these surds. In the same manner in which $F_1(x)$ was derived from $f(p)$, and then $F_2(x)$ from $F_1(x)$, derive $F_3(x)$ from $F_2(x)$, and $F_4(x)$ from $F_3(x)$, and so on, till an expression $F_a(x)$ is reached, in which the coefficients of the powers of x are rational. The expression $F_a(x)$ shall be identical with X.

For, if the factors of $F_a(x)$ be, $x-\phi_1, x-\phi_2, \ldots\ldots, x-\phi_M$, then, since the coefficients of the powers in x in $F_a(x)$ are rational, the functions $\phi_1, \phi_2, \ldots\ldots, \phi_M$, constitute (Prop. VII.) the entire series of the unequal cognate functions of $f(p)$. But the entire series of the unequal cognate functions of $f(p)$ is identical (Cor. 6. Prop. VI.) with the series of the roots of the equation, $X=0$. Therefore $F_a(x)$ and X are identical.

Proposition IX.

In the series, in Prop. VIII.,

$$x-f(p),\ F_1(x),\ F_2(x),\ \ldots\ldots,\ F_a(x) \text{ or } X, \ldots\ldots\ldots (1)$$

let the factors by whose continued product $F_{c+1}(x)$ is generated, be,

$$F_c(x),\ {}^2F_c(x),\ {}^3F_c(x),\ \ldots\ldots,\ {}^sF_c(x);\ \ldots\ldots\ldots\ldots (2)$$

where ${}^2F_c(x)$, ${}^3F_c(x)$, &c., are what $F_c(x)$ becomes, on substituting successively for Y, a surd in $F_c(x)$, not subordinate to any other surd in the function, and having the index $\frac{1}{s}$, the values $z\mathrm{Y}$, $z^2\mathrm{Y}$, &c.; z being an s^{th} root of unity, distinct from unity. Let U be a surd in $F_c(x)$, distinct from Y, and not subordinate to any other surd in $F_c(x)$, with the index $\frac{1}{\sigma}$. Then if the surd U disappear from $F_{c+1}(x)$, σ is equal to s, and the surds Y and U are (as we may express it) *similarly involved* in the function $F_c(x)$: by which we mean, that, when the function is arranged according to Def. 8, whenever one of them appears in the function in any of its powers, it occurs multiplied by a power of the other; as, Y^{λ} by U^{λ_1}, Y^{β} by U^{β_1}, Y^{δ} by U^{δ_1}, and so on; the pairs of equations,

$$\left.\begin{array}{r} h\lambda = ks + \beta, \\ h\lambda_1 = qs + \beta_1, \end{array}\right\} \dots\dots\dots\dots\dots\dots\dots (3)$$

$$\left.\begin{array}{r} H\lambda = Ks + \delta, \\ H\lambda_1 = Qs + \delta_1, \end{array}\right\} \dots\dots\dots\dots\dots\dots\dots (4)$$

and so on, subsisting; where h, H, k, K, q, Q, &c., are whole numbers, each less than s

To prevent misunderstanding, we may instance the function,

$$f(p) = p^{\frac{5}{7}}(2+p)^{\frac{1}{7}} + \left\{6 + p^{\frac{3}{7}}(2+p)^{\frac{2}{7}}\right\}\left\{2 + [p + p^{\frac{1}{7}}(2+p)^{\frac{3}{7}}]^{\frac{1}{2}}\right\}^{\frac{1}{11}},$$

as one in which the two surds $p^{\frac{1}{7}}$ and $(2+p)^{\frac{1}{7}}$ are similarly involved. For, calling the former Y and the latter U, we have $s = \sigma = 7$, $\lambda = 5$, $\lambda_1 = 1$, $\beta = 3$, $\beta_1 = 2$, $\delta = 1$, and $\delta_1 = 3$. Consequently equations (3) and (4) become,

$$\begin{aligned} 5h &= 7k + 3, \\ h &= 7q + 2; \\ 5H &= 7K + 1, \\ H &= 7Q + 3; \end{aligned}$$

where integral values of h, H, &c., less than 7, can be found:

$$h = 2,\ k = 1,\ q = 0,$$
$$H = 3,\ K = 2,\ Q = 0.$$

We proceed with the proof of the Proposition Let z_1 be a σ^{th} root of unity, distinct from unity; and when U is changed into $z_1 U$, let the terms in (2) become,

$$f_c(x),\ {}^2f_c(x),\ {}^3f_c(x),\ \dots\dots\dots,\ {}^sf_c(x) \dots\dots\dots\dots (5)$$

Since U disappears from $F_{c+1}(x)$, the continued product of the terms in (2) is not affected when we replace U by $z_1 U$. Therefore

$$F_c(x) \times {}^2F_c(x) \times \dots \times {}^sF_c(x) = f_c(x) \times {}^2f_c(x) \times \dots \times {}^sf_c(x).$$

Hence, either $F_c(x)$ is equal to one of the terms in (5), or it has with one of them, as ${}^af_c(x)$, a common measure, of less dimensions, as respects x, than $F_c(x)$. Suppose, if possible, that $F_c(x)$ is not equal to any term in (5); and that L is its H. C. M. with ${}^af_c(x)$. The expression L involves only such surds as occur in $F_c(x)$ or $\overset{a}{f_c}(x)$; but, since U is (by hypothesis) not a subordinate of any surd in the function $F_c(x)$, the substitution of $z_1 U$ for U makes no change on the surds appearing in the function: that is, the surds in $f_c(x)$, and therefore also those in $\overset{a}{f_c}(x)$, are identical with those in $F_c(x)$; and consequently the surds in L are all found in $F_c(x)$. Now the simple factors of $F_c(x)$ are (*see Prop.* VIII.) the unequal cognate functions of $f(p)$ obtained by assigning definite values to those surds in $f(p)$ which are also present in $F_c(x)$, and taking the cognate functions without reference to the surd character of the surds so made definite. Therefore (Cor 4, Prop. VI.) no expression such as L can involve merely such surds as appear in $F_c(x)$. Hence $F_c(x)$ cannot but be equal to some term in (5). Let $F_c(x) = \overset{a}{f_c}(x)$. This implies that the coefficients of like powers of x in these expressions are equal. Let x^{E} be a power of x in $F_c(x)$ involving in its coefficient the surd Y in one of its powers; the coefficients, D and D_1, of the E^{th} power of x in $F_c(x)$ and $\overset{a}{f_c}(x)$ respectively being,

$$D = \ldots\ldots + b_1 Y^{k} U^{l} + \&c.,$$

$$D_1 = \ldots\ldots + b_1 z^{k(a-1)} z^{l}_{1} Y^{k} U^{l} + \&c.,$$

where such terms as b_1 are clear of the surds Y and U, and not zero; and no two terms such as that written $Y^{k} U^{l}$ are identical; k not being zero. Since s is a prime number, and [$F_c(x)$ satisfying the conditions of Def. 8] k is less than s, we can find whole numbers, w and w_1, less than s, and such that

$$w_1 k = w s + 1 \therefore Y = (Y^{s})^{-w} Y^{w_1 k};$$

or, if Y^{k} be represented by V,

$$Y = (Y^{s})^{-w} V^{w_1}.$$

Now $(Y^{s})^{-w}$, when expressed as an integral function satisfying the conditions of Def. 8, involves only the subordinate surds of Y. Therefore, by the equation found, we can eliminate Y from $F_c(x)$, introducing in its room powers of V, but no powers of any other surd that was not previously in the function. Let $F_c(x)$, as thus exhibited, be written $F'_c(x)$. A term in $F'_c(x)$ is $b_1 V U^{l}$. Should l

be neither zero nor unity, write V_1 for U^l; and, as above, all the powers of U occurring in $F'_c(x)$ can be made to disappear; powers of V_1 being introduced into the function in their room, but no powers of any other surd that was not previously in the function. Let the function become, in consequence of this change, $F''_c(x)$; and let the coefficients of the several powers of x in $F'_c(x)$ and $F''_c(x)$ be supposed to satisfy the conditions of Def. 8, as was the case with $F_c(x)$. Then, since V and V_1 are respectively powers of surds that were present in $F_c(x)$, but do not remain (except as implicitly involved in V and V_1) in $F''_c(x)$; and since $F_c(x)$ is (by hypothesis) in a simple form, $F'_c(x)$ and $F''_c(x)$ are also in a simple form. In changing $F'_c(x)$ into $F''_c(x)$, we assumed that l was not zero. This may now be shown to be case. Equate the coefficients of x^E in $F'_c(x)$ and ${}^a f'_c(x)$; this latter expression being what ${}^a f_c(x)$ becomes when Y is eliminated, and powers of V introduced into its room. Then,

$$\ldots\ldots + b_1 V U^l + \ldots\ldots = \ldots\ldots + b\, V U^l z^{k(a-1)} z_1^l + \&c.$$

$$\therefore \ldots\ldots + b_1 \left\{1 - z^{k(a-1)} z_1^l\right\} V U^l = \&c. = 0.$$

Therefore, by Cor. 1. Def. 9, $1 - z^{k(a-1)} z_1^l = 0 \ldots\ldots (6)$

If l were zero, this would make $z^{k(a-1)}$ equal to unity: which, since the numbers, k, $a-1$, are less than s, and z is an s^{th} root of unity, distinct from unity, is impossible. Therefore l is not zero; and hence $F'_c(x)$ can be exhibited in the form $F''_c(x)$. Equate the coefficients of x^E in $F''_c(x)$ and ${}^a f''_c(x)$; this latter expression being what ${}^a f_c(x)$ becomes when Y and U are eliminated, and V and V_1 are introduced in their room. Then the equation (6) still holds. But such an equation implies, that, z being an s^{th} root of unity, and z_1 being a σ^{th} root of unity, distinct from unity, $\sigma = s$. Again, suppose V to occur in its h^{th} power in any term of $F''_c(x)$, so that $b_2 V^h V_1^{h_1}$ is a term in the coefficient of some power of x. Then, by reasoning as above, we get

$$1 - z^{kh(a-1)} z_1^{lh_1} = 0 \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

Hence, by a comparison of (6) and (7),

$$1 - z_1^{l(h-h_1)} = 0 \;\therefore\; h = h_1 \;\therefore\; V_1^{h_1} = V_1^{h}.$$

Hence $b_2\, V^{h}\, V_1^{h_1}$ becomes $b_2\, V^{h}\, V_1^{h}$: which, again, by returning from V and V_1 to Y and U, becomes $b\, Y^{kh-ws}\, U^{lh-w_1 s}$; where ws is the greatest multiple of s in kh, and $w_1 s$ is the greatest multiple of s in lh; b being an expression clear of the surds Y and U. Consequently $F_c(x)$ may be written,

$$F_c(x) = \Sigma \{ B Y^{kh-ws}\, U^{lh-w_1 s} \}; \;\ldots\ldots\ldots\ldots\; (8)$$

B being an expression clear of the surds Y and U; and the numbers, k, l, remaining the same in all the terms, such as $BY^{kh-ws}\, U^{lh-w_1 s}$, included under the symbol Σ. But equation (8) implies that the surds Y and U are *similarly involved* in $F_c(x)$.

Proposition X.

Let $f(p)$ be an integral function of a variable p, in a simple form, satisfying the conditions of Def. 8; and let

$$A\, Y^{\lambda} = B\, U^{\lambda}; \;\ldots\ldots\ldots\ldots\; (1)$$

where Y is a surd in $f(p)$, with the index $\frac{1}{s}$; and A is an expression, not zero, involving only surds, distinct from Y, which occur in $f(p)$; λ being a whole number, not zero, and less than s; and the expressions B, U, are what A and Y respectively become on changing T, a chief subordinate of Y, with the index $\frac{1}{\sigma}$, into z T, z being a σ^{th} root of unity, distinct from unity; T not being a subordinate of any surd in the expression A. Then the surd Y is of the form,

$$Y = (H\, T^{m})^{\frac{1}{s}}; \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\; (2)$$

where H is an expression clear of the surd T; and m is a whole number, less than σ. Also, σ is not equal to s.

For, let ϕ be the general expression which includes all the cognate functions of $A\, Y^{\lambda}$, taken without reference to the surd character of any of the surds in $A\, Y^{\lambda}$, except T and Y; and let ϕ^{s}, arranged so as to satisfy the conditions of Def. 8, be,

$$\phi^s = D + D_1 z_1 T + D_2 z_1^2 T^2 + \ldots\ldots + D_{\sigma-1} z_1^{\sigma-1} T^{\sigma-1};$$

where z_1 is an indefinite σ^{th} root of unity; and D, D_1, &c., are clear of the surd T. Then

$$(A Y^{\lambda})^s = D + D_1 T + D_2 T^2 + \&c;$$

$$\text{and, } (B U^{\lambda})^s = D + D_1 z T + D_2 z^2 T^2 + \&c.$$

$$\therefore T D_1 (1 - z) + T^2 D_2 (1 - z^2) + \&c. = 0.$$

This equation involves only such surds as occur in $f(p)$. Therefore (Cor. 1, Def. 9) the coefficients, $D_1(1 - z)$, $D_2(1 - z^2)$, &c., vanish separately. But, since σ is a prime number, and z is a σ^{th} root of unity, distinct from unity, none of the terms, $1 - z$, $1 - z^2$, &c., vanish. Therefore D_1, D_2, &c., must all vanish; and

$$A Y^{\lambda} = D^{\frac{1}{s}}$$

Raise both sides of this equation to the r^{th} power; r and n being whole numbers such that

$$r\lambda = ns + 1.$$

$$\text{Then, } (A Y^{\lambda})^r = (A^r Y^{ns}) Y = (D^r)^{\frac{1}{s}},$$

$$\text{or, } P Y = Q^{\frac{1}{s}}; \ldots\ldots\ldots\ldots\ldots (3)$$

where P and Q involve only such surds, exclusive of Y, as are present in $A Y^{\lambda}$; and Q is clear of the surd T. Let the forms of P and Y be,

$$P = b + b_1 T + b_2 T^2 + \ldots\ldots + b_{\sigma-1} T^{\sigma-1}, \quad \ldots\ldots\ldots (4)$$

$$Y = (h + h_1 T + h_2 T^2 + \ldots\ldots + h_{\sigma-1} T^{\sigma-1})^{\frac{1}{s}}; \ldots\ldots\ldots (5)$$

where b, b_1, &c., h, h_1, &c., are clear of the surd T. Suppose, if possible, that the terms b_1, b_2, &c., are all zero. Then $P = b$; and,

$$b^s h + b^s h_1 T + b^s h_2 T^2 + \&c. = Q.$$

But since Q is clear of the surd T, the coefficients, $b^s h_1$, $b^s h_2$, &c., in this equation, must (Cor. 1, Def. 9) vanish separately. Now, A is (by hypothesis) not zero; therefore P is not zero; therefore b^s is not zero. Therefore all the terms, h_1, h_2, &c., vanish: which (since T is a subordinate of Y) is impossible. Hence at least one of the terms, b_1, b_2, &c., as b_c, does not vanish. But this leads to the conclusion that all the terms,

$$b,\ b_1,\ b_2,\ \ldots\ldots,\ b_{\sigma-1},\ \ldots\ldots\ldots\ldots\ldots\ (6)$$

except b_c, must vanish. For, from (3) and (4), we have,

$$\mathrm{Y}\,b + \ldots\ldots + b_c\,\mathrm{Y}\,\mathrm{T}^{c} + b_r\,\mathrm{Y}\,\mathrm{T}^{r} + \&c. = \mathrm{Q}^{\frac{1}{s}}.$$

From this equation eliminate the surd $\mathrm{Q}^{\frac{1}{s}}$, in the same way in which X_1 was eliminated from equation (4) Prop. I. The result is,

$$\ldots\ldots + b_c\,\mathrm{Y}\,\mathrm{T}^{c}\,\mathrm{E} + b_r\,\mathrm{Y}\,\mathrm{T}^{r}\,\mathrm{E}_1 + \&c. = 0.$$

The conditions necessary in order that E and E_1 may both vanish, are,

$$b_c\,\mathrm{Y}\,\mathrm{T}^{c} = k\,\mathrm{Q}^{\frac{1}{s}},$$

$$b_r\,\mathrm{Y}\,\mathrm{T}^{r} = q\,\mathrm{Q}^{\frac{1}{s}},$$

k and q being constant quantities; and these equations give us,

$$q\,b_c\,\mathrm{T}^{c} = k\,b_r\,\mathrm{T}^{r}:$$

which, T^{c} and T^{r} being distinct powers of T, not exceeding the $(\sigma-1)^{\text{th}}$, is (Cor. 1, Def. 9) impossible. Therefore b_c is the only term in (6) which does not vanish; and, from (3), (4), and (5),

$$b_c^{s}\,h\,\mathrm{T}^{cs} + \ldots\ldots + b_c^{s}\,h_a\,\mathrm{T}^{cs+a} + b_c^{s}\,h_m\,\mathrm{T}^{cs+m} + \&c. = \mathrm{Q}\ \ldots\ldots\ (7)$$

If h_m be a term in the series, h, h_1, &c., which is not zero, all the other terms in that series vanish. For, if h_e be another term, let

$$c\,s + e = w\,\sigma + \beta,$$

$$\text{and, } c\,s + m = w_1\,\sigma + \delta;$$

where β and δ are whole numbers, less than σ. Then, since e and m are not equal, and each of them is less than σ, β and δ are not equal. And so likewise as regards the other terms. Therefore (Cor. 1, Def. 9), all the coefficients, $b_c\,h_a$, $b^{s}\,h_m$, &c., in (7), must vanish, except the one occurring in the term which is equal to Q. But h_m does not vanish. Therefore all the terms, h, h_1, &c., except h_m, or (as we may write it) H, must vanish; and Y is reduced to the form,

$$\mathrm{Y} = (\mathrm{H}\,\mathrm{T}^{m})^{\frac{1}{s}}.$$

Also, equation (7) becomes,

$$\overset{s}{b_c} \, H \, T^{cs+m} = Q:$$

which (Cor. 1, Def. 9) is only possible if the number, $cs+m$, be a multiple of σ. Hence σ and s are not equal to one another.

Cor.—If an equation such as (3) subsist, the form of the surd **Y** is that given in (2), and s and σ are unequal.

Proposition XI.

In the series, in Prop. VIII.,

$$x - f(p), \; F_1(x), \; \ldots\ldots, \; F_a(x) \text{ or } X,$$

let the factors by whose continued product $F_{c+1}(x)$ is generated, be,

$$F_c(x), \; \overset{2}{F}_c(x), \; \overset{3}{F}_c(x), \; \ldots\ldots, \; \overset{s}{F}_c(x); \ldots\ldots\ldots\ldots (1)$$

where $\overset{2}{F}_c(x)$, $\overset{3}{F}_c(x)$, &c., are what $F_c(x)$ becomes, on substituting successively for Y, a surd in $F_c(x)$, not subordinate to any other surd in the function, and having the index $\frac{1}{s}$, the values $z\,Y$, $z^2\,Y$, &c.; z being an s^{th} root of unity, distinct from unity. Also suppose, that, besides Y, there are no surds in $F_c(x)$ which disappear from $F_{c+1}(x)$, except subordinates of Y. Let T, a chief subordinate of Y, with the index $\frac{1}{\sigma}$, disappear from $F_{c+1}(x)$, in which case T is not a subordinate of any surd in $F_c(x)$ except Y. When T is changed into $z_1\,T$, z_1 being a σ^{th} root of unity, distinct from unity, let the terms in (1) be transformed into,

$$_1X_1, \; _2X_1, \; _3X_1, \; \ldots\ldots, \; _sX_1.$$

Generally, if $_aX_b$ be what $\overset{a}{F}_c(x)$ becomes when T is changed into $z_1^b\,T$, b being a whole number in the series, 1, 2, ..., σ—1, the expression, $_aX_b$, comprehends $s(\sigma-1)$ particular forms:

$$\left.\begin{array}{l} _1X_1, \; _2X_1, \; \ldots\ldots, \; _sX_1, \\ _1X_2, \; _2X_2, \; \ldots\ldots, \; _sX_2, \\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \\ _1X_{\sigma-1}, \; _2X_{\sigma-1}, \; \ldots\ldots, \; _sX_{\sigma-1}. \end{array}\right\} \ldots\ldots\ldots\ldots\ldots (2)$$

Then, if $F_c(x)$ be equal to a term in (2), an equation,

$$Y = P\,Y_1^{\lambda}, \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

must subsist; where Y_1 is what Y becomes when T is replaced by z_1 T;

and P is an expression involving only surds which occur in $F_c(x)$, exclusive of Y; λ being a whole number, distinct from zero and less than s, satisfying the condition,

$$\lambda^{\sigma} = w\,s + 1\,; \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

where w is a whole number. Also, if Y be not of the form shown in equation (2) Prop. X, λ is not uuity, and s is not 2.

Let us in the mean time reason on the supposition that $F_c(x)$ is equal to a term in the first horizontal line of (2). We here make an observation to which we shall have occasion subsequently to refer. When an expression is equal to some term in a series such as that constituted by the terms in the first horizontal line of (2), any one of the terms in the series may be assumed to be that to which the expression in question is equal; because any particular term in the series stands, in fact, as the representative of all the terms in the series, in consequence of the s distinct values which may be given to the surd Y_1. Proceeding, therefore, on the supposition that $F_c(x)$ is equal to a term in the first horizontal line of (2), we may understand that $F_c(x)$ is equal to ${}_1X_1$. Take x^E, a power of x in $F_c(x)$ having some power of Y present in its coefficient; and let the coefficient of x^E in $F_c(x)$, satisfying the conditions of Def. 8, be,

$$D = \ldots\ldots + A_c\,Y^c + A_n\,Y^n + \&c.\,;$$

where A_c, A_n, &c., none of them zero, are clear of the surd Y; no two powers in the series, Y^c, Y^n, &c., being identical. Then, D_1 being the corresponding coefficient in ${}_1X_1$, and B_c, B_n, &c., being what A_c, A_n, &c., bcome when T is changed into z_1 T, we have

$$D_1 = \ldots\ldots + B_c\,Y_1^c + B_n\,Y_1^n + \&c.$$

But $D = D_1$. Therefore, by Prop. II., the terms, $A_c\,Y^c$, AY^n, &c., taken in some order, are equal to the terms, $B_c\,Y^c$, $B_n\,Y^n$, &c., each to each Hence we may put

$$A_c\,Y^c = B_m Y_1^m\,;$$

where $B_m\,Y_1^m$ is some term in the series, $B_c\,Y_1^c$, $B_n\,Y_1^n$, &c. And, since A_c and B_m involve only surds which occur in $F_c(x)$, exclusive of Y, this equation can easily be reduced to one of the form (3); λ not being zero, because neither c nor m is zero. Now, from equation (2), the following may be derived by Prop. III.:

$$\left.\begin{aligned} Y_1 &= k_1 P_1 Y_2^{\lambda}, \\ Y_2 &= k_2 P_2 Y_3^{\lambda}, \\ Y_3 &= k_3 P_3 Y_4^{\lambda}, \end{aligned}\right\} \dots\dots\dots\dots \quad (5)$$

and so on; where k_1, k_2, &c., are s^{th} roots of unity; and P_1, P_2, &c., are what P becomes when T is successively changed into $z_1 T$, $z_1^2 T$, &c.; Y_1, Y_2, &c., being what Y becomes when T is successively changed into $z_1 T$, $z_1^2 T$, &c. By eliminating Y_1 betwixt equation (3) and the first of equations (5), Y_1 and Y_2 betwixt (3) and the two first of equations (5), and so on, we get

$$\left.\begin{aligned} Y &= P Y_1^{\lambda}; \\ Y &= k_1^{\lambda} P P_1^{\lambda} Y_2^{\lambda^2}; \\ Y &= k_1^{\lambda} k_2^{\lambda^2} P P_1^{\lambda} P_2^{\lambda^2} Y_3^{\lambda^3}; \end{aligned}\right\} \dots\dots\dots \quad (6)$$

and so on. Hence generally,

$$Y = Q Y_n^{\lambda^n - \rho}, \dots\dots\dots\dots \quad (7)$$

where n is any whole number whatsoever; and ρ is the greatest multiple of s in λ^n; and Q is an expression which involves only such surds as occur in $F_c(x)$, exclusive of Y; none of the surds which it involves having T as a subordinate. Now equation (7) has been found on the hypothesis that $F_c(x)$ is equal to a term in the first line of (2). But, by the same course of reasoning, an equation such as (7) may be established, should $F_c(x)$ be given equal to a term in any line of (2). And equation (7) includes the form (3). Therefore, when $F_c(x)$ is equal to a term in (2), whatever be the line of (2) in which that term occurs, an equation such as (3) subsists. In order to establish equation (4), we observe that equation (7), when n is taken equal to σ, becomes,

$$Y = Q Y^{\lambda^{\sigma} - \rho}.$$

Let $\lambda^{\sigma} - \rho = m$, m being less than s. Then

$$Y - Q Y^m = 0.$$

But, since $F_c(x)$ is a function in a simple form, this equation is (Cor. 1, Def. 9) impossible, unless Y and Y^{m} be be the same power of Y, that is, unless m be unity. Therefore

$$\lambda^{\sigma} = \rho + 1:$$

an equation of the form (4). Should λ be unity, it is plain, referring to the manner in which the first of equations (6) was obtained, that

$$A_c\, Y^c = B_c Y_1^c\,;$$

and consequently (Prop. X.) the surd Y is of the form shown in (2) Prop. X.; so that, if Y be not of that form, λ cannot be unity. In this case, also, s cannot be 2; for were s equal to 2, λ could have no other value than unity.

Cor. 1.—Should $F_c(x)$ not be equal to a term in (2), then no such equation as (3) admits of being formed. For, since T disappears from $F_{c+1}(x)$, the continued product of the terms in the first horizontal line of (2) is equal to that of the terms in (1): both products being $F_{c+1}(x)$. Hence $F_c(x)$ has a common measure with some term in the first line of (2), which term (on the principle pointed out in the Proposition) may be assumed to be ${}_1X_1$. Let L be the H. C. M. of $F_c(x)$ and ${}_1X_1$. Since the roots of the equation, $F_c(x) = 0$, are (Prop. VII.) the unequal cognate functions of $f(p)$, obtained by assigning definite values to those surds in $f(p)$ which are also present in $F_c(x)$, and taking the cognate functions without reference to the surd character of the surds so rendered definite, L, which is of less dimensions, as respects x, than $F_c(x)$, cannot (Cor. 4. Prop. VI.) involve, in the coefficients of the powers of x, merely such surds as occur in $F_c(x)$. But the only surd not in $F_c(x)$, which can possibly appear in L, is Y_1; because, with the exception of Y_1, all the surds in ${}_1X_1$ are found in $F_c(x)$. Hence Y_1 cannot be absent from L. But if such an equation as (3) subsisted, all the powers of Y_1 in L might be eliminated from L, without any surds being introduced into L, except such as are found in $F_c(x)$. Hence no such equation as (3) can be formed.

Cor. 2.—Should no equation such as (3) subsist, any function involving merely such surds as are in $F_c(x)$, together with Y_1, is in a simple form. For suppose, if possible, that $\psi(p)$ is such a function, and that it is not in a simple form. Then an equation such as (1) Prop. I. must subsist; all the surds occurring in it being found in $\psi(p)$. One of these must be Y_1; else all the surds in the equation would be present in $F_c(x)$: which is impossible. Also Y_1 is not a subordinate of any surd in the equation, because all the surds in the equation except Y_1 are present in $F_c(x)$, and Y_1 is not in $F_c(x)$; so that no surd to which Y_1 is subordinate can appear in $F_c(x)$. Let then the equation, satisfying the conditions of Def. 8, be,

$$H + H_1 Y^{\lambda} Y_1^{\lambda_1} + H_2 Y^{\beta} Y_1^{\beta_1} + \&c. = 0,$$

where H, H_1 &c., are clear of the surds Y and Y_1; at least one number in the series, λ_1, β_1, &c., (say λ_1), not being zero; the corresponding coefficient H_1 being at the same time distinct from zero; and no two terms in the series $Y^{\lambda} Y_1^{\lambda_1}$, $Y^{\beta} Y_1^{\beta_1}$, being identical. Then (Cor. 1, Prop. I.) an equation,

$$Y^{\lambda} Y_1^{\lambda_1} = P \left(Y^{\beta} Y_1^{\beta_1}\right)^m, \quad \ldots\ldots\ldots\ldots\ldots \quad (8)$$

must subsist; where P is an expression involving only such surds as occur in the expressions H, H_1, &c., or are subordinates of the surds Y, Y_1; m being either unity or zero: the term $Y^{\beta} Y_1^{\beta_1}$ standing as the type of any term in the series, $Y^{\lambda} Y_1^{\lambda_1}$, $Y^{\beta} Y^{\beta_1}$, &c., after the first. But, should m be zero, equation (8) is of the form (3): which, since $F_c(x)$ is not equal to a term in (2), is (Cor. 1) inadmissible. Should m be unity, equation (8) becomes

$$Y^{\lambda-\beta} Y_1^{\lambda_1-\beta_1} = P.$$

Here, by hypothesis, the numbers $\lambda-\beta$, $\lambda_1-\beta_1$, do not both vanish. Should the latter vanish, the equation is at variance with the supposition that $F_c(x)$ is in a simple form. Should the former vanish, the equation is at variance with the fact that ${}_1X_1$ is in a simple form; which, however, it must (Prop. IV.) needs be. Should neither vanish, the equation is of the inadmissible form (3). Hence the function $\psi(p)$ cannot but be in a simple form.

Cor. 3.—Should $F_c(x)$ not be equal to a term in (2), the equations,

$$\left.\begin{aligned} F_c(x) &= L \times L_1 \times L_2 \times \ldots\ldots \times L_{s-1}, \\ F_e(x) &= K \times K_1 \times K_2 \times \ldots\ldots \times K_{s-1}, \end{aligned}\right\} \quad \ldots\ldots\ldots \quad (9)$$

and so on, subsist; where L is the H. C. M. of $F_c(x)$ and ${}_1X_1$;

L_1, that of $F_c(x)$ and ${}_2X_1$; L_2, that of $F_c(x)$ and ${}_3X_1$; and so on; and K is the H. C. M. of $F_c(x)$ and ${}_1X_2$; K_1, that of $F_c(x)$ and ${}_2X_2$; and so on: all the expressions L, K, L_1, K_1, &c., being of the same dimensions as respects x. For, since $F_c(x)$ necessarily has a common measure with more than one term in the first line of (2), let us (on the principle pointed out in the Proposition) take ${}_1X_1$ to be a term in that line, such that the H. C. M. of $F_c(x)$ and ${}_1X_1$ is not of less dimensions, as respects x, than the H. C. M. of $F_c(x)$ and any other term in the first line of (2). Then, X' being the general symbol under which all the terms in the first line of (2) are comprehended, let the H. C. M. of $F_c(x)$ and X' be sought in the ordinary method; the process being continued till that stage is reached, where, in the case of $F_c(x)$ and ${}_1X_1$, the operation has an end. Let the remainder R, [that is, in the general case of F_c () and X'], reduced to an integral function, and satisfying the conditions of Def. 8, no two terms such as $Y^{\lambda} Y_1^{\lambda_1}$, in the coefficient of any power of x being identical, be,

$$R = \ldots\ldots + x^E \left(\ldots\ldots + q\, Y^{\lambda}\, Y_1^{\lambda_1} + \ldots\ldots\right) + \&c.;$$

q and the corresponding coefficients which are not expressed being clear of the surds Y and Y_1. Then, if R_1 be what R becomes in the particular case of $F_c(x)$ and ${}_1X_1$,

$$R_1 = \ldots\ldots + x^E \left(\ldots\ldots + q\, z'\, Y^{\lambda}\, Y_1^{\lambda_1} + \ldots\ldots\right) + \&c.;$$

where z' is some (not definite) power of z. But $R_1 = 0$. This implies that the coefficients of the different powers of x vanish separately. Also (Cor. 3) any function involving merely such surds as are in $F_c(x)$, together with Y_1, is in a simple form. Therefore, if

$$\psi(p) = \ldots\ldots + q\, z'\, Y^{\lambda}\, Y^{\lambda_1} + \&c. = 0,$$

$\psi(p)$ is a function in a simple form. Therefore (Cor. 1, Def. 9) q, with all other such coefficients, must be zero. Therefore R vanishes, as well as R_1. And, in the case when $F_c(x)$ is compared with any one in particular of the terms in the first line of (2), it is not possible for a remainder, prior to that which in the general case is R to vanish; because (by hypothesis) the H. C. M. of $F_c(x)$ and ${}_1X_1$

is not of less dimensions than the H. C. M. of $F_c(x)$ and any term in the first line of (2). The fact, therefore, of R being zero, implies that $F_c(x)$ has a common measure with each of the terms in the first line of (2), and that its H. C. M. with any of these terms is of the same dimensions as its H. C. M. with any of the rest. Let L be the H. C. M. of $F_c(x)$ and ${}_1X_1$, L_1 that of $F_c(x)$ and ${}_2X_1$, and so on. The terms L, L_1, &c., are all of the same dimensions; L_1, in fact, being what L becomes on substituting $z\,Y_1$ for Y_1; and so on. Also, since all the factors of the terms in the first line of (2), being factors of $F_{c+1}(x)$, are unequal, it follows that all the factors of the terms L, L_1 &c., are unequal. This, taken in connection with the fact that $F_c(x)$ is a factor of the continued product of the terms in the first line of (2), shows that $F_c(x)$ is equal to the continued product of the terms L, L_1, &c. Thus the first of equations (9) is established. In the same manner the others can be established.

Cor. 4.—Should $F_c(x)$ not be equal to a term in (2), an equation of the form,

$$Y\,Y_2^{\beta} = P\,Y_1^{\lambda}, \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (10)$$

must subsist; β and λ being whole numbers, distinct from zero: and P an expression involving only surds which occur in $F_c(x)$, exclusive of Y; while Y_2 is what Y becomes when T is changed into z_1^2. For, let N be the H. C. M. of ${}^2F_c(x)$ and ${}_1X_1$, N_1 that of ${}^2F_c(x)$ and ${}_2X_1$, and so on, Q being the H. C. M. of ${}^2F_c(x)$ and ${}_1X_2$, Q_1 that of ${}^2F_c(x)$ and ${}_2X_2$, and so on: in which case the terms, N, N_1, &c., are respectively what L, L_1, &c., (see Cor. 3), become on changing Y into zY; and Q, Q_1, &c., are what K, K_1, &c., become on changing Y into z Y. Then, in the same way in which equations (9) were found, we can establish the equations.

$${}^2F_c(x) = N \times N_1 \times N_2 \times \ldots\ldots \times N_{s-1},$$

$${}^2F_c(x) = Q \times Q_1 \times Q_2 \times \ldots\ldots \times Q_{s-1}.$$

Now suppose, if possible, that such an equation as (10) cannot subsist. Then, exactly as it was shewn in Cor. 2, [proceeding upon the hypothesis that such an equation as (3) cannot subsist], that any function involving merely such surds as are in $F_c(x)$, together with Y_1, is in a simple form, we may demonstrate [proceeding upon the hypothesis that such an equation as (10) cannot subsist] that any function involving merely such surds as are in $F_c(x)$, together with Y_1 and Y_2, is in a simple form. This being premised, we remark, that, in (9), L is either equal to one of the expressions K, K_1, &c., or has a common measure with more than one of them. Let K_c be a term in the series K, K_1, &c., such that the H. C. M. of L and K_c is not of less dimensions than the H. C. M. of L and any other term in the series. Take K', the general form which includes all the terms K, K_1, ..., K_s, and likewise all the terms Q, Q_1, ..., Q_{s-1}; the latter series being derived from the former by changing Y into z Y. Perform the operation of finding the H. C. M. of L. and K', stopping at the point where, in the particular case of L and K_c, the process comes to an end. If at this stage the remainder be R, and R_1 be the corresponding remainder in the case of L and K_c, the forms of R and R_1 are,

$$R = \ldots\ldots + x^E\left(\ldots\ldots + q\,Y^{\lambda}\,Y_1^{\lambda_1}\,Y_2^{\lambda_2} + \&c.\right) + \&c.,$$

$$R_1 = \ldots\ldots + x^E\left(\ldots\ldots + q\,z^{\lambda}\,Y^{\lambda}\,Y_1^{\lambda_1}\,Y_2^{\lambda_2} + \&c.\right) + \&c.;$$

the expressions being similar to those in Cor. 3. But since $R_1 = 0$, we find (as in Cor. 3) that $R = 0$; it being kept in view that any function which involves merely such surds as occur in $F_c(x)$, together with Y_2 and Y_1, is in a simple form. Hence L has a common measure with every term included under the general symbol K', and therefore it is a factor of ${}^2F_c(x)$ as well as of $F_c(x)$: which, since $F_c(x)$ and ${}^2F_c(x)$ have no common factors, is impossible. Therefore an equation such as (10) must subsist.

Cor. 5.—The same suppositions being made as in Cor. 4, the following equations must subsist:

$$\left.\begin{aligned}
Y\,Y_2^{\beta} &= P\,Y_1^{\lambda}\,; \\
Y\,Y_4^{\beta^2} &= P_1\,Y_2^{\lambda_1-\beta}\,; \\
Y\,Y_6^{\beta^3} &= P_2\,Y_3^{\lambda_2-\beta\lambda}\,; \\
Y\,Y_8^{\beta^4} &= P_3\,Y_4^{\lambda_3-\beta\lambda_1}\,; \\
Y\,Y_{10}^{\beta^5} &= P_4\,Y_5^{\lambda_4-\beta\lambda_2}\,;
\end{aligned}\right\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

and so on; where Y_c is what Y becomes when T is changed into $z_1^c T$; and P, P_1, P_2, &c., are expressions which involve only surds, exclusive of Y, occurring in $F_c(x)$; and the whole numbers, 1, λ, λ_1, λ_2, &c., are such, that, if λ_a, λ_{a+1}, λ_{a+2}, be three consecutive terms in the series, they are related to one another by the equation,

$$\lambda_{a+2} = \lambda\, \lambda_{a+1} - \beta\, \lambda_a \quad \ldots\ldots\ldots\ldots \quad (12)$$

For, the first equation in (11) subsists, by Cor. 4. From this we can deduce, by Prop. III. the following, including the first of (11):

$$\left.\begin{array}{l} Y\, Y_2^{\beta} = P\, Y_1^{\lambda}, \\ Y_1\, Y_3^{\beta} = {}^1P\, Y_2^{\lambda}, \\ Y_2\, Y^{\beta} \quad {}^2P\, Y_3^{\lambda}, \end{array}\right\} \ldots\ldots\ldots\ldots \quad (13)$$

and so on; where ${}^1P$ is the product of an s^{th} root of unity by what P becomes on changing T into $z_1 T$; ${}^2P$, the product of an s^{th} root of unity by what P becomes on changing T into $z_1^2 T$; and so on. Raise the first $(2c-1)$ equations in the series (13) to the following powers respectively, viz.: the first to the first power, the second to the λ^{th} power, the third to the λ_1^{th} power, the fourth to the λ_2^{th} power; ...., the $(c-1)^{\text{th}}$ to the $(\lambda\ )^{\text{th}}$ power, the c^{th} to the $(\lambda_{c-2})^{\text{th}}$ power, the $(c+1)^{\text{th}}$ to the $(\beta\lambda_{c-3})^{\text{th}}$ power, the $(c+2)^{\text{th}}$ to the $(\beta^2\lambda_{c-4})^{\text{th}}$ power, the $(c+3)^{\text{th}}$ to the $(\beta^3\lambda_{c-5})^{\text{th}}$ power, ..., the $(2c-2)^{\text{th}}$ to the $(\beta^{c-2}\lambda)^{\text{th}}$ power, and the $(2c-1)^{\text{th}}$ to the $(\beta^{c-1})^{\text{th}}$ power. By multiplying together the results thus obtained, we get

$$Y\, Y_1^{\lambda}\, Y_2^{\lambda_1+\beta}\, Y_3^{\lambda_2+\beta\lambda}\, Y_4^{\lambda_3+\beta\lambda_1} \ldots\ldots Y_c^{2\beta\lambda_{c-3}}\, Y_{c+1}^{\beta(\beta\lambda_{c-4}+\lambda_{c-2})} \ldots\ldots Y_{2c}^{\beta^c} =$$
$$P_{c-1}\, Y_1^{\lambda}\, Y_2^{\lambda\lambda}\, Y_3^{\lambda\lambda_1} \ldots\ldots\ldots\ldots Y_c^{\lambda\lambda_{c-2}}\, Y_{c+1}^{\lambda\beta\lambda_{c-3}} \ldots\ldots Y_{2c-1}^{\lambda\beta^{c-1}};$$

where P_{c-1} is an expression like P, ${}^1P$, &c., involving only such surds, exclusive of Y, as occur in $F_c(x)$. But, by (12), we have

$$\begin{array}{l} \lambda_1 + \beta = \lambda\lambda, \\ \lambda_2 + \beta\lambda = \lambda\lambda_1, \\ \ldots\ldots\ldots\ldots \\ \lambda_{c-2} + \beta\lambda_{c-4} = \lambda\lambda_c\ , \end{array}$$

and so on; so that the equation obtained above is reduced to

$$Y\, Y_{2c}^{\beta^c} = P_{c-1}\, Y_c^{\lambda\lambda_{c-2} - 2\beta\lambda_{c-3}}.$$

But, by (12),

$$\lambda_{c-1} - \beta\lambda_{c-3} = \lambda\lambda_{c-2} - 2\,\beta\,\lambda_{c-3}\,.$$

$$\therefore\ Y\,Y_{2c}^{\beta^c} = P_{c-1}\,Y_c^{\lambda_{c-1} - \beta\lambda_{c-3}}\ :$$

which is the general form that includes all the equations in the series (11).

Cor. 6.—The $(\sigma + 1)^{th}$ equation in the series (11) is,

$$Y\,Y_2^{\beta^{\sigma+1}} = P_\sigma\,Y_1^{\lambda_\sigma - \beta\lambda_{\sigma-2}}\,.$$

By comparing this with the first of equations (11), we get

$$Y_2^{\beta(\beta^\sigma - 1)} = P^{-1}\,P_\sigma\,Y_1^{\lambda_\sigma - \beta\lambda_{\sigma-2} - \lambda}\,.$$

But, by Cor. 1, in connection with Prop. III., this is impossible unless

$$\beta^\sigma - 1 = ws, \ \ldots\ldots\ldots\ldots\ldots\ldots\ (14)$$

w being a whole number. Therefore equation (14) must subsist.

Proposition XII.

A given algebraical function of a variable p can always be expressed as an integral function in a simple form; the following conditions being at the same time satisfied: *First,* that there shall be no surd in the function, of the form,

$$Y = (H\,T^m)^{\frac{1}{s}}\ ;\ \ldots\ldots\ldots\ldots\ldots\ldots\ (1)$$

where T is a chief subordinate of Y, with the index $\frac{1}{\sigma}$, which is not equal to $\frac{1}{s}$; and m is a whole number, not zero, and less than σ; and H is an expression clear of the surd T; *secondly,* that no two surds, V and V_1, principal or subordinate, shall be similarly [see Prop. IX.] involved in the function.

For, should the given function, when rendered integral, be not in a simple form, an equation such as (1) Prop. I. must subsist; all the surds in the equation being surds which occur in the function. Substitute, then, in the function, for Y_c, wherever it occurs in any of its powers, its value as furnished by (1) Prop. I. Then, when the function is rendered integral, the number of surds present in it, (principal and subordinate being both reckoned), will be less, by at least one, than it was before. Again, should the function involve a surd Y, of the form shown in (1), then, since s and σ are unequal prime numbers, we may choose c and w, whole numbers, such that

$$cs + m = w\sigma.$$

$$\therefore\ Y = T^{-c}\,(H\,T^{w\sigma})^{\frac{1}{s}}.$$

Let $H\,T^{w\sigma}$, when made to satisfy theconditions of Def. 8, be written K; and substitute for Y, wherever it occurs in the function in any of its powers, the value furnished by the equation,

$$Y = T^{-c}\,(K)^{\frac{1}{s}};$$

where it will be observed that the surd $K^{\frac{1}{s}}$ has no subordinates which were not subordinates of Y, while it has not as a subordinate the surd T, which was a subordinate of Y. Once more, suppose that two surds, V and V_1, with the common index $\frac{1}{s}$, are similarly involved in the function: that is to say, when the function has been arranged according to Def. 8, wherever one of the surds V and V_1 appears in any of its powers, it occurs multiplied by a power of the other; as V^{λ} by $V_1^{\lambda_1}$, V^{β} by $V_1^{\beta_1}$, V^{δ} by $V_1^{\delta_1}$, and so on; the pairs of equations (3) and (4). Prop. IX, subsisting. Let $V = U^{\frac{1}{s}}$, and $V_1 = U_1^{\frac{1}{s}}$; and put

$$V^{\lambda}\,V_1^{\lambda_1} = \left(U^{\lambda}\,U_1^{\lambda_1}\right)^{\frac{1}{s}} = Y^{\frac{1}{s}}.$$

$$\therefore\ V^{h\lambda}\,V_1^{h\lambda_1} = V^{ks+\beta}\,V_1^{qs+\beta_1} = Y^{\frac{h}{s}}$$

$$\therefore\ V^{\beta}\,V_1^{\beta_1} = A\,Y^{\frac{h}{s}};$$

A being put for $V^{-ks}\,V_1^{-qs}$. Since the surds V and V_1 have the common index $\frac{1}{s}$, the expression A may be exhibited so as to involve only surds which are subordinates of V or V_1. Let A be so exhibited. In like manner,

$$V^{\delta}\,V_1^{\delta_1} = B\,Y^{\frac{H}{s}};$$

where B is an expression of the same character with A. And so on. Substitute for $V^{\lambda} V_1^{\lambda_1}$, $V^{\beta} V_1^{\beta_1}$, $V^{\delta} V_1^{\delta_1}$, the values, $Y^{\frac{1}{s}}$, $A Y^{\frac{h}{s}}$, $B Y^{\frac{\pi}{s}}$, &c. Then, when the function is rendered integral, the number of surds present in it, (principal and subordinate being both reckoned), will be less, by at least one, than it was before. Let modifications of the three different kinds described continue to be made as far as possible. It is obvious that a limit will ultimately be reached; and if the function be then rendered integral, it will be an integral function in a simple form, containing no surd such as Y in (1), and having no two surds similarly involved in it.

Cor.—In $f(p)$, a function which has been made to undergo the modifications described in the Proposition, let Y be a surd, not subordinate to any other in the function; its index being $\frac{1}{s}$. Also, let T and t be two surds, with the common index $\frac{1}{\sigma}$, which is not equal to $\frac{1}{s}$, subordinate to Y, but neither of them subordinate to any other surd in $f(p)$; and suppose that the form of Y is,

$$Y = (H\, T^m)^{\frac{1}{s}}; \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

where m is a whole number, less than σ; and H is an expression in which the surds T and t are similarly involved. As in the Proposition, we can choose c and w, whole numbers, such that

$$c\,s + m = w\,\sigma.$$

$$\therefore\ Y = T^{-c}\,(K)^{\frac{1}{s}};$$

where K is put for $H\,T^{w\sigma}$; that is, K is the product of an expression which is clear of the surds T and t, by one in which T and t are similarly involved. Hence again, as in the Proposition, we can eliminate the surds T and t from K, introducing in their room a single new surd V; one of the surds T and t, as t, disappearing from the function altogether. And, since T and t are not subordinates of any surd in $f(p)$ except Y, the function, after being subjected to this change of form, may still, if necessary, be made to satisfy the different conditions described in the Proposition. So that, upon the whole, an algebraical function of a variable p may be exhibited as an integral function in a simple form, with no two surds similarly involved in it; nor with any surd involved in it of the form (1); nor with any surd involved in it, which, while not subordinate to any other in the function, is of the form (2).

Proposition XIII.

Let $f(p)$ be an integral function of a variable p, in a simple form, containing no surd such as Y in (1) Prop. XII, nor any surd, which, while not subordinate to any surd in the function, is of the form shown in (2) Prop. XII; and having no two surds similarly involved in it. Let Y be a surd in $f(p)$, with the index $\frac{1}{s}$, not subordinate to any other in the function; and let the function, arranged so as to satisfy the conditions of Def. 8, be,

$$f(p) = A + A_c Y^c + A_n Y^n + \&c.; \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

where A_c, A_n, &c., none of them zero, are clear of the surd Y; A also being clear of the surd Y; and Y^c, Y^n, &c., are distinct powers of Y. Suppose that T and T_1 are two chief subordinates of Y, with the indices $\frac{1}{\sigma}$ aud $\frac{1}{\sigma_1}$; but that neither of them is a subordinate of any other surd in the function $f(p)$. When T is changed into z_1T, z_1 being a σ^{th} root of unity, distinct from unity, let $f(p)$, Y, A, A_c, &c., be transformed into $f_1(p)$, Y_1, B, B_c, &c.; and, when T_1 is changed into z_2T_1, z_2 being a σ_1^{th} root of unity, distinct from unity, let these same expressions become $f_2(p)$, ${}_1Y$, b, b_c, &c.; so that

$$\left.\begin{aligned} f_1(p) &= B + B_cY_1^c + B_nY^n + \&c., \\ \text{and, } f_2(p) &= b + b_c({}_1Y^c) + b_n({}_1Y^n) + \&c. \end{aligned}\right\} \quad \ldots\ldots\ldots\ldots \quad (2)$$

Then, if $f_1(p) = f_2(p)$, it can be proved by the same reasoning as in Prop. II, that the terms,

$$B_cY_1^c, \; B_nY_1^n, \; \&c.,$$

taken in some order, are equal to the terms,

$$b_c({}_1Y^c), \; b_n({}_1Y^n), \; \&c.$$

But should the numbers σ and σ_1 not be both equal to s, the equation,

$$B_cY_1^c = b_c({}_1Y^c), \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

cannot subsist.

For suppose, if possible, that equation (3) subsists. Then the reasoning of Prop II. makes it plain that $B_n Y_1^n$ is equal to $b_1\,({}_1Y^n)$, and so on. We will therefore assume this. The s^{th} powers of $A_c Y^c$ $B_c Y_1^c$, and $b_c\,({}_1Y^c)$, arranged so as to satisfy the conditions of Def. 8, are of the forms,

$$\left.\begin{aligned} (A_c Y^c)^s &= D + D_1 T^m T_1^n + D_2 T^M T_1^N + \&c., \\ (B_c Y_1^c)^s &= D + z_1^m D_1 T^m T_1^n + z_1^M D_2 T^M T_1^N + \&c., \\ \{b_c({}_1Y^c)\}^s &= D + z_2^n D_1 T^m T_1^n + z_2^N D_2 T^M T_1^N + \&c., \end{aligned}\right\} \cdots\cdots (4)$$

where D, D_1, &c., are clear of the surds T and T_1; no two terms in the series, $T^m T_1^n$, $T^M T^N$, &c. being identical with one another. There must be at least one term in the series D_1, D_2, &c.; else $(A_c Y^c)^s$ would be reduced to D; in which case (Cor. Prop. X.) the surd Y would be of the inadmissible form given in (1) Prop. XII. But, from (3) and (4),

$$T^m T^n D_1 (z_1^m - z_2^n) + T^M T_1^N D_2 (z_1^M - z_2^N) + \&c. = 0.$$

Hence, by Cor. 1. Def. 9, the coefficients of $T^m T_1^n$, $T^M T_1^N$, &c., vanish separately. But, since the expressions on the right hand side of (4) satisfy the conditions of Def. 8, the terms D_1, D_2, &c., do not vanish. Therefore

$$z_1^m - z_2^n = 0,$$
$$z_1^M - z_2^N = 0,$$

and so on: from which it follows that $\sigma_1 = \sigma$; and also that $z_2 = z_1^u$; where u is a whole number, less than σ, and such that

$$\left.\begin{aligned} un &= w_1\sigma + m, \\ uN &= w_2\sigma + M, \end{aligned}\right\} \cdots\cdots\cdots\cdots\cdots\cdots (5)$$

and so on; w_1, w_2, &c., being whole numbers. Let V be put for $T^m T_1^n$. Since σ_1 has been proved equal to σ, the surds T and T_1 have a common index; and V may be considered a surd with the same index as that of T and T_1. Take W and w_3, whole numbers less than σ, and such that

$$Wm = w_3\sigma + M.$$

Therefore, from (5), $Wn = w_4\sigma + N$,

$$\text{and, } T^M T_1^N = H V^W;$$

w_4 being a whole number; and H, an expression clear of the surds T and T_1. And so on. Hence the form of $(A_c Y)^{cs}$ is,

$$(A_c Y)^{cs} = D + D_1 V + D_2 H V^W + \&c.; \text{ .... } (6)$$

neither of the surds, T, T_1, appearing (except as implicitly involved in V) on the right hand side of the equation. From the expressions A_c and Y let the surd T_1 be eliminated, by substituting for it, where-ever it occurs in any of its powers, its value derived from the equation,

$$V = T^m T_1^n; \text{ .... } (7)$$

and, when thus modified in form, let A_c and Y, satisfying the conditions of Def. 8, become respectively P and U. Then the surd T cannot (otherwise than as implicitly involved in V) be a subordinate of U. For suppose, if possible, that it is. Put Q to represent the expression, $D + D_1 V + \&c.$ Then

$$P U^c = Q^{\frac{1}{s}}. \text{ .... } (8)$$

Now, any function involving merely such surds as occur in equation (8), exclusive of $Q^{\frac{1}{s}}$, is in a simple form; for, all the surds in the expressions, P, U, and Q, except the surd V, are found in $f(p)$; and, if an equation such as (1) Prop. I. could be formed, involving the surd V, that equation, when V was replaced by $T^m T_1^n$, would be reduced to a corresponding equation involving only surds in $f(p)$; which, since $f(p)$ is in a simple form, is impossible. Hence, since the surd T, a chief subordinate (on the hypothesis at present made) of U, is not present in Q, it is (by Cor. Prop. X.) implied in equation (8) that the form of U is

$$U = (L T^\lambda)^{\frac{1}{s}},$$

where L is an expression involving merely such surds, exclusive of U and T, as occur in the expressions P, U, and Q; and λ is a whole number less than s. Restore U to the form Y; and let the surd V, in L, be replaced by its value in (7). Then

$$Y = \left\{ T^{\lambda} \left(\ldots\ldots + C_1 V^{d_1} + C_2 V^{d_2} + \&c. \right) \right\}^{\frac{1}{s}}$$

$$= \left\{ T^{\lambda} \left(\ldots\ldots + H_1 T^{[d_1 m]} T_1^{[d_1 n]} + H_2 T^{[d_2 m]} T_1^{[d_2 n]} + \&c. \right) \right\}^{\frac{1}{s}};$$

where C_1, C_2, &c., are clear of the surds V and T; and H_1, H_2, &c., are clear of the surds T and T_1; the whole numbers, $[d_1 m]$, $[d\,n]$, &c., representing the remainders left after the greatest multiples of σ have been rejected from $d_1 m$, $d_1 n$, &c. But this form of Y is the inadmissible form given in (2) Prop. XII. Consequently the surd T is not a subordinate of U. This leads to the conclusion that the surd T does not (except as implicitly involved in V) appear in the expression P. For suppose, if possible, that P is of the form, satisfying the conditions of Def. 8,

$$P = L + L_1 T^{\lambda} + L_2 T^{\beta} + \&c.; \ldots\ldots\ldots\ldots\ldots (9)$$

where L, L_1, &c., may involve the surd V, but are clear of T; and none of the terms L_1, L_2, &c., are zero; and T^{λ}, T^{β}, &c., are distinct powers of T. Then, if the form of U be, $U = Q_1^{\frac{1}{s}}$, and if QQ_1^{-c}, when rendered integral, and made to satisfy the conditions of Def. 8, be written t, we have, by (8) and (9),

$$t^{\frac{1}{s}} = L + L_1 T^{\lambda} + L_2 T^{\beta} + \&c.$$

From this equation let the surd $t^{\frac{1}{s}}$ be eliminated, in the same manner in which X_1 was eliminated from equation (4) Prop. I. The result is,

$$LK + K_1 L_1 T^{\lambda} + K_2 L_2 T^{\beta} + \&c. = 0.$$

Here, since the surd T does not (except as implicitly involved in V) appear in t, the expressions K, K_1, &c., are clear of the surd T. Therefore (Cor. 1, Def. 9), the terms LK, K_1, K_2, &c., vanish separately. But, from the manner in which K, K_1, &c., originated, this implies that

$$L = ct^{\frac{1}{s}} ;$$

$$L_1 T^{\lambda} = kt^{\frac{1}{s}} ;$$

$$L_2 T^{\lambda} = qt^{\frac{1}{s}} ;$$

and so on; c, k, q, &c., being constant quantities. Hence, there cannot be more than one term in the series L_1, L_2, &c.; else we should have

$$q L_1 T^{\lambda} = k L_2 T^{\beta} :$$

which (Cor. 1, Def. 9) is impossible. For a similar reason, L must vanish; and the form of $t^{\frac{1}{s}}$ is,

$$t^{\frac{1}{s}} = L_1 T^{\lambda} .$$

Therefore, if $\lambda s = \delta\sigma + r$, we have

$$t = L_3 T^{r},$$

where L_3 is clear of the surd T; and r is a whole number, less than σ, but (since s and σ are unequal) not zero. But

$$t = Q\, Q_1^{-c} = Q \left(U^{-c}\right) .$$

$$\therefore\ L_3 T^{r} = Q \left(U^{-c}\right)^{s} .$$

And, when the expression on the right hand side of this equation is rendered integral, it is clear of the surd T. Therefore, by Cor 1. Def. 9, L_3 must vanish. Hence t vanishes: which implies that P or A_c vanishes. But (by hypothesis) A_c does not vanish. Therefore T does not appear in the expression P. In like manner, if, when T_1 is eliminated from A_n [see (1)] by substituting its value as furnished by equation (7), A_n, made to satisfy the conditions of Def. 8, be written P_1, it may be proved, since the equation,

$$B_n Y_1 = b_n \left({}_1Y^{n}\right)$$

has been shown to subsist, that the surd T does not appear (except as implicitly involved in V) in A_n. Ultimately, we get

$$f(p) = P' + P U^{c} + P_1 U^{n} + \&c. ; \ldots\ldots\ldots\ldots\ (10)$$

where P', P, &c., are what A, A_c, &c., in (1), become on substituting for T_1 its value as furnished by (7); the expression on the right hand side of (10) being clear of both the surds T and T_1, except as these surds are implicitly involved in V. Hence the surds T and T_1 are similarly involved in $f(p)$: which is contrary to hypothesis. Therefore the equation (3) cannot subsist.

Proposition XIV.

Let the equation, $X=0$, be an algebraical equation of the fifth degree, in which the coefficients of the powers of x are rational functions of a variable p; X being incapable of being broken into rational factors, that is, factors having the coefficients of the powers of x rational. Then, should the roots of the equation, $X=0$, admit of being represented in algebraical functions, they are all contained in the expression,

$$f(p)=A+(A_1+B_1\sqrt{C})(D+D_1\sqrt{C})^{\frac{1}{5}}+(A_2+B_2\sqrt{C})(D+D_1\sqrt{C})^{\frac{2}{5}}$$
$$+(A_3+B_3\sqrt{C})(D+D_1\sqrt{C})^{\frac{3}{5}}+(A_4+B_4\sqrt{C})(D+D_1\sqrt{C})^{\frac{4}{5}};\ldots(1)$$

where C, D, D_1, A, A_1, B_1, A_2, B_2, &c., are rational functions of p.

For let $f(p)$, a root of the given equation be reduced (Prop. XII.) to a simple integral form, containing no surd such as Y in equation (1), Prop. XII., nor any surd, which, while not subordinate to any surd in the function, is of the form shown in (2), Prop. XII., and having no two surds similarly involved in it. Take Y, a surd in $f(p)$, not subordinate to any other in the function. Then, if we consider the manner in which the terms of the series,

$$x-f(p),\ F_1(x),\ F_2(x),\ \ldots\ldots,\ F_a(x) \text{ or } X,\ \ldots\ldots\ldots\ldots (2)$$

in Prop. VIII, are formed, it appears, that, in an equation of the t^{th} degree, the reciprocal of the index of Y is a measure of t. Hence, in the case before us, the index of Y is $\frac{1}{5}$; and from this it follows that the series (2) is reduced to the two terms,

$$x-f(p),\ X.$$

Besides Y, there can be no surd in $f(p)$, which is not a subordinate of Y; for, if U were a surd in $f(p)$, distinct from Y, and not subordinate to any surd in $f(p)$, then, since the coefficients of the different powers of x in X are rational, the surd U disappears from X; consequently (Prop. IX.) the index of U is the same with that of Y, and the surds U and Y are similarly involved in $f(p)$: which is not the case. Hence $f(p)$ contains no surds, except Y and its subordinates. Let T be a chief subordinate of Y, with the index $\frac{1}{\sigma}$. Then, since the coefficients of the different powers of x in X are rational, T disappears from X. Let the factors by the continued product of which X is produced be [compare (1) Prop. XI]

$$\{x - f(p)\} \text{ or } F_e(x),\ {}^2F_e(x),\ \ldots\ldots,\ {}^5F_e(x): \ldots\ldots\ldots (3)$$

and, when T is changed into $z_1 T$, z_1 being a σ^{th} root of unity, distinct from unity, let the terms in (3) be transformed into

$$ {}_1X_1,\ {}_2X_1,\ \ldots\ldots,\ {}_5X_1 \ \ldots\ldots\ldots\ldots (4)$$

Then, since the terms in (4) are the five factors of X, $F_e(x)$ must be equal to one of these terms, which (on the principle pointed out in Prop XI.) may be assumed to be ${}_1X_1$. Consequently (Prop. XI.)

$$Y = P\, Y_1^{\lambda}\ ; \ \ldots\ldots\ldots\ldots (5)$$

where Y_1 is what Y becomes when T is changed into $z_1 T$; and P is an expression involving only surds in $f(p)$, distinct from Y; λ being a whole number, neither zero nor unity, less than 5, and such that

$$\lambda^{\sigma} = 5w + 1,\ \ldots\ldots\ldots\ldots (6)$$

where w is a whole number. Since σ is a prime number, the only values of λ, less than 5, which satisfy equation (6), are 1 and 4 And λ is not unity. Therefore $\lambda = 4$. Hence $\sigma = 2$; and T is of the form, $T = \sqrt{C}$. Next, suppose, if possible, that U is a chief subordinate of Y, distinct from T. By the same process of reasoning as above, it may be shown that the index of U is $\frac{1}{2}$; and, if ${}_1Y$ be what Y becomes when U is taken with the negative sign, $-U$, the equation,

$$Y = Q\left({}_1Y^4\right),$$

subsists; where Q is an expression such as P in (5). Therefore

$$P\, Y_1^4 = Q\left({}_1Y^4\right).$$

By raising both sides of this equation to the fourth power, keeping in view that the common index of Y_1 and ${}_1Y$ is $\frac{1}{5}$, we get

$${}_1Y = R\, Y_1\ ; \ \ldots\ldots\ldots\ldots (7)$$

where R is an expression, like P and Q, clear of the surds Y_1 and ${}_1Y$.

When U is changed into the negative expression, $-U$, let the terms in (3) become,

$$^{1}X\,,\ ^{2}X\,,\ \ldots\ldots\,,\ ^{5}X\ ; \ \ldots\ldots\ldots\ldots\ (8)$$

and, since $F_c(x)$ must be equal to one of the terms in (8), assume (on the principle pointed out in Prop. XI.) that $F_c(x) = {}^{1}X$. Take x^m, a power of x in $F_c(x)$, such that some power of Y is present in its coefficient E; and, E_1 and E_2 being the corresponding coefficients of x^m in ${}_1X_1$ and ${}^1X$, let E, E_1, and E_2, satisfying the conditions of Def. 8, be,

$$E = B + B_c Y^{c} + B_n Y^{n} + \&c.,$$
$$E_1 = b + b_c Y_1^{c} + b_n Y_1^{n} + \&c.,$$
$$E_2 = \beta + \beta_c\left({}_1Y^{c}\right) + \beta_n\left({}_1Y^{n}\right) + \&c.\ ;$$

where B_c, B_n, &c., none of them zero, are clear of the surd Y; B also being clear of Y; and no two terms in the series, Y^c, Y^n, &c., are identical with one another; Y_1, b, b_c, &c., being what Y, B, B_c, &c., become in passing from $F_c(x)$ to ${}_1X_1$; and ${}_1Y$, β, β_c, &c., what these same quantities become in passing from $F_c(x)$ to ${}^1X$. Then, because ${}_1X_1$ and ${}^1X$ are each equal to $F_c(x)$, they are equal to one another. This implies that E_1 and E_2 are equal to one another; but (Prop. XIII.) $b_c Y_1^{c}$ is not equal to $\beta_c\left({}_1Y^{c}\right)$. It may be shown, however, exactly as in Prop. II., that the terms, $b_c Y_1^{c}$, $b_n Y_1^{n}$, &c., taken in some order, are equal to the terms, $\beta_c\left({}_1Y^{c}\right)$, $\beta_n\left({}_1Y^{n}\right)$, &c., each to each; and, if the steps of the demonstration be referred to, it will be seen, that, since equation (i) subsists, $b_c Y_1^{c}$ must be equal to to the term $\beta_c\left({}_1Y^{c}\right)$: which is impossible. Therefore U cannot be a chief subordinate of Y; and T is the only chief subordinate of Y. Again, suppose that U is a chief subordinate of T, with the index $\frac{1}{\rho}$; and, when U is changed into $z_2 U$, z_2 being a ρ^{th} root of unity, distinct from unity, let the terms in (3) become,

$${}_1X,\ {}_2X,\ \ldots\ldots\,,\ {}_5X\ ;\ \ldots\ldots\ldots\ldots\ (9)$$

the surds Y and T at the same time becoming y and t. Then if E_3 be the coefficient of x^m in ${}_1X$, we may put

$$E_3 = \beta + \beta_c y^c + \beta_n y^n + \&c.,$$

where y, β, β_c, &c., are what Y, B, B_c, &c., become in passing from $F_c(x)$ to ${}_1X$. Since $F_c(x)$ is equal to one of the terms in (9), we may assume (on the principle pointed out in Prop. XI.) that it is equal to ${}_1X$; in which case E is equal to E_3; or,

$$B + B_c Y^c + \&c. = \beta + \beta_c y^c + \beta_n y^n + \&c. \dots (10)$$

Therefore (Cor. Prop. I.) an equation of one or other of the forms,

$$Y^c = L\, y^r, \dots\dots (11)$$

$$Y^c = L, \dots\dots (12)$$

must subsist; where L is an expression involving only such surds as are found in the expressions, B, β, B_c, β_c, &c., or are subordinates of Y or y; and y^r is a term in the series Y^c, Y^n, &c., y^c, y^n, &c., distinct from Y^c. Let us assume that equation (12) subsists. Then L cannot be clear of the surd t: else all the surds in L would be found in $F_c(x)$: in which case, by Def. 9, equation (12) would be impossible. The expression L, therefore, satisfying the conditions of Def. 8, may be written,

$$L = H + H_1 t,$$

where H and H_1, the latter not zero, are clear of the surd t. Hence

$$Y^c = H + H_1 t.$$

From this it follows (Cor. Prop. I.) that an equation of one or other of the forms,

$$Y^c = h\,H, \dots\dots (13)$$

$$Y^c = h\,H_1 t, \dots\dots (14)$$

must subsist; where h is an expression involving only surds which are found in H or H_1, or are subordinates of Y or t, and therefore only such surds, exclusive of Y, as occur in $F_c(x)$. But equation (13) is impossible, by Cor. 1. Def. 9. Also, should (14) subsist, we should have, (since $\frac{1}{2}$ is the index of t),

$$Y^{2c} = h';$$

where h' is an expression involving only surds which occur in $F_c(x)$. But this is (Cor. 1, Def. 9) impossible. Therefore neither equation (14) nor equation (13) can subsist; and hence equation (12) cannot subsist. Therefore equation (11) must subsist; and we may assume that y^r in (11) is a term in the series, y^c, y^n, &c. ; for, were it such a term as Y^n, equation (11) would be reduced to the inadmissible form (12). If then we substitute for y in (10) its value derived from (11), we may [keeping in view that no such equation as (12) can subsist] demonstrate, by reasoning similar to that employed in Prop. II. and Cor. Prop. I., that $B_c Y^c$ is equal to some term, as $\beta_a y^a$, in the series $\beta_c y^c$, $\beta_n y^n$, &c. Let the fifth powers of $B_c Y^c$ and $\beta_a y^a$, satisfying the conditions of Def. 8, be,

$$(B_c Y^c)^5 = h + h_1 T,$$
$$(\beta_a y^a)^5 = k + k_1 t;$$

where h and h_1 are clear of the surd T ; and k and k_1 are clear of the surd t ; and (Cor. Prop. X.) h_1 is not zero. Therefore, from the equation,

$$h + h_1 T = k + k_1 t,$$

we have (Cor. Prop. I.) an equation of one or other of the forms,

$$T = l ,$$
$$T = lt, \ldots\ldots\ldots\ldots \quad (15)$$

where l is an expression involving only such surds as occur in h, h_1, k, k_1, or are subordinates of T or t ; that is, l involves only surds in $F_c(x)$, exclusive of T. But (Def. 9) T cannot be equal to l. Therefore equation (15) subsists. Since t is formed from T by changing U into z_2 U, let the forms of T, t, and l, be,

$$T = (R + R_1 U + R_2 U^2 + \ldots\ldots + R_{\rho-1} U^{\rho-1})^{\frac{1}{\ }},$$
$$t = (R + R_1 z_2 U + z_2^2 R_2 U^2 + \&c.)^{\frac{1}{2}}$$
$$l = S + S_1 U + S_2 U^2 + \ldots\ldots + S_{\rho-1} U^{\rho-1};$$

where R, S, R_1, S_1, &c., are clear of the surd U. Then, from (15),

$$(v + v_1 U + \ldots\ldots + v_{\rho-1} U^{\rho-1}) T = (v + v_1 U + \&c.)(S + S_1 U + \&c.)t$$
$$= (V + V_1 U + \ldots\ldots + V_{\rho-1} U^{\rho-1}) t;$$

where the expression, $V + V_1 U + \&c.$, is generated by the multiplication together of the two expressions, $v + v_1 U + \&c.$, $S + S_1 U + \&c.$; the coefficients, V, V_1, &c., being clear of the surd U. Let us determine the ρ unknown quantities, $v, v_1, \ldots\ldots, v_{\rho-1}$, by means of the simple equations,

$$v = V,$$
$$z_2 v_1 = V_1,$$
$$z_2^2 v_2 = V_2,$$
$$\cdots\cdots\cdots\cdots$$
$$z_2^{\rho-1} v_{\rho-1} = V_{\rho-1}.$$

Then equation (15) gives us

$$(v + v_1 U + \&c.)\,(R + R_1 U + \&c.)^{\frac{1}{2}} =$$

$$(v + v_1 z_2 U + \&c.)\,(R + R_1 z_2 U + \&c.)^{\frac{1}{2}}.$$

Hence, by Prop. X., one of the surds in $F_c(x)$, viz. T, is of the form of Y in (1) Prop. XII.: which (by hypothesis) is impossible. Hence U cannot be a chief subordinate of T; and therefore $f(p)$ involves no surds except Y and its subordinate T; the latter being of the form $T = \sqrt{C}$. Consequently $f(p)$ is of the form (1).

We may notice a particular form in which $f(p)$ admits of being expressed. By means of equation (5), we can reduce (1) to the following:

$$\begin{aligned} f(p) = A &+ (A_1 + B_1\sqrt{C})\,(D + D_1\sqrt{C})^{\frac{1}{5}} \\ &+ (A_2 + B_2\sqrt{C})\,(D + D_1\sqrt{C})^{\frac{2}{5}} \\ &+ (A_1 - B_1\sqrt{C})\,(D - D_1\sqrt{C})^{\frac{1}{5}} \\ &+ (A_2 - B_2\sqrt{C})\,(D - D_1\sqrt{C})^{\frac{2}{5}}. \end{aligned}$$

But, as thus exhibited, $f(p)$ is not in a simple form.

Cor. 1.—The exact resolution, in algebraical functions, of an equation of the fifth degree, is only possible when X admits of being broken into rational factors, or when the roots can be reduced to the form (1). Hence, in the most general case, the exact resolution, in algebraical functions, of an equation of the fifth degree, cannot in the nature of things be effected. *A fortiori*, the exact resolution, in algebraical functions, of equations of degrees above the fifth, cannot, in the most general case, be effected.

Cor. 2.—In all the cases in which the roots of a quintic equation, whose coefficients are rational functions of a variable p, admit of being represented in algebraical functions, the principles which have been established enable us actually to solve the equation. For, if X can be broken into rational factors, these factors may easily be found; and thus the solution of the quintic is obtained. Should X not admit of being broken into rational factors, assume $f(p)$ equal to the expression in (1). Substitute for $f(p)$ in X the expression to which x is thus assumed equal; and let the result of the substitution be,

$$b+(a_1+b_1\sqrt{C})(D+D_1\sqrt{C})^{\frac{1}{5}}+(a_2+b_2\sqrt{C})(D+D_1\sqrt{C})^{\frac{2}{5}}$$
$$+(a_3+b_3\sqrt{C})(D+D_1\sqrt{C})^{\frac{3}{5}}+(a_4+b_4\sqrt{C})(D+D_1\sqrt{C})^{\frac{4}{5}};$$

where the expressions, b, a_1, b_1, a_2, b_2, &c., as well as C, D, D_1, are to be assumed rational. Put

$$a_1=0,\ a_2=0,\ a_3=0,\ a_4=0,$$
$$b=0,\ b_1=0,\ b_2=0,\ b_3=0,\ b_4=0;$$

and these equations will enable us to find the unknown quantities in the value of $f(p)$: it being taken for granted that the rational roots of an algebraical equation, having the coefficients rational functions of a variable, can always be found.

NOTE.—From what has been proved, it appears that the roots of an algebraical equation of a degree higher than the fourth do not, in the most general case, admit of being represented in finite algebraical functions; and we have seen how an equation of the fifth degree, whose coefficients are rational functions of a variable p, may be actually solved, whenever, in consequence of particular relations among the coefficients, the roots are capable of being algebraically represented. It is easy to extend the conclusions which have been obtained to equations of every degree; and, from the principles established in the above Propositions, to show *how an algebraical equation of any degree, whose coefficients are functions of a variable p, may be exactly solved, in all cases in which an exact solution in finite algebraical functions is in the nature of things possible.* This we propose to do in a subsequent paper.

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

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PART II.

Introductory Notice.

In the first of this series of papers, published in the January Number of the *Canadian Journal*, we gave a brief review of the more common characters or properties employed in the determination of minerals. The present paper exhibits the practical application of these characters, in the distribution of our Canadian minerals into a small number of easily recognized groups, so arranged as to lead at once to the names of the included substances.

By referring to the heads of this arrangement or classification,* as given below, it will be seen that there are four principal groups: *A*, *B*, *C*, and *D*: the first two containing those minerals which exhibit a metallic aspect; and the other two containing our glassy, stony, pearly, or earthy-looking minerals. The metallic-looking substances placed in group *A* are sufficiently hard to scratch window-glass; whilst those placed in group *B*, are too soft to effect this. In like manner, the minerals of non-metallic aspect placed in group *C*, scratch glass; whilst those placed in group *D*, are less hard than glass, and are consequently unable to scratch that substance. The term "glass," as employed in this sense, means ordinary window-glass. By these simple characters it is easy to determine in a minute, to which group a substance under examination belongs. This determined, we proceed to a consideration of the sub-groups, **1**, **2**, **3**, &c., of the group in question. In the sub-group or section to which the substance will thus be found to belong, there will probably be some three or four, or perhaps half-a-dozen, other minerals; but these, it will be seen, are readily distinguishable, one from another, by colour,

* The general reader should understand that this classification is a purely artificial one, intended solely to lead to the recognition of minerals by means of their more obvious or easily determined characters—somewhat on the principle of the Linnæan classification of plants.

colour of streak, structure, or other easily determined character. In this manner we arrive, without difficulty, at the name of our mineral.

To illustrate this by example, let it be supposed that we have a piece of a red, dull, and somewhat earthy-looking substance, the name of which we wish to ascertain. By its non-metallic aspect, we see at once that it belongs either to group *C* or to group *D*. We try if it will scratch glass. It is not sufficiently hard to do this : hence it belongs to group *D*. Turning now to the respective sub-groups or sections under *D*, we find that our mineral has no taste, and hence does not belong to *D* 1. Neither does it take fire (although it blackens) when a thin splinter of it is held for a moment in the flame of a candle, or in the flame of an ignited match : and hence it does not belong to *D* 2. It has, however, a *coloured streak** (red), and so belongs to the next section, *D* 3. Now in this section there are only two minerals with red streak : or only one, indeed, of undoubted Canadian occurrence—*Earthy Red Iron Ore*, commonly called *Red Ochre ;* and as our mineral becomes magnetic after exposure to the flame of a match or candle, it can be nothing else than a specimen of that substance. This example will be sufficient to shew the method of procedure to be followed in order to ascertain the name, &c., of an unknown mineral, by reference to the annexed TABULAR DISTRIBUTION. In this connexion, it has been thought advisable to include a few substances of more or less common occurrence in the United States, although not yet found in Canada ; and also to refer occasionally, in smaller type, to some other minerals of economic value or popular interest, so as to make the subject more complete, and render our Tables available for the examination of the small collections sometimes imported into this country for the purposes of study. Some of the substances thus noticed, may also be discovered eventually in Canada. Finally, it should be observed that the descriptions of these various minerals, given in our TABULAR DISTRIBUTION, are necessarily exceedingly brief, referring only to matters of easy comprehension or general importance. When, however, the name of a mineral is once discovered, the reader, if he desire to pursue the subject further, can refer for fuller details to any of our ordinary works on Mineralogy.

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* For an explanation of these characters, technical terms, &c., see Part I.

A Tabular Distribution of Canadian Minerals, including, also, a few other Mineral Substances of common occurrence.

GENERAL INDEX.

The reader is to determine, by this Index, the group and sub-group to which his unknown mineral belongs; and he is then to refer to the descriptions given under that sub-group in the pages immediately following the Index.

Aspect Metallic	Hard enough to scratch glass	*A.*
	Not hard enough to scratch glass ..	*B.*
Aspect Non-metallic..	Hard enough to scratch glass	*C.*
	Not hard enough to scratch glass ..	*D.*

A. Aspect metallic. Hard enough to scratch glass:

Colour, Light Brass-yellow .... *A* 1.
Colour, Pale copper-red .... *A* 2.
Colour, Tin-white, or Silver-white .... *A* 3.
Colour, Steel-grey, Black, or Brown .... *A* 4.

B. Aspect metallic. Not hard enough to scratch glass:

Malleable or Ductile.............................. *B* 1.
Yielding to the nail .... *B* 2.
Not yielding to the nail .... *B* 3.

C. Aspect non-metallic, (glassy, stony, &c.) Hard enough to scratch glass:

Infusible. Very hard: not yielding to the knife...... *C* 1.
Infusible, or nearly so. Yielding to the knife ...... *C* 2.
Fusible. Not yielding water in the bulb-tube........ *C* 3.
Fusible. Yielding water in the bulb-tube (*fig.* 22). .. *C* 4.

D. Aspect non-metallic, (stony, glassy, &c.) Not hard enough to scratch glass:

Soluble, and thus affecting the taste .... *D* 1.
Taking fire when held (in thin splinters) in the flame of a candle .... *D* 2.
Not exhibiting the above reactions. Streak, coloured *D* 3.
Streak, white. Not yielding water in the bulb-tube .. *D* 4.
Streak, white. Yielding water in the bulb-tube (*fig.* 22.) *D* 5.

A. Aspect Metallic. Hardness sufficient to scratch glass.

A 1.—Colour, Light Brass-yellow.

Iron Pyrites.—A substance of a pale brass-yellow colour, with greyish-black streak, occurring in amorphous, globular, and other masses, and in Monometric crystals (cubes, generally with alternately-striated faces, pentagonal dodecahedrons, &c., *figs.* 23, 24, 25.)

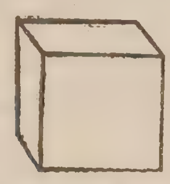

Fig. 23.

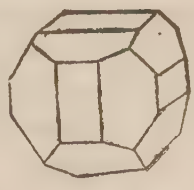

Fig. 24.

Fig. 25.

H. 6.0–6.5 ; sp. gr. 4.8–5.1. Fusible, with sulphur fumes, into a magnetic globule. One hundred parts contain: sulphur, 53·5 ; iron, 46·7 ; but the iron is sometimes in part replaced by a little cobalt or nickel, and occasionally minute portions of gold and silver are accidentally present. Iron pyrites occurs in all kinds of rocks, and is exceedingly common ; but is useless as an ore of iron. It yields copperas, or iron-vitriol, by decomposition ; and it is often converted on the surface, or wholly, into hydrated brown oxide of iron. It sometimes forms the substance of organic remains, as in many of the Trilobites, &c., of our Utica Slate. Amongst the principal Canadian localities,* we may note, more especially, the counties of Pontiac (Clarendon Township), Terrebonne, Berthier (Lanoraie Seign.), and Sherbrooke (Garthby Township), in Canada East ; the vicinity of Balsam Lake, where it occurs with magnetic pyrites ; and many places on the north shore of Lake Huron, Lake Superior, &c. A nickeliferous variety occurs in D'Aillebout, Berthier Co. ; and an auriferous variety in Vandreuil, Beauce Co., C. E. We have obtained some brilliant, though small, crystals from the white feldspathic trap of the Montreal Mountain ; and also from the Niagara limestone, and other fossiliferous

* For the localities mentioned in these descriptions, we are very largely indebted to the publications of the Canadian Geological Survey, and espeecially to the *Esquisse Géologique du Canada*, by Sir W. E. Logan and T. Sterry Hunt. We shall be greatly obliged to our readers for any information respecting localities of Canadian minerals; and more especially, if a small fragment of the substance referred to in the information, be furnished at the same time. A piece no larger than our ordinary pea will be of sufficient size. Although we are constantly receiving specimens of different kinds for examination, the exact localities of these are generally kept secret by the senders, in the belief that something has been discovered of more than usual value.

rocks; but iron pyrites occurs chiefly in our Laurentian and Huronian Formations, and in the Metamorphic district of the Eastern Townships. The general reader will find these geological terms fully explained in some of the succeeding papers of this series.

Radiated Pyrites, or *Marcasite*, also belongs to this Section, but it does not appear to have been noticed in Canada. It has the same composition as common Pyrites, but crystallizes in the Trimetric or Rhombic System. Many globular specimens, with radiated structure, sometimes referred to Marcasite, belong truly, it should be observed, to common Pyrites.

A. 2.—Colour, Pale Copper Red (usually with grey or black external tarnish.)

Arsenical Nickel.—Pale copper-red, tarnishing dark-grey. Streak, brownish-black. Chiefly in small amorphous masses. H. 5·0–5·5 (it scratches glass feebly.) Sp. gr. 7.3–7.7 (a salient character.) Fusible, with strong odour of garlic. One hundred parts contain: Arsenic, 56; Nickel, 44. This substance, often called *Copper-Nickel* from its copper-red colour, is the common ore of nickel; but in Canada it is very rare. It has been found in small quantities in Michipicoten Island, Lake Superior. A substance composed of sulphur, arsenic, and nickel, occurs likewise, but in very small quantities, at the Wallace Mines, Lake Huron. It is somewhat less hard than Arsenical Nickel. The Townships of Bolton and Ham, in the metamorphic district of the Eastern Townships, are also cited as localities of nickel ore. The ore is said to occur there very sparingly in Serpentine, associated with Chromic Iron Ore.

A. 3. Colour, Tin or Silver-white (sometimes with grey or yellowish external tarnish.)

Arsenical Pyrites (Mispickel.)—Tin or silver-white, inclining to light steel grey. Streak, greyish-black. In amorphous and granular masses, and in modified rhombic prisms (Trimetric System.) H. 5.5–6.0; Sp. gr. 6.0–6.4. Fusible, with garlic odour, into a magnetic globule. One hundred parts contain: sulphur, 20; arsenic, 46; iron, 34. This mineral is of very common occurrence in many countries. It is quite useless as an ore of iron, but is employed in Germany and elsewhere in the production of arsenious acid, the white arsenic of commerce. Arsenious acid is obtained also, and more abundantly, from arsenical nickel and certain cobalt ores. In Canada, arsenical pyrites occurs in small quantities with common iron pyrites, &c., in our azoic and metamorphic rocks more especially, at various localities: as at the Lake Huron Mines; in Clarendon Township (Pontiac Co.); in the Chaudière Valley, &c. It sometimes contains a little cobalt, in which case, after exposure before the blow-pipe to drive off the greater part of the arsenic and sulphur, it fuses with with borax into a rich blue glass.

The common cobalt ores (Smaltine and Cobaltine) belong also to this Section, but they have not yet been discovered in Canada.

A 4. *Colour, Steel-grey, Iron-black, or Brown.* (*No fumes before the Blow-pipe.*)

[Principal Minerals.—Streak, dull-red: *Specular Iron Ore.* Strongly magnetic; streak, black: *Magnetic Iron Ore.* Yielding water in the bulb-tube; streak, yellowish-brown: *Brown Iron Ore.*]

Specular Iron, or *Red Iron Ore.*—Dark steel-grey, often inclining to blueish red. Streak, dull-red, the same as the colour of the earthy varieties described in Section *D* 3. In rhombohedral crystals and crystalline groups, and in lamellar, micaceous, and fibrous-botryoidal masses, the latter often called Red Hæmatite. H. 5.5–6.5; sp. gr. 4.3–5.3. In thin splinters, fusible on the edges (although commonly said to be infusible.) Becomes also magnetic after exposure to the blow-pipe, and is often feebly magnetic in its normal condition. One hundred parts contain: Oxygen, 30; Iron, 70. This mineral is one of the most valuable of the Iron Ores. In Canada, it is exceedingly abundant, more especially in our Laurentian rocks, although less so than the Magnetic Iron Ore. It occurs chiefly in these rocks in the Township of MacNab, on the Ottawa, where it constitutes a vast bed, twenty-five feet thick, in crystalline limestone; and also associated with crystalline limestone at Iron Island, Lake Nipissing (Mr. Murray.) In the Huronian rocks, it is found at the Wallace Mine, Lake Huron; and it occurs likewise in metamorphic chloritic schists (altered Silurian shales of the age of the Hudson River group), associated with magnetic iron ore, dolomite, &c., in the Eastern Townships of Sutton, Bolton, and Brome.

Ilmenite.—This substance, (normally, perhaps, a compound of the sesqui-oxides of titanium and iron,) has an iron-black or dark steel-grey colour, with black or dark reddish-brown streak. It closely resembles and passes into *Specular Iron Ore.* At Baie St. Paul, C.E., a large deposit of Ilmenite, three hundred feet in length and ninety feet broad, occurs in a feldspathic rock of the Laurentian series. It is associated with small orange-red grains of rutile. The same substance (according to Sir W. Logan,) occurs also, mixed with magnetic iron ore, in a thick bed in serpentine, in Vaudreuil, Beauce County, C.E.

Magnetic Iron Ore.—Iron-black, with sub-metallic lustre and black streak. Occurs in monometric crystals (octahedrons and rhombic dodecahedrons, *figs.* 26 and 27), in amorphous masses of a granular or lamellar structure, and also in small grains. Strongly magnetic, often with polarity. H. 5.5–6.5 ; sp. gr. 4.9–5.2. Infusible, or nearly so. One hundred parts contain: Oxygen, 27.6 ; iron, 72.4 ; (or sesquioxide of iron, 69 ; protoxide of iron, 31.) This when pure, is the most valuable of all the iron ores. Its black streak, and strong magnetism, (and, when crystallized, its form), easily distinguish it from specular iron ore. In the Laurentian rocks of Canada, it occurs in vast beds, rendering this Province one of the richest iron-containing countries of the world. It occurs also abundantly amongst the metamorphosed Silurian strata of the Eastern Townships. Its principal "Laurentian" localities comprise: the Townships of Marmora, Belmont, and Madoc, with those of South Sherbrooke, Bedford, and Crosby, in Canada West ; and the Townships of Hull aud Litchfield, on the Ottawa, in Canada East. The supply at these localities is apparently inexhaustible. The Townships of Bolton and Brome, and the Chaudière Valley, may be cited amongst the localities of this ore in the metamorphic district south of the St. Lawrence. In this district, however, as remarked by Sir William Logan, its value is much lessened by admixture with titanic iron, chlorite, &c. In the form of black magnetic sand (either alone or mixed with *iserine*,), this ore is also of exceedingly common occurrence on the shores of many of our lakes, islands, &c. The black iron-sand of the Toronto "Peninsula" is a well-known example.

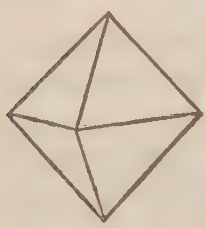

Fig 26.

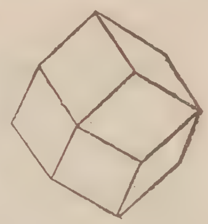

Fig. 27.

Iserine.—This is a black titaniferous iron ore, bearing the same relation to *Magnetic Iron Ore* that *Ilmenite* bears to *Specular Iron.* It occurs chiefly in the form of magnetic sand, or in small granular masses, mixed with magnetic iron ore. It occurs with "iron sand" on our lake shores, &c., and probably with magnetic iron in the Eastern Townships. It can only be distinguished from the latter mineral by a blow-pipe (or other chemical) examination. Fused on charcoal with microcosmic salt in a reducing flame, the glass becomes, on cooling, deep red.

Chromic Iron Ore.—This substance is also closely related to Magnetic Iron Ore. It has a black colour, with sub-metallic lustre, and dark-brown streak. It occurs commonly in amorphous granular masses, and consists normally of sesqui-oxide of chromium and oxide of iron. H. 5.5; sp. gr. 4.3–4.6. Bolton and Ham, in the "metamorphic district" of the Eastern Townships (where it occurs in veins of about a foot in thickness, in serpentine) are its principal Canadian localities. It is found also in other places throughout this district, in small grains, in dolomite and magnesite rocks. When quite pure, it may be distinguished from magnetic iron ore by its brown streak and lower sp. gr.; as well as by its want of (or feeble) magnetism. Chromic Iron Ore is used for the preparation of chromium compounds, employed in dyeing, painting, &c.

Brown Iron Ore (*Limonite*).—Brown of various shades, with sub-metallic (or sometimes stony or silky) aspect, and yellowish-brown streak. Occurs chiefly in botryoidal masses with fibrous structure (a variety often called *Brown Hœmatite*), and also in vesicular and earthy amorphous masses (*Bog Iron Ore*). H. 5.0–5.5; sp. gr. 3.5–4 0. Blackens before the blow-pipe, and becomes magnetic. In the bulb-tube (*fig.* 22) it gives off water. One hundred parts contain (if the substance be pure): Sesqui-oxide of iron, 85.6; water, 14.4. This is likewise a valuable ore of iron. The *Bog Iron Ore* variety (in addition to *yellow ochre* described in Section *D* 3) is that which chiefly occurs in Canada. This variety is a comparatively recent product; and its formation, indeed, is still going on in places, by deposition from water in the form of carbonate of iron oxide, this being afterwards converted into the hydrated sesqui-oxide. It occurs in great abundance in Post-tertiary deposits in the Three Rivers District, C.E., (yielding the celebrated "St. Maurice, or Three Rivers Iron," largely employed for castings); and also in the County of Norfolk, C.W.; besides many other localities. Altogether, the following Townships and Seigniories are enumerated by Sir William Logan (*Esquisse géologique du Canada*) as yielding this ore: Middletown, Charlotteville, Walsingham, West Gwillimbury, Fitzroy, Eardley, March, Hull, Templeton, Vaudreuil, St. Maurice, Champlain, Batiscan, Ste. Anne, Port Neuf, Nicolet, Stanbridge, Simpson, Ireland, Lauzon, St. Vallier, &c. These bog iron ores always contain a small amount of phosphoric acid, which becomes reduced during the process of smelting, and usually renders the iron (by the presence of phosphide or phosphuret of iron) "cold-short." Cold-short iron is more or less brittle, and, hence, as a general rule, it is only available for castings. The St. Maurice ores are said, however, to yield excellent malleable iron.

NOTE.—As the minerals of this Section (*A* 4) present, in many of their varieties, a somewhat doubtful metallic aspect,* they will be referred to again, under Group *C*.

B. *Aspect metallic. Hardness insufficient to scratch glass.*

B 1. *Malleable or Ductile.*

[Principal Minerals:—Colour yellow: *Native Gold.* Colour white, with dark tarnish: *Native Silver.* Colour dark lead-grey: *Sulphide of Silver.* Colour copper-red: *Native Copper.*]

Native Gold.—Rich golden-yellow; in small granular or subcrystalline masses, scales, and dust. Sp. gr. varying from about 16.0 to 19.0. Easily fusible, but otherwise inalterable before the blowpipe. Distinguished by this latter character, and also by its high sp. gr., its malleability, &c., from copper pyrites, iron pyrites, and other substances of a similar aspect. Another salient character, applicable more especially to dust gold, is the quality of remaining unaffected by nitric acid. In Canada, native gold occurs over a wide area (in alluvial sands, &c.) in the metamorphic district south of the St. Lawrence, although not in sufficient abundance to cause the regular working of the auriferous sands of this district to be remunerative. The sands of the following streams and rivers, more particularly, are stated by Sir William Logan to contain gold: The Guillaume, Lessard, Bras, Touffe-des-Pins, Du Lac, Famine, Du Loup, Metgermet, and Poser's stream; with the Chaudière and St. Francis. These, with the exception of the St. Francis, belong chiefly to Beauce Co., C.E. Sir William Logan states also, that native gold has been found in small quantities in a vein with Specular Iron Ore, in the township of Leeds, Megantic Co., C.E. Traces of gold have likewise been discovered in the native silver of Prince's Mine, Lake Superior. (See, also, auriferous varieties of Iron Pyrites, *A* 1; Copper Pyrites, *B* 3;

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* The term "aspect," as here employed, refers not merely to the "lustre" of the substance, but to its general appearance and characters, taken together. Thus but few, if any, specimens of Bog Iron Ore exhibit a metallic lustre properly so-called; and yet most persons, on taking up one of these specimens, would refer it at once to the metallic group, or, in other words, would consider it to be a metallic substance of some kind.

and Blende, *B* 3.) The gold of the Eastern Townships contains, according to Professor Sterry Hunt, from 11 to 13 per cent. of silver. Small grains of *Platinum* and *Iridosmium* are mixed with it here and there, as in the sands of the Rivière du Loup, &c.

Native Silver.—Silver-white, often with dark or yellowish external tarnish. Found chiefly in crystalline arborescent groups, and in small, scaly, granular, or wire-like masses, associated with native copper, at St. Ignace and Michipicoten Islands ; and with sulphide of silver, &c., in calcareous spar, at Prince's Mine, Spar Island, Lake Superior. Sp. gr. 10-11. Easily fusible.

Sulphide of Silver (or *Silver Glance*).—Dark lead-grey or black, with shining streak. Perfectly ductile. Chiefly in small masses with native silver, sulphide of copper, galena, malachite, &c., in a vein of quartz and calc spar, at Prince's Mine, Lake Superior. Sp. gr. about 7.2. Fusible and reducible to metallic silver *per se* before the blow-pipe. One hundred parts contain: Sulphur, 13 ; silver, 87. It is easily distinguished from sulphide of copper, galena, &c., by its perfect malleability, as well as by its blow-pipe characters.

Native Copper :—Copper-red, with shining streak. Chiefly in arborescent and amorphous masses, more rarely in determinable crystal-groups (Monometric.) H. 2.5–3.0. Perfectly malleable. Sp. gr. about 8.9. Easily fusible, imparting a green colour to the flame. Native copper occurs in immense abundance on the south shore of Lake Superior, but on the Canada side of the lake it has been found in small quantities in St. Ignace and Michipicoten Islands. In the latter Island, at Maimanse and Mica Bay, accompanying *copper glance* and *copper pyrites*. It does not appear to occur at all amongst the extensive deposits of copper pyrites, &c., on Lake Huron. In the Eastern metamorphic district, native copper is said to have been noticed at St. Henri, Dorchester County.

B. 2. *Yielding to the Nail*

[Principal Minerals: Streak white, *Mica*. Streak black, colour, black or dark-grey: *Graphite*. Streak and Colour lead-grey; imparting a pale green tint to the blow-pipe flame: *Molybdenite*.]

Mica :—In laminar or scaly masses, with a false pearly-metallic aspect. Colour, various ; streak, white. See Section *D*. 4.

Graphite :—Chiefly in black or dark-grey foliated masses or small scales. Feels somewhat greasy ; marks on paper ; sectile, and flexible in thin pieces; H. 1.0–2.0; Sp. gr. about 2.0. Inalterable before the blow-pipe. It occurs in small scales disseminated more or less throughout our Laurentain formation, and more especially in the crystalline limestones of that series; but its principal Canadian localities are the townships of Grenville (Addington County,) and Fitzroy (Carleton County,) on the Ottawa. At the former locality it constitutes several veins, each of an average thickness of about five inches; and is associated with garnets, zircon, feldspar, and other minerals. Graphite when of fine granular structure and dark colour, is extensively employed, under the popular name of Plumbago or "Black-Lead," in the manufacture of the so-called black-lead pencils. It consists, however, simply of carbon (or of carbon mechanically mixed with oxide of iron,) and does not contain a trace of lead. Our Canadian graphite is unfortunately too coarse and not sufficiently intense in colour for pencils, but, according to Sir William Logan, it may be used in the manufacture of refractory crucibles. Some samples that we have seen, might be employed also when ground to powder, as a polishing material for grates and stoves.

Molybdenite:—This substance much resembles graphite, but is of a lighter colour; and whilst it leaves a black trace on paper, it makes a dull greenish streak on smooth porcelain. It occurs chiefly in small scaly masses of a lead-grey colour. Like graphite it feels somewhat greasy, and it is also flexible. H. 1.0–2.0; Sp. gr. 4.4–4.8. Infusible, but it colours the blow-pipe flame pale-green, and volatilizes very slowly, depositing a white crust of molybdic acid on the charcoal. One hundred parts consist of: sulphur 41, molybdenum 59. It is not uncommon in small quantities amongst our Laurentian rocks generally, and in the intrusive granites of that formation. As special localities, we may cite from the Reports of the Geological Survey: Jerome, C. E.; Mud Turtle Lake, north of Balsam Lake; the River Doré near Gros Cap; and a granite vein on the west side of Terrace Cove, Lake Superior. Molybdenite is the principal source of molybdenum compounds, used in porcelain painting, and as a reagent in certain chemical experiments, &c.

To this section belong also, *Pyrolusite* or *Black Manganese Ore*, and *Sulphide of Antimony* or *Grey Antimony Ore*. The former (a compound of oxygen 36.7, manganese 63.3) occurs chiefly in radiating fibrous masses of a black or dark steel-grey colour, and is quite infusible. We have received a specimen said to have been found in the Eastern Townships or the neighbourhood, a district in which the Earthy or Bog Manganese Ore is of not uncommon occurence (see Section D.) Pyrolusite is found also in the adjoining State of Vermont. It is a valuable ore. *Sulphide of Antimony* has not hitherto been recognised in Canada. It occurs principally in fibrous masses of a lead or steel-grey colour, often with a dark or iridescent tarnish. A thin splinter will melt in the flame of a candle without the aid of the blow-pipe. It has been found in Maine, New Hampshire, &c., in the United States.

B. 3. *Not yielding to the Nail.*

(Principal Minerals:—Colour reddish; garlic-like odour before the blowpipe: *Arsenical Nickel.* Colour reddish, with blue or variegated tarnish; *Purple Copper Pyrites.* Colour, bronze-yellow; magnetic: *Magnetic Pyrites.* Colour, brass-yellow, often with variegated tarnish; streak, blackish-green: *Copper Pyrites.* Colour, dark-grey, often with green or blue tarnish; (Sp. gr. under 5.8) *Copper Glance.* Colour lead-grey; breaking easily into rectangular fragments; (Sp. gr. over 7.0): *Galena.* Colour, dark brown or various; streak brown; Infusible: *Zinc Blende.*

Arsenical Nickel:—Colour light copper-red, sometimes with greenish-white coating; exceedingly heavy; yielding an arsenical or garlic-like odour before the blowpipe. Many (or most) specimens are just hard enough to scratch glass; hence, this substance is described in full under Section *A* 2, above. As a Canadian mineral, it is comparatively unimportant.

Magnetic Pyrites:—Colour brownish or bronze-yellow, with black streak. Chiefly in amorphous masses. Magnetic, and often exhibits polarity. H. 3.5–4.5; Sp. gr. 4.4–4.7. Fusible, with sulphur fumes. Easily converted, by roasting, into red oxide of iron. One hundred parts contain: sulphur 39.5, iron 60.5. This substance, like the common pyrites, is not employed as an ore of iron. It occurs in considerable veins in St. Jerome, C. E.; also in the Chaudière Valley, where it is in part auriferous; and, in large quantities, about Balsam Lake, &c., C. W.

Copper Pyrites.—Brass-yellow, often with a variegated tarnish; streak, dark green or greenish-black. Chiefly in amorphous masses; sometimes in small tabular and tetrahedral crystals (Dimetric.) H. 3.5-4·0; Sp. gr. 4.1–4.3. Fusible with sulphur fumes into a magnetic globule. One hundred parts consist of: sulphur 35, copper 34.5, iron 30.5. This mineral is one of the most important of the copper ores. It is the characteristic ore of our Huronian rocks.* It occurs abundantly in these, at the Bruce and Wallace mines, Root River, Echo Lake, &c., on Lake Huron; and in the Michipicoten Islands, Lake Superior. It occurs likewise, but in comparatively small quantities in the Laurentian formation: as in the Seigniory of Lanoraie, Berthier County, C.E.; &c.; and it has also been found in the metamorphic district of the Eastern Townships; more especially in Upton, Drummond County, (where an argentiferous variety occurs,) and in Acton, Bagot County. At the latter locality it is auriferous.

Purple Copper Pyrites, (Erubescite):—Colour pale brownish-red, but always more or less masked by a rich blue or variegated tarnish; streak, greyish-black, by which (as well as by its colour, &c.,) this species may be easily distinguished from the variegated specimens of copper pyrites or yellow copper ore. Chiefly in amorphous or small granular masses accompanying yellow copper pyrites in quartz. Sometimes, as observed by the writer (*Canadian Journal*, New Series: vol. 1, page 187) in pseudomorphs, or altered (Dimetric) tetrahedrons, after the yellow ore. H=4.0; sp. gr. 4.4–5.0. Fusible with sulphur fumes into a magnetic globule. One hundred parts contain (as a mean): sulphur 25, copper 60, iron 15. This mineral occurs with copper pyrites at most of the localities given in the description of that substance, above. It is found also in the townships of Inverness and Leeds, Megantic County, C.E.

Sulphuret of Copper, or Copper Glance:—Dark lead-grey often with blue or green tarnish; streak, black and slightly shining. Chiefly in amorphous masses, more rarely in small flat six-sided crystals (Trimetric.) H 2.5–3.0; sp. gr. 5.5-5.8. Fusible with bubbling, colouring the flame green, and leaving a copper globule surrounded in

* The following Table shows (in a descending order) the positions of the rock-groups recognised in Canada. These groups, with their various subdivisions, &c., will be discussed in detail in one of the succeeding Parts of this series of papers, but the present Table may prove useful in the mean time.

Modern or Post-Tertiary Deposits.
The true Drift Formation.
(Here a great break occurs in the geological scale as represented in Canada.)
Carboniferous Formation (developed in part only in Gaspé.)
Devonian Formation,
*Silurian Formation,**
Huronian Formation,
Laurentian Formation.

* The great fossiliferous formation of Canada. Metamorphosed or rendered crystalline in part, in the so-called "metamorphic district" of the Eastern Townships and surrounding region.

general by a dark scoria. One hundred parts contain: sulphur 20.2, copper 79.8. This valuable ore occurs in some abundance at the Bruce Mines, Lake Huron. It is also found at Prince's Mine on Spar Island, Lake Superior, as well as in the Michipicoten Islands and in the Island of St. Ignace on that Lake, associated with copper pyrites, native copper, &c. It occurs likewise (with purple copper pyrites, &c.,) in the eastern metamorphic district: as in the townships of Leeds and Inverness in Megantic county. In the former of these townships it lies, according to Sir William Logan, in a ferruginous dolomite, associated with specular iron ore and a small quantity of native gold.

Galena:—Lead-grey, with black and somewhat shining streak. In amorphous masses of lamellar or granular structure, and in monometric crystals—more especially in cubes and cubo-octahedrons, *fig* 28. It breaks easily, owing to its well-marked cubical cleavage, into rectangular fragments. H. 2.5; sp. gr. 7.2–7.7. Decrepitates before the blow-pipe and yields lead globules, with the deposition of a yellow coating on the charcoal. One hundred parts contain: sulphur 13.4, lead 86.6; but a portion of the sulphide of lead is generally replaced by sulphide of silver. The silver in most of the Canadian samples, however, is insufficient to meet the cost of its extraction. Galena is the source of nearly all the lead of commerce. It occurs in Canada in very many places, but nowhere, apparently, in large quantities. It is chiefly found in connection with the crystalline limestones of the Laurentian formation, associated with crystallized calc-spar and sulphate of baryta, and sometimes also with zinc blende and iron pyrites. It occurs thus, occasionally forming thin veins, in the townships of Lansdowne and Bastard, (Leeds County, C.W.;) Bedford (Frontenac County, C.W.;) Fitzroy (Carleton County, C.W.;) Ramsay (Lanark County, C.W.;) Petite Nation (Ottawa County, C. E.;) and, in smaller quantities, in many other townships lying more especially along the southern outcrop of the Laurentian country. Galena has been met with also in the Huronian rocks of the Michipicoten and Spar Islands, Lake Superior, associated with copper ores, calc-spar, amethyst-quartz, &c., and on the neighbouring shores. Also in the metamorphic district of Eastern Canada; more especially in the quartz veins of the Chaudière Valley (with zinc blende, common and magnetic pyrites, native gold, &c.) as in the seigniories of Vaudreuil and St. George.

Fig 28.

Zinc Blende:—This substance varies in its aspect from sub-metallic to vitreo-resinous. The more metallic-looking specimens are dark-brown, black, brownish-yellow or brownish-red, with yellowish or reddish-brown streak, and high lustre. Found chiefly in lammellar and small irregular masses, and in more or less obscure crystals of the Monometric system. H 3.5–4.0; sp. gr. 3.9–4.2. Infusible. One hundred parts contain: sulphur 33, zinc 67. Zinc Blende, although so abundant in many countries, can scarcely be called an ore of zinc: the attempts to employ it for the extraction of the metal, having hitherto proved of very partial success. It may be used however, when ground to powder, as the basis of a wash or paint for frame buildings and wood-work generally. In Canada, Zinc Blende occurs in some abundance at Prince's Mine on Spar Island, and at Maimanse, Lake Superior, with copper ores, galena, &c. Also in small quantities with galena, in the townships of Lansdowne, Bedford, &c., (see under *galena*, above); and in the eastern metamorphic district of the Chaudière Valley. The Blende of this latter locality (seigniories of Vaudreuil and St. George, Beauce Co.,) has been shewn by Mr. Sterry Hunt of the Geological Survey, to be slightly auriferous.

(*To be continued.*)

REMARKS ON THE PAPER HEADED "THE ODAHWAH INDIAN LANGUAGE," PUBLISHED IN THE CANADIAN JOURNAL FOR NOVEMBER, 1858.

BY F. ASSIKINACK.

Read before the Canadian Institute, 14th January, 1860.

The paper which appeared in the *Canadian Journal* for November, 1858, headed "The Odahwah Indian Language," was intended to give some particulars relating to the language of the Odahwahs. Although the Odahwahs and Ojibwas may be considered to speak one common language, they, nevertheless, differ in several respects; and in many cases these distinctions are scarcely perceptible in common conversation, and any one who is not well acquainted with both languages may easily confound the dialect of one tribe with that of the other. On looking over the paper alluded to above, after its publication, I discovered a few irregularities which had found their way into it previous to its going to press; and as I do not hold myself responsible for these mistakes, I will point out as briefly as possible the passages which appear to me to be inaccurate, with some additional remarks on each of the several points in question.

1. At page 482 we have "*Naubegwun;*" this word should be written *Naubequan* or *Naubekwaun;* it is supposed to be derived from *Naubekwa*, a verb intransitive of the third person singular, and which implies the act of a person running a string or thread through the eye of something, such as a needle, beads and the like. The name may have been given by the Indians to a ship, on account of its having many ropes about it. The verb from *Naubekwaun* is *Naubekwauneka*, he builds a ship.

2. On the same page, *Tibahahkewenine*, a land surveyor, is said to be from *Tibahiga*, he measures. Now the substantive from this verb is *Tibahigawenine*, a measurer, or a man who measures, and it may mean a measure of cloth, of lumber, of grain, or anything else, and appears to be merely the verbal form of *Tibahigun*, a measure, which I consider the root from which all others having the idea of a measure are derived. The verb for he measures, having reference to land exclusively, is *Tibahahkee*, from *Tibahigun*, and *ahke*, land; and from the compound verb and *ahnine*, a man, is derived, in my opinion, *Tibahahkewenine*, simply, a measure of land. I may further observe *Tibahkonigun* signifies a yard-stick, turned into a verb, Tibakonigu, literally, *he measures cloth by the yard-stick.* None of the verbs above can take a noun after it, and it is somewhat doubtful whether the first syllable should begin with T or D; but this doubt is removed when the verbs are employed as transitives which considerably change at the same time, preserving, however, under all circumstances the letter B, the most important part of the original word. Thus, Odibowahu and mitigoon, he measures a tree or trees, animate, Odibahahu ahke, he measures land, inanimate.

3. At page 483, "*Ninahwind*" and "*Kinahwind*" are given for *we*—these are Ojibwa pronouns, not Odahwah. The latter tribe never put D at the end of these words. The Odahwahs say for we, *Ninahwin* and *Kinahwin*, with a slight nasal sound of the last

syllable. The difference between these two forms of the first person plural is this, that when I take *Ninawin* I exclude the person I am speaking to, but when I make use of *Kinahwin* I include him, that is, he belongs to the same company or party as I do. In ordinary conversation these pronouns are not used in full; for example, Nindizhahmi and Kidizhahami, we go; but when the speaker wishes to make his expression clear, strong, &c., then he repeats the forms in full using particles as the same, thus, *Ninahwin*, go, *Nindizhahmi*, we ourselves are going *Kinahwin sah*, go, *Kiguhizhahmi*, we ourselves will or must go. When one or more of the party are selected or spoken of, there is no such change in the Odahwah as is observed in the English or in other languages, for you say, one of us, we simply have *puizhig ninahwin* or *ninahwin puizhig*, *puizhig kinahwin tuhizhah*, one of us will go. *Neezh yamah nisswe kinahwui*, two or three of us; for or on account of one of us, *puizhig kinahwin ondje*.

4. On page 485, we are informed that "Mississippi is the Indian name of a large river in America." "It is composed of *Missi* which in composition words corresponds to *Michah*, and signifies very great." The first part of this sentence has the appearance of being too positive, and it would be better to qualify it by saying Mississippi *is said* to be the Indian name, &c., for even now I could not say positively that it is an Indian name. I can only suppose that it was meant for *Mashziebe* by which name it is known to the Odahwahs. As regards *Missi* I have been unable to discover any such particle in the Odahwah, either as it stands here or in composition. I presume, therefore, it belongs to some other tribe. *Michah* is an Ojibwa adjective. The Odahwahs have it *Mishah* with S, not C, in the middle. Although they frequently make use of the former, but always in composition as an adverbial adjective, as *Michahbaweze*, he is a stout man; *Michahkoze*, it is a large tree. *Mishah* when used alone never varies, but when it forms part of a word it assumes different shapes as in *Mashizebe Mishikaikaike*, a large hawk; *Misahkig*, a seal, literally, a large otter, from negiz an otter. *Mishah* is an inanimate form, and when it refers to an animate object it is written thus, *Mindido*.

5. Further down on the same page we have "*Nibissininewug*," inhabitants at Nibissing. There are two ways of writing this word: first, when the name is written fully it stands thus, singular, *Nibissiwenine;* plural, *Nibissiweninewug*, but when the fourth syllable, *we*,

is omitted, the last syllable begins with Y not W, namely *Nibissinino*, plural, *Nibissinineyug;* therefore, *Nibissininewug*, as given in the *Canadian Journal* for November, 1858, is not correct. This rule applies to many other words when contracted, for example, *gata-ahninewug*, the ancients take away *ah*, and we have *gatanineyug*.

I have now endeavoured to notice the irregularities as they occur in the article under review. I do not, of course, pretend to say that my statements are correct in every respect, but it has been my desire to convey the most correct information on the subject that it is in my power to give.

With regard to verbs, I have thought it proper to add one remark at the end of this paper in reference to the third person, as this part of the Indian verb appears to have peculiarities quite different from the first and second person, singular or plural, and which have been found rather difficult to explain by some persons. In the first place I may state that there are two words which represent he, she, his, hers, and theirs; namely, *win* and *o*. *Win* is always in the singular number, but *o* is sometimes plural. Whilst the first and second invariably express the personal pronoun, it is always omitted in the third, so far as verbs which do not take a noun after them are concerned, which I suppose are to be regarded in some measure as intransitives, but when a noun can be put after them, O is added to the third person, and *win*, in some instances: for example, *bimosa*, he walks, *inaindum*, he thinks, *nibah*, he sleeps, *ahkoze*, he is sick; this is also the case with verbs derived from substantives, as it will be seen from the following—although they govern nouns when translated into English. *Naubekwauneka*, he builds a ship, from *Naubekwaun*, a ship; *Wigiwameka*, he builds a house or dwelling, from *wigiwam;* *Mahkoka*, he hunts after the bear, from *Mahkwuh*, a bear. We will take others, verbs with their substances: *Naubekwaun odozhitoon*, he makes a ship; *onahgahdaun owigiwam*, he leaves his house; *mahkurm onisauro*, he kills a bear; *geizhah*, he went; *win go geizhah wahdi*, he went then himself. Sometimes both *win* and *o* are made use of, as *win go obedoon*, he brings it himself.

The third person also differs in this from the first and second, that where it admits a noun after it, of the masculine or feminine gender, the noun has only one form for singular and plural; thus, *mitigoon ogeeshkahwahn*, he cut down a tree or trees. Here *mitigoon* stands for the singular as well as the plural number, as it will appear more clearly from the following example: *puizhig mitigoon ogeeshkahwahn*, he cuts down one tree; *ningodwahk mitigoon ogegeeshkahwahn*, he cut down one hundred trees. With nouns, however, of the neuter gender, similarly governed, there is a distinction between the singular and plural, for instance, *ahnit*, a spear, *ahnit odahyaun*, he has a spear; *ahniteen odahyaunun*, he has spears. Strictly speaking, verbs derived from nouns denote the profession or business of a person; thus, *naubekwauneka*, he builds a ship,—means also his profession or business is to build a ship.

The words *win* and *o* which frequently represent the personal and possessive pronouns of the third person, are likewise omitted in the event of an objective case of the first and second persons coming after a verb transitive. These appear to usurp the place of the third person, for example, *Ni wahbahrnig*, he sees me, *Ki wahbahrnig*, he sees you. *Ni minig*, he gives it to me. Here we see *Ni* and *Ki* are plural where *win* and *o* should be; but when the verb has reference to a case of the third person, then the nominative of the third person keeps its proper place at the beginning of the verb, thus, *Owahbahmahn*, he sees him or them, *Ominahn*, he gives it to him. The pronouns of the third person are also omitted in the passive voice, namely, *Wahbahmah*, he is seen, *Nisah*, he is killed. Deponent verbs, Nisidizo, he kills himself, *Kitchiahpitanimo*, he thinks a good deal of himself. *Ni wahbahrnig* is distinguishable from the first and second persons by its final syllable *ig*, the first is *Ni wahbahmah*, I see him. I may here observe that the first and second have invariably the same termination; but the third person does not always agree with these, as it will appear from the following:—*Nindahkooz*, I am sick, *Kidahkooz*, you are sick, *ahkooze*, he is sick; *Ningoosah*, I fear him, *Kigoosah*, you fear him, *ogoosaun*, he fears him or them, *ogootaun*, he fears *it*.

The preceding observations, although constituting a mere outline of the subject, will serve to convey a general idea of the more important peculiarities regarding the third person of an Indian verb. If the subject be deemed of sufficient interest, it may perhaps be referred to more fully, in a future communication.

REVIEWS.

North West Territory. Reports of Progress; together with a preliminary and general report on the Assiniboine and Saskatchewan exploring expedition, made under instructions from the Provincial Secretary, Canada. By Henry Youle Hind, M. A. John Lovell, Toronto, 1859.

From the great interest felt by the people of Canada in the North West Territory, and its capacity as a scene of future occupation by industrious settlers, the appearance of Professor Hind's Report on the Assiniboine and Saskatchewan exploring expedition, will be welcomed with a lively curiosity as to its various contents. Nor will such curiosity fail to find much to gratify it in the volume just issued from the press. Topographical and Geological Maps and Sections accompany the letter-press, executed on so large a scale as readily to present to the eye the minutest features that the opportunities of the exploring party enabled them to note; and well executed wood-cuts illustrate the additions contributed to North American Palæontology, by the good use which Professor Hind has made of his very favourable opportunities.

Chapter XVI. introduces the "Geological Report," with a sketch of the surface geology of part of the valley of Lake Winnipeg. Notices of numerous traces of glacial action, follow, with descriptions of many indications of change in the contour of the land. Many records of former water-courses and the aspect of ancient river-valleys have also been noted. Next to the valley of the Qu'Appelle, Professor Hind remarks "the old course of the Little Souris through the depression now occupied by the Back-fat Lakes is the most curious and imposing. Standing upon one of the most prominent of the Blue Hills of the Souris, near their southern extremity, the ancient valley can be traced as far as the first lake, which is distinctly seen by the unassisted eye, and with a good marine telescope its outline is plainly visible." In this as in other localities unheeded changes in the course of rivers have, in comparatively recent times, wrought important alterations on the contour of the region; while at other points, vast, unstable sand-hills and dunes are in constant motion and render extensive ranges of country mere barren wastes.

In the following chapter, as well as in others, exposed sections are figured and described, with their included minerals and fossils. A boldly sketched view on p. 172, exhibits a specimen of exposed cliff at

Grindstone Point, Lake Winnipeg, composed of Chazy Limestone, illustrating the exceedingly picturesque character that generally prevails throughout that Lake Coast. Extracts from the reports and narratives of Messrs. Foster and Whitney, Sir John Richardson, Dr. Owen and other observers, accompany Professor Hind's own notes, and supply many new hints whereby to judge of the mineral resources and the prevailing geological character of this great unoccupied territory. To complete the report in its scientific bearings on the geological aspects of the various districts explored, the services of the American Palæontologist, Mr. F. B. Meek, and of Mr. E. Billings of the Canadian Geological Survey, have been called into requisition ; the former describing Cretaceous fossils, and the latter those of the Silurian and Devonian formations. It was impossible, in so rapid an exploratory journey, with many other objects demanding the special attention of the observers, that anything like a complete palæontological series of illustrative specimens could have been secured ; but enough has been done in this department to supply interesting materials for comparison with the Nebraska territory, and the rocks of the great basin of the Upper Missouri. Mr. Meek, whose labours in the latter district, are well known to American Geologists, remarks, after a general reference to the collections made by Professor Hind, in proof of the value of this portion of the exploratory party's work : "It is very desirable that a good series of specimens should be obtained from this remote northern locality, not only for the purpose of determining the age of the formation, but for the light they might throw upon far more interesting questions respecting the probable climatic conditions in these high northern latitudes during the Secondary Period." The fossil plants, Acephala, Gasteropoda, and Cephalopoda of the Cretaceous formations are minutely described, and the new species named. From the latter, we select one or two, which we are able to illustrate by means of the well executed wood engravings prepared for the report. Figs. 1, and 2, are Lamellibranchiata procured from their matrix of soft lead gray argillaceous rock, on the Little Souris River, and named after one of members of the exploring party, *Anomia Flemingi.*

Plate II. is chiefly occupied by large and well executed figures of the *Ammonites Barnstoni*, the *Ammonites Billingsi* ; and a beautiful variety of the Nautilus, termed the *Dekayi* ; but probably greater interest will be felt by many in the following less showy *Productus*, supposed to be from carbonifeous limestone, and therefore viewed

with special reference to its importance as possibly indicating the existence of coal in the Red River district. "There is some evidence," says Mr. Billings, "of the existence of at least a portion of the carboniferous system in this region. The fossil figured here, procured

from a Half-breed, who said he collected it from the solid rock, at some place on the Red River, is a *Productus* of the group *Semireticulati,* all of which appear to be confined to the carboniferous series. The specimen is not worn, and presents all the appearance of having been freshly broken from the rock." These will suffice to indicate the character of the palæontological novelties contributed to science by Professor Hind, as the result of his recent journey. They furnish an interesting foretaste of the treasures in store for future scientific explorers of the territory, and of the value of the present report as the first clue to the economic characteristics of the valley of the Red River.

The volume has only reached us after a considerable portion of the present number was already in type; and we are limited therefore both by available time and space, in our notice of its various contents. We leave therefore to the daily press the discussion of such practical sections as those which treat of the extent and characteristics of the lake and river systems of the regions explored; of their Wooded and Prairie Land; and of the areas fit for settlement. These will doubtless receive abundant attention, and be discussed in all their bearings, by those who, alike on economic and political grounds, anticipate the speedy occupation of the explored areas by Canadian and British settlers.

Turning from this practical aspect of the exploring party's report, to the interest which attaches to the narrative of an intelligent traveller's observations in a country still mainly occupied by the wild Indian in his natural state, the volume presents many curious passages which we would gladly transfer to our pages. But one or two must suffice to direct our readers to the original work. Professor Hind and his party were thrown a good deal among the various tribes of Indians—Crees, Sioux, Blackfeet, and Ojibways,—who find hunting grounds, or opportunities of trading at the Hudson's Bay Company's Forts, in the territory explored. The picture he draws of the Red Man, exhibits in no very flattering aspect, the improvident, superstitious, and treacherous savage, whom civilization visits seemingly only to exterminate. Here is an account of one of the processes of reckless improvidence persisted in by the Indians on the Prairies, whereby a sterile and forbidding aspect is stamped on vast tracts of country along the courses of the Qu'Appelle and Assiniboine Rivers. A few miles west of the Souris Forks, the Qu'Appelle is only nineteen feet wide, while the great valley through which the river winds its way is still a mile broad and two hundred feet deep. Here, says Professor Hind, "we caught a glimpse of the blue outline of the Grand Coteau, with a treeless plain between This afternoon we saw three fires spring up between us and the Grand Coteau. They were Indian signs, but whether they referred to the presence of buffalo, or whether they were designed to intimate to distant bands the arrival of suspicious strangers, we could not then tell, and not knowing whether they were Crees, Assiniboines, or Blackfeet, we became more cautious. In a few days we ascertained that the fire had been put out* by Crees, to inform their friends that they had found buffalo.

"The grandeur of a prairie on fire belongs to itself. It is like a volcano in full activity, you cannot imitate it, because it is impossible to obtain those gigantic elements from which it derives its awful splendour. Fortunately, in the present instance the wind was from the west, and drove the fires in the opposite direction, and being south of us we could contemplate the magnificent spectacle without anxiety. One object in burning the prairie at this time, was to turn

* This native expression; 'put out fire,' signifies to set the prairie on fire.

the buffalo; they had crossed the Saskatchewan in great numbers near the Elbow and were advancing towards us, and crossing the Qu'Appelle not far from the height of land; by burning the prairie east of their course, they would be diverted to the south, and feed for a time on the Grand Coteau before they pursued their way to the Little Souris, in the country of the Sioux, south of the 49th parallel.

"Putting out fire in the prairies is a telegraphic mode of communication frequently resorted to by Indians. Its consequences are seen in the destruction of the forests which once covered an immense area south of the Qu'Appelle and Assiniboine. The aridity of those vast prairies is partly due to this cause. The soil, though light, derives much of its apparent sterility from the annual fires. In low places and in shallow depressions where marshes are formed in spring, the soil is rich, much mixed with vegetable matter, and supports a very luxuriant growth of grass. If willows and aspens were permitted to grow over the prairies, they would soon be converted into humid tracts in which vegetable matter would accumulate, and a soil adapted to forest trees be formed. If a portion of prairie escapes fire for two or three years the result is seen in the growth of willows and aspens, first in patches, then in large areas, which in a short time become united and cover the country; thus retarding evaporation and permitting the accumulation of vegetable matter in the soil. A fire comes, destroys the young forest growth, and establishes a prairie once more. The reclamation of immense areas is not beyond human power. The extension of the prairies is evidently due to fires, and the fires are caused by Indians, chiefly for the purpose of telegraphic communication, or to divert the buffalo from the course they may be taking. These operations will cease as the Indians and buffalo diminish, events which are taking place with great rapidity."

Thus we perceive that the poor Indian learns as little as the Buffalo, to profit by experience, or to adopt from the white settlers any of those simplest arts of civilization, whereby the whites, though as yet a mere handful among the Indian Tribes of that vast territory, are destined to be their supplanters; and the rapid diminution of the latter is already noted as a process in full activity. The Indians, however, as will be seen, though hopelessly indifferent to all prudential regard of their own reckless proceedings, are jealously alive to the encroachments of the Whites, on their territories and hunting grounds.

After an interesting description of Sand Hill Lake, and the remarkable drifting dunes which have invaded the Great Valley; Professor Hind narrates his visit to Shortstick, the Chief of the Crees of that region, near the south branch of the Saskatchewan. The Crees were camping out, in the all-important occupation of their great annual Buffalo hunt, and their Chief sent on a party of mounted Crees, accompanied by his son, who informed the strangers, that they were engaged in the construction of a new Buffalo-pound; and as soon as it was ready, the visitors were invited to repair thither, and witness the capture of the Buffalo. The scene which he then witnessed was one full of interest to the traveller, and singularly illustrative of the improvident recklessness of the Indian hunters. We shall abridge somewhat, the graphic narrative, omitting some of the details, which, though vivid and truthful illustrations of this particular phase of Indian life, can be sought for in the pages of the original report, by such as desire to master all the minutiæ of the dreadful scene of butchery.

"We passed through the camp," says Professor Hind, "to a place which the Chief's son pointed out, and there erected our tents. The women were still employed in moving the camp, being assisted in the operation by large numbers of dogs, each dog having two poles harnessed to him, on which his load of meat, or pemican, or camp furniture was laid. After another smoke, the Chief's son asked me, through the interpreter, if I would like to see the old buffalo pound, in which they had been entrapping buffalo during the past week. With a ready compliance I accompanied the guide to a little valley between sand hills, through a lane of branches of trees, which are called 'dead men' to the gate or trap of the pound. A sight most horrible and disgusting broke upon us as we ascended a sand dune overhanging the litlle dell in which the pound was built. Within a circular fence 120 feet broad, constructed of the trunks of trees, laced with withes together, and braced by outside supports, lay tossed in every conceivable position over two hundred dead buffalo. From old bulls to calves of three months old, animals of every age were huddled together in all the forced attitudes of violent death. * * *

"The Indians looked upon the dreadful and sickening scene with evident delight, and told how such and such a bull or cow had exhibited feats of wonderful strength in the death struggle. The flesh of many of the cows had been taken from them, and was drying in the sun on stages near the tents. At my request the Chief's son jumped into the pound, and with a small axe knocked off half a dozen pair of horns, which I wished to preserve in memory of this terrible slaughter. "To-morrow," said my companion, "you shall see us bring in the buffalo to the new pound."

"After the first run, ten days before our arrival, the Indians had driven about 200 buffalo into the enclosure, and were still urging on the remainder of the herd, when one wary old bull, espying a narrow crevice which had not been closed by the robes of those on the outside, whose duty it was to conceal every orifice, made a dash and broke the fence, the whole body then ran helter skelter through the gap, and dispersing among the sand dunes, escaped, with the exception of eight who were speared or shot with arrows as they passed in their mad career. In all, 240 animals had been killed in the pound, and it was its offensive condition which led the reckless and wasteful savages to construct a new one. This was formed in a pretty dell, between sand hills, about half-a-mile from the first, and leading from it in two diverging rows, the bushes they designate dead men, and which serve to guide the buffalo when at full speed, were arranged. The dead men extended a distance of four miles into the prairie, west of and beyond the Sand Hills. They were placed about 50 feet apart, and between the extremity of the rows might be a distance of from one and a half to two miles.

"When the skilled hunters are about to bring in a herd of buffalo from the prairie, they direct the course of the gallop of the alarmed animals by confederates stationed in hollows or small depressions, who, when the buffalo appear inclined to take a direction leading from the space marked out by the dead men, show themselves for a moment and wave their robes, immediately however hiding again. This serves to turn the buffalo slightly in another direction; and when the animals having arrived between the rows of dead men, endeavour to pass through them, Indians here and there stationed behind a dead man, go through the same operation, and thus keep the animals within the narrowing limits of the converging lines. At the entrance to the pound, there is a strong trunk of a tree placed about one foot from the ground, and on the inner side a shallow excavation is made, sufficiently deep, however, to prevent the buffalo from leaping back when once in the pound. As soon as the animals have taken the fatal spring they begin to gallop round and round the ring fence looking for a chance of escape, but with the utmost silence the women and children on the outside hold their robes before every orifice until the whole herd is brought in, they then climb to the top of the fence, and with the hunters who have followed closely in the rear of the buffalo, spear or shoot with bows and arrows or firearms at the bewildered animals rapidly becoming mad with rage and terror, within the narrow limits of the pound. It is then that a dreadful scene of confusion and slaughter begins, the oldest and strongest animals crush and toss the weaker; the shouts and screams of the excited Indians rise above the roaring of the bulls, the bellowing of the cows and the piteous moaning of the calves. The dying struggles of so many strong, full grown animals crowded together, furnish a revolting and terrible picture, but with occasional displays of wonderful brute strength and rage; while man, in his savage, untutored and heathen state, shows both in deed and expression how little he is superior to the noble beasts he so wantonly and cruelly destroys."

After witnessing this highly characteristic illustration of Indian habits, Professor Hind held a formal interveiw with the Cree Chief, the description of which furnishes a definite expression of the jealousy with which the encroachments of the white men are regarded by the wild hunter tribes. After describing the dress of the Cree Indians, which was of the scantiest description; and the painting, as well as the scars and gashes—record of mourning for departed friends,—with which their bodies were marked, the author thus proceeds: "I enquired the age of an extremely old fellow who asked me for medicine to cure a pain in his chest; he replied he was a strong man when the two Companies (the Hudson's Bay and the North West) were trading with his tribe very many summers ago. He remembers the time when his people were as numerous as the Buffalo are now, and the buffalo thick as trees in the forest. The half-breeds thought he was more than 100 years old. Shortstick accepted the presents of tea, tobacco, bullets, powder and blankets I made him, with marked satisfaction, and expressed a wish to learn the object of our visit. We held a 'talk' in my tent, during which the chief expressed himself freely on various subjects, and listened with the utmost attention to the speeches of the Indians he had summoned to attend the Council.

"All speakers objected strongly to the half-breeds' hunting buffalo during the winter in the Plain Cree country. They had no objection to trade with them or with white people, but they insisted that all strangers should purchase dried meat or pemican, and not hunt for themselves.

"They urged strong objections against the Hudson's Bay Company encroaching upon the prairies, and driving away the buffalo. They would be glad to see them establish as many posts as they chose on the edge of the prairie country, but they did not like to see the plains invaded. During the existence of the two companies, all went well with the Indians; they obtained excellent pay, and could sell all their meat and pemican. Since the union of the companies they had not fared half so well, had received bad pay for their provisions, and were growing poorer, and weaker, and more miserable year by year. The buffalo were fast disappearing before the encroachments of the white men, and although they acknowledge the value of firearms they thought they were better off in old times, when they had only bows and spears, and wild animals were numerous. I asked Shortstick to name the articles he would like to have if I came into his country again. He asked for tea, a horse of English breed, a cart, a gun, a supply of powder and ball, knives, tobacco, a medal with a chain, a flag, a suit of fine clothes, and rum. The talk lasted between six and seven hours, the greater portion of time being taken up in interpreting sentence by sentence, the speeches of each man in turn. They generally commenced with the creation, giving a short history of that event in most general terms, and after a few flourishes about equality of origin, descended suddenly to buffalo, half-breeds, the Hudson Bay Company, tobacco and rum."

These extracts sufficiently illustrate the varied characteristics of the Report, which extends to upwards of 200 large double-columned quarto pages, and embraces an Itinerary, with topographical information rendered in the concisest form; Reports of Progress, by different members of the exploring party; Meteorological and Geological details; and a narrative embodying descriptions of scenery, native habits, and such incidents of travel as are at once attractive to the general reader, and of value to those who are desirous of ascertaining the fitness of the region for a scene of emigration, and a future Province of British North America.

Report of the Geological Survey of the State of Iowa. By James Hall, State Geologist, and J. D. Whitney. Iowa: 1858.

The first part of this Report—dated 1858, and embracing the general geology and the palæontology of the State, by Professor Hall, with its physical geography, chemistry, and economic geology by J. D. Whitney, and sundry geological details by A. H. Worthen —has been issued within the last few months by the Legislature of Iowa. The palæontological portion of the Report is bound up separately. It contains some twenty-nine or thirty steel-plate engravings of very superior execution, exhibiting about a thousand figures of the more characteristic or remarkable fossils collected during the prosecution of the Survey. Mere sketches of scenery, on the other hand, however pleasing in themselves, have been very properly dispensed with in this Report. Illustrations of that kind add enormously to the costs of publication, without offering, as a general rule, any compensating advantages.

The oldest recognised rock in the State of Iowa appears to be the Potsdam Sandstone, This, blended intimately with the Calciferous Sand Rock, is sparingly developed along the line of the Mississippi, in the extreme North-East corner of the State. The other subdivisions of the Silurian Series, and those of succeeding formations up to the coal measures, follow in more or less regular gradation, with their lines of strike running in a general N.W. and S E. direction, or, as stated by Professor Hall, at right angles to the Cincinnati axis and the lines of disturbance along the Appalachian Chain. Owing to this direction of the strata, they are cut successively by the Mississippi River, and show from north-east to south-west the following sequence:—The Potsdam Sandstone and Calciferous Sand Rock; the St. Peters Sandstone; the Trenton beds; the Galena limestone (looked upon as an upper portion of the Trenton Group;) the Hudson River Shales, showing only a narrow outcrop-band; the Leclaire Limestone (see below); the Onondaga Salt-Group, the equivalents of the Upper Helderberg Limestone, Hamilton, and Chemung groups; the Carboniferous Limestone; and the Coal Measures. Although these follow one another regularly, here and there an underlying division is exposed by denudation or river-cutting in some of the tributary vallies of the Mississippi. Thus, amongst other examples, the Trenton Limestone re-appears within the Galena Limestone area along the line of Turkey River; and the Carboniferous Limestone, within the area of the Coal Measures, along the valley of the River Des Moines. Professor Hall remarks, that, in tracing westward such of these geological formations as are known in New York and Pennsylvania, they are found to thin out gradually, becoming indeed, in some instances, so attenuated as to be scarcely recognizable, more especially in a district deeply covered, like that of the greater part of Iowa, with Drift and modern deposits. It is to this attenuation of the strata, as well shewn by Professor Hall, that the comparatively subdued aspect of this western country is owing. The united strata are not sufficiently thick to admit of the production of any strongly-marked features, by either denudation or ordinary disturbing forces. Where anticlinals exist, they occupy low levels; and the only real elevations of the district have been produced by denuding agencies on undisturbed or nearly horizontal strata, where these, under special conditions (as in the case of the Niagara Limestone) have presented a more than ordinary thickness to the denuding force. On comparing these results with the phenomena exhibited in the district of the Catskill Mountains and the Appalachians, where the diminished strata of the West occur in accumulations of vast thickness, our author appears inclined to refer the general production of mountain chains, more to the action of denudation, than to that of elevating or disturbing forces. But, in this, his views are surely pushed too far. That denudation has produced mountain masses amongst undisturbed strata, as in the Catskill district, in the old red sandstone country of the Western Highlands of Scotland, and elsewhere, all the world must admit; and equally that anticlinals often occupy comparatively low levels, as the beds of rivers, &c.: but when we extend our survey to the great mountain systems of the Earth—the Andes and their prolongations, which brim the eastern contour of the Pacific, the towering Himalayas, the Alps, and other chains, it becomes manifest that elevation has been there produced by disturbing agencies of no ordinary intensity. The bare occurrence of highly inclined and vertical (and sometimes even of reversed) strata, as seen in all these mountainous districts, the presence of stupendous volcanoes in many of them, with other well-known phenomena, point incontestibly to this fact. Denudation may have been concerned, and largely, in the excavation of valleys amongst these, in the production of lines of escarpment, and so forth; but denudation has there played the part of a mere secondary agent. The great views of Elie de Beaumont, however exaggerated and extended beyond their legitimate limits by some geologists, are still in their main features undoubtedly worthy of our reception; and these views are based essentially on the formation of mountain chains by elevating forces.

Amongst the more interesting facts discovered by Professor Halls' exploration of Iowa, may be cited, first of all, the occurrence of the Hudson River Group in that State and in Illinois; represented by more or less bituminous shaly layers, having an entire thickness of no more than sixty or seventy feet, and thus affording a remarkable exemplification of the law of decrease of sedimentary matter in the westward extension of the palæozoic beds. These Hudson River shales are the equivalents of the "Blue Limestone" of Cincinnati (formerly thought to be Trenton), and the "Blue Shale" of Wisconsin. They appear to be principally exposed around Dubuque, or in a narrow band from the vicinity of Bellevue to somewhere about the head waters of the western branches of Turkey River; growing gradually thinner and thinner, until they finally die out. Another fact of no little geological interest, brought out by this survey, is the discovery of a magnesian limestone formation lying above the Niagara Limestone, and not previously recognised in the Mississippi valley. Professor Hall has named this the Leclaire Limestone, from its development around that locality. It occupies, apparently, a considerable area, having within its limits the main portion of the Wapsipinecon river; and it forms more especially by its undulations the so-called "Upper Rapids" of the Mississippi. Professor Hall shows that these Leclaire beds occupy the same geological horizon as the Galt limestone of Canada West, and he is inclined to look upon the two as geologically identical. If this, on further examination, prove to be the case, it will furnish an additional argument for the separation of the Galt beds from the Onondaga salt group with which at present they are conventionally placed.

In his very interesting sketch of the physical geography of Iowa, Mr. Whitney enters on a somewhat extended description of the causes to which the absence of arboreal vegetation on the prairie lands may be considered due. He attributes the principal cause of this, and apparently on conclusive grounds, to the peculiar and highly comminuted condition of the surface soil. "Taking into consideration all the circumstances under which the peculiar vegetation of the prairie occurs, we are disposed to consider (he remarks,) the nature of the soil as the prime cause of the absence of forests and the predominance of the grasses over this widely extended region. And although chemical composition may not be without influence in bringing about this result, which is a question worthy of careful examination, yet we conceive that the extreme fineness of the particles of which the prairie soil is composed, is probably the principal reason why it is better adapted to the growth of its peculiar vegetation, than to the development of forests. It cannot fail to strike the careful observer that where the prairie occupies the surface, the soil and superficial material have been so comminuted as to be almost in the state of an impalpable powder. This is due partly to the peculiar nature of the underlying rocks and the facility with which they undergo decomposition, and partly to the mechanical causes which have acted during and since the accumulation of the sedimentary matter forming the prairie soil. If we go to a thickly wooded region like that of the nothern peninsula of Michigan, and examine those portions of the surface that have not been invaded by the forest, it will be observed that the beds of ancient lakes which have been filled up by the slowest possible accumulation of detrital matter, and are now perfectly dry, remain as natural prairies, and are not trespassed on by the surrounding woods. We can imagine no other reason for this than the extreme fineness of the soil which occupies these basins, and which is the result of the slow and quiet mode in which they have been filled up...... Applying these facts to the case of the prairies of larger dimensions farther south, we infer, on what seems to be reasonable grounds, that the whole region now occupied by the prairies of the northwest was once an immense lake, in whose basin sediment of almost impalpable fineness gradually accumulated; and that this basin was drained by the elevation of the whole district, but at first so slowly, that the finer particles of the superficial deposits were not washed away, but allowed to remain where they were originally deposited. After the more elevated portions of the former basin had been laid bare, the drainage becoming concentrated in narrow channels, the current thus produced, aided perhaps by a more rapid rise of the region, acquired sufficient velocity to wear down through the finer material on the surface, wash away a portion of it altogether, and mix the rest so effectually with the underlying drift materials, or with abraded fragments of the rocks in place, as to give rise to a different character of soil in the valleys from that of the elevated land. This valley soil being much less homogeneous in its composition, and containing a larger proportion of coarse materials than that of the uplands, seems to have been adapted to forest vegetation; and, in consequence of this, we find such localities covered with an abundant growth of timber." Where the so-called "groves" occur upon higher levels of the prairies, there is always a partial acccumulation of drift and other coarse materials, in place of true prairie-sediment; and the same is observable, according to Mr. Whitney, wherever timber is found upon the bottom-prairies of the Mississippi and Missouri valleys south of Iowa.

In the concluding and principal portion of Mr. Whitney's Report, numerous analyses are given of the dolomites, limestones, coals, and other economic substances, of the State; and the great lead region is described with much detail. The lead ore lies essentially in the Galena limestone, in "gash" or shrinkage veins, and in caverns, openings, or pockets, all of which are cut off at comparatively small depths beneath the surface. The whole of this portion of the Report is drawn up in an exceedingly clear and able manner, and will well repay the perusal of those interested in mining operations.

We have already alluded to the beautifully executed plates, in illustration of the Palæontology of the survey, engraved under the superintendence of Professor Hall. The letter-press to these is exceedingly copious, and contains many additional diagrams illustrative of crinoid structures. Another advantageous feature, as compared with the descriptions in the published volumes of the Palæontology of New York, is the definition of the various genera, given in connection with the characters of their respective species. All the described forms, however, belong to the Devonian and Carboniferous formations: the Silurian fossils, met with during the survey, having been previously figured in Dr. Owen's Report on the geology of Wisconsin, and in other publications. A few plates of the more characteristic of these fossils would contribute nevertheless to the utility of the present work, without any very material addition to its cost; and we trust the legislature of Iowa will afford the means of effecting this, in the volume which is yet to appear. To the enlightened legislature of this far western State—a State added but yesterday, as it were, to the Union—too much credit cannot be accorded for these goodly and important volumes, so useful to agriculture and practical art, and so liberally presented to the scientific world.

E. J. C.

Outlines of Natural Theology for the use of the Canadian Student. By James Bovell, M.D., Professor of Natural Theology in Trinity College, Toronto, C. W. Toronto: Printed by Rowsell and Ellis, 1859.

The accomplished author of this work is well known to the readers of the *Canadian Journal*, as occupying a prominent position in the scientific ranks of Canada; whilst, in the special department of physiology, his reputation has extended beyond the Province. The work now before us, unlike the general character of Dr. Bovell's writings, is strictly a compilation from various sources, put together in accordance with the author's special views; but this is fairly stated by Dr. Bovell, and is indeed in keeping with the proposed object and plan of the book: a book not intended for the critical investigation of the scientific inquirer, to whom the facts brought forward in it must necessarily be familiar, but one offered to the student of Natural Theology, as a convenient and accessible text-book, in the prosecution of his studies. This being the general intention of the work, it has been thought advisable to elucidate the subjects discussed in its pages, by a considerable number of wood-engravings and some lithographed geological sections. Of the engravings, chiefly restorations of extinct reptilian and other types, some few, perhaps, might have been judiciously omitted; and, as the work is intended mainly for Canadian students, it would have been as well—so far as regards the older rock formations—to have substituted Canadian subdivisions for the local terms and groupings more or less peculiar to the British Isles. Subordinate matters of this kind, however, can easily be rectified in a future edition; and in alluding to them here, we do so, truly, in no hypercritical spirit.

Analytically considered, the subject matter of Dr. Bovell's work, as there discussed, involves two distinct principles: the proofs of a great First Cause or Creator, and the exposition of Divine goodness and wisdom as shewn in natural objects and phenomena; and secondly, the reconciliation of geological discoveries with the statements of the Mosaic Record. Under the first division of his subject, the author refutes, with great force and skill, many of the pantheistic and other prevalent doctrines of a cognate character, that have been put forth more or less openly of late years, not only in continental Europe, but by names of distinction also in British science. The passages in which these doctrines are thus discussed, will well repay the reader's perusal. We would willingly have quoted from them; but the necessary extracts—due regard being had to the continuity of the argument—would be too copious for our pages; and hence, in justice to the author, we must refer the reader to the work itself. It is in this part of his treatise more especially, that the varied knowledge, eloquence, and acumen of our author are brought fully into play. We do not think he is so happy in the more purely geological portion of his book. It is to some extent a matter of opinion, but we fear he will find few geologists at the present day willing to subscribe to his interpretation of the Mosaic Record as given in the pages before us. Following Buckland, more particularly, Dr. Bovell interprets the word DAY in its literal sense, and looks consequently on the narrative of Moses as taking up the history of the world's creation, not from the Beginning—beyond the mere allusion to a beginning in the first verse of Genesis—but from the commencement of the present, or, what we may call, the Human Epoch. No reference, it is assumed, is made in the sacred record to the earlier creations of the globe, but those types alone are spoken of, which immediately preceded man's advent upon the scene, and which formed the parent-stocks of the fauna and flora that now people the earth and its waters. So far, perhaps, so well. But the holy writings record distinctly the elaboration of the world, or (according to those who adopt Buckland's theory) its regeneration, from a void or chaotic condition: and have we in the later periods of geological history any proofs of the existence of such a state? Dr. Bovell replies in the affirmative, and points to the so-called "Glacial Epoch" which marks according to his view the close of the great Tertiary age. But this is the weak point in his argument. It is a position indeed, perfectly untenable. The Glacial epoch, far from marking the close of the Tertiary age, belongs rather to the present, or forms a complete period of passage between the two epochs. Between the Tertiary Age and the Glacial Period it is absolutely impossible to draw a strict line of demarcation; and still less are we able to draw one between the latter and the existing era. Many types, both animal and vegetable, have survived the glacial epoch; and (as so ably pointed out by Edward Forbes) it is evidently to the agency of this glacial period, as it came gradually on and gradually diminished in intensity, that the isolation of many arctic plant-colonies is due. That the Alpine plants of the Pyrennees and Scotland, for example, isolated from the surrounding vegetation, find their kindred species amongst the flora of northern Scandinavia,—that the Alpine plants of the United States are related specifically to the flora of Labrador—depends evidently, (unless we adopt the theory of centres of creation) on a southern migration of these forms during the gradual development of this period of cold, and on their subsequent destruction in intervening districts, as the glacial forces slowly dwindled back to within their present limits. It must not be forgotten, moreover, that the results of glacial disturbance, were apparently confined to northern and extreme southern latitudes, in place of being of universal manifestation. Within the tropics for example, our true Drift deposits—the accumulations of glacial agencies on submerged areas—are properly unknown. This fact alone, consequently, points to a very different condition of things from that indicated by the language of the sacred record. Nor can the comparatively modern uprise of large areas in South America and elsewhere, help to sustain our author's opinion ; because these elevated tracts are the results of forces really still in action, and afford nowhere the slightest indication of the former existence of one grand and vast convulsion affecting equally the whole globe.

We need not carry our analysis farther ; but it would be easy to shew that if we took the close of any geological period as our starting point—so far as it is possible to determine this—equal difficulties would beset the literal interpretation of the Mosaic *day*. But truly —and the fact becomes more and more apparent as work after work, like that now under notice, becomes added to our stock—human science as yet is all too unprepared to undertake the investigation of these grave and apparently impenetrable mysteries. Whilst thus compelled, however, to dissent from the views of our author, as expressed in this portion of his work, we may fairly add our testimony to the general value of the work itself. As a treatise of undoubted merit, and as a home product both of pen and press, it well deserves the attention of all interested in the progress of Canadian literature.

E. J. C.

BOOK RECEIVED :—*A Course of Practical Chemistry*. By Henry Croft, F.C.S., etc. Toronto : Maclear and Co, 1860.

Want of space compels us to postpone our notice of Professor Croft's useful Handbook of Analytical Chemistry, just published by Maclear and Co, until the next issue of the *Journal;* but, in the mean time, we may recommend it as being especially adapted to the requirements of our Medical and University students.

SCIENTIFIC AND LITERARY NOTES.

GEOLOGY AND MINERALOGY.

AGELACRINITES BILLINGSII. A NEW SPECIES.

PRELIMINARY NOTICE OF, BY E. J. CHAPMAN.

Mr. W. M. Roger, an undergraduate of the University of Toronto, and one of our most esteemed students, lately submitted to us a collection of fossils obtained by him from the Trenton Limestone of Peterboro', Canada West. Amongst these, we discovered an undescribed species of the rare and interesting genus, *Agelacrinites.* We propose shortly to publish a complete description, with a figure, of this new species; but beg, in the meantime, to bestow upon it the above specific name, after the distinguished palæontologist of our Geological Survey, who has contributed so pre-eminently to our knowledge of the peculiar group of forms to which the genus *Agelacrinites* belongs, or to which it is closely related. Our specimen presents a flat, circular form, exactly half-an-inch in diameter. It has five straight, or nearly straight, rays, composed of a double series of interlocking or alternating plates, and terminating in well defined rounded points, about one line from the margin of the shell or test. In the centre of the disc where the mouth is usually thought to be situated, there are five comparatively large and somewhat rhombic plates, the first ray-plates, one being common to each two adjacent rays. In the space between two of the rays, and at a distance of about two lines from the centre of the test, there is a well-marked "anal-pyramid" (or "ovarian aperture") surrounded, apparently, by ten plates: five being situated in alternate position within the other five, exactly as in Hall's *Hemicystites parasitica* (=*Agelacrinites parasiticus*). All the other portions of the inter-radial areas, with the margin of the test, are covered by *imbricating* or *partially-overlapping* and irregularly disposed plates of various sizes. At the margin there are about three or four rows of very small and exceedingly numerous plates, narrow and pointed, and succeeded by larger plates, of which the greatest diameter (unlike that of the marginal plates) lies parallel to the circumference. These are again succeeded by somewhat smaller and more pointed plates. *A. Billingsii* differs most obviously from *A. Dicksoni*, the only other Canadian species yet recognised (if we allow the *Edrioaster* of Billings to be a thoroughly distinct genus), by the possession of *straight* in place of *curved* rays, and by its exceedingly numerous marginal plates. It agrees much more nearly with the Niagara limestone species, *A. parasiticus* (Hall's *Hemicystites parasitica*); but from this it is distinguished essentially by the width of its rays (and by the ray-plates) being largest in the centre of the disc, and by the rays terminating in well-defined rounded points. In Hall's species, the rays are quite narrow and close together at the centre, and they broaden outwards, and, to use Professor Hall's language, "coalesce with the plates of the body;" or, in other words, are altogether undefined at their extremities. These characters are exactly the reverse of those which obtain in *A. Billingsii.* Besides which, in Hall's form there appears to be only a single row of small border-plates, but that is probably an uncertain character. The other distinctions, however, are amply sufficient to separate the two species. Finally, it should be mentioned, that, not wishing to add to the already too copious list of unnecessary synonyms, we have obtained the confirmatory opinion of Mr. Billings as to the distinctness of our species from his *A. Dicksoni*. When we wrote to Montreal, we did not think of the apparent resemblance of the new species to *A. parasiticus*, but we have no doubt Mr. Billings will agree with us also in placing the two apart. In the extended notice of our species, we propose to give a general analysis of the genus *Agelacrinites*, with a comparative view of its structural relations and affinities; as, on these points, we have some new suggestions to offer.

NEW FOSSILS FROM THE COAL MEASURES OF NOVA SCOTIA.

The following abstract is from a paper by Professor J. W. Dawson, L.L.D., of Montreal, read at a recent meeting (14th December, 1859) of the Geological Society of London:

On revisiting the South Joggins in the past summer, Dr. Dawson had the opportunity of examining the interior of another erect tree in the same bed which had afforded the fossil stump from which the remains of *Dendrerpeton Acadianum* and other terrestrial animals were obtained in 1851 by Sir C. Lyell and himself. This second trunk was pointed out to him by Mr. Boggs, the Superintendent of the Mine. It was about 15 inches in diameter, and was much more richly stored with animal remains than that previously met with. There were here numerous specimens of the land-shell found in the tree previously discovered in this bed,—several individuals of an articulated animal, probably a Myriapod,—portions of two skeletons of *Dendrerpeton*,—and seven small skeletons belonging to another Reptilian genus, and probably to three species.

The bottom of the trunk was floored with a thin layer of carbonized bark. On this was a bed of fragments of mineral charcoal (having Sigillaroid cell-structure), an inch thick, with a few Reptilian bones and a *Sternbergia* cast. Above this, the trunk was occupied, to a height of about 6 inches, with a hard black laminated material, consisting of fine sand and carbonized vegetable matter, cemented by carbonate of lime. In this occurred most of the animal remains, with coprolities, and with leaves of *Noeggerathia (Poacites)*, *Carpolithes*, and *Calamites*, also many small pieces of mineral charcoal showing the structures of *Lepidodendron*, *Stigmaria*, and the leaf-stalks of Ferns. The upper part of this carbonaceous mass alternated with fine grey sandstone, which filled the remainder of the trunk as far as seen. The author remarked that this tree, like other erect *Sigillariæ* in this section, became hollow by decay, after having been more or less buried in sediment: but that, unlike most others, it remained hollow for some time in the soil of a forest, receiving small quantities of earthy and vegetable matter, falling into it, or washed by rains. In this state it was probably a place of residence for the snails and myriapods and a trap and tomb for the reptiles; though the presence of coprolitic matter would seem to show that in some instances at least the latter could exist for a time in their underground prison. The occurrence of so many skeletons, with a hundred or more specimens of land snails and myriapods, in a cylinder only 15 inches in diameter proves that these creatures were by no means rare in the coal-forests; and the conditions of the tree with its air-breathing inhabitants imply that the Sigillarian forests were not so low and wet as we are apt to imagine.

The little land shell, specimens of which with the mouth entire have now occurred to the author, is named by him *Pupa vetusta.* Dr. Dawson has found entire shells of *Physa heterostropha* in the stomach of *Menobranchus lateralis* and hence he supposes that the *Pupa* may have been the food of the little reptiles the remains of which are associated with them.

Two examples of *Spirorbis carbonarius* also occurred; these may have been drifted into the hollow trunk whilst they were adherent to vegetable fragments, The Myriapod is named *Xylobius Sigillariæ,* and regarded as being allied to *Iulus.*

The reptilian bones, scutes, and teeth referable to *Dendrerpeton Acadianum* bear out the supposition of its Labyrinthodont affinities. Those of the new genus, *Hylonomus,* established by Dr. Dawson on the other reptilian remains, indicate a type remote from *Archegosaurus* and *Labyrinthodon,* but in many respects approaching the Lacertians. The three species determined by the author are named by him *H. Lyellii, H. aciedentatus,* and *H. Wymani.*

ON THE CLASSIFICATION OF METEORITES—BY THE BARON VON REICHENBACH.

The following distribution of Meteoric Stones and Iron Masses, in accordance with their physical characters, is condensed from a long and interesting paper (*Anornung und Eintheilung der Meteoriten : von Freihern von Reichenbach*) in a late number of *Poggendorff's Annalen.*

Section I. Iron-free Meteorites of low specific gravity and light color, with vitreous crust—

First Group—Meteorites from:
Langres, G=3.55.
Bishopsville, G=3.11.
Jonsal (Transition member to Second Group), G=308.

Second Group—Meteorites from:
Juvenas, G=3.11.
Stannern, G=3.07.
Constantinople, G=317.

Section II. Meteorites (almost iron-free) of a whitish or pale-blueish color in the mass, with disseminated pyrites; and, in general, a dull crest. Mostly cavernous, and more or less brittle:

First Group—Dark granules absent, or very sparingly scattered through the mass—

A. Whitish Meteorites from:

Macerata, G. —; Vouillé, G. 3.55; Nashville, G. 3.58; Bachmut, G. 3.42; Mauerkirchen, G. 3.45; Glasgow, G. 3.53; Kuleschofka, G. 3.49; Zaborzica, G. 3.40; Hartford, G. 3.58; Czartorya, G. —; Milena, G. —; Yorkshire, G. 3.61; Forsyth, G. 3.44; Politz, G. 3.37; Aumières, G. —; Chandacapur, G. —; Kikina, G. —; Oesel, G. —; Charkow, G. 3.49; Ekaterinoslaw, G. 3.77; Kakova; G. —; Garz, G. —; Apt, G. 3.48; Askoe, G. 3.66.

B. Blueish Meteorites from:

Slobodka, G. 3.47; Château-Renard, G. 354; Toulouse, G. 3.73; Girgenti, G. 3.76. Lissa, G. 3.50; Killeter, G. —; Oahu, G. 3.39; Cereseto, G. —; Favars, G.—

Second Group—Characterized by the presence of numerous enclosed globules, imparting to the mass a coarse-granular structure—

A. Transition-members to Group I. Meteorites from:

Sales, G. 4.47; Parma, G. 3.39.

B. Containing dark granules. Meteorites from:

Lucé, G. 3.47; Nanjemoy, G. 3.66; Clarac, G. 3.50; Benares, G. 3.36; Utrecht, G. 3.57; Little Piney (Mo., U.S.), G. —; La Baffe, G. 3.66; Timochin, G. 3 60; Divina, G. 3.55; Horzowitz, G. 3.60; Richmond, G. 3.47; Pultown, G. 3.33.

C. Containing dark and light granules intermixed. Meteorites from:

Siena, G. 3.39; Lontalax, G. 3.07; Nobleborough, G. 3.09; Bialystok, G. 3.17; Massing, G. 3.21.

Section III. The Meteorites of this Section present a grey colour, from finely disseminated magnetic iron ore (Fe 0, Fe $^{2}0^{3}$.)* They are more strongly coherent, and contain more iron, with less pyrites, than those of the preceding sections. Their specific gravity is also higher.

A. Light-grey Meteorites from:

Sigena, G. 3.63; Macao, G. 3.73; Charsonville, G. 3.71.

B. Meteorites of a somewhat darker grey colour, from:

Esnande, G. —; Berlanguillas, G. 3.49.

C. Meteorites of a blueish-white or grey colour, with numerous well-defined spots or flecks, from:

Liponas, G. 3.66; Gütersloh, G. 3.54; Weston, G. 3.53; Okaninah, G. —; Tipperary, G. 3.64; Limerick, G. 3.65; L'Aigle, G. 3.43; Seres, G. 3.71; Madaras, G. 3.50; Bremervörde, G. 3.53; Agen, G. 3.61; Doroninsk, G. 3.63.

D. Meteorites of a dark-grey colour, from:

Lixna, G. 3.66; Cabarras, G. 3.63; Grünneberg, G. 372; Heredia, G. —; Blausko, G. 3.70; Tabor, G. 3.65; Barbotan, G. 3.62; Wesseley, G. 3.70; Krasnoi-Ugol, G. 3.49; Kursk, G. 3.55; Tunga, G. —; Ohaba, G. 3.11; Borkut, G. 3.24.

Section IV. Meteorites of a green colour. From:

Ensisheim, G. 3.48; Simbirsk, G. 3.54; Wenden, G. 3.70; Erxleben, G. 3.64.

Section V. Dark-coloured brown or black Meteorites, containing carbonaceous matter. From:

Alais, G. 1.70; Capland, G. 2.69; Kaba, G. —; Renazzo, G. 3.26.

Section VI. Meteorites containing coarse brown patches not due to rust or oxidation. From:

Chantonnay, G. 3.47; Mainz, G. 3.44.

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* These magnetic iron grains may very probably contain a portion of the magnesia found in all the Meteorites of this Section. The verification of this idea, after Rammelsberg's discovery of magnesia in some of the Vesuvian iron ores, would be of no little interest.—E. J. C.

Section VII. The Meteorites of this Section occupy a middle place between the stone and the iron meteorites. They contain a considerable amount of metallic iron.

First Group—With intermixed Olivine of the finest colour. Mean specific gravity=5.0 (?) From:

Atacama, —; Siberia (the Pallas Meteorite), —; Saxony, —; Brahin, —; Bitburg, —.

Second Group—Mexican Meteorites, also containing Olivine, but with more metallic iron than the Meteorites of the first group. Mean specific gravity =6.5 (?) From:

Manji; Tejupilco; Xiquipilco; Bata; Ocatitlan; Istlahuacan.

Section VIII. Iron Meteorites exhibiting "Widmannstet's Figures." From:

Seeläsgen, G. 7.66; Bendego, G. 7.88; Bohumilitz, G. 7.65; Bruce, G. —; Union County, G. 7.07; Cosby, G. 7.26; Madoc, G. 7.85; Misteca, G. 7.38; Burlington, G. 7.72; Guildford, G. 7.67; Durango, G. 7.88; St. Rosa, G. 7.30$\frac{1}{3}$; Buff, G. 7.10; Seneca, G. 7.34; Carthago, G. —; Schwetz, G. 7.77; Texas, G. 7.82; Lockport, G. —; Red River, G. 7·82; Petropawlowsk, G. 7.76; Caille, G. 7.64; Lenarto, G. 7.73; Sevier, G. —; Elbogen, G. 7.74; Ashville G. 7.90; Agram, G. 7.82; Löwenfluss, G. —; Tazewell, G. 7.30; Charlotte, G. —; Putnam, G. 7.69.

Section IX. Iron Meteorites which do not exhibit the definite crystal markings of those belonging to the last Section—

First Group—Transition Meteorites to Section VIII. Crystal figures partially developed. Meteorites from:

Caryfort, G. —; Zacatecas, G. 7.55.

Second Group—Containing minute points and needles of white iron. From: The Cape of Good Hope, G. 7.50; Rasgata, G. 7·55; Salt River, G. 6.83; Kamtschatka, G. —.

Third Group—Containing iron in irregular masses. From:

Chester, G. —; Arva, G. 6·81; Caille, G. 7.64.

Fourth Group—Masses of Meteoric Iron, with subordinate markings in straight lines. From:

Tucuman, G. 7.56; Senegal, G. 7.72; Claiborne, G. 6.82.

Fifth Group—Entirely destitute of form-markings on the etched and polished surface. Meteorites from:

Tarapaca, G. 6.50; Green County, G. —; Hauptmannsdorf, G. 7.71; Smithland, G. —.

In addition to the paper from which the above classification is abridged, the Baron von Reichenbach has published in another number of Poggendorff's *Annalen*, an elaborate essay on the general composition of Meteoric masses. From this paper we extract the following tables—showing the mean composition, as calculated from various analyses, of stony and iron meteorites generally.

I.

Stone-Meteorites.

Iron	25.08	27.42
Nickel	1.54	
Cobalt	0.01	
Chromium	0.44	
Manganese	0.29	
Tin	0.03	
Copper	0.03	
Lime	1.56	64.48
Magnesia	18.53	
Alumina	2.35	
Silica	41.69	
Soda	0.30	
Potash	0.14	
Carbon	0.07	2.45
Phosphorus	0.01	
Sulphur	2.35	
Chlorine	0.02	
Oxygen and loss	5.56	
	100.00	

II.

Iron-Meteorites.

Iron	90.22	98 62
Nickel	7.49	
Cobalt	0.44	
Chromium	0.03	
Manganese	0.08	
Tin	0.08	
Lead	0.05	
Copper	0.03	
Magnesium	0.16	0.54
Aluminum	0.31	
Potassium	0.07	
Carbon	0.13	0.41
Phosphorus	0.05	
Sulphur	0.15	
Chlorine	0.08	
Loss	0.43	
	100.00	

E. J. C.

MATHEMATICS, NATURAL PHILOSOPHY, AND ASTRONOMY.

ON THE RESOLUTION OF ALGEBRAIC EQUATIONS.

While the remarkable researches of Professor G. P. Young are passing through the pages of this *Journal*, demonstrating the impossibility of solving algebraically the general equation of the fifth or higher order, a pamphlet has been published by the well-known analyst, Mr. Jerrard, in which he professes to demonstrate the *possibility* in the case of the general quintic. In reviewing this pamphlet, the editor of the *Philosophical Magazine* frankly confesses that he has not had courage to face the complicated analysis by which Mr. Jerrard attains his conclusion, and asserts his contentment with Abel's demonstration (as modified by Wantzel) of the contrary proposition. The validity of this demonstration has, however, been several times attacked, and, as we are not aware that it has ever been published in English, we here translate from Serret's *Cours d'Algèbre Supérieure* the demonstration in Wantzel's words, with an abstract of the preliminary propositions, from the same author, on which it is founded.

By a *circular permutation* of any letters it is implied that if the letters be arranged round a circle, each one is to be replaced by the one that precedes it in going round the circle. Thus, a, b, c, d, e, is circularly permuted into b, c, d, e, a.

By a *transposition* is meant an interchange of *two* letters only. It is readily shown that *every* permutation among a given set of letters can be represented by a set of simultaneous *circular* permutations; and that every *circular* permutation of (say) p letters is equivalent to $(p-1)$ successive transpositions. The following propositions are demonstrated by Cauchy:

Prop I.—*If a function of given letters remains unchanged by every circular permutation of p letters ($p>3$), it will also remain unchanged by any circular permutation of three letters.*

Prop. II.—*If a function of given letters can only acquire two distinct values by any permutations of its letters, it is changed by a single transposition; and, in general, it is or is not changed by a permutation, according as this permutation is equivalent to an odd or an even number of successive transpositions.* Hence in particular:

Prop. III.—*A function which has only two distinct values is not changed by circular permutations of three or of five letters.*

Serret proceeds (Lesson 21st), to examine the nature of algebraic functions. A function of any quantities, $a, b, c, \ldots$ is algebraic when it can be obtained by performing upon them any of the following operations any finite number of times: (1) addition or subtraction; (2) multiplication; (3) division; (4) extraction of roots with prime indices. These operations, of course, include involution to integral powers, and extraction of roots with indices not prime. A function involving only the operations (1), (2), is a *rational* and *integral* function of the quantities; involving (3) also, it is *rational;* involving all four, it is general. If, then, A, B, C, ... denote rational functions of $a, b, c, \ldots$; $p, q, r, \ldots$, prime numbers; f, the operation of forming any rational function: then

$$f(a, b, c, \ldots\ldots \sqrt[p]{A}, \sqrt[q]{B}, \sqrt[r]{C}, \ldots)$$

is called a function of the *first order.*

If $A_1, B_1, C_1, \ldots$ denote functions of the *first* order; $s, t, \ldots$ primes, then

$$f(a, b, c, \ldots \sqrt[p]{A}, \ldots \sqrt[s]{A_1}, \sqrt[t]{B_1}, \ldots)$$

is a function of the *second order.* And, generally, a function of the μ^{th} order will be of the form

$$f(h, k, l, \ldots \sqrt[p]{H}, \sqrt[q]{K}, \ldots)$$

where f always denotes a rational function; H, K, ... are functions of the order $\mu-1$; $p, q, \ldots$ are primes; $h, k, l, \ldots$ are functions of the $(\mu-1)$th or lower orders. From this form any radical, which can be expressed rationally in terms of the other radicals and quantities, can be eliminated; and ultimately it is shown that a function of the μ^{th} order can be thrown into the form

$$\alpha + p^{\frac{1}{n}} + \beta p^{\frac{2}{n}} + \ldots\ldots\ldots\ldots + \lambda p^{\frac{n-1}{n}}$$

where $\alpha, \beta, \ldots \lambda$ are functions of the order μ; n, a prime; p, a function of order $(\mu-1)$ whose n^{th} root cannot be expressed rationally in terms of $\alpha, \beta \ldots \lambda$.*

* Serret makes a further distinction among functions of the same order as being of different *degrees*, but his definition is strangely obscure, and this distinction does not appear to have any effect whatever on the subsequent reasoning. His use of the term *degree* is also inconsistent with the sense in which the word is employed in Wantzel's memoir.

If, now, the general value of the root x, of an equation $f(x) = 0$ of the mth degree, can be expressed in algebraic functions of the co-efficients, let the above form be assumed for it and be substituted in the equation. The result will be of the form

$$A + Bp^{\frac{1}{n}} + Cp^{\frac{2}{n}} + \ldots\ldots\ldots + Lp^{\frac{n-1}{n}} = 0.$$

where A, B, ... L, are rational functions of $p, \alpha, \beta, \ldots \lambda$; and it is shown that this requires

$$A = 0, B = 0, \ldots\ldots\ldots L = 0;$$

whence it follows that the above expression for x will still satisfy the equation when $p^{\frac{1}{n}}$ is replaced by $tp^{\frac{1}{n}}$, t being any nth root of unity. We thus obtain n quantities, which are roots of the proposed equation,* and it is thence easily proved that all the quantities $p^{\frac{1}{n}}, \alpha, \beta, \ldots \lambda$, are rational functions of the roots. By a similar investigation it follows that any other function which enters into any of the quantities $p^{\frac{1}{n}}, \alpha, \beta, \ldots \lambda$, put under the assumed general form, is also a rational function of the roots; and hence it is concluded generally that

Prop. IV.—*If an equation is algebraically resolvible, we can give to the root such a form that all the algebraic functions of which it is composed are rational functions of the roots of the equation.*

We now proceed to Abel's demonstration as modified by Wantzel, the inverted commas indicating, according to Serret, the text of Wantzel's memoir.

Let $f(x) = 0$ be an equation of the mth degree with arbitrary co-efficients, and let its m roots be denoted by $x_1, x_2, \ldots x_m$, and let us suppose them capable of being expressed as algebraic functions of the co-efficients.

"If the equation $f(x) = 0$, is satisfied by the value x_1, of x, whatever be the co-efficients, we ought to reproduce x_1, identically by substituting in its expression the rational function [of the roots] corresponding to each radical involved in that expression. Also, the roots being wholly arbitrary, every [apparent] relation between them must be in reality an identity, and will not cease to subsist when we exchange the roots one among the other in any way whatever."

"Let y denote the first radical, following the order of calculation [*i.e.*, a radica of the first order with index $\frac{1}{n}$, n prime] which enters into the value of x_1, and let $y^n = p$; then p depends directly on the co-efficients of $f(x) = 0$, and will be expressed by a symmetrical function of the roots $F(x_1, x_2, x_3, \ldots)$; y will be a rational function, $\phi(x_1, x_2, x_3, \ldots)$ also of the roots. (Prop. IV)."

"Since the function ϕ is not symmetrical, (for if it were, the nth root of p would be exactly extracted), it ought to change when two of the roots, x_1, x_2, for instance, are permuted; but the relation $\phi^n = F$ will always be satisfied. Then

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* Serret remarks that all these roots are different, but his proof of this is curiously erroneous; still it is otherwise easy to see that such must be the case. He adds, however "Au surplus, cette remarque n'est pas indispensable pour ce qui va suivre."

the function F being unchanged by this permutation, and the values of ϕ being the roots of $y^n = F$, we have

$$\phi(x_2, x_1, x_3, \ldots\ldots) = \alpha\,\phi(x_1, x_2, x_3, \ldots\ldots)$$

α being a [definite] nth root of unity."

"If we now interchange x_1, x_2, the above becomes

$$\phi(x_1, x_2, x_3, \ldots\ldots) = \alpha\,\phi(x_2, x_1, x_3, \ldots\ldots),^*$$

whence, by multiplying in order, we have $\alpha^2 = 1$. This result proves that the number n, supposed prime, is necessarily 2, so that *the first radical which presents itself in the value of the unknown must be of the second degree.* This is what, in fact, happens in those equations which we know how to resolve."

The function ϕ having only two values, changes by any *transposition* whatever, and will not be changed by a circular permutation of three or five letters, for such permutations are equivalent to an even number of transpositions. (Prop. II., III). Let us continue the series of operations indicated to form the value x_1 of x.

"Combining the first radical with the coefficients of $f(x) = 0$, (or the function ϕ with symmetrical functions of the roots) by means of the first operations of algebra, we obtain thus a function of the roots, susceptible only of two values, and, consequently, invariable for circular permutations of three letters. (Prop. III.) The succeeding radicals may furnish more functions of the same kind if of the second degree. Suppose that we have come to a radical, for which the equivalent rational function is not invariable for these permutations. Denoting it by $y = \phi(x_1, x_2, x_3, \ldots.)$ then in the equation $y^n = p$, we shall still have $p = F(x_1, x_2, x_3, \ldots.)$ but this function will no longer be symmetrical, but only invariable for circular permutations of three letters. If in ϕ we replace x_1, x_2, x_3, by x_2, x_3, x_1, the relation $\phi^n = F$ will still subsist; and, since F does not change by the substitution, we shall have

$$\phi(x_2, x_3, x_1, x_4, \ldots.) = \alpha\,\phi(x_1, x_2, x_3, x_4, \ldots.).$$

α being a [definite] nth root of unity."

"Performing in this equation, once and again, the circular substitution x_2, x_3, x_1, we have

$$\phi(x_3, x_1, x_2, x_4, \ldots.) = \alpha\,\phi(x_2, x_3, x_1, x_4, \ldots.)$$
$$\phi(x_1, x_2, x_3, x_4, \ldots.) = \alpha\,\phi(x_3, x_1, x_2, x_4, \ldots.)$$

and, multiplying the three equations, we obtain $\alpha^3 = 1$. Thus n is 3."

"If the number of the quantities $x_1, x_2, x_3, x_4, \ldots.$ is greater than 4, or if the equation $f(x) = 0$ is of a higher degree than the fourth, we can perform

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* Mr. Cockle (*Phil. Mag.* 1859, p. 510), remarks that this step "tacitly assumes the whole question, viz., that the surd is a quadratic. The only legitimate inference from $\phi(x_2, x_1, \ldots.) = \alpha\,\phi(x_1, x_2, \ldots.)$ is $\phi(x_1, x_2, \ldots.) = \alpha^{-1}\,\phi(x_2, x_1, \ldots.)$ where α^{-1} is the inverse of α," Mr. Cockle appears to us to have misconceived Wantzel's reasoning which recalls that "every relation among the roots must be an identity," and we are therefore entitled to permute the roots in any way in such a relation as the one above. Mr. Cockle further alludes to some objection brought by Sir W. R. Hamilton, against the validity of Abel's proof, that every radical is a rational function of the roots. We have not been able to discover where Sir W. R. Hamilton's strictures are to be found, and certainly can detect no flaw in the demonstration of the above in Serret's work.

in ϕ a circular substitution of five letters, replacing x_1, x_2, x_3, x_4, x_5, by x_2, x_3, x_4, x_5, x_1. The function F will not change, and we shall have

$$\phi(x_2, x_3, x_4, x_5, x_1, \dots) = \alpha\,\phi(x_1, x_2, x_3, x_4, x_5, \dots)$$

and, repeating the same substitution,

$$\phi(x_3, x_4, x_5, x_1, x_2, \dots) = \alpha\,\phi(x_2, x_3, x_4, x_5, x_1, \dots),$$

with three other equations similarly formed. Multiplying these together, we have $\alpha^5 = 1$, and this requires $\alpha = 1$, for α is a third root of unity. Thus the function ϕ is invariable for circular permutations of 5 letters," and, consequently, also of 3. (Prop. 1.)

"Thus, *all the radicals involved in the root of a general equation of a higher degree than the fourth, must be equal to rational functions of the roots, which remain invariable for circular permutations of three roots.* Substituting these functions in the expression for x_1, we arrive at an equality of the form $x_1 = \psi(x_1, x_2, x_3, x_4, x_5, \dots)$ which ought to be an identity; but this is impossible, for the right-hand member remains invariable when we replace x_1, x_2, x_3 by x_2, x_3, x_1, while the left-hand member evidently changes. It is then impossible to resolve by radicals a general equation of the fifth or any higher degree."

"The preceding demonstration shows at the same time that in equations of the third and fourth degrees, the first radical in the order of operations ought to be a square-root, and the second a cube-root. These circumstances, in fact, present themselves in the known formulas for these equations." J. B. C.

THE NEW PLANET.

M. Le Verrier enjoys the happy peculiarity that his brilliant theoretical discoveries are verified at once, and with the most complete and unexpected facility. His audacious announcement of the place of a planet beyond Uranus, led to the discovery of Neptune on the very evening of its reception at Berlin, and now his still more wonderful announcement of a planet interior to Mercury turns out to have been capable of verification before it was made. The following extract from *Galignani*, in default of more detailed accounts, will give some idea of this most brilliant achievement, which has at length shot Le Verrier far in advance of his rival Mr. Adams, who divided with him the honor of Neptune's discovery.

"Our readers must recollect M. Le Verrier's surprising communication to the Academy of Sciences on the 12th of September last, in which he announced a certain error in the secular motion of the perihelion of Mercury, which could not be otherwise explained, than by supposing another planet to exist between Mercury and the Sun. It would now seem that M. Le Verrier, to whom the world owes the unprecedented prediction of the existence of the planet Neptune, has had the no less unexampled good-fortune, richly due to his scientific attainments and unceasing energy, of seeing his second prediction also verified. The *intra-Mercurial planet has been found.* Such is the astounding intelligence announced to the Academy by M. Le Verrier himself, and, not only has it been found, but it was so several months before M. Le Verrier discovered its existence by calculation; and stranger still, the finder is not an Astronomer, but a physician, Dr. Lescarbault by name, living at Orgeres (Eure et Loir.) The facts are simply these: on the 26th March last, the sky was overcast in many parts of France, but the Sun shone bright on the plateau of Orgeres. Dr. Lescarbault, happening at the time to have a little leisure, took an observation of the Sun through his telescope, and saw to his surprise a small round black spot pass over the Sun's disk. He carefully noted down the time, and afterwards calculated that the chord described by the planet subtended an arc of about 9 m. 13s. M. Le Verrier having published the result of his calculations in September last, the Doctor wrote to him to acquaint him with the above fact. This was sufficient reason for M. Le Verrier to set out for Orgeres. Here he learned that Dr. Lescarbault was a man of great learning and universally respected, and that he had but one fault—that of troubling himself too much about the stars. On arriving at Dr. Lescarbault's abode, M. Le Verrier was astonished to find a regular Observatory there, with instruments chiefly contrived by the Doctor himself, in consequence of his very limited financial means The worthy physician not having a chronometer has nevertheless made himself a pendulum striking seconds, by means of an ivory ball and a bit of string. M. Le Verrier asked him many questions on his observations—and his manner of acquiring the data relating to the new planet, and received the most satisfactory answers. According to M. Le Verrier's calculations, the chord described by the planet must have subtended an arc of 9 m. 17 s. So that the Doctor with his clumsy apparatus was only 4 s. wrong. The Doctor estimates the diameter of the new planet at 310 leagues, and the inclination of its orbit to the ecliptic at 12 degrees. If such are its dimensions, it is likely that there are more planets still in that region. The revolution round the Sun is performed in 19 days and 17 hours; in its greatest elongations, its distance from the Sun does not exceed 7 degrees, while Mercury's maximum elongation is 25 degrees. It was lucky that M. Le Verrier had resolved upon going in person; for, the Doctor's observatory being strangely deficient in paper, his calculations were generally written in charcoal on a deal-board, and when it was full, the Doctor used to plane it down by way of cleaning it. This precious deal-board, charged with all the calculations relating to the planet, has been obtained by M. Le Verrier, and presented to the Academy."

The preceding will make a capital page in the Romance of Science. Mr. Scott, the Chamberlain of the City of London, writes to the *Times*, claiming that he also saw this (or another) planet about Midsummer, 1847, crossing the sun's disk at sunset, seeming, by a hasty calculation, to be of the same size as Venus, or about 4,000 miles in diameter. No transit of Venus or Mercury occurred at the time; and Mr. Scott thinks he could not have mistaken a spot of the sun, as the image was "perfectly circular, and its outline was as sharply defined as a blot of the darkest ink on the whitest of paper," and, moreover, it had disappeared at sunrise; whereas, had it been a spot, its position would have required six or seven days before it would have been carried out of sight. Mr. Scott communicated his observation to several persons, but had not sufficient confidence to publish so startling a fact. Dr. Dick, however, on becoming aware of it, referred him to a passage in one of his works, where, with the doctor's well-known facility of conjecture, he had speculated on the possibility of the existence of such planets, and asserts roundly that such an object was actually seen " by Mr. Lloft and others, on the 6th of January, 1818," but who Mr. Lloft—and who the others were—seems not to be known to the present generation of astronomers. Mr. Scott is also of opinion that his planet cannot be Doctor Lescarbault's, on account of the difference in size. Another correspondent of the *Times* writes, that a conjunction of Lescarbault's planet, must have occurred at the dates of both Mr. Lloft's and Mr. Scott's observations, but Mr. Hind comes to the conclusion, that at neither of them could this planet have been visible. Transits this year may be expected between the 25th March and 10th April, and between 28th September and 13th October; each transit not exceeding four hours and a half in duration. It is to be hoped that astronomers will catch the wanderer at one of these periods. Meanwhile it will be curious to ascertain whether this planet, or one of its group may not explain the puzzling observations by Cassini and others, of a supposed satellite of Venus. J. B. C.

CANADIAN INSTITUTE.

SESSION—1859-60.

FIRST ORDINARY MEETING—*3rd December*, 1859.

Hon. G. W. ALLAN, M.L.C., President, in the Chair.

I. *The Report of the Council relative to the change of name of the Institute was read and laid on the Table.*

(Copy.)

Final Report of Committee on proposed change of name and new charter.

To the Council of the Canadian Institute,—Your Committee beg to report that, in furtherance of the directions remitted to them relative to the proposed change of name of the Institution and the suggested application for a Royal Charter with extended powers—

They obtained an interview with His Excellency, who was pleased to express his willingness to exercise his full official influence for the accomplishment of the wishes of the Institute.

At the same time His Excellency expressed some doubt as to the expediency of conferring the exclusive right to such a name as *The Royal Society of Canada*, on an Institution having its head quarters permanently established in Upper Canada; and reserved his final decision on that point."

From the information, however, which your committee received, as to the probable cost of a Royal Charter, added to the difficulties suggested in reference to the proposed designation of the Institute, they recommend that the Council delay for the present taking any steps for procuring such new charter. At the same time your committee feel bound to represent to the Council that their conviction of the injuries to be apprehended from the confusion of the Canadian Institute with Mechanics' Institutes and other societies of a merely local character, consequent on the correspondence in name, is in no degree abated. In the debates in the Legislative Assembly during the past Session, which led to the withdrawal of many of the annual grants heretofore made to Mechanics' Institutes, the majority of the speeches referred to the Canadian Institute under the belief that it was the local Institute of Toronto: corresponding in all ways, and especially in respect to its claims for the continuance of its annual grant, to the ordinary Mechanics Institutes of the province.

It is for the Council to consider whether a change of name would suffice to prevent such confusion in future; or what other means is best calculated to give the requsite prominence to the esentially provincial character of the Institute, and to secure for it the continuation of those funds which have been expended by it on objects of a purely public and Provincial character; and in no degree for the promotion of individual or local interests, these being amply provided for by the annual income derived from members' subscriptions.

Should the Council on further consideration, revert to a change of name for the Canadian Institute, as the means best calculated to ward off the dangers arising from confusion with mechanics' and other local Institutes, your committee have reason to believe that a new provincial charter with such changes of name and constitution, as, after mature deliberation, should seem most expedient, will be readily accorded to the Institute by His Excellency.

All of which is respectfully reported,

(Signed,) G. W. ALLAN,

Canadian Institute, Nov. 29th, 1859. *Convener.*

II. The following gentlemen, who were proposed at the last meeting of the Institute for membership, and those elected previously by the Council during the recess, were balloted for and declared duly elected members:

William Ince, Esq., Toronto.
A. E. Williamson, Esq., Toronto.
W. C. Campbell, Esq., Toronto.
J. A. Cattanach, Esq., Toronto.
W. Tassie, Esq., Galt.
G. H. Wilson, Esq., Toronto.

III. *The following papers were read.*

1. By the Rev. J. McCaul, LL.D:
"On Ancient Shields."
2 By Professor Chapman:
"On Canadian Minerals."

SECOND ORDINARY MEETING—10*th December*, 1859.

Hon. G. W. ALLAN, M.L.C., President, in the Chair.

I. *The following gentlemen were elected members:*

John Paterson, Esq., Toronto.
Herbert F. Tuck, Esq., Toronto.

II. *The following donation for the Library was announced, and the thanks of the Institute voted to the donor.*

From T. C. Wallbridge, Esq.

The Poetical Works of James Haskins, A.B., M.B., Trinity College, Dublin. Ed. by Henry Baldwin, A.M., Osgoode Hall, U.C., Barrister at Law. One Vol.

III. *The following paper was read.*

By Doctor Rae.

"On the Search for Franklin."

IV. The requisite nominations for the election of office-bearers for the ensuing year, were made; and the President announced the annual general meeting to be held on the 17th inst., to receive the Report of the Council, to elect office-bearers and members of Council for the ensuing year, and for other business.

ANNUAL GENERAL MEETING—17*th December*, 1859.

Hon. G. W. ALLAN, M.L.C., President, in the Chair.

I. *The following gentlemen were elected members:*

Doctor James Ross, Toronto.
Doctor John Wanless, Toronto.
W. T. Thomas, Esq., Toronto.
Doctor—Lizars, Toronto.
Rev. A. Wickson, M.A., Toronto.
Rev. E. Hatch, B.A., Toronto.
Doctor H. H. Wright, Toronto.

II. A ballot having been taken for officers of the Institute, for the ensuing year, the following gentlemen were declared duly elected, viz:

President	Professor D. Wilson, LL.D.
1st Vice President........	Professor H. Croft, D.C.L.
2nd do	Rev. Professor W. Hincks, F.L.S.
3rd do	Professor J. Bovell, M.D.
Treasurer................	D. Crawford, Esq.
Corresponding Secretary ...	Professor J. B. Cherriman, M.A.
Recording do ...	Patrick Freeland, Esq.
Librarian................	Professor H. Y. Hind, M.A.
Curator	J. F. Smith, Jun., Esq.
Council..................	Hon. G. W. Allan, M.L.C.
	Professor E. J. Chapman.
	Sandford Fleming, Esq.
	W. Hay, Esq.
	G. R. R. Cockburn, M.A.

III. The report of the Council for the year 1858–59, was then read and adopted on motion of Professor Hind, seconded by Doctor Morris.

IV. The President brought before the Meeting a recommendation from the Council that the Institute should note its sense of the valuable and zealous services rendered by Doctor Wilson as chief Editor of the Canadian Journal, by a mark of recognition similar to that made two years ago.

It was then moved by G. A. Pyper, Esq., seconded by Captain Dick.

That the Council be empowered to carry into effect the recommendation made by them through the President to the Institute, in reference to some recognition of the valuable services of Doctor Wilson as Editor of the Journal. Carried.

V. *The following paper was read.*

By Professor Chapman:

"On the Geology of Belleville and surrounding district."

VI. Moved by S. Fleming, Esq., seconded by G. A. Pyper, Esq., that the President do now leave the chair and that Prof. Hincks be called thereto. Carried.

VII. Moved by P. Freeland, Esq., seconded by S. Spreull, Esq., that the cordial thanks of the Institute be given to the Hon. G. W. Allan for his valuable services during the past year as President of the Institute. Carried.

ANNUAL REPORT OF THE COUNCIL FOR 1859.

The Council of the Canadian Institute, at the expiration of their term of office, have the honor to lay before the Members, the usual yearly report of the proceedings and progress of the Society. Since the last annual report, 35 new names have been added to the list of Members; but the *total* number constituting the Society, has undergone a considerable reduction, as will appear by the following statement:

Members at commencement of Session 1858–59		650
New Members elected, Session 1858–59		30
By Council, during recess		3
Total		683
Deduct—Deaths	8	
Left the Province	11	
Withdrawn	34	
Struck off for non-payment of Subscription, per Committee's report	129	
Athenæum Members, who have never paid their subscriptions since the amalgamation of the societies	34	
		216
Total on 30th November, 1859		467
Composed of—Honorary Members		4
Life Members		36
Corresponding Members		5
Members		410
Junior Members		12
Total		467

This decrease in the total number of Members, compared with last year has been occasioned, (irrespective of losses by death or removal), by striking off the names of a large number from the roll, who have persisted, for an unreasonable length of time, in ignoring the Treasurer's claims upon them, and neither paid their subscriptions nor sent in their resignations.

The necessity for removing from the roll these merely nominal members, most of whom had been defaulters for several successive years, had long been strongly felt by the Council; and before the close of the last Session, a Special Committee was appointed to revise the list, with a view to striking off those who appeared, from the Treasurer's returns, to be hopeless defaulters. This necessary, but unwelcome duty, has been very carefully and considerately performed, and none but those who have proved themselves so long unmindful of the claims of the Society as to leave no hope of their amendment, have had their names removed from the roll.

In reality, therefore, this *temporary* decrease in the numerical strength of the Institute, has neither diminished its pecuniary resources as compared with past years, nor should it be considered as any indication of decreasing interest in the Society's operations, or of less hearty co-operation or support on the part of its friends generally, as the Members now cut off have long been such only in name, and were rather a source of weakness than of strength.

Since the last Session, a blank has occurred in the list of Honorary Members, by the death of one whose name conferred honor on the Society, and whose memory will long be perpetuated in Canada, by the enduring memorial of one of the noblest productions of his genius. But a few short weeks before the completion of the Victoria Bridge, at Montreal, Robert Stephenson closed his earthly career. Struck down at the age of fifty-one, while in the full maturity of his great and vigorous intellect, he has passed away—if not full of years, yet full of honors—leaving behind him a name which will long survive, not only in the grateful memory of his countrymen, but which will be cherished and honored in every part of the world, where exalted genius and practical energy and worth, are honored and appreciated.

Just six years ago, when this Society was still in its infancy, Mr. Stephenson, then on a visit to this country, honored the Institute by allowing his name to be enrolled on the list of Honorary Members; and in answer to the address which was presented to him on that occasion by the Council, he expressed his strong sense of the benefits which might accrue to the cause of science in this country through the instrumentality of such associations as the Canadian Institute—not only by the publication of its *Journal* and the communications read at its meetings, but more especially by discussions on the subjects of the various papers brought under the consideration of the Society.

The Council would fain hope that this expression of opinion on the part of one whose experience so well qualified him to judge, may not be forgotten, but have its due weight with every Member of the Association, inducing more active and zealous co-operation in furthering the objects of the Institute, and rendering it a powerful and efficient agent in advancing the scientific progress of the country.

In one very important particular,—the extension of its Library,—the Institute has continued to make satisfactory progress, and the Council have pleasure in reporting, that many valuable additions have been made to it during the past year, chiefly through the liberality of various donors, to several of whom the Institute has before been very largely indebted.

The following is a list of the various books added to the Library, by purchase or otherwise, during the year:

BOOKS PURCHASED.

Books marked thus (*) are in parts, or unbound.

	VOLS.
Crania Britannica. Decade III	1*
Rawlinson's Herodotus. Vols. 2 and 3	2
Canadian Almanac for 1859	1*
Dietrichsen and Hannay's Royal Almanac for 1859	2*
Encyclopædia Britannica. 8th edition. Vols 17 and 18	2
Wanderings of an Artist among the Indians of North America. By Paul Kane	1
Miller's Popular Geology	1
Substance of a Journal during a residence at the Red River Colony, British North America, from 1820—23. 2nd edition, enlarged	1
Chronological History of North Eastern Voyages of Discovery, and of the Eastern Navigations of the Russians. By Capt. J. Burney, F.R.S	1
Cavendish, Debates on the Quebec Bill, 1774	1
Bopp's Comparative Grammar. Vols. 1, 2 and 3	3
Total	14

BOOKS BOUND FROM PERIODICALS RECEIVED.

Illustrated London News, July to December, 1858	1
Mining Journal, 1858	1
Builder, 1858	1
Journal of the Society of Arts. Vols, 3 and 6	2
Athenæum, July to December, 1858	1
Artizan, 1858	1
Canadian Merchants' Magazine, 1858	2
Journal of the Franklin Institute, 1858	2
Civil Engineers and Architects Journal, 1858	1
Journal of Education, Upper Canada, 1858	1
Journal de l'Instruction Publique, 1858	1
Art Journal, 1858	1

DONATIONS OF BOOKS TO THE LIBRARY.

From Office of Routine and Records.

Appendix to Vol. 16 of the Journal of Legislative Assembly, 1858. 1–2, No. 1; 2 to 4, No. 2; 3–4–5–13, No. 3; 13 to 20, No. 5; 20 to 29, No. 6; 29 to 43, No. 7; 29–43, No. 8; 43–65, No. 9	7
Appendix to Vol. 17 of the Journals of the Legislature, 1859. 1–5, No. 1; 5–9, No. 2; 9–36, No. 3	3
Trade and Navigation Reports, 1858	1
Journals Legislative Assembly. Vol. 17, 1859	1*
Report of Progress Geological Survey of Canada, 1857	1

From Hon. J. R. Brodhead, *Washington.* VOLS.

Patent Office Reports, U. S., 1857:—Agriculture, 1 Vol.; Mechanics, 3 Vols 4
Smithsonian Report, 1857.. 1
Explorations and Survey for a Railroad route from the Mississippi River to the Pacific Ocean, 1853-56. Vols. 8 and 9........................ 2

From the United States Patent Office, *Washington.*

Patent Office Reports, 1856:—Agriculture, Vol. 1; Mechanics, Vols. 1, 2, 3.. 4
Do 1857 Do Vol. 1; Do Vols. 1, 2, 3.. 4

From the Regents *of the University, Ex-Officio Trustees of the State Library in behalf of the State of New York.*

Documents relative to the Colonial History of the State of New York, procured in Holland, England, and France. By John Romeyn Brodhead, Esq. Vol. 2 1
Catalogue of the Books on Bibliography, Topography, and Engraving, in the New York State Library, 1858 1
Annual Report of the Trustees of the New York State Library made to the Legislature, February, 1858.. 1
Seventy-first Annual Report of the Regents of the University of the State of New York, made to the Legislature, January 28th, 1858.................. 1*
Eleventh Annual Report of the Regents of the University of the State of New York on the condition of the State Cabinet of Natural History, and the Historical and Antiquarian Collection, 16th March, 1858 .... 1*

From Col. J. H. Lefroy, Rl. Artillery, F.R.S., &c., *London.*

Mortality of the British Army, at home and abroad, and during the Russian War, as compared with the mortality of the Civil Population in England. Illustrated by Tables and Diagrams from Report of the Royal Commission, 1858 .... 1*
Contribution to the Sanitary History of the British Army during the late war with Russia, &c., 1859 1
Geology of North America. By Jules Marcou. With three Geological Maps and seven plates of Fossils, 1858.. 1
Ordnance Trigonometrical Survey of Great Britain and Ireland. Published by order of the Master General and Board of Ordnance, 1858............ 1
Account of the Principal Triangulation Plates. Ordnance Survey 1
Military sketch of the Island of St. Helena. By Capt. E. Palmer, Royal Artillery, F.R.G.S. 1850-52. Lit'd. at the Top. Department of the War Office. Col. James, R.E., F.R.S., M.R.I.A., &c., Director..............M.1

From Henry J. Bohn, Esq., *York Street, Covent Garden, London.*

Diary and Correspondence of Samuel Pepys, F.R.S., Secretary to the Admiralty in the reigns of Charles II. and James II, &c. &c. By Lord Braybrooke. 6th Edit. Vols. 1, 2, 3, 4.. 4
The Pretenders and their adherents. By John Henage Jesse. New Edition. Complete in one volume, &c. 1

	VOLS.
Life and Letters of John Locke, with extracts from his Journal and Common place Books. By Lord King. New Edit., with a general Index	1
Letters on the History of Christian Dogmas. By Dr. Augustus Neander. Edited by Dr. J. L. Jacobi. Translated from the German by J. E. Ryland, M.A. In two Vols. Vol. 1 and 2	2
General History of the Christian Religion and Church. Translated from the German of Dr. Augustus Neander by J. Torrey, &c. Part 1, Vol. 9. Part 2, Vol. 9	2
Bibliographers' Manual of English Literature, &c. By W. T. Lowndes. New Edition, Revised, corrected, and enlarged, by H. G. Bohn. Vol. 1, Part 2, Vol. 2, Part 1	2
The Orlando Furioso. Translated into English verse from the Italian of Ludovico Ariosto. With Notes by Will. Stewart Rose. Vols I. and II.	2
Holbein's Dance of Death. Exhibited in elegant Engravings on Wood, &c. By Francis Douce, Esq., F.A.S. Also Holbein's Bible Cuts, &c. Introduction by Thos. F. Dibdin	1
Parables of Frederic Adolphus Krummacher. Translated from the German. 7th Ed., &c.	1
A Book for a Corner, &c. By Leigh Hunt. Two vols. in one	1
Noble Deeds of Women, or Examples of Female Courage and Virtue. By Elizabeth Starling	1
Pope's Poetical Works. Vol. II. By R. Carruthers	1
Elements of Botany. By M. Adrien de Jussieu. Translated with considerable additions by James Hewetson Wilson, F.L.S., &c. &c. &c............	1
Humbolt's Cosmos. Vol. V.	1
Medals of Creation, or First Lessons in Geology. By Gideon Algernon Mantel, L.L.D., &c., in two volumes Vols. I and II..................	2
Vegetable Physiology and Systematic Botany. By W. B. Carpenter, M.D., &c. Edited by Edwin Lankester, M.D., &c.	1
Anecdotes of Dogs. By Ed. Jesse, Esq	1

From Prof. James Hall, *Albany, New York.*

Report on the Geological Survey of Iowa. Vol. 1. Parts 1 and 2.	2

From Educational Department *of Lower Canada.*

Rapport du Surintendant de l'Education dans le Bas-Canada pour l'année 1857. French....................................	1*
Do do do do English ...	1*
Rapport du Surintendant de l'Education dans le Bas-Canada pour l'année 1858	1*

From R. S. M. Bouchette, Esq.

British Dominions in North America, or a Topographical and Statistical Description of the Provinces of Upper and Lower Canada, &c. &c. By Jos. Bouchette, Esq., Surveyor General of Lower Canada, &c. &c. London, 1832. Vols. 1 and 2	2
Bouchette's Topographical Dictionary of Lower Canada. London, 1832......	1

From E. B. O'Callaghan, LL D., *Albany, United States Patent Office. Reports for* 1857.

	vols.
Agriculture	1
Mechanics. Vol. II.	1

From Royal Dublin Society.

Journal of the Society. Vol. I., 1856-7	1

From Smithsonian Society, *Washington.*

Smithsonian Contributions to Knowledge. Vol. X.	1

From T. D. Harrington, Esq.

Teneriffe, an Astronomer's Experiments, or Specialities of a Residence above the Clouds. By C. Piazzi Smith, &c.	1

From Historical Society of Pennsylvania.

Publications of the Society. Contributions to American History. Memoirs. Vol. VI.	1

From Hon. East India Company.

Geological Survey of India, Geological Museum. Vol. I. Part 2. Published by order of the Right Hon. the Governor in Council	1

From United States Coast Survey Office, *Washington, with compliments of* Prof. A. D. Bache.

Report of the Superintendent of United States Coast Survey for 1856 & 1857	2

DONATION OF PAMPHLETS.

From Prof. G. Lawson, *Kingston.*

Transactions of the Scottish Arboricultural Society. Vol. I, Parts 1, 2, 3......	3*
Remarks on Lepas Anatifera, Linn	1*
On the occurrence of Cinchonaceous glands in Galiaceæ, &c.	1*
On the structure of the Victoria Regia	1*
Report on Musci and Desmideæ, &c.	1*
Papers read to Botanical Society of Edinburgh..	2*
Bemerkungen von Gilbert J. French	1*

From Prof. Kendall, M.A. *T. College.*

Theory and Experiment, a lecture delivered before the Board of Arts and Manufactures for Lower Canada, 20th December, 1858	1*
Defence of Dr. Gould, by the Scientific Council of the Dudley Observatory..	1*

From Bernard Quaritch, *London, England.*

Catalogue Raisonné of rare, valuable and curious books,			January,	1859......	1*
Do	do	do	February,	do	1*
Do	do	do	April,	do	1*
Do	do	do	May,	do	1*
Do	do	do	June,	do	1*
Do	do	do	July,	do	1*
Do	do	do	August,	do	1*
Do	do	do	Sept.	do	1*
Do	do	do	October,	do	

From Universitas Regia Fredericana, Christiania.	VOLS.
Physikalske Meddelelser Ved A-Arndsten, 1858	1*
Asaf-den Helliges Saga, Universitets Program for Andet Semester, 1853	1*
Oord lak Boltsebog, Jl 1832–1849	1*
Morphologie Végetale, J. M. Norman, 1857	
Sur les Phenoménes d'érosion	1*
Inversio Vesicæ Urinariæ, L. Voss	1*
Aubert Lateinischen Grammatik, 1856	1*
Zulu-Sproget Grammatik, 1850	1*
Symbolæ ad Historiam Antiquiorem Rerum Norvegicarum, P. A. Munch, His. Prof.	1*
Graptolitherne	1*
Forhandlinger ved de Skandinaviske Naturforskeres Syvende möde 1, Christiania Den 12–18, Juli, 1856	1*
Statistiske Tabeller for Kongerigct Norge, 1857	2*
Udtog of Norges-Riges Historie. Christiania, 1834	1*

From Office of Routine and Records.

Report of the Postmaster General for year ending 30th September, 1858	1*
Report of the Crown Land Department, for the year 1858	1*
Public Accounts,—Province of Canada, year 1858	1*
Summary of Proceedings, Legislative Assembly, 2nd Session, 6th Parliament, 1859	1*
Report of Committee on Banking and Currency	1*
Third Report on Public Accounts	1*
And Sheets, Proceedings of Legislative Assembly, Bills, Reports of Select Committees, &c.	

Received from Society of Antiquaries of the North, Copenhagen, Denmark.

Memoirs of Northern Antiquaries, 1840–1844	1*
Do do 1845–1849	1*
Do do 1852	1*
Runeindskrift I. Piræeus, Inscription Runique du Pirée	1*
Saga J'åtvardar Konungs Hins Helga, &c., 1852	1*
Cabinet d'Antiquités Américaines à Copenhague, 1858	2*

Sheets.

Mémoire sur la découverte de l'Amerique au dixième siècle, par Charles C. Rafn. Second Tirage	1*
Société Royale des Antiquaires du Nord, le premier Janvier, 1858	1*
Discovery of America by the Northmen	2*
Antiquités de l'Orient, Monuments Runographiques Interprétés, par C. C. Rafn, &c	1*
Sur la construction des salles dites des Géants par S. M. le Roi Frédéric VII. de Danemark	1*
Saga Jàtvardar Konungs Hins Helga, &c., 1852	1*
Société Royale des Antiquaires du Nord, 1858. Sheets, 8 pages. Duplicate.	1*
Discovery of America by Northmen. Duplicate	2*

	VOLS.
Connection of the North men with the East	2*
Books recently published by the Royal Society of Northern Antiquaries ... Critical Opinions on works recently published by Royal Soc. N. Antiqua.	2*
Société Royale des Antiquaires du Nord........................ Séance Annuelle du 29 Janvier, 1838	2*
Do du 26 do 1837	1*
Do du 1er do 1858	2*
Do du Cabinet d'Antiquités Américaines	2*
Do Antiquitates Americanæ........................	2*

From J. W. DAWSON, *L.L.D., F.G.S., Principal of McGill College, Montreal.*

Additional on the Post Pliocene Deposits of the St. Lawrence Valley.........	2*
Catalogue of Canadian Plants in the Holmes Herbarium in the Cabinet of the University of McGill College. Prepared by the late Prof. James Barnston, M.D........................	1*
On the Lower Coal Measures, as developed in British America by J. W. Dawson, LL.D., F.G.S., Principal of McGill College, Montreal, Proceedings of Geological Society, April 28, 1858, pages 61–67	1*

From HISTORICAL SOCIETY, *Chicago.*

First Annual Statement of the Trade and Commerce of Chicago, ending 31st December, 1858	1
Sketches of the History of Ogle County, Illinois, and the early settlement of the Northwest, written for the *Polo Advertiser*	1*
First Circular of the Law School of the University of Chicago, year 1859–60	1*
Seventh National Exhibition by the Western States Agricultural Society, to be held at Chicago, September 12, 13, 14, 15, 16, and 17, 1859. $20,000 offered in premiums	1*

From the HISTORICAL SOCIETY, *Montreal.*

Mémoires et Documents relatif à l'Histoire du Canada, publiés par la Société Historique de Montréal........................	1*

From the ROYAL GEOGRAPHICAL SOCIETY *of London, per Mr.* ALLAN. *Through Mr.* TODD, *Librarian, Legislative Assembly.*

Proceedings of – Vol. III, No. 1, 1859; No. 2, 1859; No. 5, 1859	3*

From G. D. GIBB, *M.D., M.A., F.G.S., &c., &c., London.*

A Chapter on Fossil Lightning, by Doctor Gibb........................	1*

From HARVARD UNIVERSITY.

Catalogue of Officers and Students, year 1859–60. First term	1*

Catalogues from Mr. ALLEN, *Publisher, London.*

Allen's Bibliotheca Americana........................	1*
Do Books relating to America	1*
Do Old Books relating to America........................	1*

From L. HEYDEN, ESQ., Junior.

Inauguration of the Dudley Observatory, at Albany, 28th August, 1856	1*
Proceedings of the American Association for the advancement of science, 10th Meeting held at Albany, N. Y., August, 1856........................	1*

From CAPTAIN MEADE, U. S. A.	VOLS.
Charts illustrative of the United States Topographical Survey of the North American Lakes	1
From SOCIETIES, *in exchange for Journal.*	
Journal of Education for Upper Canada, 1859	
" Franklin Institute, 1859	
" Education for Lower Canada, 1859	
" de L'Instruction Publique, 1859	
" the Society of Arts (duplicate), 1859	
Artizan, London, 1859	
Silliman's Journal, 1859	
Canadian Naturalist and Geologist, 1859	
Queen's Bench Reports, 1859 (three Numbers)	
Proceedings of the Boston Natural History Society. Vol. 6, pages 401—432; Vol. 7, pages 1—128	
The Atlantis, Dublin, 1859	
Transactions of the Academy of Science, St. Louis. Vol. 1, No. 3, 1859	1*
Bulletin de la Société Géologique de France, for 1857, four Nos.; 1858, four Nos.	8*
Annales des Mines. Nos. for 1856, one; 1857, six; and 1858, six	13*
Historical Recollections of the Essex Institute. Vol. 1, 1839. Nos. 1—4	4*
Transactions of the Royal Scottish Society of Arts. Vol. 5. Part II. 1859	1*
Fifteenth Semi-Annual Report of the Water Commissioners of the City of Chicago	1*
Charter and By-Laws of the Chicago Historical Society, and list of officers	1*
Journal of the American Geographical and Statistical Society. Vol. 1. Nos. 1, 2, 3, 4, for January, February, March, and April, 1859	4*
Annals of the Lyceum of Natural History of New York. Vol. 6. February, 1858, Nos. 8 and 9, 1; September, 10—13, 1. Vol. 7. December, 1858; March, 1859, Nos 1—3, 1	3*
From MAJOR LACHLAN.	
Christy's Letters on Geology, 1848	1*
Report of the Nantahala Land and Mineral Company	1*
From HON. G. W. ALLAN, M.L.C.	
Monogram of the Trochilidæ. Parts 15 and 16	2*

DONATIONS FOR THE MUSEUM.

From T. C. WALLBRIDGE, ESQ.	NOS.
Geological Specimens	2
From HIS EXCELLENCY THE GOVERNOR GENERAL.	
Specimens of the Coinage of Canada—in a Case.	
Silver Twenty Cent pieces	2
Ten do.	2
Five do.	2
Copper One do.	2

From Rev. V. Clementi, *B.A, Peterborough, C. W.* NOS.

Skull of a Beaver (Castor Fiber) from Stoney Lake, C. W. Trapped by John Naugun, an Indian of the Mississauga, 1858 1
Specimens of Fossils 11
Skins of the star nosed Mole 2
Specimen of Columnaria Alveoluta from Indian River, Dummer, Peterborough 1

From C. J. Bethune, Esq., *Trinity College, Toronto.*

Box of Fossils. Specimens 57

From Prof. Dawson, *L.L.D, F.G.S., Montreal, per* Prof. Chapman, *Toronto.*

Specimens of the Devonian Plants of Gaspé. Numbering 12

From James Wright, Esq., *Toronto.*

An Indian Pipe found in Meaford, C. W 1

From G. B. Wyllie, Esq., *Toronto.*

Canadian Lynx stuffed 1

From T. D. Harrington, *Toronto.*

Bag of Pebbles and Indian Earthenware from Lake Huron 1
One old Coin. Ob. Head Apollo. Reverse Tripod 1

From Major Lachlan.

Geological Specimens of the Mount Auburn Rocks, Ohio ...... Numbering 35

From W. Hay, Esq.

Brainstone (Meandrina Cerebreformis) from the Bermudas 1

From J. Gould, Esq., *London.*

Box of birds, skins—Specimens Trochilidæ 50

The list of Papers read during the Session of 1858–9 will be found to contain very many communications of great interest. Amongst them are several valuable contributions to the natural history of the country, and many others also bearing directly on the mineral and other economic resources of the Province; both of them a class of subjects to which the Council would especially invite their members to assist in contributing.

COMMUNICATIONS.

The subjoined list contains the titles of the various Papers read at the ordinary meetings of the Session 1858–9:

Prof. E. J. Chapman—"On the alleged discovery of a Conus in the drift of Western Canada." 4th December, 1858.

Prof. Dr. D. Wilson.—"Notices of the Beaver in Europe and Canada." 4th December, 1858.

Prof. Rev. W. Hincks, F.L.S.—" On Canadian Ornithology. 11th December, 1858.

F. Assikinack, Esq.—"On the Grammatical Construction of the Odahwah Language" Read by Prof Wilson, 11th December, 1858.

Dr. Oille.—"On Parasites." 11th December, 1858.

Prof. E. J. Chapman.—"On a new species of Asaphus," 18th December, 1858.

W. Weir, Esq.—"On the Manufactures of Canada." 18th December, 1858.

Dr. Harvey.—"On the Increase and Decline of Malarious Diseases in the Valley of the Grand River." Read by Prof. Croft. 8th January, 1859.

Major Lachlan.—"Sketch of the Geology of Ohio," accompanying a series of specimens illustrative of the same. Read by Prof. E J. Chapman. 15th January, 1859.

Prof. D. Wilson.—"Notice of an ancient Stone Axe, inscribed in unknown characters, recently turned up by the plough in New Jersey." 15th January, 1859.

Jos. Bouchette, Esq.—"Report upon Explorations in the North West." Read by Andrew Russell, Esq. 22nd January, 1859.

Prof. H. Croft, D.C.L.—"On Dust Storms." 22nd January, 1859

Dr. Rae.—"(1) "On the Formation of Icebergs," and (2) "On the Transportation of Boulders." 29th January. 1859.

Dr. Morris.—"On a Species of Intestinal Worm found in the White Fish.' 29th January, 1859.

Prof. G. T. Kingston, M.A.—"Meteorological report for year 1858." Toronto, 5th February, 1859.

Prof. D. Wilson, LL.D.—"On the Pre-Columbian Discovery of America." 5th February, 1859.

T. G. Cottle, M.D.—"On the Cranes of Canada." Read by Rev. Prof. Hincks F.L.S. 12th February, 1859.

Prof. E. J. Chapman.—"Remarks on certain specimens of Canadian Marble." 12th February, 1859.

Prof. D. Wilson, LL.D.—"Remarks on the Quigrich, an ancient Scottish Relic." 12th February. 1859.

E. Billings, F.G.S.—"On the Fossil Corals of the Devonian Rocks of Canada." Read by Prof E. J. Chapman. 19th February, 1859.

Rev. Prof. G. P. Young, M.A.—"The exact solution of General Algebraical Equations of every degree, in all cases where the roots or any number of them admit of being Algebraically represented." 19th February, 1859.

Rev. J. McCaul, LL.D.—"On some Mint Marks of the Lower Empire." 19th February, 1859.

Rev. Prof. W. Hincks, F.L.S.—"The Sensational Philosophy respecting the Human Mind and its operations, the treatment it has met with, and its real character and pretensions." 26th February, 1859.

W. G. Tomkins, Esq., C.E.—"On Comparative Tabular Meteorological observations in Canada, England, and Russia." Read by S. M. Jarvis, Esq. 26th February, 1859.

W. Hay, Esq., Architect.—"Some Remarks on Iron Construction as applied to Street Architecture." 5th March, 1859.

T. G. Cottle, Esq., M.D.—"On two Rare Birds observed in Canada." Read by Rev. Prof. Hincks, F.L.S. 5th March, 1859.

Prof. E. J. Chapman.—"Remarks on some Specimens of Fossil Plants from the Devonian Rocks of Gaspé, presented to the Institute by Prof. J. W. Dawson, F.G.S.." 5th March, 1859.

B. R. Morris, Esq., M. D.—"On the luminous appearance of the sea, commonly called phosphorescent." 12th March, 1859.

Prof. H. Y. Hind, M. A.—"On the Qu'Appelle or Calling River, and the diversion of the waters of the south branch of the Saskatchewan, down the Qu'Appelle valley, to the Assiniboine River, and past Fort Garry into Red River, with a view to the establishment of direct steam communication from the Red River to the foot of the Rocky Mountains, in a line nearly west from Fort Garry." 19th March, 1859.

Rev. Prof. W. Hincks, F. L. S.—" On the Canadian species of Lynx." 19th March, 1859.

Prof. H. Croft, D. C. L.—" Some experiments with Ruhmkorff's Induction Coil." 19th March, 1859.

Rev. C. Dade.—" On the Law of Storms," read by Prof. Cherriman, M.A. 26th March, 1859.

Rev. J. McCaul, LL.D.—" New Readings of Old Inscriptions." 26th March 1859.

J. F. Smith, Esq.—" Notes on some of the more characteristic Fossils of the Hudson River Group of Western Canada." Read by Prof. E. J. Chapman. 2nd April, 1859.

Prof. D. Wilson, LL,D.—" Notes on the Development of New Varieties among the Intrusive Populations of America." 2nd April, 1859.

John Langton, M.A.—" On the Age of Trees." 9th April, 1859.

C. Smallwood, M.D.—" On the Meteorological Phenomena of Lower Canada for 1857–8." Read by Prof. Cherriman, M.A. 9th April, 1859.

E. M. Hodder, M.D.—" On the influence of the Storms during the winter of 1858–9 on the Peninsula, and the probable effects on the Esplanade and Harbor." 16th April, 1859.

S. Fleming, Esq., C. E.—" On the Settlement of Wild Land." 16th April, 1859.

In submitting the Report laid before them by the Editing Committee, the Council would take the opportunity of expressing their deep sense of the zeal and efficiency with which the late general Editor, Dr. Wilson, has discharged the arduous duties connected with the editorial superintendence of the Journal. Under his able management, and with the valuable assistance of the other members of the Editing Committee, the Journal has continued to maintain the high character which it has so long enjoyed, and through its instrumentality the Society is not only becoming more widely and favorably known in this Province, but is also rapidly extending its intercourse with the scientific bodies both of Europe and America. Having continued his editorial superintendence for a period of four years, often at a considerable sacrifice of personal convenience, and to the interruption of other pursuits, Dr. Wilson has now expressed his desire to be released from his duties, and the Council are glad to have it in their power to congratulate the Institute on having secured the services of so able and efficient a successor as Professor Chapman, who has consented to fill the chair of General Editor.

REPORT OF THE EDITING COMMITTEE.

The Editing Committee beg leave to submit their Annual Report to the Council, on completing the fourth volume of the new series of the *Canadian Journal.*

Bearing in view the objects of the Institute as a society designed to promote the development of a native Canadian Science and Literature, the committee have continued to aim at the acquisition of such communications as are calculated, along with the critical Reviews and Scientific and Literary Notes, to maintain the special character which the Journal is designed to bear among the periodicals of the Province. Among the contributions to the present volume, special thanks are due to Mr. E. Billings, of the Canadian Geological Survey, for his valuable paper on the Fossil Corals of the Devonian Rocks of Canada West, as well as for the carefully executed illustrations which added so largely to its interest. While, however, the utility of the *Canadian Journal* is acknowledged, alike as a provincial mediumfor the interchange of communications on exclusively scientific and literary subjects, and also as a means of intercourse with men of science both in Europe and America; the editors have also anxiously desired to bear in view the aims and interests of the members at large. They have accordingly deemed it perfectly compatible with the objects of such a Journal, to introduce occasionally, especially in the departments of criticism and literary notes, subjects of a more general and popular interest than can be supposed to attach to strictly scientific contributions. By such means it is hoped that the Journal has accomplished purposes equivalent to the printed proceedings of the older and more exclusive scientific societies of Europe: serving not only to diffuse valuable scientific and literary information, but also to constitute a bond of mutual interest and union among a body of members scattered throughout the Province.

During the past year the Editing Committee have added the following societies and learned foreign bodies to the free list furnished in former reports. From the increasing value of the exchanges which they continue to receive, and the direct intercourse thereby established with the principal scientific societies of Europe and America, they feel justified in regarding this as one of the most important functions of the Institute as a provincial society:

Geological Survey of India, Calcutta.
Royal Dublin Society.
American Geographical and Statistical Society, New York.
American Antiquarian Society, Boston.
Historical Society of Pensylvania.
Harvard University, Cambridge, Massachusetts.
Natural History Society, Montreal.
Literary Society, Quebec.
Hamilton Association, Canada West.

The Committee continue to receive gratifying evidence of the favourable reception of the printed proceedings of the Institute, as shown in reference to them, and still more in the re-publication of extracts, and even of whole papers from their pages, in British and Foreign Journals. In addition to this, one of the learned societies of Europe: the Royal Society of Northern Antiquaries, of Copenhagen, of which His Majesty, the King of Denmark, is President, in acknowledging the receipt of the Journal during the past year, through their distinguished Secretary, C. C. Rafn communicated the desire of the Society to elect the President of the Canadian Institute, and the Editor of its Journal, on their rank of Honorary Members.

The Journal has been conducted, since the establishment of the New Series, under the editorial superintendence of Dr. Wilson, with the aid and co-operation of the members of the Editing Committee; and with such results as to justify the course adopted, in rendering this series strictly a periodical issue of original papers, embodying the printed proceedings of the Institute. This object having been secured, and the present General Editor having expressed his desire to be relieved of duties he has now fulfilled for four years, the Editing Committee have much pleasure in reporting, that the General Editorship has been undertaken by Professor Chapman; whose frequent contributions to the Journal in past years, as well as his high standing in a department of science so important in its practical bearing on the development of the mineral and other economic resources of the Province, render him peculiarly fitted for the responsible duties thus devolved on him.

An unusually large space has been devoted to the department of reviews during the past year; while at the same time they are fewer in number than in former volumes; the object aimed at having been to transfer mere notices of books to the notes, and to give to the department more of the character of review articles. With a larger body of contributors, this section might be extended with great advantage, and the Journal increased in size, and rendered acceptable to a much wider circle of readers; while the opportunity thereby afforded for the discussion of important questions in science and literature could in no degree detract from the legitimate characteristics of such a periodical. The Committee, however, cannot overlook the fact, that a large portion of the materials hitherto contributed to this department have been the work of two or three members, on whom, accordingly, an amount of labour has been imposed, which, though freely rendered, must be felt to be an undue tax on the voluntary services of so small a number, in a society of some hundred members, including many well qualified to share in such labours.

It was the intention of the Committee to have aimed at giving increased interest to the Journal during the past year, by means of illustrations, but a series of disappointments by the artist engaged on the work, involving much trouble and anxiety to the editor, ended in the abandonment of the scheme for the present. The Committee however, have pleasure in calling attention to the beautiful lithograph of the Quigrich, which as a specimen of art, executed in Toronto, cannot but be regarded as a highly satisfactory proof of progress, when it is borne in remembrance that similar illustrations for a former volume had to be procured from New York.

In conclusion, the Committee have to express their earnest hope that the new General Editor may be able to secure such an amount of varied and hearty co-operation, as, while materially lessening his own labours, shall contribute fresh attractions both to the publications and the meetings of the Institute.

Toronto, 3rd December, 1859. DANIEL WILSON, *Convener.*

On referring to the details given in the Treasurer's Report submitted below, it will be seen that the general funds of the Institute are, upon the whole, in a satisfactory condition. The Building Fund has been slightly increased by the accumulation of interest, but the Council deem it right to call the attention of the Members to the fact, that the subscription list for that *special* purpose still remains uncollected, and unless some steps are taken during the ensuing year to call in at least a per centage on the amounts subscribed, much of what appears to the credit of the Fund *on paper*, may be lost altogether.

The Council have hitherto refrained from urging the payment of their subscriptions upon the contributors to the Fund, as in consequence of the pressure of the times, it was not deemed expedient to proceed with the building, and it therefore seemed unreasonable to press for subscriptions which were not immediately required. But as there is every reason to hope that the time is not far distant when returning prosperity and the improved financial condition of the country, will justify the Council in proceeding with the work, it seems to them most desirable that some efforts should in the mean time be made, to place the Fund on a more satisfactory footing. Until the Institute is installed in a permanent house of its own, it can scarcely be expected that any satisfactory progress will be made in carrying out one of the *special* objects for which the Society was instituted—the formation of a Museum illustrative of the Natural History, the Geological and Mineral products, and the economic and industrial resources of the Province. It is true that many valuable contributions have already been made to our collection, but with our present limited accommodation, and the uncertainty as to future arrangements, it is impossible to render this department of any practical utility or interest either to the members generally or to the public at large. The Council therefore venture to hope that the liberality of the friends of the Institute and the exertions of its Members, will enable their successors to place the Building Fund on a more satisfactory footing and that the impediments which have hitherto interposed themselves to the commencement of the building itself, will speedily be removed.

TREASURER'S REPORT, 1859.

Statement of the Canadian Institute General Account for 1859.

	£	s.	d.	Total
Dr.				
Cash Balance from last year	£420	16	0	
" Received from Members	254	18	0	
" Journal and Periodicals	47	16	7	
" Parliamentary Grant	250	0	0	
" due by Members	299	13	6	
" due for sale of Journal (old series)	20	17	6	
" " " (new series)	56	16	3	
				£1350 17 10
Cr.				
Cash paid on account of Journal (1858)	71	16	1	
" " " (1859)	227	1	8½	
" " Library	34	10	7½	
" " Museum	5	16	11½	
" " Sundries	212	18	3½	
" due on account of Journal	37	10	0	
" " Sundries	24	17	3	
Balance in favor of the Institute	736	6	11	
				£1350 17 10

Statement of Building Fund.

Cash balance and investment from last year	£1663	9	3
" received for interest on loans	180	17	6
" donation	1	0	0
Subscription list	534	15	0
	£2380	1	9

The Treasurer in account with the Canadian Institute.

Dr.

Cash balance from last year	420	16	0			
Securities	1425	0	0			
Interest on securities	180	17	6			
Cash received from Members	254	18	0			
" for Journal and Periodicals	47	16	7			
" Parliamentary Grant	250	0	0			
				£2579	8	1

Cr.

Cash paid on account of Journal (1858)	71	16	1			
" " " (1859)............	227	1	8½			
" " Library and Museum	40	7	7			
" " Sundries..................	212	18	3½			
Securities	1425	0	0			
Balance..	602	4	5			
				£2579	8	1

D. Crawford, *Treasurer.*

AUDITORS' REPORT, 1859.

Toronto, 9th December, 1859.

Examined Vouchers with Cash Book. Balance in hands of Treasurer six hundred and two pounds four shillings and five pence, correct, and securities for one thousand four hundred and twenty-five pounds exhibited.

Samuel Spreull,
Gogrge R. R. Cockburn, } *Auditors*

Before drawing their report to a close, the Council desire briefly to refer to a question which was brought under the notice of the Institute, during its Session of 1858–59, and on which a final report from a Committee of Council was submitted to the Members at their last General Meeting. The subject of this report was the inconvenience which had been found to arise from the present appellation of the Society,—the name of *Institute* having led to its being confounded with other associations of a purely local character: insomuch that when the withdrawal of the grants to Mechanics' and other *local* Institutes was under discussion in the Legislative Assembly, during their last Session, the Canadian Institute, from its similarity of name, was classed with the others, and had it not been for the timely exertions of some friends of the Association, would probably have been deprived of its annual grant.

As the report alluded to, has been entered upon the minutes of the Society, the Council do not deem it necessary to refer to the subject beyond expressing their conviction of its importance, and their hope that the matter will not be allowed to drop, but that further consideration will be given to it during the course of the ensuing Session.

In conclusion, the Council would remind the Members of the Institute, that even should it hereafter be deemed expedient to seek for a change of NAME, it must still rest with the Members of the Institute themselves, by their active co-operation and diligent exertions, to stamp the Association with such an unmistakeable character of vitality and usefulness,—to render it so truly a representation of the science and intellect of the Province,—as in a great measure to prevent the danger of its being confounded, (except by those who will not take the trouble to inform themselves,) with associations of less extended or inferior aims.

G. W. ALLAN, *President.*

THIRD ORDINARY MEETING—*7th January*, 1860.

Hon. G. W. ALLAN, M. L. C. President, in the Chair.

I. *The following Gentlemen were elected Members:*

Hon. W. CAYLEY, M. P. P, Toronto.

HENRY CAWTHRA, Esq., Toronto.

II. *The following donations to the Library were announced, and the thanks of the Institute voted to the donors:*

From the Publishers, B. DAWSON & SON.

Archaia, or Studies of the Cosmogony and Natural History of the Hebrew Scriptures: by J. W. Dawson. LL.D., F.G.S. One Vol.

From THE CHIEF SUPERINTENDENT OF EDUCATION *for Upper Canada.*

Annual Report of the Normal, Model, Grammar and Common Schools in Upper Canada for the year 1858, with Appendix. By the Chief Superintendent of Education for Upper Canada. Two Vols. Unbound.

From DR. HAYDEN OF ALBANY (through PROF. CHAPMAN.)

Two Maps of Nebraska Territory.

III. An address presented by the Council to Alex. M. Ross and James Hodges, Civil Engineers, congratulating them upon the opening of the Victoria Bridge, and the reply of those Gentlemen to that address, was read by the Secretary.

Toronto, 19th Dec. 1859.

To Alexander Mackenzie Ross and James Hodges, Esqrs., the Engineer and the Builder of the Victoria Bridge:

Gentlemen,—At a special meeting of the Council of the Canadian Institute, convened this day, the following resolution, congratulating you on the completion of the magnificent work with which your names are so intimately connected, was adopted unanimously.

Resolved.—That the Victoria Bridge at Montreal having this day been opened for public traffic, the Council of the Canadian Institute deem it a fitting opportunity to congratulate Messrs Alexander Mackenzie Ross and James Hodges, Civil Engineers, on the completion of that great and noble work.

The Institute have watched with a double interest the progress of the Victoria Bridge, not only as a work of the highest national importance, but also as closely associated with the name of Robert Stephenson: that renowned and much lamented engineer, whom the Institute had the high honor to enroll amongst its members on the occasion of his visit to Canada, prior to the commencement of the great undertaking which has just been brought to so successful a completion.

In the Victoria Bridge, Canadians must not only feel that they possess one of the noblest monuments of engineering skill and science existing on this continent; but that also, by the completion of this magnificent structure, a great highway has been opened, over which the trade and commerce not only of Canada, but of the furthest west, may at all times flow: uninterrupted by the natural obstacles which have heretofore opposed themselves for a large period of the year, to a free communication with the sea-board.

To the gentlemen whose names are so closely connected with this great work, the Council of the Institute desire now to express their sincere congratulations on the successful termination of their labours; and they desire also by this resolution, to record in the archives of this Society (expressly established for the promotion of Science and Industry) the completion of the noble monument of Science and Mechanical skill which has this day been opened to the traffic of the Province.

The Council further resolved that copies of the above resolution should be engrossed and transmitted to Messrs. Ross and Hodges.

(Signed,) G. W. ALLAN, President.

Reply. Copy. MONTREAL, 27th December, 1859.

To the President and Council of the Canadian Institute, Toronto.

Gentlemen,—We have the honor to acknowledge receipt of copies of Resolution passed at a special meeting of your Council, convened on the 19th instant, in which you congratulate us, as Engineer and Builder, on the completion of the Victoria Bridge, that day opened for public traffic.

In returning you our thanks for the notice you have taken of ourselves in connexion with the termination of our labors, a notice, which to us is more valuable, emanating from a Society established for the promotion of Science and Industry, and numbering so many respected names amongst its members, we rejoice to think that the work with which our names have been connected, is one which is so highly calculated to assist in developing the interests of a country for the prosperity of which our best wishes can never cease to be formed

And it is not only our present hope, but our confident belief, that the sacrifices which this Province has made with such enlightened foresight in order to establish a great and ever open highway of communication betwixt the rising territories of the farthest west and the Atlantic sea board, will in due time find a return corresponding to the spirit in which that great enterprise was conceived, and the perseverance with which the means have been found for bringing it to a successful completion.

Amidst so much that is calculated to afford satisfaction to all concerned, our pleasure is yet damped by the melancholy reflection, that the distinguished man to whom you allude, with whose name this undertaking is so closely associated, has been prevented from witnessing its completion by a too early death.

Again begging to tender you our grateful and respectful acknowledgements,

We have the honor to be,

Gentlemen,

Your very faithful Servants,

(Signed,) ALEXANDER M. ROSS.

" JAMES HODGES.

V. *The following papers were read :*

1. By the President, Prof. Daniel Wilson, LL.D. :
   The Annual Address.
2. By Prof. H. Y. Hind, M.A. :
   " On the distribution of Clay Iron Stone in the Carbonaceous rocks of Rupert's Land, or the North Western Territory, and its value as a source of Iron in that Country."

FOURTH ORDINARY MEETING—14*th January*, 1860.

Prof. D. WILSON, LL.D., President, in the Chair.

I. *The following Gentlemen were elected Members :*

ALEX. M. ROSS, Esq., Civil Engineer, Montreal, Honorary Member.
JAMES HODGES, Esq., Civil Engineer, Montreal, Corresponding Member.
JOHN H. HUNT, Esq., M.D. Army Medical Staff, Toronto. } ordinary
WALTER O'HARA, Esq., Toronto. } members.

II. *The following papers were read :*

1. By F. Assikinack, Esq. :
   "On some peculiarities of the Odahwah language."
2. By Rev. Prof. W. Hincks, F.L.S. :
   Specimens of a Canadian Flora.

FIFTH ORDINARY MEETING—21*st January*, 1860.

Professor WILSON, LL.D., President, in the Chair.

I. *The following papers were read :*

1. By the Hon. G. W. Allan, M.L.C. :
   " On the Topography of the Roman Forum, Illustrated by a series of Photographic views."
2. By the President, Professor Wilson, LL.D :
   " Observations on the skull of a Circassian Lady, brought from Kertch in the Crimea."

SIXTH ORDINARY MEETING—28*th January*, 1860.

Prof. DANIEL WILSON, LL.D., President, in the Chair.

I. *The following Gentlemen were elected Members :*

ALFIO DE GRASSIE, Esq., Toronto, Ordinary Member.

George Tate, Esq., Toronto.
Thomas Grundry, Esq., Toronto.
Thomas Moss, M.A., Toronto.
James Pollock, Esq., Toronto.
} Ordinary members.

Reginald Reynolds, Esq., Toronto, Junior member.

II. *The following papers were read:*

1. By Prof. H. Y. Hind, M.A:

"Remarks on Indian Art, illustrated by a collection of Indian relics, obtained during the Assiniboine and Saskatchewan expedition.

2. Dr. Bovell made some observations on the skull of an infant Indian found with many others in a pit near Weston.

SEVENTH ORDINATY MEETING—*4th February*, 1860.

Professor D. Wilson, LL.D., President, in the Chair.

I. *The following Gentlemen were elected Members:*

The Hon. Mr. Justice Hagarty, Toronto.
Rev. E Cooper, M. A.

II. *The following donation to the Institute was announced, and thanks voted to the donors:*

A copy in chromo-Lithography of the picture by Paul Kane, Esq., of the death of a Blackfoot Chief. By Messrs. Fuller & Bencke.

III. *The following Paper was Read:*

1. By Professor Bovell, M.D.

"Notes of a visit to Barbadoes in 1859."

ERRATA.

The following errata occur in the first part of the paper "On the Resolution of Equations," which appeared in the January Number of the Journal:

Page 22, line 10, *for* said, *read* surd.

Page 23, line 29, *for* z_2 in the second term of the value of $\phi(p)$, *read* z_2^2.

Page 27, line 13, *for* U^m, *read* U_m.

Page 27, line 21, and page 28, line 13, *for* same, *read* some.

Page 31, line 7, delete the comma before the word "having."

Page 34, line 10, *for* same, *read* some; also, in the last line of the same page, *for* A_cY, *read* A_cY^c.

Page 35, line 16, insert the sign + before Y^c.

Page 38, line 22, instead of Y, after the word "expressions," *read* Y_c.

METEOROLOGY.

MEAN METEOROLOGICAL RESULTS AT TORONTO, FOR THE YEAR 1859.

BY PROFESSOR KINGSTON, M. A., DIRECTOR OF THE PROVINCIAL MAGNETIC OBSERVATORY.

(*Read before the Canadian Institute, February 11th*, 1860.)

The mean temperature of the year 1859 was 44°.19, which differs only 0°.08 in excess from the average of 20 years.

The mean temperatures of the several months were in six instances above and six below their respective averages. As shown by the table, the warmest month absolutely though relatively a cold one, was July, and the month that was absolutely coldest, though it was relatively warm, was February. The warmest month relatively, was March, being 6°.27 above the average, and the relatively coldest month December, which was lower than the average by 8°.08. December was the coldest December on record, being 3°.2 colder than the coldest December previously recorded.

The warmest day was July 12th, with a mean temperature 79°.88, and the coldest January 10th, with a mean temperature —8°.65.

The highest temperature of the year was 88°0 being 2°.5 below the average. It occurred on July 12th, already mentioned as the warmest day. The lowest temperature of the year, occuring on January 10th, (also the coldest day in the year,) was —26°.5 being 14°.7 below the average, and the lowest ever recorded at the observatory. The absolute annual range thus amounted to 114°.5.

Humidity.—The mean humidity of the year was .74, being nearly identical with that of 1858. The annual march, as exhibited in the monthly means, corresponded in its alternate increase and diminution, very accurately with that of the preceding year, and in most cases showed nearly exactly the same numbers.

Clouds.—The extent of sky clouded, on the average of the year, was nearly $\frac{3}{5}$ of the hemisphere, and for nine months the sky was on the average at least half overcast. This accords with the experience of previous years, but in the distribution of cloudiness among the different months, a want of parallelism is apparent.

Wind.—The resultant direction of the wind, was N 61° W. The mean velocity of the year was 8.17 miles per hour, which was 1.60 miles above the average, and shows an increase on the two preceding years. The most windy month was April, with a mean velocity 10.79 miles, and the least windy month May, with a mean velocity, 5.70 miles. The most windy day, was March 19th, when the mean velocity was 31.16 miles, the greatest recorded; and the calmest day September 23rd.

The most windy hour on the average of the year, was from 1 P.M. to 2 P.M. with a mean velocity 11.00 miles; and the calmest hour, from midnight to 1 A.M.

when the mean velocity was 6.64 miles. These statements agree very nearly with those made in the preceding year, when the most windy hour was from 2 to 3 P.M. and the calmest hour, from midnight to 1 A.M.

Rain and Snow.—The depth of rain 33.274 inches, shows an increase of more than 5 inches on that of the year 1858, and was 2.415 above the average. The depth of snow shows also an increase of 9 inches on that of the preceding year. This however, was principally due to the heavy falls in December, as the amount that fell in other months was below the average in every case but in January, when it exceeded it only by about 3 inches. The total depth of rain and melted snow exceeded the average by 2.724 inches.

November was the most rainy month with respect to the amount of rain, and June with respect to its frequency. The smallest amount of rain fell in February, and the fewest rainy days occurred in December.

The heaviest rain occurred on August 23rd, when it fell to the depth of 1.655 inches, and the heaviest fall of snow on December 18th, when the depth was estimated at 6 inches.

The fall of rain was distributed over 127 days, and the fall of snow over 87 days, including 23 days which occurred in December alone; and there were 169 days only, or less than half the year, without either rain or snow.

The rain occupied about 514 hours and the snow about 380 hours in its fall, making thus a total of about 894 hours, or 37¼ days, during which either rain or snow was falling; a result it is to be remarked differing only by about one day from that of last year.

The hour at which rain or snow was most frequent, was between 2 P.M. and 3 P.M. and the hour most free from rain and snow, on the average of the year, was between 1 A.M. and 2 A.M.

Thunderstorms.—There were 30 thunderstorms, reckoning as such those cases in which thunder or lightning occurred accompanied by rain or hail, besides 16 instances in which the thunder or lightning occurred singly or together, but without rain or hail.

Auroras.—The auroras in 1859 were not quite so numerous as in 1858, but there was an increase in the number of days in which those of the first class were observed. The aurora of August 28th, and the following days, was probably one of the most remarkable ever recorded, when considered with respect to its brilliancy, its duration, and the extent of the earth's surface at which it was visible. It was accompanied by an extraordinary magnetic disturbance. The magnets were deflected from their normal positions to the extent of about 2° 7′ in the dclination and 2° 20′ in the dip; and in the horizontal and vertical components of the force, there was a departure from their normals, of about .08 and .006 of their respective normal absolute values. The magnitude of these deviations will be better appreciated when it is remembered that a disturbance is reckoned large when the declination differs 5′, the dip 1′, the horizontal force .0012, and the vertical force .00026, from their respective normals.

The following is the general Meteorological abstract for the year 1859, deduced from the observations taken at the Provincial Observatory:

GENERAL METEOROLOGICAL

Provincial Magnetical Observatory,

LATITUDE, 43° 39'.4 North. LONGITUDE, 5 h. 17 m. 33 s. West. ELEVATION ABOVE

	Jan.	Feb.	March.	April.	May.
Mean Temperature	° 26.44	° 26.04	° 36.34	° 39.53	° 55.16
Difference from average (20 years)	+ 2.72	+ 3.21	+ 6.27	− 1.47	+ 3.78
Thermic Anomaly (Lat. 43° 40' N.)	− 6.36	− 8.66	− 3.76	−10.67	− 2.94
Highest Temperature	43.2	46.2	54.2	64.8	79.6
Lowest Temperature	−26.5	2.1	9.8	22.6	39.5
Monthly and Annual Ranges	69.7	44.1	44.4	42.2	40.1
Mean Maximum Temperature	30.46	31.85	42.10	46.54	63.40
Mean Minimum Temperature	18.55	19.71	30.48	32.92	47.13
Mean Daily Range	11.91	12.15	11.62	13.62	16.26
Greatest Daily Range	39.8	21.9	20.9	27.2	25.4
Mean Height of Barometer	29.6770	29.6321	29.4125	29.5350	29.6598
Difference from average (12 years)	+.0472	+.0196	− 2189	−.0721	+.0763
Highest Barometer	30.311	30.002	30.255	30.046	29.986
Lowest Barometer	28.934	28.877	28.286	28.993	29.224
Monthly and Annual Ranges	1.377	1.125	1.969	1.053	0.762
Mean Humidity of the Air	.81	.79	.75	.63	.67
Mean Elasticity of Aqueous Vapour	.126	.117	.168	.154	.298
Mean of Cloudiness	0.72	0.74	0.65	0.59	0.41
Resultant Direction of the Wind	S 81 W	N 54 W	N 64 W	N 36 W	N 72 E
Resultant Velocity of the Wind	3.17	2.72	1.96	2.33	1.59
Mean Velocity (Miles per hour)	8.76	8.50	10.39	10.79	5.70
Difference from average (12 years)	+1.12	+0.69	+2.28	+3.21	−0.66
Total Amount of Rain (in inches)	1.449	0.455	4.054	2.527	3.410
Difference from average (19 and 20 years)	−0.031	−0.588	+2.501	+0.035	+0.105
Number of Days Rain	6	6	15	9	11
Total Amount of Snow (in inches)	16.4	8.3	1.0	1.2	0.0
Difference from average (17 years)	+ 2.89	−9.00	−8.25	−1.18	−0.08
Number of Days Snow	19	14	8	8	0
Number of Fair Days	10	9	10	15	20
Number of Auroras observed	0	3	8	7	4
Possible to see Aurora (No. of Nights)	13	11	17	17	22
Number of Thunderstorms	0	1	2	0	5

REGISTER FOR THE YEAR 1859.

Toronto, Canada West.

LAKE ONTARIO, 108 feet. APPROXIMATE ELEVATION ABOVE THE SEA, 342 feet.

June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year 1859.	Year 1858.	Year 1857.	Year 1856.	Year 1855.
° 58.30	° 66.87	° 66.61	° 55.18	° 42.99	° 38.90	° 17.89	° 44.19	° 44.74	° 42.73	° 42.16	° 43.96
− 2.97	− 0.19	+ 0.49	− 2 80	− 2.28	+ 2.25	− 8.08	+ 0.08	+ 0.64	− 1.34	− 1.99	− 0.29
− 6.30	− 1.83	− 1.89	− 6.32	−10.81	− 4.30	−18.11	− 6.81	− 6.26	− 8.27	− 8.84	− 7.02
86.4	88.0	82.2	75.4	69.8	62.6	54.8	88.0	90.2	88.2	96.6	92.8
32.2	44.7	45.8	35.7	22.3	21.8	− 6.0	−26.5	− 7.3	−20.1	−18.7	−25.4
54.2	43.3	36.4	39.7	47.5	40 8	60.8	114.5	97.5	108.3	115.3	118.2
66.93	74.65	75.01	62.68	50 38	43.95	25.26					
49.82	59.20	59.38	49.32	37.05	32.77	12.94					
17.11	15.45	15.63	13.36	13.33	11.19	12.32	13.66	13.84	16.38	18.29	18.19
27.8	24.3	24. 7	22.8	26.0	25.4	26.7	39.8	31.2	37.0	44.2	39.4
29.6196	29 6483	29.5990	29.6686	29.6146	29.6746	29.7092	29.6209	29.6267	29.6054	29.5999	29.6249
+.0378	+.0510	−.0371	+.0145	−.0252	+.0558	+.0629	+.0010	+.0068	−.0145	−.0200	+.0050
29.966	30.141	29.811	30.049	29.962	30.252	30.392	30.392	30.408	30.361	30.480	30.552
29.260	29.159	29.306	29.038	29.018	28.881	29.201	28.286	28.849	28.452	28.459	28.459
0.706	0.982	0.505	1.011	0.944	1.371	1.191	2.106	1.559	1.909	2.021	2.093
.69	.70	.70	.75	.72	.78	.87	.74	.73	.79	.75	.77
.355	.471	.463	.337	.214	.190	.099	.249	.259	.254	.244	.263
0.50	0.46	0.40	0.65	0.64	0.81	0.73	0.61	0.60	0.60	0.57	0.60
N 77 W	N 56 W	N 36 W	N 44 W	N 68 W	N 81 W	N 53 W	N 61 W	N 41 W	N 74 W	N 71 W	N 62 W
1.95	1.48	1.62	1.60	5.04	3.39	4.29	2.24	1.59	2.54	3.03	2.51
7.19	5.81	5.96	6.36	8.12	9.65	10.77	8.17	7.64	7.99	8.31	8.18
+2.18	+1.08	+0.76	+0.95	+2.36	+2.45	+2.73	+1.60	+1.21	+1.68	+2.19	+2.33
4.085	2.611	3.990	3.525	0.940	5.193	1.035	33.274	28.051	33.205	21.505	31.650
+0.887	−0.879	+1.063	−0.574	−1.617	+2.084	−0.571	+2.415	−2.674	+2.223	−9.329	+0.286
16	12	11	15	11	12	3	127	131	134	99	103
Inapp.	...	...	...	Inapp.	0.6	37.4	64.9	45.4	73.8	65.5	99.0
...	...	...	...	−0.94	−2.56	+22.21	+ 3.09	−16.2	+11.1	+ 3.6	+37.4
2	...	...	...	4	9	23	87	67	79	69	64
13	19	20	15	18	13	7	169	178	171	198	198
3	4	4	8	5	2	5	53	59	26	35	46
20	21	23	17	18	9	11	199	198	189	212	204
8	6	4	4	0	0	0	30	19	28	25	38

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—DECEMBER, 1859.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Days.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M	10 P.M.	M'N	6 A.M	2 P.M	10 P.M	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M	2 P.M	10PM	Re-sul't.	ME'N		
1	29.326	29.295	29.680	29.4478	°48.0	°53.8	°31.7	°44.37	°+13.58	.320	.370	.155	.281	.95	.89	.86	.90	S b W	S b W	N W b W	°N 79 W	6.0	10.5	16.0	10.23	15.00	0.255	0.1
2	.813	.802	30.103	.9272	23.8	17.6	13.6	17.27	—13.22	.114	.083	.067	.082	.89	.85	.83	.84	N N W	N W	W N W	N 37 W	14.2	17.5	9.0	12.51	13.02	...	2.5
3	30.336	30.317	30.180	30.2720	1.7	8.2	11.1	6.80	—23.28	.038	.055	.055	.049	.80	.86	.74	.81	N N W	N	N N E	N 12 E	9.4	12.5	18.2	14.00	14.54	...	2.0
4	29.931	29.845	—	—	14.7	25.9	—	—	—	.072	.107	—	—	.85	.76	—	—	N N E	N E	N	N 22 E	20.6	13.5	9.0	12.90	13.24	...	2.5
5	.864	.801	29.798	29.8172	27.7	36.8	36.8	34.25	+ 4.87	.135	.203	.196	.184	.89	.93	.89	.92	N N E	E N E	Calm.	N 66 E	10.5	8.4	0.0	3.39	3.67	Inap.	...
6	.707	.432	.451	.5242	38.2	40.7	36.8	38.08	+ 9.02	.220	.250	.203	.218	.95	.98	.93	.94	E b N	E N E	W	N 68 W	5.8	8.2	13.5	4.73	10.51	0.780	3.5
7	.576	.731	.881	.7448	22.0	20.1	7.1	15.38	—13.28	.111	.091	.048	.080	.94	.85	.78	.86	W N W	W	W b N	S 88 W	12.5	12.6	4.0	8.48	8.59	...	2.5
8	.915	.929	.983	.9458	4.3	18.0	6.8	9.60	—18.87	.046	.081	.048	.056	.87	.81	.81	.82	W	W S W	W S W	S 70 W	7.0	9.5	4.2	5.58	5.66	...	...
9	.809	.586	.621	.6738	16.5	26.3	23.4	22.25	— 5.90	.083	.130	.101	.107	.90	.91	.81	.88	S W b W	S W	W	S 66 W	1.5	15.0	20.5	13.49	18.46	...	0.5
10	.970	30.017	.753	.9040	9.7	12.6	27.0	15.60	—12.25	.057	.066	.129	.082	.85	.86	.88	.87	N W	N W	S S W	S 79 W	14.6	0.5	17.0	4.54	7.86	...	...
11	.551	29.365	—	—	29.5	35.0	—	—	—	.149	.166	—	—	.92	.82	—	—	S W	S S W	S W	S 74 W	11.2	12.5	29.0	15.29	17.94	...	0.2
12	.424	.484	.655	.5435	10.8	12.2	6.4	8.35	—19.00	.046	.059	.052	.053	.65	.78	.90	.84	W	W S W	W N W	N 68 W	20.6	10.2	1.8	5.01	5.70	...	0.1
13	.799	.878	.898	.8687	4.6	19.8	16.5	13.65	—13.50	.048	.076	.069	.069	.90	.71	.77	.84	W N W	Calm.	N b E	N 5 E	5.6	0.0	8.8	5.54	6.02	...	3.0
14	.835	.823	.822	.8285	15.4	18.7	17.6	15.80	—11.17	.083	.089	.088	.080	.95	.87	.92	.90	N	N	N b W	N 9 W	13.8	7.5	4.8	7.29	7.53	...	0.2
15	.810	.799	.826	.8165	14.7	25.9	12.6	17.48	— 9.28	.072	.107	.066	.080	.85	.76	.86	.82	N W	N W	S W	S 45 W	1.0	0.6	1.5	1.61	1.67	...	Inp.
16	.810	.785	.793	.7982	19.1	31.0	29.5	26.60	+ 0.03	.090	.133	.154	.124	.87	.76	.94	.85	Calm.	Calm.	N b E	N 16 E	0.0	0.0	9.4	3.36	4.07	...	...
17	.683	.548	.454	.5427	27.7	28.8	29.7	29.03	+ 2.67	.142	.137	.163	.150	.94	.86	.99	.93	N N E	E b N	E b N	N 73 E	13.2	24.4	21.5	20.23	20.49	...	4.0
18	.324	.305	—	—	31.7	31.7	—	—	—	.170	.177	—	—	.95	.99	—	—	E b N	E b N	S b W	S 69 E	21.2	10.5	7.5	4.21	11.01	...	6.0
19	.353	.395	.510	.4245	32.8	34.4	31.7	32.97	+ 6.90	.180	.158	.162	.164	.96	.79	.90	.87	S W b W	W b S	W S W	S 63 W	12.3	9.0	4.2	8.05	8.08	...	0.4
20	.398	.201	.273	.2928	30.3	31.7	27.7	29.60	+ 3.72	.148	.162	.142	.151	.88	.90	.94	.92	Calm.	N	W N W	N 40 W	0.0	4.8	8.2	5.34	5.84	...	1.5
21	.436	.559	.608	.5423	22.0	22.7	20.9	21.68	— 4.10	.111	.102	.095	.099	.93	.83	.85	.85	W N W	W b N	W b S	S 88 W	8.0	17.5	13.8	13.16	13.33	...	0.2
22	.613	.564	.485	.5452	16.5	20.5	14.4	17.02	— 8.67	.083	.100	.070	.085	.90	.91	.83	.89	W	W b N	W	N 88 W	9.2	10.0	3.4	6.78	6.82	...	...
23	.423	.370	.411	.4075	18.3	15.3	10.4	14.12	—11.45	.080	.071	.062	.071	.81	.82	.89	.86	W b S	W	N W b W	N 88 W	13.4	18.0	14.0	13.59	14.88	...	0.3
24	.591	.649	.657	.6402	0.3	11.1	12.2	7.78	—17.70	.044	.055	.071	.057	.97	.74	.94	.90	N	W	W b S	S 89 W	4.2	8.2	16.6	9.84	10.19	...	0.2
25	.604	.374	—	—	13.6	25.6	—	—	—	.067	.100	—	—	.83	.72	—	—	W b S	W S W	W S W	S 77 W	7.8	7.5	2.5	4.56	4.59	...	0.2
26	.238	.333	—	—	30.3	31.3	—	—	—	.148	.155	—	—	.88	.88	—	—	W b S	W N W	W N W	N 48 W	2.5	17.5	15.0	10.77	12.21	...	Inp.
27	.923	30.051	30.115	30.0352	14.9	6.6	0.6	6.07	—19.22	.076	.048	.040	.050	.89	.80	.88	.84	N b E	N b E	N b E	N 18 E	7.0	12.8	8.5	11.65	12.18	...	...
28	30.068	30.068	30.058	30.0728	—2.3	1.7	—0.4	-0.53	—25.68	.036	.038	.041	.038	.90	.80	.94	.88	N E	N E	N E b E	N 45 E	18.5	18.8	21.5	18.13	18.18	...	3.5
29	29.915	29.598	29.317	29.5987	1.0	6.4	12.9	7.02	—18.15	.041	.050	.075	.055	.88	.85	.96	.89	N E	N E	N E	N 48 E	17.6	19.8	13.0	13.57	14.07	...	4.0
30	.361	.389	.513	.4388	12.2	24.5	13.6	16.05	— 9.12	.071	.105	.055	.074	.94	.80	.67	.80	N N W	W S W	W S W	S 73 W	2.0	12.6	17.0	13.69	13.90	...	...
31	.724	.769	.838	.7852	—0.8	1.5	—2.6	-1.08	—26.22	.037	.033	.033	.035	.88	.73	.87	.85	W S W	W b S	W b S	S 75 W	18.5	19.4	16.4	14.64	14.71	...	...
M	29.7108	29.6862	29.7186	29.7092	16.52	21.03	17.23	17.89	— 9.20	.097	.110	.094	.099	.89	.83	.87	.87	....	....	....	....	9.99	11.28	11.28	......	10.77	1.035	37.4

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR DECEMBER.

Highest Barometer............................ 30.392 at 11 a. m., on 3rd } Monthly range=
Lowest Barometer .... 29.201 at 4 p. m. on 20th } 1.191 inches

Self-regist'ing Thermom.
- Maximum Temperature .... 54°8 on p. m. of 1st } Monthly range=
- Minimum Temperature .... − 6°0 on a. m. of 31st } 60°8
- Mean maximum Temperature .... 25°26 } Mean daily range=
- Mean minimum Temperature .... 12°94 } 12°32
- Greatest daily range .... 26°7 from p. m. of 10th to p. m. of 11th.
- Least daily range.................. 2°2 from a. m. to p. m. of 7th.

Warmest day......... 1st ... Mean temperature......... 44.37 } Difference = 45°45.
Coldest day........... 31st ... Mean temperature.........—1°08 }

Maximum Radiation. { Solar.................................. 60°5 on p. m. of 1st } Monthly range=
{ Terrestrial...............................—13°3 on a. m. of 8th } 73°8.

Aurora observed on 5 nights, viz., on 13th, 14th, 15th, 23rd, and 30th.
Possible to see Aurora on 11 nights; impossible on 20 nights.
Snowing on 23 days,—depth 37.4 inches; duration of fall 163.4 hours.
Raining on 3 days,—depth 1.035 inches; duration of fall 28.5 hours.
Mean of cloudiness = 0.73.
Most cloudy hour observed, 4 p. m., mean = 0.80; least cloudy hour observed, 10 p. m., mean, = 0.64.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
3046.27	1109.62	1631.23	4216.08.

Resultant direction N. 53° W.; Resultant Velocity 4.29 miles per hour.
Mean velocity........................... 10.77 miles per hour.
Maximum velocity .... 35.0 miles, from 1 to 2 a. m. on the 11th.
Most windy day......................... 17th...Mean velocity 20.49 miles per hour.
Least windy day .... 15th...Mean velocity 1.67 ditto.
Most windy hour... 11 p. m. to midnight...... Mean velocity 11.67 ditto. } Difference
Least windy hour... 5 to 6 a. m....................Mean velocity 10.22 ditto. } 1.45 miles.

1st. Fog 3 to 4 p. m. Very mild day.
3rd. Solar Halo from 8.30 a. m. to 2 p. m.
5th. Fog 2 to 4 p. m. Mild day.
6th. Dense Fog 10.15 a. m. to 7 p. m. Very mild day.
13th. Beautiful display of Auroral Light and Streamers tinged with purple and red in N.N.E. from 5 to 6.45 a. m.
17th and 18th. Stormy days. Wind very high, with heavy fall of snow.
28th and 29th. Very cold, stormy days; high wind, and heavy fall of snow.
31st. Lunar Corona from 6 to 7 p. m.
Very rapid change of Temperature from 1st to 2nd; Mean Temperature 1st =44°37—Mean Temperature 2nd=17°27—Difference 27°10. Maximum on 1st, 4 p. m. 54°8—Minimum on 2nd, 2 p. m. 17°5—Range in 22 hours =37°3.

The Resultant Direction and Velocity of the Wind for the month of December, from 1848 to 1859 inclusive, were respectively N 70° W, and 2.79 miles.

The Mean Temperature of December, 1859, was the coldest yet recorded at Toronto, having been no less than 3°2 below that of December, 1845, which was the coldest previously noted; and 8°08 lower than the average of 20 years.

The depth of snow was more than twice the mean quantity, and absolutely the greatest recorded here in December.

The Mean Velocity of the Wind was 2.75 miles per hour above the average of 12 years.

The month was, therefore, excessively cold, very windy, and remarkable for an unusual depth of snow.

COMPARATIVE TABLE FOR DECEMBER.

Year.	Temperature. M'n.	Diff. from Aver.	Max ob'd.	Min. ob'd.	Range.	Rain. No. of days.	Inch's.	Snow. No. of days.	Inch's.	Wind. Resultant Direction.	V'y.	Mean Force or Velocity.
	°	°	°	°	°							
1840	24.3	—1.7	41.0	—4.4	45.4	3	Inap.	18	...	...	...	....
1841	28.7	+2.7	45.5	+2.4	43.1	7	6.600	5	...	...	...	1.33 lbs.
1842	24.7	—1.3	40.3	+3.8	36.5	3	0.880	17	...	...	...	0.61
1843	30.0	+4.0	41.1	+2.7	38.4	6	1.040	8	8.1	...	...	0.53
1844	28.2	+2.2	48.9	—0.8	49.7	6	Imp.	6	4.2	...	...	0.40
1845	21.1	—4.9	37.6	—2.7	40.3	2	Inap.	12	4.7	...	...	0.70
1846	27.5	+1.5	49.2	+3.7	45.5	5	1.215	9	6.0	...	...	0.57
1847	30.1	+4.1	50.0	+6.6	43.4	7	1.185	8	6.8	...	...	0.35
1848	29.1	+3.1	49.1	+0.6	48.5	7	2.750	7	16.5	S 83° W	1.12	5.44 mls.
1849	26.5	+0.5	41.3	—5.2	46.5	5	0.840	12	9.6	N 82° W	2.56	6.23
1850	21.7	—4.3	48.3	—9.7	58.0	2	0.190	18	29.5	N 44° W	2.93	7.40
1851	21.5	—4.5	43.8	—10.5	54.3	6	1.075	15	10.7	N 82° W	4.00	7.37
1852	31.9	+5.9	51.0	+13.9	37.1	7	3.995	10	20.1	S 69° W	1.03	6.54
1853	25.3	—0.7	42.2	—5.2	47.4	4	0.625	13	22.3	N 35° W	2.39	4.98
1854	21.9	—4.1	41.8	—5.9	47.7	5	0.590	12	17.2	N 44° W	4.30	8.56
1855	26.8	+0.8	45.9	—2.1	48.0	6	1.845	10	29.5	S 88° W	5.29	11.38
1856	22.9	—3.1	41.2	—9.1	50.3	6	1.790	20	16.3	S 87° W	4.62	11.56
1857	31.9	+5.9	45.6	+5.7	39.9	7	3.205	14	9.0	N 89° W	2.51	6.84
1858	27.4	+1.4	43.6	+5.0	38.6	11	1.657	18	10.4	N 18° W	1.66	9.36
1859	17.9	—8.1	54.8	−3.3	58.1	3	1.035	23	37.4	N 53° W	4.29	10.77
M	25.97	...	45.11	−0.72	45.83	5.4	1.606	12.7	15.19	....	...	8.04 Ml.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—JANUARY, 1860.

Latitude—43 *deg.* 39.4 *min. North. Longitude*—5 *h.* 17 *m.* 33 *s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direc-tion.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10PM	ME'N		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 AM.	2 PM.	10 P.M.	Re-sult'.	ME'N		
					°	°	°	°	°												°							
1	29.853	29.875	—	—	—0.8	9.0	—	—	—	.034	.048	—	—	.81	.73	—	—	W	W S W	W b N	N 85 W	3.9	8.3	3.5	5.69	6.85	...	...
2	30.084	30.112	30.092	30.1037	—1.5	7.5	9.0	4.40	—20.80	.038	.049	.054	.045	.91	.78	.82	.83	N	N N W	W b S	N 87 W	6.6	3.2	11.4	4.45	6.54	...	0.2
3	29.918	29.705	29.713	29.7725	11.8	17.6	18.7	16.42	— 8.73	.063	.089	.089	.080	.86	.92	.87	.87	S W b S	W S W	W b S	S 66 W	16.2	15.5	10.5	12.54	12.68	...	1.5
4	.675	.791	30.079	.8667	20.2	10.8	—1.2	9.32	—15.82	.097	.045	.039	.060	.89	.63	.94	.83	W b S	N W b W	W N W	N 58 W	8.0	29.0	4.8	11.08	11.43	...	0.2
5	30.108	30.103	30.117	30.1113	6.1	18.0	14.4	12.33	—12.80	.048	.071	.076	.064	.82	.73	.91	.83	N W b W	W b S	W S W	S 77 W	2.2	13.8	9.0	9.60	9.77	...	...
6	29.989	29.720	29.632	29.7575	13.3	27.7	31.4	24.32	— 0.82	.070	.106	.158	.108	.89	.69	.89	.79	W b S	S W b S	S W b W	S 52 W	8.4	10.0	10.0	9.76	9.92	...	inap.
7	.442	.290	.438	.3925	33.9	36.8	35.3	35.18	+10.05	.190	.205	.185	.193	.97	.93	.90	.93	S W	S W b W	W b S	S 54 W	4.0	7.5	1.3	3.68	3.78	0.200	...
8	.400	.382	—	—	34.2	37.5	—	—	—	.196	.186	—	—	.99	.83	—	—	S W b S	S W b W	W b N	S 68 W	5.6	9.6	7.0	7.03	8.00	inap.	...
9	.820	.732	.555	.6948	32.4	33.9	35.0	33.82	+ 8.68	.161	.164	.185	.171	.87	.84	.91	.87	Calm.	E	E b N	S 89 E	0.0	12.5	5.6	6.04	6.18	0.170	inap.
10	.546	.596	.523	.5495	36.1	41.5	37.0	38.22	+13.17	.205	.212	.219	.206	.96	.80	.99	.90	E b N	W b S	S b E	N 15 E	1.2	3.0	2.5	3.41	7.73	0.340	0.1
11	.507	.739	.919	.7430	28.5	19.8	13.3	19.60	— 5.45	.147	.091	.058	.096	.94	.84	.73	.87	N N W	N W b N	N b W	N 25 W	26.6	19.0	2.0	11.07	11.27	...	0.2
12	.856	.739	.830	.8120	10.4	22.3	21.2	18.85	— 6.23	.062	.079	.085	.079	.89	.66	.75	.77	Calm.	S W b W	W S W	S 78 W	0.0	14.5	12.5	8.51	11.63	...	...
13	30.049	.950	.845	.9500	10.0	18.0	12.9	12.32	—12.77	.054	.097	.069	.068	.78	.98	.89	.88	N b E	E	N E b N	N 43 E	10.0	8.5	2.7	5.00	5.23	...	0.5
14	29.678	.457	.322	.4728	10.0	25.9	24.8	20.08	— 5.02	.061	.113	.120	.097	.89	.81	.90	.87	Calm.	Calm.	Calm.	S 67 W	0.0	0.0	0.0	2.24	2.51	...	...
15	.192	.155	—	—	26.6	33.5	—	—	—	.134	.170	—	—	.93	.88	—	—	W S W	W S W	S W b W	S 56 W	14.5	12.3	17.5	13.89	14.10	...	...
16	.244	.325	.476	.3598	35.7	37.5	27.7	32.98	+ 7.98	.180	.177	.113	.151	.86	.79	.74	.79	W S W	W S W	N W b N	N 65 W	10.0	6.0	13.2	6.30	8.46	inap.	...
17	.488	.480	.489	.4908	20.1	22.7	18.7	20.20	— 4.82	.098	.077	.089	.087	.91	.64	.87	.81	N W b N	N b W	N b E	N 17 W	5.5	5.8	2.4	4.57	4.81	...	0.1
18	.414	.305	.363	.3637	18.3	28.1	26.6	25.25	+ 0.28	.080	.130	.134	.118	.81	.84	.93	.86	Calm.	S W	W b N	S 78 W	0.0	10.0	10.5	7.75	10.18	...	2.0
19	.555	.563	.407	.5103	19.8	24.1	28.5	24.33	— 0.55	.095	.107	.104	.105	.90	.82	.65	.80	N W b N	W S W	W S W	S 73 W	12.8	12.0	14.4	11.67	13.12	...	inap.
20	.480	.435	.289	.3927	26.6	38.4	38.2	34.68	+ 9.83	.126	.157	.177	.155	.87	.67	.77	.77	W S W	S W b N	S W	S 52 W	7.6	8.4	12.5	9.65	9.81	...	...
21	.329	.422	.540	.4415	33.5	40.7	29.5	33.98	+ 9.20	.156	.170	.136	.152	.81	.66	.83	.77	W S W	W b N	N W	N 79 W	7.0	8.6	2.8	4.16	4.58	...	...
22	.450	.472	—	—	24.1	37.1	—	—	—	.114	.182	—	—	.87	.83	—	—	Calm.	W	W b N	N 79 W	0.0	15.2	13.5	10.33	10.83	...	0.2
23	.872	.854	.784	.8377	24.5	33.5	32.1	30.15	+ 5.48	.088	.125	.150	.119	.67	.65	.82	.70	W N W	W S W	S W	S 56 W	1.0	5.2	4.4	4.11	4.49	...	...
24	.635	.360	.282	.4218	35.0	42.9	45.4	41.48	+16.92	.185	.185	.263	.203	.91	.66	.86	.77	S W	S W	W S W	S 70 W	6.0	14.0	14.0	12.54	13.49	0.030	...
25	.483	.606	.726	.6212	36.0	34.1	27.0	31.92	+ 7.33	.119	.104	.129	.113	.56	.52	.88	.64	W	W b N	N W b W	N 66 W	15.5	28.0	22.0	18.88	19.28	...	...
26	.866	.736	.687	.7510	20.1	21.6	20.5	20.68	— 3.80	.091	.087	.073	.082	.85	.75	.67	.75	N W b W	Calm.	Calm.	N 59 W	14.0	0.0	0.0	1.51	1.51	...	...
27	.603	.494	.591	.5568	20.2	27.4	13.6	19.57	— 4.78	.090	.113	.061	.088	.84	.75	.76	.81	N W b N	W N W	Calm.	N 71 W	1.0	17.5	0.0	5.63	8.63	...	1.0
28	.265	.388	.774	.4923	23.0	18.7	11.5	17.13	— 7.17	.106	.082	.061	.083	.86	.81	.83	.84	S E	N	N W b N	N 3 W	11.0	11.5	3.5	4.50	7.60	...	2.5
29	.682	.477	—	—	9.7	31.7	—	—	—	.057	.139	—	—	.85	.77	—	—	Calm.	S W	S W	S 56 W	0.0	22.2	16.5	14.30	16.29	...	...
30	.401	.374	.330	.3790	27.4	30.3	33.2	28.35	+ 4.25	.102	.119	.122	.108	.68	.70	.64	.68	W N W	S W b W	W S W	N 86 W	21.3	14.6	18.0	16.43	20.31	...	0.1
31	.705	.856	.991	.8717	7.9	4.3	—3.3	2.35	—21.63	.055	.035	.024	.037	.89	.66	.66	.74	N b E	N b E	N	N 9 E	8.0	10.0	11.0	9.19	9.36	...	0.1
M	29.6543	29.6205	29.6459	29.6429	21.51	26.31	23.12	23.38	— 1.42	.106	.115	.114	.110	.85	.75	.82	.81	....	....	....	....	7.35	11.47	8.35	......	9.37	0.740	8.7

Highest Barometer . . . . 30.142 at 8 a. m. on 2nd, } Monthly range=
Lowest Barometer . . . . 29.155 at 2 p. m. on 15th, } 0.987 inches.

Self-registering Ther.
Maximum temperature . . . . 46°4 on p.m. of 24th } Monthly range=
Minimum temperature . . . . —6°8 on a.m. of 5th } 53°2
Mean maximum temperature . . 29°83 } Mean daily range = 12°25.
Mean minimum temperature . . 17°58 }
Greatest daily range . . . . . . 30°5 from a. m. to p.m. on 29th.
Least daily range . . . . 3.5 from a. m. to p.m. on 26th.

Warmest day . . 24th ... Mean Temperature . . . 41°48 } Difference=39°13.
Coldest day . . . 31st ... Mean Temperature . . . 2°35 }

Maximum Radiation { Solar . . . . 62°4 on p. m. of 21st } Monthly range=
{ Terrestrial . . . . —17.5 on a. m. of 5th } 79°9.

Aurora observed on 5 nights, viz.: 11th, 20th, 21st, 27th, and 28th; possible to see Aurora on 16 nights; impossible on 15 nights.
Snowing on 16 days; depth 8.7 inches: duration of fall 50.5 hours.
Raining on 6 days; depth, 0.740 inches; duration of fall, 24.2 hours.
Mean of cloudiness=0.71; most cloudy hour observed, 8 a. m., mean=0.86: least cloudy hour observed, midnight, mean=0.47.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1949.15	1848.88	382.98	4887.57

Resultant direction, N 89° W; Resultant Velocity, 6.09 miles per hour.
Mean velocity of the wind 9.37 miles per hour.
Maximum velocity . . . 33.5 miles per hour, from 1 to 2 a.m., on 31st.
Most windy day . . 30th—Mean velocity, 20.31 miles per hour. } Difference
Least windy day . . 26th—Mean velocity, 1.51 do } 18.80 miles.
Most windy hour, 1 to 2 p. m.—Mean velocity, 12.11 do } Difference
Least windy hour, 7 to 8 a.m.—Mean velocity, 7.33 do } 4.78 miles.

2nd. Imperfect Lunar Halo, from 9.30 p. m.—6th. Perfect Lunar Halo, from 11.30 p. m.—9th. Lunar Halo at 9 p. m.—12th. Lunar Halo at midnight.—14th. Dense Fog from 6 to 8 a. m.—29th. Lunar Halo during the evening.—30th. Stormy, but very mild day.—31st. Well defined Lunar Halo, from 6.40 to 7.50 p. m.

Great change of temperature from 30th to 31st. Mean temperature, 30th, = 23°35 Mean temperature, 31st, = 2°35. Difference, 26°00. Maximum on 30th at 4 p. m., 34°0. Minimum on 31st, at midnight, —5°1. Range in 32 hours = 39°1.

The Resultant Direction and Velocity of the Wind for the month of January, from 1848 to 1860 inclusive, were respectively N. 76° W., and 2.99 miles.

The mean Temperature for the month of January, 1860, differed but little from the average of 21 years. The Rain and Snow, were both less than the average; the former, by 0.703—the latter, by 4.54 inches. The velocity of the Wind, was 1.62 miles per hour above the average of 13 years. The month was therefore dry, and windy, and was characterized by some very rapid changes of temperature.

COMPARATIVE TABLE FOR JANUARY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant Direction.	Resultant Velocity.	Mean Velocity
	°	°	°	°	°					°		
1840	17.0	— 6.7	40.6	—13.8	54.4	4	1.395	11	...	...	...	...
1841	25.6	+ 1.9	41.7	— 4.1	45.8	2	2.150	14	...	...	...	0.36 lbs
1842	27.9	+ 4.2	45.8	1.3	44.5	5	2.170	9	...	...	...	0.78 "
1843	28.7	+ 5.0	54.4	1.5	52.9	6	4.295	12	14.2	...	...	0.69 "
1844	20.2	— 3.5	44.6	— 7.7	52.3	7	3.005	11	24.9	...	...	0.70 "
1845	26.5	+ 2.8	43.0	— 3.4	46.4	5	...	9	22.7	...	...	0.70 "
1846	26.7	+ 3.0	41.2	0.3	40.9	5	2.335	10	6.0	...	...	0.55 "
1847	23.3	— 0.4	42.6	— 2.2	44.8	7	2.135	5	7.5	...	...	1.09 "
1848	28.7	+ 5.0	51.5	—12.0	63.5	7	2.245	8	7.1	N 82 W	2.03	5.82ms.
1849	18.5	— 5.2	40.1	—15.2	55.3	4	1.175	10	9.2	N 63 W	3.06	6.71 "
1850	29.7	+ 6.0	46.3	10.6	35.7	5	1.250	8	5.2	N 37 W	0.69	5.80 "
1851	25.5	+ 1.8	43.2	—12.8	56.0	4	1.275	10	7.8	S 77 W	3.26	7.69 "
1852	18.4	— 5.3	37.3	— 7.0	44.3	0	0.000	19	30.9	N 68 W	3.14	7.67 "
1853	23.0	— 0.7	40.9	— 6.6	47.5	1	0.290	6	7.5	N 27 W	2.52	6.34 "
1854	23.6	— 0.1	45.2	— 4.3	49.5	7	1.270	11	7.5	N 77 W	2.44	6.91 "
1855	25.9	+ 2.2	48.2	— 4.7	52.9	5	0.525	13	23.3	N 73 W	1.91	7.26 "
1856	16.0	— 7.7	33.1	—12.1	45.2	0	0.000	14	13.6	N 75 W	5.24	10.69 "
1857	12.8	—10.9	34.6	—20.1	54.7	3	inapp.	16	21.8	N 70 W	4.96	10.31 "
1858	30.0	+ 6.3	45.8	7.5	38.3	6	1.152	11	4.0	S 81 W	2.33	7.40 "
1859	26.4	+ 2.7	41.5	—26.5	68.0	6	1.449	19	16.4	N 71 W	3.17	8.76 "
1860	23.4	— 0.3	45.4	— 5.1	50.5	6	0.740	16	8.7	N 89 W	6.09	9.37 "
Mean	23.70	...	43.19	—6.50	49.69	4.5	1.443	11.5	13.24	...	...	7.75

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—DECEMBER, 1859.

(NINE MILES WEST OF MONTREAL,)

BY CHARLES SMALLWOOD, M.D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Velocity in miles per hour.			Rain in inches.	Snow in inches.	Weather, &c. A Cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.			6 A.M.	2 P.M.	10 P.M.
1	29.681	29.523	29.865	20.2	35.0	42.1	.091	.190	.261	.85	.95	98	N E b E	W b N	S S W	3.00	0.60	14.12	0.174	...	Cu. Str. 10.	Rain.	Cu. Str.
2	30.111	30.062	30.096	22.3	17.6	9.0	084	072	051	71	75	77	N b W	N b E	E b S	16.27	4.30	4.46	...	1.90	Do. 10.	Cu. Str. 10.	Snow. [Lu. Ha.
3	625	661	724	—12.0	10.0	— 3.0	019	054	032	56	78	82	W b S	E b N	N E	16.21	4.01	0.71	...	...	Clear.	Clear.	C. Cu. Str. 10.
4	575	356	361	— 5.0	15.4	10.1	032	080	054	83	91	78	N E b E	N E b E	N E b E	15.17	12.43	28.30	...	3.50	Snow.	Snow.	Snow.
5	323	220	252	11.0	23.7	24.2	062	117	123	89	90	93	N E b E	N E b E	N N E	11.93	8.12	4.02	...	...	Cu. Str. 10.	Cu. Str. 10.	Cu. Str. 10.
6	099	29.934	29.982	26.1	36.4	39.2	140	191	232	98	90	96	N E b E	E S E	S E b E	0.71	3.42	6.94	0.360	...	Do. 10.	Gentle Rain.	Rain.
7	29.605	616	980	35.0	32.6	27.4	197	176	129	95	93	88	S S W	S W	W b S	14.42	4.41	14.70	0.946	...	Rain.	Rain.	Cu. Str. 8.
8	30.109	30.201	30.214	— 0.9	12.2	3.2	036	045	043	84	60	80	W b S	W b S	S E b E	18.42	2.65	2.41	...	...	Clear.	Clear.	Do. 2.
9	177	29.950	29.823	1.1	19.1	19.0	040	077	081	85	76	78	S E b E	S E b E	S E b E	1.41	4.46	8.22	...	0.70	Cu. Str. 2.	Snow.	Snow.
10	29.957	30.136	30.180	17.1	9.2	1.0	081	080	040	91	70	85	W b S	W b S	S S W	9.42	1.51	16.75	...	2.60	Snow.	Cu. Str. 4.	Clear.
11	845	29.788	29.466	1.0	9.0	12.2	040	051	066	85	77	91	N E b E	N E b E	N E b E	1.22	2.43	2.65	...	1.10	Cu. Str. 10.	Snow.	Snow.
12	500	663	810	— 2.0	—6.6	—10.6	034	028	021	84	81	77	W	W b S	S S W	21.48	15.42	7.82	...	...	Clear.	Clear.	Clear.
13	30.118	30.228	30.337	—13.9	6.9	—10.0	120	046	022	76	76	79	S	S b W	N N W	8.41	1.48	0.80	...	...	Do.	Do.	Do.
14	318	100	201	— 2.5	8.5	2.8	032	057	044	83	88	86	N E b E	N E b E	N E b E	10.95	2.92	6.27	...	0.70	Cu. Str. 10.	Cu. Str. 10.	Snow.
15	29.936	29.937	139	11.0	19.7	14.3	062	081	072	89	77	88	S W	S b W	S W	26.90	7.30	4.60	...	...	Do. 10.	Clear.	Clear.
16	30.138	30.102	22[illegible]	18.1	23.8	16.1	084	100	074	90	80	83	S	N E	N E b E	1.00	0.01	0.08	...	...	Do. 10.	Cu. Str. 9.	Do.
17	235	214	118	13.6	20.2	19.1	063	074	087	80	69	83	N E b E	N E b E	N E b E	0.00	3.50	12.08	...	...	Clear.	Clear.	Do.
18	29.923	29.782	29.762	18.9	20.1	20.1	088	096	096	84	85	83	N E	N E b E	N E b E	11.41	15.62	15.80	...	4.40	C. C. St. 10.	Snow.	Snow.
19	712	701	695	21.1	28.4	32.9	096	129	162	85	83	89	N E b E	S W	S b W	17.20	0.88	1.85	...	0.20	Do. 10.	Do.	Cu. Str. 10.
20	740	600	410	30.0	34.1	38.3	154	158	224	91	79	90	S W b S	N E b E	N E b E	7.40	0.21	5.41	...	0.90	Do. 10.	Snow.	Snow.
21	500	627	796	20.1	21.1	10.9	097	100	088	92	85	80	W S W	W b S	S	3.30	11.72	23.07	...	1.70	Do. 10.	Cu. Str. 8.	Cu. Str. 2.
22	850	800	808	5.0	20.1	— 0.2	041	085	034	74	83	80	S b E	S S E	S S E	6.99	1.62	1.40	...	...	Do. 4.	Clear.	C. F. Au. B. Z. L.
23	681	880	573	5.0	22.8	19.0	041	095	090	76	75	90	N E	S E	S b E	0.33	0.45	7.79	...	1.40	Do. 10.	Cu. Str. 10.	Snow.
24	692	803	898	—10.0	—7.8	—16.9	024	021	015	79	76	71	W	W	W S W	25.56	0.10	4.50	...	...	Do. 2.	Clear.	Clear.
25	890	816	838	—20.1	—0.5	— 4.0	012	023	032	67	88	86	N b E	S E	N E b E	0.50	0.01	6.17	...	0.75	Do. 10.	C. Str. 8.	Snow.
26	628	520	700	— 6.4	5.6	6.6	028	049	048	81	87	88	N E	N E b E	N E	21.36	6.70	5.20	...	1.06	Snow.	Snow.	Clear Au. Bor.
27	30.076	30.270	30.397	— 9.1	—1.3	—16.5	019	034	015	60	86	71	W	N W	W	19.60	11.05	7.52	...	...	Clear.	Clear.	Do.
28	460	440	535	—29.2	—0.5	—23.5	007	034	010	53	80	60	W	S W	N W b W	0.52	0.00	0.00	...	...	Do.	Do.	Do. Ft. Au. B.
29	452	269	085	—32.6	—9.9	—14.0	008	017	015	52	57	70	S S E	E S E	E b S	0.01	1.00	2.22	...	...	Do.	Do.	Hazy.
30	29.781	29.710	29.701	— 4.0	8.0	6.3	031	056	051	80	82	87	N E b E	E b N	S W	17.37	3.67	1.50	...	2.96	Snow.	Snow.	C. Str. 10.
31	907	823	965	3.2	9.0	2.5	036	046	042	72	76	86	W	W	S b W	15.16	7.01	4.10	...	...	Cu. Str. 10.	Clear.	Do. 2.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—JANUARY, 1860.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Movement in Miles in 24 hours.	Mean of Ozone.	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.912	30.001	30.091	—12.0	— 2.1	—16.9	.020	.034	015	.76	.83	70	w n w	n w	w b s	5.30	0.6	...	...	Clear.	Clear.	Clear.
2	30.240	278	337	—21.9	— 1.0	—15.0	009	028	019	40	68	70	w b s	w b s	w b s	172.60	1.0	...	...	Do.	Cu. Str. 7.	Do.
3	439	241	105	—25.4	—14.2	— 6.8	008	013	026	58	51	80	w b s	n e b e	n e b e	19.80	1.0	...	1.30	Cu. Str. 4	Do 10.	Snow.
4	29.930	29.926	135	— 2.0	16.0	— 2.1	036	067	028	84	68	68	n e	n e b e	w n w	74.10	1.3	...	1.51	Snow.	Snow.	Cu. Str. 4.
5	30.313	30.298	298	—14.6	8.0	0.0	017	048	038	70	77	55	w	w b s	s s w	104.70	1.6	...	...	Cu. Str. 4.	Clear.	Do. 10.
6	236	067	29.893	8.4	24.4	21.0	057	088	085	88	67	78	s w	s s w	s	152.80	2.6	...	...	Do. 10.	Cu. Str. 10.	Do. 10.
7	29.874	29.651	583	29.2	33.4	36.9	087	162	199	83	84	90	s	s b w	w s w	8.80	3.3	0.110	Inp.	Do. 10.	Do. 10.	Rain.
8	597	630	723	32.4	38.8	37.0	168	201	178	92	85	81	s w b s	s w	w n w	220.00	4.3	...	...	Do. 10.	Do. 10.	Cu. Str. 10.
9	30.165	30.049	30.073	21.0	28.9	20.9	085	123	085	78	77	78	w n w	s w b s	n e b e	116.10	0.6	...	...	Clear.	Clear.	Do. 10.
10	29.851	29.746	29.750	31.4	36.6	35.0	168	200	197	95	93	94	s b e	e n e	e s e	69.40	3.3	Inap	2.11	Cu. Str. 10.	Rain.	Do. 10.
11	649	754	30.103	33.7	19.8	5.0	182	092	046	94	92	85	w b s	n e b e	w n w	58.90	4.3	0.210	0.75	Rain.	Snow.	Do. 10.
12	30.107	30.158	29.843	— 6.5	15.1	21.0	028	070	085	81	81	78	n b w	s w b s	s w b w	152.50	1.0	...	...	Clear.	Cu. Str. 10.	Do. 9.
13	455	406	30.342	—24.6	— 3.2	— 6.7	009	025	021	60	61	62	n n w	e	n e b e	262.70	0.6	...	...	Do.	Clear.	Do. 10.
14	177	29.946	29.694	— 8.4	2.0	7.0	025	036	049	80	72	86	n e b e	n e b e	n e b e	114.40	1.0	...	2.75	Cu. Str. 10.	Do.	Clear.
15	29.436	220	319	5.1	25.5	32.1	041	111	162	74	81	89	n e b e	w	n w b n	106.70	3.0	...	0.46	Do. 10.	Cu. Str. 8.	Snow.
16	304	276	460	32.0	40.1	33.8	168	225	162	89	90	84	w s w	w s w	w	235.30	4.6	...	...	Do. 8.	Do. 9.	Clear.
17	694	710	785	10.1	12.0	0.0	054	051	038	78	70	85	w	w	w	169.50	2.6	...	...	Do. 8.	Clear.	Do.
18	805	794	708	—12.2	6.0	3.0	016	043	040	70	75	85	s s w	n e b e	n e b e	61.30	1.0	...	0.60	Do. 4.	Cu. Str. 9.	Snow.
19	642	710	756	2.4	14.2	17.1	040	067	078	86	80	81	n e b e	w s w	w s w	172.10	1.3	...	1.00	Do. 10.	Clear.	Cu. Str. 10.
20	560	570	454	24.6	33.4	29.0	105	162	142	80	84	88	w	w s w	s e	122.30	1.3	...	0.70	Do. 10.	Cu. Str. 4.	Do. 2. Au. Br.
21	320	314	680	18.4	38.3	34.3	129	201	190	83	86	95	w s w	w b n	w b s	110.10	4.2	...	...	Do. 4.	Do. 10.	Do. 4.
22	691	497	614	24.2	31.9	29.1	106	148	142	83	80	88	s e b e	n e b e	s e b e	197.50	2.3	...	...	Eo. 10.	Do. 10.	Clear.
23	976	918	30.029	15.4	33.3	20.3	072	162	089	82	84	80	w	c s w	s b w	166.10	3.0	...	0.50	Do. 4.	C. C. Str. 4.	Do.
24	970	464	29.301	20.9	36.4	35.6	097	191	197	85	90	95	s s e	s e b e	n e b e	19.00	3.6	0.140	...	Do. 10.	Cu. Str. 19.	Rain.
25	280	314	639	23.2	32.2	22.1	179	167	084	98	98	71	w b s	w b s	w n w	549.20	8.0	0.014	...	Do. 8.	Do. 8.	Clear.
26	914	974	981	20.0	16.2	6.1	091	068	048	85	76	75	w b n	w b s	s w	340.10	1.3	...	...	Do. 4.	Clear.	Do.
27	979	709	794	— 2.0	13.0	7.0	034	054	050	84	71	88	e s e	n e b e	n n w	22.80	2.0	...	0.52	Clear.	Cu. Str. 10.	Snow.
28	775	594	904	1.0	12.2	0.5	032	045	030	70	60	69	w	w b s	w b s	132.90	1.0	...	...	Cu. Str. 10.	C. C. Str. 4.	Clear.
29	30.037	880	615	— 7.4	23.3	22.9	024	078	095	79	59	79	w s w	s s w	s b w	84.80	2.0	...	...	Clear.	Clear.	Cu. St. 10.
30	29.320	437	421	28.4	28.2	28.7	129	117	129	82	75	82	w n w	w b n	s s w	294.50	5.0	...	0.70	Cu. Str. 10.	Snow.	Do. 10.
31	942	30.067	30.239	2.0	0.0	— 4.0	034	032	031	71	70	83	w b s	n w	n w	483.30	3.0	...	1.00	Do. 6.	Cu. Str. 10.	C. 4. Lu. Halo.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR DECEMBER, 1859.

Barometer	Highest, the 3rd day	30.726
	Lowest, the 20th day	29.410
	Monthly Mean	29.971
	Monthly Range	1.316
Thermometer	Highest, the 1st day	42°1
	Lowest, the 29th day	—32°6
	Monthly Mean	8°93
	Monthly Range	74°7
Greatest intensity of the Sun's rays		38°0
Lowest point of terrestrial radiation		—36°6
Mean of Humidity		.808

Rain fell on 3 days, amounting to 1.480 inches; it was raining 26 hours 20 minutes.
Snow fell on 14 days, amounting to 23.87 inches; it was snowing 150 hours 30 miuutes.
Most prevalent wind, N. E. by E.
Least prevalent wind, S.
Most windy day, the 4th day; mean miles per hour, 15.30.
Least windy day, the 28th day; mean miles per hour. 0.14.
Aurora Borealis visible on 3 nights.
Lunar Halo visible on 1 night.
Zodiacal Light visible on 1 night.
Ozone was present in large quantities.
The Electrical state of the atmosphere has indicated high tension.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR JANUARY, 1860.

Barometer	Highest, the 13th day	30.455
	Lowest, the 21st day	29.314
	Monthly Mean	29.861
	Monthly Range	1.141
Thermometer	Highest, the 16th day	46°4
	Lowest, the 3rd day	—25°4
	Monthly Mean	13°15
	Monthly Range	71°8
Greatest Intensity of the Sun's Rays		66°4
Lowest point of Terrestrial Radiation		—27°1
Mean of Humidity		.786

Rain fell on 5 days, amounting to 0.474 inches; it was raining 24 hours and 40 minutes.
Snow fell on 14 days, amountiug to 11.90 inches; it was snowing 74 hours and 40 minutes.
Most prevalent wind, the W. by S.
Least prevalent wind, E.
Most windy day, the 25th day; mean miles per hour, 24.88.
Least windy day, the 1st day; mean miles per hour, 0.21.
Aurora Borealis visible on 1 night.
Lunar Halo visible on 1 night.
Solar Halo visible on 1 day.
The electrical state of the atmosphere has indicated moderate intensity.

MEAN RESULTS OF METEOROLOGICAL OBSERVATIONS AT HAMILTON, C.W., FOR THE YEAR 1859.

1859.	THERMOMETER.					BAROMETER.			DAYS.			YEARS.
Months.	Mean at 9 a. m.	Mean at 9 p. m.	Mean of both.	Highest.	Lowest.	Mean.	Highest.	Lowest.	Rainy.	Slight Showers.	Dry.	Mean Temperature of
January	26°.45	27°.9	27°.175	49°	—29°	29.707	30.20	28.96	5	7	19	1847...48.163
February	27.7	29.5	28.6	54	— 3	.614	29.94	.94	1	10	17	1848...49.295
March	37.096	38.526	37.811	63	17	.437	30.17	.44	4	8	19	1849...48.105
April	41.11	40.8	41.11	65	20	.512	.00	29.00	2	7	21	1850...48.732
May	58.77	57.13	57.95	86	36	.688	.00	.36	3	5	23	1851...48.756
June	64.33	61.73	63.03	92	37	.681	.00	.37	1	6	23	1852...48.248
July	72.51	70.65	71.58	97	50	.518	.12	.35	2	9	20	1853...49.474
August	70.00	69.66	69.83	87	4	.672	29.85	.39	1	7	23	1854...49.102
September	58.36	58.73	58.66	79	32	.698	30.06	.16	2	8	20	1855...47.316
October	45.58	46.29	45.935	76	25	.66	29.96	.28	4	6	21	1856...44.888
November	39.53	41.60	40.57	73	24	.679	30.20	.00	3	6	21	1857...45.868
December	21.36	22.26	21.81	60	— 6	.574	.17	.10	5	13	13	1858...48.142
Mean Temp...	......	......	46.996	...	......	29.637	......	...	33	92	240	......

THE CANADIAN JOURNAL.

NEW SERIES.

No. XXVII.—MAY, 1860.

ON THE DEVONIAN FOSSILS OF CANADA WEST.

BY E. BILLINGS, F.G.S.

Extracted from the Report of the Geological Survey of Canada for 1860,—*in preparation.*

The Devonian Rocks of Canada West consist of portions of the Oriskany Sandstone, Schoharie Grit, Onondaga Limestone, Corniferous Limestone, Hamilton, Portage, and Chemung Groups. The fossils of the first of these formations are about to be published by Professor Hall, in his forthcoming third volume of the *Palæontology of New York;* and I shall therefore postpone the examination of such as we have from that rock until after the appearance of that work. Under the term Corniferous Limestone, as it will be used hereafter throughout this paper, are included all those rocks which would probably in the State of New York be divided into three groups,—the Schoharie Grit, Onondaga Limestone, and Corniferous Limestone. At any rate, the two latter seem to be in Canada united by their palæontological characters. The Hamilton Shales we classify as a separate formation immediately overlying the Corniferous Limestone. The Portage and Chemung Groups are also distinct; but I shall leave the examination of their fossils for some future occasion.

These rocks are, in Canada West, highly fossiliferous, and in some places even densely crowded with the remains of extinct species of corals, encrinites, molluscs, trilobites, and large fishes. The fossils, however, are for the greater part in so imperfect a condition, that few of the species can be well defined from the collections made thus far, and, on account of the scarcity of good specimens, many years must elapse before anything approaching to a complete description of the whole fauna of the period can be produced. To accomplish this within a reasonable time, will require the co-operation of many local observers, each devoting his leisure hours to the minute examination of all the rocks in the neighbourhood of his residence, and each influenced to do so by the desire of promoting the cultivation of the sciences in this Province. With a number of such men distributed throughout the fossiliferous regions of Canada, the work will advance rapidly. Without some voluntary assistance of this kind, the progress must be extremely gradual, so difficult is it to procure good specimens of most of the species. Few are aware of the importance of long-continued researches in a single locality, or even in a single quarry. I devoted the greater part of the spare time of seven years to the examination of an area of which all the exposed patches of rock, if put together, would not make a superficies of one square mile, and yet its treasures were not exhausted. Since I left, others have entered the same field, and have been rewarded by the discovery of many interesting new facts. There are hundreds of such localities in Canada yet to be explored; and if there were a good observer in or near each of them, and if all would freely communicate the fruits of their labours, the combined results could not be otherwise than important to science, and highly creditable to the country.

In making collections, the mode of procedure is exceedingly simple. All that is to be done is to examine the rocks, and if they contain fossils, collect them. The specimens should then be sent where the species can be determined. Unless the observer publishes some account of his facts, or (in case he does not feel competent to do so himself) communicates them to some other person who can and will give them publicity, the labour is lost. In the following and other articles to be published in this Journal hereafter, I intend to give figures and descriptions of many of our Devonian Fossils, and hope that they may be, to some extent, useful in assisting the local observer to name his specimens. That he can name all that he may find, by comparing them with the figures and descriptions, I am well aware, from my own experience, is impossible. There are numerous species concerning which the most experienced practical naturalists would remain in doubt, although assisted in the examination by all the aids that can be drawn from extensive libraries of scientific works. Let no beginner, therefore, feel disappointed or discouraged should he fail to satisfy himself that he has succeeded in naming his specimens correctly from books. These papers will be of some service; but I shall also be most happy to examine and name (so far as I can) collections from any part of the Province, on condition that I shall be permitted to describe the new forms, and retain, for the Provincial Collection, a specimen of each species of which we have not already examples in the Museum. This would be beneficial to all parties, and greatly promote the advance of science in this country. I earnestly hope, that at least a few of those who reside in the vicinity of fossiliferous Devonian rocks in Canada West, may be induced to render me their assistance in this way. The specimens should be carefully wrapped up in paper and packed in a strong box, and sent to the Geological Survey at Montreal. Delicate fossils should be protected, by being placed in a separate box, otherwise they will be crushed by the others. When a fine fossil, such as a well preserved trilobite, encrinite, or othoceratite, is imbedded in a piece of stone, no attempt should be made to chisel it out. Unless the operation is performed by a most experienced hand, in nine cases out of ten the specimen will be greatly injured, if not totally destroyed. The locality of each specimen should be given. I am particularly desirous of procuring specimens of fossil shells which exhibit the inner surface, since it is from such that the characters of the genera can be best worked out. As soon as they are examined, the specimens will be sent back, free of expense.

ZOOPHYTA.

In a paper published in the *Canadian Journal* for March, 1859, I gave an account of forty-three species of corals from the Devonian rocks of Canada West. In the following article I shall describe eleven new species; and there are from ten to fifteen others which must remain until better specimens can be procured. I think it probable that altogether there are eighty species of corals in these rocks in Canada, and many of them were so prolific, that the zoophyta must have constituted four-fifths in bulk of the whole fauna of the period. In England and in Germany, the grand coralline horizon of the Devonian era lies in the middle of the series. The fauna of the Corniferous Limestone and Hamilton Shales would therefore appear to be more nearly related to the middle than to the lower Devonian of Europe. Such is the position assigned to them in the third edition of Sir Roderick Murchison's noble work, *Siluria.* But if it can be shewn that the coralline beds of Canada include the Schoharie Grit of New York (as I strongly suspect they do), then this latter formation must also be added to the middle Devonian. On this latter point, however, I can give no positive opinion, as the fossils of the Schoharie Grit of New York are totally unknown to the scientific world.

The following may be given as a table shewing approximately the position of the different American sub-divisions of the Devonian system, as indicated by the evidence of the fossil corals:

Old Red Sandstone, or Catskill Group	Upper Devonian.
Chemung Group	Upper Devonian.
Portage Group	Upper Devonian.
Genesee Slate	Middle Devonian.
Tully Limestone	Middle Devonian.
Hamilton Group	Middle Devonian.
Marcellus Shale	Middle Devonian.
Corniferous Limestone	Middle Devonian.
Onondaga Limestone	Middle Devonian.
Schoharie Grit	Middle Devonian.
Cauda-galli Grit	Lower Devonian.
Oriskany Sandstone	Lower Devonian.

It is important to observe, that in Gaspé we find some of the characteristic fossils of the Oriskany Sandstone intermingled in the same beds with those of the Upper Pentamerus Limestone, and therefore it may be that when these Gaspé rocks are studied, we shall find it difficult to draw the line between the Lower Devonian and the Lower Helderberg.

Genus STRIATOPORA.—(Hall.)


Fig. 1.


Fig. 2.


Fig. 3.


Fig. 4.

Fig. 1. *Striatopora Linneana.*
Figs. 2, 3, 4. *Trachypora elegantula.*—Fig. 4 is a portion enlarged: the upper figure a longitudinal section.

Generic characters.—"Ramose, coralla solid; stems composed of angular cells; apertures of cells opening upon the surface into expanded angular cup-like depressions; interior of the cell rayed or striated, striæ extending beyond the aperture of the cell."—(HALL. *Palæontology of New York, vol.* 2, *page* 156.)

STRIATOPORA LINNEANA.—*N. Sp.*

Description.—Stems two or three lines in diameter, branching at an angle of from 75° to 80°; cells variable in size, the greater number with the expanded mouth one line wide, and the circular cavity at the bottom from one-third to one-half of a line; the smaller or younger cells, of all sizes, are somewhat uniformly distributed among the larger. In the perfect specimens the mouths of the cells are everywhere in contact with each other, the edges of the walls between them sharp, and the form more or less polygonal, generally five or six sided. In worn specimens the cells are more nearly circular, and the walls obtusely rounded on the edge. The striæ in the cell mouths not observed. I have seen only two specimens of this species, and am unable, therefore, to state to what extent the stems may vary in thickness. In *S. rugosa* (Hall),* Hamilton Group, Iowa, the cells are distant from each other nearly their own diameter, and the stem is branched at an angle of about 55° (in the specimen figured). In *S. flexuosa* (Hall),† Niagara Group, the cells are, upon an average, more than one line and a half wide, and many of them two lines. Our species, therefore, must be regarded as distinct from either.

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* *Geology of Iowa.* Vol. 1, Part 2, page 479, Pl. 1, fig. 6.
† *Palæontology of New York.* Vol. 2, page 156, pl. 40 B, fig. 1*a*.

Locality and formation.—Township of Bosanquet, lot 25, con. 5. Shales of the Hamilton Group.

Collectors.—A. Murray, J. Richardson.

STRIATOPORA FORMOSA.—*N. Sp.*

Description.—Stems from one line and a half to three lines in thickness; cells of an uniform size or very nearly so, three-fourths of a line in width, opening out on the surface at an angle of about 45° with the longitudinal axis of the stem, the cell mouths very gradually expanded, apparently fifteen fine obscure striæ occupying the whole surface of the upper lip.

This species differs from *S. Linneana* in having the cells smaller and of an uniform size. The cell mouths are as wide in stems, one and a half lines in thickness, as they are in the largest specimens seen. I have not ascertained the angle at which the stems bifurcate. In perfect specimens, where the cells are empty, on looking into them obliquely downwards, they are seen to become circular just below the edge of the lower lip, their diameter there being a little less than half the transverse width of the mouth.

Locality and formation.—Corniferous Limestone, near Woodstock.

Collector.—A. Murray.

Genus TRACHYPORA.—(Edwards and Haime.)

Generic characters.—"Corallum dendroid, the branches presenting calyces which are only slightly salient, and in which there are no radiating septa; cœnenchyme very abundant, solid, and with the surface marked by strong, irregular, vermicular, and sub-echinulated striæ." —(EDWARDS and HAIME. *Polypiers Fossiles des Terrains Palæozoiques.* Page 305.)

The only species of this genus heretofore known, is *T. Davidsoni* (E. and H.), which occurs in the Devonian Rocks at Ferques, in France.

TRACHYPORA ELEGANTULA.—*N. Sp.*

(*See Figs.* 2, 3, 4.)

Description.—Stems (in the specimens examined) from two to two and a half lines in diameter, branching at an angle of about 75°. Cells arranged in four or five rows, parallel with the axis of the stem; they are oval, about one line in length and two-thirds of a line wide, with an elevated margin at the sides, in general effuse above, rarely effuse below. The space between the cells is marked with irregular, flexuous, broken striæ, four or five in the width of one line; the elevated margin at the sides of the cells exhibits from seven to nine short oblique ridges or tubercles. In the longitudinal rows, the cells are sometimes in contact with each other, and often separated by distances equal to half their own length, or a little more. In *T. Davidsoni*, the cells are not arranged in linear series, and the striæ are of a different form.

Locality and formation.—Lot 25, con. 5, Bosanquet.

Collectors.—A. Murray and J. Richardson.

Genus ALVEOLITES.—(Lamarck.)

The following three species appear to belong to this genus:

ALVEOLITES ROEMERI.—*N. Sp.*

Description.—Stems from two to three lines in diameter, usually cylindrical, but sometimes sub-palmate, branching. Cells transversely oval, about half a line wide and one-fourth of a line in length; in general distant from each other from half a line to two-thirds of a line in the longitudinal direction of the stem, and half that distance in the transverse direction.

In some specimens the cells are not quite so distant as above stated, and it may be that these should constitute a distinct species. In *A. labiosa* (*Canadian Journal*, March, 1859), the cells, when perfect, are scarcely one-fourth of a line wide; *A. cryptodens* (*Loc cit*), is, upon the whole, a larger species, with the cells about a line distant.

The stems appear to bifurcate at an angle of from 50° to 60°; but the specimens are not sufficiently perfect to determine this character with certainty.

Locality and formation.—Lot 25, con. 5, Bosanquet. Hamilton Shales.

Collectors.—A. Murray, J. Richardson.

ALVEOLITES GOLDFUSSI.—*N. Sp.*

Description.—This species occurs in irregularly circular depressed masses, several inches wide and one or two inches in height. The corallites radiate from a point in the bottom, and the mass, rapidly increasing in width, has a very obtusely turbinate form, flattened and undulated on the top, and apparently composed of horizontal superimposed layers. The cells are transversely sub-oval or sub-triangular, usually with one curved side and two straight sides. In some parts of the mass, especially on the edges, they approach the sub-circular polygonal form, but usually they are wider in the one direction than in the other. The width is in general three-fourths of a line (sometimes one line), and the height half a line. The bottom of the mass is either in part or wholly covered by a thin, smooth, but concentrically undulated epitheca.

Fig. 5.

Fig. 6.

Fig. 5. *Alveolites Goldfussi.*—Upper side of a small specimen.
Fig. 6. *Alveolites Fischeri.*—One side of a frond.

This species resembles *A. suborbicularis* (Lamarck) of the Devonian Rocks of England, France, and Germany; but in that species there is a groove on one side of the cell, and a corresponding ridge on the side opposite. I have not been able to detect these characters in very well preserved specimens of *A. Goldfussi,* and feel satisfied that it is therefore a distinct species.

Locality and formation.—Lot 25, con. 5, Bosanquet. Hamilton Shales.

Collectors.—A Murray, J. Richardson.

Alveolites Fischeri.—*N. Sp.*

(*See Fig.* 6.)

Description.—This species is found in the shape of flattened, palmate, obscurely branching fronds, celluliferous on both sides. Some of the fragments appear to be portions of undulated expansions, two to four lines in thickness, and several inches wide. The majority of the specimens, however, indicate a palmated form, two to four inches in length, from half an inch to more than one inch wide, and from one to three lines in thickness. The cells, when perfect, are transversely sub-oval or sub-triangular, usually with one curved and two straight sides, from half a line to two-thirds of a line wide; distant from each other about two-thirds of a line in the vertical, and a little less in the transverse direction of the frond. When well preserved, the lower lip, or edge of the cell, is thin, sharp, and uniformly arched. In the very thin fronds (one line in thickness), the cells open out on the surface at a very acute angle, apparently 15° to 20°; but in the thicker specimens the angle is greater—sometimes 45°.

Locality and formation.—Bosanquet. Shales of the Hamilton Group.

Collectors.—A. Murray, J. Richardson.

Alveolites squamosa.—*N. Sp.*

Description.—This species is found in wide, flat, irregular expansions, sometimes six or seven inches in breadth, and from half an inch to one inch and a half in thickness; composed of successive, and often much distorted, layers; the cells opening out upon the surface very obliquely, and separated from each other by exceedingly thin partitions, which, when silicified and well brought out by the action of the weather, present a peculiarly rough squamose appearance. The cells are linear, in general about half a line in length, and apparently one-tenth of a line in width. One of the specimens examined exhibits two spots, one-fourth of an inch wide each, where the cells are less than half the average size. There are obscure indications of a central ridge on one side of the cell in this species, as there is in *A. suborbicularis.*

This species differs from *A. Goldfussi* in having much smaller and more compressed cells. In a space one-fourth of an inch square, I have counted ninety-seven cells; and the average appears to be from seventy-five to one hundred, with here and there spots holding double that number. In *A. Goldfussi* there are from sixteen to thirty in the same area. On comparing the figures of *A. suborbicularis* in the works of Goldfuss, Sandberger, and Bronn, it will be seen that in that species there are about fifty cells in one-fourth of an inch square. The difference in the size (great though it be) might not be sufficient to separate these three species, but the form of the cells appears to be also different. *A. Goldfussi* has not the groove on the outer lip, nor the ridge on the inner, that is exhibited by *A. suborbicularis;* while *A. squamosa*, although possessing the ridge, does not seem to have the groove; and besides, the cells are in general linear, instead of sub-oval or sub-polygonal.

Locality and formation.—Township of Cayuga. Corniferous Limestone.

Collector.—J. De Cew.

Syringopora Maclurei.—(Billings.)

Syringopora tubiporoides.—(Billings.) *Canadian Journal*, Vol. IV. page 115. March, 1859.

Not *S. tubiporoides* (Yandell and Shumard), nor of M. Edwards and J. Haime. *Polypiers fossiles des terrains palæozoiques*, p. 292.

Since the publication of this species in the *Canadian Journal* in March last, Professor Dana, of New Haven, has informed me that the true *S. tubiporoides* is a much larger form, and is supposed to be an *Eridophyllum*. I thought I could identify ours by the description given in the work of Edwards and Haime, but it now appears quite certain that it is not the same; and also that their fossil cannot be the *S. tubiporoides* of Yandell and Shumard. In order, therefore, to avoid confusion, I propose to change the name of this species to *S. Maclurei*.

In my description, the corallites are said to have a diameter of about one line and a half; but, after examining other specimens, I find that in the greater number it is more nearly one line. In some of the colonies, many of the tubes are full one line and one-third in thickness, and it was upon these my first statement was founded.

Sometimes the groups are exceedingly irregular, the corallites widely separated and straggling through the rock.

Favosites turbinata.

Favosites turbinata (Billings.) *Canadian Journal*, March, 1859.

The description of this species was published in the *Canadian Journal* for March, 1859. At that time the only specimens I had seen were from the Corniferous Limestone, but we have now several from the Hamilton Group. The species differs from all other *Favosites* known, in its peculiar mode of growth. The form resembles that of a large cyathophylloid coral,—turbinate, the base or smaller pointed extremity usually curved, but occasionally straight; more or less rapidly expanding upwards; sometimes so much elongated as to become irregularly cylindrical; several inches in diameter, and (though rarely) two feet in length. The more common length is from two to six inches. But the most remarkable character is, that

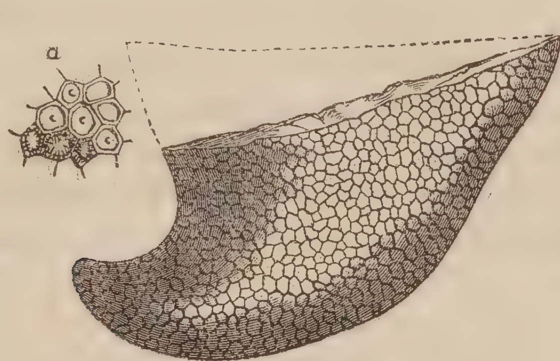


Fig. 7.

Fig. 7. *Favosites turbinata.*—A small curved specimen. *a*. exhibits the different appearances of the cells.

the whole surface, except the larger end, is covered with a thick epitheca, which completely closes all the tubes. In general, the substance of the epitheca only fills the mouth of the tube, but leaves the walls so far visible that the polygonal form of the cells can be distinctly seen. In such specimens, the disc which closes the mouth of the corallites sometimes retains the impressions of the radiating septa, and thus presents an obscurely stellate appearance. There are some with an epitheca so thick, that it not only fills the cells but also entirely conceals the walls, so that the whole mass exhibits an uniformly smooth surfrace.

In the original description, the corallites are said to be "usually somewhat less than a line in width." In one of the specimens from the Hamilton Group, the cells are, upon an average, full one line in diameter, with here and there one nearly a line and a half wide; and no doubt others will be found still larger, for in all the species of Favosites this character is somewhat variable. The description, therefore, should state that the cells are about one line in width, a little more or less. This species is now known to occur in the Oriskany Sandstone, the Corniferous Limestone, and in the Hamilton Shales. I have ascertained that there are one, two, or three rows of pores; usually two.

F. Gothlandica and F. hemispherica.

Both of these species occur in the Hamilton Group, at Bosanquet; the former in dome-shaped masses, from three inches to a yard in diameter, with cells about one line and a half wide: the latter in somewhat flat, undulating expansions, from three inches to one foot or more in width, and from less than one to three inches in thickness. In some specimens of the latter, the cells are half a line wide, or thereabouts, and of an uniform size all over the whole surface; but in others there are numerous spots where the cells are only one-fourth of a line in width. In this respect the specimens from the Hamilton Group agree exactly with those of the Corniferous Limestone.

Diphyphyllum Archiaci.—*N. Sp.*

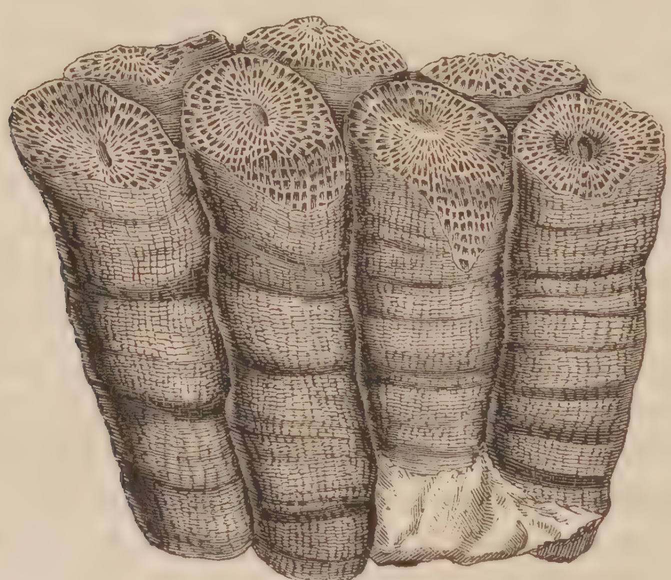


Fig. 8.

Fig. 8. *Diphyphyllum Archiaci.*

Description.—Corallum forming large masses of parallel nearly straight cylindrical stems, in contact with each other, or nearly so, and which, when full grown, are from six to eight lines in diameter. The young stems are added by lateral or marginal gemmation, and are at first two or three lines in diameter, their adult size being attained at the length of two or three inches. At the diameter of four or five lines, there are between thirty and thirty-five radiating septa; at six or eight lines, usually about fifty; but occasionally in those of the larger size, from seventy-five to eighty may be seen.

Fifty appears to be the common number. There are two or three transverse diaphragms in one line. In most of the corallites there is a central area, one line or a little less in diameter, into which the radiating septa do not penetrate. Others in the same mass seem to be without this central area. Surface with a somewhat thick epitheca, which, where perfectly preserved, is beautifully ornamented with fine crowded, encircling striæ, from fifteen to twenty in the width of one line. In addition to these fine striæ, there are numerous usually sharp-edged annulations, varying from less than one-fourth of a line in width and depth, to one or two lines. Some of the corallites exhibit sudden constrictions of growth, which give to them the appearance of a series of short turbinate stems inserted into each other.

The epitheca is often entirely or partially worn away, and the fine striæ can only be seen when the surface is in a very perfect state of preservation.

It is probable this coral occurs simple as well as aggregate.

Variety.—A fragment from Lot No. 2, Con. 4, Townsend, three inches and a half in length and seven lines in diameter, and with about fifty radiating septa, appears to belong to this species, but differs in having the surface with only five encircling striæ to one line. Resembles *Cyathophyllum cæspitosum* (Goldfuss); but that is a smoother species, and, according to McCoy, only four or five lines in diameter.

Locality and formation.—Lot 25, Con. 5, Bosanquet. Hamilton Shales.

Collectors.—A. Murray, J. Richardson.

HELIOPHYLLUM EXIGUUM.—*N. Sp.*

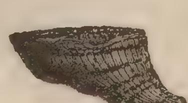


Fig. 9.

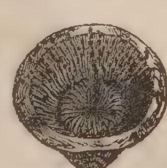


Fig. 10.

Fig. 9. *Heliophyllum exiguum.*—Side view. Fig. 10. The same.—View of the cup.

Description.—Small, turbinate, more or less curved, often flattened on the side of the convex curvature, radiating septa between sixty and eighty; about six obscure arched striæ to one line on their flat sides, and the same number of spines on their edges. The depth of the cup is equal to one-fourth or one-third of the whole length of the coral. In small specimens, the margin of the cup is thin and sharp; but in the large ones rounded, and one line or a little more in thickness. About one-half of the radiating septa reach the centre, and form a small rounded elevation on the bottom of the cup. There is a septal fossette on one side, which, in all the specimens I have seen, reaches the centre. The surface exhibits a few sharp constrictions of growth, with rounded annulations between them, the latter often abruptly terminated on their upper sides. In very perfect specimens, fine encircling striæ of variable size, apparently from eight to fifteen in the width of one line. The horizontal striæ, which indicate the number of the septa, are distinctly visible, but not strongly marked. The position of the septal fossette is indicated on the outside of the cup by two septal ridges, which extend the whole length of the coral, and constitute one of the lines along which the younger septa were added from time to time.

The greater number of the specimens are from six to nine lines in length, but some are full one inch. The width of the cup is always a little less than the length of the entire fossil. The most common number of septa is sixty. The arched striæ and spines are not often preserved.

Locality and formation.—Rama's Farm, near Port Colborne. Corniferous Limestone.

Collector.—E. Billings.

CYATHOPHYLLUM ZENKERI.—*N. Sp.*

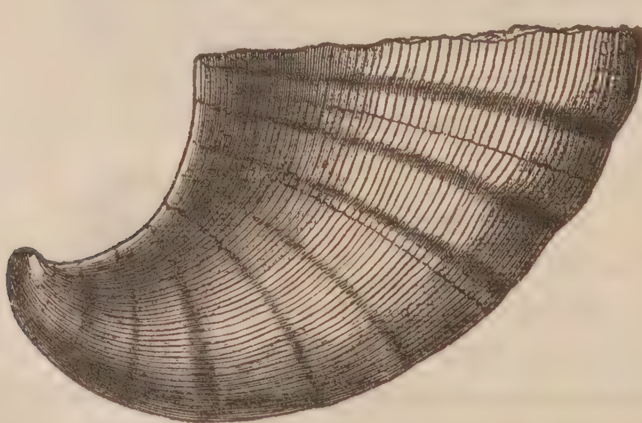


Fig. 11.

Fig. 11. *Cyathophyllum Zenkeri.*—Side view of a large specimen.

Description.—Corallum simple, turbinate, strongly curved at the pointed base, gently and uniformly arched above, gradually enlarging to the diameter of one inch and a half at a length of two inches and a half. Cup about three-fourths of an inch in depth, the form of the bottom variable, either with a smooth space or a small pit in the centre, or covered with the prolonged radiating septa; these latter about one hundred and fifty in number; the interseptal spaces filled for a short distance from the outer surface with small sub-lenticular cells, of which there are about four in one line; a small space beneath the bottom of the cup in full-grown specimens, with flexuous transverse diaphragms. Surface, when perfect, with sometimes a few inconspicuous encircling annulations of growth, but often with a somewhat smooth aspect, longitudinally marked with the septal striæ, of which there are, on an average, five or six in the width of two lines; when partially decorticated, the interseptal spaces roughened with small subimbricating projections or notches, with their sharper edges usually turned upwards—about four of these in one line. The largest specimen that I have seen is three inches and one-fourth in length, measured along the surface of the side with the larger or convex curve, and one inch and a half on the lesser curve. The diameter of the cup, in the same specimen, is one inch and a half. Several others that I have seen are from one to two inches and a half in length.

The arrangement of the septa in the bottom of the cup appears to vary a good deal in different individuals. In one specimen two inches in length, there is a deep septal fossette on one side, and a pit in the centre of the cup. The septa branch off, as it were, on each side of a depressed line, extending from the central pit to the fossette. In another, about the same size, the septa all reach the centre in the bottom of the cup, and are there somewhat twisted together. There is a septal fossette in this specimen also. In a third individual, with a cup one inch in diameter, there is a smooth space two lines wide in the centre, with an obscurely indicated septal fossette. I think it probable that most of the large individuals will be found to have the bottom smooth.

The form of the walls of the cup also varies according to the age of the individual. In the immature it is thin, and the septa alternate somewhat in size. But in the large ones (three inches in length) the interseptal spaces are filled with the cellular tissue nearly to the free edges of the septa, and the wall of the cup is thus rendered solid for the thickness of two lines, or a little more.

In those large ones, also, it is to be observed that the septa are of a nearly uniform size when seen in the upper part of the wall of the cup.

There are several species of fossil corals in the Corniferous Limestone, which resemble this one in external appearance:

1. *Zaphrentis prolifica.*—The greater number of the specimens are about the same size as those of *C. Zenkeri*, but are more slender towards the base, seldom uniformly curved, the septa alternating in size in the walls of the cup, and the septal striæ four in two lines. The worn specimens do not exhibit the roughened nodulose exterior presented by *C. Zenkeri* when partially decorticated.

2. *Cyathophyllum Lesueuri.*—This is a somewhat larger species, with the septa (just within the margin of the cup) distant nearly one line from each other, but with the septal striæ as closely arranged as they are in *C. Zenkeri;* and further, under certain conditions, exhibiting ten striæ to two lines.

3. *Zaphrentis cornicula.*—(Edwards & Haime.) This species has not been found to my knowledge in Canada, but I have before me two specimens from Ohio (from Dr. Shumard.) The surface resembles *C. Zenkeri*, but then the septa inside of the cup are denticulated on their edges and, besides, are large and small alternately. *Z. cornicula* appears to be a *Heliophyllum.*

4. *Clisiophyllum Oneidaense.*—The perfect specimens are marked with numerous sharp annulations, but when the outer surface has been worn away, the interseptal spaces exhibit either transverse diaphragms, nearly a line distant from each other, and turned upwards, or small projections similar to those of *C. Zenkeri*, but two or three times more distant.

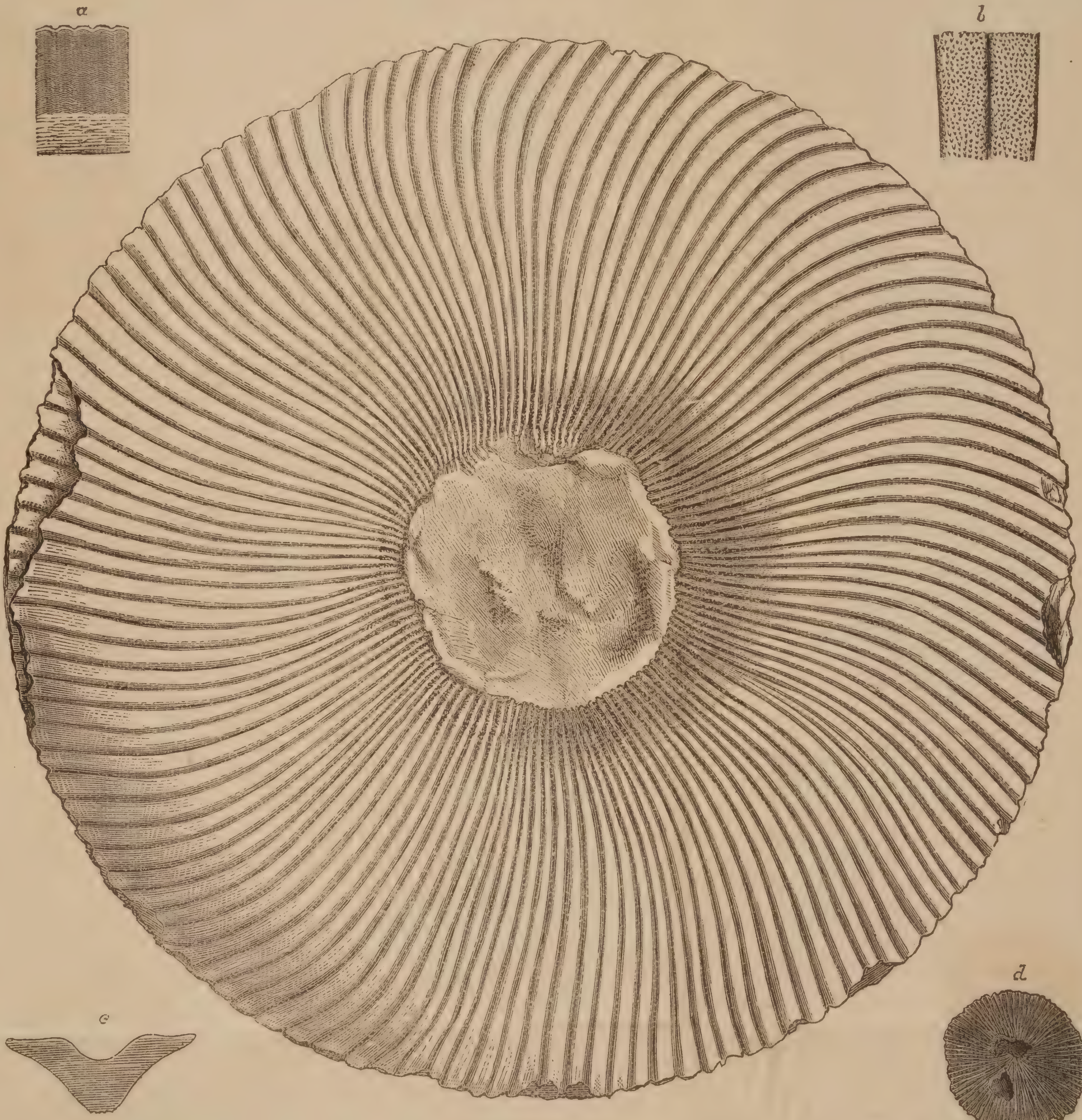
Locality and formation.—Rama's Farm, near Port Colborne.
Collector.—E. Billings.

CHONOPHYLLUM MAGNIFICUM.—*N. Sp.*

(*See Plate* I.)

Description.—Short, turbinate, expanding to the width of six or seven inches at a height of four inches and a half; upper surface constituting a nearly flat circular disc, with a rounded cavity in the middle, one inch and a half wide, from which radiate one hundred and twenty-five depressed convex ridges; the grooves between them

PLATE I.



CHONOPHYLLUM MAGNIFICUM.—*(See page 264.)*

The large figure is a view of the cup. Fig. *a*, vertical section of a portion near the side. Fig. *b*, portion of the surface of two of the rays a little enlarged. Fig. *c*, vertical section reduced to one-sixth natural size. Fig. *d*, Transverse section near the base.

narrow, and somewhat angular in the bottom. These ridges are gently curved in crossing the broad flat margin of the cup. The depth of the central cavity is about one inch. A transverse or horizontal section shews that many of the septa (probably one-half of them) reach the centre. In a vertical section, extending downwards, so as to cut off the outer extremities of a few of the radiating ridges, it is shewn that the grooves on the floor of the cup indicate the position of the septa, and that the ridges are the interseptal spaces. The structure, as exhibited in this section, consists of excessively thin, parallel, horizontal laminæ (apparently from thirty to forty in the thickness of one line.) These laminæ are arched upwards between the septa, the curve corresponding with the convexity of the radiating ridges. In the lower part of the corallite, the interseptal tissue is much coarser. The surfaces of the radiating ridges appear to be covered with small tubercles. (See Pl. I. *b*.)

The only specimen of this truly magnificent coral that I have seen, is imbedded in an upright position in the rock, the broad circular disc of the cup (with the greater number of the rays well exposed by the action of the weather) being just on a level with the surface of the stratum. The width of the disc or cup in this individual is six and a half inches ; and it exhibits one hundred and twenty-five radiating ridges, which attain a breadth of about two lines at the margin. It is highly probable that in other specimens the number of rays may be a little less or greater than it is in this one. The thickness of the piece of rock in which it is imbedded is three inches ; and on the under surface a transverse section of the coral is exhibited, with a diameter of one inch and a half, and consequently it expands from that size to a width of more than six inches in the length of three inches. At this rate of tapering, the total length of the perfect fossil must be about four inches and a half. Most probably a small portion of the pointed base is more or less curved. I have not seen the surface below the edge of the disc.

This species resembles *Chonophyllum perfoliatum* (Goldfuss), but is much larger, and has double the number of radiating septa.

Locality and formation.—Lot No. 1, con. 14, Township of Walpole.

Collector.—J. De Cew.

BRACHIOPODA.

Genus LINGULA.—(*Bruguière.*)

Of this genus, only one species has been found in the Devonian rocks of Canada West. The specimens are too imperfect for description.

STREPTORHYNCUS PANDORA.—*N. Sp.*

Fig 12.

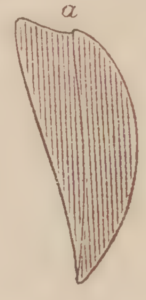


Fig. 13.

Fig. 12. *Streptorhyncus Pandora.*—View of the dorsal valve.
Fig. 13.—Longitudinal section.

Description.—Shell semioval, or sub-quadrate; length about three-fourths the width, hinge line equal to the greatest width of the shell, sometimes a little less, usually forming a right angle with the sides of the cardinal extremities; front margin broadly rounded. Ventral valve depressed semiconical, most elevated at the beak, thence descending with a slightly concave or nearly flat slope in all directions, to the margin. Area of ventral valve, large triangular, extending the whole length of the hinge line, sloping outwards at an angle of about 100°, with the plane of the lateral margin; foramen triangular, very conspicuous, its width at base nearly twice the height, nearly or altogether closed by a convex deltidium. Dorsal valve moderately convex, gently compressed towards the cardinal angles. Surface with very narrow, strongly elevated, radiating ridges, of which there are from four to six in the width of one line; the increase appears to be both by bifurcation and interstitial addition, the latter mode being the most common.

Width of a specimen of medium size, sixteen lines; length of same, from the beak of the ventral valve to the front margin, twelve lines; height of area of ventral valve at the beak, two lines and three-fourths; width of foramen at base, four lines and a half. Another specimen is twenty lines wide and sixteen in length. Besides these, there are other imperfect specimens from two inches to two inches and a half in width, which I have no doubt belong to the species.

The inclination of the area of the ventral valve, judging from several fragments that I have examined, appears to vary considerably.

This species belongs to that group of the genus of which *O. umbraculum* (Schlotheim) is a characteristic form. Mr. Davidson has recently placed the species of this type in the gems *Streptorhyucus* (King) with the following remark: "The shells composing this sub-genus, are closely related to *Strophomena;* they are usually semicircular, convex or concavo-convex, and externally striated; the ventral valve possessing a prolonged and oftentimes bent or twisted beak."—(Geologist, March, 1860.) The species vary greatly in size and form, and Mr. Davidson has, therefore, united under one name (*S. crenistria*) no less than twelve varieties, which have all been considered to be distinct by various authors. Our fossil closely resembles *S. crenistria* in external form, but differs in not having the radiating striæ crenulated, and further in the form of the occlusor muscular impressions in the dorsal valve. According to Davidson's figure, there is a small process between the two branches of the cardinal process of the dorsal valve, which does not exist in ours. I shall give some further illustrations of this species hereafter. It is only since this article was sent to the press that I have procured specimens which exhibit the interior of both valves.

Locality and formation.—Lot No. 6, Con. 4, Townsend. Also at Rama's farm, near Port Colborne, and near Woodstock.

Collectors.—A. Murray, E. Billings and J. De Cew.

ORTHIS LIVIA.—*N. Sp.*

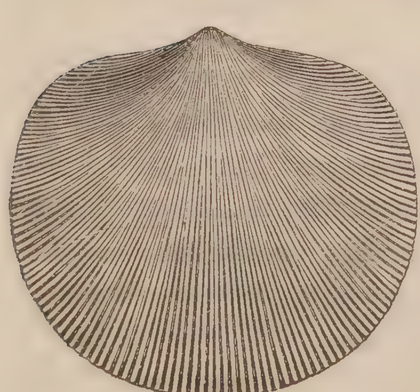


Fig. 14.

Fig. 15.

Fig. 16.

Fig. 14. *Orthis Livia.*—Ventral valve. Fig. 15.—Longitudinal section of the same. Fig. 16.—Dorsal valve.

Description.—Sub-orbicular or sub-quadrate; length about eight-ninths of the width; greatest width, usually a little in front of the middle; length of hinge line, one half to two-thirds the width of the shell; cardinal extremities rounded; sides in most specimens somewhat straight, often sufficiently curved to give a circular aspect to the shell; front angles obtusely rounded; front margin in general broadly convex, sometimes with a small space in the middle nearly straight. Dorsal valve of a medium convexity, most elevated about the middle; the outline forming a uniform arch from the depressed beak to the front margin; the slope from the umbo towards the cardinal angles, gently concave; sometimes a barely perceptible mesial depression, commencing in a point at the beak, and becoming obsolete at one half or two-thirds the length; area small, lying in the plane of the lateral margins; beak minute, forming a small triangular projection, rising scarcely one-fourth of a line above the edge of the area, the point not incurved over, but situated in the plane of the area. Ventral valve moderately convex, most elevated at between one-fourth and one-third the length from the beak, thence descending with a somewhat flat or gently convex slope, to the front and sides, and with a more sudden and somewhat concave slope to the hinge line and cardinal angles; the umbo small, prominent, neatly defined, terminating in a small rounded beak, which is incurved so as to overhang the edge of the area, either not at all or scarcely one-tenth of a line; area triangular, about one-fourth larger than that of the dorsal valve, forming an angle of about 105° with the plane of the lateral margin. The foramen not observed, but appears to be wider than high. On looking at the dorsal valve in a direction perpendicular to the plane of the shell, the small rounded umbo of the ventral valve can be seen rising about one-third of a line above the dorsal beak.

Surface with small sub-angular radiating ridges, of nearly a uniform size, from eight to ten in the width of three lines, increasing by bifurcation, strongly curved outwards to the upper part of the sides and cardinal angles, the intervening grooves sub-angular in the bottom, and equal to the ridges in width. In very perfect specimens, very fine concentric sub-lamellar concentric striæ are visible, seven or eight to one line. In certain conditions of preservation also, the radiating ridges are seen to be sub-tubular, and exhibit numerous small oval or circular openings on their edges, each about the eighth or tenth of a line in width, and from one-fourth to two-thirds of a line distant from each other.

Width of largest specimen examined, eighteen lines; length, sixteen lines; thickness or depth of both valves, seven lines; height of area of ventral valve at the beak, one line; area of dorsal valve, four-fifths of a line; distance between the beaks, one line; length of hinge-line, ten lines. The most common size appears to be one inch in width. The beak of the ventral valve is incurved, so that it would touch a plane projected horizontally through the valve, at one-half the depth of the cavity.

In some specimens the ventral valve has a faint, barely perceptible mesial fold, extending from the umbo towards the front.

This species is allied to *O. Vanuxemi*, but is more coarsely striated. It may be identical with one of the other species described in the Report of the Regents of the New York University, but as it is impossible to identify it with any of the descriptions, I propose to name it as above.

Locality and formation.—Township of Walpole. Corniferous Limestone.

Collector.—J. De Cew.

ORTHIS VANUXEMI.—(Hall.)

Fig. 17. Fig. 18. Fig. 19.

Fig. 17. *Orthis Vanuxemi.*—Ventral valve. Fig. 18.—Longitudinal section of the same. Fig. 19.—Dorsal aspect.

ORTHIS VANUXEMI.—Hall. *Tenth Annual Report of the Regents of the University of the State of New York*, p. 135, 1857.

This species is closely allied to *O. Livia*, but is more nearly a perfect ellipse, or more nearly circular, and has about fifteen radiating striæ in the width of three lines. Its width is from nine to eighteen lines, and its length about one-sixth or one-seventh less than its width.

It occurs in the Hamilton Shales, in the Township of Bosanquet.

RHYNCONELLA TETHYS.—*N. Sp.*

Fig. 20.

Fig. 21.

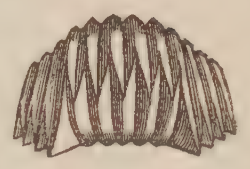


Fig. 22.

Figs. 20, 21.—Side views of the specimens of *R. Tethys.* Fig. 22.—Front view.

Description.—In this species the body of the shell, excluding the beaks, is transversely sub-oval ; from the beaks the sides diverge at an angle of about 110°, and are nearly straight, or gently concave, for about one-third the length of the shell, below which they are regularly rounded ; front margin broadly rounded, nearly straight in the middle for the width of the mesial fold. On a side view the outline is obliquely sub-conical, the base obtusely rounded, the lower three-fourths of the ventral valve straight, forming an angle of about 100° with the ventral half of the base ; the dorsal contour gently arched, and the dorsal half of the base rounded. The mesial sinus of the ventral valve commences at about mid-length, and increases only slightly in depth, until the front margin is reached, when the middle portion of the shell, for the width of the sinus, is rather suddenly bent towards the dorsal valve, with an abruptly rounded curve, and forms about three-fourths of the depth of the base. There are five angular ribs in the sinus, their extremities deeply forked to receive the projecting points of the grooves between the ribs of the dorsal valve ; on each side of the sinus there are six principal ribs, their extremities a little turned upwards ; above these, three or four smaller ones. The upper part of this valve is narrowly convex, with a prominent umbo, and incurved beak ; in the lower half, a little concave towards the lateral margins, owing to the elevation of the extremities of the ribs. Dorsal valve with all the central region depressed convex, the margin of the shell on each side of the mesial fold in front abruptly bent towards the ventral valve ; the umbo obtuse, divided along the middle for a short distance by a narrow, barely perceptible depression, the beak strongly incurved under that of the ventral valve. The mesial fold dies out at two-thirds the length, the shell (of the fold) at the lower extremity bent towards the ventral valve at an obtuse rounded angle, and extending about one-fourth across the base. On the mesial fold there are six ribs, the middle four most prominent; on each side of the fold there are also six, their extremities strongly curved towards the ventral valve.

I have seen no specimens with the true surface of the shell preserved.

Length of specimen upon which the above description is founded, nine lines, greatest width at about one-third the length from the front, ten lines; depth of both valves at the front, six lines; width of mesial fold at front, five lines, and of the sinus, five lines and a half.

Judging from the appearance of several imperfect specimens, the depth of both valves at the front must be very variable.

I have seen some small specimens from four to six lines in length, with a beak nearly erect. These, I think, are the young of *R. Tethys.*

Locality and formation.—County of Haldimand. Corniferous Limestone.

Collector.—J. De Cew.

Rhynconella Medea.—*N. Sp.*

Description.—Oval or sub-triangular, body of shell, excluding the beaks, transversely sub-elliptical; greatest width a little below the middle; apical angle, about 100°; both valves rather convex. Ventral valve with a neatly defined, rounded umbo, and closely incurved beak; a wide, shallow, concave, mesial sinus, which becomes obsolete at about two-thirds the length from the front. Dorsal valve, with a broad, depressed, convex, mesial fold, extending two-thirds the length of the shell, umbo rather prominent, obtusely rounded, beak incurved beneath that of the ventral valve. Surface with between thirty and thirty-five small sub-angular ribs on each valve; ten on the mesial fold, and nine in the sinus.

Length, eleven lines. Width, twelve lines. Depth, seven lines; width of sinus at front margin, six lines.

The specimen is a little distorted towards the front, so that all the details of the outline cannot be given. The sides diverge from the beak at an angle of about 100°, and are straight for half the length of the shell. They then appear to be somewhat narrowly, but regularly, curved round to the front, which is also, I think, broadly rounded.

Locality and formation.—Township of Rainham, Concession 3, Lot No. 2.

Collector.—J. De Cew.

Rhynconella Thalia.—*N. Sp.*

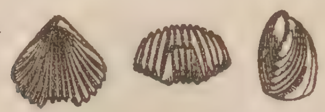


Fig. 23. Fig. 24. Fig. 25.

Fig. 23. *Rhynconella Thalia.*—Dorsal view. Fig. 24.—Front view. Fig. 25.—Side view.

Description.—Shell small, apical angle varying from about 70°, in very small specimens, to 105° in the large ones; sides straight in the upper half, regularly curved in the lower half; front broadly rounded with usually a portion in the middle straight, or even slightly concave; valves about equally convex. Ventral valve with a sinus which gradually dies out at one half, or a little more, of the length from the front; beak acute, much elevated, slightly incurved; three simple acutely angular ribs in the mesial sinus, and six or seven on each side. Dorsal valve a little more strongly convex than the ventral valve; the front of the mesial fold elevated so that on the side view the base of the shell is a nearly straight line almost at a right angle with the lower part of the outline of the valve; umbo rounded with a faint mesial depression; beak incurved into the cavity of the ventral valve; surface with four ribs on the fold, and six or seven on each side.

Length of the largest specimen examined, four lines; width, four and one-fourth lines; depth, two and a half lines; width of the sinus, nearly two lines; apical angle, 102°.

Another specinen is four lines wide, three and a half in length, two in depth, sinus, two lines, and apical angle 105°.

A third is two lines and three-fourths in length, and the same in breadth; depth, one line and three-fourths; apical angle, 88°. The sinus is distinct but not deep.

Specimens less than two lines in length exhibit scarcely a trace of a sinus, and have the apex more acute than any of the above-mentioned.

This species closely resembles the ordinary Lower Silurian forms, such as *R. plena,* and young individuals of *R. increbescens.*

Locality and formation.—Near Woodstock. Corniferous Limestone.

Collector.—A. Murray.

RHYNCONELLA (?) LAURA.—*N. Sp.*

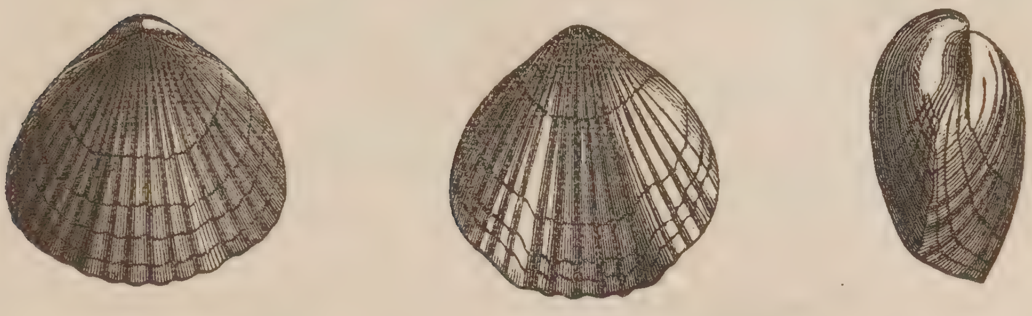


Fig. 26. Fig. 27. Fig. 28.

Fig. 27. *Rhynconella Laura.*—Dorsal aspect. Fig. 27. The same; ventral aspect.
Fig. 28. Side view.

Description.—Ovate; greatest width at about one-third of the length from the front; sides gently arched from the beak to the line of the greatest width; front angles narrowly rounded; both valves convex, sometimes rather gibbous. Ventral valve most elevated a little above the middle; umbo rather obtusely rounded, not very prominent; beak short, obtuse, closely incurved, in contact with the umbo of dorsal valve; a broad mesial sinus which usually becomes obsolete at one half the length, but can be sometimes traced nearly to the beak. Dorsal valve with a mesial fold, corresponding with the sinus of the ventral valve in length.

Surface with about seventeen rather large rounded obscure slightly elevated ribs, of which there are four or five in the mesial sinus, and five or six on the mesial fold. A few squamose rings of growth.

Length of large specimen twelve lines; width eleven lines. Another individual from the same locality is nine lines long and ten wide.

Locality and formation.—Bosanquet. Hamilton Shales.

Collectors.—T. Richardson, A. Murray.

Genus ATHYRIS.—McCoy.

There is much difference of opinion as to the propriety of retaining this generic name. It implies that the shells have no foramen in the ventral valve, and yet many species are placed in the genus which have the beak distinctly perforated. Some palæontologists are, therefore, in favor of using De Orbigny's appellation *Spirigera,* instead of *Athyris.* Nearly all of the Silurian species, and some of those from the Devonian rocks, have the beak so strongly incurved, that no foramen can be seen. For such, at least, the name *Athyris* does not appear to be very inappropriate. Mr. Davidson still retains it, not only for those which have the foramen concealed, but also for those with it open. It appears probable that the genus will sooner or later be sub-divided, and in that case *Athyris* might be retained for the species with closely incurved beak, and *Spirigera* for some of the others. I shall give some account of the generic characters of this group of shells in another article. The following species are placed in the genus provisionally.

ATHYRIS CLARA.—*N. Sp.*

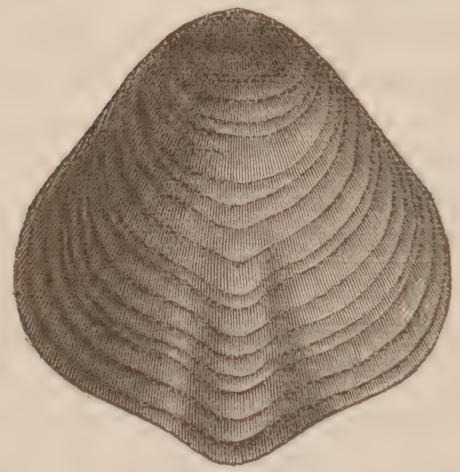


Fig. 29.

Fig. 30.

Fig. 31.

Fig. 32.

Fig. 29. *Athyris Clara.*—Ventral view of large specimen.
Fig. 30.—Dorsal view of the same.
Fig. 31.—Side view.
Fig. 32.—Dorsal view of a smaller specimen.

Description.—Nearly smooth, ovate or sub-rhomboidal, greatest width, about the middle, a short linguiform projection in the middle of the front margin, both valves convex, ventral valve the larger, with its beak strongly incurved. Length from one to two inches; width equal to, a little less or a little greater than the length. The ordinary size is about one inch and a half in length.

The ventral valve is strongly and smoothly convex, the outline evenly arched from beak to front, more abruptly curved above than below, the umbo prominent, the beak rather small, neatly rounded at the sides, and closely incurved. The linguiform projection in the middle of the front margin, is often a simple extension of a portion of the shell, without a sinus, but occasionally there is either a short, shallow depression, or a narrow rounded mesial fold, which seldom, however, extends towards the beak more than three or four lines. The upper half of the dorsal valve is sometimes evenly convex, but in general an indistinct, more or less broadly rounded carination, can be traced from the umbo along the middle to the front, where it becomes abruptly elevated into a short, prominent, rounded fold, which extends into the linguiform projection. On each side of the median line, this valve is gently convex, and often exhibits a rather flat slope to the lateral margins. The beak is strongly incurved, and appears to be deeply buried in the cavity beneath the umbo of the ventral valve.

If a line be drawn across the shell at mid-length, and another at one-fourth the length from the front, the greatest width will be found to range between the two. Many of the specimens are obtusely angular at the sides, and in such the margins above and below the angles are somewhat straight, the upper two sides converging to the beak, and the lower two to the linguiform extension in front, giving to the shell a rhomboidal instead of an ovate outline.

At first sight, the surface appears to be smooth, with a few concentric squamose lines of growth. On closer examination, numerous indistinct, radiating lines, may be seen. Of these, there are from two to four in the width of one line, and they sometimes appear to lie beneath the surface of the shell. In very perfect specimens, the surface exhibits fine concentric striæ, from ten to fifteen in the width of one line, and these are most distinct towards the front margin.

Beneath the beak of the detached ventral valves, there is a wide, triangular foramen, not visible when the valves are united. The inside of the beak is entirely hollowed out into a deep pit or channel, which opens directly into the cavity of the shell. The impressions of the divaricator muscles occupy part of a sub-triangular space, the upper angle of which is situated just where the excavation beneath the beak opens out into the visceral cavity. The lower side of this space is nearly straight, and the two lower angles rounded. The lateral margins of the space are usually sub-parallel in the lower half, while in the upper half they approach each other, and meet above to form the upper angle. In some specimens the space is more nearly triangular, and it would appear, therefore, that its form is a little variable. The length of the space is about one-third the whole length of the ventral valve, and its width at the lower margin a little less than its length. The lower margin is situated a little above a line drawn across the shell at mid-length. The lower three-fourths of the space is striated longitudinally, and divided into two equal portions by an obscure median groove.

On each side, at the base of the foramen, there is a short, stout tooth. The dental plates below the teeth extend but a short distance into the visceral cavity, when, becoming suddenly much diminished in height, they form a low ridge along the upper margin of the muscular space. The upper part of the muscular space is deeply excavated into the substance of the shell, which is very thick and solid in the rostral half.

I have not seen the interior of the dorsal valve.

Externally this species resembles *A. tumida* (Dalman,) but the muscular impressions in the interior of the ventral valve are widely different in the two species.

Locality and formation.—Rama's farm, near Port Colborne, and at many places in the County of Haldimand. Corniferous Limestone. Specimens, with the valves united, are rare, but the upper part of the ventral valve, with the umbo and beak preserved, is not uncommon.

Collectors.—A. Murray, J. De Cew, E. Billings.

Athyris Maia.—*N. Sp.*

Description.—Smooth, ovate, or sub-rhomboidal. Ventral valve strongly convex, most gibbous in the upper half; umbo prominent, large, giving to the shell, on a side view, somewhat of the aspect of a *Pentamerus;* beak strongly incurved, but not touching the surface of the dorsal valve; a shallow, concave mesial sinus, extending from the front all the way to the beak. Dorsal valve moderately convex, with a convex mesial fold, which becomes obsolete near the beak. Length, from one inch to one inch and a half. The proportional width is variable. In some specimens it is exactly equal to the length, but in others it is either a little greater or a little less. Greatest width, about the middle, or a little in front of the middle, at which point the rhomboidal specimens are angular, but in the more oval forms, gently convex.

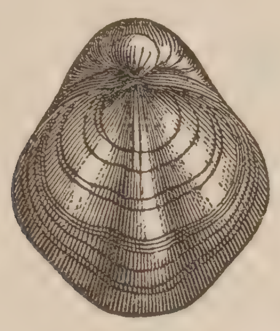


Fig. 33.

Fig. 34.

Fig. 33. *Athyris Maia.*—Dorsal aspect. Fig. 34.—The same; ventral aspect.

The following characters may be more particularly noted:

The umbo of the ventral valve is rather large and prominent, the beak well defined, strongly incurved, but in general not in contact with the umbo of the dorsal valve; a short false area beneath the beak. The mesial sinus is shallow, evenly rounded in the bottom, or sometimes with an indistinct fold along the middle. Its width at the front margin is somewhat variable, but is usually about five lines, and it becomes gradually narrower and shallower upwards, but is more or less distinctly visible quite to the beak. On a side view, the outline of this valve presents a continuous curve, most abrupt in the upper half, the greatest elevation being at about one-third the distance from the beak to the extremity of the linguiform extension in front.

The dorsal valve has a smooth, rounded fold, extending almost to the beak, but is otherwise pretty evenly convex. It appears to possess a straight hinge-line, the length of which is greater than half the whole width of the shell; the beak small, not much incurved. The greatest convexity of this valve is about the middle, and on a side view the outline, in consequence of the elevation of the mesial fold, continues at the same height, and somewhat parallel to the lateral margin until it reaches the front.

The linguiform projection is sometimes considerably extended, and the shell has then a rounded, rhomboidal form, but in other specimens this part of the shell is truncated, and a fifth side, situated in the front margin, is thus formed.

The specimens that have come under my observation have in general the same amount of convexity, the depth of both valves being in all about two-thirds the greatest width.

The surface is nearly smooth; a few obscure concentric undulations of growth and fine striæ,—of the latter, twelve to fifteen in the width of one line are visible on well preserved shells. There are also faint indications of longitudinal radiating lines. A fragment of one individual of this species exhibits a surface uniformly marked with fine rounded concentric undulations (not striæ), of which there are four of five in the width of one line.

This species has, to some extent, the aspect of a *Pentamerus;* but its internal structure, as exhibited in the numerous broken specimens that I have examined, shews it to be congeneric with *A. Clara.* It differs from that species in having the mesial fold and sinus extending the whole length of the shell, and the beak of the ventral valve not touching the umbo of the dorsal valve.

Locality and formation.—St. Mary's, Township of Blanshard. Corniferous.

Collectors.—Mr. W. G. Tomkins, C. E., St. Mary's, C. W.; A. Murray; J. Richardson.

Athyris (?) Scitula.—(Hall.)

Atrypa scitula.—Hall. *Geology of the Fourth District of the State of New York,* p. 171, fig. 1.

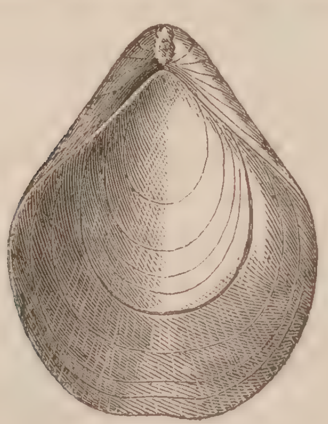


Fig. 35.

Fig. 36.

Fig. 37.

Fig. 38.

Figs. 35 to 38.—Different views of a small and large specimen of *A. scitula.*

The above figures represent different views of two specimens of a species which appears to me to be identical with that figured in the work above cited. It varies greatly in size. The length of the largest specimen that I have seen is seventeen lines, the greatest width fourteen lines, depth eight lines. The smallest is about two lines in length, and many of intermediate sizes have been observed to make out the series. It is not certain that this species belongs to the genus *Athyris*.

Locality and formation.—County of Haldimand. Corniferous Limestone.

Collectors.—J. De Cew, E. De Cew.

Athyris (?) Clusia.—*N. Sp.*

Description.—Elongate oval; greatest width at about one-fourth the length from the front margin; sides diverging at an angle of about 75° and somewhat straight, or gently convex, for rather more than half the length; front angles rounded; front margin nearly straight, or gently convex. Both valves depressed convex, smooth in the upper half, the front margin with four or five wide shallow concave indistinct folds or grooves which become obsolete at less than half the length. Beak of ventral valve erect, apparently a little incurved at the tip.

Length five lines; greatest width at one-fourth the length from the front margin, three lines; depth of both valves at one-third the length from the beak, one line and one-fourth.

The above description is founded on a single small specimen. I have seen a fragment of another that must have been, when perfect, seven lines in length, and I am inclined to think that the one described is a young individual of the species.

This species differs from *A. scitula*, principally in being proportionally much flatter, and in having the front margin undulated by several obscure folds.

Locality and formation.—Lot No. 45, Con. 1, Cayuga. Corniferous.

Collector.—J. De Cew.

Athyris (?) unisulcata.—(Conrad.)

Atrypa unisulcata.—Conrad. *Annual Report Geological Survey, New York.* 1841, p. 56.

Rhynconella unisulcata.—Hall. Tenth Annual Report of the Regents of the University of the State of New York. 1857, p. 125.

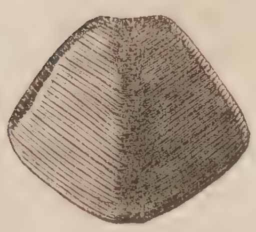


Fig. 39.

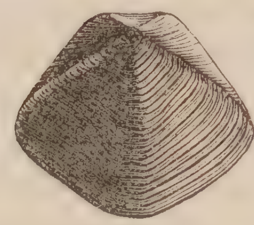


Fig. 40.

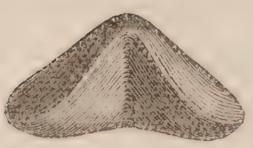


Fig. 41.

Fig. 42.

Fig. 39. *Athyris unisulcata*.—Ventral view. Fig. 40.—The same; dorsal aspect.
Fig. 41.—View of front margin. Fig. 42.—Side view.*

Description.—Shell quadrilateral or sub-triangular; greatest width near the front margin; sides nearly straight from the beak to the line of the greatest width, where there is a prominent angle on each side of the shell, thence converging and nearly straight to the middle of the front margin. Dorsal valve with a mesial fold which occupies the whole of the shell except a small portion on each side in the upper half; the slope from the ridge of the fold to the sides usually gently concave. In some specimens a single strongly impressed groove along the ridge of the mesial fold. The ventral valve has a deep mesial sinus equal to its whole width; a small strip of the margin between the beaks and the point of the greatest width inflected at a right angle or thereabout towards the dorsal valve. The beak is incurved over the umbo of the dorsal valve, but its tip not quite in contact with the surface of the dorsal shell. The surface is nearly smooth, a few obscure concentric undulations, and, in some specimens, indications of fine radiating striæ visible.

Length of large specimen, nine lines; width, eleven lines.

This species varies greatly in form. Some have the front margin nearly straight, and are thus almost triangular. Others are quadrangular or rhomboidal from the great projection in the middle of the front margin. The sinus of the dorsal valve is sometimes so shallow

* These figures are not very good, but as they will serve to give an approximate idea of the form of one of the varieties, I have thought it best to use them.

that the valve has the appearance of a flat space along the middle. The groove on the ridge of the dorsal valve either extends to the front margin of the shell, or dies out at a greater or less distance from the beak.

The length of the shell ranges from two to nine lines, and is always a little less than the width.

Locality and formation.—County of Haldimand. Corniferous Limestone. Not common.

Collectors.—J. De Cew, E. De Cew, and E. Billings.

Athyris (?) rostrata.—(Hall.)

Atrypa rostrata.—Hall. *Geology of the Fourth District of New York*, page 202, fig. 2.

Fig. 43. Fig. 44.

Figs. 43, 44. *Athyris rostrata.*—Dorsal and side views.

Description.—Elongate oval, both valves evenly convex and smooth. Ventral valve the larger, most ventricose in the upper half; beak proportionally large, sub-cylindrical, incurved, not in contact with the umbo of dorsal valve, apparently perforated by a large foramen. Dorsal valve smaller than the ventral, but proportionally as strongly convex, umbo rather broadly rounded, beak incurved and deeply buried beneath that of the ventral valve.

Length about six lines; greatest width a little in front of the middle of the ventral valve, five lines; depth of both valves a little above the middle, three lines and a half.

The surface at first sight appears to be quite smooth, but upon a closer examination it will be found to exhibit some fine obscure concentric rings of growth.

This neat little fossil is smaller and proportionally broader, and more ventricose than *A. scitula*.

Locality and formation.—Lot 26, con. 3, Bosanquet. Hamilton Shales.

Collectors.—A. Murray and J. Richardson.

ATHYRIS (?) CHLÖE.—*N. Sp.*

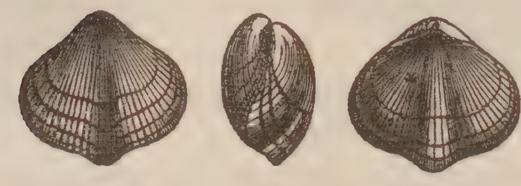


Fig. 45. Fig. 46. Fig. 47.

Fig. 45. *Athyris Chloe.*—Ventral valve. Fig. 46.—Side view.
Fig. 47.—Dorsal view.

Description.—Transversely sub-oval; greatest width usually about the middle, sometimes a little above or below; front margin often with a rounded projecting lobe in the middle; both valves convex. Ventral valve with a concave mesial sinus which occasions a linguiform projection in the middle of the front margin, and becomes obsolete at about half the length of the shell; umbo well defined; beak closely incurved down to the umbo of the dorsal valve, usually, if not always, perforated at the tip by a small circular aperture. Dorsal valve with a rounded mesial fold which elevates the middle of the front margin and becomes obsolete at about half the length.

Surface with somewhat obscure rounded but apparently much depressed, simple or undivided radiating ribs, of which there are on an average in the specimens examined, three in the width of one line. There are also, especially towards the front margin, a few squamose rings of growth. There appear to be some fine concentric striæ, but the surface in the specimens is not quite perfect.

Width, from five to nine lines; length, a little variable, according to the greater or less developement of the mesial fold.

In one specimen with the fold large, the length is seven lines to a width of nine lines.

In this species I have detected no appearance of an area, but in perfect specimens the hinge-line is extended to three-fourths the width of the shell, and in such cases the cardinal angles, although rounded, are elevated and much compressed.

Locality and formation.—Lot No. 26, con. 3, Bosanquet. Hamilton Shales.

Collectors.—A. Murray, J. Richardson.

(*To be continued.*)

NOTES ON LATIN INSCRIPTIONS FOUND IN BRITAIN.

PART V.*

BY THE REV JOHN M^C^CAUL, LL.D.,

PRESIDENT OF UNIVERSITY COLLEGE, TORONTO.

16. In Horsley's *Britannia Romana, Northumberland*, xcvi., we have the following inscription :

SILVANO
PANTHEO
PRO · SAL
RVFIN · TRIB · ET
LVCILLAE · EIVS
EVTYCHVS
LIB · COS
V · S · L · M ·

* Since Part IV. was published, I have had access to the *Archæologia Æliana*, and have read the paper by Mr. Hodgson, to which reference is made in my note in page 355. In that paper, after a critical examination in detail of each phrase or passage of the inscription, Mr. H. proposes the following reading of it:—

"*IMPP . CAESS.*
L . SEP . SEVERO PIO PERT . P . M.
ARAB . PARTH . ADIABENICO MAXI.
COS . III . ET M . AVREL . ANTONINO PIO
COS . II . AVG . *ET P . SEPT . GETAE . NOB . CAES . COS*
PORTAM CVM MVRIS VETVSTATE DI-
LAPSIS JVSSV ALFEN . SENECINIS VO
COS . CVRANTE COL . ANITI . ADVENTO PRO
AVG . NN . COH . I . VANGION . ———
CVM AEMI . SALVIAN . TRIB.
SVO A SOLO RESTI.

Which may thus be explained at length :—

Imperatoribus Cæsaribus
Lucio Septimio Severo Pio Pertinaci, Pontifici Maximo,
Arabico, Parthico, *Adiabenico Maximo,*
Consuli tertiùm, et Marco Aurelio Antonino Pio,
Consuli secundo, Augustis, et Publio Septimio Getæ, nobilissimo Cæsari, consuli
Portam cum Muris Vetustate di-
lapsis, Jussu Alfeni Senecinis (Senecionis?) Viri
Consularis, curante Antistio (or Anitistio) Advento, pro
Augustis nostris, Cohors prima Vangionum ——
Cum Æmilio Salviano, Tribuno
Suo, a Solo restituit."

On comparison with the reading which I proposed in No. XXIII. of this Journal, p. 359, it will be observed that there are several points of difference; but on re-consideration of the

Horsley expands it thus: "Silvano Pantheo pro salute Rufini tribuni et Lucillæ ejus Eutychus libertus consulis votum solvit libens merito," and supplies *uxori* after *ejus*, in the fifth line. The only doubt which I have as to the accuracy of this expansion, relates to LIB · COS. If Eutychus had been a freedman of the Consul, as Horsley believed, the order, according to usage, would have been COS · LIB; and instead of the office, *consul*, the name of the individual would have been given, for consuls, as such, had no *liberti*. I regard LIB · as standing for *Librarius*, and COS · for *consulis*. The *librarius* was a book-keeper, who had charge of the accounts, and is mentioned in many inscriptions, in connexion with the officer or body in whose service he was, e. gr. LIB · PRAEF · *Librarius Præfecti*, LIB · CH ·, *Librarius cohortis*.

17. Amongst the *Marmora Oxoniensia* is an altar, found at Chester, bearing an inscription of the date A.D. 154, which has been frequently copied and explained.*

There can be but little doubt that the true reading of the inscription is as follows :

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subject, I see no reason for changing the opinions which I have expressed in the article and embodied in the restoration. The only question, about which some doubt is suggested, relates to the date. The notice in the inscription of Caracalla as Cos. II. of course fixes the date within the cancelli—205, the year of his second consulship, and 208, the year of his third consulship. Mr. Hodgson argues for 207, assuming that the emperors were at the time in Britain, and adopting Horsley's opinion that "Severus came into the island in the year 207 at latest." He finds confirmation of his assumption as to the presence of the emperors, in the title of Senecio being in this inscription *vir consularis*, instead of *legatus eorum pr. pr.*, as it appears on a stone found at Greta Bridge.

Although the conjecture, that the change of title indicates "the exercise in person [by the emperors] of both the military and civil powers of the government, rendering the office of legate no longer necessary," seems plausible, yet there can, I think, be no doubt that both Mr. Horsley and Mr. Hodgson are in error in fixing 207 as the year of the arrival of the emperors in Britain. The statement of Xiphiline, that Severus died in the island "three years after he undertook the British expedition," suggests 208 as the date of his arrival, for he died in 211 (on February the 4th; not the 12th, as given by Mr. Hodgson in a note); and this date (208) is confirmed by reference to coins e. gr., one of Caracalla's bearing the legend :

PROF . AVGG . PONTIF . TR . P . XI COS . III.

from which it appears that the *profectio Augustorum* took place in the eleventh TRIB. POT. and third COS. of Caracalla, *i.e.* 208. I am still of opinion, for the reason stated in the note, p. 359, that 205 is the most probable date of the inscription, although it is possible that the intention of those who set up the stone may have been to indicate that the work was commenced, carried on, and completed during the time in which Severus was COS . III., Caracalla COS . II., and Geta COS.

* It is especially interesting on account of the epithet *Tanarus*, which is given to Jupiter; and the supposition is not improbable, that *Tanarus*, *Taras*, and *Taranuncus* denote the same deity, the *Thor* of the northern nations.

I·O·M·TANARO
T·ELVPIVS·GALER
PRAESENS·GVNTIA
PRI·LEG·XX·V·V
COMMODO ET
LATERANO COS
V·S·L·M

Of the interpretations which have been proposed, the most extraordinary is that given by De Wal, in his *Mythologiæ Septentrionalis Monumenta.* He expands it thus :

"Jovi Optimo Maximo Tanaro,
Titus Elupius, Galeria *tribu*,
et Præsens, Guntia *tribu*,
Primipilares legionis xx Valeriæ Victricis,
Commodo et
Laterano consulibus,
Votum solvunt lubenter merito."

The obvious objections to this rendering are, that there is no ground for supposing that the altar was erected by two persons, and that there is no authority for a tribe called *Guntia*. I can see no reason for rejecting the opinion adopted by Horsley (*Britannia Romana*, p. 315), and Orelli (n. 2054), that GVNTIA is the name of the birth-place of Titus Elupius Præsens, scil. *Guntia*, a town in Vindelicia. The *legitimus ordo nominum*, from the *prænomen* to the *patria*, is thus preserved, with the exception, indeed, of the *nomen patris*, but that is omitted in the inscription. Gough's objection (*Camden's Britannia*, vol. iv. p. 89) to the position of the tribe (*Galeria*) between the names (*Elupius* and *Præsens*), with his consequent preference of *Galerius*, is not worth considering; for it is plain that he was not aware that, in the normal arrangement of Latin names, the *nomen patris* and *tribus* come between the *nomen gentilicium* and the *cognomen*. And yet Mr. Wright (*Celt, Roman, and Saxon*, p. 260), influenced perhaps by the objection, gives *Galerius*.

Horsley suggests a doubt whether we should read PRI for *primipilus*, or PRE for *præfectus ;* but there seems no ground for questioning the received reading. With Henzen, however, I think it uncertain whether we should regard it as standing for *primipilus* or *princeps*. Of the two I prefer the latter, as we find PRI · PRI. for *princeps prior*, or *primus*, in Orelli, n. 3451.

18. In the *Celt, Roman, and Saxon*, there is an instructive chapter on "The different races in Roman Britain," in which Mr. Wright has collected the scattered notices which bear on the Ethnology of the period. As might be expected in a task of considerable labour, and involving many minute details, some errors have crept in, which require notice, lest they should mislead others. One of these (page 253) is, that "Caius Antiochus Lysimachus, commemorated in a Greek inscription found in Scotland, was no doubt a Greek."

Mr. Wright has been led into error by a mistake in Professor Thomson's edition of *Stuart's Caledonia Romana*. In No. 1 of Plate VI. of that work,* a stone, preserved in the Museum of the Society of Antiquaries of Scotland, is figured, in which the name Lysimachus occurs; but the stone was found, not in Scotland, but in Africa, and Prof. Thomson acknowledges the mistake in his preface.

19. Mr. Wright also remarks, in the same chapter:

"Uriconium (*Wroxeter*) appears to have been occupied by Thracians: Cirencester by Thracians and Indians."

There is no doubt that an inscription has been found at each of those places, which furnishes evidence that a horseman of a Thracian cohort was buried in each, but there is no ground for the assertion that there were "Indians" at Cirencester. An inscription, indeed, was found there, commemorating *Dannicius*, a horseman *alæ Indianæ;* but this body did not derive its name from the nationality of the men composing it. It was probably called after *Julius Indus*, mentioned in *Tacit. Ann.*, iii. 42; and there is reason to believe that the men serving in it were, for the most part, *Treviri*. The *alæ* seem to have received such designations† as *Indiana, Frontoniana, Sebosiana*, from the names of the officers who first raised or organized them, and in this respect resembled the military bodies in our own service in the East Indies, known by such names as "Jacob's," or "Hodson's Horse."

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* The stone is a sepulchral memorial of Antiochis, the daughter of Lysimachus. It is not easy to tell, from the faint copy which I have before me, what the letters are which Mr. Wright read "Caius;" but they unquestionably do not stand for that name. The first letter seems to be L, from which I infer that they most probably are *sigla* for the year of the Emperor, as is common in the Greek inscriptions of Egypt and Cyrene.

† *Vide* Henzen, nn. 5442 and 6722; also Roulez, *Mem. de l'Acad. Royale de Belgique* vol. xxvii. p. 12.

20. In 1830, an ancient grave-stone was found in excavating the foundations of Mr. J. S. Padley's house, in Lincoln. It is figured in the *Gentleman's Magazine* for 1842, p. ii. p. 351; and the inscription is given in the *Monumenta Historica Britannica*, p. cxii. n. 53*a*; and by Henzen, n. 6676, as follows:

L · SEMPRONI · FLA
VINI · MILTIS · LEGVIIII
Q (?) ALAVDI SEVERI
AER VIIANOR XXX
ISPANICA LERIA
CIVI MA

It is plain that the first two lines are to be read:

L[ucii] Semproni[i] Fla-
vini mil[i]tis leg[ionis] nonæ

but there is considerable doubt as to the word or words preceding SEVERI, in the third line. Mr. Padley remarks, that if the first letter in the line be Q, it may stand for *quadratæ*, i.e. *legionis nonæ quadratæ;* and reads the following word as "Alaudæ (a lark), a name given to legions, the soldiers of which wore tufted helmets, supposed to resemble the crest of the lark." The Editor of the Magazine suggests that the letter is G (not Q), "and is certainly some epithet of the legio Alauda. Perhaps galeatæ alaudâ, crested by the lark; or galeritæ alaudâ." The rest of the line, I SEVERI, is read by Mr. Padley as *Julii Severi*, and the reading is illustrated by the observation that "Julius Severus was a governor of Britain under Hadrian." The Editor of the *Monumenta Historica Britannica* adopts *Alaudæ*, but doubts whether I should be read as *Julius* or *Junius*, as there were two proprætors of Britain named *Severus;* the one, *Julius*, under Hadrian, the other, *Junius*, under Commodus. Henzen is of opinion that the latent reading of the line is "*Sub curA* (or something similar) cLAVDI SEVERI." I have but little doubt that Henzen's emendation CLAVDI is correct; and I regard the first A in ALAVD as a mistake for C. One of the *cognomina* of the 5th legion was *Alaudæ;* whilst those of the 9th were *Hispanica* and *Macedonica*. The first letter of the line, which is stated to resemble "the letter *q* inverted," and "the Etruscan G, the Roman G reversed," appears to me to be merely an inverted C, standing, as it often does, for *centuria*, and denoting that Lucius Sempronius Flavinus was a soldier in that century of the 9th legion, which was under the command of Claudius Severus. Such a notice of the *century*, with the name of the centurion, is frequently found in the sepulchral inscriptions of soldiers. To Mr. Padley's reading of the next line, "aerum vii; annorum xxx," there can be no objection, as *aerum* is sometimes used for *stipendiorum*. *Vide* Orelli, nn. 3551, 3552; and Henzen, nn. 5202, 6841. The fifth line is read by Mr. Padley as "Ispanica Leria;" and the sixth as "Civitas Materna." Henzen adopts this reading of the fifth line, remarking that Leria was a city of Hispania Tarraconensis; but suggests, for the sixth, instead of "Civitas Materna," "Civi Ma[ximi exempli.]" There are, I think, but few scholars who would regard either of these interpretations of the last line as satisfactory; and on reference to the copy of the inscription in the Magazine, I find that there is no authority on the stone for the second I in CIVI, and that MA is most probably an erroneous reading of NIA. It appears to me, then, that we may read the last line thus: C · IVNIA, *curante Junia*, denoting the person who had caused the memorial of Flavinus to be executed. For the reasons which I have stated, I would read the whole inscription *in extenso* thus:

L · SEMPRONI · FLA	L[ucii] Semproni[i] Fla-
VINI · MILTIS · LEG VIIII	vini, mil[i]tis leg[ionis] viiii,
Ↄ CLAVDI · SEVERI	c[enturia] Claudi[i] Severi,
AER · VII ANOR · XXX	aer[um] vii, an[n]or[um] xxx,
ISPANICA LERIA	[H]ispanica Leria,
C · IVNIA	c[urante] Junia.

21. At the Mount, near York, there has been recently discovered "a slab, upwards of six feet long, with four incised figures in the upper part, and below them an inscription of six lines, of which nearly the whole is legible." "The inscription, as far as it can be deciphered, reads as follows:

D · M · FLAVIAE · AVGVSTINAE
VIXIT · AN · XXXVIIII · M · VII · D · XI · FILIVS
NVS · AVGVSTINVS · VXT · AN · I · D · III
AN · I · M · VIIII · D · V · CAERESIVS
I · LEG · VI · VIC · CONIVGI · CARI
ET · SIBI · F · C."

[*i.e.*: D[iis] M[anibus] Flaviæ Augustinæ;
Vixit an[nis] xxxviiii, m[ensibus] vii, d[iebus xi.] Filius
nus Augustinus V[i] x[i]t an[no] i, d[iebus] iii,
an[no] i, m[ensibus] viiii, d[iebus] v, Cæresius
i leg[ionis] vi vic[tricis] conjugi cari-
et sibi f[aciendum] c[uravit.]

The Rev. J. Kenrick lately read a paper on the subject before the Yorkshire Philosophical Society, from the report of which, in the *Gentleman's Magazine* for January, 1860, I have taken the foregoing particulars. On the interpretation of the inscription, Mr. Kenrick offered the following remarks:

"The monument appears to have been raised by Cæresius, a soldier of the sixth conquering legion, to the Manes of his wife, Flavia Augustina, and two children, who died in their infancy, and prospectively for himself. Only the termination, NVS, of the son's name remains; there is room on the stone for the letters necessary to form FLAVIANVS, which is not unlikely to have been the name. But the space before the term of life, in the fourth line, is so small, that there is only room for a single name, and we must suppose an ellipsis of VIXIT to be supplied from the preceding clause. CAERESIVS is a name, which, in the forms CAERETIVS and CAERECIVS, occurs in Gruter. The beginning of the fifth line may have contained the second name of Cæresius, which one might have expected to be followed by some designation of his military character or office, as CENT·MIL. or TRIB·MIL. It is difficult to find any word ending in I, which could grammatically have stood in this position. The number of the cohort is often prefixed to the names of auxiliaries, prætorians, &c., but not of legionaries; and though the number of *stipendia* and years of service is often noted in inscriptions to deceased soldiers, it could hardly be looked for on a monument which a soldier had prepared for himself. It is natural to conjecture that the I is a remnant of an L, in which case MIL may have preceded the title of the legion, but the appearance of the stone does not favour the conjecture. The space at the beginning of the sixth line is, no doubt, to be filled up with the remaining letters of CARISSIMAE."

The only difficulty in the inscription is, as Mr. Kenrick points out, in the I before LEG. He justly rejects the suppositions that the number either of the cohort or of the *stipendia* is denoted by I as a numeral. The natural conjecture is certainly that it should be read L, as the last letter of MIL; but that is not favoured by the appearance of the stone. Under the circumstances, I am inclined to propose PRI, as in article 17 of this paper, for PRI[NCEPS]. There is little use in speculating on the second name of *Cærecius;* but there seems to be sufficient space before PRI for some such as FVSCVS, the cognomen of the *Cærecius* mentioned in p. ccclxxix, n. 6, of Gruter.

22.* At Corbridge (the ancient *Cortospitum*), two altars were found bearing Greek inscriptions. One of them is figured in Dr. Bruce's *Roman Wall*, p. 313, and the inscription is thus translated:

" ΑΣΤΑΡΤΗΣ	Of Astarte,
ΒΩΜΟΝ Μ'	The altar
ΕΣΟΡΑΣ	You see,
ΠΟΥΛΧΕΡ Μ'	Pulcher
ΑΝΕΘΗΚΕΝ	replaced."

This translation omits that pleasing characteristic, which is often found in Greek inscriptions, whereby the object is regarded as addressing the reader; and not only is ME overlooked in the second and in the fourth line, but the sense of ΑΝΕΘΗΚΕΝ is not correctly expressed. It does not mean "replaced," but "set up," "erected," "dedicated." Mr. Wright, p. 269, correctly renders it:

" Of Astarte
the altar me
you see,
Pulcher me
dedicated."

i.e. You see me the altar of Astarte; Pulcher dedicated me. He also notices the circumstance, that the inscription "forms a line in Greek hexameter verse." It is strange, that, being aware of this, he did not observe that a slight emendation will give the same structure in the inscription on the other altar. Following Horsley, he reads:

" ΗΡΑΚΛΕΙ	To Hercules
ΤΙΡΡΙΩ	the Tyrian
ΔΙΟΔΩΡΑ	Diodora
ΑΡΧΙΕΡΕΙΑ	the high-priestess."

It is plain that ΤΙΡΡΙΩ destroys the metre, and that the verse should stand thus:

ΗΡΑΚΛΕΙ ΤΥΡΙΩ ΔΙΟΔΩΡΑ ΑΡΧΙΕΡΕΙΑ.

i.e. Ἡρακλεῖ Τυρίῳ Διοδώρα ἀρχιέρεια.

In another Greek inscription, found at Chester, in, I believe, 1856, we have also an Hexameter, which has escaped the notice of Dr.

* As the number of Greek inscriptions found in Britain is very small, I have thought it better to incorporate any remarks, which I have to offer on them, with my Notes on Latin Inscriptions.

J. Y. Simpson, in his paper on the subject in the *Proceedings of the Soc. of Antiq. of Scotland*, vol. ii. p. i. p. 80. He reads the words, which form the verse,* thus:

ΕΡΜΟΓΕΝΗΣ
ΙΑΤΡΟΣ ΒΩΜΟΝ
ΤΟΝΑΑΝΕΘΗΚΑ.

i.e. ΕΡΜΟΓΕΝΗΣ ΙΑΤΡΟΣ ΒΩΜΟΝ ΤΟΝΑ ΑΝΕΘΗΚΑ.

It is evident that the fourth letter in the third line is not Α but Δ, and that the Ε, which follows it in ΤΟΝΔΕ, is here elided. Accordingly the verse should be:

ΕΡΜΟΓΕΝΗΣ ΙΑΤΡΟΣ ΒΩΜΟΝ ΤΟΝΔ' ΑΝΕΘΗΚΑ.

i.e. I, Hermogenes, a physician, dedicated this altar.

23. In Mr. C. Roach Smith's *Collectanea Antiqua*, vol. i. p. 135, a grave-stone, which was found some sixty years ago in Whitechapel, London, is figured; and the following explanation is given of the inscription which is on it:

"D . M.
IVL . VALIVS
MIL . LEG . XXVV
AN . XL . H . S . E
C . A . FLAVIO
ATTIO . HER

Dïis Manibus. Julius Valius miles legionis vicesimæ valentis victricis, anno quadragesimo, hic sepultus est. Caio Aurelio herede."

There is no difference between this expansion and that proposed in the *Gentleman's Magazine*, vol. liv. p. 672, excepting the emendation of the number of the legion, which Mr. Smith correctly gives as xx, instead of xxx, and the accidental omission of *Flavio Attio* between *Aurelio* and *herede*.

As there are obvious objections to this rendering, I would read the inscription thus:

D · M ·	D[iis] M[anibus];
IVL · VALIVS	Jul[ius] Valius,
MIL · LEG·XX · V · V	Mil[es] leg[ionis] xx V[aleriæ] V[ictricis],
AN · XL · H ·S · E	An[norum] xl, h[ic] s[itus] e[st],
C · A · FLAVIO	c[uram] a[gente] Flavio
ATTIO · HER·	Attio her[ede].

* The preceding words [ΣΩΤ] ΗΡΣΙΝ [ΥΙΙ] ΕΡΜΕΝΕΣΙΝ seem to be a portion of an irregular pentameter.

24. In the same work of Mr. Smith's, vol. iii. p. 201, we find the following notice of "an imperfect inscription found at Caernarvon (Segontium), which was contributed to the 'Archælogia Cambrensis,' by Mr. James Foster."

"It is on two pieces of stone, which, on comparison, appeared to have belonged to one and the same slab;

· · · EPT . SEVERVS . PIUS . PER · ·
· · · VREL . ANTONINV · · · · · ·
· AQVAEDVCTIVM VETVS · · · · ·
· · · BS . COH . I . SVNC . RESIT · · ·
· · · VIPF · · ·
· · · IVL · · ·

"The first two lines mention Severus and Caracalla; the second and third [third and fourth] refer to an aqueduct or aqueducts, which, having become decayed through age, had been restored by the first cohort of the Tungri; that is to say, presuming the SVNC of the engraving in the "Archæologia Cambrensis" for April, 1853, should be TVNG. The remaining lines probably gave the name of the commander of the cohort, and that of the superintendent of the work of restitution."

It is plain, that Mr. Smith correctly explains

[S]EPT[IMIVS] SEVERVS · PIVS · PER[TINAX]
[A]VREL[IVS] ANTONINV[S]

as standing for the Emperors Severus and Caracalla; and

AQVAEDVCTIVM VETVS[TATE]
[COLLA]BS[VM] COH[ORS] I SVNC RESTIT[VIT]

as referring to* an aqueduct, which, having become decayed through age, had been restored. Nor is his opinion as to the contents of the fifth and sixth lines improbable; but I have no doubt that the cohort named in the fourth line is not *cohors prima Tungrorum*, but *cohors prima Sunuc*[*orum*], the N and V being ligulate. This cohort is mentioned in the *tabula honestæ missionis* found at Stannington, in Yorkshire (*Gough's Camden*, iii. p. 263, *Monum. Hist. Brit.* n. 9), from which it appears that at the time (A.D. 124) it was serv-

* I regard *aquæductium* as used for *aquæductum*.

ing in Britain under the command of *Auluntus Claudianus*. This Caernarvon stone is valuable, as it and the *tabula* are the only extant memorials of the cohort. The *Sunuci*, or *Sunici*, were a Belgic people. They are mentioned by Tacitus and Pliny, but their position has not been exactly defined. It is probable, however, that they lived between Cologne and the Meuse, about the eastern part of the modern Belgic province of *Limbourg*.

25. In the *Archæologia Æliana*, vol. iv., a broken slab, which was found in Birdoswald *(Ambloganna)* during the excavations which were made under the direction of Mr. Potter in 1852, is figured; and that gentleman gives the following expansion of the inscription, which it bore:

"SVB MODIO IV	Sub[limo] Dio Ju-
LIO LEG AVG PR	-lio leg[ato] Aug[ustali] Pro-
PR COH I AEL DC	Prætori Coh[ors] i Æl[ia] D[a]c[orum]
CVI PRAEEST M	cui præest M[arcus]
CL MENANDER	Cl[audius] Menander
TRIB	Trib[unus]."

Mr. Potter is of opinion, that "if this reading be correct, there is reason to suppose that the Julius here mentioned was Julius Severus, who, in the time of Hadrian, was proprætor of Great Britain;" and after examination, rejects a different reading which had been suggested, viz. *Sub Modio Julio*.

I am unable to comprehend the grounds on which Mr. Potter adopted *Sublimo Dio*, a reading which is unprecedented and scarcely intelligible. I concur with Mr. Smith (*Collectanea Antiqua*, iii. p. 201), in preferring *Sub Modio Julio*, which (as Mr. Potter remarks) gives "the name of a proprætor of Britain not hitherto known." I am not satisfied, however, as to the correctness of *Julio*. The fracture of the slab seems to have so materially injured the letters, in the second line, given as LI, that it may reasonably be doubted whether that be the right reading. I am inclined to venture on the conjectures, that the injured letters are ST, and that the *Modius Justus* named here is the same, who, at a different time, was LEG· AVG·PR·PR of Numidia. He is mentioned in the following inscription given by Renier (*Inscriptions de l'Algérie*, n. 44):

STAT · AGRIP	Stat[iæ] Agrip-
PINAE CON	pinæ, con-
IVGIS MO	jugis Mo-
DI IVSTI LEG	di[i] Justi, leg[ati]
AVG · PR · PR	Aug[usti], Pr[o] Pr[ætore],
CONSVLIS	Consulis,
SPEGVLATO	Speculato-
RES ET	res et
BENEFICIARI	Beneficiari[i].

In Mommsen's *Inscript. Neapolit.* n. 5274, we also find the names *Modius Justus.*

REMARKS ON THE LAW OF STORMS, AS SET FORTH IN A TRACT PUPLISHED BY RICHARD BUDGEN, IN THE YEAR 1730.

BY THE REV. C. DADE, M.A.

Read before the Canadian Institute, March 26th, 1849.

Among the "Curiosities of Literature" may justly be reckoned the numerous family of Tracts, especially those of a bygone age. These "Sibylline leaves," as they may be called, take a wide range, for there is scarcely a branch of human learning which they leave untouched. The theologian, the physician, the lawyer, the historian, may find in them much valuable metal amidst a heap of dross and refuse. The philosopher may detect the rude germ and faint lineaments of many a theory confirmed and illustrated by the labours of a succeeding generation, and the practical operator may discover projects and inventions appropriated perhaps, without scruples, by those who have reaped where they never sowed. They rescue from oblivion remarkable persons and events, throw light upon the manners aud customs of our forefathers, relieve the generalization of history by presenting life-like pictures of a bygone age ; and we have seen of what signal service they have been made to render in the hands of a consummate master, by elucidating many a dark passage of the annals of our country. The collection, therefore, and preservation of these "*dis-*

jecta membra" is far from being an unprofitable service. From their very nature they were fleeting and evanescent, and often doomed to an ephemeral existence, wanting those attributes of bulk and density to which many a huge folio and quarto owes its preservation.

The tract under consideration is worthy of notice on more than one account. It gives a minute and apparently trustworthy record of an extraordinary natural phenomenon. It exhibits the rude and imperfect outline of that which the youngest in the family of Sciences is rapidly ripening into just form and proportions. It points out to the meteorologist of the present day, richly furnished with all the means and appliances which the genius of the philosopher, aided by the skill of the mechanic, can supply, the way in which these phenomena were dealt with by those who were utterly without such helps. And in the particular case under consideration it will lead to the enquiry whether it has not anticipated a theory capable of great results and expansion, which has been claimed as the offspring of the present generation.

The title of this tract is as follows: "The Passage of the Hurricane from the seaside at Bexhill, in Sussex, to Newingden Level, the twentieth day of May, 1729, between nine and ten in the evening, containing :—

(1) An account of the Weather and bearing of the Winds that preceded the Hurricane, with the celerity of its circular and progressive motion.

(2) A particular account of the Damage and Devastation of the Buildings, Timber, &c., that stood in the way of its course.

(3) Some observations on the way and manner of its course.

(4) By way of enquiry, some account attempted of the causes of Tempests, Whirlwinds, and Hurricanes. By Richard Budgen.

The tract is dedicated to "Sir Hans Sloane, Bart., the President, and to the Council and Fellows of the Royal Society," and is accompanied by an "Exact Plan" describing the passage of the Tornado or Hurricane, which is represented by a spiral line, shewing its breadth, and likewise that the gyration was from E. to W. The divisions of the several Estates passed over by the Hurricane are carefully delineated, the whole being a well executed diagram.

Who or what the said R. B. was, we have no means of knowing. He was a dilligent observer of the weather in his way, and he alludes to his own and his friends' journals. He seems to have been a man of an inquisitive and philosophical turn of mind, and a projector withal, for we have another production of his in which he describes a notable invention of his own, viz.: "An Engine to work by the Wind, that with a long time, and a close and intent application of thoughts, and a large expence in making and altering of models, I have now brought to answer the ends proposed." These ends were nowise trifling, and had they answered the anticipations of the worthy projector would doubtless, instead of having been consigned to the limbo of forgetfulness, have earned for him the expected immortality. However, as an observer of nature, he seems to have been most indefatigable. In his description of the hurricane and its effects, he does not omit the smallest particular from the "uprooting of over a thousand and five oaks on the demesne of Sir Thomas Webster, Bart.," to the damaging of a stack of chimneys, or the unroofing of a pig-stye. He opens his narrative by saying, "We had the surprising horror of seeing (at about twenty miles distance), such unintermitting coruscations, together with such dreadful darting and breaking forth of liquid fire at every flash of lightning in the way of the hurricane, as perhaps has not been seen in this climate for many ages. He proceeds to give "a careful collation of the weather for the nine days preceding the hurricane," as follows:

"May 11.—Storm of hail in the evening, wind W. b. N., the wind for a long time before having been northerly.

12.—White frost, warm and fair with moderate breeze S. b. W.

13.—Clear, light breeze from the S.

14.—Cloudy, light breeze from W.

15.—Very clear, warm breeze from S. E.

16.—Very serene air, with a sensible increase of heat; wind S. E.

17.—Very clear with a soft W. wind.

18.—Very serene, and began to be exceeding hot and sultry. Wind S.

19.—A somewhat thick air in the morning, but very clear and exceeding hot in the afternoon. Wind S. W. b. S.

20.—A slight flying tempest in the morning with a little scattering rain. The rest of the day very clear and extreme hot and sultry. Wind S. till about 5 P.M., when there began to appear a haziness in the S., which by degrees, with a vanishing edge, arrived at our zenith about 7 P.M., when there began to appear plain symptoms of a tempest. We distinctly heard the thunder at 8 P.M., and had a prospect of two different tempests. It appeared like a prodigious smoke rolling from a limekiln. It landed about 9 P.M., its course being nearly from S. b. W. to N. b. E. Length of its track twelve miles, which it passed over in twenty minutes; and seventy rods may be taken for the mean diameter of its vertiginous motion."

"The duration of the offensive wind could not exceed twenty seconds. The direct velocity of the storm is forty-two feet in a second, to which adding forty-three feet, for the increase by the vertiginous or spiral motion, makes eighty-five feet, which is the space run through in every second of time near the outward verge of the gyration, and the velocity by which all obstacles received the impulse of the wind."

Budgen alludes to the "storm's eye"—the *El ojo* of the Spanish mariners—often noticed since.* "At Ewhurst a brightness was observed in the clouds approaching about the breadth that afterwards appeared to have been taken in by the hurricane, and such a strong light during the time of the greatest violence of the storm, as far exceeded any of the preceding flashes of lightning."

Again, he observes:—"By passing thro' and between buildings, touching both sides, and by the circular lanes in some places, in woodlands that were full of timber, and by some particular buildings rent in divers parts by impulses of several directions, undeniably proves that the swift vertiginous motion of hurricanes is not owing to any force equally impressed upon the fluid in motion, according to, and as they are commonly compared to, liquid whirlpools, &c., but rather that the offensive part of the fluid, which moves with such violence as scarcely to be resisted, appears to have taken in not more than $\frac{1}{20}$th or $\frac{1}{25}$th of the diameter of the whirlwind or fluid in a vertiginous motion, for where it raged with the greatest violence in the thickets of timber some trees had not the least appearance of a storm, yet all the trees about them were torn up by the roots and shattered into splinters."

Again:—"That its motion was contra-solem, or from the right hand to the left, was plain from all bodies being drove down near the eastern verge towards the north, and near the western towards the south. By increasing in breadth as it ascended to the tops of the

* "A very remarkable fact is that while all around the horizon was a thick dark bank of clouds, the sky above was so perfectly clear that the stars were seen."—*Reid on the Law of Storms*, p. 393, &c.

hills, gives reason to believe the body of the hurricane was like a truncated cone inverted, which, perhaps, when this knowledge is raised to a higher pitch, and these appearances better understood, may be found a necessary form not only for hurricanes, but all kinds of spouts and whirlwinds."

It is not necessary to follow the author in his minute details of the devastation caused by this hurricane. Suffice it to say that it levelled buildings, tore up by the roots, splintered, or destroyed a vast number of oak trees, to the number of 1,300 or 1,400 on one estate alone. The description is valuable for it proved from ocular demonstration the theory of the rotary and progressive motion of storms, as set forth by the author. We need not dwell upon the latter portion of his essay, in which he endeavours to account for the origin of these awful phenomena. Budgen admits the necessity of more extended observation in after times as a fit employment for some "philosophical genius." His words are, (page 11),—"Neither does it appear to me that any just conclusion from reasoning can be produced without being furnished not only with a long series of observations, but a good collection of such kind of experiments as have not yet been tried, or at least never published;" and the object of his tract was to "collect such certain facts as had the appearance of being most useful, and assisting to lead a philosophical enquirer towards the causes." We see then, in the pamphlet before us, the law of storms clearly enunciated. The hurricane, from actual observation, is found to have a progressive motion nearly in a straight line, and, at the same time, a circular motion contra-solem, and we see that this doctrine was established by R. Budgen one hundred and twenty-nine years ago. Now, in the Foreign *Quarterly Review*, we read the following statement: "Col. Reid lays no claim to originality in this discovery (*i.e.*, the Law of Storms) which belongs essentially to Mr. Redfield, of New York, who was *the first person* (Col. Reid says) that gave any just notion of the nature of hurricanes. It is due to Mr. Redfield to mention that until Col. Reid informed him of Col. Coppers having previously suggested the rotary theory of storms, he was quite ignorant of the fact. The doctrine held by Mr. Redfield, and we think substantiated by the facts brought together by him and Col. Reid, is that a hurricane or great gale is simply a whirlwind revolving in a direction contrary to the hands of a watch, or from right to left, supposing yourself in its centre, and that at the same time the centre of the vortex is advancing in a line nearly straight, at a rate of progression which is very slow compared with the velocity of rotation."

Thus it appears that this theory, set forth as original in 1835, was explicitly enunciated in 1730 by Richard Budgen; and we might almost say demonstrated by an appeal to facts. We are not now talking of its developement in later years, or of that vast accumulation of details due to the industry and research of later observers. We may further remark, that in this sketch no mention is made of any kind of philosophical instruments. It would have signally added to the interest and value of the observations, had there been careful records of the thermometer and barometer; but these instruments, though long before invented, were little known and used by any but the learned, and were rude in their construction and equipments. It is only in the present age that the skill of the artist has been enlisted in the service of the philosopher, and theory and practice made to go hand in hand. Nevertheless, as was observed in the outset, these rude and imperfect attempts are not unworthy of notice. No modern philosopher will be inclined to say "*Pereant isti qui ante nos nostra dixerunt,*" but will rather award a just meed of praise to those obscure seekers after knowledge, who, with means and appliances so scanty, were yet enabled to accomplish so much.

REVIEWS AND NOTICES OF BOOKS.

Course of Practical Chemistry, as adopted at University College, Toronto. By Henry Croft, F.C.S., Professor of Chemistry, University College. Toronto: Maclear & Co., 1860.

Perhaps in no one department of science, is so much active interest displayed at present, as in that of Chemistry. This is due, without doubt, to the important bearings of Chemical Science on many of the leading questions of the day. In Agriculture, in Technology—throughout the wide field which that department properly embraces—in Medicine, Pharmacy, and Medical Jurisprudence, its practical applications are prominent and manifold; whilst, to its more indirect influence and reactions, many of its sister sciences owe, in great part, the rapidity of their modern progress. The great advance made in these latter times by Chemistry itself, has been essentially brought about by the perfection of one of its branches—that which relates to the analysis of mineral and organic bodies, and which, in conventional language, is often called *Practical Chemistry*. This forms, as it were, the basis or groundwork on which the whole structure of Modern Chemistry has been reared. Without a knowledge of the accurate composition of bodies—a knowledge won only by the gradual perfection of chemical analysis—the law of Definite Proportions or Combining Weights, with its natural sequence the Atomic Theory, the great facts of Isomorphism, the Theory of Compound-Radicals, and other leading views of the modern science, would have been still unrecognised. The Chemical-Reagent and the Balance, it should also be remarked, first truly deprived the designing hosts of the *Subtles* and *Faces* of their knavish office, in dispelling the alchemistic dreams in which this science originated, and which so long controlled its progress.

Chemistry is often taught, or attempted to be taught, in schools and elsewhere—but how? In many instances, simply by word of mouth, by recitations from some elementary text-book, in which merely the broad facts of the science are set forth and commented upon in popular language, whilst neither teacher nor pupil possesses the slightest practical knowledge of the various bodies whose properties are brought under discussion. We once heard a school-teacher of this kind, discourse very flowingly on some chemical topics, but who, on being subsequently applied to by one of his scholars for information as to whether a certain substance, a sample of which he brought him, contained copper, was utterly unable to reply, or even to suggest the proper means by which the question might be solved. This is certainly not a desirable method of either teaching or learning chemistry; and he who would obtain a correct knowledge, elementary or otherwise, of this subject, is strongly urged, after mastering its general principles, to resort to his reagents, his blowpipe, and his test-tubes; and to familiarise himself with at least the common properties and reactions of the ordinary metals and non-metallic elements, and their compounds. No special laboratory is required for this purpose, nor is any expensive apparatus necessary. One of our best chemists, the celebrated Dr. Wollaston, kept all his working instruments on a tea-tray. A trustworthy handbook will be wanted, and the student cannot certainly find a more suitable one for his purpose, than that of which the title is placed at the head of this notice. The name of its author is a sufficient guarantee that the work has been well performed. Although various treatises on Chemical Analysis exist, many of these are too extensive for general use, and others are not readily procurable in this country; and thus, Professor Croft's very excellent manual will supply the Canadian student with a long-felt want. The work is divided into four sections. The first treats of apparatus and reagents; the second gives the reactions of the more common bases and acids, with tables for the detection of these bodies; the third comprises the detection of poisons, both mineral and vegetable; and the fourth includes special directions on alkalimetry and acidimetry, the analysis of soils and mineral waters, the examination of bile and urinary calculi, and other matters. The work is thus not only adapted to the requirements of our University and other general students; but, to the medical student, also, it will prove equally acceptable. E. J. C.

Examples of the Application of Trigonometry to Crystallographic Calculations, drawn up for the use of Students in the University of Toronto. By E. J. Chapman, Professor in University College; late Professor in University College, London. Toronto: Printed by Lovell & Gibson, Yonge Street, 1860.

The University of Toronto having adopted the "Application of Trigonometry to Crystallographic Computations" as one of the honor subjects for students of the fourth year, the graduated series of examples, given with some introductory matter in the present pamphlet, has been drawn up to convey a general idea of the principles involved in this application.

The examples are illustrated by five lithographed plates, containing various original diagrams, designed expressly for this memoir. Amongst others, two new projections are given, shewing, at a glance, the relative positions of the forms of the Trimetric System of Crystallization—to which group, as that best adapted to exhibit the nature of crystallographic calculations in general, the examples are chiefly confined. This method of projection may be applied equally to all the other systems; and its employment by the student will be found, it is thought, of much advantage, in fixing in the memory the form-relations of the different crystal groups. The Notation employed is also new; and in some additional remarks, a quick and simple method of computing the axial ratios of Rhombohedrons, with four diagram illustrations, is laid before the reader.

SCIENTIFIC AND LITERARY NOTES.

FRANKLIN INSTITUTE: PHILADELPHIA.

We have much pleasure in calling attention to the following notice, recently forwarded to us by the Franklin Institute of Philadelphia. The munificent offer of Mr. Boyden is open, it will be seen, to all residents of North America and the West India Islands:

BOYDEN PREMIUM.

Uriah A. Boyden, Esq., of Boston, Mass., has deposited with the Franklin Institute the sum of one thousand dollars, to be awarded as a Premium to "any resident of North America, who shall determine by experiment whether all rays of light, and other physical rays, are, or are not transmitted with the same velocity."

The following conditions have been established for the award of this Premium:

1. Any resident of North America, or of the West India Islands, may be a competitor for the Premium. The Southern boundary of Mexico being considered as the Southern limit of North America.

2. Each competitor must transmit to "Wm. Hamilton, Actuary of the Franklin Institute, Philadelphia, a memoir describing in detail the apparatus, the mode of experimenting, and the results; and all memoirs received by him before the first day of January, one thousand eight hundred and sixty two, (1862,) will, as soon as possible after that date, be transmitted to the Committee of Judges.

3. The Board of Managers of the Franklin Institute, shall, before the first day of January, one thousand eight hundred and sixty-two, select three citizens of the United States, of competent scientific ability, to whom the memoirs shall be referred; and the said Judges shall examine the memoirs, and report to the Franklin Institute whether in their opinion, any, and if so which of the memoirs is worthy of the Premium. And, on their report, the Franklin Institute shall decide whether the Premium shall be awarded as recommended by the Judges.

4. Every memoir shall be anonymous, but shall contain some motto or sign by which it can be recognised and designated, and shall be accompanied by a sealed envelope, endorsed on the outside with the same motto or sign, and containing the name and address of the author of the memoir. It shall be the duty of the Actuary of the Franklin Institute, to keep these envelopes securely, and unopened until the Judges shall have finished their examinations; when, should the Judges be of opinion that any one of the memoirs is worthy of the premium, the corres-

ponding envelope shall be opened, and the name of the author communicated to the Institute. The other envelopes shall be destroyed without being opened.

5. Should the Judges think proper, they may requre the experiments described in any of the memoirs to be repeated in their presence.

6. The memoir which may obtain the Premium, shall become the property of the Franklin Institute and shall be published as it may direct. Any unsuccessful memoir will be returned to the author at his request.

GEOLOGY AND MINERALOGY.

ANALYSIS OF CANADIAN WOLFRAM.—BY T. STERRY HUNT, F.R.S.

In volume 1, page 308, (New Series), of the *Canadian Journal*, will be found a crystallographic and mineralogical description, by Professor Chapman, of a specimen of Wolfram, discovered in a boulder of gneiss on the shore of "Chief's Island," Lake Couchiching, Canada West. A chemical examination of a portion of this specimen has yielded the following results:—

The specific gravity of the mineral was found to be 6·938. Two grammes of it were finely levigated, and decomposed by prolonged digestion with *aqua regia;* after which, the solution was evaporated to dryness, and the residue being heated with water and hydrochloric acid, the insoluble yellow portion was separated, washed with spirit of wine, and finally digested with ammonia. The ammoniacal solution left by evaporation and ignition, 1·469 grm. of tungstic acid. The residue, insoluble in ammonia, weighed ·048 grm. It was heated in a platinum crucible with fluorid of potassium, and an excess of sulphuric acid to drive off any silica which might be present, and then fused with the resulting bisulphate of potash. The fused mass was transparent, but on adding water white flakes separated, =·039 grm., and the solution contained ·005 of oxide of iron and manganese. The loss, equal to ·004 grm., was supposed to be silica, and the white matter, which was grey after ignition, and insoluble in a solution of potash, was regarded as niobic acid.

The iron was separated as peroxyd from the hydrochloric solution by carbonate of baryta, and equalled ·181 of protoxyd. The manganese, being lost by an accident, was calculated from the difference. We have thus, for 100 parts of this specimen of Wolfram, the following composition:—

Tungstic acid	73·45
Niobic acid (?)	1·95
Protoxyd of iron	9·05
Protoxyd of manganese	15·35
Silica	·20
	100·00

[These results lead to the general formula 2 (FeO,WO^3) + 3 (MnO, WO^3); the specimen belonging to the *mangano-wolframit* of Breithaupt, as stated in the mineralogical description referred to above.]

NOTES ON THE GEOLOGY OF THE BLUE MOUNTAIN ESCARPMENT, IN COLLINGWOOD TOWNSHIP, CANADA WEST.—BY E. J. CHAPMAN.

1. The elevated tract of land, known popularly as the "Blue Mountains," in the Township of Collingwood, C.W., and which forms a somewhat striking feature in the scenery of that district, constitutes a spur (or more properly, perhaps, the north-eastern point), of the line of escarpment which runs from the western extremity of Lake Ontario to the western shores of Georgian Bay: its face being opposed, generally, to the east or north-east. The range of this escarpment north of Dundas was briefly pointed out by Mr. Murray, of the Geological Survey, in his Report for 1850-1. It has also been laid down by Mr. Sandford Fleming in a small railway-map published in 1857. The Report accompanying Mr. Fleming's map contains, in addition, a slight but substantially correct sketch of the general geological features of the surrounding district. In Mr. Murray's Report, the formations west of the escarpment (commencing with the Upper Silurians) are alone considered.

2. Near the base of the "Blue Mountains," on the shore of Nottawasaga Bay, the Trenton Limestone constitutes the lowest visible formation. This, which at the spot in question scarcely appears above the ordinary level of the lake, is succeeded by interstratified beds of bituminous limestone and bituminous shale, belonging to the base of the Utica Slate series. This peculiar interstratification of shale and limestone is alluded to by Mr. Murray in his Report (for 1848-9) on the shores of Georgian Bay and the west coast of Lake Huron. Three fossils are especially abundant in these beds, viz.:—*Triarthrus Beckii*, *Asaphus Canadensis*, and a *Lingula* allied to *L. obtusa*, if not identical with that species. Another lingula, *L. quadrata*, is also not uncommon. The trilobites are usually in a fragmentary condition: the glabella, &c., of *T. Beckii*, and the pygidium of *A. Canadensis*, being the parts commonly met with. The lingulæ, on the contrary, are beautifully preserved; and their dark, lustrous shells stand out in strong relief on the light gray weathered surface of the rock. *Orthis testudinaria* is also of not uncommon occurrence; and, in some beds, ill-preserved graptolite fragments, belonging apparently to *G. pristis*, are occasionally met with. A small species of *Leperditia* is likewise present in great numbers. It is identical with that first discovered in the Utica Slate of Western Canada by Mr. J. F. Smith, and which is still, we believe, without a specific name.

3. The Utica Slate deposit, comprising altogether a thickness of about seventy or eighty feet, passes under the Mountain, and is succeeded by greenish and other colored arenaceous shales or thin-bedded sandstones belonging to the Hudson River group. This latter formation appears (at this locality) to constitute the chief mass of the mountain. Its thickness cannot be far short of 650 feet. On the northern face of the escarpment it is exposed in several gullies, but it yields scarcely a trace of fossils: an indistinct *ambonychia radiata* and some faint graptolite markings were alone obtained. Farther west, as where the formation comes out on Georgian Bay, and at Owen Sound, fossils occur in it, however, in some abundance.

4. On the top of the mountain, some exposures of siliceous limestone occur. These beds belong undoubtedly to the Clinton sub-formation; so that, between

their outcrop and the upper termination of the Hudson River Group, the Medina Sandstone should be found. It is, nevertheless, impossible to determine this in a satisfactory manner, and consequently to ascertain the exact thickness of the Hudson River Group, as the intermediate space is so greatly obscured by drift and vegetation.

5. The beds of siliceous limestone on the top of the Mountain are polished and striated by glacial action. The polished surface of the stone exhibits two sets of striæ or furrows, crossing at a slight angle, but having a general N.N.W. and S.S.E. direction. Here and there, the lines of furrow pass across projecting hard points, under the south side, or lea, of which, a slight interruption in the furrow takes place. This shows the abrading agency to have moved from the north, southwards.

6. On passing over the summit of the mountain, towards the south-west and west, limestone strata, containing Niagara fossils, crop out; but, as these extend beyond the limits of the Blue Mountain district, they were not specially examined.

7. The slopes of the Mountain and the surrounding country are more or less thickly covered by drift-clay and boulders. At the foot of the Mountain, on the south-east side, a high ridge of drift extends for some miles in a direction roughly parallel to the escarpment. This ridge has at first sight a certain resemblance to the terminal moraine of an ancient glacier; but it is evidently nothing more than a sub-aqueous formation or fringing bank, accumulated during the drift period, when the summit of the mountain formed a broad shoal, or low island, in the glacial sea. The formation of the escarpment itself is due to the denuding forces of a still earlier time; and the enormous amount of sedimentary matter carried off during its denudation, may to some extent be realized, when we consider its height above the general level of the country, and its extension to the south of Lake Ontario.

PROFESSOR DAWSON, LL.D., ETC., ON VEGETABLE STRUCTURES IN COAL.

The February number of the Journal of the Geological Society contains, amongst other valuable papers, a communication of no ordinary interest, by Dr. Dawson of McGill College, Montreal, on the characters of the different vegetable structures preserved in coal. The paper is illustrated by a great number of lithographed figures, without the aid of which, it would be useless to attempt anything like a special analysis of its contents. The structures preserved in the soft fibrous layers called "mineral charcoal," are first investigated; and afterwards, those preserved in the compact or lustrous portion of ordinary coal. Many new and exceedingly interesting details are brought out by these investigations, rendering Dr. Dawson's paper one of the most valuable contributions to our knowledge of the Carboniferous flora, that has appeared for some time. The paper concludes with a few general deductions, as given in the following extract:—

1. With respect to the plants which have contributed the vegetable matter of the coal, these are principally the *Sigillariæ* and *Calamiteæ*, but especially the former. With these, however, are intermixed remains of most of the other plants of the period, contributing, though in an inferior degree, to the accumulation of

the mass. This conclusion is confirmed by facts derived from the associated beds,—as, for instance, the prevalence of *Stigmaria* in the underclays, and of *Sigillariæ* and *Calamites* in the roof-shales and erect forests.

2. The woody matter of the axes of *Sigillariæ* and *Calamiteæ* and of Coniferous trunks, as well as the scalariform tissues of the axes of the *Lepidodendreæ* and *Ulodendreæ*, and the woody and vascular bundles of Ferns, appear principally in the state of mineral charcoal. The outer cortical envelope of these plants, together with such portions of their wood and of herbaceous plants and foliage as were submerged without subaërial decay, occur as compact coal of various degrees of purity; the cortical matter, owing to its greater resistance to aqueous infiltration, affording the purest coal. The relative amounts of all these substances found in the states of mineral charcoal and compact coal depend principally upon the greater or less prevalence of subaërial decay, occasioned by greater or less dryness of the swampy flats on which the coal accumulated.

3. The structure of the coal accords with the view that its materials were accumulated by growth, without any driftage of materials. The *Sigillariæ* and *Calamiteæ*, tall and branchless, and clothed only with rigid linear leaves, formed dense groves and jungles, in which the stumps and fallen trunks of dead trees became resolved by decay into shells of bark and loose fragments of rotten wood, which currents would necessarilly have swept away, but which the most gentle inundations or even heavy rains could scatter in layers over the surface, where they gradually became imbedded in a mass of roots, fallen leaves, and herbaceous plants.

4. The rate of accumulation of coal was very slow. The climate of the period, in the northern temperate zone, was of such a character that the true Conifers show rings of growth not larger nor much less distinct than many of their modern congeners.* The *Sigillariæ* and *Calamites* were not, as often supposed, composed wholly, or even principally, of lax and soft tissues, or necessarily short-lived. The former had, it is true, a very thick cellular inner bark; but their dense woody axes, their thick and nearly imperishable outer bark, and their scanty and rigid foliage would indicate no very rapid growth or decay. In the case of *Sigillariæ*, the variations in the leaf-scars in different parts of the trunk, the intercalation of new ridges at the surface representing that of new woody wedges in the axis, the transverse marks left by the successive stages of upward growth—all indicate that at least several years must have been required for the growth of stems of moderate size. The enormous roots of these trees, and the conditions of the coal-swamps, must have exempted them from the danger of being overthrown by violence. They probably fell, in successive generations, from natural decay; and, making every allowance for other materials, we may safely assert that every foot of thickness of pure bituminous coal implies the quiet growth and fall of at least fifty generations of *Sigillariæ*, and therefore an undisturbed condition of forest-growth enduring through many centuries. Further, there is evidence that an immense amount of loose parenchymatous tissue, and even of wood, perished by decay; and we do not know to what extent even the most durable tissues may have disappeared in

* Paper on Fosils from Nova Scotia. Quart. Journ. Geol. Soc. 1847.

this way; so that in many coal-seams we may have only a very small part of the vegetable matter produced.

5. Lastly, the results stated in this paper refer to coal-beds of the middle coal-measures. A few facts which I have observed lead me to believe that, in the thin seams of the lower coal-measures, remains of *Nœggerathia* and *Lepidodendron* are more abundant than in those of the middle coal-measures.* In the upper coal-measures similar modifications may be expected. These differences have been to a certain extent ascertained by Goeppert for some of the coal-beds of Silesia, and by Lesquereux for those of Ohio;† but the subject is deserving of further investigation, more especially by the means proposed in this paper, and which I hope, should time and opportunity permit, to apply to the seventy-six successive coal-beds of the South Joggins.

HIPPURITE LIMESTONE IN JAMAICA.

Mr. Lucas Barrett, Director of the Geological Survey of Jamaica, has discovered examples of *Hippurites* and *Ventriculites* in limestones of Cretaceous age in Jamaica. The Hippurite limestone occurs on the Plantain Garden River, and also on the central mountains at an elevation of 2,500 feet above the sea. These remarkable forms of the higher Cretaceous series, so abundant in Southern Europe, were met with some years ago, it may be remarked, by Ferdinand Ræmer, in Texas.‡

CALCEOLA IN THE UPPER SILURIAN ROCKS OF TENNESSEE.

Until quite recently, but one undoubted species of the genus Calceola (viz., *C. sandalina*) was recognised by palæontologists. This species was thought also to be exclusively confined to Devonian rocks. Professor Stafford, in a paper published in a late number of *Silliman's Journal*, now maintains, and apparently on good data, that the supposed *C. sandalina*, of Tennessee, is a distinct species; and that the deposits in which it occurs, belong really to the Niagara period. He proposes for the new species, the name of *Calceola Americana*. It is associated in Tennessee with *Orthis elegantula*, *Platyostoma Niagarensis*, *Caryocrinus ornatus*, &c. It differs from *C. Sandalina*, in not exhibiting any groove or furrow on the central process of the larger valve; in the absence of the internal rows of punctures as occurring in the European species; and by other well-marked characters. Good examples of *C. sandalina* (shewing the interior of the valves), may be seen in the collection of the University of Toronto.

FOSSIL FOOT-TRACKS OF THE CONNECTICUT VALLEY.

Mr. Roswell Field, of Greenfield, Massachusetts, who has devoted his leisure time for many years to the study of the supposed *ornithichnites* of the Connecticut sandstone, and whose collections of these remarkable tracks are perhaps un-

* I may refer to my late paper on Devonian Plants from Canada for an example of a still older coal made up principally of remains of Lycopodiaceous plants of the genus *Psilophyton*. (Quart. Journ. Geol. Soc. No. 60, p. 477.)

† Report of Survey of Ohio, 1858.

‡ Persons interested in Palæontology, will find examples of *Hippurites*, and other so-called *Rudistes*, in the Geological Museum of the University of Toronto.

rivalled, has published some interesting remarks on the subject, in the last number of *Silliman's Journal.* In these remarks, Mr. Field expresses his conviction that the foot-tracks in question are of reptilian origin. Many of the supposed biped tracks are now shewn to have been made by quadrupeds; and in some instances, in which the animals appear to have sunk deeply in the yielding sediments, the impression caused by the tail is plainly visible in the form of a central groove.

EIGHTH SUPPLEMENT TO DANA'S MINERALOGY.

In the absence of Professor Dana, who is now in Italy, the usual semi-annual Report on the progress of Mineralogy has been well and carefully drawn up by Professor G. J. Brush. No very remarkable works have appeared since the date of the last Supplement, nor have any very important researches been published. Some of the more interesting, comprise: Rammelsberg's discovery of Magnesia in the Vesuvian Iron Ores, and the foundation of his new species, the Magnoferrite; the recognition of Tin Ore (Cassiterite) in specimens from *Los Angelos*, California, by Dr. C. T. Jackson; and the suggested Trimetric or Monoclinic crystallization of Tourmaline, by Jenzsch and Breithaupt. In connection with the subject of Mineralogy, we may mention with regret the recent death of the veteran professor, J. F. L. Hausmann, of Göttingen. Professor Hausmann died on the 26th of last December, at the advanced age of seventy-seven. E. J. C.

CONTRIBUTIONS TO METEOROLOGY,

Reduced from observations taken at St. Martin, Isle Jesus, C. E.

BY CHARLES SMALLWOOD, M. D., LL. D.,
Professor of Meteorology in the University of McGill College, Montreal.

These observations extend over the year 1859. The geographical co-ordinates are Latitude 45° 32′ North, Longitude 73° 36′ West, from Greenwich. The cisterns of the Barometers are 118 feet above the mean sea level. The results obtained are reduced from tri-daily observations taken at 6 A. M., 2 P. M., and 10 P. M. These periods divide the day into three equal parts of eight hours each. The self-registering principle is applied to many of the instruments, and the usual corrections are also applied for temperature and any peculiarity in their construction. The readings are frequently verified, so as far as possible to insure accuracy.

Atmospheric pressure.—The highest reading of the Barometer during the year, occurred at 4 P. M., on the 3rd of December, and indicated 30.726 inches, which is the highest reading on record here *except one*, which took place on the 8th of January, 1855, when the Mercurial column stood at 30.876 inches. The extreme height of December last, did not seem to extend very far East or West. The highest reading at Toronto, kindly furnished me by Professor Kingston, was 30.392 inches, and at Quebec 30.563 inches. At Temple Grove, on the eastern slope of the Mountain, the residence of the Hon. Mr. Justice McCord, it attained a *maximum* of 30.865 inches, and these observations may be fully relied upon, coming from Mr. McCord, the "Pioneer of Canadian Meteorology." This reading is the highest recorded by him. At Montreal, Dr. Hall gives the *daily mean* of the reading as 30.744 inches. At Point St. Charles, the highest reading was 30.771 inches. At Portland, Maine, Mr. Henry Willis gives the *maximum* reading of the day at 30.70 inches. The lowest reading was at 6 A. M., on the 19th of March, and indicated 28.620 inches. The readings at Portland on that day, are recorded as being also the *minimum* reading of the year. This circumstance of low reading has given the greatest monthly range of the year to March. August gives the lowest range of the year, viz., 0.530 inches. The mean Barometer pressure for the year was 29.821 inches, which exceeds by 0.008 of an inch only, the mean of last year. The mean height of the Barometer for the months were as follows:

January..	30.021 inches.	May	29.834 inches.	September	29.771 inches.
February.	29.837 "	June.....	29.784 "	October ..	29.779 "
March. ..	29.686 "	July	29.818 "	November	29.940 "
April....	29.638 "	August ..	29.760 "	December	29.971 "

The monthly range for the year was as follows:

January...	1.487 inches.	May	0.696 inches.	September.	1.063 inches.
February..	1.588 "	June......	0.671 "	October ...	0.909 "
March	1.872 "	July	0.564 "	November .	1.259 "
April	1.232 "	August ...	0.530 "	December .	1.316 "

The greatest range within twenty-four hours, with a rising column, occurred on the 2nd and 3rd of December, and rose from 30.062 to 30.661 inches, equal to a rise of 0.599 of an inch, and the greatest range with a falling column, was on the 18th and 19th March, and which fell from 29.650 inches to 28.620 inches, equal to 1.030 inches of variation; a sudden rise also occurred on the 14th September from 8 A. M. till 1 P. M., and indicated 0.251 of an inch of rise in three hours.

Temperature of the Atmosphere.—The mean temperature of the year was 40°73 F., which is 0°69 of a degree higher than the mean of last year (1858,) and indicates 0°83 of a degree lower than the mean of a series of years. This is owing to the low temperature of January and of December. The mean temperature of the months is as follows:

January	10°90	May............	59°42	September	54°31
February	15°62	June	62°00	October	42°42
March	30°93	July	67°58	November........	29°38
April...........	38°63	August	68°72	December	8°93

December is the coldest December on record here by 4°83 degrees, compared with a series of years. February of last year (1858) was the coldest February on record here, the mean temperature being 7°56. July, which for a series of years has indicated the highest mean temperature, was 1.14 degrees lower than the month of August. This was owing to the heavy rain storms of July. June of 1858 was the warmest month of that year—the highest reading of the Thermometer for this year was on the 17th of May, and indicated 99.2 degrees, which is the highest reading of the Thermometer for the month of May on record. The highest reading for a series of years has been in July; and February, for a corresponding number of years, has indicated the lowest reading, but December of this year (1859) shows a *minimum* of 4.38 degrees compared with a series of years, and January 2.36 degrees below the average or mean of a like series of years. The lowest reading of the year was on the 10th of January, and at 6 A. M. indicated —43°6 (below zero,) a degree of cold almost unprecedented in the annals of Canadian Meteorology, the cold term showed .124 hours 30 minutes, during which the Thermometer was below zero. Mercury froze in open vessels—the *mean* temperature of the 9th day was —27°8, of the 10th —29°0, and of the 12th —28°2. This cold term was felt generally throughout Canada and the Eastern States, and travelled from the west, eastward. At Rochester, which is 4° 15′ West of this Observatory, and 398 feet higher above sea level, the extreme cold was felt some hours earlier than at this place. At New York the temperature was —9°0; at Boston, —14°8; at Toronto, —26°5; at Quebec, —40°8; at Huntingdon, —44°0, and Mercury was said to have become quite hard in fifteen minutes, when exposed in a saucer. The great absolute range or climatic difference for the year, was 142.8 degrees, and the monthly range of temperature (or climatic difference) was as follows:

January	88°0	May	69°0	September	49°2
February	66°7	June	59°9	October	63°7
March	59°0	July	61°6	November	48°0
April	60°2	August	54°7	December	74°7

The mean temperature of the Winter Quarter was 12°96, of the Spring Quarter 42°66, of the Summer Quarter 66°10, and of the Autumn Quarter 42°03.

Frost occurred in every month of the year. The Thermometer, sunk eighteen inches in the ground, indicated in May a temperature of 58°, in June 66°10, in July 76°2, and in August 73°0.

Humidity of the Atmosphere.—The mean relative amount of Humidity for the year (saturation being 1.000) was .768, which was .010 less than the mean of last year. The mean Humidity for the months was as follows:

January	.792	May	.708	September	.797
February	.776	June	.706	October	.754
March	.823	July	.705	November	.819
April	.792	August	.742	December	.808

July was the driest month, and this is borne out by the observations of a series of years; complete saturation was not observed during the year.

Rain fell on 98 days, amounting to 49.741 inches; it was raining 527 hours 20 minutes, and was accompanied by thunder on 20 days. The amount of rain which fell indicated 0.294 of an inch less than the amount of last year, but exceeded by 6.736 inches the mean amount of a series of years, and the number of days upon which rain fell exceeded by twenty-five the average amount of a like number of years. The greatest amount fell in September, on the 11th day, from 3 h. 40 min. P. M., to 4 h. 24 min. P. M., making one hour and forty-four minutes of time, there fell 1.670 inches of rain; and on the 4th of August, in two hours of time, there fell 2.000 inches of rain.

Snow fell on 58 days, amounting to 94.68 inches; it was snowing 440 hours, 40 minutes. This shows an increase of 35·69 inches over the amount which fell last year, but the amount is nearly equal to the average of a series of years. February and December, are the months which give the greatest amount of snow. The first snow of the winter of 1858–9, fell on the 4th of November—the last snow of spring fell on the 23rd of April.

Evaporation.—The amount of evaporation from the surface of water, during the six months for which observations are recorded (owing to frost,) was 15.29 inches. This is considerably below the average or mean of a series of years. The evaporation from the surface of ice exceeded the usual amount.

Wind.—The most prevalent wind was the N. E. by E., and the least prevalent the South. The aggregate horizontal movement in miles for the year, was 59224.60 miles, which exceeds by 17886.00 miles the amount of last year. The mean annual velocity was 6.19 miles per hour, which is 1.58 miles per hour more than the mean velocity of last year. The following is the monthly horizontal movement in miles:

January..	4889.90 miles.	May	4415.70 miles.	September	3941.10 miles.
February .	3656.80 "	June	3463.10 "	October ..	5579.01 "
March....	6861.29 "	July	2744.00 "	November.	4701.50 "
April	5847.90 "	August ..	2780.00 "	December.	5679.20 "

March was the most windy month, and July the calmest. The greatest velocity observed was 37.20 miles per hour.

The greatest Intensity of the Sun's Rays was in August, and indicated 110.8 degrees. The lowest point of Terrestrial Radiation was in January, and was —43°6 (below zero.)

Clouds.—There were 56 days cloudless, and 129 nights suitable for Astronomical purposes.

Dew.—The yearly amount of Dew was below the usual mean or average.

The Aurora Borealis was visible at observation house on 36 nights. A very brilliant display occurred on the 28th of August, observed in Canada, the West Indies, and Europe.

The Zodiacal Light was bright and well defined.

Lunar Haloes visible on seven nights.

Parhelias were visible on five days.

The winter of 1859–60 fairly set in on the 22nd of November.

Ozone.—The mean annual of Ozone has shewn about the usual average quantity.

Atmospheric Electricity.—The tri-daily observations are still continued in this important branch of science, but are far too extended for a short notice.

The Eclipse of the Sun was visible on the 19th of July.

Crows (*Corvus corone*) first seen 8th of March. The Song Sparrow (*Fringilla melodia,*) first heard 14th of March; Wild Ducks (*Anser Canadensis,*) first seen flying south, 18th March; Swallows (*Hirudo rufa*) first seen 19th April; Frogs (*Rana fontinalis*) first heard 16th of April; Shad (*Alosa prostabilis*) first caught 23rd May; Fire Flies (*Lampyris corusca*) first seen 24th May; Snow

Birds (*Plectrophanes nivalis*) first seen 10th of November—Crows did not winter here.

Plum tree in flower 11th of May; Lilac in full leaf 14th of May; Dandelion in flower 12th May; Wild Strawberry in flower 25th May, matured 24th June; Gooseberry in leaf 8th May; Currant in leaf 18th May.

The potato rot, which was but partial this year, commenced on the 8th of August.

St. Martin's, Isle Jesus, 1st Feb., 1860.

CANADIAN INSTITUTE.

Session 1859—60.

EIGHTH ORDINARY MEETING—11*th February*, 1860.

Prof. Wilson, LL.D., President, in the Chair.

I. *The following Gentlemen were elected Members:*

Charles M. Fuller, Esq., Lithographer, Toronto.
S. H. Strong, Esq., Barrister, Toronto.
William Canniff, M.D., M.R.C.S., Toronto.
Thomas Griffith, Junr., Toronto (*Junior Member.*)

II. *The following Papers were read:*

1. By the Rev. Prof. W. Hincks, F.L.S.:

"On some Questions in relation to the theory of the structure of Plants of the Orders Brassicaceæ and Primulaceæ."

2. By Prof. Kingston, M.A.:

"On the Meteorological Phenomena of 1859."

NINTH ORDINARY MEETING—18*th February*, 1860.

Prof. Wilson, LL.D., President, in the Chair.

I. *The following Gentleman was elected a Member:*

Caleb E. English, M.A., Barrister, Toronto.

II. *The following donations for the Library were announced, and the thanks of the Institute voted to the donors:*

Books marked with an asterisk (*) are in parts or unbound.

From the Geographical and Statistical Society, New York:

	VOLS.
Bulletin of the Society. Vol. I. 3 Nos.	1*
do. Vol. II.	1*
Journal of the Society. Vol I. 10 Nos.	1*
Johnson's Railroad to the Pacific	1*
Criminal Statistics of New York. 1854	1*
Hewitt on Iron	1*
Life and Travels of Professor Keilhau	1*

VOLS.

Report of the Council of the American Geographical and Statistical Society, for 1857 .... 1*

First Annual Report of the Cooper Union, for the Advancement of Science and Art.. 2*

From the Chicago Historical Society.

Fourth Annual Report of the Chicago Reformatory School. 1859 .... 1*

From the Author.

Croft's Practical Chemistry 1

III. *The following Papers were read:*

1. By Sandford Fleming, Esq., C.E.:
   "On some improved varieties of Rail-joints."
2. By Prof. Hind, M.A.:
   "On the Manufacture of Shale Oil from the Utica Slate of Collingwood."
3. By C. Fuller, Esq.:
   "On the Processes and Results of Chromo-Lithography, illustrated by Drawings and Specimens of the process in all its stages."

TENTH ORDINARY MEETING—25*th February*, 1860.

Prof. Wilson, LL.D., President, in the Chair.

I. *The following Papers were read:*

1. By the Rev. W. S. Darling:
   "Remarks on the Manuscripts of the Middle Ages."
2. By the Rev. Prof. G. P. Young, M.A.:
   "On the relation which can be proved to subsist between the area of a plane triangle and the sum of the angles, on the hypothesis that Euclid's eleventh axiom in any case fails."
3. By the Hon. G. W. Allan, M.L.C.:
   "Notes on some of the different Races composing the population of the Nile Valley. Illustrated by coloured drawings procured by the Author when in Egypt."

ELEVENTH ORDINARY MEETING—3*rd March*, 1860.

Prof. Wilson, LL.D., President, in the Chair.

I. *The following Papers were read:*

1. By T. C. Wallbridge, Esq.:
   "On some ancient Mounds on the shores of the Bay of Quinté."
2. By W. Graeme Tomkins, Esq., C.E.:
   "On the thickness of the Earth's crust."
3. By P. Freeland, Esq.:
   "Notes on some specimens of Diatomaceæ, collected on the St. Lawrence." Illustrated by Microscopical specimens.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—FEBRUARY, 1860.

Latitude—43 *deg.* 39.4 *min. North. Longitude*—5 *h.* 17 *m.* 33 *s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Result't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 AM.	2 PM.	10 P.M.	Re-sult'.	ME'N		
1	30.038	30.042	30.030	30.0422	° −8.4	° 8.6	° 5.0	° 1.70	° −22.18	.027	.041	.044	.037	.88	.64	.79	.76	N b E	W S W	W N W	° N 71 W	7.0	7.5	3.0	3.23	3.72	...	...
2	30.012	30.051	30.129	30.0728	5.3	14.7	11.5	10.98	−12.87	.046	.060	.066	.058	.82	.71	.92	.81	Calm.	W N W	W b N	N 75 W	0.0	1.6	1.0	2.46	2.47	...	inap.
3	30.112	29.937	29.862	29.9603	7.5	18.3	19.1	14.35	− 9.42	.049	.068	.090	.067	.78	.68	.87	.78	W b N	S E	Calm.	S 25 E	1.6	7.3	0.0	3.06	3.90	...	0.1
4	29.920	.993	30.015	.9788	14.0	23.4	19.1	19.42	− 4.27	.074	.068	.096	.083	.91	.54	.94	.80	N W bW	Calm.	Calm.	N 34 W	8.2	0.0	0.0	0.34	0.85	...	...
5	.869	.666	—	—	25.2	33.2	—	—	—	.122	.151	—	—	.90	.80	—	—	Calm.	S E b E	S	S 13 E	0.0	9.0	6.0	4.20	6.45	0.135	0.2
6	.268	.342	29.337	.3195	37.5	37.5	33.2	35.52	+12.00	.213	.143	.166	.172	.94	.63	.87	.83	S W	W b S	Calm.	S 79 W	10.0	13.0	0.0	5.79	5.96	...	...
7	.407	.633	.728	.6033	32.1	30.3	25.6	28.28	+ 4.85	.157	.103	.089	.112	.86	.61	.63	.71	S W b W	W b N	S W b W	N 81 W	7.3	20.0	8.0	10.10	10.43	...	inap.
8	.657	.572	.532	.5792	25.6	35.0	31.0	29.97	+ 6.60	.120	.158	.140	.139	.87	.77	.80	.83	S W bW	S W b S	S S W	S 38 W	6.2	8.3	5.0	6.80	6.92	...	...
9	.336	.034	.390	.2565	31.0	41.5	13.3	27.87	+ 4.60	.155	.153	.046	.121	.89	.57	.60	.70	S W b S	W S W	N WbW	N 79 W	6.5	17.5	38.5	18.15	22.98	inap.	...
10	.788	.937	.961	.9118	5.0	10.6	5.7	7.07	−16.20	.044	.041	.047	.045	.79	.57	.78	.74	N W b N	N W bN	N b W	N 29 W	16.0	8.6	4.5	7.66	8.44	...	0.2
11	.725	.417	.469	.5382	8.2	19.8	12.0	13.97	− 9.30	.057	.095	.067	.076	.91	.90	.90	.91	N N E	S S E	N	N 1 E	5.5	2.0	5.5	2.67	7.10	...	2.0
12	.788	.791	—	—	2.4	21.6	—	—	—	.047	.101	—	—	.96	.87	—	—	N W b N	S W bW	W S W	S 74 W	3.2	11.0	0.5	4.18	5.17	...	...
13	.571	.449	.571	.5323	21.6	30.3	29.5	27.33	+ 4.08	.109	.148	.144	.136	.94	.88	.87	.90	Calm.	W b S	N	N 10 W	0.0	2.0	7.0	3.59	4.08	...	4.0
14	.737	.827	.853	.8122	22.0	18.9	4.6	14.50	− 8.77	.104	.071	.048	.071	.87	.68	.90	.81	N	N N W	N b E	N 4 E	10.5	10.5	12.2	8.56	11.29	...	...
15	.671	.411	.239	.4223	16.9	24.8	27.0	23.87	+ 0.62	.084	.112	.136	.115	.90	.84	.93	.89	E	E b S	W S W	S 70 E	16.0	14.5	9.6	5.56	13.59	...	3.0
16	.336	.490	.632	.5117	18.3	11.5	3.9	9.57	−13.80	.088	.061	.045	.059	.87	.82	.86	.85	N W	W b N	N N W	N 62 W	27.0	22.0	6.0	12.19	13.18	...	...
17	.747	.683	.511	.6318	−4.4	9.0	8.2	4.88	−18.47	.032	.042	.052	.043	.90	.64	.82	.78	N N W	N N W	N E b N	N 66 E	5.0	1.2	9.5	5.45	7.51	...	...
18	.131	28.929	.107	.0503	19.4	12.2	9.7	13.40	−10.03	.080	.071	.057	.071	.76	.94	.85	.88	E	N E b N	N N W	N 13 E	23.0	20.6	15.0	16.25	20.73	...	9.0
19	.347	29.617	—	—	7.5	15.8	—	—	—	.043	.054	—	—	.69	.59	—	—	N N W	W N W	W	N 73 W	26.4	4.4	4.0	9.06	11.79	...	...
20	.569	.471	.578	.5382	22.7	34.2	27.4	28.28	+ 4.67	.110	.149	.117	.129	.90	.75	.77	.82	S W b S	S W	W S W	S 55 W	17.5	10.4	5.0	7.08	7.17	...	0.3
21	.669	.720	.647	.6748	19.8	39.1	38.9	33.72	+ 9.98	.089	.148	.194	.154	.83	.61	.81	.78	W S W	S S W	N E b E	N 80 E	3.2	4.5	10.5	4.96	7.00	0.305	...
22	.329	.120	.075	.1577	38.9	46.9	45.4	43.83	+20.02	.228	.272	.292	.259	.96	.84	.96	.90	N b E	S E	W S W	S 2 W	11.3	2.8	8.0	3.88	8.15	0.275	...
23	.054	.247	.581	.3137	38.2	32.8	22.7	30.88	+ 6.95	.203	.137	.087	.137	.87	.74	.71	.76	S W b S	W	W N W	N 78 W	8.0	28.5	19.6	15.88	17.43	inap.	inap.
24	.609	.560	.634	.5977	22.0	23.9	15.8	20.48	− 3.65	.101	.096	.072	.086	.86	.74	.80	.77	N W	N W	N W b N	N 59 W	8.0	16.0	8.0	9.32	10.15	...	inap.
25	.681	.719	.867	.7677	14.4	22.3	18.0	18.42	− 5.92	.064	.066	.071	.067	.76	.56	.73	.68	W b N	W b N	N W	N 68 W	7.2	18.0	1.5	10.04	10.57	...	inap.
26	.972	.900	—	—	13.6	31.3	—	—	—	.067	.129	—	—	.83	.73	—	—	N W	S S W	S W b W	S 31 W	1.6	13.5	13.0	8.01	8.75	...	...
27	.735	.767	.906	.8142	35.3	45.4	41.3	40.22	+15.50	.164	.206	.172	.181	.80	.67	.65	.72	S W	S W	N b W	N 81 W	5.7	2.8	11.0	2.32	4.86	...	...
28	30.013	.994	.955	.9837	36.0	33.5	33.2	34.27	+ 9.37	.180	.165	.166	.169	.85	.86	.87	.85	N N E	E b N	E	N 75 E	4.8	10.2	9.5	8.28	8.53	0.230	...
29	29.840	.755	.659	.7382	33.2	39.7	40.4	37.90	+12.88	.173	.226	.250	.222	.91	.93	.99	.96	E	Calm.	N E b N	N 52 E	4.3	0.0	6.3	3.70	3.99	0.385	...
M	29.6382	29.6040	29.6507	29.6324	20.48	26.57	21.66	22.83	− 0.84	.110	.116	.110	.112	.87	.72	.82	.81	....	....	....	....	8.66	9.92	7.85	....	8.73	1.330	18.8

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR FEBRUARY, 1860.

Highest Barometer . . . . . . 30.136 at midnight on 2nd, } Monthly range=
Lowest Barometer . . . . 28.920 at 2.30 p. m. on 18th, } 1.216 inches.

Self-registering Ther.:
- Maximum temperature . . . . 50°2 on p.m. of 22nd } Monthly range=
- Minimum temperature . . . . —8°5 on a.m. of 1st } 58°7
- Mean maximum temperature . . 29°43 } Mean daily range = 14°11.
- Mean minimum temperature . . 15°32 }
- Greatest daily range . . . . . . 26°5 from p. m. of 4th to a. m. of 5th.
- Least daily range . . . . 2.4 from a. m. to 2 p. m. of 7th.

Warmest day . . 22nd ... Mean Temperature . . . 43°83 } Difference=42°13.
Coldest day . . . 1st ... Mean Temperature . . . 1°70 }

Maximum Radiation { Solar . . . . 65°5 on p. m. of 22nd } Monthly range=
{ Terrestrial . . . . . . —19.5 on a. m. of 17th } 85°0.

Aurora observed on 2 nights, viz.: on 16th and 21st,; possible to see Aurora on 11 nights; impossible on 18 nights.
Snowing on 13 days; depth 18.8 inches: duration of fall 69.8 hours.
Raining on 7 days; depth, 1·330 inches; duration of fall, 45.5 hours.
Mean of cloudiness=0.67; most cloudy hour observed, 6 a. m., mean=0.74: least cloudy hour observed, 10 p. m.; mean=0.60.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
2201.86	1109.92	1223.78	3232.44

Resultant direction, N 61° W; Resultant Velocity, 3.28 miles per hour.
Mean velocity of the wind 8.73 miles per hour.
Maximum velocity . . . 40.6 miles per hour, from 8 to 9 p.m. on the 9th.
Most windy day . . . 9th—Mean velocity, 22.98 miles per hour.
Least windy day . . . 4th—Mean velocity, 0.85 do
Most windy hour, noon to 1 p. m.—Mean velocity, 11.08 miles per hour. } Difference
Least windy hour, 11 p. m. to midnight.—Mean velocity, 6.84 do. } 4.24 miles.

1st. Lunar Halo and Corona from 7.30 to midnight (very perfect.)—3rd. Lunar Halo during the evening.—6th. Eclipse of the Moon partially visible from 7 to 9 p. m. —8th. Lunar Corona from 9 to 11 p. m.—9th. Hail shower at noon. Rapid descent of temperature from 2 p. m. to midnight—range in 10 hours =32°2.—13th. Solar Halo during forenoon (well defined.)—14th. Solar Halo at 2 p. m. (imperfect.)—21st. Ground fog 7 a. m. Mild day.—22nd. Thunderstorm 6 to 8 p. m. (first of the season.)—27th. Solar Halo 2 p. m.; Lunar Halo 10 p. m.—29th. Dense fog all day; sheet lightning in S. W. at 10 p. m.

The Resultant Direction and Velocity of the Wind for the month of February, from 1848 to 1860 inclusive, were respectively N. 69° W., and 2.96 miles.

Great change of temperature from 2 p. m. of 9th to 8 a. m. of 10th. Range in 18 hours = 37°6.

The mean Temperature for the month of February, 1860, was exactly the average of the last 21 years. The depth of Rain and Snow recorded were both in excess of the average, the former by 0.273; the latter by 1.42 inches. The mean velocity of the Wind, was also greater than the average of 13 years, by 0.85 miles per hour.

COMPARATIVE TABLE FOR FEBRUARY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant Direction.	Resultant Velocity.	Mean Velocity
	°	°	°	°	°					°		
1840	28.0	+ 5.2	49.1	— 8.3	57.4	8	1.475	6	...	...	...	...
1841	22.4	— 0.4	43.4	— 0.3	43.7	1	inapp.	9	...	...	...	0.61 lbs
1842	26.9	+ 4.1	48.7	+ 2.5	46.2	8	3.625	9	...	...	...	1.03 "
1843	14.5	— 8.3	37.5	—10.2	47.7	1	0.475	21	14.4	...	...	1.05 "
1844	26.0	+ 3.2	47.1	— 0.4	47.5	4	0.430	7	10.0	...	...	0.43 "
1845	26.0	+ 3.2	46.6	— 3.9	50.5	5	Imp.	9	19.0	...	...	0.99 "
1846	20.4	— 2.4	41.4	—16.2	57.6	0	0.000	13	46.1	...	...	0.65 "
1847	21.5	— 1.3	42.2	— 1.0	43.2	2	0.550	13	27.3	...	...	0.69 "
1848	26.6	+ 3.8	46.9	— 0.6	47.5	4	0.775	8	10.8	N 65 W	2.53	5.69ms.
1849	19.5	— 3.3	41.1	— 9.2	50.3	2	0.240	13	19.2	N 41 W	1.48	6.58 "
1850	26.0	+ 3.2	49.2	+ 1.3	47.9	7	1.235	9	23.1	N 80 W	3.43	7.61 "
1851	27.6	+ 4.8	50.2	+ 1.3	48.9	7	2.600	4	2.4	N 64 W	1.99	6.94 "
1852	23.4	+ 0.6	41.2	— 3.2	44.4	3	0.650	11	13.0	S 75 W	3.34	6.42 "
1853	24.1	+ 1.3	43.4	— 0.6	44.0	4	1.030	15	12.6	N 49 W	2.51	7.30 "
1854	21.1	— 1.7	42.7	— 5.7	48.4	5	1.460	15	18.0	N 7 E	1.73	6.91 "
1855	15.4	— 7.4	37.3	—25.0	62.3	2	1.770	14	21.8	N 40 W	4.34	8.17 "
1856	15.7	— 7.1	35.3	—18.7	54.0	0	0.000	8	9.7	N 81 W	7.70	10.71 "
1857	28.5	+ 5.7	51.2	— 5.9	57.1	11	3.050	11	11.7	S 78 W	3.68	9.82 "
1858	17.0	— 5.8	40.9	— 6.6	47.5	1	inapp.	16	26.7	N 72 W	3.22	9.12 "
1859	26.0	+ 3.2	43.3	+ 3.9	39.4	6	0.455	14	8.3	N 54 W	2.72	8.50 "
1860	22.8	0.0	48.1	— 8.4	56.5	7	1.330	13	18.8	N 61 W	3.28	8.73 "
Mean	22.83	...	44.13	—5.49	49.62	4.2	1.057	11.3	17.38	...	...	7.88

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—MARCH, 1860.

Latitude—43 *deg.* 39.4 *min. North.* *Longitude*—5 *h.* 17 *min.* 33 *sec. West.* *Elevation above Lake Ontario,* 108 *feet.*

Days.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M	10 P.M.	M'N	6 A.M	2 P.M	10 P.M	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M	2 P.M	10PM	Resul't.	ME'N		
					°	°	°	°	°												°							
1	29.459	29.439	29.582	29.4993	41.5	45.3	41.5	42.85	+17.63	.257	.284	.250	.262	.98	.94	.96	.95	N E b E	N b E	W S W	S 83 W	8.6	4.8	11.3	3.12	6.93	0.017	...
2	.580	.817	.918	.7852	36.1	48.3	35.0	40.15	+14.73	.195	.225	.142	.184	.92	.66	.70	.74	S W b S	W N W	N b E	N 69 W	17.5	22.2	2.3	3.90	12.76	...	...
3	.616	.220	.236	.3443	36.4	43.3	44.7	41.07	+15.35	.200	.212	.116	.173	.93	.75	.37	.68	E b N	S S W	W S W	S 69 W	15.5	12.0	21.5	13.76	20.35	0.015	...
4	.414	.611	—	—	36.8	33.5	—	—	—	.110	.088	—	—	.50	.46	—	—	W	W	N W b W	N 83 W	27.5	32.0	3.5	14.52	16.57	...	0.2
5	.500	.270	.324	.3507	27.7	35.5	31.6	31.63	+ 5.43	.106	.155	.148	.137	.69	.75	.83	.76	S E b E	E b S	N b W	N 63 E	11.0	9.8	8.3	4.60	7.41	...	...
6	.582	.645	.465	.5428	29.9	35.3	33.5	33.08	+ 6.58	.139	.153	.156	.153	.83	.74	.81	.81	N W b N	E	E b N	N 78 E	2.5	11.2	16.0	12.35	12.96	0.265	0.1
7	.159	.094	.301	.1930	36.8	52.5	41.8	45.42	+18.60	.203	.292	.148	.232	.93	.74	.55	.73	N E b E	Calm.	W	W	8.5	0.0	3.2	7.94	9.68	...	...
8	.396	.471	.484	.4588	40.0	47.1	36.1	40.35	+13.12	.138	.158	.145	.130	.54	.48	.68	.52	W b N	W b N	N W b N	N 63 W	18.5	18.0	8.6	13.07	14.07	...	...
9	.421	.367	.439	.4110	27.0	31.7	23.4	26.57	— 0.95	.093	.096	.108	.094	.63	.53	.86	.67	N N W	W	N W b W	N 49 W	13.2	21.2	21.0	19.28	20.01	...	0.2
10	.514	.506	.579	.5413	15.4	27.0	27.7	23.77	— 4.05	.064	.086	.092	.085	.72	.58	.60	.65	N W b N	N W	W N W	N 52 W	19.2	24.5	20.0	18.02	18.36	...	inap.
11	.603	.461	—	—	25.6	38.9	—	—	—	.110	.125	—	—	.80	.52	—	—	W b N	W	N b W	N 75 W	6.6	15.4	1.0	6.61	8.64	...	0.5
12	.334	.579	.767	.5825	22.0	21.2	14.2	18.28	—10.27	.096	.082	.054	.075	.81	.72	.65	.74	N	N W b N	N W	N 31 W	22.8	27.6	18.8	19.81	20.46	...	1.0
13	.826	.808	.764	.7997	16.9	28.5	29.4	25.65	— 3.32	.078	.118	.130	.109	.83	.75	.79	.78	Calm.	S S W	W N W	S 55 W	0.0	10.8	4.2	4.06	5.22	...	inap.
14	.734	.712	.792	.7525	24.1	37.9	37.8	34.00	+ 4.68	.107	.137	.190	.145	.82	.60	.84	.72	W N W	S S W	N W	S 82 W	2.8	5.8	5.8	2.70	3.91	...	...
15	.862	.896	.903	.8853	28.8	44.0	33.5	36.17	+ 6.45	.129	.153	.140	.149	.81	.53	.73	.70	N W	W	S S E	S 25 W	6.0	5.8	3.8	1.92	3.82	...	...
16	.916	.863	.808	.8637	28.8	45.4	35.7	36.83	+ 6.80	.129	.215	.148	.162	.81	.70	.71	.73	S S E	S E	Calm.	S 74 E	4.8	5.8	0.0	3.07	3.50	...	...
17	.838	.841	.868	.8535	32.8	46.7	41.5	40.18	+ 9.73	.134	.199	.211	.179	.72	.62	.80	.71	E b N	E b S	N E	N 75 E	3.6	6.0	6.0	3.86	4.32	...	...
18	.903	.834	—	—	34.2	50.9	—	—	—	.168	.220	—	—	.85	.58	—	—	N E	E b S	E b S	N 73 E	1.4	9.2	3.5	5.80	6.40	...	...
19	.646	.508	.466	.5310	39.7	42.5	38.6	40.78	+ 9.52	.217	.263	.207	.229	.89	.97	.88	.89	N E b E	E b S	W b N	S 62 E	5.0	6.5	11.5	0.89	4.83	.585	...
20	.334	.340	.512	.4002	35.3	40.7	25.9	34.60	+ 2.93	.189	.180	.093	.148	.92	.70	.66	.71	W S W	W b N	N W	N 58 W	7.0	19.5	32.0	20.38	22.77	Inap.	0.2
21	.642	.685	.739	.6910	18.7	28.1	27.0	24.78	— 7.30	.051	.108	.093	.082	.49	.70	.63	.60	N W	N W	N W	N 44 W	26.2	30.6	22.8	28.77	28.83	...	...
22	.622	.398	.449	.4828	22.7	37.1	32.1	31.07	— 1.42	.045	.084	.165	.099	.37	.37	.90	.55	N W	N W	W b N	N 51 W	32.6	32.6	12.0	20.00	21.48	...	...
23	.444	.288	.262	.3240	26.7	35.0	29.5	30.33	— 2.45	.140	.142	.121	.134	.96	.70	.74	.80	N E b E	S E	W N W	N 82 W	2.3	7.2	8.0	5.46	10.08	...	0.1
24	.193	.242	.347	.2678	25.9	28.1	24.1	25.68	— 7.48	.125	.116	.085	.107	.88	.75	.65	.76	W b N	N W b W	W b N	N 64 W	18.8	17.2	14.5	17.14	17.50	...	0.1
25	.365	.429	—	—	22.3	29.7	—	—	—	.085	.104	—	—	.71	.63	—	—	N W b W	N W b N	N W b W	N 53 W	16.8	17.8	11.0	16.16	16.44	...	inap.
26	.668	.654	.715	.6803	20.7	31.3	23.4	25.35	— 8.63	.071	.079	.094	.078	.64	.45	.73	.59	N W	W N W	N W b N	N 39 W	17.0	14.0	4.0	10.10	10.66	...	...
27	.630	.512	.404	.5112	22.3	41.5	35.1	33.78	— 0.63	.100	.134	.165	.131	.83	.50	.81	.68	W S W	S S W	S W b W	S 47 W	5.6	21.5	9.0	12.28	13.63	...	...
28	.405	.436	.400	.3978	29.5	32.1	30.6	31.30	— 3.42	.136	.150	.093	.131	.83	.81	.54	.74	W N W	W N W	S W b W	N 82 W	22.0	22.2	9.2	12.81	14.71	...	...
29	.234	.295	.393	.3090	30.3	48.0	33.5	39.07	+ 3.97	.112	.146	.140	.135	.66	.44	.73	.58	S W b W	S S W	Calm.	N 86 W	6.4	8.0	0.0	4.45	6.13	...	...
30	.330	.214	.167	.2325	30.6	57.4	45.4	45.03	+ 9.53	.144	.151	.272	.189	.85	.30	.90	.67	N W	S S W	S W	S 45 W	3.0	22.5	10.0	10.82	11.52	...	...
31	.044	.078	.174	.1077	46.9	66.4	46.2	53.20	+17.28	.272	.431	.178	.270	.84	.65	.56	.64	W S W	W S W	N b W	N 84 W	15.2	19.4	4.0	7.96	10.66	...	...
M	29.5159	29.4881	29.5281	29.5111	29.39	39.92	33.29	34.48	+ 4.10	.136	.168	.144	.148	.78	.65	.73	.71	....	....	....	....	11.87	15.52	9.90	......	12.41	0.882	2.4

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR MARCH.

Highest Barometer .... 29.934 at 8 a. m., on 6th } Monthly range= 0.890 inches
Lowest Barometer .... 29.044 at 6 a. m. on 31st }

Self-regist'ing Thermom.:
- Maximum Temperature .... 67°0 on p. m. of 31st } Monthly range= 54°2
- Minimum Temperature .... 12°8 on a. m. of 13th }
- Mean maximum Temperature .... 41°89 } Mean daily range= 14°54
- Mean minimum Temperature .... 27°35 }
- Greatest daily range .... 30°1 from a. m. of 7th.
- Least daily range .... 2°8 from a. m. to p. m. of 12th.

Warmest day......... 31st ... Mean temperature......... 53.20 } Difference = 34°92.
Coldest day.......... 12th ... Mean temperature......... 18°28 }
Maximum Radiation. { Solar .... 79°0 on p. m. of 31st } Monthly range= 81°6.
{ Terrestrial .... —2°6 on a. m. of 13th }

Aurora observed on 12 nights, viz., on 12th, 13th, 14th, 15th, 16th, 17th, 19th, 21st, 23rd, 26th and 27th.
Possible to see Aurora on 19 nights; impossible on 12 nights.
Snowing on 11 days,—depth 2.4 inches; duration of fall 22.4 hours.
Raining on 5 days,—depth 0.882 inches; duration of fall 22.0 hours.
Mean of cloudiness = 0.49.
Most cloudy hour observed, 6 a. m., mean = 0.56; least cloudy hour observed, 10 p. m., mean, = 0.41.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
3679.66	1155.32	1051.26	6116.93

Resultant direction N. 64° W.; Resultant Velocity 7.61 miles per hour.
Mean velocity .... 12.41 miles per hour.
Maximum velocity .... 39.5 miles, from 11 a. m. to noon on the 22nd.
Most windy day .... 21st ......Mean velocity 23.83 miles per hour. } Difference= 25.33 miles.
Least windy day .... 16th......Mean velocity 3.50 ditto. }
Most windy hour... 2 to 3 p. m. .... Mean velocity 16.33 ditto. } Difference 6.60 miles.
Least windy hour... 11 p. m. to midnight......Mean velocity 9.73 ditto. }

1st. Dense Fog from 6 to 10.30 a. m.—2nd. Lunar Halo 10 p. m. and midnight.—5th. Indistinct Solar Halo 11 a. m.—8th. Wild pigeons very numerous. Lunar Halo from 11.30 p. m.—13th. Imperfect Solar Halo at 3 p. m.—14th. Zodiacal light very bright 7 to 8 p. m.—19th. Dense Fog 7 to to 9 p. m., emitting a very offensive odour. 20th, 21st and 22nd. Cold stormy days.—28th. Imperfect Lunar Halo 8 to 9 p. m.—29th. Very perfect Lunar Halo from 8 p. m.—30th. Imperfect Lunar Halo at 8.30 p. m.—31st, Indistinct Lunar Halo at 10 p. m.

Almost continued displays of Auroral Light from 12th to 27th of this month; some of them very brilliant.

The Resultant Direction and Velocity of the Wind for the month of March, from 1848 to 1860 inclusive, were respectively N 61° W, and 3.58 miles.

The month of March, 1860, was warm, dry, and very windy.
The Mean Temperature was 4°19 above the average of the last 21 years.
The depth of rain was 0.637 inches, and the depth of snow 6.47 inches less than their respective averages.
The Mean Velocity of the Wind for the month, was not only the greatest for any March on our record, but it was absolutely the most windy month of the whole series, giving an excess above the average of the last 13 years of 3.97 miles per hour.

COMPARATIVE TABLE FOR MARCH.

Year.	Temperature.					Rain.		Snow.		Wind.		
	M'n.	Diff. from Aver'	Max ob'd.	Min. ob'd.	Range.	No. of days.	Inch's.	No. of days.	Inch's.	Resultant Direction.	Resultant V'y.	Mean Force or Velocity.
1840	° 33.3	° +3.0	° 56.9	° 8.7	° 48.2	8	1.640	8	...	...	...	....
1841	27.7	—2.6	53 5	—6.9	60.4	5	1.170	7	...	...	...	0.51 lbs.
1842	35.8	+5.5	68.7	14.9	53.8	4	3.150	8	...	...	...	0.70
1843	21.3	—9.0	38.6	—2.8	41.4	2	0.625	18	25.7	...	...	1.18
1844	31.3	+1.0	50.3	9.6	40.7	8	2.470	8	14.0	...	...	0.57
1845	35.4	+5.1	61.7	9.9	51 8	5	Imp.	8	2.8	...	...	0.66
1846	33.1	+2.8	49.3	7.6	41.7	9	1.965	5	2.3	...	...	0.30
1847	26.2	—4.1	44.3	4.8	39.5	5	0.850	6	4.2	...	...	0.71
1848	28.6	—1.7	58.9	0.9	58.0	5	1.220	6	9.7	N 66° W	2.03	5.80 mls.
1849	33.5	+3.2	53.4	15.4	38.0	7	1.525	2	2.3	N 3° W	1.48	5.37
1850	29.8	—0.5	46.0	6.0	40.0	2	0.745	7	11.2	N 52° W	2.62	7.62
1851	32.4	+2.1	58.7	13.1	45.6	3	0.770	9	8.8	N 21° W	1.93	7.65
1852	27.7	—2.6	44.8	—3.2	48.0	8	3.080	12	19.5	N 8° W	0.71	5.81
1853	30.6	+0.3	56.3	—0.1	56.4	6	1.080	8	7.1	N 58° W	2.60	5.96
1854	30.7	+0.4	52.8	10.4	42.4	9	2.425	3	2.8	N 53° W	3.39	8.03
1855	28.5	—1 8	48 6	—2.9	51.5	5	1.485	11	18.1	N 88° W	4.76	9.95
1856	23.1	—7.2	39.3	—13.6	52.9	0	0.000	12	16.2	N 71° W	7.68	11.39
1857	27 8	—2.5	56.5	—3.9	60.4	4	0.335	15	11.3	N 63° W	6.63	10.84
1858	28.4	—1.9	54.1	—5.5	59.6	10	0.917	6	0.2	N 58° W	5.45	8.56
1859	36.3	+6.0	53.7	10.4	43.3	15	4.054	8	1.0	N 64° W	1.96	10.39
1860	34.5	+4.2	66.4	14.2	52.2	5	0.882	11	2.4	N 64° W	7.61	12.41
M	30.29	...	52.99	4.14	48.85	5.9	1.519	8.5	8.87	....	...	8.44 Ml.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—FEBRUARY, 1860.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 *deg.* 32 *min. North. Longitude*—73 *deg.* 36 *min. West. Height above the Level of the Sea*—118 *feet.*

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone.	Rain in Inches.	Snow in Inches.	Weather, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	30.143	30.205	30.173	—25.0	— 5.2	—11.1	.010	.026	015	.64	.70	55	N E b E	S S W	S	7.23	0.5	...	...	Clear.	Clear.	Clear.
2	190	280	260	—11.6	12.1	2.1	116	039	038	56	57	73	N E b E	S E b E	N E b E	0.52	0.5	...	...	Hazy.	Cirri 4.	Cu. Str. 10.
3	470	300	201	1.0	16.8	3.2	032	053	042	70	58	86	N E b E	N E b E	N E b E	4.90	1.5	...	Inp.	Cu. Str. 10	Cu. Str. 4.	C. C. 4. Lu. H.
4	141	197	053	1.0	17.9	10.9	041	068	057	85	67	79	N E b E	N E b E	S E b E	42.60	2.5	...	...	Do. 10.	Clear.	Clear.
5	014	002	29.840	— 5.6	28.7	30.8	028	129	161	81	80	90	S E b E	E b S	E b S	100.10	2.6	...	...	Hoar frost.	Cu. Str. 10.	Cu. Str. 10.
6	29.380	29.320	375	33.0	40.9	37.0	168	212	199	88	83	90	S b E	S b E	S W	136.20	5.3	Inp.	Inp.	Cu. Str. 10.	Do. 10.	Do. 10.
7	500	529	860	30.1	33.2	23.4	148	170	100	88	87	80	W	W b S	S W	264.00	4.0	...	...	Do. 10.	Do. 10.	Clear.
8	869	874	899	20.5	26.8	18.6	091	105	093	84	75	90	S W	W S W	W S W	67.70	3.0	...	...	Do. 2.	Clear.	Do.
9	567	109	068	18.2	38.9	37.7	088	195	209	90	80	90	S W	S W b S	S W	47.90	2.0	Inp.	...	Clear.	Cu. Str. 10.	Slight rain.
10	504	897	30.131	4.6	1.0	— 5.0	038	034	022	73	71	63	W b N	W N W	N N W	655.10	2.0	...	0.50	Snow.	Clear.	Clear.
11	30.102	914	29.862	—13.3	— 4.1	— 1.0	012	025	036	49	66	84	W S W	W S W	N E b E	117.70	2.0	...	...	Clear.	Do.	Snow.
12	005	729	974	— 1.1	18.0	11.6	028	082	051	68	83	70	N E b E	S W	S W	146.90	2.3	Inp.	Inp.	Cu. Str. 10.	Cu. Str. 4.	Cu. St. 10.
13	29.842	580	701	15.1	31.9	23.1	070	148	106	81	80	85	S S E	S b W	W N W	6.90	4.0	...	Inp.	Do. 10.	Slight snow.	Do. 10.
14	30.047	864	142	— 1.1	19.9	1.0	028	065	032	66	62	70	W S W	W S W	W	106.70	3.3	...	...	Clear.	Clear.	Clear. Zod. Lt.
15	252	941	846	— 8.1	7.0	6.5	018	036	037	58	56	63	N N E	N E b E	N N E	151.40	2.3	...	...	Do.	C. C. Str. 4.	Cl. Im. Lu. Ha.
16	29.424	422	689	20.0	25.8	10.3	091	123	054	84	88	77	E b S	S b E	W	223.00	5.0	...	7.90	Snow.	Snow.	Clear.
17	894	799	876	—13.0	12.6	— 7.2	019	039	019	74	51	60	W	W	W	67.00	0.5	...	...	Clear.	Clear.	Clear. Au. Bor.
18	803	614	374	—19.2	4.0	3.1	008	038	036	40	72	78	S W	N E b E	N E b E	115.60	3.0	...	1.00	Do.	Cu. Str. 10.	Snow.
19	256	340	774	8.9	12.9	6.4	051	054	037	78	71	69	N E b E	W	W b N	539.60	3.3	...	5.10	Snow.	Do. 10.	Clear. Au. Br.
20	894	650	664	1.0	25.3	28.3	030	111	135	69	81	88	S b E	S b E	S W b S	123.20	1.6	...	1.10	Cu. Str. 2.	Do. 10.	Cu. Str. 10.
21	801	754	950	26.0	49.5	31.0	111	272	142	81	78	84	W b S	S b W	S S W	103.10	1.3	...	...	Cir. Cum. 4.	Clear.	Cl. splen. A.B.
22	874	462	297	17.2	42.4	39.9	076	261	234	80	96	93	N E b E	S b E	S E	59.80	7.6	0.295	...	Cu. Str. 10.	Rain.	C. Str. 2. Au. B.
23	075	028	320	35.4	38.4	34.2	183	223	194	91	95	97	S S W	S S W	W S W	111.60	6.6	0.147	...	Clear.	Do.	Cu. Str. 10.
24	676	682	779	16.0	21.1	15.1	059	064	061	65	56	73	W S W	W S W	W S W	397.40	4.0	...	...	Cu. Str. 10.	Cirri. 2.	Clear.
25	961	827	971	10.4	25.0	13.2	052	094	059	71	68	74	S W b S	S W	W	91.80	3.3	...	...	Do. 10.	Clear.	Do.
26	30.244	30.164	30.090	3.7	22.7	19.0	030	079	087	59	65	84	W b N	S W	S S E	87.00	4.6	...	...	Clear.	Cu. Cu. 4.	Cu. Str. 10.
27	29.979	29.960	29.901	15.0	46.1	39.0	072	262	201	82	84	86	N E b E	S E	S b W	26.10	8.0	Inp.	...	Cu. Str. 10.	Cu. Str. 10.	Do. 4.
28	30.321	30.300	30.260	20.1	28.4	24.1	091	129	111	85	82	85	N E	N N E	N E b E	204.00	6.0	...	...	Do. 4.	Do. 4.	Do. 10.
29	157	030	29.954	21.7	32.0	34.6	106	168	180	86	88	89	N E b E	N E b E	N E b E	127.30	10.0	0.174	...	Do. 10.	Rain.	Do. 10.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—MARCH, 1860.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M.D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone.	Rain in inches.	Snow in inches.	Weather, &c. A Cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.745	29.583	29.533	32.1	35.0	34.8	.168	.204	.196	.89	1.00	.97	N E b E	N E b E	S E b E	64.00	10.0	0.361	...	Cu. Str. 10.	Slight rain.	Rain.
2	425	516	30.043	32.3	41.3	32.2	175	228	155	95	87	89	W S W	W b S	W N W	254.30	7.0	...	...	Do. 10.	Cu. Str. 6.	Clear.
3	30.102	431	29.087	21.3	32.4	39.2	090	156	201	80	82	84	N E b E	S E b E	S E	148.80	1.3	...	...	Clear.	Do. 9.	Cu. Str. 10.
4	29.300	434	759	31.0	34.0	21.1	155	170	080	89	80	71	S b W	S b W	W N W	147.50	1.3	...	Inap.	Do.	Snow.	Clear.
5	768	500	612	14.1	26.8	10.9	067	123	048	81	87	69	S W b S	W b S	N E b E	165.00	3.0	...	0.14	Cu. Str. 10.	Do.	Cu. Str. 10.
6	856	722	904	8.3	27.0	20.9	057	099	085	80	69	78	S E	S E b E	N E	121.70	3.0	...	Inap.	Clear.	Clear.	Clear.
7	824	600	420	19.1	38.2	34.4	077	201	190	76	86	95	N N E	N E b E	E S E	157.70	3.0	Inap.	1.00	C. Str. 10.	Snow.	Rain.
8	353	256	520	29.4	42.8	36.7	136	230	184	83	85	85	S E b E	S b W	W S W	146.60	4.0	...	...	Clear.	Cu. Str. 9.	Cu. Str. 4.
9	452	462	479	28.0	32.1	21.6	123	143	090	82	79	78	N W	N W	N W	137.10	1.0	...	...	Do.	Do. 10.	Cu. Str. 10.
10	348	301	454	16.0	28.4	21.1	070	129	080	80	82	71	E	W	W	654.40	1.0	...	Inap.	Snow.	Do. 10.	Do. 10.
11	547	440	601	20.0	32.0	28.2	090	143	128	78	79	83	W	W	W	451.80	1.0	...	...	Clear.	Clear.	Clear.
12	669	625	670	18.9	26.9	27.0	087	112	129	85	76	88	N E b E	N E b E	N E b E	211.80	0.5	...	Inap.	Cu. Str. 10.	Cu. Str. 10.	Cl. Ft. Au. Br.
13	976	850	914	11.4	35.9	22.7	056	170	079	72	80	65	S W b S	S W b S	S W b W	172.20	0.5	...	...	Clear.	Clear.	Clear. Au. Br.
14	971	797	790	13.4	41.0	31.0	052	190	142	72	74	84	S W b W	S W	S W b S	9.70	1.0	...	...	Do.	Do.	Do. do.
15	30.017	962	944	24.4	49.6	36.1	105	290	177	80	82	85	S W b S	S W b S	S b E	2.20	1.5	...	...	Do.	Do.	Clear.
16	130	747	942	29.0	57.9	46.0	129	343	241	82	72	84	S b W	S b W	S	0.80	1.5	...	...	Do.	Do.	Clear. Au. Br.
17	050	994	949	31.1	54.1	39.4	155	362	190	80	87	80	S b E	S b E	S E	1.00	1.3	...	...	Do.	Do.	Cl. A. B. So. H.
18	159	939	932	30.1	52.0	37.6	148	334	178	89	86	83	E	E b N	E b S	0.00	3.3	...	...	Do.	Do.	Clear. Au. Br.
19	29.920	492	479	30.0	60.0	49.0	148	317	223	89	62	64	E b N	S E b E	S S E	0.00	3.6	...	...	Do.	Do.	Do. do.
20	354	042	369	39.0	39.0	37.0	201	223	199	86	95	90	S S E	W S W	S S W	1.00	4.3	0.017	...	Cu. Str. 10.	Rain.	Cu. Str. 9.
21	479	527	624	20 0	24.0	17.0	106	094	068	86	73	75	W b S	W	W b N	133.90	2.0	...	0.51	Do. 10.	Snow.	Do. 10.
22	327	318	560	10.1	20.9	17.2	048	096	078	78	85	83	W b N	W	S S W	306.30	2.3	...	1.38	Snow.	Cu. Str. 10.	Clear.
23	541	324	329	6.4	34.0	23.6	049	144	100	89	75	79	S W	S W	S S W	65.90	1.0	...	...	Clear.	Clear.	Do. Au. Br.
24	125	080	210	21.1	52.9	26.1	080	131	117	71	70	76	S S W	W b S	W S W	220.80	2.3	...	Inap.	Cu. Str. 4.	C. C. Str. 8.	Cu. Str. 10.
25	214	234	500	19.6	34.0	31.6	081	155	149	77	79	84	W S W	S W b S	W b N	164.90	3.3	...	1.10	Snow.	Snow.	Do. 10.
26	679	532	829	23.6	36.2	26.3	100	149	117	79	71	81	W	W S W	W S W	176.10	3.3	...	...	Cu. Str. 10.	Cu. Str. 4.	Do. 10.
27	797	547	610	12.1	40.0	33.0	060	182	156	80	73	85	S W b S	S W b S	S W b S	90.80	1.0	...	...	Clear.	Clear.	Clear.
28	361	350	471	34.6	36.1	26.9	149	170	115	74	80	83	S	W	S W	194.00	1.0	...	...	Do.	C. Str. 4.	C. C. Str. 9.
29	501	400	514	17.0	33.7	27.6	078	162	123	85	84	82	S S W	S W	S	21.60	1.3	...	...	Cu. Str. 10.	Do. 10.	Clear.
30	574	183	164	24.2	52.6	40.0	100	282	221	79	73	90	S b W	S S E	S S W	2.10	4.0	...	...	Clear.	Clear.	Do.
31	162	28.714	008	33.6	61.1	45.0	182	383	251	91	71	84	S E	S W	W S W	152.00	2.0	...	...	C. C. St. 4.	Do.	Do.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR FEBRUARY, 1860.

Barometer	Highest, the 3rd day	30.470
	Lowest, the 23rd day	29.028
	Monthly Mean	29.813
	Monthly Range	1.442
Thermometer	Highest, the 21st day	49°5
	Lowest, the 1st day	—25°0
	Monthly Mean	15°70
	Monthly Range	74°5
Greatest Intensity of the Sun's Rays		68°1
Lowest point of Terrestrial Radiation		—27°4
Mean of Humidity		.751

Rain fell on 7 days, amounting to 0.616 inches; it was raining 29 hours and 55 minutes.
Snow fell on 8 days, amounting to 15.60 inches; it was snowing 48 hours and 25 minutes.
Most prevalent wind, the N. E. by E.
Least prevalent wind, the S.
Most windy day, the 10th day; mean miles per hour, 28.30.
Least windy day, the 2nd day; mean miles per hour, 0.18.
Aurora Borealis visible on 4 nights.
Lunar Haloes visible on 2 nights.
The electrical state of the atmosphere has indicated moderate intensity.
Zodiacal Light visible. Venus prevents an early or well defined view.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR MARCH, 1860.

Barometer	Highest, the 18th day	30.159
	Lowest, the 31st day	28.714
	Monthly Mean	29.562
	Monthly Range	1.445
Thermometer	Highest, the 31st day	61°1
	Lowest, the 6th day	8°3
	Monthly Mean	30°52
	Monthly Range	52°8
Greatest intensity of the Sun's rays		83°0
Lowest point of terrestrial radiation		8°0
Mean of Humidity		.813

Rain fell on 3 days, amounting to 0.378 inches; it was raining 23 hours 10 minutes.
Snow fell on 10 days, amounting to 4.10 inches; it was snowing 43 hours 1 minute.
Most prevalent wind, the W.
Least prevalent wind, the E.
Most windy day, the 10th day; mean miles per hour, 27.26.
Least windy day, the 19th day; calm.
Crows first seen on the 1st day.
Song Sparrow (*Fringilla melodia*) first heard on the 10th day.
Distant Lightning on the 5th day.
Wild Geese (*Anser Canadensis*) first seen on the 27th day.
Aurora Borealis visible on 8 nights.
Solar Halo visible on 1 day.
The Electrical state of the atmosphere has indicated rather feeble intensity.

ADDITIONAL NOTE.

CALCEOLA IN THE UPPER SILURIAN ROCKS OF TENNESSEE.

Since writing the note under the above title (page 307), it has occurred to us that an Upper Silurian species of *Calceola*, from Tennessee, was described by F. Roemer, some years ago, under the name of *C. Tennesseensis*. Professor Stafford's species is perhaps identified with this.—E. J. C.

THE CANADIAN JOURNAL.

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NOTICE OF A SKULL BROUGHT FROM KERTCH, IN THE CRIMEA.

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Read before the Canadian Institute, January 21st, 1860.

The Anglo-French campaign of 1855 in the Crimea, led to a general familiarity with much concerning that remarkable peninsula, of which we were in ignorance before. Its geography, its ethnology, and its antiquities all attracted attention; and rewarded research by novel disclosures; and its ancient history acquired a fresh interest, and received new illustrations from the investigations of the half obliterated remains of its long extinct past. Among its ancient historical sites, which, owing to peculiar circumstances, received a large share of attention, that of Kertch is, on various accounts, the most remarkable. Built on the site where, some 500 years before Christ, the Greek city of Panticapæum was founded, it was the centre of an area rich with memorials of the strangely chequered past, which has seen the same spot successively occupied by Milesian Greeks, Romans, Huns, Tartars, Genoese, Turks, and Russians. The Russian occupation of the Crimea dates only from a late period in the eighteenth century, but since then, a Museum had been formed in the town of Kertch, in which were preserved many historical antiquities of the Crimean Bosphorus; and especially sepulchral relics recovered from the tumuli which abound on the site of the ancient Milesian colony.

Learning from an old fellow-student that he was about to proceed to the Crimea to join the Army Medical Staff, I wrote to him, drawing his attention to various objects worthy of observation; and in directing his notice to the treasures accumulated in the Museum at Kertch, specially requested him to note for me—should opportunity offer,—the characteristics of an ancient Macrocephalic skull preserved there. It is referred to in Captain Jesse's "Notes of Travel in Circassia and the Crimea," where it is said to have been found in the neighbourhood of the Don. The interest of such cranial remains increases in value, from the evidence they furnish of ancient analogies to the remarkable artificial compression which now we associate almost exclusively with American crania.

It chanced, as is now well known, that, in the fortunes of war, the town of Kertch fell into the hands of the Anglo-French invaders; and some few of its ancient treasures were preserved and transmitted to the British Museum. By far the greater portion of the Museum collections however, were barbarously spoiled by the rude soldiery; and among the rest doubtless perished the little-heeded relic of the Macrocephali of the Crimea, first described by Hippocrates, five centuries before our era. Blumenbach has figured in his first Decade, an imperfect compressed skull, received by him from Russia, which he designates as that of an Asiatic Macrocephalus; and in 1843, Rathke communicated to Müller's "*Archiv für Anatomie*," the figure of another artificially compressed skull, also very imperfect, but specially marked by the same depression of the frontal bone. This example is described as procured from an ancient burial-place near Kertch in the Crimea; and no doubt other illustrations of the peculiar physical characteristics of the ancient Macrocephali of the Bosphorus will reward future explorers, when the attention of those engaged in such researches, or even in ordinary agricultural labours on the site, is specially directed to the interest now attaching to them.

Meanwhile, however, my hopes of obtaining any further facts from the Macrocephalic cranium seen by Captain Jesse in the Kertch Museum, had been dissipated by the dispersion and wanton destruction of its treasures; and I had ceased to think specially of Crimean crania, when I was gratified by receiving the gift of a skull, including the lower jaw, brought from Kertch, and described by the donor, as that of a Circassian lady. In form it presented no correspondence with the Macrocephalic type to which my inquiries had been previously directed, for the forehead is markedly vertical, and in its general proportions it is strikingly characterised as a brachycephalic cranium of unusual width at the parietal protuberances, while marked by much delicacy and beauty, especially in the facial bones.

A special interest attaches to the evidences of physical form, as well as of philological characteristics, pertaining to the tribes of the Caucasian area, owing to the factitious importance that has been assigned to certain of them in modern Ethnology. It may not, therefore, be altogether valueless to put on record the facts connected with the recovery of the Crimean cranium in question; and to note the peculiarities of its form and measurements; though, from the mixed character of the population of Kertch it would not be safe to assign the crania of its modern cemetery to any absolute ethnological group, or to make them the basis whereon to found data for classification, or for any comprehensive generalization.

Dr. Latham, in his "Varieties of Man," classes the nations and tribes of the area within the range of Mount Caucasus under the generic designation of Dioscurian Mongolidæ, including in its chief divisions: The Georgians; the Lesgians; the Mizjegi; the Irôn; and the Circassians. He derives the term Dioscurian, from the ancient sea-port of Dioscurias, where the chief commerce between the Greeks and Romans and the natives of the Caucasian range took place. According to Pliny, it was carried on by one hundred and thirty interpreters, so numerous were the languages; and one striking characteristic of the locality, still noticeable, is the great multiplicity of mutually unintelligible tongues. This therefore is the idea designed to be conveyed by the term Dioscurian. Caucasian would have been a preferable, because more familiar and precise term, but it has been already appropriated as an Ethnological division, in a way sufficiently confusing and indefinite, without adding thereto by the creation of such a contradictory union of terms, as would arise from such a designation as Caucasian Mongolidæ,—almost equivalent, in popular acceptation, to European Asiatics!

The use of both epithets, Caucasian and Mongolian, is traceable to Blumenbach, and the history of his adoption of the former supplies a curious example of a term, subsequently employed as one of the most comprehensive heads of classification, having its origin from the fewest possible premises. Among the captives taken by the Russians in one of their frequent inroads on the country lying between Mount Caucasus and the Euxine, was a Georgian woman, who was carried prisoner to Moscow, and died suddenly there. The body was made the subject of anatomical examination by Professor Hiltenbrandt, and the skull having been prepared, was subsequently presented to Dr. Asch, of St. Petersburg. From him it passed into the hands of Blumenbach, and its peculiar symmetry and beauty appear to have made a lively impression on his mind. That this was not without good reason appears from the following description of the Georgian cranium by Dr. Lawrence :

"The form of this head is of such distinguished elegance, that it attracts the attention of all who visit the collection in which it is contained. The vertical and frontal regions form a large and smooth convexity, which is a little flattened at the temples; the forehead is high and broad, and carried forward perpendicularly over the face. The cheek-bones are small, descending from the outer side of the orbit, and gently turned back. The superciliary ridges run together at the root of the nose, and are smoothly continued into the bridge of that organ, which forms an elegant and finely turned arch. The alveolar processes are softly rounded, and the chin is full and prominent. In the whole structure there is nothing rough or harsh, nothing disagreeably projecting. Hence it occupies a middle place between the two opposite extremes, of the Mongolian variety, in which the face is flattened, and expanded laterally; and the Ethiopian, in which the forehead is contracted, and the jaws also are narrow and elongated anteriorly."

Little could the poor Georgian captive dream of the posthumous honours and admiration that were to atone to her for her living wrongs. She has avenged herself on her European captors, by introducing uncertainty and confusion into the science for illustrating which Blumenbach regarded her symmetrical cranium as a peculiarly valuable prize. It was in the Third Decade of his anatomical descriptions of skulls, published in 1795, that the skull of the fair Georgian was introduced, accompanied by a glowing description of its elegance and unequalled grace; and a reference to the beauty of the Georgian women, which, as his example proved, lives even in their fleshless bones. A comparison of the skull with a cast of one of the most beautiful classic busts in the Townley collection, seemed to the enthusiastic craniologist as though he had acquired the actual skull of the head from which the ancient marble was copied; and when placed alongside of the only Greek skull in his collection, the Georgian was superior to it, the Greek being next in rank.

Hence it was that Blumenbach adopted his Georgian skull as a typical cranium, for the most perfectly developed division of the human species. In the same decade in which the Georgian skull appears, the term *Caucasian* is introduced in connexion with it; and along with this term of classification appear also those of Mongolian and Ethiopian; and these, with the epithets Malay, and American,—subsequently added,—formed the names of a quinary division of the human species, which he conceived his physical researches to have established. By the term Caucasian, Blumenbach meant no more than the adoption of a convenient name for his highest division of the human species, the typical characteristics of which were most completely epitomised in his symmetrical cranium. But the associations and historical traditions connected with Mount Caucasus, supplied a tempting basis for theory and speculation. The mountain range was assumed by some as the central point for the origin of mankind; and the epithet derived from it is now associated with so many extravagant ideas, and so much loose and confused classification, that the vague uncertainty it has acquired is abundantly sufficient to justify its abandonment. When, however, Dr. Latham substitutes the term Dioscurian for Caucasian, in its limited sense as applicable to the inhabitants of the actual area of Mount Caucasus, he does so not only from different data to those employed by Blumenbach, but even in defiance of such analogies as their ascertained physical conformation seems to suggest. He accordingly admits that he occupies exceedingly debateable ground. "So long has the term Caucasian been considered to denote a type of physical conformation closely akin to that of the Iapetidæ, *i. e.* pre-eminently European, that to place the Georgians and Circassians in the midst of the Mongolidæ, is a paradox. Again, the popular notions founded upon the physical beauty of the tribes under notice, are against such a juxta-position; the typical Mongolians, in this respect, have never been mentioned by either poet or painter, in the language of praise." Perhaps, however, the facts which justify Dr. Latham in saying of

Blumenbach's solitary Georgian skull, "never has a single head done more mischief to science, than was done in the way of posthumous mischief, by the head of this well-shaped female from Georgia," may have had their influence in tempting to the Caucasian paradox of his Dioscurian Mongols. The classification, at any rate, entirely ignores physical conformation, and rests on vocabulary analogies, confirmed by an opinion expressed by Mr. Norris, of the Asiatic Society, that on the surer evidence of grammatical comparison, the closest philological affinity of the Dioscurian languages is with the Aptotic ones, of which the Chinese is generally accepted as the type.

It is scarcely necessary to say, that languages may belong to a different class from the people who speak them. Europe supplies abundant and well authenticated illustrations of this. An Englishman speaking Chinese, does not thereby become a Mongol, nor will the adoption of the English tongue by the Chinese emigrants to Australia and elsewhere, affect their essentially Mongolian physical characteristics. Dr. Latham accordingly refers to the want of sufficient evidence for discussing the physical elements of classification in his Dioscurian Mongols. "Physiological objections," he observes, "based upon the symmetry of shape and delicacy of complexion on the part of the Georgians and Circassians, I am at present unable to meet. I can only indicate our want of osteological data, and remind my readers of the peculiar climatological conditions of the Caucasian range; which is at once temperate, mountainous, wooded, and in the neighbourhood of the sea—in other words the reverse of all Mongol areas hitherto enumerated. Perhaps, too," he adds, "I may limit the extent of such objections as a matter of fact. It is only amongst the chiefs, where the personal beauty of the male portion of the population is at all remarkable. The tillers of the soil are, comparatively speaking, coarse and unshapely."

The latter remark—whatever be its value,—may be made of the tillers of the soil everywhere; but if the Georgian and Circassian mothers are generally as graceful and beautiful in form as the concurrent opinion of travellers affirms them to be, the perpetuation of anything approximating to a Mongol physical type in their sons, would be one of the greatest marvels in physiological ethnology. In the absence, however, of osteological data, the smallest contribution towards the accumulation of the requisite facts may have its value.

The history of the cranium to which I now direct attention, is as follows: Dr. Michael Turner was present in the Crimea, and in active service on the medical staff, during the Anglo-French Invasion of 1855, and witnessed the capture of Kertch. At that period, its population was estimated at between seven and eight thousand; and was composed of Tartars, Cossacks, Greeks, Russians, and a sprinkling from the tribes bordering on the shores of the Black Sea. More than two-thirds of the whole population of the Crimea are a mixture of the pure Asiatic Mongol Tartar with the modified European Turk; and except among the nobles, or murses, and partially among the population of the northern valleys, they abundantly indicate their Tartar origin in their features.

The antipathies which the mutual wrongs of Russian and Turk have created, have obliterated in the minds of the latter any idea of kindred with the Tartar, or semi-Turkish population of the Crimea; and after the sack and pillage of the town of Kertch, the Turkish troops carried their violence so far, as to open and spoil the graves in the Christian cemeteries; and on finding trinkets and relics in some of the first they opened, a general desecration ensued. The articles found consisted of rings, beads, and amulets, and also of crucifixes, and images of the saints; and these were sought for, and appropriated by the Turkish soldiers, with the utmost indifference to the condition in which they left the ravished occupants of the desecrated graves. Whilst strolling in the neighbourhood of the city where such shameful spoliation had been carried on, Dr. Turner passed through a large cemetery, which he was led to believe had been confined exclusively to members of the Greek Church, from the number of large marble crosses heading the graves. Most of the latter were opened, and rifled of such of their contents as could tempt the cupidity of the spoilers; and the skeletons and partially desiccated remains of their former occupants lay strewed about the ground. On looking into one of the open graves which had been thus despoiled, he was tempted to examine the nature of the sepulture, as the body still remained in its original position; and also to ascertain whether the marauders had left anything of value behind. He accordingly jumped into the grave, and turning over the loose soil with his hands, he was struck, on uncovering the head, by its long black hair and beautiful teeth. The body was not yet returned to the dust, so that the interment was one of no very remote date from that of the disturbance of what cannot properly under such circumstances be called its last resting place. The muscles, which still remained on the forehead, were dry and contracted, and across the forehead, and round the head, was a broad gold fillet, sufficiently indicating that the grave was tenanted by one who had occupied a high social rank. No other ornaments or relics were observed, the whole of those having doubtless been removed by the original riflers of the grave. Dr. Turner did not consider it a very serious aggravation of the desecration to which the dead had already been subjected, to possess himself of the skull, which struck him as one peculiarly marked with indications of former delicacy and beauty; and through the kind intervention of my friend Dr. C. W. Covernton, it has since been transferred to me.

From a comparison with other skulls procured by him, Dr. Turner at first inclined to the opinion that he had acquired the cranium of a Greek lady. The breadth at the parietal protuberances, however, along with other marked features, differ essentially from the Greek type of head; and as there were many Circassians among the wives of the most influential and affluent families in the city, the probabilities he conceives are, *a priori*, in favour of its being ascribed to a people celebrated for the beauty of its females, and for their frequent introduction both to Turkish and Græco-Russian households around the Euxine. An elaborately sculptured, but broken marble cross at the head of the grave, added additional proof that the once loved and lost beauty of some Kertch household, whose remains were subjected to such indignities, had been ranked, during her life-time, among the finest porcelain of human clay. Under the peculiar system which prevails in oriental households, however, and by which Christian as well as Ottoman alliances are influenced, a wide area is embraced within the possible origin of the beauties who adorn such eastern homes; and a comparison of the most strikingly marked characteristics of this head with the varying types of cranium pertaining to what may be regarded, even in some respects philologically, as the European ethnic area, would rather suggest its classification among Armenian than Circassian forms. The materials however, for arriving at any very definite conclusion are limited, and perhaps inadequate for positive generalizations; and it may suffice to put on record such minute descriptions and measurements, as may afford the means of future comparison.

The skull, as already indicated, is that of a female, of fully 30 years of age. The bones of the face are characterised by great delicacy. The zygomata are slight, and inclose a space proportionally small by the zygomatic arch. The face is altogether small for the head, giving the idea of a considerable breadth of forehead ; though it will be seen that the parietal diameter is in greater excess than usual when compared with the frontal diameter. The teeth, the beauty and completeness of which attracted the attention of Dr. Turner when first exposed in the cemetery at Kertch, have since mostly fallen out: but with the exception of one decayed molar, such as remain fully accord with his description, and with the delicacy of the superior and inferior maxillaries. The forehead is smooth, with no projection of the frontal sinuses, and no depression above the nasal suture, but with marked frontal protuberances at the upper angles of the forehead. The occipital protuberance is slight, and the profile of the calvaria exhibits a markedly vertical aspect both in its frontal and occipital outlines. The frontal bone passes somewhat abruptly from the forehead to the top of the skull, thereby giving a square form to the profile instead of the more usual arched curvature ; so that, with the nearly vertical occiput, the cranium has a singularly compact outline, when viewed in profile. The parietal bones are large, with a gradually increasing protuberance to their greatest diameter, a little behind the line of the mastoid processes. Owing to this the outline of the vertical aspect presents somewhat the form of a truncated wedge, narrowing gradually and with a nearly uniform diminution until abruptly rounded off into the forehead at the frontal protuberances.

The following are the most characteristic measurements of this skull :—

Longitudinal Diameter	6.7
Parietal Diameter..............	5.7
Frontal Diameter.........................	3.8
Zygomatic Diameter	4.4
Vertical Diameter.........................	4.7
Intermastoid Arch	14.3
Intermastoid Line	3.7
Length of Face	6.2
Horizontal Circumference	19.7

Dr. J. Aitken Meigs has remarked in his "Cranial Characteristics of the Races of Men," chiefly founded on data supplied by the

Morton Collection in the Academy of Sciences at Philadelphia: "The extreme South-eastern section of the European ethnic area, occupying mainly the table-land of Iran, is represented in the Morton Collection by six Armenian, two Persian, and one Affghan skull. A general family resemblance pervades all these crania. They are all, with one exception, remarkable for the smallness of the face, and shortness of head. In the Armenian skull, the forehead is narrow and well formed, the convexity extending upwards and backwards towards the parietal protuberances and laterally towards the temporal bones. The greatest transverse diameter is between the parietal bones. This feature, combined with the flatness of the occiput, gives to the coronal region, an outline resembling a triangle with all three angles truncated, and the base of the triangle looking posteriorly. In fact, the whole form of the calvaria is such as to impress the mind of the observer with a sense of squareness and angularity. The dimensions of the orbits are moderate; the malar bones small, flat, and retreating; zygomatic processes slender, and the general expression of the face resembling that of the Circassians, from which latter it differs in being shorter." On nearly all those points, the Kertch skull closely corresponds to this description of Armenian Cranial characteristics. The only noticable exceptions are in the orbits, which may be described as somewhat large, but with their perpendicular diameter the greatest; and in the length of the face, which has more of the assigned Circassian dimensions. The formation of the lower jaw indicates a delicately pointed and small chin. Viewed altogether, the peculiar features of this skull are well defined, and sufficiently characteristic to enable an experienced craniologist to assign it, with little hesitation, to the Iranian group, with its included Georgians, Lesgians, Circassians, and Armenians. Of those the last named—to which the Kertch cranium seems by its most prominent peculiarities to belong,—possesses some characteristics of peculiar interest. In his "Varieties of Man," Dr. Latham places the Armenians foremost among his "unplaced stocks;" but regarding them from a philological point of view, he seems to consider them as in some respects presenting indications of a link between the Indo-European and the Semitic groups; but he also adds: "it is through the Armenian, that the transition from the Mongolidæ, to the Atlantidæ, is most likely to be recognised." Obtained as the skull now described has been, under peculiar and somewhat unique circumstances, and with a minuteness of evidence relative to the social condition and the vital characteristics originally pertaining to her whose sepulture was involved in the ravages of the Crimean war, which led to its acquisition: the facts recorded in this paper, may possess some slight value as a contribution to data now accumulating from the labours of many independent workers, and destined ultimately to establish physical ethnology on a sure and well-determined basis.

GEOMETRIC PROBLEMS RELATING TO CURVES HAVING DOUBLE CONTACT.

BY J. W. MARTIN, LL.D., TORONTO.

Read before the Canadian Institute, 10th March, 1860.

Given a circle and a point o inside it; if a line passing through o and cutting the circle in the points a and b be divided externally in m, so that $\frac{(ao \times bm)}{am \times bo} = \frac{co}{c'o}$ segments of fixed chord passing through o then tangent to circle from m will be to perpendicular from m on rt the polar of o as secant of angle which cc' makes with diameter of circle passing through o to unity.

If ac bc' be produced, they will meet at p, a point on rt; and if from p we draw a line parallel to cc' it must pass through m, the anharmonic ratio of the pencil $p.\ a\ o\ b\ m$ being as $co : c'o$, and as the angle $bpm = bc'o = bap$ $(pm)^2 = am \times bm =$ square of tangent to circle from m, locus of m $\therefore$ is $s - e^2\alpha^2 = o$, $s = o$ being equation of circle, and $\alpha = o$ that of the line rt. In like manner, if p be joined with middle point of cc' joining line meets ab in m'. So that $\frac{ao \times bm'}{am' \times bo} = \frac{co}{c'o}$ and locus of m' is $s + e'^2\alpha^2 = o$, e' being $=$ to cc' divided by sum of perpendiculars on rt from c and c'. The conics $s - e^2\alpha^2 = o$, $s - e'^2\alpha^2 = o$, are polar reciprocals. The lines coc', $fo\,f'$, each of which makes with diameter of circle passing through o, an angle whose secant $= e$ are parallel to the asymptotes of the conic $s - e^2\alpha^2 = o$, and polars of the points where the asymptotes cut (rt), while the line joining their middle points is the polar of the centre. If from any point on (rt) tangents be drawn to circle and the two conics, points of taction lie on a right line passing through o, and anharmonic ratio of any four points on rt is = that of lines drawn from o to points of taction where tangents drawn from the four points on (rt) touch either conic.

ON SOME QUESTIONS IN RELATION TO THE THEORY OF THE STRUCTURE OF PLANTS OF THE ORDERS BRASSICACEÆ AND PRIMULACEAE.

BY THE REV. W. HINCKS, F.L.S.
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Read before the Canadian Institute, 11th February, 1860.

The title of my paper embraces two distinct Botanical notes or topics which would appear interesting to the theoretical Botanist who has had some experience in such studies, but which would hardly at all have engaged the attention of most practical students of the science, and which it may almost seem hopeless to attempt making intelligible to those who do not make Botany a pursuit, yet it appears to me that as we all profess an interest in the advancement of science, and as our society is formed on the plan of social meetings for mutual entertainment and improvement as well as for endeavouring to produce something that may be useful beyond our own circle —it must be right that whilst I only bring before you what I hope may either posess some novelty, or at least contribute something towards a just decision on disputed points—I should endeavour to bring it forward in such a manner that all who desire various information may understand the question under discussion and the opinions proposed for their acceptance—I am afraid indeed that after all many will think the subject little worth their notice; I venture however to assure them, that inquiries of this kind are deemed of some importance as well as curiosity, so that if I were so fortunate as to contribute any thing towards clearing either of the doubtful points about to be examined, I should find many to agree with me, that the labour would not be wasted. I have only reason to fear my being found unequal to the difficulties of the case. I am however, giving you speculations which have occasionally occupied me during a number of years and which are founded on cautious and repeated observations of facts, not without study of the judgments pronounced by writers of authority which I desire to treat with respect whilst I freely examine their merits.

Our first inquiry relates to the real nature of the order of the parts of the flower in a tribe of plants well known as *cruciform flowers*, and familiar from the wall-flower, stock, cabbage, and several common weeds constituting the order *Brassicaceae* of Lindley. Plants of this order are distinguished by a very peculiarly constructed seed-vessel divided into two cells by a partition which is not easily brought into analogy with anything in the ordinary constitution of seed-vessels, and whilst the calyx and corolla consist of four parts each in the usual relative positions, the number of parts in the Gynoecium or ovary, is *apparently* only two, and the androecium shows six stamens in two pairs with a single lower one at each end. Now it is well known to all who have attended to the subject, that every flower consists of circles of leafy organs variously modified in their development, the inner circle consisting of what are now called carpels, of which the apex is the stigma, and the margin usually at least bears the ovules—next follows the circle of stamens, often indeed several circles, each stamen consisting of a filament corresponding to the mid rib of the leaf, and an anther most commonly of two cells formed from its expansion, the parenchyma of one surface being converted into pollen grains. Outside the stamens occur the petals, or inner enveloping circle, and outside all the calyx, consisting of pieces called sepals. Now it is the general rule that these circles alternate one with the other in regular order, the inner circle being indeed peculiarly liable to have its number of parts reduced by pressure, and the others exhibiting occasional anomalies from adherence, irregularity and suppression or abortion, either of a whole circle or some part of it. Every flower is formed on a certain definite plan as to the number of circles and of parts contained in each, and as to their relative position, and when there is any deviation from equal numbers and alternate arrangement we always expect to be able to offer some explanation which shall shew it to be a case naturally arising under the general law. Although five is the natural number of parts in each circle in Exogenous plants, it is by no means unusual to meet with four or even, under pressure, more especially towards the interior of the flower, and rarely in the outer circles, three and two. In cruciform flowers the calyx and corolla have four parts each, the stamens are six, unequal, and there are seemingly but two carpels though with an anomalous connection between their opposite edges, which demands explanation. The late eminent Robert Brown, than whom a higher authority cannot be appealed to, considered the fruit as *really* consisting of two carpels, whose placental edges are at the part where they first touch each other, but the exterior covering of each of which extends until the parts meet in a median line, thus forming a spurious partition. There is nothing impossible in this explanation since the separation of the principal portion of the carpel leaving the placenta in its position, occurs in other instances, and there are probably examples sufficient to justify the notion of the spurious partition though it is something extraordinary. Considering the cases in which a line is observable down the middle of the partition, and others in which there is a partial or even entire separation into two parts, it must I think be agreed that the partition is due to the meeting in the middle of two parts projecting from the placental lines; but I confess I greatly prefer another theory which had occurred to myself many years ago, and which I have since ascertained to have been proposed by Lindley and defended by Kunth. This is the supposition that the fruit is really formed of four carpels, two of which are abortive, their remains forming the partition, whilst the remarkable circumstance of the stigmas being in the line of the placentæ is accounted for by the fact that each stigma is double, formed by the union of one from each carpel, the tip of the carpel dividing into two portions as in some other instances. This explanation is greatly confirmed by the manner in which the alternate circles of cruciferous flowers exhibit increased development in opposite directions, the largest pair in one circle being opposed to the lesser pair in the next. On the whole, though Dr. Gray adheres to Brown's theory, I cannot but consider the other as better explaining all the facts of the case, and it is especially confirmed to my mind, by the consideration of the deviative structure of Parolinia. In vain it is contended by Moquin Tandon and Webb, in their ingenious article on the subject, that the prolongation of the valves into extremities with two horns is an unmeaning and unimportant accident. I cannot look at the figures which are said faithfully to represent the fruit of Parolinia, and which I have copied for your

information, without perceiving the very parts which make up the ordinary fruit in this tribe, the two portions of the stigmas and the styles being kept from adhering as usual by an unusual development of the inner pair of carpels, which is usually only represented by the partition, but here forms an interior style with its stigmas. Occasional monstrosities of the wallflower, in which it has a four-celled fruit, and the genus *Te tracelion* which has one constantly, confirm this explanation. I am not even quite sure that the theory of the four carpels, as maintained by Lindley and Kunth, is identical with that which I am defending, as I have not here access to the works in which it is proposed, but my own theory applies Brown's explanation of the structure of the stigmas with what seems to me a much more satisfactory view of the nature of the partition and the general symmetry of the flower, and I should be disposed to say is liable to no serious objection.

The difficulty, however, which yet remains, respecting the nature of the peculiar arrangement of the stamens, is probably to be accounted much greater than that which I think has been overcome respecting the structure of the fruit. Dr. Lindley, in his account of the order in the Vegetable Kingdom, if I rightly understand his meaning, (which however is obscurely expressed) takes essentially the same view which I am disposed to favour. His words are: "their stamens are "arranged thus: two stand opposite each of the anterior and "posterior sepals, and one opposite each of the lateral sepals; "there being six stamens to four sepals, instead of either four "or eight as would be normal. Now in which way does this arise? "Is the whorl of stamens to be considered double, one of the series "belonging to the sepals and one to the petals, and of these a part "imperfect? I am not aware of any such explanation having been "offered, nor do I know of a better one. It appears to me that the "outer series is incomplete by the constant abortion of the stamens "usually belonging to the anterior and posterior sepals, the two pairs "that remain belonging in fact to four petals." The obscurity here arises from the expression "belonging to the sepals and petals," applied to circles of stamens, which is unusual and not very expressive. There is also an absence of any notice of the glands in this connection, though they must be accounted rudimentary stamens and ought unquestionably to be taken into account in any attempt at restoring the true symmetry of the flower. They are found in numbers varying from two to ten in different species. In some genera indeed entirely suppressed, but in others conspicuous enough and offering us assistance, which is surely not to be rejected. The extreme number ten with the four carpels, 6 stamens usually developed, 4 petals and 4 sepals gives 28 parts or 7 circles of 4 parts each. There is a peculiarity in the arrangement of the parts which also affords us important assistance in explaining the appearances, to which sufficient attention has not been given. If we look at the calyx or outer circle, we perceive that the anterior and posterior sepals are exterior to the lateral pair and a

little more developed, in some instances so much as to produce small gibbous protuberances like incipient tails at their bases. The circle of petals is very equal, alternating with the sepals. It is followed by the shorter pair of stamens, which has the appearance of being exterior to the other four, and the circle according to our theory, is completed by two glands, (being rudimentary stamens,) which in many genera are conspicuous in front of each pair of longer stamens and opposite to the anterior and posterior sepals. The four longer stamens form the next circle, which like the petals is equal; within this are to be placed 4 glands, which are manifest in many species at each side of the outer stamens, but whose position is really interior to the longer stamens. There is another set of glands of which two immediately behind the shorter stamens are not unfrequently to be traced, very rarely the least appearance of the whole four, and then we arrive at the carpels of which the most developed pair having their faces to the smaller stamens and lateral sepals, bear the seeds on their edges and unite a stigmatic segment from each to form the stigmas immediately over their line of junction; the other pair of carpels lies just within this, and is almost uniformly abortive, the remains forming the partition, but in Parolinia, as we have seen, it produces stigmas.

It is remarkable that whilst analogies for the illustration of the structure of Brassicaceae have been sought—not always judiciously—from Papaveraceae and Fumariaceae, so little use has been made of Capparidaceae the order really most nearly related to Brassicaceae, and belonging to the same alliance. In this we have the same tendency to circles of four parts, but slight irregularity intrudes to a greater extent, and the number of stamens is increased by the development in many instances of those which in Brassicaceae only appear as glands in a rudimentary condition, and of more numerous circles. The carpels are generally supported on a protrusion of the axis, so that the fruit seems elevated on a stalk within the flower, a circumstance not unknown in Brassicaceae, as is seen in the remarkable genus Stanleya. The irregular number of stamens, 6 instead of 8 or 12, is found in many Capparidaceae. In some of them a spurious partition more or less perfect occurs, and has probably the same origin as in Brassicaceae, in others the carpels are reduced to two, and the pod is like one of a cruciform flower without the partition. In others again more carpels than two seem to be developed, perhaps a whole circle of four.

I must now explain the theory of Moquin Tandon and Webb, adopted and defended by Dr. Gray, for explaining the peculiarity of the Androecium in Brassicaceae. They leave the glands out of consideration and reduce the six stamens to a single circle of four primitive parts, by regarding each pair of the longer stamens as one original organ, separated into two by a principle called chorisis or deduplication. This principle, first proposed for the explanation of certain phenomena by Duval, consists in a supposed tendency of parts originally single, and which must be taken as one in explanation of symmetry, to divide themselves either into several layers, one in front of the other, or in several portions standing side by side. This has been extensively applied by some botanical theorists, but Dr. Lindley entirely rejects it, maintaining that there is no sufficient evidence of any single case. I cannot but admit that it affords some very plausible explanations of difficult cases, yet some of those most relied upon, seem to me very doubtful; several obviously to admit of other better explanations, and even if there is some truth in the principle, it is peculiarly liable to abuse in its applications. Dr. Gray follows Brown in believing that the Gynoecium of Brassicaceae consists of only two carpels, a view which has been already sufficiently commented upon. Though particular in describing the glands, and employing them as characters of genera and species, he does not refer to them in judging of the symmetry of the order, and he relies on the arguments of Moquin Tandon and Webb, to prove that the six stamens represent one circle of four. These arguments then I must review:—

1st. In some species, as *Clypeola cyclodontea*, the filaments of the solitary stamens are furnished with two teeth, one on each side, whilst those of the double stamens have but one on their outer side. If we join these two stamens together, so that they form but one, a bidentate filament will result entirely similar to the solitary stamens. This is without doubt plausible, but we must recollect that the two anthers of a stamen represent the two sides of the lamina of the leaf, their presence therefore shows the completeness of the organ, whilst the tooth-like projection on the filament is only representative of a wing to the petiole, or an angle at the bottom of the leaf; since then each of the pairs of stamens has its two anthers, we must conclude that the development of the tooth at the inner side in the pair of stamens is prevented by the two organs being so near to each other, which causes a pressure unfavourable to such development.

2nd. In other species a longer or shorter portion of the filament remains simple, thus in *Sterigma tomentosum* the division takes place as far as the middle; and in Anchonium Billardieri in a third part only of the upper portion of the filament. Here the position of the longer stamens, double only in their upper portion, is exactly the same as that of the solitary stamens—these facts I reply afford no argument, because they are easily explained by partial coherence (an exceedingly common occurrence) of organs really distinct, and the two anthers tend to prove this distinctness.

3. In Vella pseudo-cytisus we find in the place of the double stamens, a single one, its filament being frequently rather broader, sometimes divided only at its summit, sometimes entirely undivided, but bearing in that case an anther wholly or partially gemminated. I have not examined this case, but the description indicates a more complete coherence of two organs. Instances however which occur, of only one stamen being found in the place of the pair, are only cases in which that circle, as

well as several of the others, has two of its parts suppressed, and are perfectly consistent with the theory previously explained.

4. Many Cruciferæ become tetrandrous by pelorization; others are normally so. In either case the four stamens are thus equal. This, I answer, is at least as easily explained in our theory as on that of the separation of stamens into two.

5. Finally, certain Cruciferæ instead of returning to the quaternary type recede from it. The single stamens undergo a change analogous or very similar to that of the double pair. One of us has observed flowers of *Matthiola incana*, in which the single stamens were cleft throughout their entire length, each portion being provided *with half an anther and half a filament*. M. Lestiboudois speaks of a Cheiranthus Cheiri in which these stamens were completely geminated, not laterally as the longer pair, but from without inwards. M. Lermye met with a flower of the same species, which had the lower stamens doubled exactly as the upper. Now let these cases be fairly considered: the first appears to show that a stamen may be occasionally slit vertically, but it is acknowledged that there is no increase in the real number of parts, each portion it is expressly stated consisting of half an anther (a single cell,) and half a filament. This may render more probable Dr. Lindley's explanation of Fumariaceæ, destroying an analogy on which Dr. Gray greatly relies, but it supplies no argument in favour of a single primitive organ having become two perfect ones with all their parts. The case observed by Lestiboudois is apparently not one of Chorisis, but of development under the stimulus of cultivation of the gland, which is often noticed *within* the short stamens; that of M. Lermye requires to be more accurately described, but it must not be hastily assumed to have consisted in a division of the single stamen into two perfect ones, it may have been a case like that seen by one of the authors themselves, a mere fissure of the stamen into two parts; or it is perhaps just possible that the single stamen may have been suppressed, and the two glands which often appear at each side of it, developed into a pair of stamens. It is certainly not sufficient without more exact information, to support or overthrow a theory. Dr. Gray relies so completely on the arguments of Messrs. Moquin Tandon and Webb, that I need only farther observe that even if Chorisis furnishes the true explanation of the symmetry of Fumariaciæ, which I hold to be very doubtful, there is no such relation between that order and Brassicaceæ as would oblige

us to extend the principle to this latter, and I cannot but conceive that a more probable explanation has been proposed.

My note on the structure of Primulaceæ relates to one point which I have not seen rightly explained. In this order the stamens are observed to be constantly opposite the petals, a circumstance which always seems to need some explanation. In the present case, I think it evident that it is due to the abortion of a circle of parts belonging to the intermediate position between the petals and stamens and alternating with both. A careful examination of almost any Primula, the Auricula affording an excellent example, shows that the coloured eye of the flower consists of a series of pieces like the petals, as it were fastened on to them, and in such an order that the middle of each arch of the eye is exactly placed between two of the petals. In the genus *Aretia* this is still more evident. In Samolus a set of abortive stamens occurs between the petals, and the same is the case with several species of Lysimachia; in Cyclamen this organ is also easily observed, and in Glaux the proper corolla as well as its double is suppressed. From these examples we are enabled ideally to restore the lost circle, where it is most completely suppressed, and thus to comprehend the true symmetry and the reason of a seeming departure from a general rule. In how many other cases of opposite circles a similar explanation may be justified, I will not presume to say. In respect to this order I think it entirely satisfactory, but it is not the only one conceivable, for any one who has carefully considered a Camelia, in which the numerous circles of petals, instead of alternating as is usual, are forced into regular lines radiating from the centre, will be ready to admit the possibility of parts which are normally alternate becoming opposite by a sort of twist, and what occurs occasionally as a variety, may occur uniformly or nearly so, from a like cause, more constantly operating on a particular tribe, so that we are by no means driven to imagine without evidence an intermediate circle, in every instance of opposite parts, nor is there any necessity for assuming the occurrence of Chorisis where it cannot be distinctly proved.

THE RELATION WHICH CAN BE PROVED TO SUBSIST BETWEEN THE AREA OF A PLANE TRIANGLE AND THE SUM OF THE ANGLES, ON THE HYPOTHESIS THAT EUCLID'S 12TH AXIOM IS FALSE.

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Read before the Canadian Institute, 25th February, 1860.

I propose to prove in the present paper, that, if Euclid's 12th Axiom be supposed to fail in any case, a relation subsists between the area of a plane triangle and the sum of the angles. Call the area A; and the sum of the angles S; a right angle being taken as the unit of measure. Then

$$A = k\,(2-S);$$

k being a constant finite quantity, that is, a finite quantity which remains the same for all triangles. This formula may be considered as holding good even when Euclid's 12th Axiom is assumed to be true; only k is in that case infinite.

Before proceeding with the proof of the law referred to, I would observe, that, while on the one hand Euclid's 12th Axiom is assuredly *not an Axiom* in the proper sense of the term, that is, not a self-evident truth, on the other hand *it has never been demonstrated* to be true. I even feel satisfied, from metaphysical considerations, that a demonstration of its truth is impossible. Legendre's supposed demonstration, which Mathematicians appear to have accepted as valid, was shown by me, in the *Canadian Journal* for November, 1856, to be erroneous.* For the sake of those who may not have the former

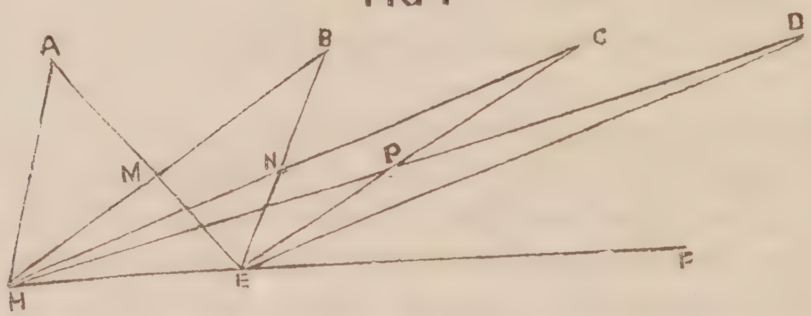
* In an Essay on Mathematical Reasoning, appended to his Mathematical Euclid, Dr. Whewell refers to the attempts which have been made to dispense with Euclid's 12th Axiom. "No one," he writes, "has yet been able to construct a system of Mathematical truth by means of Definitions alone, to the exclusion of Axioms; though attempts having this tendency have been made constantly and earnestly. It is, for instance, well known to most readers, that many mathematicians have endeavoured to get rid of Euclid's Axioms respecting straight lines and parallel lines; but that *none of these essays have been generally considered satisfactory.*" The last clause in this statement calls for remark. Sir John Leslie objected to Legendre's reasoning; but on grounds which (as Professor Playfair showed in the *Edinburgh Review*) are altogether frivolous. Playfair maintained that Legendre's proof was satisfactory; and since then, till the publication in the *Canadian Journal* of the article above referred to, mathematicians have—by their silence at least—acquiesced in his verdict. If Legendre's proof has been generally considered unsatisfactory, why did none of those by whom such a view was taken show where the reasoning is defective

numbers of the *Journal* at hand, the substance of my refutation of Legendre is given in an Appendix to the present paper.

Proposition I.

The sum of the angles of a triangle AHE (Fig. 1) is not greater than two right angles.

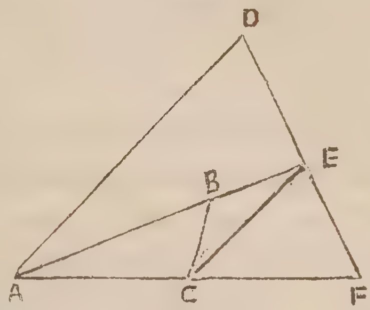
FIG 1



For, produce HE to F. Bisect AE in M. Draw HMB, making MB = HM; and join BE. In like manner construct the triangle CHE; N being the middle point of BE; and CN being equal to HN. In like manner construct the triangle DHE; P being the middle point of CE; and DP being equal to PH. And so on indefinitely. Denote by S, S_1, S_2, &c., the sum of the angles of the triangles AHE, BHE, CHE, &c., respectively; and by A_1, A_2, A_3, &c., the angles HBE, HCE, HDE, &c., respectively. Then it is plain that the quantities S, S_1, S_2, &c., are all equal to one another. Also, as the number n becomes indefinitely great, the angle A_n becomes indefinitely small. For, the sum of all the angles in the series, A, A_1, A_2, &c., is less than AEF; and, since the series, A, A_1, &c., may be made to contain an indefinite number of terms, those terms which are ultimately obtained must be indefinitely small, in order that AEF may be a finite angle. But, the exterior angle DEF being greater than the interior and opposite angle DHE, S_3 cannot exceed two right angles by D. And $S_3 = S$. Therefore S cannot exceed two right angles by D or A_3. In like manner it may be proved that S cannot exceed two right angles by A_n, whatever n be. And A_n is ultimately less than any assignable angle. Therefore S cannot exceed two right angles by any finite angle whatsoever.

Cor. 1.—If a line AE (Fig. 2) be drawn from A, an angle of a triangle ADF, to a point in the opposite side; and if the sum of the angles of the triangles DFA and EAF respectively be S and S_1; S is not greater than S_1. For let s be the sum of the angles of the triangle ADE; then

FIG 2



$$S = F + FAE + EAD + D,$$
$$\text{and, } S_1 = F + FAE + AEF.$$
$$\therefore S_1 - S = AEF - (EAD + D),$$
$$= AEF + AED - (AED + EAD + D),$$
$$= 2 - s;$$

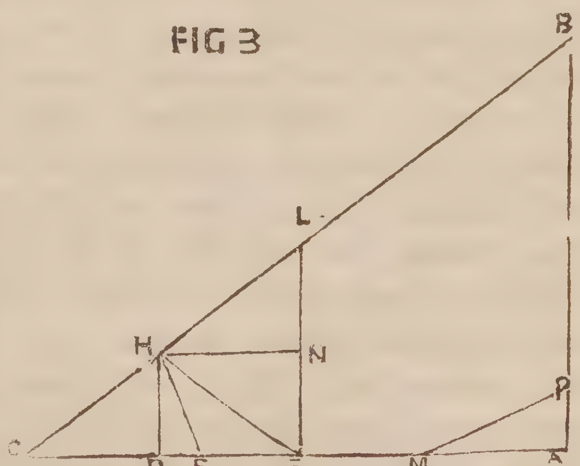
a right angle being taken as the unit of measure. But, by the Proposition, s is not greater than 2. Therefore S is not greater than S_1.

Cor. 2.—From B, a point within the triangle DAF, draw BC to a point C in AF; and let S_2 be the sum of the angles of the triangle ABC. Then S_2 is not less than S. For, produce AB to E; and join EC. Then, by Cor. 1, S_2 is not less than the sum of the angles of the triangle AEC; which sum, again, is not less than S_1, or the sum of the angles of the triangle AEF; and S_1 is not less than S. Therefore S_2 is not less than S.

Proposition II.

If any triangle CHE (Fig. 3) have S, the sum of its angles, equal to two right angles, every triangle has the sum of its angles equal to two right angles.

FIG 3



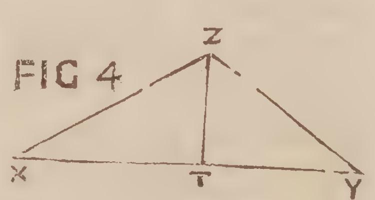
For, CE being a side which is not less than any other side of the triangle CHE, let fall HD perpendicular on CE. Then HD cannot fall without the base CE; else (supposing it to fall beyond E) the angles CEH would be greater than a right angle: hence, because CE is not less than CH, the angle CHE would be greater than a right angle: so that S would be greater than two right angles: which (Prop. I.) is impossible. Produce CD to F; making DF = CD.

Draw FN perpendicular to CF, and equal to HD. Produce it to L, making LN = HD; and join HL and HN. Then the sum of the angles of the triangle CHD is not less (Cor. 1. Prop. I.) than S; that is, it is not less than two right angles. Therefore (Prop. 1) it is equal to two right angles. But (4. I. E.) the triangles CHD and FHD are every way equal. Therefore angle HCD = angle HFD. But the sum of the angles DCH and DHC has been proved to be equal to a right angle. Therefore the angle CHD = the angle DHF = the angle HFN. Therefore (4. I. E.) the triangles DHF and HFN are every way equal; and hence HNF is a right angle. Consequently (4. I. E.) the triangles HNF and HNL are every way equal. Hence

$$\begin{aligned}\angle \mathrm{LHF} + \angle \mathrm{CHF} &= 2 \angle \mathrm{NHF} + 2 \angle \mathrm{CHD} \\ &= 2 \angle \mathrm{HFD} + 2 \angle \mathrm{CHD} \\ &= 2 \angle \mathrm{HCD} + 2 \angle \mathrm{CHD} \\ &= 2 \text{ right angles.}\end{aligned}$$

Therefore CHL is a straight line. Also the sum of the angles of the triangle LCF is equal to two right angles. Hence, beginning with the hypothesis that the sum of the angles of the triangle CHD is equal to two right angles, we have found that the sum of the angles of the triangle LCF is equal to two right angles; the sides of the latter triangle being double those of the former. By going on in the same manner, we can find a triangle ABC, with one of its angles BAC a right angle, and the sum of all its angles equal to two right angles; and having each of the sides greater than any given line. Suppose now that $x\,y\,z$ (Fig. 4) is any triangle whatsoever; $x\,y$ being not less than either of the other sides: in which case, as DH (Fig. 3) falls within the base CE of the triangle HCE, the perpendicular $z\,t$ from z (Fig. 4) upon $x\,y$ falls within the line $x\,y$. Then the triangle BAC (Fig. 3) being constructed in the manner above described, so that each of the sides BA and AC may be greater than any of the lines xz, xy, yz, in Fig. 4, cut off MA equal to xt, and AP to zt. The sum of the angles of the triangle BAC is not greater (Cor. 2, Prop. I.) than the sum of the angles of the triangle PAM or xzt. That is, the sum of the angles of the triangle xzt is not less than two right angles. Hence (Prop. I.) it is equal to two right angles. In like manner the

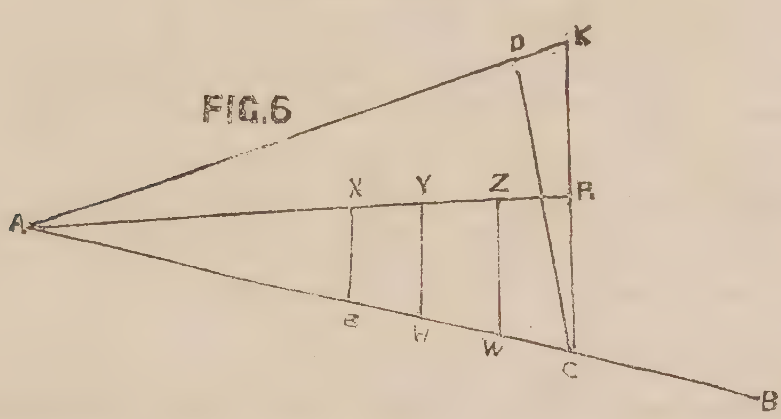
FIG 4



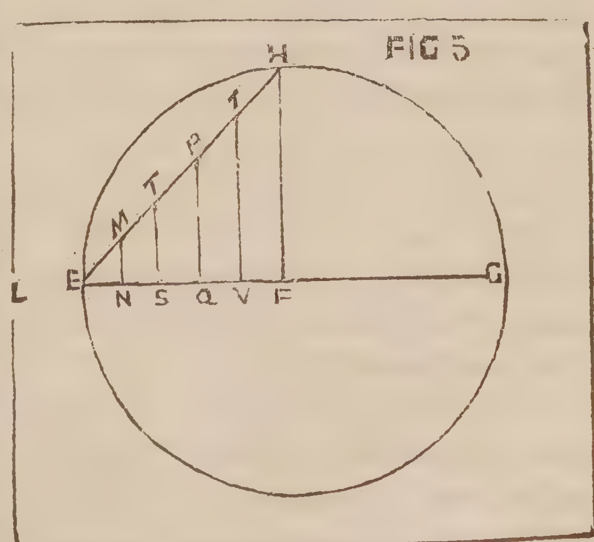
sum of the angles of the triangle *zty* is equal to two right angles. Therefore the sum of the angles of the triangle *xzy* is equal to two right angles.

Cor.—Either every triangle has the sum of its angles equal to two right angles, or no triangle has the sum of its angles so great (see Prop. I.) as two right angles.

Proposition III.



If the base CD of a triangle ACD (Fig. 6) be diminished indefinitely according to any law, while neither of the other sides becomes greater than a given line AB, the area of the triangle ACD becomes ultimately less than any finite space L (Fig 5); and the sum of its angles does not ultimately differ from two right angles by any finite angle.



For, within the area L take a point F. Then, by choosing a radius sufficiently small, we can describe, with F as a centre, a circle lying wholly within L, and therefore less than L. Draw a diameter EG, with a radius HF perpendicular to it. Join EH; and from any point M in EH let fall MN perpendicular on EF. By bisecting NF, and again bisecting the parts obtained, and so on, we can divide NF into n equal parts; where n may be taken greater than any number that can be named. Let NF be so divided into the n equal parts, FV, VQ, ... , SN; the number n being taken so great that n times MN is greater than the given line AB. Let TV, PQ, &c., be perpendicular to NF. Suppose then the base DC of the triangle ADC (Fig. 6) to diminish, according to the law of its variation, until CD becomes less than FV; and, if AC be not less than AD, produce AD to K, making AK=AC. Join CK; draw AR perpendicular to CK; and cut off the parts Rz, zy, yx, &c., each equal to MN, until AR is exhausted; the last part being possibly less than MN. At the points of section, z, y, x, &c., raise the perpendiculars zw, yh, xb, &c. Then, because CD is (by hypothesis) less than FV or NS (Figs. 5 and 6), and because it is obviously greater than CR, NS is greater than CR. Also, because n times MN is greater than AB, and AC is (by hypothesis) not greater than AB, n times MN is greater than AC. Much more is n times MN greater than AR. And the parts Rz, zy, &c., were cut off each equal to MN. Hence the number of such parts is not greater than n; and the number of the spaces,

Rw, zh, yb, &c., ... (1)

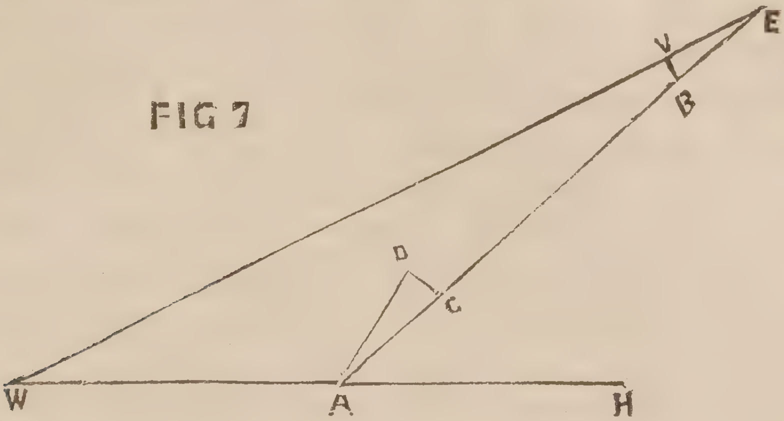
into which the triangle ARC is divided, is not greater than the number of the spaces,

FT, VP, ... , SM, ... (2)

into which the figure MNFH has been divided. But since NS is greater (as we have proved) than RC, and MN is equal to Rz, the space RzwC may be wholly inserted within the space MNSt, and is therefore less than that space. But RzwC is the greatest space in the series (1), and MNSt is the least in the series (2). Hence, since the number of terms in (1) is not greater than the number of terms in (2), the sum of the terms in (2) is greater than that of the terms in (1): that is, the triangle ACR is less than MNFH. Hence the triangle AKC is less than the circle EHG. Much more is the triangle ADC less than the space L.

In the next place, suppose, if possible, that, as CD is indefinitely diminished, the sum of the angles of the triangle ACD ultimately differs from (in which case it must, by Prop. I, be less than) two right angles by more than the finite angle BAH (Fig. 7); BA being, as in the previous case, a given line which neither of the sides, AC, AD, ever exceeds. Produce HA to any point W, and AB to any point E. Join EW; and draw BV perpendicular on EW. Let the base DC (Figs. 6 and 7) be diminished, according to the law of its variation, until DC is less than VB. Then ultimately the triangle ADC may be wholly inserted (as in Fig. 7) within the triangle EWA. For,

FIG 7



since the sum of the angles of the triangle ADC falls short (by hypothesis) of two right angles by more than the angle BAH, the angle DAC must be ultimately less than the angle BAW; and therefore DA falls between BA and WA. Again, the point D cannot lie beyond EW; else DC would be greater than the perpendicular from C upon EW, and consequently (since AC is less than AB) greater than BV: which is contrary to hypothesis. Hence (Cor. 2, Prop. I.) the sum of the angles of the triangle ADC is not less than the sum of the angles of the triangle EWA But the sum of the angles of the triangle ADC is (by hypothesis) less than the angle EAW: which is impossible. Consequently, as DC diminishes indefinitely, neither of the other sides, AD, AC, becoming at any stage greater than AB, the sum of the angles of the triangle ADC cannot ultimately differ from two right angles by any finite angle.

Proposition IV.

If ABC and FCD (Fig. 8) be two triangles of equal areas, and having the angle ACB equal to the angle FCD; and if S be the sum of the angles of the triangle ABC, and *s* the sum of the angles of the triangle FCD; S and *s* are equal to one another.

For, if the sides FC and CD be equal to AC and BC, each to each, the triangles ABC and FCD are equal in every respect. It is therefore only necessary to consider the case in which FC is greater than AC: in which case (in order that the triangle ABC may not be a part of the triangle FCD) CD must be less than BC. Place the triangles so that AC and CF may be in the same straight line; in which case, since the angle ACB is equal to the angle FCD, BC and CD are in the same straight line. Cut off CE equal to CB, and CK equal to CA; and join EK. Then (4. I. E) the triangle ECK is every way equal to the triangle ABC. Therefore triangle ECK=triangle FCD; and consequently triangle EDH=triangle FKH. Cut off HM equal HE, and HP equal to HD; and join MP. Then triangle HMP is every way equal to triangle EDH. Therefore triangle HMP=triangle HKF; and consequently triangle KMN=triangle FNP. The point P cannot fall beyond F, so as to make HP greater than HF; for, if it did, the point M would (in order that the triangle HKF may not be a part of the triangle HMP) fall between K and H; in which case the angle F would be greater than the angle HPM; that is, F would be greater than the angle HDE; whereas, since the exterior angle of a triangle is greater than either of the interior and opposite angles, the angle HDE is greater than F. In like manner it can be proved that the point P does not coincide with F. And therefore P is between H and F; which implies that M is beyond K in the line HKM. Hence, from the two given equal triangles ACB and FCD, with the angles at C equal to one another, we have passed to the equal triangles KMN and FNP, with the angles at N equal to one another. Let S_1 be the sum of the angles of the triangle KMN; and s_1 the sum of the angles of the triangle FNP. Then

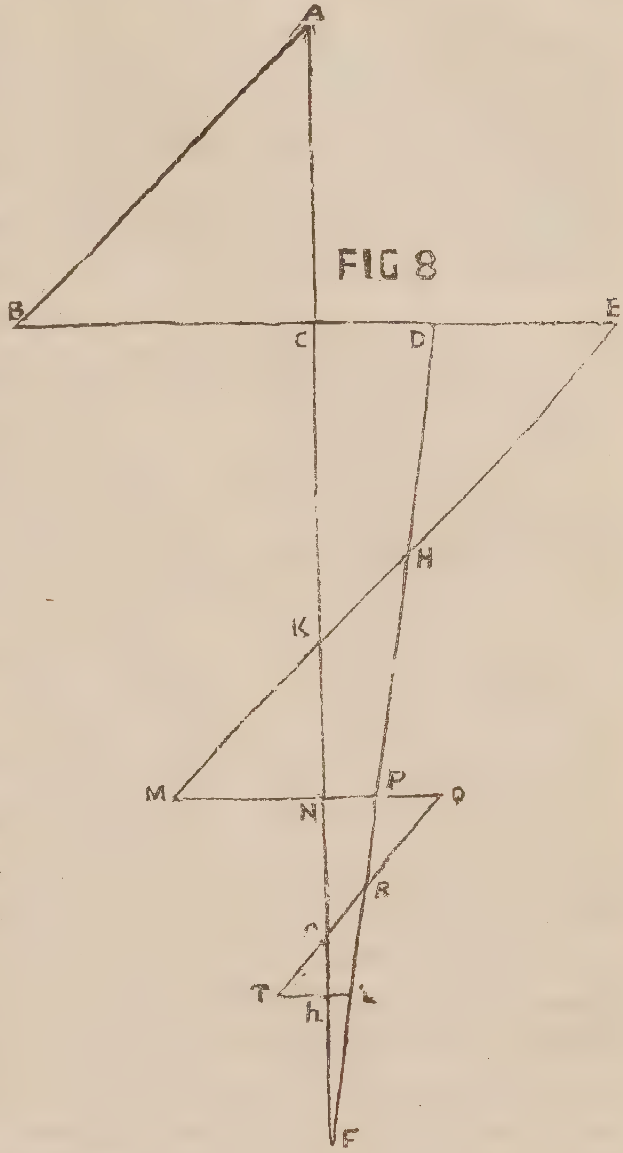
$$\begin{aligned} S_1 - s_1 &= M + MKN - (F + FPN) \\ &= E + EKC - (F + FDC) \\ &= B + A \quad - (F + FDC) \\ &= S - s. \end{aligned}$$

Let the same construction that was made with reference to the triangles ABC and FDC be now made with reference to the triangles KMN and FNP; that is to say, cut off NQ equal to NM, and Nr equal to NK. Join Qr. Cut off RL equal to RP, and RT equal to RQ. Join TL, cutting NF in h. Then Q must lie beyond P, on the line NPQ; for, if it did not, the point r would lie beyond F on the line NrF; in which case the angle Q would be greater than the angle NPF; that is, the angle E would be greater than the angle CDF; which is not true. And the point Q lying beyond P, the point r must fall between N and F. Hence, as above, we can prove that the triangles Trh and FLh are equal to one another; and, if S_2 be the sum of the angles of the triangle Trh, and s_2 the sum of the angles of the triangle FLh,

$$S_2 - s_2 = S_1 - s_1 = S - s.$$

We can go on thus indefinitely, forming a series of pairs of equal triangles KMN and PNF, Trh and FLh, &c., to which there is no limit; and, if S_n be the sum of the angles of the first triangle in the n^{th} pair, and s_n the sum of the angles of the second triangle in the n^{th} pair,

$$S_n - s_n = S - s.$$



But, as the series of triangles, FPN, FLh, &c., is indefinitely increased in number, by a continued repetition of the construction above described, the base (such as hL) of the triangle ultimately obtained becomes indefinitely small. For

$$\begin{aligned} BC &= CD + DE \\ &= CD + NP + MN \\ &= CD + 2NP + hL + Th, \end{aligned}$$

and so on, without limit; so that, if the base (such as hL) of the triangle (such as FLh) ultimately obtained did not become indefinitely small, the finite line BC would be greater than the sum of an indefinite number of lines, none of which was less than a given finite line: which is impossible. Since therefore the base (such as hL) of the triangle (such as FhL) ultimately obtained must become indefinitely small, the sum of the angles of the triangle (such as FLh) ultimately obtained cannot (Prop. III.) differ by any finite angle from two right angles. That is, S_n does not continue, as n is indefinitely increased, to differ by any finite angle from two right angles. In like manner, if it be observed that CF is greater than the sum of the lines, AC or CK, KN, *rh*, &c., it will appear that s_n does not ultimately differ by any finite angle from two right angles. Therefore ultimately the quantity, $S_n - s_n$, is less than any assignable angle. But it was proved that

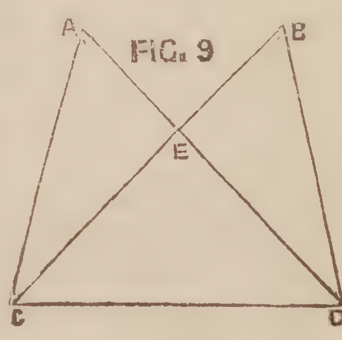
$$S_n - s_n = S - s.$$

Therefore S and *s* do not differ by any finite angle; that is, they are equal to one another.

Cor. 1.—If two triangles ACB and FCD, having the angle ACB equal to the angle FCD, be unequal; and ACB be the greater; then S, the sum of the angles of the triangle ACB, is not greater than *s*, the sum of the angles of the triangle FCD. For, the same construction as that described in the Proposition may be made, until a point is reached at which one of the triangles obtained, as T*hr*, has the sides, T*h*, *hr*, either less than L*h* and *h*F respectively, or greater than L*h* and *h*F respectively. The former of these cases cannot occur; because then the triangle T*hr* would be less than the triangle F*h*L, and consequently the triangle ACB less than the triangle FCD: which is impossible. Hence the latter case must occur, viz.: that a triangle T*hr* must be found, having T*h* greater than *h*L, and *rh* greater than *h*F; and therefore, since the triangle F*h*L can be wholly inserted in the triangle T*hr*, the sum of the angles of the triangle T*hr* is not greater (Cor. 2, Prop. 1.) than the sum of the angles of the triangle F*h*L. Hence S is not greater than *s*.

Cor. 2.—If two equal triangles (Fig. 9) ACD and BCD have the common base CD, and if S be the sum of the angles of the former, and *s* the sum of the angles of the latter, S is equal to *s*. For the difference between S and *s* is the same as the difference between the sum of the angles of the triangle ACE and the sum of the angles of the triangle BDE. But, by the Proposition, these latter quantities are equal to one another. Therefore S=*s*.

FIG. 9

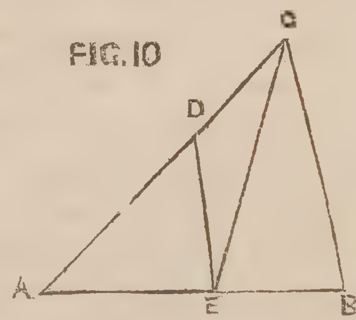


Cor. 3.—Let the two triangles (see fig. to Cor. 2) ACD and BCD, on the common base DC, be unequal. Then, if S be the sum of the angles of the triangle ACD, and *s* the sum of the angles of the tri-

angle BCD, and if the former triangle be greater than the latter, S cannot be greater than s. For the difference between S and s is equal to the difference the sum of the angles of the triangle ACE and the sum of the angles of the triangle BED. But the former of these quantities (since the triangle ACE is greater than the triangle BED) is not greater (Cor. 1) than the latter. Therefore S is not greater than s.

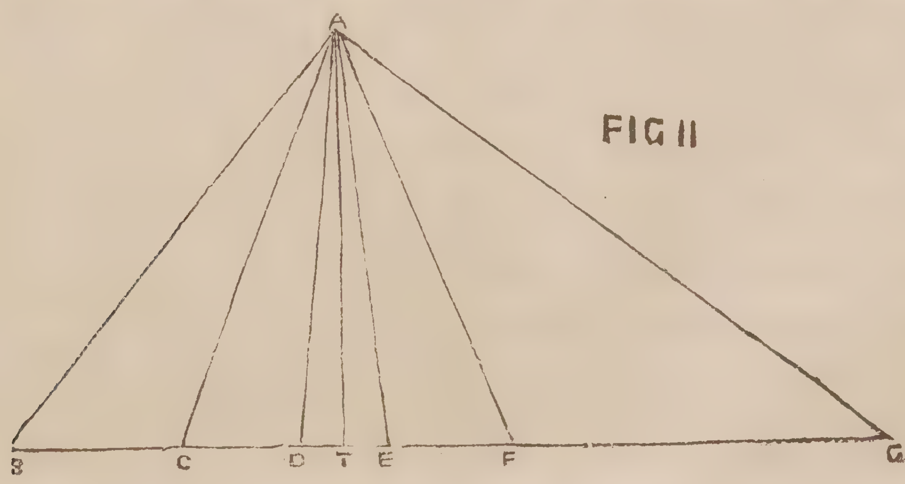
Cor. 4.—In the case supposed in the previous Corollary, should the assumption be made that the angles of a triangle are not (see Cor. Prop. II.) equal to two right angles, S must be less than s. For, by the reasoning in the Proposition and in the foregoing Corollaries, it appears that the difference between S and s is equal to the difference between the sum of the angles of a triangle ACB (Fig. 10) and the sum of the angles of a triangle ADE inscribed within the former in the manner shown in the figure. Suppose, if possible, that $S=s$. Then the angles of the triangle ADE are together equal to those of the triangle ACB. Therefore (Cor. 1. Prop. I.) they are equal to those of the triangle ACE. Therefore angle ADE is equal to the sum of the angles DCE and DEC. Therefore the angles of the triangle DEC are together equal to two right angles: which is at variance with the hypothesis on which we are at present proceeding. Hence S is not equal to s. But (Cor. 3) S is not greater than s. Therefore S is less than s.

FIG. 10



Cor. 5.—If the triangle ABG (Fig. 11) be divided by the straight line AC into two parts, of which ACG is the greater, two lines AD

FIG 11



and AE can be drawn, cutting off triangles ADC and AEC, the one less, and the other greater, than ABC, but neither of them differing from the triangle ABC by an area so great as a given area; while at the same time the difference between the sum of the angles of the triangle ABC and the sum of the angles of either of the triangles, ACD, ACE, is less than any given angle.

If the hypothesis be made that the angles of a plane triangle are together (see Cor. Prop. II.) equal to two right angles, the problem can be effected by the methods which Euclid describes.

We onlyn eed, therefore, to show how it can be performed on the hypothesis that the angles of a plane triangle are not equal to two right angles. Bisect CG in F; and join AF. The triangles ABC and ACF have a comon side AC. Therefore (Cor. 4) the area of the one will (on the hypothesis on which we are now proceeding) be less than, equal to, or greater than, the area of the other, according as the sum of the angles of the former is greater than, equal to, or less than, the sum of the angles of the latter. Now we can find the sum of the angles of each by construction. Therefore we can tell whether the triangle ACF is less than, equal to, or greater than, the triangle ABC. Should the triangle ACF be greater than the triangle ABC, we may repeat the construction; bisecting CF, and drawing a line from A to the point of section. By repeating this construction sufficiently often, the base (such as CD) of the triangle (such as ACD) ultimately obtained will become less than any assignable line; and hence the area of the triangle will become (Prop. III.) less than any assignable area, and consequently less than the triangle ABC. Let ACD, the triangle obtained by bisecting CE, and joining AD, be less than the triangle ABC; the triangle AEC being greater than ABC. Bisect DE in the point *t*; and join A*t*. Find, as above, whether the triangle AC*t* is less or greater than the triangle ABC, or equal to it. Should it be greater, the triangle ABC lies between the limits, ACD and AC*t*; but should it be less, the triangle ABC lies between the limits AC*t* and ACE. And so on. Ultimately we obtain two limits, which we may suppose to be represented by the triangles ACD and ACE, between which the triangle ABC lies, the base DE of the triangle ADE, which is the difference of the limits, being made as small as we please. Therefore (Prop. III.) the area of the triangle ADE becomes ultimately indefinitely small; so that each of the triangles ACD and ACE becomes indefinitely near in area to the triangle ABC.

At the same time (Prop. III.) the sum of the angles of the triangle ADE becomes indefinitely near to two right angles. Let S be the sum of the angles of the triangle ABC; S_1, the sum of the angles of the triangle ACD; S_2, the sum of those of the triangle ACE; and δ, the difference betwixt two right angles and the sum of the angles of the triangle ADE. Then δ is equal to the difference betwixt S_1 and S_2; so that, since δ ultimately becomes indefinitely small, the difference betwixt S_1 and S_2 ultimately becomes indefinitely small. And (Cor. 4) S is intermediate betwixt S_1 and S_2. Therefore ultimately its difference from either of them becomes indefinitely small.

Proposition V.

If a line LD (Fig. 12) be drawn from L to any point D in the base of a triangle LBC; and if A represent the area, and S the sum of

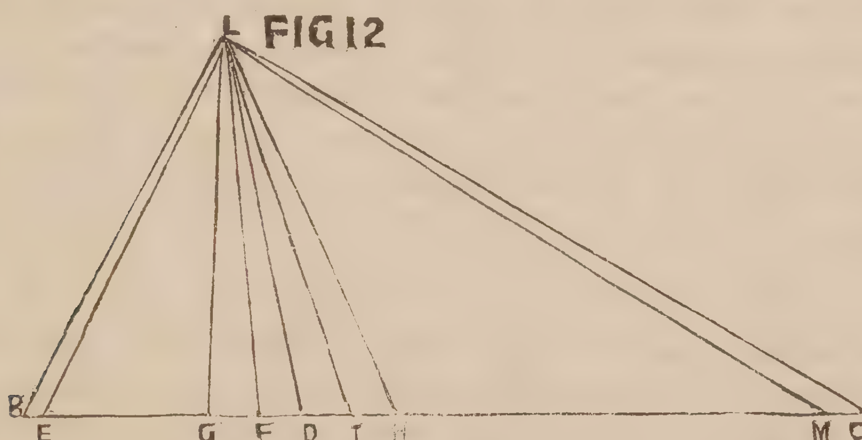


FIG 12

the angles, of the triangle LBD; and a represent the area, and s the sum of the angles, of the triangle LDC; then, reasoning on the hypothesis that the angles of a plane triangle are (see Cor. Prop. II.) unequal to two right angles, we can prove that $A : a = 2 - S : 2 - s$; a right angle being taken as the unit of measure.

For, by taking FD sufficiently small, the triangle LFD can be made (Prop. III.) smaller than any given space; the sum of its angles also falling short of two right angles by an angle less than any given angle. Having cut off a small triangle LFD from LBD, we can next (Cor. 5, Prop. IV.) draw lines LG, LG_1, LG_2, &c., (only the first of these lines is expressed in the figure), in such a manner that the triangle LGF shall differ from the triangle LFD by a space less than any given space, the sum of its angles at the same time differing from the sum of the angles of the triangle LFD by an angle less than any given angle; and that the triangle LGG_1 shall differ from the triangle LGF by a space less than any given space, the sum of its angles at the same time differing from the sum of the angles of the triangle LGF by an angle less than any given angle; and so on, till the whole of the triangle LBD has been exhausted, except a remainder LBE, which is less than the triangle to which it is adjacent. Proceed next to divide the triangle LDC into triangles LDT, LTH, &c., related to the triangle LFD and to one another in the same manner as the triangles LFG, LGG_1, &c.; the remainder LMC being finally left over, less than the triangle to which it is adjacent. Then, since any two adjacent triangles in the series,

$$\text{LDF, LFG, } LGG_1, \text{ \&c.}, \quad \ldots\ldots \quad (1)$$

which together constitute the triangle LDE, may be made as nearly equal as we please, we can make every one of them as nearly equal to the first as we please. And, from a similar consideration, it appears that we can at the same time make the sum of the angles of any triangle in the series as nearly equal as we please to the sum of the angles of the first. In like manner we can make every one of the triangles in the series,

$$\text{LDT, LTH, \&c.}, \quad \ldots\ldots \quad (2)$$

which together constitute the triangle LDM, as nearly equal to LDF as we please; the sum of the angles of each being at the same time made as nearly equal as we please to the sum of the angles of the triangle LDF. Let there be N terms in the series (1), and n in the series (2). Then

$$\text{LED} = \text{N times LFD} \backsim \text{Q}; \quad \ldots\ldots \quad (3)$$

Q being a quantity which we may arrange to have as small as we please. In like manner,

$$\text{LMD} = n \text{ times LFD} \backsim q; \quad \ldots\ldots \quad (4)$$

q being a quantity which we may arrange to have as small as we please. Again, if S_1 be the sum of the angles of the triangle LFD, $S_1 \backsim h_1$ the sum of the angles of the triangle LFG, $S_1 \backsim h_2$ the sum of the angles of the triangle LGG_1, and so on, and S_2 the sum of the angles of the triangle LED, we have

$$S_2 = NS_1 - 2(N-1) \backsim h_1 \backsim h_2 \backsim \text{\&c.}$$
$$\therefore 2 - S_2 = N(2 - S_1) \backsim h; \quad \ldots\ldots \quad (5)$$

where, since we may arrange to have h_1, h_2, &c., as small as we please, we may understand that h is a quantity which we can arrange to have as small as we please. In like manner, if S_3 be the sum of the angles of the triangle LDM, we can get

$$2-S_3 = n\,(2-S_1) \backsim k\,; \qquad (6)$$

k being a quantity which we can arrange to have as small as we please. Hence, from (5) and (6), we can order our construction so as to make the ratio, $2-S_2 : 2-S_3$, as nearly equal as we please to the ratio, $N : n$; the same means by which this is secured having the effect of rendering [see (3) and (4)] the ratio, LED : LMD, as nearly equal as we please to the ratio, $N : n$. Hence we can order our construction so as to make the two ratios,

LED : LMD,

and, $2-S_2 : 2-S_3$,

as nearly equal as we please. This is accomplished by the means above described, whatever be the length of the line FD. It may therefore be still accomplished, though FD be taken indefinitely small. But as FD is indefinitely diminished, the area of the triangle LFD, and therefore that of the triangle LBE is (Prop. III.) indefinitely diminished. Hence, as FD is indefinitely diminished, the ratio of the triangles LED and LBD ultimately becomes indefinitely near to a ratio of equality; the ratio of the triangles LDM and LCM also becoming, under the same circumstances, indefinitely near to a ratio of equality. Consequently, by taking FD small enough, the ratio, LBD : LCD, or, $A : a$, becomes indefinitely near to the ratio, LED : LMD. In like manner it can be proved, that, as FD becomes indefinitely small, the ratio, $2-S_2 : 2-S_3$, approximates indefinitely to the ratio, $2-S : 2-s$. Therefore the ratio, $A : a$, cannot differ by any finite amount from the ratio, $2-S : 2-s$. That is,

$$A : a = 2-S : 2-s.$$

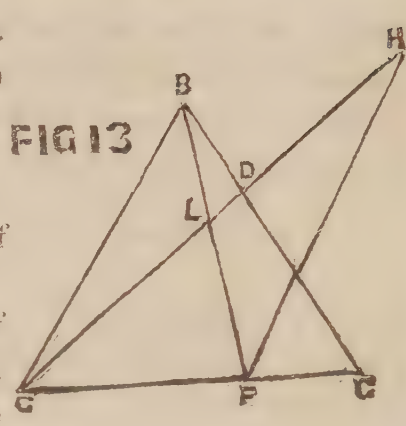
Proposition VI.

If BGC and HCF (Fig. 13) be any two plane triangles, S being the sum of the angles of the former, and s the sum of the angles of the latter; then, reasoning on the hypothesis that the angles of a plane triangle are not equal (see Cor. Prop. II.) to two right angles, we can prove that

tri. BGC : tri. HCF=2−S : 2−s :

a right angle being taken as the unit of measure.

FIG 13



For join BF; and let S_1 be the sum of the angles of the triangle CLF and S_2, the sum of the angles of the triangle BCF. Then (Prop. V.),

$$\begin{aligned} \text{triangle BCG : triangle BCF} &= 2-S : 2-S_2; \\ \text{and, triangle BCF : triangle LCF} &= 2-S_2 : 2-S_1; \\ \text{and, triangle LCF : triangle HCF} &= 2-S_1 : 2-s. \\ \therefore \text{triangle BCG : triangle HCF} &= 2-S : 2-s. \end{aligned}$$

Cor.—If A be the area of the triangle BCG, we have

$$A = k\,(2-S);$$

k being a finite quantity, which remains the same for all triangles.

APPENDIX.

Legendre endeavours to make it appear,* without the assistance of any special Axiom, that C, the third angle of a triangle ABC, is determined from the other two, A and B, independently of the magnitude of c, the intervening side. If this be made out, all the properties of parallel lines can easily be deduced. The difficulty is to demonstrate the fundamental position. But here it may be well to quote Legendre's own words: "Soit l'angle droit égal à l'unité, alors les angles A, B, C seront des nombres compris entre 0 et 2; et puisque

* It may be proper to mention that Legendre has treated the subject of parallel lines in two different ways, one in the text of his *Elements of Goemetry*, and the other in the notes to that work. Playfair considers the former method "quite logical and conclusive," as well as the latter; only objecting to it that it is "long and indirect," and too "subtle" for "those who are only beginning to study the Mathematics." But, as the admission of Legendre himself is on record that this method is *not* conclusive; as it is, in fact, palpably the reverse—taking for granted what requires proof, as much as Euclid's Axiom does; no further attention need be given to it. The proof here criticised—a proof, the fallacy of which was for the first time (it is believed) pointed out by the author of the present paper in the *Canadian Journal* for November, 1856—is that advanced by Legendre in the Notes to his Geometry.

$C = \phi$ (A, B, *c*), je dis que la ligne *c* ne doit point entrer dans la fonction ϕ. Un effet, on a vu que C doit être entierement determiné par les seules données A, B, *c*, sans autre angle ou ligne quelconque ; mais la ligne *c* est heterogene avec les nombres A, B, C ; et si on avait une equation quelconque entre A, B, C et *c*, on en pourrait tirer la valeur de *c* en A, B, C, d' où il resulteroit que *c* est egale a un nombre, ce qui est absurde. Donc *c* ne peut entrer dans la valeur de C et on a simplement $C = \phi$(A, B)." Sir John Leslie committed the unaccountable mistake of supposing the argument here stated, to be, "that the line *c* is of nature heterogeneous to the angles A and B, and therefore cannot be compounded with these quantities"—whereas the argument plainly is that *c*, which is a line, cannot be expressed in terms solely of A, B, C, which are numbers. "The quantities A, B, C," says Playfair, in his exposition of Legendre's reasoning, are "angles; they are of the same nature with numbers, or mere expressions of ratio, and, according to the language of Algebra, are of no dimension. The quantity *c*, on the other hand, is the base of a triangle; that is to say, a straight line, or a quantity of one dimension. Of the four quantities, therefore, A, B, C, *c*, the first three are of no dimensions, and the fourth or last is of one dimension. No equation, therefore, can exist involving all these four quantities and them only: for, if there did, a value of *c* might be found in terms of A, B, and C; and *c* therefore would be equal to a quantity of no dimensions: which is impossible."

In this reasoning it is assumed, that, because C is *determined by* A, B, *c*, therefore C can be *expressed in terms of* A, B, *c*. Now Legendre does not prove that when a quantity is determined by certain others, it can be expressed in terms of them; and I affirm that such *a principle, without limitation, is not true.*

For example, consider the angle C of the triangle ABC. And let it be observed that I mean the angle itself, that is, the inclination of *a* and *b* to one another, and not the numerical value of the angle, calculated upon the supposition that a right angle, or any other angle, has been assumed as a unit of measure. The angle C is *determined by* the sides, *a*, *b*, *c*; yet it cannot be expressed in terms of these quantities alone; because *the value of an angle can only be indicated by pointing out its relation to some other angle or angles*; and therefore cannot be expressed by means simply of lines It is true that *the numerical value* of C may be expressed in terms of *a*, *b*, and *c*;

viz., in an equation where only the ratios of a, b, and c, occur; the ratios being numbers. Thus, if $b=\beta a$, and $c=\gamma a$, we might have

$$\text{numerical value of } C=f(\beta, \gamma).$$

But this is altogether a different thing from saying that C *itself*, the angle properly so called, the inclination of a and b to one another, can be expressed in terms of a, b, and c. Now, if C itself (not its numerical value, but the absolute angle) is determined by a, b, and c; and if, nevertheless, it cannot in the nature of things be expressed in terms of a, b, and c; Legendre's demonstration, the very foundation of which is that a quantity which is determined by certain others, can be expressed in terms of them, falls to the ground.

Should it be maintained that C (the angle itself) may be expressed in terms of the numbers β and γ, *a right angle being understood to be the unit of measure*; or more fully thus:

$$C = \text{right angle} \times f(\beta, \gamma);$$

I reply that in the same manner the line c, in Legendre's reasoning, may be expressed in terms of A, B, C, *some line* L being understood to be the unit of linear measure; thus:

$$c = L \times f(A, T, C).$$

ON A NEW SPECIES OF AGELACRINITES, AND ON THE STRUCTURAL RELATIONS OF THAT GENUS.

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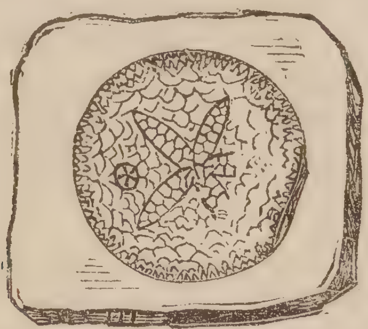
Read before the Canadian Institute, 17*th March*, 1860.

Introductory Notice.—The accompanying figure represents, on a somewhat enlarged scale, the upper side of the undescribed species of Vanuxem's rare and interesting genus *Agelacrinites*, referred to in a late number of the *Canadian Journal*. As there stated, the species in question was discovered amongst some Lower Silurian fossils, from the Trenton Limestone of Peterborough, Canada West, collected by Mr. W. M. Roger, of the University of Toronto. It is dedicated to the able palæontologist of the Geological Survey of Canada, whose researches have so greatly added to our knowledge of the obscurer organisms of the Silurian age, and who has done so much, in all respects, for the advancement of Canadian Palæontology.



The present communication is sub-divided into two short sections. The first contains a detailed description of the new species. This description, it should be remarked, however, is founded on a single example. The second section comprises an analytical review of the genus *Agelacrinites* in general, more especially with regard to its structural relations and affinities.

1. *Description of Agelacrinites Billingsii.*—Body, circular, or nearly so. In the specimen on which this description is based, its diameter exactly equals half an inch. It is slightly convex above, and flat, or apparently somewhat concave below. From the centre of the upper side, five rays, composed each of a double series of alternating or interlocking plates, radiate towards the margin of the disc, and terminate in well-defined points at about the twelfth of an inch from this margin. The rays, in the solitary specimen under examination, exhibit no traces of pores, even when strongly magnified. Nevertheless, pores may have been, and probably were, originally present. It is easy to conceive how minute orifices of this kind might become obliterated during fossilization; whilst, on the other hand, the object of the rays is altogether inexplicable, unless we look upon them as really representing ambulacral areas. Moreover, poriferous ray-plates have actually been discovered in certain examples of *Agelacrinites;* and analogy, consequently, would lead us to infer that, in all, they existed originally. These rays, at their origin, leave a small central space covered by larger and somewhat rhombic plates. The latter appear to be five in number, and to constitute the first ray-plates, one being common to two adjacent rays. Very possibly, however, each of these rhombic plates may be divided through the centre, longi-

tudinally; for the specimen is at this spot much broken, and the plates are pressed more or less one over the other. The inter-radial spaces and the margin of the disc are covered by numerous, irregularly disposed, scale-like, and partially imbricating plates. At the margin these are very small, exceedingly numerous, and arranged in three or four irregular rows, with their longest diameter pointing towards the centre of the disc. To these succeed a series of larger plates, having their greatest diameter in a direction at right angles to that of the border plates, or, in other words, parallel with the circumference of the disc. To these succeed, again, other and somewhat smaller plates, all partially overlapping. This arrangement of the surface plates seems to be an extreme modification of that which obtains in *A. Hamiltonensis* of Vanuxem, and *A. Bohemicus* of F. Roemer; but the larger plates merge gradually, as it were, into the others, and thus there is no defined circle of large plates separating (as in the latter types) the border plates from those of the centre. Finally, in one of the inter-radial spaces, at a distance of about one-sixth of an inch from the centre of the disc, a well-marked "pyramidal orifice" is situated This, in the specimen under examination, is about one-twenty-fourth of an inch in diameter, and is made up, apparently, of ten plates, in two sets of five—one set alternating within the other, as in Hall's *Hemicystites parasitica.* The under side of our species remains unknown, but, in the specimen examined, it is not attached to a shell or other organic body; and hence, as shewn moreover by examples of other species, the genus cannot properly be considered a parasitic one.

Agelacrinites Billingsii differs essentially from our Canadian *A. Dicksoni* of Billings, (and also from the *Edrioaster Bigsbyi* of that palæontologist), by the possession of *short* and *straight* rays, and by its numerous marginal plates. It is also at once distinguished by its straight rays, independently of other characters, from the typical Devonian species, *A. Hamiltonensis* of Vanuxem, and the more recently discovered Carboniferous species, *A. Kaskaskiensis* of Hall. It agrees, on the other hand, somewhat closely with Hall's *Hemicystites parasitica = Agelacrinites parasiticus* from the Niagara Limestone of New York; but, in this latter species, the rays are very narrow at their origin, and are connected there (in the centre of the disc) by a small tubercle or rounded plate. In place of becoming narrower also towards the margin (as in *A. Billingsii*) and terminating in well-defined points, they become rapidly broader, "coalesce with the plates of the body," (Professor Hall), and are altogether undefined at their extremities. These characters, as given in the Palæontology of New York (vol. 2, p. 245; and plate 51, figs. 18–20) from an examination of several specimens, are exactly the reverse of those which obtain in our new species. Whilst, also, (although this character is probably somewhat indefinite,) the small border plates in *A. Billingsii* form two or three circles, in *A. parasiticus* they appear to occur only in a single row.

2. *Analytical Review of the Genus Agelacrinites and its included species.*—The generic characters of *Agelacrinites* may be thus defined. Form, circular; stemless; flat or concave below, and somewhat convex above; and covered by numerous small plates, arranged in part irregularly, and in part in regular order. The definitely arranged plates form five rays (ambulacral areas, ?) which originate at the centre of the upper side of the body. These rays are either short and straight, or long and curved. They are also composed of a double series of small polygonal plates, interlocking along the central line of the ray; or, otherwise, of a single (?) series of plates (Roemer's *A. Rhenanus*). The irregularly arranged plates are elliptical or circular, variable in size, very numerous, thin, scale-like, and imbricating; or, imbricating at and around the margin of the disciform body, and joining by their edges in the more central part of the disc. The marginal plates are commonly very small, and, in some species, are separated from the more central plates, by a circle of comparatively large pieces. In the centre of one of these (interambulacral ?) spaces, and about midway between the apex of the body and the margin, is situated an orifice covered by a pyramid of five or more (moveable ?) plates. The apex itself, or centre and origin of the rays, is covered by a single circular plate; or is surrounded by five or ten angular plates—these latter constituting the first plates of the rays. Characters of the under side of the body, position of mouth, &c., not definitely known.

From this definition, it is clear, as, indeed, universally allowed, that *Agelacrinites* belongs to the ECHINODERMATA. In the present state of our knowledge, however, it is impossible to refer it satisfactorily to any one of the admitted Orders or Families of that class. With the Crinoids proper, and the Blastoids, it appears to have only general affinities; but with the Cystideans it is evidently closely connected: more especially by the possession in common of a pyramidal orifice or, so called, anal-pyramid. It differs from the cystidean structure, nevertheless, in many important respects. The peculiar rays, the imbricating plates, the absence of a stem, for example, are essential points of difference. The imbrication of the plates serves to connect it, through the genus *Protaster*, with the Euryales or the Ophiurians; and the conformation of the rays, in certain species, appears to afford another link in support of this view. But is it not equally related to the Echinida? After a careful consideration of the subject, I cannot refrain from hazarding an opinion that the position of the mouth, as usually given, is erroneous. In several species, as in *A. parasiticus* and *A. Kaskaskiensis* of Hall (*Geology of Iowa,* Vol. I., Part II., Plate xxv.) the centre or origin of the rays is a simple disc or rounded tubercle—incontestably, no mouth: and hence we may fairly assume, that, in other species, the mouth must also be situated elsewhere. The question then arises as to the real nature of the pyramidal orifice. This is usually looked upon either as an anal orifice, or as an ovarian aperture. Neither of these views is by any means certain, nor, indeed, apparently susceptible of proof. To consider this orifice as the mouth, however, appears a still less satisfactory conclusion. In the Crinoids proper, the true position of the mouth is still, strictly, unknown. It is considered in some genera to be in the centre of the "vault," or upper surface; and in others to occupy an excentric position, as between two of the arms, &c. This latter view is unsustained by any proof, beyond the mere occurrence of an orifice at the points in question. The excentric orifice may or may not be the mouth. But if we omit these forms from consideration, and turn to those types of Radiata, in which the position of the mouth is no longer doubtful, that organ, it will be seen, is invariably situated in the centre of the body, except in the Family of the *Spatangidæ*, the highest Family or natural group of the entire series. In the other Families of the ECHINIDA, in the ASTERIDA, OPHIURIDA, and other Orders in which the position of the mouth is truly known, the mouth is always central. This is evidently its normal position in the radiated type of structure, and one, consequently, that we should scarcely expect to see departed from, except in the case of those forms which stand at the higher limit of the series. Unless this view be adopted, we must almost necessarily assume, that, in the Radiata, there are certain natural groups (not yet thoroughly worked out) which are perfectly unconnected with each other; and in which, respectively, the higher forms foreshadow an advanced type of structure, whilst the lower forms present the normal type. The higher forms of a low group, however lowly organized as to their entire structure, will be thus in certain respects, in advance of the lower forms of a higher group. Whatever grounds there may be to believe that some law of this kind really holds good in Nature, its application in the present place would be evidently forced. Discarding therefore the idea, that, in the pyramidal orifice of the Cystideans and Agelacrinites, the mouth is represented, this latter organ must be sought for in another place. Reasons have already been stated against this being the centre of the rays. Its true position will be found, I believe, in the centre of the under side of the body. But—it may be urged in objection to this—the genus *Agelacrinites* is sessile: is attached by its under surface to shells and other foreign bodies: and hence the mouth cannot be there situated. Several examples, it is quite true, have been met with attached in this manner to brachiopod shells; but this is by no means a general condition of occurrence; and, rightly considered, is no proof of an original *permanent* attachment. It is just as exceptional a mode of occurrence, indeed, as that from which Vanuxem derived the name of the genus.

This suggestion as to the true position of the mouth, cannot, of course, be satisfactorily adopted, until confirmed by the examination of more perfect specimens than those hitherto discovered; or until the proper functions of the pyramidal orifice, in this genus and in the cystideans, are clearly ascertained. But under any view, it seems obvious, that, without a forced collocation, these peculiar forms cannot be placed in any existing group. In the present restricted state of our knowledge, at least, they must form a group apart. Mr. Billings (Decade III. of Canadian Organic Remains, under description of *Agelacrinites Dicksoni*) appears inclined to regard them as constituting a sub-order of Star-fishes; and he proposes to arrange them in this connection, under the term of *Edrio-asteridæ*. This name seems objectionable, however, on two grounds: first, because the supposed sessile (*id est*, parasitic,) condition of *Agelacrinites* is by no means proved; and secondly, because the relations of the genus to the Star-fishes—in so close a way, at least, as the name would imply—is not yet established. For these reasons I would suggest the term THYROIDA, in allusion to the valved aperture, as the name of the special group or order framed for the reception of these forms. The following scheme will then represent the probable relations of the various leading groups belonging to the Echinodermata generally:

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Crinoida.
Blastoida.
Cystidea.——
            Thyroida——
                        Asterida.
                        Ophiurida.
                        Euryalida.
            Echinida.
                  Holothurida.
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In the group THYROIDA, we have, at present, but one Family—that of the AGELACRINITIDÆ, comprising, probably, but one known genus: *Agelacrinites*. The recognised species of this genus are enumerated in the annexed tabular view:

Sub-kingdom RADIATA, Class ECHINODERMATA, Order THYROIDA, Family AGELACRINITIDÆ, Genus AGELACRINITES.

Synopsis of Species.

A.—LOWER SILURIAN SPECIES:

(Rays curved):

1. *A. Buchianus*, E. Forbes.
2. *A. Cincinnatiensis*, Roemer.
3. *A. Dicksoni*, Billings.
4. *A. (Edrioaster) Bigsbyi*, Billings.

(Rays straight):

5. *A. Bohemicus*, Roemer.
6. *A. Billingsii*, Chapman.

B.—UPPER SILURIAN SPECIES:

(Rays straight):

7. *A. parasiticus*, Hall.

C.—Devonian Species:

(Rays curved):

8. *A. Hamiltonensis*, Vanuxem.
9. *A. Rhenanus*, Roemer.

D.—Carboniferous Species:

(Rays curved):

10. *A. Kaskaskiensis*, Hall.

REVIEWS.

Journal de L'Instruction Publique, Vol. III. 1859. *Publié par le Département de l'Instruction Publique. Redigé par l'honorable Pierre J. O. Chauveau, Surintendant de l'instruction publique du Bas-Canada, et par M. Joseph Lenoir, du département de l'instruction publique, assistant rédacteur.* Montreal, Bas-Canada.

The Journal of Education for Lower Canada, Edited by the Honourable P. J. O. Chauveau, Superintendent of Education for Lower Canada, and by James Phelan, Esq., of the Department of Education, Assistant Editor. Vol. III, 1859. Montreal.

The receipt of the completed volumes of the French and English Journals of Education for Lower Canada at an early period of the present year, would have induced us to notice them with the commendations they are so well entitled to, had not an unusual pressure on our very limited space prevented our overtaking this, as well as other intended references to Canadian publications. The primary purpose of both Journals is, we presume, to furnish a vehicle for official and semi-official communications to Trustees, Teachers, and others connected with the various local branches of the educational department. The active and intelligent Superintendent of Education for Lower Canada has, however, availed himself of the existence of such periodicals to render them the mediums of a great deal of interesting and instructive information for both the French and English speaking population of the Lower Province. Along with a judicious selection from French and English periodicals, both Journals are also characterised by original articles and reviews of a very creditable character.

We can conceive of such a Journal materially contributing to popular education in many ways. Standard poems re-appear here, with novel claims to attention and interest. We find such an old and familiar favourite as Gray's Elegy, for example; but it assumes for us new Canadian attractions when read here, accompanied by the anecdote of Wolfe repeating it the night before his death-victory, as he rowed along the St. Lawrence, to visit some of the out-posts; and exclaiming to a companion officer---who heard the beautiful, and then recent poem, for the first time,—that he would rather be the author of that poem, than win the glory of the morrow's victory! What an added charm is thus given, for us, to that beautiful elegy, as we picture to ourselves the youthful general gliding along under the wooded heights of the St. Lawrence, the night before that memorable 13th of September, 1759, on which he fell in the crisis of his triumph, and repeating :—

> "The boast of heraldry, the pomp of power,
> And all that beauty, all that wealth e'er gave,
> Await alike the inevitable hour :—
> The paths of glory lead but to the grave."

In like manner the Centenary Burns Celebration at Montreal, gives occasion for other quotations equally familiar and welcome. Among other fruits of that remarkable recognition of the Scottish peasant bard, are translations of some of his popular verses. His "Caledonia" is thus paraphrased by a native Canadian, M. Joseph Lenoir, the assistant editor of the Journal :—

> "O myrtes embaumés, laissez les autres terres
> Nous vanter à l'envi leurs bosquets solitaires,
> Dont l'été fait jaillir d'enivrantes odeurs.
> J'aime mieux ce vallon, frais et riant asile,
> Où, sur un lit d'argent, coule une onde tranquille,
> Sous la fougère jaune et les genêts en fleurs."

The reader will not estimate the less, this offering from the Canadian to the Scottish muse, from having placed alongside of it, the corresponding stanza in its original homely Scottish guise :—

> "Their groves o' sweet myrtle let foreign lands reckon,
> Where bright-beaming summers exalt the perfume;
> Far dearer to me yon lone glen o' green breckan,
> Wi' the burn stealing under the lang yellow broom."

Properly speaking this quatrain is but half of the true stanza, but it is so rendered in our French Canadian version. Although presenting occasional counterparts such as this, and embracing a good deal of educational information in common, the French and English journals are quite distinct, though each characterized by the same commendable effort to adapt it to the special tastes and sympathies of its readers. Indeed a local interest and a Canadian feeling of a healthful kind pervade both Journals. Bishop Laval, the Hon. James McGill, Generals Brock, Wolfe, and Montcalm ; Jacques Cartier, Champlain, and other notable names interestingly associated with the early history of the province, are introduced to the reader in connexion with historical narratives of discoveries made, Colleges founded, or victories won on Canadian soil. The illustrative wood-cuts are also appropriate, and well executed; including views of the most important public buildings of Lower Canada, of its monuments, and some of its most striking city scenes. The Editors also merit the high commendation of aiming at the very difficult achievement of dealing in an impartial and unsectarian spirit with the questions of education, which in the Lower Province are affected by elements of language, race, and creed, very partially felt in Upper Canada.

Feeling as we do, how greatly some means is required for getting hold of the whole population of Lower Canada, and developing among the people feelings of a common sympathy and interest in the spirit of intelligent progress which is at work in the great centres of our public provincial life, we cordially wish success to both Educational Journals, and shall welcome new evidences of improvement, such as we have good reason for anticipating, with each succeeding volume.

D. W.

On the Origin of Species by means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life. By Charles Darwin, M.A., &c. London, John Murray, 1860.

The idea of a *species* as conceived by most minds, is that of a distinct and independent creation, capable of continuing itself unchanged in all its fundamental characters, although subject to partial modification by the influence of external agencies. It is believed, moreover, by those who hold this view, that all our living species having been thus separately created from the beginning of the existing geological age or present condition of things, no real species (*id est,* a type-form capable of continuing itself) has originated, or is capable of being originated, by the intermixture of two distinct types. Such is the general, but not the universal, belief. An opposite view, dating probably from a very distant period, has been brought forward and maintained, from time to time, by many philosophic minds. This view is to the effect that what we call *species*, are no independent-creations—at least for the greater part—but are simply *varieties*, arising from the modification of a few original types, or, if pushed to its extreme length, of a single originally-existing organism. The object of Mr. Darwin's book is to impart an increased vitality and support to this view, by arguments based on a large series of facts, the accumulation of many years of research on his own part and on that of other naturalists. The present work purports to be merely a general synopsis of the materials thus gathered together, and of the results to which their consideration tends ; but it is on a sufficiently extended plan to enable us to test, fairly, the relative solidity of the structure which its facts and arguments support.

Although an hypothesis of this kind must naturally seem to those who consider the question seriously for the first time, as one wholly indefensible and preposterous ; it is nevertheless probable, that, few persons have ever made the close contemplation of Nature their study for any time, without having experienced, at one period or another, the visitation of sundry hauntings of a similar character. When we see, for example, certain forms, at first remarkably distinct, become more and more closely connected by after-discoveries, until the one appears to merge into the other, and our once clear definitions become no longer tenable ; when we see in many species the extraordinary varieties sometimes produced by the crossing and intercrossing of other varieties ; when we consider the transition stages of fœtal development, the homologies of organic structure, the presence of rudimentary organs in many forms, the marked relations which obtain more or less between all living and extinct types of the same series, with other facts of an allied kind—the question becomes forced upon us : why is this ? Why these relations, these homologies, these transition-phases of embryonic development, these rudimentary organs, these closely-connected forms, if all species were separate and distinct creations ? Why, in other words, this recognised unity of plan, amidst this variety of structure, unless by the long-continued modification of an original unit-organism ? Here, however, we merely express our inability to fathom the design of the CREATOR in these varied repetitions, so to say, of the CREATIVE THOUGHT; and the transmutation theory, with all Mr. Darwin's ingenious and eloquent reasonings, offers to us no real help in our difficulty. We yield willing homage to the unquestionable ability which his book displays in so many of its details; we go with him most willingly to a certain point, but there our steps are arrested by obstacles that we are altogether unable to surmount. In his introductory observations, for example, we find the following statements:

"Although much remains obscure, and will long remain obscure, I can entertain no doubt, after the most deliberate study and dispassionate judgment of which I am capable, that the view which most naturalists entertain, and which I formerly entertained—namely, that each species has been independently created—is erroneous. I am fully convinced that species are not immutable; but that those belonging to what are called the same genera are lineal descendants of some other and generally extinct species, in the same manner as the acknowledged varieties of any one species are the descendants of that species."

Now, if the author had confined himself to these limits; if he had sought, by his laborious collection of facts and his skilful deductions, to prove the truth of his opinion as here expressed—using the term *species*, not in its absolute or normal sense, but as limited by our present knowledge—many, we think, who cannot honestly follow him farther, would have become his willing disciples. That various so-called genera have merely the right to rank as species, we firmly believe, and confidently look forward to such researches as those in which Mr. Darwin is engaged, to afford direct proofs of this conclusion * Thus far then we are prepared to listen trustfully to Mr. Darwin's teachings, but when he seeks to carry his applications beyond this, we lose our convictions; certain broad and apparently insurmountable barriers stand up before us; and we find ourselves unable to believe, for example, in the probability of a true transition-link between the carnivorous, retractile-clawed Felidæ, and the four-stomached, hoofed, and herbivorous sheep: and yet this is nothing to what the theory advocated in Mr. Darwin's book would impose upon us.

* It is somewhat remarkable, that, with regard to genera and species, the Inorganic subdivision of Natural History should differ so completely from the Organic branches of that study. That which to the majority of Mineralogists is simply a species, to the Botanist and Zoologist would rank as a genus, and be subdivided into species and varieties. Mineralogy was at one time, in this respect it is true, in unison with these other departments; but notwithstanding various attempts from time to time, to raise its varieties into species, and to bestow upon these latter, "Natural History" names, the broader and more philosophic view has long prevailed.

"It may be asked how far I extend the doctrine of the modification of species. The question is difficult to answer, because the more distinct the forms are which we may consider, by so much the arguments fall away in force. But some arguments of the greatest weight extend very far. All the members of whole classes can be connected together by chains of affinities, and all can be classified on the same principle, in groups subordinate to groups. Fossil remains sometimes tend to fill up very wide intervals between existing orders. Organs in a rudimentary condition plainly show that an early progenitor had the organ in a fully developed state; and this in some instances necessarily implies an enormous amount of modification in the descendants. Throughout whole classes various structures are formed on the same pattern, and at an embryonic age the species closely resemble each other. Therefore I cannot doubt that the theory of descent with modification embraces all the members of the same class. I believe that animals have descended from at most only four or five progenitors, and plants from an equal or lesser number.

Analogy would lead me one step further, namely, to the belief that all animals and plants have descended from some one prototype. But analogy may be a deceitful guide. Nevertheless all living things have much in common, in their chemical composition, their germinal vesicles, their cellular structure, and their laws of growth and reproduction. We see this even in so trifling a circumstance as that the same poison often similarly affects plants and animals; or that the poison secreted by the gall-fly produces monstrous growths on the wild rose or oak-tree. Therefore I should infer from analogy that probably all the organic beings which have ever lived on this earth have descended from some one primordial form, into which life was first breathed."

It is very clear, as already stated, that many of the so-called species of naturalists, are not true species, but simply varieties; and hence, arguments founded merely on closely related forms, are of comparatively little weight as regards the main question here at issue. For the proper acceptation of the theory, it will be necessary to show the passage of one truly distinct type into another, or of these into some common parent-type, so as to render an explanation of the structural homologies and other relations existing between them. If this cannot be effected by reference to existing Nature, let us look back into the rock-preserved annals of the Past, and see if these will lend us any aid. Mr. Darwin is forced to acknowledge that Geology fails, in this respect, to furnish any direct support to his hypothesis. But then, he argues, the geological record is incomplete. In place of a full and connected history, it offers to us only a few isolated leaves of the great book of the Past. Granting this, it must nevertheless be considered highly adverse to his view—as he himself, indeed, has candidly stated—that in these stony annals we find everywhere the same unity of plan with the same distinctness of type as in existing Nature; and that in no part of the world can we glean from them any examples even approaching to a transitional series of forms, in the sense demanded by the theory. But leaving this subject for awhile, let us examine the theory itself, as modified and set forth in Mr. Darwin's Essay, a little more in detail. We will take in succession the more prominent chapters of the book, and attempt respectively, a brief analysis of their contents.

In his first chapter, the author discusses the variations to which species give rise under domestication. He considers more especially and in great detail, the various breeds of the domestic pigeon. He shews, and every one must be familiar with this fact, the extraordinary differences in external aspect, mode of flight, etc., exhibited by many of these. So great is this diversity of character, that Mr. Darwin thinks an Ornithologist would not hesitate to class most of these breeds as distinct species, if he met with them for the first time, and were led to suppose them wild birds; nay, that he would even feel warranted in placing them under several genera. And yet, Mr. Darwin regards all our known breeds as undoubted descendants of the rock pigeon, the *Columba livia*. The strongest fact, perhaps, in favour of this view, is the production from time to time in various breeds, of the normal colours of the supposed parent-type. The question however, is by no means proved. If these pigeons have all sprung from *Columba livia*, should there not be occasionally a more striking reversion to the characters of the original type? Are we moreover authorised to conclude from any *direct evidence*, that a pair of rock pigeons could ever produce the numerous varieties that we now possess? Mr. Darwin shews us that a certain amount of variation does constantly occur amongst pigeons generally, and hence he assumes *by inference* that in course of time, the variation being accumulative, so to say, we *might* obtain the breeds we now possess. It seems, however, as legitimate an inference, notwithstanding Mr. Darwin's able advocacy of the contrary view, that various sub-species or varieties of the pigeon were originally created; just as we believe the leading varieties of the dog and horse have sprung from originally-created varieties. We have certainly no authority to assume that the greyhound and the mastiff were not originally created as such, although capable of breeding together, and producing fertile offspring. We can produce varieties now, because we have varieties from which to produce them; but if we had to breed from a single variety, it seems evident that, in spite of the most judiciously-exercised selection in continuing the breed so as to produce the greatest possible variation, no great success could in this respect be arrived at; and a return to the characters of the original type would be constantly occurring. In the case of the dog, this is apparently allowed by Mr. Darwin, for, whilst expressing his conviction that all our domestic pigeon-breeds have descended from the rock pigeon, he does not regard our various dogs as the descendants of a single wild species. But granting that, in the case of the pigeon, and even in that of the dog, horse, &c., all known varieties have sprung from one existing or extinct type-pair—granting this—what does the admission amount to? Simply to the fact, that certain species are capable of great variation; but, after all, of a variation amounting to no real specific, much less generic, difference. Stay! cry the upholders of this theory: a certain amount of time is required for the production, in this manner, of changes to that extent. We point to the monumental records of Egypt—but these, we are told, are but the works of yesterday. We exhume the dead forms of the geologic Past—and the assumed imperfection of our record is brought against us. On this latter point however, we shall have more to say in the sequel.

In his succeeding chapter, the author discusses some important points connected with "variation under Nature;" but much of his argument is here based rather on the deficiency of our present knowledge, than on absolutely-proved facts. He points out for instance, how greatly certain naturalists differ as to what should be considered species and what varieties, in particular genera, more especially amongst plants and insects; but, rightly considered, although this may go far to prove the unnatural sub-divisions of the systematists, it cannot be looked upon as helping in any material way to explain the origin of true species: *id est,* of God's actual creations as distinguished from the necessarily imperfect conceptions of man. The grand argument of the chapter is founded on the (to a great extent, perhaps, undoubted) fact, that, in large genera, the amount of difference between the included species is often exceedingly small; and that such species present also, as a general rule, more varieties than belong to the species of smaller genera.

"From looking at species as only strongly-marked and well-defined varieties, I was led to anticipate that the species of the larger genera in each country would oftener present varieties than the species of the smaller genera; for wherever many closely related species (*i. e.* species of the same genus) have been formed, many varieties or incipient species ought, as a general rule, to be now forming. Where many large trees grow, we expect to find saplings. Where many species of a genus have been formed through variation, circumstances have been favourable for variation; and hence we might expect that the circumstances would generally be still favourable to variation. On the other hand, if we look at each species as a special act of creation, there is no apparent reason why more varieties should occur in a group having many species, than in one having few.

To test the truth of this anticipation I have arranged the plants of twelve countries, and the coleopterous insects of two districts, into two nearly equal masses, the species of the larger genera on one side, and those of the smaller genera on the other side, and it has invariably proved to be the case that a larger proportion of the species on one side of the larger genera present varieties, than on the side of the smaller genera. Moreover, the species of the large genera which present any varieties, invariably present a larger average number of varieties than do the species of the small genera. Both these results follow when another division is made, and when all the smaller genera, with from only one to four species, are absolutely excluded from the tables. These facts are of plain signification on the view that species are only strongly marked and permanent varieties; for wherever many species of the same genus have been formed, or where, if we may use the expression, the manufactory of species has been active, we ought generally to find the manufactory still in action, more especially as we have every reason to believe the process of manufacturing new species to be a slow one. And this certainly is the case, if varieties be looked at as incipient species; for my tables clearly show as a general rule that, wherever many species of a genus have been formed, the species of that genus present a number of varieties, that is, of incipient species, beyond the average. It is not that all large genera are now varying much, and are thus increasing in the number of their species, or that no small genera are now varying and increasing; for if this had been so, it would have been fatal to my theory; inasmuch as geology plainly tells us that small genera have in the lapse of time often greatly increased in size; and that large genera have often come to their maxima, declined and disappeared. All that we want to show is, that where many species of a genus have been formed, on an average many are still forming; and this holds good.

With regard to the deductions contained in this quotation, as bearing on the origin of actual species, two things have to be observed: first, that many of the so-called species of these large genera may not be, and in many cases decidedly are not, true species; and secondly, as already observed in the case of the dog, &c., many leading varieties in these genera, may be varieties of original creation, or sub-species if we choose to call them so; and thus, a larger amount of material for variation being provided in the one case than in the other, a more extended variation in the former will follow as a natural consequence.

It is just as rational to assume for example, that several pairs of a type or species *A*, differing slightly from one another but capable of fertile intermixture, were created with a single pair, or a smaller number of pairs, of another species *B*—as to suppose that these types with their varieties, and in addition, other types *C*, *D*, *E*, *F*, etc., all sprang from an unknown type-pair, *X*, endowed with an innate plasticity of nature sufficiently accommodating to produce such changes in its descendants, as, gradually branching off in different directions, led eventually to the generation of a whale, a cat, and a sheep—not to mention other and more widely separated forms. This may be a rude, and in the eyes of those who favor Mr. Darwin's view, a coarse and very unphilosophic method of putting the argument; but it is a perfectly legitimate one. Granted, we say, that our system-species, which in many instances are not species at all, are susceptible of a certain amount of variation: there your argument stops. You can go no farther except by the help of blind and gratuitous surmises; of surmises clothed certainly in attractive colours, and in some cases possessing probably the germs of an unseizable truth—but gratuitous, all the same, in the present condition of our knowledge.

Passing over a chapter headed "the Struggle for Existence," in which in brief but graphic terms, the mutual antagonism, and the no less mutual dependency of living forms, throughout the wide range of nature, is forcibly depicted, we arrive at one of the principal topics discussed in Mr. Darwin's volume. This is entitled "Natural Selection," a term employed to express the assumed tendency of Nature to avail itself of any slight change advantageous to a species, in the gradual production of varieties, and through these, of new types. The author appears to claim this principle of natural selection as a doctrine peculiar to the present work; but, in truth—as shown by his own illustration of how a fleet brood of wolves might be produced, in this manner, by the destruction of all but swift-footed prey in their locality—it is essentially identical with the views of the author of the *Vestiges of Creation.* The latter, indeed, goes farther, in recognising also the full claims of climatic and other external causes towards the production of these changes, whilst to such influences, Mr. Darwin is inclined to concede no more than a very secondary importance. Logically considered, however, the first step in this principle of "natural selection," must be more or less dependent, at least in most instances, on the agency of physical conditions. The first slight change, in an accumulative series of changes produced in a plant or animal, can scarcely be effected otherwise than through the direct or indirect influence of external causes. In his introduction, Mr. Darwin alludes to the "Vestiges of Creation," but seeks apparently to mask the mutual affinities of the two works, by assuming, for the earlier one, a theory which certainly does not in any way fairly represent its views. He states, for example:—

> "It is preposterous to attribute to mere external conditions, the structure, for instance, of the woodpecker, with its feet, tail, beak, and tongue, so admirably adapted to catch insects under the bark of trees. In the case of the misseltoe, which draws its nourishment from certain trees, which has seeds that must be transported by certain birds, and which has flowers with separate sexes absolutely requiring the agency of certain insects to bring pollen from one flower to the other; it is equally preposterous to account for the structure of this parasite, with its relations to several distinct organic beings, by the effects of external conditions, or of habit, or of the volition of the plant itself.
>
> The author of the 'Vestiges of Creation' would, I presume, say that, after a certain number of generations, some bird had given birth to a woodpecker, and some plant to the missletoe, and that these had been produced perfect as we now see them."

Now the "Vestiges" theory, really supposes nothing of the kind; but, and in so far at least in accordance with Mr. Darwin's view, that one form is capable of originating another, by a slow and accumulative process of development. The author of "the Vestiges" does not assume, for example, that a bird of an absolutely different kind ever gave birth to a woodpecker "perfect as we now see it;" but that this latter type originated from an older one, by slight, gradual, and long-continued modifications of beak, claws, &c.,—the process giving rise to a complete series of intermediate forms. The two theories are thus essentially alike; although the works themselves stand widely apart. Whilst the one contents itself with broad assumptions, the other seeks to afford proofs of its statements, and honestly brings forward and discusses points apparently hostile to its views. All the proofs it is able to collect, however, are, as we have already attempted to shew, totally inadequate to affect the main question. But—explains Mr. Darwin—although the changes recorded are confessedly slight, they are sufficient to show what would be accomplished, if greater time were called into play; and, in illustration of this, he refers to the agency of present causes in producing, contrary to an earlier belief, geological changes of the greatest magnitude. But the two cases have no true parallelism. One who had never seen the sea, or had never studied its effects, might naturally be inclined to look with incredulity on statements of its wasting powers, and of the results asserted to arise from these. But if he were to reside for a certain time on a sea-coast, where this wasting action were going on, and thus witnessed how, bit by bit, the destruction of the coast took place, he could not shut his eyes to the fact, that, however slight the annual waste, this must amount in a given number of years, to such or such a quantity. In like manner, one residing near an estuary in which rock-sediments were constantly under process of deposition, would be forced to acknowledge by what he saw daily or annually going on, that in course of time (other conditions not interfering) a delta of greater or less extent must necessarily arise. But to make the two cases parallel, we should have to assume that these natural processes would produce, not their obvious and natural results, but some altogether unexpected issue. Natural selection as maintained by Mr. Darwin, is undoubtedly a modifying power or principle of recognised action; and no one can read the section of his book which refers to that subject, without deriving profit and instruction from the perusal. But when the author attempts to establish the sufficiency of this power to effect generic changes, stronger arguments are certainly required, than any he has yet been able to bring forward.

After some additional remarks of an interesting and original character, on the laws influencing variation, but which our comparatively limited space compels us to pass over, we arrive at a distinct portion of the work, in which the author, having stated his views in detail, and advanced facts in support of the theory which these embody, takes up the so-called difficulties of this theory, or the questions which oppose themselves to its reception. Some of these have been already touched upon, and others must have suggested themselves to the reader, but we have forborne to consider them collectively until reaching the present part of the work, in which they are boldly brought forward and combated by the author himself. Mr. Darwin enunciates them as follows:

"Long before having arrived at this part of my work, a crowd of difficulties will have occurred to the reader. Some of them are so grave that to this day I can never reflect on them without being staggered; but, to the best of my judgment, the greater number are only apparent, and those that are real are not, I think, fatal to my theory.

These difficulties and objections may be classed under the following heads:—Firstly, why, if species have descended from other species by insensibly fine gradations, do we not everywhere see innumerable transitional forms? Why is not all nature in confusion instead of the species being, as we see them, well defined?

Secondly, is it possible that an animal having, for instance, the structure and habits of a bat, could have been formed by the modification of some animal with wholly different habits? Can we believe that natural selection could produce, on the one hand, organs of trifling importance, such as the tail of a giraffe, which serves as a fly-flapper, and, on the other hand, organs of such wonderful structure, as the eye, of which we hardly as yet fully understand the inimitable perfection?

Thirdly, can instincts be acquired and modified through natural selection? What shall we say to so marvellous an instinct as that which leads the bee to make cells, which have practically anticipated the discoveries of profound mathematicians?

Fourthly, how can we account for species, when crossed, being sterile and producing sterile offspring, whereas, when varieties are crossed, their fertility is unimpaired?

The first objection is met on Mr. Darwin's part by several pleas, of which we give the author's own summary below, merely stating our personal inability to see clearly the force of his replies. We should remember, in this connection, that our present knowledge is not confined to a few limited areas, but extends over almost the whole surface of the globe; and imperfect as the geological record may be, it is at least exceedingly surprising that neither dead nor existing nature in any part of the world should be capable of affording direct support, however slight, to the author's views. We cannot but think, consequently, that he asks us here to accord him too much. The following are the arguments—as given in a condensed form by the author himself—by which the first of the above most serious objections is attempted to be overcome:—

"To sum up, I believe that species come to be tolerably well-defined objects, and do not at any one period present an inextricable chaos of varying and intermediate links: firstly, because new varieties are very slowly formed, for variation is a very slow process, and natural selection can do nothing until favourable variations chance to occur, and until a place in the natural polity of the country can be better filled by some modification of some one or more of its inhabitants. And such new places will depend on slow change of climate, or on the occasional immigration of new inhabitants, and probably, in a still more important degree, on some of the old inhabitants becoming slowly modified, with the new forms thus produced and the old ones acting and reacting on each other. So that in any one region and at any one time, we ought only to see a few species presenting slight modifications of structure in some degree permanent; and this assuredly we see.

Secondly, areas now continuous must often have existed within the recent period in isolated portions, in which many forms, more especially amongst the classes which unite for each birth and wander much, may have separately been rendered sufficiently distinct to rank as representative species. In this case, intermediate varieties between the several representative species and their common parent, must formerly have existed in each broken portion of the land, but these links will have been supplanted and exterminated during the process of natural selection, so that they will no longer exist in a living state.

Thirdly, when two or more varieties which have been formed in different portions of a strictly continuous area, intermediate varieties will, it is probable, at first have been formed in the intermediate zones, but they will generally have had a short duration. For these intermediate varieties will, from reasons already assigned (namely, from what we know of the actual distribution of closely allied or representative species, and likewise of acknowledged varieties), exist in the intermediate zones in lesser numbers than the varieties which they tend to connect. From this cause alone the intermediate varieties will be liable to accidental extermination; and during the process of further modification through natural selection, they will almost certainly be beaten and supplanted by the forms which they connect; for these, from existing in greater numbers will, in the aggregate, present more variation, and thus be further improved through natural selection and gain further advantages.

Lastly, looking not to any one time but to all time, if my theory be true, numberless intermediate varieties, linking most closely all the species of the same group together, must assuredly have existed; but the very process of natural selection constantly tends, as has been so often remarked, to exterminate the parent-forms and the intermediate links. Consequently evidence of their former existence could be found only amongst fossil remains, which are preserved, as we shall in a future chapter attempt to show, in an extremely imperfect and intermittent record."

With regard to the objections placed under the second head, objections of perhaps a still more grave character, the replies, as might be expected, are even still less satisfactory. We have here, indeed, two principal difficulties which it is impossible to set aside except by the aid of entirely gratuitous suppositions. In one of these difficulties, the mode of transition of one generic form into another—of (and Mr. Darwin might have chosen a more startling example) an insectivorous quadruped into a bat, for instance—the author confesses that he can give us no rational explanation. At the same time, *he thinks such difficulties have very little weight.* The arguments here, we trust we do not speak offensively, for nothing is farther from our intention—the arguments here, become painfully akin to those of the "Vestiges." Take the following for example:

> "Seeing that a few members of such water-breathing classes as the Crustacea and Mollusca are adapted to live on the land, and seeing that we have flying birds and mammals, flying insects of the most diversified types, and formerly had flying reptiles, it is conceivable that flying fish, which now glide far through the air, slightly rising and turning by the aid of their fluttering fins, might have been modified into perfectly winged animals. If this had been effected, who would have ever imagined that in an early transitional state they had been inhabitants of the open ocean, and had used their incipient organs of flight exclusively, as far as we know, to escape being devoured by other fish?"

If the author had attempted to show that an imperfectly-flying fish might become gradually modified into a fish possessing more perfect powers of flight, the principle might perhaps be admitted, at least for the sake of discussion: but when "perfectly winged animals" are spoken of, especially in connexion with the context, the argument, if it mean anything, implies the possible transformation of a flying fish into a pterodactyle or some kind of flying reptile; and through this, or without its intervention, into a bird or a bat—a transformation involving most assuredly, greater difficulties, than any examples of petty, subordinate modifications, such as the author's tabular lists may exhibit, will help us to consider one of little weight. Turning now to the second of the grave difficulties referred to above, the formation of a complex organ, like the eye of a vertebrated animal, by the gradual modification of an inferior organ in a lower type, we may again let the author speak for himself: only warning the reader unfamiliar with geological discussions, that where Mr. Darwin speaks of our having to descend far beneath the lowest known fossiliferous stratum to discover the earliest stages by which the eye in the vertebrated class has been perfected, he assumes data altogether denied by the greater number of our most eminent geologists. The lowest sedimentary rocks (containing it should be remarked many beds which retain all their sedimentary characters, and thus agree with higher and fossiliferous strata) are *generally* looked upon as truly azoic formations: as deposits accumulated before the dawn of life upon the globe. The first fish-remains, moreover, the earliest recognised examples of Vertebrata, do not occur at or near the actual base of the fossiliferous strata, but only at the extreme upper limit of the Silurian formation; and in all our earliest fishes the eye exhibits apparently the normal structure. Fishes and other organisms, may, it is true, have lived at earlier periods than Geology indicates; but that view, whether true or false, is purely hypothetical, is opposed to the results of actual observation, and cannot therefore be legitimately introduced into an argument of this kind. But we proceed to our quotation, the last that our decreasing space will allow us to give.

"To suppose that the eye, with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration could have been formed by natural selection, seems, I freely confess, absurd in the highest possible degree. Yet reason tells me, that if numerous gradations from a perfect and complex eye to one very imperfect and simple, each grade being useful to its possessor, can be shown to exist; if, further, the eye does vary ever so slightly, and the variations be inherited, which is certainly the case; and if any variation or modification in the organ be ever useful to an animal under changing conditions of life, then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, can hardly be considered real. How a nerve comes to be sensitive to light, hardly concerns us more than how life itself first originated; but I remark that several facts make me suspect that any sensitive nerve may be rendered sensitive to light, and likewise to those coarser vibrations of the air which produce sound.

In looking for the gradations by which an organ in any species has been perfected, we ought to look exclusively to its lineal ancestors; but this is scarcely ever possible, and we are forced in each case to look to species of the same group, that is to the collateral descendants from the same original parent-form, in order to see what gradations are possible, and for the chance of some gradations having been transmitted from the earlier stages of descent, in an unaltered or little altered condition. Amongst existing Vertebrata, we find but a small amount of gradation in the structure of the eye, and from fossil species we can learn nothing on this head. In this great class we should probably have to descend far beneath the lowest known fossiliferous stratum to discover the earlier stages, by which the eye has been perfected.

In the Articulata we can commence a series with an optic nerve merely coated with pigment, and without any other mechanism; and from this low stage numerous gradations of structure, branching off in two fundamentally different lines, can be shown to exist, until we reach a moderately high stage of perfection. In certain crustaceans, for instance, there is a double cornea, the inner ones divided into facets, within reach of which there is a lens-shaped swelling. In other crustaceans the transparent cones which are coated by pigment, and which properly act only by excluding lateral pencils of light, are convex at their upper ends and must act by convergence; and at their lower ends there seems to be an imperfect vitreous substance. With these facts, here far too briefly and imperfectly given, which show that there is much graduated diversity in the eyes of living crustaceans, and bearing in mind how small the number of living animals is in proportion to those which have become extinct, I can see no very great difficulty (not more than in the case of many other structures) in believing that natural selection has converted the simple apparatus of an optic nerve merely coated with pigment and invested by transparent membrane, into an optical instrument as perfect as is possessed by any member of the great Articulate class.

He who will go thus far, if he finds on finishing this treatise that large bodies of facts, otherwise inexplicable, can be explained by the theory of descent, ought not to hesitate to go further, and to admit that a structure even as perfect as the eye of an eagle might be formed by natural selection, although in this case he does not know any of the transitional grades. His reason ought to conquer his imagination, though I have felt the difficulty far too keenly to be surprised at any degree of hesitation in extending the principle of natural selection to such startling lengths."

An entire chapter, and a most instructive one, in Mr. Darwin's book, is devoted to the subject of *Instinct*, another serious obstacle as all will readily understand, to the reception of the transmutation theory. Mr. Darwin seeks to overcome this obstacle, by establishing two points : first, that a certain amount of judgment or reason enters into the composition of instinct; and secondly, and chiefly, that, instinct can be shewn, in certain remarkable cases, to be a quality of gradation, so to say. In the cell-building instinct of the bees for example, he traces out, as he imagines, a specific connexion between the humble bees and the hive bee—the Mexican *Melipoma domestica* affording a transition-link. But here, we should consider, that, the principle of instinct is perhaps in no case a *simple specific principle*, nor even a generic one; but a principle pervading entire families or groups, and, as such, one that we might naturally infer to offer inherent degrees of variation. To establish the point aimed at by Mr. Darwin, we ought to be able to shew, that the humble-bee could be made to acquire the higher artistic-instinct of the hive-bee. We may be told that this might probably be effected under favourable circumstances, and with sufficient lapse of time; but as this assumption is altogether without proof, we have an equal right to infer that these separate amounts, or rather *kinds* of instinct, were originally bestowed on these different bees at their special creation. The followers of Mr. Darwin's theory, would, of course, ridicule the idea of a separate creation on the part of insects so nearly allied; but as they can offer us nothing to the contrary but inferences and surmises, every one is at liberty, on this point, to entertain his own opinion. Instinct may be legitimately regarded as entirely dependent upon the inherent character of the brain or its representatives, much as the mode and power of flight in birds and other winged animals, depends essentially upon the conformation of the wing. Hence the possession of peculiar instincts in the case of neuter insects incapable of continuing their race (as the neuter bees. neuter ants, &c.,) alluded to by Mr. Darwin as of difficult explanation, becomes, on the older theory, easily explained. Instinct forms, so to say, a portion of the organization of the animal: and thus, if a neuter insect were so organized as to become a fertile one, its instincts would necessarily become modified with the other parts of the organization. If instinct be really capable of improvement or modification, as the transmutation theory is forced to assert, but of which not the slightest proof is afforded, instinct and reason must in a manner be one. But all known facts are opposed to this, although the two principles are sometimes confounded by the unreflective, or by those who are disinclined to allow a certain share of reason to the lower animals. Rightly considered, these principles are not only distinct, but are actually antagonistic elements. The higher the reasoning powers, the feebler or less developed become the manifestations of the instinct principle.

We now come to the fourth great obstacle to the reception of Mr. Darwin's views—the fertility of varieties when crossed, and the sterility of the offspring of separate species in the few cases in which these latter can be made to unite. This subject is discussed by the author at some length, although necessarily under a very limited aspect. His data are chiefly, indeed almost entirely, derived from the Vegetable Kingdom, and hence, are scarcely available as fair test-elements for the proper elucidation of the question. The broad, opposing facts presented by animal hybridism are left, and unavoidably, almost untouched; or are masked under other more or less distinct inquiries: as where the author says—"Laying aside the question of fertility and sterility, in all other respects there seems to be a general and close similarity in the offspring of crossed species and of crossed varieties." Briefly, on this subject, we require to know why separate species (which under Mr. Darwin's view are nothing more than varieties) cannot be made to breed together, or do not breed together in the wild state—or why, in the few instances in which this is effected between closely allied forms, the offspring are sterile—whilst on the other hand, our known varieties breed freely, and produce fertile offspring? This is the real question at issue; and, up to the present time, it has received no definite answer, except on the assumption that true species are separate and distinct creations, and are intended by the CREATOR to remain distinct.

Some of the most striking arguments in opposition to the transmutation theory, are based on geological revelations. These have been already referred to in a previous page, but as Mr. Darwin has devoted a separate chapter to their consideration at the portion of the work to which we have now arrived, we will briefly re-discuss them before closing our review. These geological arguments are two-fold: First, the non-occurrence of intermediate or transitionary forms in rock-strata; and, secondly, the simultaneous occurrence, again and again, at various geological horizons, of entire groups of allied forms, distinct entirely (or for the greater part) from the organisms of lower and consequently earlier formed deposits. To make these points clear to our non-geological readers, we may observe, that, on each side of the Atlantic, we find certain beds entirely destitute of organic remains, underlying other beds in which these remains occur in great numbers. In some places it is difficult to draw an exact line of demarcation between the two, but that in no way affects our argument. At a certain depth all fossils cease. Now, some observers, Mr. Darwin amongst others, believe that organic forms really existed during, and perhaps before, the deposition of these fossil-free strata. Many of these strata, it should be observed, are evidently much altered, by various chemical, igneous, or other agencies, from their original sedimentary condition; and hence, fossils, if ever enclosed in them, may have become obliterated. Other strata of this fossil-free series, however, in various parts of the world, clearly retain their original characters, and do not differ, except in the absence of fossils, from many fossiliferous strata above them. From this fact, combined with the great thickness and extent of the rocks in question, most geologists consider these to be truly *azoic* rocks, formed out of sediments deposited before the actual creation of living things. If this could be absolutely proved, the transmutation theory would receive its death-blow: because in the strata which suceed or lie above these, and which constitute, be it remembered, the first or earliest fossiliferous strata really known, we find various types appearing simultaneously; and amongst these types we meet with various allied forms without any intermediate or truly transitionary links between them. If we cannot absolutely assert, however, that these Silurian forms (using the term Silurian in its extended sense) were the first created forms upon our earth, the weight of evidence is in favour, and strongly in favour, of that view. Hence, in common justice, the contrary hypothesis, resting as it does on purely negative evidence, ought not to be admitted into the discussion. But if we exclude it, what becomes of Mr. Darwin's theory? "If my theory be true," writes Mr. Darwin—"it is indisputable that before the lowest Silurian stratum was deposited, long periods elapsed, as long as, or probably far longer, than the whole interval from the Silurian age to the present day: and that during these vast yet quite unknown periods of time, the world swarmed with living creatures." But if so, where are the remains of these? Vast thicknesses of rocky strata, formed during some at least of these periods, occur in various parts of the world, but as yet no fossils have been obtained from them; whilst the remains of forms which flourished afterwards, are entombed in thousands in the overlying rocks. It is not sufficient to urge, in refutation, that the lower limit of the fossil-bearing strata has been pushed lower and lower by the discovery of an obscure graptolite, here, and the fragment of a trilobite, there. To substantiate Mr. Darwin's theory, something more than this is clearly required.

But passing over this weighty obstacle, we find in these geological revelations, others not less weighty. Above the Silurian formations, for example, we find another set of strata, to which, collectively, the term Devonian has been applied, and in which the fossils (with very few exceptions) are entirely different. Above the Devonian beds again, we come upon the Carboniferous with another distinct series of organic remains; and so on successively, through various other groups of strata, each representing a certain period of time during which it was under process of deposition in the form of muddy, sandy, or calcareous sediments. In these sediments, moreover, a portion of the flora and fauna of the period (*id est:* of the plants and animals then living) was entombed, and so preserved to us: just as we see, at the present day, the leaves, shells, bones, &c., of existing organisms, enclosed in sediments under process of deposition in seas, lakes, and estuaries. Now, on the hypothesis of distinct acts of creation, there is nothing unaccountable in the sudden appearance, successively, of these distinct sets of forms, and in the want of transitional forms amongst them; but the abrupt appearance in this manner, of numerous, varied, and distinct types; and especially, the abrupt appearance of distinct sets of these, again and again, in geological history, if not absolutely fatal, is, at least, highly adverse to the Lamarckian or transmutation view. The only possible way indeed, in this case, to reconcile fact with theory, is to maintain, with Mr. Darwin, the imperfection of the geological record. But admitting freely the imperfect state of this record, we may legitimately inquire if the imperfection be really sufficient to invalidate the force of our argument. In each of these groups of rocks, we have evidence, according to Mr. Darwin's own shewing, of the lapse of an immense interval of time—and yet, transition-forms are absent. And, again, is it not most remarkable that the annals of this imperfect record, belonging to different and distant ages, and collected from such widely distant localities, should all tell the same tale, should all point to one and the same conclusion, and that an adverse one to Mr. Darwin's view. Assuredly, this cannot be the mere effect of chance. If so, it is as remarkable as would be the case of a hundred coins, thrown at random into the air, all falling with the same face uppermost. It seems impossible therefore, to avoid the conclusion, that, although—by the advancement of organic forms generally, from lower to higher types, which it reveals; by the extinction of entire races, which it plainly announces; by the vast periods of time, which the just explanation of its facts demands—Geology might seem at first thought to favor the transmutation hypothesis: its records, when rightly and fairly read, will be found altogether opposed to that illusive view.

We have not yet reached the end of Mr. Darwin's book: several chapters still remain undiscussed, but the grand argument virtually closes here. The remaining portions of the work are occupied chiefly by additional illustrations, and by a general recapitulatory statement of the subjects brought under review in the earlier chapters of the volume. These illustrations bear principally on the difficulties attached to the commonly received belief, the special-creation theory as this has been termed; and seek to uphold the development view, not by shewing the real strength of this, but by exposing the assumed weakness of the opposing system—in its impossibility, for example, to explain the cause of various striking phenomena connected with the geographical distribution of plants and animals, the embryological development of these, and so forth.

But this is scarcely a logical, certainly not a just method, of meeting the question. The case stands thus. Certain facts are given: certain remarkable phenomena are witnessed everywhere around us. We are asked to explain them. We are forced to confess they transcend our explanation. We are asked how the world comes to be peopled by so very many different plants and animals. We reply, by the act of the CREATOR: these plants and animals being the essentially-unchanged descendants of species separately created at the commencement of the existing state of things. But, say our questioners, if this be the case, if these type-forms were all separately created, is it not most strange that certain points of resemblance should pervade the whole? Even proud Man in his physical organization is but the end-link of the series, differing only in special points of structure from the beast that perisheth. Is it not most remarkable that many forms should have been created with rudimentary organs (as the mammæ of male mammals, the soldered and abortive wings of certain insects, &c.) useless, normally, to themselves, though useful, under an enlarged development, to other forms? Is it not most startling that the fœtal forms of various animals should pass through certain stages of development, representing in part the organization of other types? Are not these and other facts that might be adduced, really without obvious explanation on the view that each species has been separately created, and kept distinct?

To these questionings, we have, of course, but one reply: These strange phenomena, we make answer, are regarded by us, as parts of a great plan, conceived and carried out by the ALMIGHTY in his wisdom, for some purpose unfathomable to us at present, and perhaps ever to remain unfathomed by our restricted powers of inquiry. Beyond this, they are as inexplicable to us, as the object of our presence here is inexplicable. They belong to those mysteries of GOD which are kept "on the outside of man's dream." Many have attempted their interpretation, but all, as yet, have failed. Not so, say the supporters of the transmutation theory—these difficulties are met and answered by the principle of "descent with modification" of species from one another. Let us do this theory no injustice. It certainly does afford a rational explanation of the remarkable facts detailed above; but when tested by other facts, it fails entirely. It is comparatively easy to invent a theory in explanation of a particular series of phenomena, provided we be allowed to exclude all collateral facts from consideration. If we look back into the history of any science, how many futile, though at one time universally-accepted theories of this kind, do we not encounter. Many of these, however, though eventually discarded, have helped by their elaboration, to enrich our knowledge; and the wide discussion to which the present work has led, will undoubtedly yield the same good fruits.

In concluding our confessedly-imperfect analysis of this noted Essay, we may perhaps be allowed to state, apologetically, that having been disappointed of a review on the subject, by another pen, we have been forced, at the eleventh hour, to throw thus hastily into form, the thoughts suggested to us by an impartial study of the work when first obtained. If we have been compelled to record our protest against the reception of what we believe to be an unfounded theory, no one, we may safely affirm on the other hand, can lay down Mr. Darwin's book, so remarkable in many points of view, without feeling that a large accession of new thought has been added by it to our common store.

E. J. C.

SCIENTIFIC AND LITERARY NOTES.

LIST OF BIRDS OBSERVED IN THE VICINITY OF HAMILTON, C. W. ARRANGED AFTER THE SYSTEM OF AUDUBON

BY THOMAS M^CILWRAITH, ESQ.

The object of the writer in preparing the following list, has been to afford such information as may be of use, should inquiry at any future period be made regarding the birds frequenting this part of the country. In its present state, the list has been drawn up from observations made during occasional excursions within a period of four years. Those who are acquainted with the subject will see that it is necessarily incomplete; but it will be easy to add the names of such species as may yet be found. In order that the list may be strictly local, no species has been mentioned which has not been found within six miles of the city limits.

Genus Buteo.—Buzzard.

1. B. borealis—*Red-tailed Hawk.* Seen in spring and fall. Not very common.
2. B. lineatus—*Red-shouldered Hawk.* More plentiful than the preceding, which it resembles in appearance and habits.

3. B. lagopus—*Rough-legged Buzzard.* Frequents the marshy shores of the Bay; feeding on mice and wounded birds.

4. B. Pennsylvanicus—*Broad-winged Buzzard.* Abundant during spring. Frequents the meadows near the Lake.

Genus Haliætus.—Sea Eagle.

1. H. leucocephalus—*Bald Eagle.* A few pairs winter round the Bay Shore, feeding on musk-rats, gulls, &c. The young birds are of a uniform brown colour; being more plentiful, and more easily approached than the adult.

Genus Pandion.—Osprey—Fish Hawk.

1. P. Haliætus—*Fish-Hawk.* Seen fishing in the Bay in spring and fall. Not known to breed here.

Genus Falco.—Falcon.

1. F. peregrinus—*Peregrine Falcon.* Accidental. Has been observed striking down ducks near Burlington Beach.

2. F. palumbarius—*Pigeon Hawk.* Common in autumn, when it attends the flocks of blackbirds which roost in the marsh.

3. F. sparverius—*Sparrow Hawk.* More common than either of the preceding. Breeds near the city.

Genus Astur.—Hawk.

1. A. Cooperi—*Cooper's Hawk.* Seen in spring and fall. Not common.

2. A. fuscus—*Sharp-shinned Hawk.* Seen in spring and fall. Not common.

Genus Circus.—Harrier.

1. C. cyaneus—*Common Harrier.* Often seen sailing over the marshes; particularly during the fall.

Genus Surnia.—Day Owl.

1. S. funerea—*Hawk Owl.* Occasionally met with during severe winters.

2. S. nyctea—*Snowy Owl.* Very plentiful during some winters, at the beach. Between November, 1858, and March, 1859, seventeen specimens were brought to market by fishermen and others. Between November, 1859, and March, 1860, only two individuals were killed.

Genus Ulula.—Night Owl.

1. U. Acadica—*Saw-whet Owl.* Frequently caught during the day, in empty houses, throughout the country. Not seen in winter.

Genus Syrnium.—Hooting Owl.

1. S. nebulosum—*Barred Owl.* The most common species of this family. Seen in spring and fall: not observed in summer.

Genus Otus.—Eared Owl.

1. O. vulgaris—*Long-Eared Owl.* Rather rare. Observed only in the fall.

2. O. brachyotus—*Short-Eared Owl.* More frequently seen than the preceding. Observed to hunt during the day, in cloudy weather.

Genus Bubo.—Horned Owl.

1. B. Virginianus—*Virginian Horned Owl.* Not very rare. No particular haunt.

2. B. Asio—*Mottled Horned Owl.* One shot on the top of a store-house at Cook's Wharf, November, 1859.

Genus Caprimulgus.—GOAT SUCKER.

1. C. vociferus—*Whip-poor-Will.* Generally distributed. Common.

Genus Chordeiles.—NIGHT HAWK.

1. C. Virginianus—*Night Hawk.* Abundant. Breeds in the woods near the Bay.

Genus Chaetura.—SWIFT.

1. C. pelasgia—*Chimney Swallow.* Abundant everywhere.

Genus Hirundo.—SWALLOW.

1. H. purpurea—*Purple Martin.* Quite common in the city.
2. H. bicolor—*White-bellied Swallow.* Abundant. Generally distributed.
3. H. fulva—*Cliff Swallow.* Less common than the preceding. Builds in colonies on the outside of barns, &c.
4. H. rustica—*Barn Swallow.* Quite common. Builds inside of barns, &c.
5. H riparia—*Bank Swallow.* Abundant. Nests in sand-banks round the Bay Shore and elsewhere.

Genus Musicapa.—*Flycatcher.*

1. M. tyrannus—*Tyrant Flycatcher.* Generally distributed. Not abundant.
2. M. crenita—*Great Crested Flycatcher.* Quite common in the woods.
3. M Cooperi—*Cooper's Flycatcher.* One individual shot in a swamp near the Bay Shore.
4. M. Acadica—*Small Green-crested Flycatcher.* Abundant in the woods.
5. M. fusca—*Pee-wee Flycatcher.* Quite common. Builds in bridges, sheds, &c.
6. M. virens—*Wood Pee-wee Flycatcher.* Less common than the preceding. Frequents dead trees.
7. M. ruticilla—*Redstart.* Common in the woods, in summer.
8. M. flaviventris—*Yellow bellied Flycatcher.* Only one found. (Not mentioned by Audubon.)

Genus Mylodoctes.—FLYCATCHER WARBLER.

1. M. mitratus—*Hooded Warbler.* Only one specimen found.
2. M. Canadensis—*Canada Flycatcher.* Quite common during spring and early summer.
3. M. Wilsoni—*Wilson's Flycatcher.* Only one specimen found.

Genus Sylvicola.—WOOD WARBLER.

1. S. coronata—*Yellow-crowned Wood Warbler.* Abundant during spring and fall.
2. S striata—*Black-poll Wood Warbler.* Rather rare. Arrives late and leaves early.
3. S. castanea—*Bay-breasted Wood Warbler.* A regular visitor in spring. Not numerous.
4. S. icterocephala—*Chestnut-sided Wood Warbler.* Rather common. Nests among the briars.
5. S. vinus—*Vine-creeping Wood Warbler.* Quite common. One of the first to arrive.
6. S. Varus—*Hemlock Warbler.* Observed in September only.
7. S. virens—*Black-throated Green Wood Warbler.* Rather common in spring.
8. S. maritima—*Cape May Wood Warbler.* Rare. Two specimens procured.

9. S. cœrulea—*Cœrulean Wood Warbler.* Abundant in some seasons: less so in others.

10. S. Blackburniæ—*Blackburnian Wood Warbler.* A regular visitor, in uncertain numbers.

11. S. æstiva—*Yellow-poll Warbler.* Abundant. Builds in shade trees in the city.

12. S. Petechia—*Yellow Red-poll Warbler.* Common in the fall; rare in spring.

13. S. Americana—*Blue Yellow back Wood Warbler.* Not very plentiful.

14. S. Canadensis—*Black-throated Blue Wood Warbler.* Plentiful in spring.

15. S. maculosa—*Black and Yellow Wood Warbler.* An irregular spring visitor.

Genus Trichas.—GROUND WARBLER.

1. T. Marilandica—*Maryland Yellow-throat.* Not common near the city: more so in retired swamps.

2. T. Philadelphia. Rare. One found May 28th, 1860.

Genus Helinaia.—SWAMP WARBLER.

1. H. celata—*Orange crowned Swamp Warbler.* Only one specimen found.

2. H. rubricapilla—*Nashville Swamp Warbler.* Quite common. Breeds near the city.

3. H. chrysoptera—*Golden-winged Swamp Warbler.* Only one specimen found.

Genus Minotilta.—CREEPING WARBLER.

1. M. varia—*Black and White Creeping Warbler.* Abundant in the woods.

Genus Certhia.—CREEPER.

1. C. familiaris—*Brown Tree Creeper.* Common. Resident.

Genus Troglodytes.—WREN.

1. T. aedon—*House Wren.* A few pairs spend the summer in the gardens of the city.

2. T. hymenalis—*Winter Wren.* Common in spring and fall.

3. T. palustris—*Marsh Wren.* Found in all the marshes round the Bay in summer.

Genus Parus.—TIT.

1. P. atricapillus—*Black-capped Tit.* Abundant. Resident.

Genus Regulus.—KINGLET.

1. R. satrapa—*Gold crested Wren.* Plentiful in spring and fall.

2. R calendula—*Ruby-crowned Wren.* Plentiful in spring and fall.

Genus Sialia.—BLUE BIRD.

1. S. Wilsoni—*Common Blue Bird.* Plentiful from early spring till late in the fall.

Genus Orpheus.—MOCKING BIRD.

1. O. Carolinensis—*Cat Bird.* Quite common. Frequents low thickets.

2. O. Rufus—*Brown Thrush.* Less common than the preceding.

Genus Turdus.

1. T. migratorius—*Robin.* Abundant; breeds in the city gardens.

2. T. mustelinus—*Wood Thrush.* Rather rare. Frequents solitary woods.

3. T. Wilsoni—*Tawny Thrush.* Rather common.

4. T. solitarius—*Hermit Thrush.* Rather common. Similar in manner and haunt to the preceding.

Genus Seiurus.—Wood Wagtails.

1. S. aurocapillus—*Golden-crowned Wood Wagtail.* Common in the woods in summer.

2. S. novaeboracensis—*Aquatic Wood Wagtail.* Common; less so than the preceding.

Genus Anthus.—Pipit.

1. A. Ludovicianus—*American Pipit.* Straggling flocks seen in spring and fall.

Genus Alauda.—Lark.

1. A. alpestris—*Shore Lark.* Occasionally seen in company with plectrophanes nivalis.

Genus Plectrophanes.—Lark Bunting.

1. P. Lapponica—*Lapland Lark Bunting.* Occasionally found in company with the succeeding species.

2. P. nivalis—*Snow-flake.* Abundant while snow remains on the ground.

Genus Emberiza.—Bunting.

1. E. graminea—*Bay-winged Bunting.* Found in any grass field in summer.

2. E. Savanna—*Savannah Bunting.* Rather rare. Similar in habits to the preceding.

3. E. pusilla—*Field Sparrow.* Not very numerous; breeds near the city.

4. E. socialis—*Chipping Sparrow.* Quite common. Builds in shade trees in streets.

5. E. Canadensis—*Tree Sparrow.* Small flocks seen during winter.

6. E. passerina—*Yellow winged Bunting.* Rather rare.

Genus Niphœa —Snow Bird.

1. N. hyemalis—*Common Snow Bird.* Common. Resident.

Genus Spiza.—Painted Bunting.

1. S. cyanea—*Indigo Bird.* Common in the woods from May till September.

Genus Ammodramus.—Shore Finch.

1. A. palustris—*Swamp Sparrow.* Breeds in the reed beds of the Bay.

Genus Linaria.—Linnet.

1. L. minor—*Lesser Redpoll Linnet.* A winter visitor. Plentiful in some seasons; less so in others.

2. L. pinus—*Pine Linnet.* Less numerous than the preceding.

Genus Carduelis.—Gold Finch.

1. C. tristis—*Gold Finch.* Abundant. A few remain during winter.

Genus Fringilla.—Finch.

1. F. Iliaca—*Fox-coloured Sparrow.* Accidental in the fall.

2. F. melodia—*Song Sparrow.* Abundant from March till November.

3. F. Pennsylvanica—*White Throated Sparrow.* Common in spring and fall.

4. F. leucophrys—*White-crowned Sparrow.* Rather rare. Only seen in spring.

Genus Pipilo.—Ground Finch.

1. P. erythropthalmus—*Towhe Bunting.* Not very numerous.

Genus Erythrospiza.—PURPLE FINCH.

1. E. purpurea—*Purple Finch.* Occasional in the woods in winter.

Genus Corythus.—PINE FINCH.

1. C. enucleator—*Pine Grosbeak.* A winter visitor, appearing in considerable numbers in some seasons, and not at all in others. Common during the winter of 1859-60.

Genus Loxia.—CROSSBILL.

1. L. Curvirostra—*Crossbill.* An irregular winter visitor.

Genus Coccoborus.—SONG GROSBEAK.

1. C. Ludovicianus—*Rose-breasted Grosbeak.* Not very numerous. Frequents secluded groves.

Genus Pyranga.—RED BIRD.

1. P. rubra—*Scarlet Tanager.* Common in the woods in summer.

Genus Dolichonyx.—RICE BIRD.

1. D. oryzivora—*Bob-o-link.* Common. Frequents grass fields.

Genus Molothrus.—COW BIRD.

1. M. pecoris—*Common Cow Bird.* Abundant all over the country.

Genus Agelaius.—MARSH BLACKBIRD.

1. A. phoeniceus—*Red-winged Starling.* Abundant in all the marshes.

Genus Icterus.—HANGNEST.

1. I. Baltimore—*Baltimore Oriole.* Common in the woods and orchards.

Genus Quiscalus.—CROW BLACKBIRD.

1. Q. versicolor—*Crow Blackbird.* Seen in spring and fall. Not observed to breed near the city.

2. Q. ferrugineus—*Rusty Grackle.* Abundant in the fall, when they spend the day in the ploughed fields, and root in the reeds of the marsh at night.

Genus Sturnella.—MEADOW STARLING.

S. Ludoviciana—*Meadow Lark.* Common from early spring till late in the fall.

Genus Corvus.—CROW.

1. C. Americanus—*Common Crow.* The main body migratory; a few resident.

Genus Garrulus.—JAY.

1. G. cristatus—*Blue Jay.* Common. A few resident.

Genus Lanius.—SHRIKE.

1. L. borealis—*American Shrike.* A few individuals seen every winter.

2. L. Ludovicianus—*Loggerhead Shrike.** Two individuals shot in April, 1860. Not observed prior to that date.

Genus Vireo.

1. V. flavifrons—*Yellow-throated Vireo.* Not very numerous.

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*It is possible that this may prove to be the *Collyrio excur bitoroides* of Baird, as according to that author, *L. Ludovicianus* is found only in the South Atlantic and Gulf States; while *C. excurbitoroides* has been gradually advancing from the west, and might be expected to occur here about this time. Without comparing specimens, it is difficult to distinguish between the two.

2. V. gilvus—*Warbling Greenlet.* Rather common. Visits the shade trees in the city.

3. V. olivaceus—*Red-eyed Greenlet.* Common in the woods in summer.

Genus Bombycilla.—Waxwing.

1. B. garrula—*Bohemian Chatterer.* An irregular winter vistor. Usually seen in company with the pine grosbeak.

2. B. Carolinensis—*Cedar Bird.* Quite common during summer, frequently staying late in the fall.

Genus Sitta.—Nuthatch.

1. S. Carolinensis—*White-bellied Nuthatch.* Common. Resident.

2. S. Canadensis—*Red bellied Nuthatch.* Common. Not seen in summer.

Genus Trochilus.—Humming Bird.

1. T. colubris—*Ruby-throated Humming Bird.* Common. Seen wherever there are flowers in summer.

Genus Alcedo.—Kingfisher.

1. A. Alcyon—*Belted Kingfisher.* Common along the Bay shores.

Genus Picus.—Woodpecker.

1. P. villosus—*Hairy Woodpecker.* Quite common. Resident.

2. P. pubescens—*Downy Woodpecker.* Quite common. Resident.

3. P. varius—*Yellow-bellied Woodpecker.* Common during summer; breeds near the city.

4. P. Arcticus—*Arctic Three-toed Woodpecker.* Rare. Two specimens procured in November, 1859.

5. P. Carolinensis—*Red bellied Woodpecker.* Rather rare. Not seen in winter.

6. P. erythrocephalus—*Red headed Woodpecker.* Common in the country; less so near the city.

7. P. auratus—*Gold-winged Woodpecker.* Quite common. Breeds near the city.

Genus Coccyzus.—American Cuckoo.

1. C. erythropthalmus—*Black-billed Cuckoo.* Not very rare.

Genus Ectopistes.—Long Tailed Dove.

1. E. migratoria—*Passenger Pigeon.* A regular visitor, in uncertain numbers.

2. E. Carolinensis—*Carolina Dove.* Accidental, in the fall.

Genus Ortyx.—American Partridge.

1. O. Virginiana—*Partridge Quail.* Common in fall and winter.

Genus Tetrao.—Grouse.

1. T. umbellus—*Ruffled Grouse.* Common. Resident.

Genus Gallinula.—Gallenule.

1. G. chloropus—*Common Gallenule.* Found in the marshes. Not very numerous.

Genus Fulica.—Coot.

1. F. Americana—*Common Coot.* Found in the marshes. Not plentiful.

Genus Ortygometra.—Croke Gallenule.

1. O. Carolinus—*Sora Rail.* Extremely abundant in all the marshes during summer.

Genus Rallus.—Rail.

1. R. crepitans—*Clapper Rail.* Occasional, in the marsh.
2. R. Virginianus—*Virginian Rail.* More plentiful than the preceding.
3. R. elegans—*Great Red-breasted Rail.* Accidental. One specimen found.

Genus Charadrius.—Plover.

1. C. Helveticus—*Black-bellied Plover.* A regular visitor at the Beach in spring and fall.
2. C. marmoratus—*Golden Plover.* More numerous than the preceding.
3. C. vociferus—*Kildeer Plover.* Occasional. Never numerous.
4. C. semipalmatus—*Ring Plover.* Numerous in spring and fall.

Genus Strepsilas.—Turnstone.

1. S. interpres—*Turnstone.* Occasional at the beach.

Genus Tringa.—Sandpiper.

1. T. pectoralis—*Pectoral Sandpiper.* Abundant in the fall.
2. T. alpina—*Red-backed Sandpiper.* Extremely abundant about the 25th of May.
3. T. subarquata—*Curlew Sandpiper.* Occasional. Not numerous.
4. T. himantopus—*Long-legged Sandpiper.* A few seen at the beach every season.
5. T. semipalmata—*Semipalmated Sandpiper.* Very abundant in spring and fall.
6. T. pusilla—*Little Sandpiper.* Not quite so numerous as the preceding, with which it associates.
7. T. arenaria—*Sanderling Sandpiper.* Quite common at the beach.
8. T. islandica—*Red-headed Sandpiper.* Never very numerous.

Genus Lobipes.—Lobefoot.

1. L. hyperboreus—*Hyperborean Lobefoot.* Occasionally seen in small ponds near the bay.

Genus Totanus.—Tatler.

1. T. macularius—*Spotted Tatler.* Breeds near all the muddy creeks round the Bay.
2. T. flavipes—*Yellow-shanks Tatler.* Rather common during spring and fall.
3. T. vociferus—*Tell-tale Tatler.* Less numerous than the preceding.

Genus Limosa.—Godwit.

1. L. fœdoa—*Great Marbled Godwit.* Occasional. Not numerous.
2. L. Hudsonica—*Hudsonian Godwit.* Rather rare.

Genus Scolopàx.—Snipe.

1. S. Wilsoni—*Wilson's Snipe.* Abundant. Migratory.

Genus Numenius.—Curlew.

1. N. longirostris—*Long-billed Curlew.* Accidental on the Lake Shore.
2. N. Hudsonicus—*Hudsonian Curlew.* Less frequent than the preceding.

Genus Ardea.—Heron.

1. A. nycticorax—*Black-crowned Night Heron.* Accidental. Migratory.
2. A. lentiginosa—*American Bittern.* Abundant in all the marshes.
3. A. exilis—*Least Bittern.* Less numerous than the preceding.
4. A. Herodias—*Great Blue Heron.* Rather common.

Genus Anser.—GOOSE.

1. A. Canadensis—*Canada Goose.* A few rest on the Bay in their migratory course.

2. A. hyperboreus—*Snow Goose.* Accidental, in the Bay.

Genus Cygnus.—SWAN.

1. C. Americanus—*American Swan.* Accidental, in the Bay.

Genus Anas.—DUCK.

1. A. boschas—*Mallard.* Common. Migratory.
2. A. obscura—*Dusky Duck.* Common. Migratory.
3. A. strepera—*Gadwall.* Rare. Only two individuals seen.
4. A. Americana—*Widgeon.* Numerous in spring and fall.
5. A. acuta—*Pin-tail Duck.* Occasional. Not numerous.
6. A. sponsa—*Wood Duck.* Quite common. A few breed near the marsh.
7. A. Carolinensis—*Green-winged Teal.* Numerous in spring and fall.
8. A. discors—*Blue-winged Teal.* Less numerous than the preceding.
9. A. clypeata—*Shoveller.* Rather rare.

Genus Fuligula.—SEA DUCK.

1. F. valisneriana—*Canvass-back Duck.* Accidental. Only two individuals seen.
2. F. ferina—*Red-head Duck.* Rather common.
3. F. marila—*Scaup Duck.* Abundant in spring and fall.
4. F. marila minor—*Lesser Scaup Duck.* Abundant. Not distinguished by Audubon from the preceding.
5. F. rubida—*Ruddy Duck.* Immense numbers taken with the gill-nets in some seasons: not seen in others.
6. F. fusca—*Velvet Duck.* Occasional, in stormy weather.
7. F. clangula—*Golden-Eye Duck.* Not very numerous.
8. F. albeola—*Dipper.* Abundant in spring and fall.
9. F. glacialis—*Long tailed Duck.* Abundant. Winters in the Lake. Often caught in the gill-nets along with white-fish, twelve miles from shore, and at a depth of 200ft. to 250ft.

Genus Mergus.—MERGANSER.

1. M. merganser—*Goosander.* Not very plentiful.
2. M. serrator—*Red breasted Merganser.* Not very plentiful.
3. M. cucullatus—*Hooded Merganser.* More numerous than either of the preceding.

Genus Sterna.—TERN.

1. S. hirundo—*Common Tern.* Visits the Bay about the end of May.
2. S. nigra—*Black Tern.* Usually accompanies the preceding.

Genus Larus.—GULL.

1. L. Bonapartii—*Bonaparte's Gull.* Common during fall.
2. L. argentatus—*Herring Gull.* Winters at the beach.
3. L. marinus—*Great Black-backed Gull.* Winters at the beach. Very difficult of approach.

Genus Uria.—Guillemot.

1. U. grylle—*Black Guillemot.* Accidental, after easterly storms.
2. U. Troile—*Foolish Guillemot.* Accidental, after stormy weather.

Genus Colymbus —Diver.

1. C. glacialis—*Loon.* Often seen in the Bay.
2. C. septentrionalis—*Red throated Diver.* Immature specimens frequent; the adult not observed.

Genus Podiceps.—Grebe.

1. P. rubricollis—*Red necked Grebe.* Rather rare. Seen only in spring.
2. P. cornutus—*Horned Grebe.* Common during summer.
3. P. Carolinensis—*Pied-bill Dabchick.* Not so numerous as the preceding.

METEOROLOGICAL OBSERVATIONS, 1859, ST. MARY'S, C. W.

To the President of the Canadian Institute.

Sir,—I have herewith forwarded a continuation of the Meteorological Observations made by me in St. Mary's, Canada West, which you received last year. They are in Reduced Tabular form for reference, and I hope may be useful as to our climate, in this the highest portion of the Province, which is about 1090 feet above the level of the ocean, and in Latitude North 43° 17′ 57″ and West Longitude about 81° 13′ 20″, as detailed in my last communication. I have prepared the paper in tabular form. Each month exhibits barometric fluctuations, similar to those in the corresponding months of 1858, indicating I presume some general law, and the mean height of the whole year did not differ more than $\frac{4}{100}$ of an inch from that of 1859. March was again the lowest last year, and had also the greatest number of rainy days.

The amount of rainfall was considerably greater this year, 1859, than in 1858, being 42·71 ins. instead of 35·42 last year; the increase mainly having fallen in the summer and autumnal months.

The direction of the air currents as in last year was mainly from the West, being 136 days in 1859, and 139 days in 1858, and the Easterly winds which invariably bring rain or snow, in this part of the Province, prevailed 85 days in 1859, to 75 days in 1858; which may account for the greater rainfall this year, especially as the increased rate is noticeable in the summer and autumnal months in both cases.

The bright, clear, sunshiny days were as before greatly in excess of the dull cloudy and rainy days, being 217 in 1859, fine &c., to 148 dull and rainy days.

In order to analyse the phenomena of the two years observations 1858 and 1859 more easily, I have divided the tables into seasons, and placed the directions of air currents, and the atmospheric appearance in the form of a percentage on the year for easier comparison, all of which can readily be seen in the accompanying Table —Named Comparative Table of years 1858 and 1859.

In conclusion, I must apologise for their brevity, but can vouch for their accuracy, and thus submit them respectfully to the Institution.

W. GRAEME TOMKINS, C.E., P.L.S. &c.

St. Mary's, March 1, 1860.

P.S.—I have appended a Comparative Table of Seasonal Temperatures deduced from my own and other authentic sources.

METEOROLOGICAL OBSERVATIONS, 1859, AT ST. MARY'S, C.W.

SEASONAL TABLE MADE FOR ST. MARY'S, A.D. 1859.

BY W. GRÆME TOMKINS, C.E., P.L.S., ETC.

Season	Month.	Barometer.	Thermom'r.	Rain in Inches.	Direction of Wind. Nor.	Sou'd.	East.	West	Atmospheric Approximation. Fine.	Ch'ge.	Dull.	Rain.
Winter.	December ...	28.85	31.45	2.88	6	8	8	9	6	8	10	7
	January	28.86	26.77	3.05	5	17	5	10	10	6	10	5
	February ...	28.77	26.96	1.34	8	4	8	8	8	5	10	5
	Mean	28.83	28.39	T 7 27	21.1f.	25.5f.	23.4p.	30p.	26.7f.	21.1p.	33.4f.	18.8p.
Spring.	March	28.62	37.45	4.08	5	7	9	10	11	6	6	8
	April	28 66	41.40	2.52	10	2	10	8	10	7	9	4
	May	28.91	59.48	2.34	4	7	14	6	15	8	5	3
	Mean	28.73	46.11	T 8.94	20.7p.	17.4p.	36.0p.	26.0p	39.4p.	22.9p.	21.8p.	16.0p.
Summer.	June	28.83	63.00	5.25	2	8	3	17	16	7	4	3
	July	28.88	71.13	2.23	10	6	4	11	16	7	4	4
	August	28.81	66.93	7.88	9	4	3	15	17	5	4	5
	Mean	28.84	67.02	T15.36	22.7p.	19 3p.	11.0p.	47p.	42.7p.	22.9p.	13.2p.	13.2p.
Autumn.	September ...	28.83	56.03	1.77	5	11	3	11	9	7	7	7
	October	28.77	39.84	3.16	10	2	8	11	9	9	6	7
	November ...	28.76	35.03	5.27	4	6	10	10	10	5	8	7
	Mean	28.78	43.63	T10.14	21.0p.	21.0p.	23p.	35p.	31p.	23.0p.	23p.	23p.
Annual Mean		28.80	46.29	42.71	21.5p.	17.7p.	23 3p.	37.5p	37.8p.	22p.	22.7p.	17.5p.

Wind from Northward 78 days.
" " Southward 76 "
" " Eastward 85 "
" Westward 136 "

137 Fine days.
80 Changeable.
83 Dull.
65 Rain or Snow.

COMPARATIVE TABLE OF YEARS 1858 AND 1859, AT St. MARY'S, C. W.

BY W. GRÆME TOMKINS, C.E., P.L.S.

Barometric Table.

	Winter.	Spring.	Summer.	Autumn.	Annual.
1858	28.83	28.75	28.92	28.87	28.84
1859	28.83	28.73	28.84	28.78	28.80
Difference—1859	...	—.02	—.08	—.09	—.04

Thermometric.

1858	27.66	42.42	73.69	49.33	48.23
1859	28.39	46.11	67.02	43.63	46.29
Difference—1859	+0.73	+2.89	—6.67	—5.70	—1.94

Rain or Snow in inches.

1858	7.63	10.73	10.99	5.87	35.42
1859	7.27	8.94	15.36	10.14	42.71
Difference—1859	—.36	—1.79	+4.37	+4.27	+7.29

Wind Direction, per centum.

Direction.	1858.	1859.	1858.	1859.	1858.	1859.	1858.	1859.	
North	17.8	21.1	10.0	20.7	33	22.7	37.0	21	+10 in '58
South	26.6	25.5	18.5	17.4	10	19.3	18.5	21	+ 9 in '59
East	24.4	23.4	31.5	36.0	11	11.0	15.2	23	+10 in '59
West	31.2	30.0	40.0	26.0	46	47.0	20.3	35	+ 3 in '58

Atmospheric Appearance, per centum.

Fine	30.0	26.7	39.0	39.4	62.0	42.7	41.5	31	+21 in '58
Change	32.2	21.1	28.4	22.9	17.5	22.9	17.5	23	+ 7 in '58
Dull	21.0	33.4	15.2	21.8	10.5	13.2	24.0	23	+18 in '59
Rain	16.8	18.8	17.4	16.0	10.0	13.2	17.0	23	+10 in '59

CANADIAN INSTITUTE.

Session—1859-60.

TWELFTH ORDINARY MEETING—*10th March*, 1860.

Professor Wilson, LL.D., President, in the Chair.

I. *The following Donation for the Library was announced, and the thanks of the Institute voted to the donor:*

From Hon. J. M. Brodhead, Washington.

Explorations for a Railroad route from the Mississippi to the Pacific Ocean. Vol. X.

II. *The following Papers were read:*

1. By the Rev. Prof. Hincks, F.L.S.:
   "On the true aims, foundations, and claims to attention of Political Economy."
2. By W. Martin, LL.D.:
   "On some geometric problems relating to curves having double contact."
3. By J. H. Dumble, Esq. C.E.:
   "On the Expansion and Contraction of Ice."

THIRTEENTH ORDINARY MEETING—*17th March*, 1860.

Prof. Daniel Wilson, LL.D. President, in the Chair.

I. *The following Donation for the Library was announced, and the thanks of the Institute voted to the donor:*

From Major R. Lachlan, Cincinnatti.

Meteorlogische Waamamingan in Nederland en Zyne Bezittingan, su afeoykingen van Temperateuer en Barometerstand op vele Plaasten en Europa. Uitgeven door het Koninklyk nederlandich Meteorologisch Instituet, 1856 and 1857. Quarto. Two Vols.

Fourth Meteorological Report of Professor James P. Espy, to the United States Government, 27th July, 1854. Quarto. Two Vols.

II. *The following Papers were read:*

1. By Professor Chapman:
   "On the Geological structure of the 'Blue Mountains' near Collingwood." (2.) "On some simple rules for calculating the thickness of Inclined Strata." And (3.) "On a new species of *Agelacrinites* from Peterboro', C. W."
2. By the Rev. Professor G. P. Young, M.A.:
   "Proof of the impossibility of representing the common transcendental functions of a variable, as finite algebraical functions."
3. By Professor Wilson, LL.D.
   "On the origin of Alphabets, in reference to he question of the age of Man."

FOURTEENTH ORDINARY MEETING—24*th March*, 1860.

Professor DANIEL WILSON, LL.D., President, in the Chair.

I. *The following Gentlemen were elected Members:*

U. OGDEN, Esq , M.D., Toronto.

ROBERT CHECKLEY, Esq , M.D., Whitby.

II. *The following Donations for the Library were announced, and the thanks of the Institute voted to the donors:*

From J. H. James, Esq., per Dr. Philbrick.

"Principles of Political Economy." 3rd Edition: by J. S. Mill. Two Vols.

From the Historical Society of Pennsylvania.

"The Record of the Court at Upland Pennsylvania, 1676 to 1681, and Military Journal kept by Major E. Druny, 1781 to 1795. One Vol.

III. *The following Papers were read:*

1. By Professor J. B. Cherriman, M.A.:
"Remarks on Newton's investigation of the Velocity of Sound."

2. By Professor Croft, D.C.L.:
"On a reputed Blue Sand from India."

FIFTEENTH ORDINARY MEETING—31*st March*, 1860.

Professor WILSON, LL.D., President, in the Chair.

I. *The following Gentleman was elected a Member:*

JOHN DE CEW, Provincial Land Surveyor, Cayuga.

II. The President announced that this was the last regular Meeting of the Session, but in consequence of there being several papers yet to read, it was proposed to adjourn to Saturday the 14th April.

Messrs. Spreull and Harman were appointed Auditors of the Treasurer's Accounts for the present year.

III. *The following Papers were read:*

1. By G. R. R. Cockburn, Esq., M.A.:
"On Rent."

2. By Professor J. B. Cherriman, M.A.:
"On a Problem in Substitutions."

3. By S. Fleming, Esq., C.E.:
"On the development of lines of Internal Communication with a view to the future progress of Canada."

SIXTEENTH ORDINARY MEETING—14*th April*, 1860.

Professor H. CROFT, D.C.L., Vice-President, in the Chair.

I. *The following Gentleman was a elected Member:*

Doctor R. W. HILLARY, Whitchurch, C. W.

II. *The following Donations for the Library and Museum were announced, and the thanks of the Institute voted to the donors.*

For the Library.—From the Royal University of Christiana, Norway.

Forhadlinger ved de Skaudenaviske Natuaporskaras Syvende Mode—1— Christiania Don. 12–18, Julie 1356. One Vol.

Generalberating fra Gausted Sindssygeasyl for aeret 1858. One Vol.

Tale Cautate bid del &c. for Kong Oscar. One Vol.

Uber die Geometrische Reprasentation &c. Von C. A. Bjerknes and Dr. O. J. Broch Professor. One Vol.

Karlamagnus Saga ok Kappa Houst. One Vol.

Al-Mufassal Edidct. J. P. Broch. One Vol.

Det Kongelige Noaske Fredericks Unversitets Aarsbereting for oaset 1856–1858. One Vol.

Traces de Buddhisme en Norvège avant l' introduction du Christianisme, par M. E. A. Holmboe. One Vol.

Beretning om en Zoologiske Reise foretagen i sommeren 1857, vad D. C. Danielssan. One Vol.

Fortegnelfe over Modeller of Landhusholdnings-Redskaber, &c. One Vol.

Personalies oplaeste ved Eaus Magestaet Kong Oscar den 1s. One Vol.

Beretning om Godsfaengslets Verksomhed i aaret 1858. One Vol.

Unbound or in Pamphlet form,—Total 12.

For the Museum.—From John Fleming, Esq.

A collection of Trilobites and other Geological Specimens from Collingwood, Canada West.

III. *The following Papers were read :*

1. By Professor Hind, M.A.:
"On the occurrence of Grasshoppers, (so called) in the North West."

2. By the Rev. Professor Hatch, B.A.:
"On Moral Relations of the Greek Oracles."

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—APRIL, 1860.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 m. 33 s. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direc-tion.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10PM	ME'N		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P. M.		6 AM.	2 PM.	10 P.M.	Re-sult'.	ME'N		
					°	°	°	°	°												°							
1	29.234	29.285	—	—	36.3	35.6	—	—	—	.193	.110	—	—	.90	.51	—	—	N w b N	N W	NW b N	N 35 W	15.8	29.8	24.0	19.93	20.09	...	...
2	.572	.526	29.415	29.4995	19.7	30.2	28.7	26.42	—10.22	.058	.091	.109	.085	.53	.54	.69	.57	N b W	S E b S	S W b S	S	13.5	10.6	11.0	2.84	9.57	. .	0.1
3	.195	28.993	.070	.0800	32.7	49.9	38.5	40.93	+ 3.92	.169	.202	.194	.191	.90	.55	.83	.76	S b E	S S W	Calm.	S 31 W	9.5	12.8	0.0	7.05	7.64	...	...
4	.082	28.962	28.970	.0088	35.6	50.8	40.8	43.70	+ 6.37	.186	.223	.213	.213	.89	.59	.83	.75	N N W	N E b E	W b N	N 69 E	7.0	17.0	24.5	4.17	14.58	0.410	...
5	.036	29.114	29.431	.2107	37.8	46.1	34.7	39.43	+ 1.72	.184	.217	.179	.176	.80	.69	.88	.72	S W b S	S W	NW b N	N 81 W	9.5	8.5	9.5	6.94	9.20	0.010	...
6	.582	.672	—	—	35.2	46.1	—	—	—	.174	.234	—	—	.84	.75	—	—	N W	S	S S W	S 16 W	4.5	11.5	4.0	2.83	5.72	...	...
7	.734	.640	.471	.6078	34.5	43.5	43.5	41.42	+ 3.00	.181	.172	.259	.198	.90	.60	.92	.75	S S W	N E b E	E b N	N 65 E	3.2	8.5	11.2	7.34	8.77	0.052	...
8	.298	.331	—	—	42.8	55.8	—	—	—	.258	.388	—	—	.94	.87	—	—	N N E	S E b E	N b W	N 4 E	6.0	4.5	18.0	5.03	7.48	...	...
9	.536	.608	.669	.6128	41.7	44.8	39.2	42.08	+ 3.05	.218	.187	.190	.202	.82	.63	.79	.75	N b W	E b S	N E b N	N 54 E	12.5	11.4	4.5	8.40	9.79	...	...
10	.504	.317	.517	.4407	38.9	47.1	41.0	41.85	+ 2.43	.185	.299	.227	.242	.78	.92	.88	.90	E N E	N E b E	NW b N	N 2 W	18.2	1.5	22.8	6.30	9.15	0.135	...
11	.543	.631	.729	.6407	35.3	49.1	35.2	39.35	— 0.38	.164	.167	.190	.170	.80	.47	.93	.72	N b W	N b E	NW b N	N 27 W	10.8	5.0	3.2	4.51	6.13	...	...
12	.691	.380	.504	.5157	30.6	50.4	38.1	40.53	+ 0.40	.144	.258	.169	.199	.85	.70	.74	.77	N W b N	S S W	W N W	S 77 W	1.0	17.0	14.0	11.86	15.49	0.045	...
13	.608	.603	.433	.5515	34.2	50.4	41.4	40.72	+ 0.28	.153	.245	.221	.200	.77	.67	.85	.79	N W b W	W S W	W b N	N 87 W	22.0	20.4	19.2	14.91	18.07	0.140	0.2
14	.546	.679	.831	.7047	28.0	29.8	25.9	27.90	—12.83	.130	.147	.078	.111	.86	.88	.56	.72	NW b W	NW b W	N N W	N 61 W	12.6	22.2	12.2	14.06	14.63	...	inap.
15	.929	.899	—	—	23.3	32.4	—	—	—	.103	.105	—	—	.82	.56	—	—	W b N	S E b E	E	S 86 E	6.2	5.8	11.0	9.24	10.10	...	...
16	.681	.529	.335	.4955	33.8	38.8	43.0	39.00	— 2.48	.166	.186	.247	.202	.85	.79	.89	.84	E	N E b E	N E b E	N 65 E	14.0	9.4	5.8	6.93	7.79	0.120	...
17	.277	.732	30.062	.7423	43.5	46.1	32.0	40.53	— 1.22	.250	.196	.121	.175	.89	.63	.66	.68	W b S	W N W	W N W	N 73 W	10.0	25.5	12.2	18.77	18.92	...	...
18	30.228	30.232	30.115	30.1905	30.6	37.6	30.6	33.90	— 8.17	.131	.122	.123	.115	.76	.55	.72	.61	N W b W	S E b E	S E	S 85 E	5.0	9.5	3.0	3.80	5.90	...	...
19	30.014	29.892	29.731	29.8603	32.0	47.5	49.0	43.73	+ 1.38	.151	.132	.264	.179	.83	.40	.76	.63	N b E	E b N	N N E	N 47 W	6.0	14.5	3.0	6.59	7.05	0.060	...
20	29.629	.479	.423	.4895	41.4	49.7	43.9	44.88	+ 2.10	.250	.338	.283	.285	.95	.95	.98	.95	N	N E b E	Calm.	N 25 E	2.5	5.8	0.0	2.33	2.78	0.100	...
21	.409	.475	.423	.4353	47.5	50.8	47.7	49.42	+ 6.32	.316	.293	.273	.298	.96	.78	.83	.84	NW b W	N E b N	N	N 11 E	1.0	5.0	6.8	7.83	8.75	0.140	...
22	.496	.526	—	—	38.1	42.1	—	—	—	.204	.204	—	—	.88	.76	—	—	N	N	N W b N	N 25 W	16.2	10.5	11.0	12.88	13.27	0.070	...
23	.643	.612	.574	.6158	34.9	43.5	32.4	36.98	— 6.72	.117	.190	.161	.151	.57	.67	.87	.68	N b W	S b W	NW b N	N 45 W	7.8	10.2	9.5	8.24	10.17	...	...
24	.638	.600	.536	.5823	30.2	36.0	32.2	32.77	—11.23	.136	.129	.155	.143	.80	.61	.85	.77	NW b W	W b N	W b S	N 75 W	13.5	20.5	9.2	15.24	15.83	...	inap.
25	.423	.499	.627	.5242	31.3	38.1	30.9	33.85	—10.55	.152	.135	.120	141	.86	.58	.69	.73	NW b W	N W	NW b N	N 40 W	16.8	19.5	19.5	15.89	16.18	...	inap.
26	.692	.738	.816	.7560	31.8	42.1	34.2	36.70	— 8.03	.116	.170	.160	.151	.64	.62	.81	.69	N W b W	NW b W	NW b N	N 46 W	14.8	14.0	4.8	10.03	10.22	...	...
27	.868	.857	.912	.8805	30.6	47.7	41.0	40.87	— 4.15	.138	.138	.210	.160	.80	.41	.81	.64	N W b N	S b W	S W b S	S 31 W	1.0	12.0	7.6	6.12	7.05	...	...
28	.913	.847	.782	.8383	36.0	49.7	39.2	41.63	— 3.77	.172	.226	.180	.193	.81	.63	.75	.73	NW b W	E	E b N	N 79 E	1.5	7.5	3.8	4.11	5.62	...	...
29	.768	.748	—	—.	37.8	52.9	—	—	—	.183	.220	—	—	.80	.55	—	—	N N E	E b S	N E b E	N 67 E	2.0	6.2	1.5	3.97	4.50	...	...
30	.666	.571	.504	.5772	41.0	57.6	48.6	50.72	+ 4.67	.218	.288	.249	.257	.85	.60	.72	.70	N N E	E	W b N	N 35 E	1.8	11.0	7.2	4.90	8.42	...	...
M	29.5887	29.5632	29.5783	29.5775	34.73	44.89	37.99	39.55	— 1.44	.170	.198	.191	.185	.81	.64	.80	.74	....	....	....	....	8.87	12.25	9.80	......	10.30	1.282	0.3

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR APRIL, 1860.

Highest Barometer . . . . 30.265 at 8 a. m. on 18th. } Monthly range=
Lowest Barometer . . . . 28.896 at 8.30 p. m. on 4th, } 1.369 inches.

Self-registering Ther.
- Maximum temperature . . . . 61°8 on p.m. of 30th } Monthly range=
- Minimum temperature . . . . 19°5 on a.m. of 2nd } 42°3
- Mean maximum temperature . . 47°04 } Mean daily range = 14°84.
- Mean minimum temperature . . 32°19 }
- Greatest daily range . . . . . . 25°6 from a. m. to p.m. 13rd.
- Least daily range . . . . 3.5 from a. m. to p. m. of 3rd.

Warmest day . . 30th ... Mean Temperature . . . 50°72 } Difference=24°30.
Coldest day . . . 2nd ... Mean Temperature . . . 26°42 }

Maximum { Solar . . . . 76°0 on p. m. of 30th } Monthly range=
Radiation { Terrestrial . . . . 5.8 on a. m. of 2nd } 70°2.

Aurora observed on 7 nights, viz.: on 9th, 11th, 12th, 14th, 18th, 23rd and 26th; possible to see Aurora on 18 nights; impossible on 12 nights.
Snowing on 5 days; depth 0.3 inches: duration of fall 7.2 hours.
Raining on 11 days; depth, 1.282 inches; duration of fall, 40.6 hours.
Mean of cloudiness=0.59; most cloudy hour observed, 2 p. m., mean=0.67: least cloudy hour observed, 10 p. m.; mean=0.49.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
3433.17	1065.19	1657.39	3420.57

Resultant direction, N 37° W; Resultant Velocity, 4.10 miles per hour.
Mean velocity of the wind 10.30 miles per hour.
Maximum velocity . . . 34.2 miles per hour, from 8 to 9 a.m. on the 17th.
Most windy day . . 1st—Mean velocity, 20.09 miles per hour. } Difference 17.31
Least windy day . . 20th—Mean velocity, 2.78 do } miles.
Most windy hour, 2 to 3 p. m.—Mean velocity, 12.90 miles per hour. } Difference
Least windy hour, 1 to 2 a. m.—Mean velocity, 7.61 do. } 5.29 miles.

5th. Thin ice on the boards at 5.30 a. m.
6th. Thin ice on the pools at 6 a. m.
8th. Frogs croaking loudly (first heard this season.)
10th. Distant thunder from 6.40 to 7.20 a. m.
15th. Imperfect Solar Halo from 9 to 10 a. m.
16th. Sheet lightning in E. from 11.30 p. m.
20th. Fog from 11 a. m. Sheet lightning in S. E. from 10.40 p. m.
21st. Dense fog to 8 a. m.
24th. Occultation of Venus from about 8 20 p. m.
27th. Perfect Solar Halo, exhibiting the Prismatic colors, from 7.30 a. m. to 4 p. m.
28th. Hoar frost 6 a. m.

Thin ice on shallow vessels every morning from 24th to 29th inclusive.

The Resultant Direction and Velocity of the Wind for the month of April, from 1848 to 1860 inclusive, were respectively N. 23° W., and 2.10 miles.

The month of April, 1860, was cold, dry and windy—the mean temperature having been 1°43 below the average of 21 years. The depth of Rain recorded was the least during the series, and 1.153 inches less than the average, and the velocity of the wind 2.51 miles per hour above the average of 13 years.

COMPARATIVE TABLE FOR APRIL.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant Direction.	Resultant Velocity.	Mean Velocity
	°	°	°	°	°					°		
1840	42.4	+ 1.5	65.9	25.3	40.6	14	3.420	2	...	...	...	...
1841	39.2	— 1.7	62.9	22.1	40.8	3	1.370	3	...	...	...	0.51 lbs
1842	43.1	+ 2.2	89.5	21.6	67.9	8	3.740	2	...	...	...	0.57 "
1843	40.9	0.0	70.0	15.1	54.9	7	3.185	3	0.1	...	...	0.46 "
1844	47.5	+ 6.6	74.5	17.2	57.3	10	1.515	1	Inap	...	...	0.24 "
1845	42.1	+ 1.2	66.0	14.8	51.2	11	3.290	4	1.5	...	...	1.00 "
1846	44.0	+ 3.1	79.4	24.4	55.0	10	1.300	2	1.3	...	...	0.55 "
1847	39.2	— 1.7	65.6	8.4	57.2	8	2.870	2	4.0	...	...	0.59 "
1848	41.3	+ 0.4	65.4	26.5	38.9	5	1.455	1	0.5	N 77 W	1.46	4.89ms.
1849	39.0	— 1.9	70.9	23.2	47.7	10	2.655	2	1.7	N 43 W	3.14	7.50 "
1850	37.9	— 3.0	63.2	18.2	45.0	7	4.720	2	1.1	N 39 W	1.12	7.64 "
1851	41.3	+ 0.4	59.2	25.8	33.4	11	2.295	3	1.2	N 14 E	2.52	8.07 "
1852	38.2	— 2.7	53.8	19.8	34.0	6	1.990	4	9.4	N 23 E	2.44	6.68 "
1853	41.9	+ 1.0	65.7	27.0	38.7	10	2.625	1	1.0	N 12 W	1.95	5.20 "
1854	41.0	+ 0.1	65.1	22.3	42.8	12	2.685	4	2.7	N 50 E	2.57	6.81 "
1855	42.4	+ 1.5	63.8	12.2	51.6	8	2.030	3	1.6	N 36 W	3.99	7.57 "
1856	42.3	+ 1.4	69.8	15.1	54.7	13	2.780	3	0.1	N 29 E	1.64	6.05 "
1857	35.4	— 5.5	51.9	10.0	41.9	10	1.755	11	12.9	N 60 W	4.15	10.24 "
1858	41.5	+ 0.6	61.5	23.8	37.7	13	1.642	2	0.1	N 14 W	1.64	9.57 "
1859	39.5	— 1.4	62.1	23.9	38.2	9	2.527	8	1.2	N 36 W	2.33	10.79 "
1860	39.5	— 1.4	60.7	19.7	41.0	11	1.282	5	0.3	N 37 W	4.10	10.30 "
Mean	40.93	...	66.04	19.83	46.21	9.3	2.435	3.2	2.26	...	...	7.79

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—MAY, 1860.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Days.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M	2 P.M	10 PM	ME'N	Excess of mean above Average	Tens. of Vapour. 6 A.M	2 P.M	10 P.M.	M'N	Humidity of Air. 6 A.M	2 P.M	10 P.M	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M	2 P.M	10 PM	Resul't.	ME'N	Rain in Inches.	Snow in Inches.
1	29.574	29.693	29.811	29.7103	° 44.6	° 42.8	° 37.8	° 41.30	° — 5.12	.235	.190	.183	.201	.80	.69	.80	.77	N N W	N W	N W b N	° N 36 W	9.4	16.8	8.2	11.65	11.82	0.003	...
2	.871	.848	.800	.8357	35.6	54.7	49.3	46.90	+ 0.18	.186	.337	.270	.260	.89	.78	.77	.79	N b W	S S W	N b W	N 30 W	13.6	6.0	10.0	4.40	7.40	...	...
3	.794	.708	.661	.7140	42.8	59.4	54.7	53.58	+ 6.53	.213	.297	.262	.258	.77	.58	.60	.63	N N W	S b W	N W	S 63 W	0.5	6.5	7.0	1.19	3.50	0.015	...
4	.651	.655	.614	.6397	49.7	65.0	54.7	56.92	+ 9.50	.278	.359	.337	.318	.77	.58	.78	.69	N N W	S S W	W b N	S 37 W	0.2	7.5	3.2	2.20	3.90	...	...
5	.639	.614	.620	.6282	53.5	66.1	48.9	56.13	+ 8.40	.299	.254	.298	.289	.72	.38	.86	.66	Calm.	S	S	S 43 W	0.0	4.6	1.5	1.07	2.03	...	...
6	.616	.530	—	—	49.3	66.3	—	—	—	.293	.419	—	—	.83	.64	—	—	W W	E b N	E b S	N 80 E	0.5	8.2	3.5	4.39	5.34	...	...
7	.515	.497	.506	.5078	51.1	73.2	63.0	62.02	+13.60	.309	.541	.409	.449	.82	.65	.71	.79	N b E	S S W	N W	N 63 W	0.8	3.2	5.2	2.96	3.82	0.080	...
8	.529	.536	.440	.5153	60.5	62.7	59.8	59.78	+11.00	.408	.454	.428	.421	.77	.79	.83	.82	E N E	E	N E b N	N 9 E	6.4	4.0	12.0	3.53	7.86	0.935	...
9	.400	.340	.414	.3832	55.8	60.1	57.2	57.02	+ 7.85	.422	.402	.439	.414	.95	.77	.94	.89	E N E	E b N	S b W	S 68 E	16.5	12.5	8.5	6.40	9.41	0.205	...
10	.486	.552	.612	.5625	52.6	60.5	51.8	54.30	+ 4.80	.386	.408	.363	.381	.97	.77	.94	.90	N E	E	N E b N	N 61 E	3.8	9.0	4.2	4.98	5.77	0.055	...
11	.673	.730	.757	.7248	52.2	61.6	56.5	57.03	+ 7.13	.358	.417	.402	.391	.92	.76	.88	.84	N E b N	E N E	N E	N 49 E	6.5	10.4	10.5	8.89	9.11	...	...
12	.798	.768	.712	.7515	54.7	62.7	56.9	58.45	+ 8.28	.380	.414	.408	.408	.89	.72	.88	.83	N N E	E b N	N E b E	N 52 E	6.2	11.6	10.5	8.64	9.32	...	...
13	.677	.662	—	—	56.5	65.4	—	—	—	.368	.418	—	—	.80	.66	—	—	N N E	E b S	N W	N 59 E	5.5	13.0	4.0	3.65	5.57	...	...
14	.624	.576	.586	.5920	55.4	67.0	54.9	61.18	+10.30	.405	.435	.249	.366	.93	.65	.58	.67	N N W	S E b S	N E b E	S 82 E	2.2	8.0	4.0	1.15	4.70	...	...
15	.654	.683	.642	.6618	55.4	59.8	50.9	56.12	+ 4.83	.371	.281	.200	.285	.85	.54	.53	.63	N N E	E	E S E	N 75 E	4.2	4.6	3.5	2.75	4.80	...	...
16	.653	.646	.695	.6678	55.4	65.9	54.4	59.42	+ 7.83	.295	.312	.287	.295	.67	.49	.67	.59	N N W	S S E	E	N 65 E	5.5	6.2	10.2	5.46	7.32	...	...
17	.757	.731	.687	.7205	50.6	59.0	54.4	55.03	+ 3.05	.215	.291	.385	.296	.57	.57	.91	.68	N E b E	E N E	N W	N 56 E	10.6	18.2	5.2	8.28	9.68	0.052	...
18	.571	.447	.303	.4257	51.1	60.1	50.4	54.05	+ 1.77	.342	.436	.340	.370	.91	.84	.93	.88	N N E	E	N E	N 64 E	3.0	8.8	3.6	4.06	4.97	0.147	...
19	.130	.088	.178	.1600	51.1	60.1	49.0	52.25	— 0.37	.347	.402	.236	.308	.92	.77	.67	.76	N W b N	W b S	N W	N 72 W	4.2	20.5	22.5	15.78	16.52	0.095	...
20	.439	.517	—	—	37.4	49.9	—	—	—	.163	.252	—	—	.72	.70	—	—	N W b N	S b W	N	N 36 W	16.0	12.6	4.0	4.56	10.54	0.015	...
21	.468	.407	.416	.4188	41.4	41.7	42.1	41.50	—11.82	.195	.237	.223	.224	.75	.89	.83	.85	N E b E	N E b E	N E b E	N 55 E	14.5	19.5	7.8	11.49	11.77	0.135	...
22	.466	.565	.674	.5807	44.6	60.1	47.5	51.43	— 2.27	.264	.401	.255	.301	.90	.77	.77	.78	N W	S S W	N b W	S 12 W	1.8	4.2	12.4	5.37	8.22	...	...
23	.790	.802	.742	.7732	43.5	58.0	45.4	50.83	— 3.13	.250	.271	.272	.276	.89	.56	.90	.75	N b W	S b W	S S W	S 27 E	2.5	4.4	1.5	1.14	3.37	...	...
24	.740	.689	.659	.6857	47.2	58.0	54.0	54.58	+ 0.30	.287	.304	.282	.297	.89	.62	.67	.70	N W	E S E	E	N 59 E	1.2	8.0	5.0	3.89	4.89	...	...
25	.627	.550	.445	.5303	56.7	68.8	57.6	61.43	+ 6.75	.278	.304	.428	.328	.60	.42	.90	.62	N E b E	E b N	N E	N 57 E	4.2	12.5	8.5	7.23	7.76	0.013	...
26	.401	.242	.266	.3013	51.8	67.3	61.2	59.40	+ 4.42	.343	.577	.375	.416	.89	.86	.69	.80	N N W	E S E	N W	N 1 W	1.5	9.4	18.5	4.59	8.83	0.010	...
27	.391	.396	—	—	55.4	65.2	—	—	—	.340	.370	—	—	.76	.59	—	—	N W b W	W b N	N	N 55 W	5.2	10.6	1.5	4.78	6.17	...	...
28	.484	.524	.600	.5397	48.6	64.1	53.3	57.02	+ 1.37	.292	.373	.344	.342	.85	.62	.84	.74	N	S S W	W	S 82 W	4.5	6.8	1.0	1.95	4.56	...	...
29	.630	.605	.562	.5725	52.2	66.6	55.4	59.47	+ 3.52	.327	.344	.371	.352	.83	.52	.85	.71	N N W	N E b E	N E b E	N 57 E	2.2	8.2	11.5	8.28	8.97	0.005	...
30	.376	.263	.319	.3193	54.7	69.5	64.1	62.95	+ 6.70	.403	.507	.487	.451	.94	.70	.81	.79	E b N	S	W b N	S 17 W	10.2	12.5	1.0	2.70	6.57	inap.	...
31	.320	.329	.420	.3570	58.0	62.7	57.2	59.15	+ 2.60	.417	.477	.404	.430	.86	.84	.86	.85	S W b W	W S W	N W	N 76 W	5.5	7.5	5.5	5.30	7.79	0.020	...
M	29.5804	29.5585	29.5610	29.5659	50.77	61.39	53.42	55.53	+ 4.05	.315	.371	.331	.338	.83	.67	.79	.76	....	....	....	....	5.45	9.54	6.95	......	7.17	1.815	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR MAY.

Highest Barometer .... 29.886 at 8 a. m., on 2nd } Monthly range=
Lowest Barometer .... 29.088 at 2 p. m. on 19th } 0.798 inches

Self-regist'ing Thermom.
- Maximum Temperature .... 74°5 on p. m. of 30th } Monthly range=
- Minimum Temperature .... 32°5 on a. m. of 2nd } 42°0
- Mean maximum Temperature .... 63°97 } Mean daily range=
- Mean minimum Temperature .... 47°79 } 16°18
- Greatest daily range .... 24°6 from a. m. to p. m. of 6th.
- Least daily range................. 5°2 from a. m. to p. m. of 1st.

Warmest day......... 30th ... Mean temperature......... 62.95 } Difference = 21°65.
Coldest day........... 1st ... Mean temperature......... 41°30 }
Maximum } Solar............................... 92°0 on p. m. of 7th } Monthly range=
Radiation. } Terrestrial...................... 21°5 on a. m. of 2nd } 70°5.
Aurora observed on 7 nights, viz., on 11th, 12th, 14th, 18th, 23rd, 24th and 27th.
Possible to see Aurora on 19 nights; impossible on 12 nights.
Raining on 16 days,—depth 1.815 inches; duration of fall 36.1 hours.
Mean of cloudiness = 0.57.
Most cloudy hour observed, 2 p. m., mean = 0.64; least cloudy hour observed, 10 p. m., mean, = 0.50.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
2441.17	659.28	2304.80	1441.04

Resultant direction N. 26° E.; Resultant Velocity 2.66 miles per hour.
Mean velocity.......................... 7.17 miles per hour.
Maximum velocity .... 29.8 miles, from 11 p. m. to midnight on 19th.
Most windy day .... 19th......Mean velocity 16.52 miles per hour. } Difference=
Least windy day .... 5th......Mean velocity 2.03 ditto. } 14.49 miles.
Most windy hour... 1 to 2 p. m.................. Mean velocity 9.55 ditto. } Difference
Least windy hour... 4 to 5 a. m. .... Mean velocity 4.94 ditto. } 4.61 miles.

2nd. Hoar Frost at 6 a. m.—4th. Corona round the Moon at 10 p. m. and midnight.—7th. Thunderstorm from 8 to 9 a. m. and 3 to 4 p. m.—8th. Heavy Thunderstorm, Lightning, Rain and large Hailstones, from 9 p. m. to midnight.—10th. Dense Fog from 6 to 8 a. m.—12th. Imperfect Rainbow at 6.50 p. m.—17th. Thunderstorm 8.30 to 10.20 p. m.—18th. Distant Thunder and slight Rain from 3 to 5 p. m.—19th. Sheet Lightning in S. W. at 8.30 p. m.—24th. Distant Thunder 2.30 and 3 p. m—25th. Thunderstorm from 8.30 to midnight.—26th. Thunderstorm, noon to 3.45 p. m. and Faint Rainbow. 4 to 5 p. m.—28th. Distant Thunder 7.30 p. m.—29th. Thunderstorm, 10 p. m. to midnight.

Heavy Dew recorded on 8 mornings during this month.

The Resultant Direction and Velocity of the Wind for the month of May, from 1848 to 1860 inclusive, were respectively N 6° E, and 1.43 miles.

The month of May, 1860, was warm, dry, and windy.
The Mean Temperature having been 3°95 above the average, was only once previously equalled in 21 years.
The depth of rain recorded is 1.419 inches less than the average. This is only a little more than half the mean amount.
The Mean Velocity of the Wind was 0.75 miles per hour above the average of 13 years.

COMPARATIVE TABLE FOR MAY.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	M'n.	Diff. from Aver.	Max ob'd.	Min. ob'd.	Range.	No. of days.	Inch's.	No. of days.	Inch's.	Resultant Direction.	Resultant V'y.	Mean Force or Velocity.
	°	°	°	°	°							
1840	53.8	+2.2	74.5	30.8	43.7	9	4.150	...	not record.	...	...	....
1841	50.5	—1.1	76.2	26.6	49.6	11	2.350	1		...	...	0.35 lbs.
1842	49.1	—2.5	74.3	30.0	44.3	7	1.275	...		...	...	0.53
1843	49.1	—2.5	79.6	28.9	50.7	5	1.570	...	...	...	...	0.52
1844	53.6	+2.0	77.7	29.0	48.7	14	5.670	...	...	...	...	0.30
1845	49.6	—2.0	76.6	29.4	47.2	8	2.300	...	...	...	...	0.55
1846	55.5	+3.9	78.1	34.3	43.8	9	4.375	...	...	...	...	0.46
1847	54.4	+2.8	72.5	27.8	44.7	12	2.040	...	...	...	...	0.29
1848	54.1	+2.5	78.5	31.9	46.6	13	2.520	...	...	N 40° W	1.31	4.93 mls.
1849	48.0	—3.6	72.5	32.7	39.8	16	5.115	...	...	N 51° E	1.97	5.33
1850	47.6	—4.0	76.3	31.1	45.2	7	0.545	1	Inapp	N 64° E	2.05	6.32
1851	51.3	—0.3	73.2	28.7	44.5	12	2.950	1	0.5	N 32° W	1.59	6.34
1852	51.4	—0.2	73.3	34.5	38.8	7	1.125	1	Inapp	S 82° W	0.99	4.00
1853	50.9	—0.7	78.4	38.4	40.0	17	4.420	1	Inapp	N 2° W	0.83	5.16
1854	52.2	+0.6	69.0	27.6	41.4	11	4.630	...	...	E	0.40	5.38
1855	53.1	+1.5	74.8	33.9	40.9	6	2.565	2	0.9	N 1° W	2.76	5.93
1856	50.5	—1.1	80.1	35.5	44.6	14	4.580	1	Inapp	N 4° E	3.99	9.81
1857	48.9	—2.7	72.5	27.9	44.6	15	4.145	1	Inapp	N 23° W	1.14	8.13
1858	48.9	—2.7	66.0	35.0	31.0	17	6.367	...	...	N 42° E	3.33	9.30
1859	55.2	+3.6	76.2	41.5	34.7	11	3.410	...	...	N 72° E	1.59	5.70
1860	55.5	+3.9	73.2	35.6	37.6	16	1.815	...	...	N 26° E	2.66	7.17
M	51.58	...	74.93	31.96	42.97	11.3	3.234	0.4	0.08	....	...	6.42 Ml.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—APRIL, 1860.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—F.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone. (tenths)	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.371	29.867	29.521	34.0	40.0	27.1	.175	.182	.117	.89	.73	82	E S E	N W	N N E	152.20	8.0	...	...	Cu. Str. 10.	Cu. Str. 10.	Cirr. 4. L. Hal.
2	788	650	700	10.0	20.0	17.0	054	065	068	78	62	75	N b W	W	S W	261.30	0.0	...	...	Clear.	Clear.	Clear.
3	574	347	351	20.1	32.1	31.9	081	143	156	77	79	89	S b E	S S E	N E b E	59.70	10.0	...	0.75	C. C. Str. 10.	Cu. Str. 10	Snow.
4	420	367	294	29.0	42.0	36.0	142	199	170	88	74	80	N E b E	N E b E	N E b E	60.70	1.5	...	...	Cu. Str. 4.	Clear.	Clear.
5	227	250	451	34.1	38.2	31.2	180	201	149	90	85	86	N E b E	N E	N E	178.80	7.6	0.500	...	Rain.	Cu. Str. 4.	C. C. Str. 8.
6	670	662	801	30.1	46.7	34.1	148	232	175	89	73	89	N W	N N E	S S W	74.00	3.5	...	1.60	Snow.	Clear.	Clear.
7	958	684	722	30.1	56.8	40.1	136	329	208	82	72	80	S S W	S S W	S E	5.00	0.0	...	...	Clear.	Do.	Do.
8	551	441	516	38.4	40.2	41.0	214	225	235	98	91	91	S S E	S S E	S b W	16.80	10.0	0.583	...	Rain.	Rain.	Cu. Str. 10.
9	654	747	972	38.0	58.0	38.0	203	365	151	83	76	70	N N E	W S W	N N E	17.00	2.0	...	...	Cu. Str. 4.	Cu. Str. 2.	C. Au. Br. Par.
10	900	654	261	28.6	42.0	40.1	129	184	225	82	70	90	N E b E	S S E	S S E	56.40	8.0	0.160	...	Do. 2.	St. 10.	Cu. Str. 10.
11	570	484	647	33.4	49.6	37.7	182	290	193	95	82	87	W b N	N N W	N b W	233.40	5.0	...	...	Clear.	Cu. Str. 4.	Rain.
12	801	402	347	30.1	55.3	42.2	148	321	237	89	74	89	E	S b E	S E	15.00	3.0	0.290	Inp.	Do.	Cir. Str. 4.	Cu. Str. 10.
13	342	479	515	34.2	41.0	40.2	170	169	203	86	65	82	W S W	W	S W	225.30	3.5	...	...	Cu. Str. 10.	C. C. Str. 4.	C. Str. 2. Au. B.
14	492	647	742	24.2	26.4	18.9	083	082	061	66	57	60	W N W	W N W	W N W	379.50	2.5	...	...	Do. 6.	Clear.	Clear. Au. Bor.
15	30.000	911	980	12.1	32.0	27.8	045	112	117	60	63	78	W N W	W S W	S W	402.40	1.5	...	...	Do,	Do.	Clear.
16	002	971	860	32.0	36.4	34.6	143	136	169	79	65	84	S S E	S S E	S S E	31.40	1.0	0.500	...	Do.	Do.	Do.
17	29.301	204	990	40.1	56.1	36.1	225	336	170	91	75	80	S S E	W S W	W N W	423.40	2.5	...	...	R. with thun.	Cu. Str. 4.	Do.
18	30.381	30.224	30.260	25.0	43.2	29.2	110	186	136	75	67	84	N N W	S W b S	S S W	213.30	1.0	...	...	Clear.	Clear.	Do.
19	272	29.914	29.860	30.0	60.1	43.4	130	396	224	78	75	79	W b S	S W	S	13.10	1.0	...	...	Do.	Do.	Clear. Au. Bor.
20	29.842	311	417	36.7	64.9	50.2	164	451	303	76	73	88	S S E	S S E	S S W	129.80	1.0	...	...	Cu. Str. 4.	C. C. Str. 8.	Do.
21	437	347	444	43.0	63.7	48.0	254	416	285	91	72	85	E	E b N	N E b E	41.10	1.5	...	...	C. C. Str. 8.	Clear.	Do. 10.
22	594	314	414	36.7	61.7	50.5	177	406	283	85	74	78	N E b E	E S E	S	195.10	1.5	...	...	Do. 4.	Do.	Clear.
23	590	414	574	34.2	54.0	39.0	155	282	167	79	67	68	W N W	W S W	W N W	167.80	1.0	...	...	Clear.	Do.	C. C. Str. 4.
24	630	454	600	31.0	39.8	30.0	136	131	130	77	55	70	W N W	W S W	W N W	151.10	1.5	...	...	Cu. Str. 10.	Cu. Str. 4.	Snow.
25	671	740	714	25.4	46.2	38.3	100	280	182	74	88	79	S S W	S E	S S W	100.90	2.5	...	0.10	Do. 2.	C. C. Str. 2.	Cu. Str. 4.
26	557	561	811	37.2	53.0	42.7	178	269	215	81	67	78	W S W	W	W N W	152.00	1.0	...	...	Clear.	Clear.	Clear.
27	914	901	954	35.2	55.2	40.3	162	218	203	80	50	82	S W b W	W b N	W S W	143.30	1.0	...	...	Do.	Do.	Do.
28	30.001	942	847	32.7	67.4	46.3	137	274	192	74	41	62	S S W	S b E	S E	9.27	1.0	...	...	Do.	Do.	Do.
29	952	900	947	35.4	72.1	55.2	127	270	269	62	32	62	N E b E	S E b E	S E b E	130.23	1.0	...	...	Do.	Do.	Do.
30	976	942	874	43.0	76.2	57.0	209	305	230	75	34	51	E S E	S E	E S E	151.40	0.5	...	...	Do.	Do.	Do.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—MAY, 1860.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M.D., LL.D.

Latitude—45 *deg.* 32 *min. North. Longitude*—73 *deg.* 36 *min. West. Height above the Level of the Sea*—118 *feet.*

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—P.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone. t'nths	Rain in inches.	Snow in inches.	Weather, &c. A Cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 PM	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.970	29.900	29.930	49.9	79.5	23.8	.228	.217	.269	.64	.26	.67	S E	S E	S E	125.36	0.0	...	...	Clear.	Clear.	Clear.
2	30.140	890	920	44.9	69.9	53.2	275	360	288	92	50	76	S E	E b S	N E	14.60	0.5	...	...	Hazy.	Do.	Do.
3	29.990	842	725	47.3	74.5	59.0	291	270	318	89	32	63	E	S W b W	S S E	8.50	0.5	...	...	Clear.	Do.	Do.
4	820	714	624	50.0	74.1	59.1	256	263	352	71	31	70	E S E	N E b E	N E b E	131.10	1.5	...	...	Cu. Str. 10.	Do.	Do.
5	860	954	981	57.0	73.2	58.4	262	345	357	55	42	70	N N E	S S E	S b E	0.10	1.0	...	...	Clear.	Do.	Do.
6	30.017	997	30.001	47.0	84.2	62.2	267	545	347	81	47	64	S E	S	S	12.20	1.0	...	...	Do.	Do.	Do.
7	29.920	902	046	54.5	72.1	57.9	383	489	385	90	62	84	S b E	S E	N N E	87.70	1.5	...	...	Hazy.	Do.	Cu. Str. 10.
8	990	941	001	47.0	74.2	60.9	267	532	449	80	63	85	N N E	S S W	S S W	153.40	1.5	...	...	Cu. Str. 4.	Cu. Str. 4.	Clear.
9	30.146	30.050	061	56.1	58.5	56.3	391	452	413	87	94	90	S E	S E	S E	100.10	3.0	Inap.	...	Clear.	Do. 10.	Cu. St. 10. Par.
10	29.947	29.814	29.879	52.2	63.4	57.4	368	543	452	96	94	94	S E	E S E	S S E	249.10	5.0	0.160	...	Cu. Str. 4.	Do. 4.	Slight rain.
11	641	846	30.056	60.3	76.1	63.6	480	541	510	91	60	88	S S E	S S E	S S E	11.16	5.3	...	...	Do. 4.	Do. 4.	C. C. Str. 8.
12	998	30.004	110	64.2	81.6	69.2	529	617	635	89	58	90	S S E	S b W	S S E	2.70	0.0	...	...	Clear.	Clear.	Clear. Au. Br.
13	980	29.894	29.914	59.6	83.1	65.6	403	597	337	79	53	59	S S E	E b S	S E b E	84.50	1.3	...	...	Do.	Do.	Cu. Str. Sr. H.
14	871	747	797	63.8	70.1	51.0	341	390	270	83	30	72	E b N	N E b E	N E b E	311.70	0.0	...	...	Do.	Do.	Cl. Solar Halo.
15	800	831	814	44.1	72.2	56.7	218	327	359	76	42	78	N b E	S S E	W S W	199.70	0.0	...	...	Do.	Do.	Do.
16	771	30.040	30.090	46.0	60.2	47.1	262	216	256	84	43	81	N E b E	E N E	E b S	222.80	0.0	...	...	Do.	Do.	Do.
17	30.140	004	119	45.5	72.4	53.0	198	524	321	63	66	80	N b E	S S E	S S E	44.64	0.0	...	...	Do.	Do.	Do.
18	29.947	29.900	29.799	50.1	64.6	60.3	326	285	426	93	48	82	S S E	S b E	S b E	113.62	6.6	Inap.	...	Do.	Cu. Str. 10.	C. St. lig'tS.W
19	489	279	187	61.1	63.0	55.0	480	491	375	90	88	93	S S E	S S E	S W	100.10	5.5	2.670	...	Cu. Str. 10.	Rain.	Rain.
20	360	639	847	32.1	38.7	34.1	162	123	155	89	54	79	W	W N W	N b W	255.20	4.0	0.742	0.70	Snow.	Cu. Str. 6.	Clear.
21	997	914	874	35.1	55.5	46.3	127	218	238	62	50	78	W	S S E	S	24.80	1.5	...	...	Clear Frost.	C. C. St. 8.	Cu. Str. 8.
22	738	819	910	47.0	51.9	48.1	298	315	310	92	83	92	S S W	N W	N W	26.80	3.0	...	...	Cu. Str. 10.	Cu. Str. 10.	Do. 8.
23	997	982	30.004	44.2	71.3	56.9	214	347	413	83	46	90	N W	W b S	S E	24.20	2.5	...	...	Clear, sl. frost.	Clear.	Do. 8.
24	30.052	30.011	002	49.5	71.6	59.0	297	503	410	85	66	82	E S E	S W	S E b E	39.10	1.0	...	...	Cu. Str. 8.	Do.	Do. 4.
25	29.904	29.879	29.891	52.6	85.7	67.4	354	610	420	90	50	63	S b W	S	E S E	8.80	2.0	...	...	Clear.	Do.	Cirr. Str. 4.
26	802	800	697	57.2	78.0	63.6	372	323	416	78	35	72	E b S	E b N	S W	228.50	1.5	...	...	Do.	Cu. Str. 9.	Do. 9. dis. lig.
27	647	582	711	53.3	63.7	56.1	348	471	390	86	81	86	S E b E	S S E	S S E	217.20	2.0	0.732	...	Rain, thunder	Do. 8.	Do. 8.
28	719	774	871	54.0	63.9	55.7	355	409	370	84	70	84	S	N E b E	S E	30.40	2.5	...	...	Clear.	Do. 2.	Cir. Str. 4.
29	927	991	947	51.2	78.2	65.7	245	594	509	65	63	81	S S W	W	W b S	113.80	2.5	...	...	Cu. Str. 10.	Cir. Str. 8.	C. C. Str. 4.
30	937	749	697	61.0	73.2	61.7	409	545	383	80	67	71	S S W	S W	S S W	20.50	1.5	Inap.	...	C. C. Str. 8.	Do. 4.	Do. 4.
31	642	571	609	63.0	76.3	62.1	478	577	460	83	64	83	S W	W b N	S W b W	206.70	2.5	0.007	...	Do. 8.	C. C. Str. 9.	Do. 8.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR APRIL, 1860.

Barometer	Highest, the 18th day	30.381
	Lowest, the 5th day	29.227
	Monthly Mean	29.669
	Monthly Range	1.154
Thermometer	Highest, the 30th day	76°7
	Lowest, the 2nd day	10°0
	Monthly Mean	40°29
	Monthly Range	66°7
Greatest Intensity of the Sun's Rays		90°9
Lowest point of Terrestrial Radiation		7°6
Mean of Humidity		.753

Rain fell on 5 days, amounting to 1.733 inches; it was raining 26 hours and 10 minutes, and was accompanied with thunder on one day.

Snow fell on 4 days, amounting to 245 inches; it was snowing 14 hours and 20 minutes.

Most prevalent wind, the W. N. W.

Least prevalent wind, the E.

Most windy day, the 15th day; mean miles per hour, 17.64.

Least windy day, the 7th day; mean miles per hour, 0.20.

Aurora Borealis visible on 4 nights.

Lunar Halo visible on 1 night.

Parhelia visible on 1 day.

Swallows *(Hirundo bicolor)* first seen on 24th day.

Frogs *(Rana pipiens)* first heard on 20th day.

The electrical state of the atmosphere has indicated high and constant tension of a negative character.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR MAY, 1860.

Barometer	Highest, the 9th day	30.146
	Lowest, the 19th day	29.187
	Monthly Mean	29.864
	Monthly Range	0.959
Thermometer	Highest, the 12th day	87°9
	Lowest, the 21st day	26°9
	Monthly Mean	59°85
	Monthly Range	61°0
Greatest intensity of the Sun's rays		99°2
Lowest point of Terrestrial Radiation		15°1
Mean of Humidity		.695
Amount of Evaporation		2°89

Rain fell on 7 days, amounting to 4.310 inches; it was raining 28 hours 52 minutes, and was accompanied by thunder on two days.

Snow fell on 1 day, amounting to 0.07 inches; it was snowing 1 hour 15 minutes.

Most prevalent wind, the S. S. E.

Least prevalent wind, the E.

Most windy day, the 14th day; mean miles per hour, 12.09.

Least windy day, the 5th day; mean miles per hour inappreciable.

Aurora Borealis visible on 1 night.

Slight frost on the mornings of the 17th, 21st and 23rd days.

Parhelia visible 1 day.

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ON SOME ANCIENT MOUNDS UPON THE SHORES OF THE BAY OF QUINTÉ.

BY THOMAS CAMPBELL WALLBRIDGE.

Read before the Canadian Institute, 3rd March, 1860.

During the early occupation of this country by the French, there existed, in what is now called Upper Canada, various artificial works of the aboriginal races, the vestiges of which, from an archæological point of view, possess a certain degree of interest at the present day. Erected at various periods, under different circumstances, and perhaps by different people, what the wear of time, the plough of the husbandman, and the spade of the curiosity seeker, have spared of these works, will scarce serve to point out the objects for which they were constructed. This is the more to be regretted since no systematic exploration of them has taken place, and the only information we have upon the subject, in many instances, is from their accidental mention in connection with other questions. In general terms, however, the antiquities of this country may be said to resemble those of the State of New York, which have been so ably described by Mr. Squier in his Aboriginal Monuments of that State; but, as most of the works explored by Mr. Squier present significant variations, an examination of the Indian works of this country would no doubt throw some additional light upon the archæology of the continent, such ruins containing the evidences of general customs and common arts among the distant tribes.

Embankments of earth styled "Indian Forts," and which are perhaps the ruins of the palisaded encampments the Hurons dwelt in, are said to be met with in the Townships of Beverley, Vaughan, Whitchurch, and the country about Lake Simcoe. The same tracts of country abound in tumuli, bone heaps, deposits of warlike stores,* and other evidences of savage life ; but the lapse of more than two centuries since the dispersion of the Huron race, their probable builders, by the Iroquois tribes, has made great havoc among their perishable contents. Some of these works, especially the palisaded enclosures, have been mentioned with more or less particularity by the early writers upon this country ; but we may search in vain the records of that period for any allusion to certain other antiquities, and which are now objects of greater interest than the works described by them as appertaining to the savages they encountered. It is difficult to reconcile this omission with the general character of the writings of that era, for, in some parts, the traces of a more ancient race must have formed prominent features in the landscape of the country, passed and re-passed, on their way to and from the Far West, by explorers and missionaries, among whom were many close observers of Indian character.

Perhaps the omission may be accounted for upon the hypothesis that the race who erected the works, passed over unobserved, had been exterminated at a period so remote, that those whom the early travelleres encountered possessed no tradition that would lead them to the discovery of existing ruins. In this category I place the mounds of the Bay of Quinté—the immediate subject of this paper—and which, though locally known for the last fifty years as artificial works, have not heretofore been mentioned in connection with the archæology of this Province. The similarity which the mounds occurring upon the shores of the Bay of Quinté bear to the barrows or tumuli described by American Antiquarians, and incidentally mentioned by other

* We were shewn, yesterday, a small bagful of Indian arrow heads, brought from Beaverton by Mr. Henry White. We understand that there are several cart loads in the place from which these were taken. They are all well shaped, and must evidently have been stored away in this place, at some remote period, for future use. Mr. White intends presenting the bagful to the Museum of the University of Toronto.—*The Leader Newspaper*, *Toronto*, 10*th July*, 1860.

writers, as found at intervals from the Alleghany to the Rocky Mountains, or even to the Pacific coast,* alike intermingling with the huge structures of the Mississippi and Ohio valleys, and the more humble works of the Atlantic States, may perhaps give them a degree of interest beyond their immediate locality.

Commencing at Rednerville, in the Township of Ameliasburg, they may be traced along the Bay shore to the Plains of Massassaga Point, a distance of about eight miles. In this space, including the islands of the so-called "Big Bay," upon which they also occur, perhaps one hundred distinct mounds can be counted; they are not, however, confined to these limits, for, from enquiries made with a view to ascertain their extent, it is probable they will be found at intervals following the shores, from the eastern to the western extremity of the Bay; they are likewise said to occur at a place called "Percy Boom," upon the River Trent, and perhaps by ascending to the head waters of that river they may be traced to the shores of the Upper Lakes, and thence to the most remote parts of the continent.

As far as has yet been ascertained, there is but one class or form of mounds in this part of the country, and the truncated cone is the shape they assume. In size they vary from a diameter at the base of thirty to fifty feet, to a diameter at the apex of twelve feet Each mound has a shallow basin or circular depression upon its summit, which, whatever be the size of the work, has a diameter of eight feet; and no mound under my observation possessed an altitude of more than five feet. It is a remarkable peculiarity of these works, that in almost every instance they occur in groups of two, and at irregular distances the one group from the other. Irregularity is likewise observable between any one mound and its fellow, these being sometimes found in juxta-position, and again from fifty to one hundred feet asunder.

The two of the same group are always of one size. With respect to the surrounding country they are situate apparently without design, now at the foot of a commanding hill, then half way down the side of a bank, and again so near the shore that in several instances they have been destroyed by the action of the water. Twice they have been found in very low or swampy ground, and in those cases they occur singly.

In the month of August, 1859, I caused five of the mounds upon Massassaga Point to be opened as follows:—Through the centre of

* Smithsonian Contributions, Vol. I, p. 2, and foot note.

one a cut was made thirty-three feet long, two feet wide, and three feet deep, to the original surface of the ground; after removing a few inches of mould, a heap of broken gneissoid rock was displayed, conforming to the shape of the outside of the work. The bits of rock composing the work were of various sizes and forms, and would weigh from one to twenty pounds each, but immediately under the basin, and forming the bottom of it, the bits of rock were much smaller than those constituting the general pile. All the pieces presented angular fractures, but no marks of tools were discovered upon them. Many of the bits of rock were in a disintegrated state, so much so as to crumble into coarse sand before the pick. This circumstance may perhaps be attributable to the employment of fire as an agency in preparing the stones for the builders, from the boulders of the adjacent plain. No other traces of fire were observed. In a cross section, at right angles to the former, and again passing through the centre of the basin, several small pieces of bone and birch bark were turned up; they were found a few inches from the surface, between the soil and the bed of stone. No other remains were discovered. It may be here remarked, that the presence of a few bones near the surface of a mound, is no indication of the purpose for which the work was originally built, for it is well ascertained that many of the mounds of the Western States, constructed evidently for different objects than those of sepulture, have been used by modern Indians for that purpose.*

The other mounds examined agreed in all particulars of construction with that above described, excepting in one pair where it was evident from what remained that the inside margin of the basin of each mound had been surrounded with flat stones placed vertically and touching at their edges, as if designed to prevent the earth falling into the hollow. Similar stones, perhaps used for the same purpose, were observed lying near most of the other mounds in this vicinity. The marginal stones have been displaced, it would appear, by the so-called "money-diggers," a class of superstitious beings everywhere found, the traces of whose Vandalism are not wanting upon most of the antiquities of this continent; and the absence of all remains in the works examined, can best be attributed to their operations. In several instances the builders have been forced, from the nature of the

* It is only a few years since, that two French Canadians, found drowned, were taken by the people of the vicinity, and buried upon one of the best preserved mounds upon Massassaga Point.

surrounding country, to carry their material from a distance, but to obtain the usual covering of mould for the pair of mounds last mentioned they have bared the smooth underlying rock of its scanty soil, in a well defined circle about the works.

The use of broken gneiss for a building material, to the almost entire exclusion of limestone, is a noticeable feature in the construction of these works, and it is the more remarkable when it is known that the latter could have been procured at much less labour from the immediate Bay shore, where it abounds in the form of debris. This circumstance may perhaps show the migration of the race, and with other characteristics assist in unveiling the customs and philosophy, or superstition, which obtained among them.

From the limited data before us, it would be impossible to determine the positive age of these mounds, but the usual evidences of the antiquity of such works are not wanting here, and will enable us to arrive at a proximate period. The growth of the largest sized forest trees upon the tops of them, (in one instance an oak stump eight feet in circumference, and now seen in a decaying state), place the date of their erection several centuries anterior to the first exploration of the country. It may also be inferred that the Massassaga Indians, who were found by the early French Voyageurs inhabiting the Bay region, were ignorant of the origin of the works, for previous to 1820, and whilst that tribe was still numerous and pagan, they allowed the mounds upon their favorite camping ground to be ransacked with impunity. Neither have the survivors of that tribe, and who were removed in 1830 to Alnwick, near Rice Lake, any known tradition which will assist this enquiry. The Bay of Quinté, and the River Trent, formed parts of a well-known route for war parties to pass to and from the west; and during the French occupation of this country, were frequently used by soldiers, missionaries, and traders to ascend to the Upper Lakes; and yet the writings of that period, in many other particulars so precise, are silent as to rites or ceremonies among the neighbouring Indians, which would have required such works. We must therefore look for information in some other quarter, and, as yet, the facts collected by the various writers of the present day, are expressed in such general terms that we cannot arrive at any satisfactory conclusion. The supposition, however, that a common custom prevailed in very distant parts of the continent, whether in branches of the same tribe or among various races, is no more unreasonable than to admit that the stone and copper axes, pipes, arrow heads, and coarse pottery of the same character, and which are everywhere found, were made by different tribes. Thus a race possessing a knowledge of mound building, in common with very distant tribes, may have been dispossessed by the Massassaga Indians, when they came, as tradition relates, from the Upper Lakes. But this is mere conjecture, and like all other theories depending in any manner upon imagination or Indian tradition, should be received with caution.

The theory so commonly held that certain relics of rude art, found among tribes who cannot be supposed to have made them, have been procured by barter, I think, from what is known of Indian character, not to be well founded. I am inclined to believe that the sculptured images, as well as the copper implements, are the fruits of distant wars; the tribe last possessing them have taken the articles by force from some more western or civilized people. This argument receives strength from the fact that the whole system of earth-works throughout the west shows that a terrific struggle was there waged for an existence; but with what result such heroic efforts were made to defend civilized communities against overwhelming barbarous hordes, the Cyclopean embankments of those regions are the only memorial. When we find, however, the vestiges of a wide-spread race, or monuments that point to one common idea, intermingled with works of a superior order, and meet with evidences of a certain civilization in parts equally distant, perhaps the fruit of plunder, we may form some conception of the turmoil that once agitated this continent.

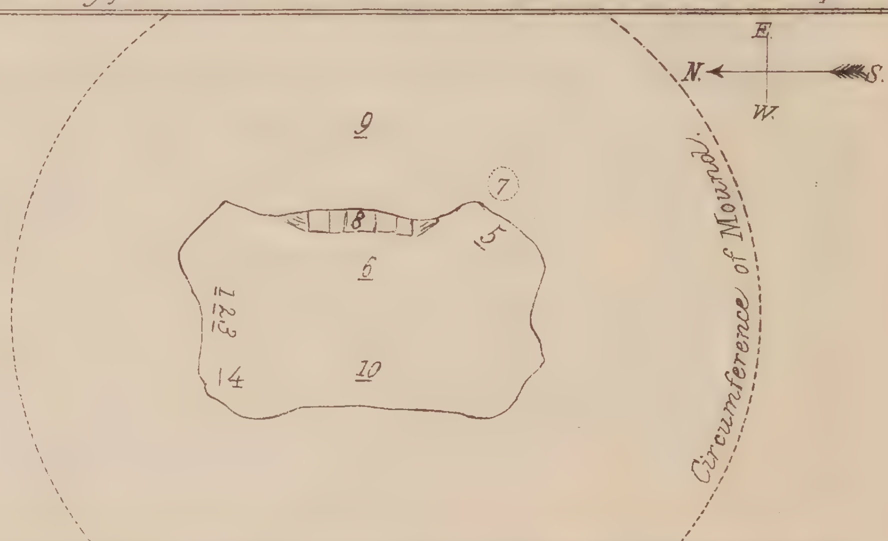
A further examination of the mounds on the Bay of Quinté, undertaken in the month of August last, in company with Henry Cawthra, Esq., of Toronto, has led to the discovery in them of human remains and objects of curiosity and art. These remains clearly point out the purpose for which the works in question were erected, and prove them to belong to the class of sepulchral mounds, such as the observations of Drake, Squier, Schoolcraft, and many other writers, show to exist over a very wide range of country.

A brief description of the work in which the remains were found, with the aid of the accompanying lithographic plates, prepared from accurate sketchings taken at the time by Mr. Cawthra, will enable the reader at once to understand the nature of all the mounds in the Bay of Quinté region.

Fig. 1.

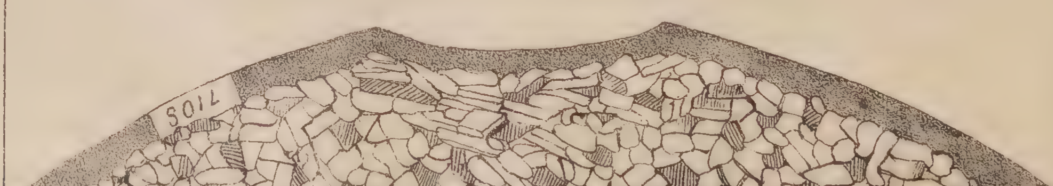
Sketch shewing position of skeleton found at root of Oak stump.

Fig. 2



Plan shewing the excavation made in the above Mound, with the positions of skeletons found therein, and the shape of the rude wall of the sepulchral chamber.

Fig. 3.



Section of Mound shewing its construction.

H. Cawthra Esqre del.

Fuller & Bencke, Lith. Vict. Hall, Toronto.

After partially opening several mounds in the vicinity of those already mentioned and with the same result as to general characteristics, we fortunately chose a mound which to all appearances had not been previously disturbed. Commencing upon the top of it and throwing out all the material from the centre of the work to the natural level of the soil beneath, we were enabled thoroughly to inspect its contents, and from very full notes made during the examination, the substance of what follows is taken. Figure 1, Plate I., presents a view of a portion of the mound, and the excavation made, with the position of a perfect skeleton, found in a sitting posture, over the head of which stands an oak stump, now measuring eight feet in circumference, but from which the tree has been felled probably thirty years. A short distance from this stump stands a red cedar one, also represented in the sketch, measuring four feet two inches in girth, and from which the tree has likewise been cut a number of years.

Figure 2, Plate I., is a diagram showing position of articles found during the examination. Figure 3, Plate I., shows a section of the mound exhibiting general features of construction.

Upon breaking the surface of this work, at a point designated by figure 10 in diagram, we came upon a flat limestone lying horizontally a few inches beneath the surface, under which were found a few fragments of human bones, and pieces of birch bark, together with a sharpened bone implement,* worn smooth by use, and in its present state nearly eight inches long.

About two feet from the surface, on removing a flat stone, three crania were exposed, in what appeared to be a rude box, composed of flat limestones. One of these crania, being uppermost, was broken by the carelessness of one of the labourers employed to excavate. It was smaller than the other two and rested upon them. Of the other heads, one laid upon its side, facing north, the body of which would lie due east and west, the feet being towards the east. The other one shewed the skull uppermost as if the body had been placed erect. On clearing away the broken stone and soil a great many bones were found, in fact almost entire skeletons; and from their positions, these evidently belonged to the heads in the box. The latter had probably been separated from them by the compression of the sides of the box

* Similar implements are mentioned in *Smithsonian Contributions*, Vol. I. page 220 Fig. 119, Nos. 1 & 3. "They were obtained," it is there stated, "from a mound in Cincinnati and were evidently formed from the tibia of the elk."

or by the intertwining roots of the overgrowing trees ; and this may also to some extent account for the position of the crania. From all the circumstances connected with these three skeletons, I am led to believe that they were originally entombed in a sitting posture, back to back, having their heads merely surrounded by flat stones, which rested upon their breasts or folded arms, whilst the remainder of the bodies were covered or built up in the general material of the work.

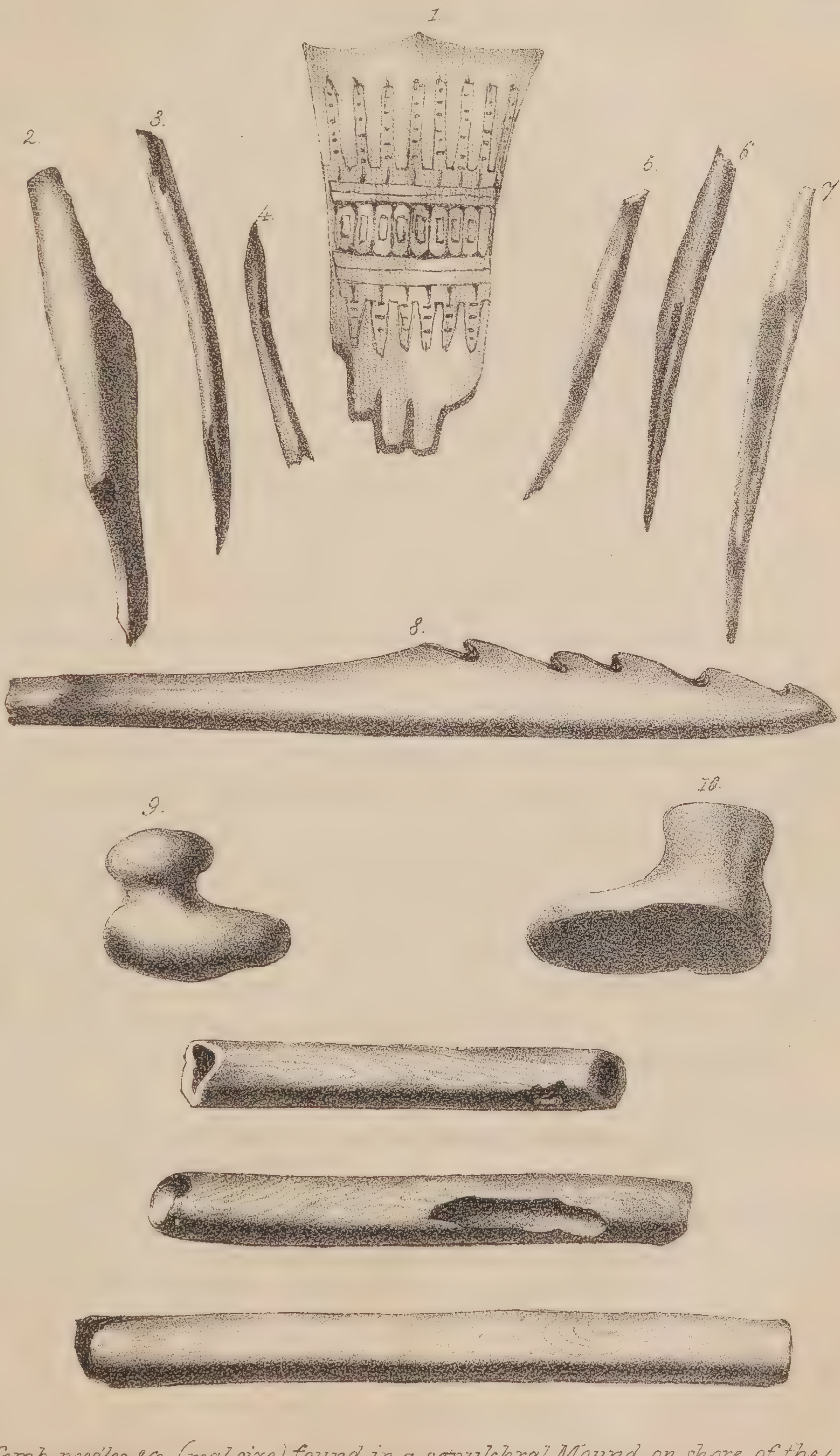
Figure 6, marks the position of a skeleton, by the side of which was found what appeared to be the contents of a magician's or conjurer's bag. The objects of art contained in it are represented in Plate II.

Figure 8, portion of wall exposed, formed of layers of limestone rudely laid up, and which appeared from examination made at different points of the circle of excavation, to be built around the edge of the enclosure containing the relics. The wall did not form a perfect circle, but the sides of it were about seven feet asunder. This work did not contain the same proportion of gneiss as the works previously described, the flat limestones, before mentioned, and soil assisting to make up the pile.

Figure 1, Plate II., is an exact representation of the back of a comb elaborately ornamented by lines scratched upon the smooth surface of a flat piece of bone. Figure 2, fragment of a bone instrument, polished perhaps by use. Figures 3, 4, 5, 6, 7, are either the teeth of the comb (fig. 1) or awl-shaped instruments, commonly found with Indian remains. Figure 8, is a barbed arrow-blade (Schoolcraft) or the point of a fish-spear (Squier). It is made of bone and polished. Figures 9 and 10, represented half-size, are waterworn limestones, somewhat resembling the Indian foot covered with a moccasin.

The three cylindrical ornaments, at the bottom of plate II., are what Mr. Schoolcraft calls baldrics, specimens of which he found in the Indian ossuaries at Beverly, Canada West ; and he remarks that "the ancient Indians formed baldrics for the body, from the hollow bones of the swan and other large birds or deers' bones, in links of two or three inches long. These were strung on a belt or string of sinew or leather." Those here represented are made of the thick parts of shells, and bear upon their outside surface a spiral groove. In some specimens the groove is not distinct, and perhaps its presence, in any case, is more attributable to necessity than design, the groove being a

Plate II.



Comb, needles &c. (real size) found in a sepulchral Mound on shore of the Bay of Quinte, Canada West.

H. Cawthra, Esq.re del.

Fuller & Bencke Lith. Vict. Hall, Toronto.

natural mark upon the part of the shell used for this purpose. They are bored from end to end and polished.

The other articles found interred with this skeleton were: 1. A number of common fossils occurring in the Trenton limestone, in the vicinity of the Bay of Quinté. 2. Several queerly shaped, waterworn stones. 3. Several fresh water shells so much decayed that they could not be preserved. 4. A few small lumps of iron ochre perhaps used for painting the face. 5. The breast bone of an eagle. 6. A bear's tusk. 7. A tooth of a beaver. It is said that Indians of other parts of the continent used beaver teeth for scraping the flesh from the hides in the process of tanning.* 8. A pair of horn-cores resembling those of a ram, a circumstance of difficult reconciliation with the undoubted antiquity of these works, unless the existence of the wild sheep of the Rocky Mountains be taken into consideration.†

The number of crania taken from this mound in a good state of preservation, is five. These are now in the possession of the writer. There were perhaps a dozen bodies originally deposited in this work.

Whatever be the origin of these remains, it is clear that the Massassaga Indians were not the builders of the works in which they are entombed, since this tribe, it is well known, buried their dead in wrappers of birch-bark, and laid them at full length a few inches beneath the surface of the soil, as the sand-hills about Belleville clearly prove. The remains found in the surface-soil of the mounds are perhaps of their interment; but the skeletons found in the sitting posture belong to some other and far earlier race. The question, to what race, is wrapt in the same mystery that overhangs the ancient mound structures which lie in the remoter regions of the West, and which of late years have been the subject of so much philosophical speculation.

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* This information was obtained from Assikinack, an Odahwah chief of the Manitoulin Island, who is now aged about 104 years.

† The above list of articles corresponds in many particulars with the remains found by Dr. Drake, in a mound examined by him, in the vicinity of Cincinnati, an account of which is given in the "Biography and History of the Indians of North America," by Samuel G. Drake. 10th edition, page 41.

SOME EXPERIMENTS ON THE CONTRACTION AND EXPANSION OF ICE.

BY J. H. DUMBLE, C.E.

Read before the Canadian Institute, 10th March, 1860.

In the September number of the *Journal* of the Canadian Institute for 1858, I gave a brief statement of facts relative to the expansion and contraction of ice, as observed by me on Rice Lake.

I stated that the contraction and expansion of ice was caused by atmospheric changes; that, up to its melting point, it expands with a high, and contracts with a low temperatnre; that it is susceptible of expansion to a much greater extent than of contraction, that when ice is equally dense, thick, and glare, and everywhere equally acted upon by a heated atmosphere, it expands from the centre towards the circumference, and that it expands towards the line of least resistance, &c.

The observations of another winter, together with actual experiment, have confirmed the correctness of this theory, with, however, one exception. The statement that ice is susceptible of expansion to a much greater extent than of contraction, is *incorrect*. Into this erroneous conclusion I was thus led: the expansion of a large field of ice, I observed, was manifested by its encroachment on the shores of the lake, in which case the ice usually fractured at the ripple mark; when, however, the line of fracture did occur at a distance from the shore, it was evinced by the appearance of a vertical ridge, formed by the fractured portions of the ice. Such being the case, I naturally expected that when the ice field contracted it would shrink away from the fracture, whether on the shore or at a distance from it, or else that fissures or cracks would be observed somewhere in the ice field, of widths commensurate to previous "shoves."

Such evidence of contraction, either the shrinkage from the line of fracture, or the existence of cracks or fissures, of widths at all approximating to the amount of expansion was not then observed by me.

Towards the latter part of last winter I had occasion to cross Rice Lake on foot; the temperature of the previous night had been very low. A slight coating of snow lay on the ice, and in it were cracks running in every imaginable direction; these cracks penetrated the ice and were filled with water, they varied in width from one-eighth

DIAGRAM, showing expansion and contraction of Ice. (100 feet in length)
Also a Thermometrical Section corresponding to the latter Ice movement

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Fuller & Bencke Lith. Vict. Hall, Toronto, C. W.

of an inch to an inch, and in the distance of a mile the number counted exceeded one hundred.

These fissures were, of course, the effect of contraction, and their aggregate widths fully compensated for the absence of the larger fissures, which I expected to have seen, and were quite equal to the maximum amount of expansion witnessed on any one occasion.

Thus, then, was I convinced of the error of my previous statement regarding the contraction of ice, and actual measurements since made have fully proved that the expansion equals the contraction of ice for equal changes of temperature.

The cause of ice contracting in the peculiar manner above mentioned, is owing, of course, to its unequal thickness, glariness, and density; the shrinkage being unequal throughout the mass, the lines of fracture are accordingly numerous and irregular.

Were ice equally thick, dense, and glare, it would contract uniformly towards its centre, and we would not then witness those irregular cracks and fissures just described; neither would be seen that enlargement, or piling up of fractured ice, which is the effect of expansion under ordinary circumstances.

Ice at formation is at its *greatest* or *maximum dimensions*, and although the temperature of water *may* be far below 32°, the latent heat given out during crystallization (as is well known) will instantly raise the temperature of the ice to that figure.

The formation of ice, like that of other substances, takes place at a certain fixed temperature, which is also that of its melting, and which remains constant during the process of its solidification.

The first movement in ice, therefore, after its formation, must necessarily be shrinkage or contraction; the fissures which occur on a large field during this process immediately fill with water, which is soon frozen. The field ice, be it remembered, still extends to its original limits, and is in a state of shrinkage.

Now, should the temperature rise to 32°, this ice will expand and overlap its original boundary by a distance just *equivalent* to the *aggregate widths* of the various cracks which previously represented the amount of contraction.

This revivifying or replenishing process accounts in the most satisfactory manner for the seemingly exhaustless expansive power of ice.

If we take the maximum expansion of ice, at any one point on Rice Lake, and divide the amount by the radius or diameter of the ice field, as circumstances may direct, a tolerably correct idea could thus be obtained of the amount of expansion per degree of temperature, per foot or per mile.

I have, however, been desirous to ascertain by actual measurement the exact extent of contraction and expansion of ice, not only for the sake of obtaining such information, but also for the purpose of verifying the deductions formed from general observations during previous winters. Circumstances prevented me from undertaking the experiment before the middle of January last, at which time I selected a mill-pond near Cobourg, in preference to Rice Lake, as the site of my operations.

The pond was adjacent to my dwelling, was shallow, (thereby preserving a more uniform temperature under the ice), and, being of small extent, my operations were not so liable to interruptions by a nip or a squeeze as they would be on Rice Lake.

As it was desirable to experiment on as large a scale as possible, I proceeded to cut an opening, in the thick pond ice, one hundred and five feet in length by ten in breadth, from which the old ice was hauled out and new ice permitted to form in its stead. A rough shed was erected over this opening to prevent the admission of snow. When the new ice within the shed attained a thickness of one and a-half inches, I reduced its dimensions to one hundred and three feet in length by seven in width, having it floating and perfectly isolated by a channel eighteen inches in width between it and the surrounding pond ice.

Within eighteen inches of each end of this floating ice, I inserted vertically small blocks of two inch pine plank, which, being frozen in, became firmly embedded in it. These blocks answered admirably the purpose of permanent fixtures, to one of which I attached and nailed the end of a seasoned pine or deal rod, three inches in width, one hundred feet in length, and one and a-quarter inches deep, and firmly connected at the joints.

To the other block was firmly clamped a target, through which the graduated end of the rod moved freely.

I may add that the graduated rod was an American engineer's levelling staff, and read accurately to the thousandth part of a foot; small rollers were placed under the rod to prevent its freezing to the ice.

This floating ice was kept perfectly isolated from the main field, day and night, with great care, and every precaution taken which prudence could suggest to insure accuracy of result.

Herewith is given a table of observations and readings of the graduated rod, from the 29th of January to the 1st of March.

In order the better to illustrate the ice movement, I constructed the accompanying diagram. The datum is time, the upper section shows the lineal contraction and expansion of a body of ice one hundred feet in length, as read from the graduated rod. The vertical scale is eight and a half times that of the actual movement, the better to exhibit the variations. The section immediately beneath the ice line represents the atmospheric changes, as indicated by the mercurial thermometer, (Fah.) to the same datum of time, and to a vertical scale corresponding to the latter ice movement.

Were the ice equally as sensitive to changes of temperature, and as quick to move as mercury, these lines, if applied to each other, would almost coincide. The lower line exhibits the thickness of the ice at different periods during the experiment.

It will be observed, on referring to the upper section, that the ice exhibited no movement from the 27th January to 1 p.m. on the 29th; although the temperature of the atmosphere varied considerably during this period; it was not until the ice attained a thickness of three inches that it became susceptible of atmospheric influences.

The phenomenon may be explained, I presume, by supposing the temperature of the ice, while yet thin, to be controlled by that of the underlying water.

The expansion and contraction of the ice from the 29th of January to the 9th of February is remarkably uniform, and exhibits its great sensitiveness to changes of temperature.

The average movement per degree per foot during this period is .00000 330. This ice, forming under cover, and protected from the deteriorating influences of sun, wind, rain, and snow, and not having been subjected to a high or wasting temperature, until the 5th ult., may, I think, be correctly termed *pure ice.*

The ice from noon on the 5th February until 10 a.m. on the 8th was, however, (with the exception of a short interval) subject to a temperature varying from 28° to 36° and and was consequently absorbing latent heat, which, of course, materially changed its character. The temperature on the eighth suddenly fell to zero, and the ice (as soon as its moist surface was consolidated) contracted at the rate, on an average, of .00000 765 per degree per foot, or more than twice the extent of its previous movement. The temperature again rose to 32°, and the ice expanded at the rate of its *last* contraction to its original or maximum dimensions.

From the 8th until the 29th of February the ice obeyed the various fluctuations of temperature (considerating its increasing thickness) with great regularity, ever maintaining the latter ratio of .00000 765 per degree per foot. A continuation of a high temperature from the 22nd to the 24th of February did not affect it in its uniform rate of movement; neither did the beams of the mid-day sun, at a temperature of 45°, which I allowed to act on it for some hours, cause further expansion than it manifested at a temperature of 34°.

The permanent and greatest length of the ice seemed to tally with a thermometrical reading of 34°; the thermometer was suspended about a foot above the ice level, and probably was two degrees higher than the atmospheric temperature at the surface. It will be remembered that the ice at this temperature was ever the same length, and the different ratios of movement were owing to the change in the character of the ice after the thaw of the 5th February, which gave it a greater shrinking, and consequently a greater expanding capacity.

Ice, at a low temperature, is extremely sensitive and brittle. On one occasion during my experiments, the temperature in my shed was plus four; outside the north wind read zero. Being anxious to lower the temperature within the shed, I desired my assistant to take a board off the roof. He did so, and in a few minutes the current of cold air from the north caused my ice to crack into two pieces, with a loud report. The ice at the time was perfectly isolated, and floating clear of the main field.

It has been often remarked on Rice Lake, that when ice attains a great thickness, it does not seem to move about with the same violence, or to the same extent, as it did when it was comparatively thin. It is a well known fact, that the greatest "shoves" occur when the ice is from four to ten inches in thickness. My experiments confirmed this fact. I found on my experimental ice, that when it increased in thickness it became tardy in its movements. In fact, the rapidity with which ice expands or contracts *is inversely as its thickness.* If ice three inches in thickness takes half an hour to move a given distance corresponding to a change of temperature, ice twenty-four inches in thickness will take four hours to expand to the same extent. Should the temperature not remain stationary, but change within the four hours, the action and movement of the ice would be accordingly checked and modified.

The lagging behind of the ice, and consequently its not responding readily to rapid changes of temperature, is well illustrated on the diagram by observations Nos. 55, 62, 65, 73, 84, 92, 96, 100, 120, and 158.

The atmosperic temperature, during the period of my experiment, did not fall below minus 4°. I found, however, in a range of 38°, that is, from minus 4° to plus 34°, the contraction and expansion at any degree within this range was *uniform*.

I think, therefore, that we may fairly assume that it preserves that uniformity to the lowest temperature known in this country.

In addition, therefore, to the deductions made in a former paper, may we not glean and add the following:—

That with the same change of temperature, the expansion and contraction of ice are equal.

That the fact that ice on a large field exceeds, during subsequent expansion, the limits of its first dimensions, is owing to the peculiar manner of its previous contraction.

That the rapidity of ice movement, due to change of temperature, is inversely as its thickness.

That the rate of expansion and contraction of *pure* ice (as measured by a deal rod, for which no allowance was made), is .00000 330 of its length per degree; and that of ordinary ice .00000 765.

Having brought to a conclusion these very interesting experiments, the object of which was to sustain and fully confirm the theories and conclusions previously deduced from a much larger field of observation, which it has done, with one exception, not only as regards the general theory but also with respect to the expansive *capacity* of ice, I now leave the subject with the hope that these preliminary investigations, on a body whose properties seem so little known to the scientific world, may yet throw important light on the perplexing glacier phenomena, and also with the hope that at other hands it may receive a further and more thorough investigation.

TABLE OF OBSERVATIONS, (ON ICE 100 FEET LONG), FEBRUARY, 1860.

No.	Date.	Hour.	Temperature.	Thickness of ice.	Graduated Rod.	Average per 0° per 100.	Average per 0° per foot.	Wind.	Remarks.
1	Jan. 29	1 P.M	32°	3 in.	.0110	.000344	.00000344	N W	
2	"	6 "	34	"	.0120	.000353	.00000353	W	
3	"	10 "	34	"	.0120	.000353	.00000353	W	
4	Jan. 30	9 A.M.	27	3½ in.	.0090	.000333	.00000333	N W	
5	"	12.0	26	"	.0085	.000327	.00000327	W	Clear.
6	"	2 P.M.	28	"	.0090	.000321	.00000320	W	
7	"	3 "	31	"	.0100	.000322	.00000322	W	
8	"	5 "	33	"	.0105	.000318	.00000308	W	
9	"	6 "	34	"	.0110	.000321	.00000321	W	Strong wind.
10	Jan. 31	12.0	22	"	.0075	.000341	.00000341	N	
11	"	12.30	19	"	.0065	.000342	.00000342	N	
12	"	2 P.M.	17	"	.0060	.000353	.00000353	N	Blowing a gale.
13	"	4 "	14	"	.0050	.000357	.00000357	N E	Snowing.
14	"	9 A.M.	9	4 in.	.0030	.000333	.00000333	E	Do.
15	"	12.0	9	"	.0030	.000333	.00000333	N E	Light wind.
16	"	2 P.M.	9	"	.0030	......	......	...	
17	"	4 "	8	"	.0027	.000337	.00000337	N E	
18	"	5 "	6	"	.0020	.000330	.00000330	N	
19	"	7.30	6	"	.0010	......	......	E	Clear.
20	Feb. 1	1 A.M.	...	5 in.	.0000	......	......	N	(Average contraction .00000336.)
21	"	6 "	4	"	.0000	......	......	N E	
22	"	9 "	10	"	.0010	......	......	N E	
23	"	11 "	14	"	.0050	.000357	.00000357	E	
24	"	3 P.M.	16	"	.0060	.000375	.00000375	E	
25	"	5 "	13	"	.0050	.000385	.00000385	E	
26	"	11 "	12	"	.0060	.000333	.00000333	E	
27	Feb. 2	4 A.M.	10	"	.0030	.000300	.00000300	N	
28	"	9 "	14	"	.0040	.000286	.00000286	N E	Snowing.
29	"	10 "	16	"	.0040	.000250	.00000250	N E	
30	"	10.30 "	18	5½ in.	.0050	.000278	.00000278	E	
31	"	1.30 "	23	"	.0070	.000304	.00000304	E	
32	"	3 P.M.	22	"	.0070	.000308	.00000308	W	
33	"	5 "	19	"	.0060	.000316	.00000316	N	
34	"	9.30 "	16	"	.0040	.000250	.00000250	...	Calm.
35	"	11 "	12	"	.0026	.000300	.00000300	...	Calm.
36	Feb. 3	3.30 A.M	18	6 in.	.0045	......	......	...	
37	"	8 "	18	"	.0045	......	......	W	
38	"	1 P.M.	22	"	.0060	.000275	.00000275	S	
39	"	4 "	20	"	.0055	.000275	.00000275	S	
40	Feb. 4	12.0	24	"	.0070	.000292	.00000292	W	
41	"	1 A.M.	22	"	.0070	.000308	.00000308	S E	Snowing.
42	"	7 "	22	"	.0070	......	......	...	
43	"	11 "	26	"	.0080	.000308	.00000308	...	Calm.
44	"	12.0	28	"	.0090	.000320	.00000321	...	
45	"	1 P.M.	30	"	.0105	.000350	.00000350	...	Ther. 60° in the sun.
46	"	5 "	30	"	.0100	......	......	...	
47	"	6 "	28	"	.0100	.000357	.00000357	...	
48	"	7 "	24	"	.0080	.000333	.00000333	S	
49	"	9 "	26	"	.0080	.000308	.00000308	S	
50	Feb. 5	2 A.M.	26½	"	.0080	.000302	.00000302	E	
51	"	7 "	24	7 in.	.0070	.000292	.00000292	S	Snowing.
52	"	10 "	32	"	.0110	.000344	.00000344	S E	Average expansion .00000314.
53	"	1 P.M.	34	"	.0120	.000353	.00000353	S E	
54	"	5 "	34	"	.0120	.000353	.00000353	S E	
55	"	7 "	33	"	.0115	.000348	.00000348	...	
56	"	8 "	36	"	.0110	......	......	...	Water on surface ice
57	Feb. 6	2 A.M.	37	"	.0110	......	......	W	Do.
58	"	7 "	33	"	.0115	.000348	.00000348	W	
59	"	11 "	32	"	.0110	.000344	.00000344	W	
60	"	3 P.M.	30	"	.0115	.000350	.00000350	N W	
61	"	5 "	28	"	.0100	.000357	.00000357	N W	
62	"	9 "	24	"	.0070	.000291	.0000291	S W	
63	Feb. 7	12.0	28	"	.0070	......	......	S W	
64	"	2 A.M.	24	"	.0070	.000291	.00000291	S W	
65	"	4 "	22	"	.0055	......	......	...	
66	"	8 "	28	"	.0055	......	......	S W	
67	"	9 "	32	"	.0090	......	......	S W	
68	"	12.0	32	"	.0110	.000344	.00000344	...	

TABLE OF OBSERVATIONS—(*Continued.*)

No.	Date.	Hour.	Temperature.	Thickness of ice.	Graduated Rod.	Average per 0° per 100.	Average per 0° per foot.	Wind.	Remarks.
69	Feb. 7	1 P.M.	34°	7 in.	.0120	.000353	.00000353	...	
70	"	3 "	35	"	.0125	.000357	.00000357	S W	
71	"	5 "	36	"	.0130	.000360	.00000361	S W	Ice dry.
72	"	9 "	28	"	.0105	......	......	...	Calm. On the move.
73	Feb. 8	12.0	28	"	.0090	.000320	.00000321	S W	
74	"	9 A.M.	32	"	.0110	.000344	.00000344	...	Ice dry.
75	"	11 "	38	"	.0120	......	......	S W	Ice wet.
76	"	11.30 "	39	"	.0120	......	......	S W	Ice melting.
77	"	12.0	37	"	.0120	......	......	...	
78	"	3 P.M.	34	"	.0120	.000353	.00000353	W	Average, .00000341.
79	"	4 "	34	"	+.0120	.000760	.00000760	...	General average,
80	"	7 "	32	"	.0120	......	......	...	from Jan. 9 to 3 p.m.
81	"	8 "	32	"	.0120	......	......	N W	Feb. 8, (.00000330).
82	"	9 "	17	"	.0065	......	......	N W	Surface water of ice
83	"	11 "	13	"	+.0015	......	......	N W	freezing.
84	Feb. 9	12.0	8	"	—.0045	......	......	...	
85	"	3 A.M.	6	"	—.0095	.000750	.00000750	N W	Blowing a gale.
86	"	6 "	Zero.	8 in.	—.0140	......	......	N	Average contrac-
87	"	8 "	4	"	—.0110	.000750	.00000750	N	tion, .00000760.
88	"	9.30 "	6	"	—.0100	.000666	.00000666	N	
89	"	11 "	9	"	—.0090	.000550	.00000550	N	
90	"	12.0	10	"	—.0060	.000800	.00000800	N	
91	"	2 P.M.	12	"	—.0050	.000750	.00000750	N	
92	"	9 "	7	"	—.0050	......	......	...	
93	Feb. 10	1 A.M.	10	"	—.0050	.000900	.00000900	Calm	
94	"	5 "	10	"	—.0040	......	......	E	
95	"	8 P.M.	11	"	—.0040	.000909	.00000909	E	
96	Feb. 11	10 A.M.	12	"	—.0040	.000833	.00000833	E	
97	"	1 P.M.	20	"	+.0010	.000750	.00000750	...	Note 20° Temp. of
98	"	3 "	24	"	+.0050	.000791	.00000791	N	drift snow on ice.
99	"	8 "	17	"	+.0020	......	......	N	
100	"	10 "	16	"	+.0010	......	......	N	Swept off snow.
101	Feb. 12	12.0	13	"	—.0020	......	......	N	Still drifting.
102	"	2 A.M.	10	"	—.0040	.001000	.09001000	N	
103	"	6 "	9	9 in.	—.0080	.000666	.00000666	N	
104	"	9 "	13	"	—.0060	.000692	.00000692	N	
105	"	11 "	19	"	—.0010	.000684	.00000684	N	
106	"	1 P.M.	23	"	+.0030	.000739	.00000739	...	
107	"	3 "	24	"	+.0050	.000791	.00000791	W	
108	"	6 "	24	"	+.0060	......	......	S W	
109	Feb. 13	8 A.M.	26	"	+.0055	.000750	.00000750	E	
110	"	12.0	34	"	+.0120	.000765	.00000765	W	Average expansion,
111	"	2 P.M.	34	"	+.0120	.000765	.00000765	E	.00000772.
112	"	8 "	30	"	+.0120	......	......	...	
113	Feb. 14	4 A.M.	26	"	+.0080	......	......	...	
114	"	8 "	26	"	+.0060	.000770	.00000770	N E	
115	"	12.0	26	"	+.0060	......	......	...	
116	"	1 P.M.	27	"	+.0065	.000760	.00000760	...	
117	"	3.30 "	28	"	+.0080	.000786	.00000786	...	
118	"	10 "	15	"	—.0020	.000800	.00000800	...	Clear night.
119	Feb. 15	4 A.M.	12	"	—.0050	.000750	.00000750	...	
120	"	12.0	20	"	—.0000	.000700	.00000700	...	
121	"	2 P.M.	20	"	+.0010	.000750	.00000750	N W	Snowing.
122	"	5 "	22	"	+.0030	.000773	.00000773	N W	
123	"	10 "	29	"	+.0090	.000793	.00000793	S E	
124	Feb. 16	9 A.M.	18	"	+.0020	.000888	.00000888	S E	
125	"	11 "	18	10 in.	+.0015	.000861	.00000861	N E	
126	"	2 P.M.	18	"	+.0015	......	......	N W	
127	"	3 "	16	"	+.0000	.000875	.00000875	N W	
128	"	6 "	14	"	—.0020	.000850	.00000850	W	
129	"	9 "	8	"	—.0080	.000750	.00000750	W	
130	Feb. 17	6 A.M.	...	"	—.0140	......	......	...	Average contrac-
131	"	8 "	—4	"	—.0170	.000750	.00000750	N	tion, .00000788.
132	"	5 P.M.	+14	"	—.0040	.000714	.00000714	N E	
133	"	8 "	6	"	—.0090	.000833	.00000833	...	
134	"	10 "	4	11 in.	—.0110	.000750	.00000750	N E	
135	Feb. 18	8 A.M.	12	"	—.0090	......	......	...	[through roof.
136	"	10 "	12	"	—.0090	......	......	...	Snowing, drifting

TABLE OF OBSERVATIONS—(*Continued.*)

No.	Date.	Hour.	Temperature.	Thickness of ice.	Graduated Rod.	Average per 0° per 100 feet.	Average per 0° per foot.	Wind.	Remarks.
137	Feb. 18	12.0	18°	11 in.	—.0060	......	......	N E	
138	"	2.0	18	"	—.0040	......	......	...	
139	"	6 P.M.	16	"	—.0010	.000812	.00000812	...	
140	Feb. 19	9 A.M.	10	"	—.0080	.000600	.00000600	...	
141	"	5 P.M.	16	"	—.0030	.000689	.00000689	...	
142	"	9.30 "	10	"	—.0065	.000750	.00000750	E	
143	Feb. 20	8 A.M.	26	"	+.0030	......	......	..	
144	"	9.30 "	27	"	+.0050	......	......	W	Moves slowly.
145	"	12.30 "	30	"	+.0070	......	......	E	
146	"	2.30 "	32	"	+.0100	.000750	.00000750	W	
147	"	6 P.M.	34	"	+.0120	.000765	.00000765	W	
148	Feb. 21	8 A.M.	20	12 in.	+.0010	.000750	.00000750	E	
149	"	12.0	34	"	+.0120	.000765	.00000765	...	
150	"	2 P.M.	38	"	+.0120	......	......	...	
151	"	4 "	37	"	+.0140	.000757	.00000757	...	Ice dry.
152	Feb. 22	12.0	37	"	+.0120	......	......	...	
153	Feb. 23	12.0	32	"	+.0110	.000750	.00000750	...	
154	Feb. 24	12.0	30	"	+.0100	.000800	.00000800	...	
155	Feb. 25	12.0	24	"	+.0005	.000600	.00000600	...	
156	"	5 P.M.	24	"	+.0005	.000600	.00000600	...	
157	"	10 "	17	"	+.0004	.001060	.00001060	...	
158	Feb. 26	8 A.M.	12	"	—.0072	.000600	.00000600	N E	
159	"	9.30 "	22	"	—.0060	......	......	...	
160	"	5 P.M.	30	"	+.0070	.000700	.00000700	...	
161	Feb. 27	8 A.M.	34	"	+.0120	.000765	.00000765	S W	
162	"	12.0	45	"	+.0120	......	......	...	Exposed ice to sun.
163	Feb. 28	12.0	34	"	+.0120	.000765	.00000765	S W	Average expansion, .00000741. General average, .00000763.

ON THE INTRUSIVE ROCKS OF THE DISTRICT OF MONTREAL.*

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At the close of my Report for 1856, I had occasion to call attention to the composition of some varieties of intrusive rock, occurring n the vicinity of Montreal, and locally known as white traps. These rocks, which are sometimes compactly crystalline, at others are porphyritic, the base being dull and earthy in aspect, and enclosing crystals of feldspar. My analyses showed these rocks to be essentially composed of a feldspar approaching orthoclase in composition, with occasional admixtures of a silicate of alumina and alkalies decomposable by acids, together with carbonates of lime, magnesia, and oxyd of iron. These carbonates were sometimes entirely wanting, but in other varieties of the rock equalled five or six per cent. In

* From the Report of Progress for the year 1858.

like manner certain varieties gave to muriatic acid only traces of alumina from the decomposable silicate, which in other specimens equalled five or six per cent. and in one case from 36·0 to 46·0 per cent. and had the composition of natrolite, gelatinizing with acids; the insoluble portion in this as in the other cases consisted of a feldspar resembling orthoclase. This rock which contained besides, about seven per cent. of carbonates, I described under the name of phonolite. (Report for 1856, p. 490.)

The feldspathic residue from these white traps contains from 60·0 to 66·0 per cent. of silica, and only traces of lime, with from 10·0 to 13·0 per cent. of alkalies, in which potash sometimes predominates, while more often soda makes up the larger portion, a fact observed in many orthoclase feldspars, especially those from trachyte; for to this class of rocks the white traps are for the most part to be referred, as already indicated by Sir W. E. Logan when describing as a trachytic porphyry, the feldspathic trap from Chambly, whose analysis is given at page 486 of the Report just cited. (See also Sir William Logan's Report for 1847, p. 17.)

Under the title of trachytes, lithologists have included a large class of igneous rocks, generally more or less rough to the touch (as the name indicates,) white or of pale colors, and composed essentially of orthoclase or a closely related feldspar, with small portions of mica, hornblende and more rarely pyroxene. Some varieties contain disseminated grains of quartz. The typical trachytes have an uncrystalline base, which is sometimes porous and at others compact, generally dull and earthy in aspect; the base is sometimes vitreous and passes into obsidian and pumice, while in others it is finely crystalline. These varieties often become porphyritic from the dissemination of crystals of glassy feldspar and other minerals, passing into the so-called argillophyre or clay porphyry. The base is sometimes highly silicious and becomes a sort of petrosilex, which is probably nothing more than an intimate mixture of quartz and feldspar; through such trachytes, and those which contain disseminated quartz, we have a passage to true granites, which consist of orthoclase feldspar mingled with quartz and mica. There are not wanting trachytes whose whole mass is coarsely crystalline, constituting granitoid and even gneissoid trachytes. Such are some of the rocks about to be described, which are only distinguished from true granites and syenites by the absence of quartz. The analyses of other trachytic rocks show them to consist of orthoclase mingled with more basic feldspars, or with hydrated silicates like natrolite, thus passing into phonolites. The accidents of structure which are supposed to characterize this class of rocks are however so little dependent upon chemical composition that in many of the so-called trachytic rocks of Hungary and Guadaloupe the predominant mineral is a basic feldspar like labradorite, containing large amounts of lime and soda, with but little potash.

Among the trachytic rocks of Lower Canada, I have met with none which are porous or vitreous The white trachytic dykes at Lachine are finely granular, and sometimes earthy in texture; they occasionally assume a concretionary structure, and are often porphyritic from the presence of crystals of feldspar. The reddish-gray trachytic porphyry of Chambly offers an example of well-defined feldspar crystals in a paste consisting of finely lamellar orthoclase with a slight excess of silica and small portions of mica. Several dykes about Montreal consist of a trachytic porphyry with large feldspar crystals in a compact purplish or lavender-gray base of a waxy lustre, which effervesces with acids from an admixture of carbonates, and closely resembles in appearance certain trachytes from the Siebengebirge upon the Rhine. Other varieties can hardly be distinguished from the so-called domite, the trachyte of the Puy de Dôme, and exhibit small drusy cavities. The presence of carbonates in trachytes has generally been overlooked; Deville, however, found seven per cent. of carbonate of lime in a trachytic rock from Hungary, and I have observed it disseminated in some of the trachytes of the Siebengebirge.

In my report already referred to, I have shown that some of the trachytes of our vicinity apparently contain carbonates of magnesia and iron, and perhaps of manganese, in addition to carbonate of lime. Many of these rocks weather to some depth of a reddish-brown from the peroxydation of the iron. One of this kind, which forms a large dyke in the limestones at the Mile-End Quarries, is remarkable for its large proportio of carbonates. It is grayish-white with dark gray spots, granular, sub-vitreous in lustre, and has the aspect of an impure quartzite. It loses by ignition 11·0 per cent. of its weight; reduced to powder it effervesces freely with nitric acid, disengaging carbonic acid, which when heat is applied is mingled with nitrous fumes from the peroxydation of the iron. 100 parts of the rock gave in this way to the acid 4·84 of alumina, besides lime, magnesia and iron, which represented as carbonates equalled carbonate of lime 11·60, carbonate of magnesia 3·58, carbonate of iron 3·82=19·00; a small portion of these bases was perhaps united with the alumina in a silicate. The insoluble residue gave as follows:

	I.
Silica,	61·62
Alumina,	21·00
Lime,	2·69
Magnesia,	(traces)
Potash,	4.66
Soda,	5·35
Volatile,	2·37
	97·69

It will be seen that this residue is near to orthoclase, or rather to oligoclase in composition; as I have suggested in a previous Report, the decomposition of a portion of the feldspar, which has been converted into a hydrated silicate of alumina with loss of the alkalies and a portion of silica, will explain the presence of water and an excess of alumina, not less than the deficiency of silica and alkalies in the feldspathic matter of the more earthy of these trachytes.

These trachytic rocks occur in dykes cutting the dolerites and melaphyres of the Mountain of Montreal, and constitute the little island known as Moffatt's Island, but the most remarkable exhibition of them is met with in the mountains of Brome and Shefford. The former occupies an area of about twenty square miles in the township of Brome and the western part of the township of Shefford, and consists of a great mass of trachyte rising into several rounded hills, of which Brome and Gale Mountains are the principal, and may have an elevation of about 1000 feet above the surrounding plain, from which the intrusive rock rises boldly. It shows divisional planes, giving it the aspect of stratification, and is divided by other joints into rectangular blocks. Another similar mass, covering an area of about nine miles, is met with in the township of Shefford a little to the N.W., and distant in the nearest point only about two miles from the last. These masses of rock, as Sir W. E. Logan has shown in his Report for 1847, break through the slates and sandstones of the upper portion of the Hudson River group, which in that vicinity, although on the confines of the metamorphic region, are but little altered.

The rock of these two mountainous areas presents but very slight differences, being everywhere made up in great part of a cleavable feldspar with small portions of brownish-black mica or of black hornblende, which are sometimes associated. The proportion of these two minerals to the mass is never above a few hundredths and often less than one-hundredth. The other minerals are small brilliant crystals of yellowish sphene and others of magnetic iron, amounting together probably to one-thousandth of the mass; in some finer grained varieties rare crystals of sodalite and nepheline are met with.

These rocks never contain quartz, but being made up entirely of cleavable grains of feldspar without any cementing material, are very friable and subject to disintegration; so that for some distance around the mountains, the soil is almost entirely made up of the disaggregated crystals of feldspar, which however show but little tendency to decomposition, and retain their lustre. The rock is sometimes rather finely granular, but is often composed of cleavable forms, which are from one-fifth to one-half of an inch in breadth and sometimes nearly an inch in length. The cleavages of the feldspar are those of orthoclase. The lustre is vitreous and in the more opaque varieties pearly, but the crystals never exhibit that eminently glassy lustre nor the fissured appearance which characterises the feldspar of many foreign trachytes, identical with these in composition. The colour of the feldspars of these mountains is white, passing to reddish on the one hand, and to pearl or lavender-gray on the other.

Specimens of the rock of Brome Mountain were taken from the side near the village of West Shefford; it was coarsely crystalline, lavender-grey in colour, and contained a little brown mica, sphene and magnetic iron, but no hornblende. The density of fragments of the mass was found to be 2·632—2·638. Selected grains of the feldspar had the specific gravity of 2·575 and did not yield anything to the action of hydrochloric acid. The analysis was effected in the usual way by fusing with an alkaline carbonate. The alkalies were determined from another portion, which was decomposed by ignition with a mixture of carbonate of lime and muriate of ammonia. The analyses of two portions from different specimens gave as follows:

	II.	III.
Silica,	65·70	65·30
Alumina,	20·80	20·70
Lime,	·84	·84
Potash,	6·43	....
Soda,	6·52	....
Volatile,	·50	....
	100·79	

A specimen from the south side of Shefford Mountain was next examined. A little above the place where it was collected, the rock was a coarse greyish-white feldspar with a little black mica, and closely resembled that just described, but the portion selected contained a little black brilliant hornblende in crystalline grains about the size of those of rice, with very small portions of magnetite and yellow sphene, disseminated in a base, which although completely crystalline, was more coherent and finer grained than that of Brome, rarely exhibiting cleavage planes more than one-fourth of an inch in length. Its colour was yellowish-white, and it was sub-translucent with a somewhat pearly lustre. Fragments of the rock gave a specific gravity of 2·607—2·626—2·657. By crushing and washing the mass, the white feldspar grains were separated from the heavier minerals, and had in powder a specific gravity of 2·561.

The composition of this feldspar is almost identical with that from the trachytes of Brome and Chambly. For the sake of comparison, the analysis of the crystals from the latter is subjoined. (A.) See Report for 1856, p. 486.

Analysis gave for the feldspar of Shefford :

	IV.	A.
Silica,	65·15	66·15
Alumina,	20·55	19·75
Lime,	·73	·95
Potash,	6·39	7·53
Soda,	6·67	5·19
Volatile,	·50	·55
	99·99	100·1

Going westward from the mountains of Brome and Shefford, which from their proximity and their identity of composition may be looked upon as forming but one great trachytic mass, we meet with a series of intrusive masses, less extensive, but similar in attitude, and which, as Sir Wm. Logan has remarked, are placed along the line of an anticlinal, traceable as a gentle undulation for 180 miles across the country as far west as the Lac des Chats on the Ottawa. The hills lying to the west of Brome and Shefford are in the order of their succession, Yamaska, Rougemont, Belœil, Montarville, Mount Royal and Rigaud, all of which are intruded through Lower Silurian strata. A few miles to the south of Belœil is Mount Johnson or Monnoir, another intrusive mass, which although somewhat out of the range of those just mentioned, apparently belongs to the same series. The mineral composition of these intrusive masses varies considerably, not only for the different mountains, but for different portions of the same mountain.

Yamaska Mountain.—The greater portion of this mass is a granitoid trachytic rock, which differs from that of Brome and Shefford in being somewhat more micaceous and more fissile. The dark brown mica is in elongated flakes, and hornblende is absent in the specimens collected, which however hold small portions of magnetite and minute crystals of amber-yellow sphene; these seem to be disseminated in veins of segregation, which are of a lighter colour than the mass.* The feldspar grains which make up this rock are brilliant, of a vitreous lustre, and often yellowish or reddish-gray in colour. Separated by washing from the crushed mass, the crystalline feldspar in powder had a density of 2·563, and gave by analysis as follows (V.) Another specimen of this granitoid trachyte, having been crushed and separated by a sieve from the greater portion of the mica, gave for the composition of picked grains (VI.):

	V.	VI.
Silica,	61·10	58·60
Alumina,	20·10	21·60
Peroxyd of iron,	2·90	2·88
Lime,	3·65	5·40
Magnesia,	·79	1·84
Potash,	3·54	3·08
Soda,	5·93	5·51
Volatile,	·40	·80
	98·41	99·71

The south-eastern part of the mountain offers a composition entirely different from the last, being a diorite made up of a pearly white crystalline translucent feldspar, with black brilliant hornblende, ilmenite and magnetic iron. This rock is sometimes rather fine grained, though the elements are always very distinct to the naked eye, while in other portions large cleavage surfaces of feldspar half an inch in breadth are met with, which exhibit in a very beautiful manner the striæ characteristic of the polysynthetic macles of the

* For an examination of the sphene of the Yamaska Mountains see the Report for 1851, p. 119. By an error of the press, the determined specific gravity is said to be 2·76 instead of 3·76.

triclinic feldspars. The associated crystals of hornblende are always much smaller and less distinct, forming with grains of feldspar a matrix to which the larger feldspar crystals give a porphyritic aspect. Finer grained bands, in which magnetite and ilmenite predominate, traverse the coarser portions, often reticulating ; while the whole mass is also occasionally cut by dykes of a whitish or brownish-gray trachytic rock, which is often porphyritic. If, as is not improbable, these dykes belong to the great trachytic portion of the mountain, it would show that here as in Mount Royal, the trachytes are more recent than the dolerites or diorites, but the relations of these different rock have yet to be made out.

A portion of the coarse grained diorite selected for examination, contained besides the minerals already enumerated, small portions of black mica, with grains of pyrites, and a little dessemi-nated carbonate of lime, which caused the mass to effervesce slightly with nitric acid. The macled feldspar crystals, sometimes half an inch in length and beautifully striated, were so much penetrated by hornblende that they were not fit for analysis, but by crushing and washing the rock a portion of the feldspar was obtained which did not effervesce with nitric acid, and contained no visible impurity except a few scales of mica. The specific gravity of the powdered feldspar was 2.756—2.763. It was attacked by hydrochloric acid with separation of pulverulent silica, but the complete analysis by this means was somewhat difficult, a portion of the mineral escaping decomposition, so that the ordinary method of fusion with an alkaline carbonate was had recourse to. Two analyses gave as follows :—

	VII.	VIII.	B.
Silica	46.90	47.00	47.40
Alumina	31.10	32.65	30.45
Peroxyd of iron	1.35		.80
Lime	16.07	15.90	14.24
Magnesia	.65	....	.87
Potash	.58	....	.38
Soda	1.77	....	2.82
Volatile	1.00	....	2.00
	99.42		98.96

This feldspar then approaches closely in composition to anorthite, which although formerly regarded as a rare species, has recently been shown by Deville, Damour and Forchammer to enter into the composition of the volcanic rocks of Iceland and Teneriffe, and Scott has lately described a coarse-grained diorite from near Bogoslowsk in the Urals, which contains a feldspar of specific gravity 2.72, composed of silica 46.79, alumina 33.16, peroxyd of iron 3.04, lime 15.97, potash 0.55 ; soda 1.28=100.79. It is associated with a greenish-black aluminous hornblende, containing some soda and titanic acid, together with a little mica and some quartz. (*Phil. Mag.* (4,) xv. 518). Quartz was also observed by Delesse in the orbicular diorite of Corsica, the feldspar of which contains according to him silica 48.62, and lime 12.02, approaching to anorthite in composition. In all of these feldspars however, the proportion of silica is somewhat greater than in pure anorthite, which contains only 43.2 per cent. of silica. I have already in a previous Report discussed the question of the composition of these feldspars, and my reasons for regarding them as mixtures of two or more species. (Report for 1853-56, p. 383, and *Phil. Mag.* (4) ix. 262.) I may here call attention to my analysis of the Bytownite of Thompson from near Ottawa; this is a granular feldspar, forming with occasional grains of hornblende a diorite, and having a specific gravity of 2.732, which in my Report for 1850, p. 39, I described as an impure anorthite. Its analysis is for comparison placed along side of that of the feldspar of the Yamaska diorite, and marked B.

Mount Johnson or *Monnoir*, is composed of a diorite which in general aspect greatly resembles that of Yamaska except that it is rather more feldspathic; the finer grained varieties are lighter colored and exhibit a mixture of grains and small crystals of feldspar with hornblende, brown mica and magnetite. Frequently however the rock is much coarser grained, consisting of a mixture of feldspar grains with slender prisms of black hornblende often half an inch long and one-tenth of an inch broad, and numerous small crystals of amber colored sphene.

In this aggregate there are imbedded cleavable masses of the feldspar often an inch long by half an inch in breadth. At the southern foot of the mountain large blocks of the coarse grained diorite are found in a state of disintegration, affording detached crystals of feldspar with rounded angles, and weathered externally to an opaque white from partial decomposition. Near the base of the mountain a coarse grained variety of the diorite encloses small but distinct crystals of brown mica, and a fine grained micaceous variety near the summit contains sphene.

The feldspar in all the specimens of which I have examined appears uniform in its character; it is white, rarely greenish, or grayish; lustre vitreous inclining to pearly. In its cleavages it resembles oligoclase, to which species it is shown to be related by its specific gravity and chemical composition; but I have never seen among its crystals the polysynthetic macles so common in triclinic feldspars. The specific gravity of a carefully selected fragment was 2.631, of another specimen in powder 2.659. The analyses of two different specimens gave as follows:

	IX.	X.
Silica	62.05	62.10
Alumina	22.60	
Peroxyd of iron	.75	
Lime	3.96	3.69
Potash	1.80	
Soda	7.95	
Volatile	.80	
	99.91	

Belœil or Rouville Mountain.—The specimens which I have examined from this mountain may be described as a micaceous diorite. The feldspar, which predominates so far as to give a light grey colour to the rock, is in white translucent vitreous cleavable grains, with small distinct prisms of black hornblende and scales of copper-colored mica. Magnetic iron is also disseminated, and the rock resembles the micaceous portion of Yamaska. A portion of the feldspar separated by washing, still retained a little mica, and gave by analysis:

	XI.
Silica	58.30
Alumina, Peroxyd of iron	24.72
Lime	5.42
Magnesia	.91
Potash	2.74
Soda	6.73
Volatile	.50
	99.32

It will be seen that this feldspar approaches very closely to that from Yamaska numbered VI., and there is much resemblance between the two rocks.

Montarville or Boucherville Mountain.—The collection of specimens from this intrusive mass offers two or three remarkable varieties of rock not met with in the mountains already described; and characterized by the presence of augite and olivine. The first variety consists almost entirely of coarsely crystalline black augite, with small scales of brown mica, and rare grains of white feldspar; others of calcite are also scattered throughout the mass, and their removal by solution has left numerous little pits on the weathered surface; it may be described as a highly augitic dolerite. Another and remarkable variety appears to form the greater part of the mountain; it consists of olivine in rounded crystalline masses, from one-tenth to half an inch in diameter, associated with a white or greenish-white crystalline feldspar, black augite and a little brown mica and magnetic iron. The augite appears both in the form of small grains, and of well defined crystals, often an inch in length by half an inch in diameter, and partially coated with a film of brown mica; the olivine is evidently the predominant mineral.

An average specimen of this olivinitic dolerite was reduced to powder; it did not effervesce with nitric acid, and when ignited lost only 0.5 per cent. When heated with sulphuric acid the olivine was readily decomposed with a separation of silica, and by the subsequent use of a dilute solution of soda, followed by hydrochloric acid, and a second treatment with the alkaline ley, 55.0 per cent. of the mass were dissolved. The dissolved portion consisted of,

	XII.
Silica	37.30
Magnesia	33.50
Protoxyd of Iron	26.20
Alumina	3.00
	100.00

Another portion of the same pulverized specimen was gently warmed with dilute sulphuric acid, and the silica being removed from the residue by a solution of soda, some grains of olivine which still remained, were decomposed by a repetition of the process. The undissolved portion equalled 44·7 per cent., and appeared to consist of feldspar and pyroxene, with some mica and a little magnetite. The acid solution gave a quantity of magnesia equal to 18·0 per cent. of the rock.

Selected grains of the olivine were now submitted to analysis.

The powdered mineral gelatinized with hydrochloric acid even in the cold, and was almost instantly decomposed when warmed with sulphuric acid diluted with an equal volume of water, the silica separating for the most part in a flocculent form, and enclosing small grains of undecomposed mineral, which were left after dissolving the ignited silica. One or two hundredths of silica were however retained in solution, and were precipitated by ammonia with the oxyd of iron. Two analyses of separate portions of the olivine gave as follows, after deducting the undecomposed mineral :

	XIII.	XIV.		Oxygen.
Silica,	37·13	37·17	=	19·82
Magnesia,	39·36	39·68	=	15·87
Protoxyd,	22·57	22·54	=	5·10
	99.06	99.39		

If we suppose the 18-0 per cent. of magnesia fouud above to correspond to olivine containing 39-5 per cent. of magnesia, we shall have 45-5 per cent. of olivine in the rock examined. The silicates not attacked by sulphuric acid were decomposed by fusion with an alkaline carbonate, and gave as follows :

	XV.
Silica,	49.35
Alumina	18.92
Protoxyd of iron	4.51
Lime	18.36
Magnesia	6.36
Loss (alkalies ?)	2.50
	100.00

A crystal of the black cleavable augite from the olivinitic dolerite had a hardness of 6.0 and a density of 3.341 ; its powder was ash-gray. Analysis gave,

	XVI.
Silica	49.40
Alumina	6.70
Lime	21.88
Magnesia	13.06
Protoxyd of iron	7.83
Soda with traces of potash	.74
Volatile	.50
	100.11

In some portions of the dolerite of Montarville, the feldspar is more abundant and appears in slender crystals, with augite and a smaller proportion of olivine than the last. A specimen of this variety crushed and washed, gave 3.9 p. c. of magnetic iron, and 10.0 p. c. of a mixture of ilmenite with olivine. The feldspar was obtained nearly pure, in the form of slightly yellowish vitreous grains having a density of 2.731–2.743. Its analysis gave the composition of labradorite:

	XVII.
Silica	53·10
Alumina	26·80
Lime,	11·48
Peroxyd of iron,	1·35
Magnesia,	·72
Potash,	·71
Soda,	4·24
Volatile,	·60
	99·00

Rougemont.—The rocks from this mountain offer very great varieties in composition and appearance. Some portions are a coarse grained dolerite in which augite greatly predominates; grains of feldspar are present, and a little disseminated carbonate of lime. In some specimens the augite crystals are an inch or more in diameter, with brilliant cleavages, and grains of pyrites are abundant, with calcite, in the interstices. This rock approaches closely to the highly augitic dolerite of Montarville. The olivine which characterises the latter mountain is also very abundant in two varieties of dolerite from Rougemont. One of these consists of a grayish-white finely granular feldspathic base, in which are disseminated well defined crystalline grains of black augite and amber coloured olivine, the latter sometimes in distinct crystals The proportions of these elements vary in the same specimen, the feldspar forming more than one-half the mass in one part, while in the other the augite and olivine predominate. By the action of the weather the feldspar acquires an opaque white surface, upon which the black lustrous augite and the rusty-red decomposing olivine appear in strong contrast.

Another variety of dolerite from this mountain may be described as a fine grained grayish-black basalt enclosing a great number of crystals of dark bottle-green translucent olivine, which appear in high relief upon the weathered surfaces, and are often half an inch in diameter.

In Sir Willam Logan's notes upon this mountain it is remarked that dykes of a fine grained granitic trap cut the augitic mass; and I find among the collections from this locality specimens of a light gray rock which is made up of a white crystalline feldspar with small prisms of black hornblende and scales of brown mica, resembling somewhat the finer grained diorite of Mount Johnson, while others more micaceous approach to that of Belœil.

Mount Royal or Montreal Mountain.—A large portion of this mountain consists of a dolerite in which augite greatly predominates, resembling the highly augitic varieties of Rougemont and Montarville. The white crystalline feldspar, which is often very sparsely disseminated, is at other times more abundant, and occasionally predominates in bands, which traverse the dark coloured rock and appear to be veins of segregation. At the east end of the mountain a variety of dolerite containing olivine occurs; it consists of a base of grayish-white granular feldspar, which constitutes in the specimen before me about one-half the mass, and incloses crystals of a brilliant black augite, and others of semi-transparent amber-yellow olivine. This rock closely resembles the feldspathic olivine rock of Rougemont described above, but the imbedded crystals are somewhat larger, although much smaller than the crystals of the same mineral in the dolerite of Montarville. A portion of the feldspar freed as much as possible from augite, gave by analysis the following result, which shows that it approaches labradorite in composition:

	XVIII.
Silica,	53·60
Alumina,	25·40
Peroxyd of iron,	4·60
Lime,	8·62
Magnesia,	·86
Alkalies, by difference,	6·12
Volatile,	·80
	100·00

The Silica contained 1·60 of matter insoluble in carbonate of soda, apparently titanic acid from intermingled ilmenite, from whence a portion of the oxyd of iron is also derived.

Rigaud Mountain.—This, the most western of the series of intrusive masses under consideration, is in great part made up of a rock which approaches in character those of Brome and Shefford, being an aggregation of large crystalline grains of what appears to be a reddish orthoclase, often without any cementing medium; at other times the feldspar crystals are imbedded in a fine grained grayish base, and the rock closely resembles the trachytic porphyry of Chambly. Quartz and hornblende are both however sometimes present, the rock passing into a granite or syenite. These rocks are cut by thin veins or dykes of a hard reddish-brown jasper-like feldspathic rock.

A portion of Rigaud Mountain however consists of a rather coarse grained diorite, which is made up of a crystalline feldspar, white or greenish in colour, with small prisms of brilliant black hornblende and crystals of black mica, in some specimens the feldspar and in others the hornblende predominating. These diorites resemble closely those of Belœil and Rougemont.

The rocks of all these mountains, and especially of Montreal and Rigaud, still demand a great deal of study, and these observations and analyses are to be looked upon only as preliminary to a more extended examination, which shall determine the mutual relations of the trachytes, diorites, dolerites and olivinitic rocks above described, as well as their probable relations to the stratified deposits of more ancient periods.

The eruption of these augitic and olivinitic rocks was evidently antecedent to the deposition of the Lower Helderberg rocks, since in the dolomitic conglomerate of that age we meet with fragments of augite, olivine and mica identical with those found in the dolerites just described (Report 1857, p. 202.)

The metamorphic action exerted by these intrusive masses upon the Silurian strata in their immediate vicinity appears to have been very local, but it is not less worthy of study, inasmuch as its results on a small scale resemble those produced by the wide-spread action which has altered such vast areas of similar rocks in the Green Mountain chain, far removed from the influence of intrusive rocks.

Among the sandstones and shales of the Hudson River group which surround Rougemont, there occur beds of those highly ferruginous dolomites so often met with in this formation, and similar to those which I have described in previous Reports.

In one of these, which is conglomerate or concretionary in its structure, the paste has been converted into a dark greenish crystalline hornblende, which retains its colour on the weathered surfaces, while the nodules of buff coloured dolomite have become reddish-brown and pulverulent.

In another specimen of this rock, also from Rougemont, and made up of thin layers of white crystalline red-weathering dolomite with others of a compact greenish-gray mineral, are interposed layers of blackish green crystalline hornblende from one-sixth to one-fourth of an inch in thickness; like the other bands they are variable in thickness and interrupted. Occasionally the cleavages of the hornblende, which are nearly perpendicular to the beds, are seen cutting through thin layers of the dolomite, which as before, weathers reddish-brown.

A portion of the rock free from hornblende was attacked with effervescence by warm dilute nitric acid, which dissolved 54.0 per c. of carbonates of lime, magnesia and iron. The soluble portion had the following composition:

Carbonate of lime	38.9
" magnesia	31.2
" iron	29.9
	100.0

Minute grains of pyrites were disseminated through the rock, which gave to the acid traces both of copper and nickel. The residue decomposed by fusion with carbonate of soda was found to contain—silica 65.40; alumina 10.10; lime 0.56; magnesia 2.05; protoxyd of iron 4.80; titanic acid 7.30; volatile 2.20; loss (alkalies?) 7.59 = 100.00.

The fossiliferous limestones around the mountain of Montreal appear to have suffered very little change from the proximity of the igneous rocks. In one instance a portion of the limestone for the distance of five or six inches from the dolerite was seen to be whitened, and intermixed with a portion of a greenish matter having somewhat the aspect of serpentine. Nitric acid dissolved from the crushed rock carbonate of lime with some alumina and a trace of magnesia, and the residue dried at 212° F., gave by analysis, silica 40.20; alumina 9.30; protoxyd of iron 5.22; lime 36.40; magnesia 3.70; volatile 0.20 = 95.02. The insoluble matter of these limestones is generally aluminous, and contains only traces of earthy protoxyd bases. A portion of the gray fossiliferous limestone from the vicinity of the mountain left by the action of a dilute acid a residue black with carbonaceous matter, which became white by ignition, and equalled 12·8 per cent. of the rock. It was an impalpable powder which gave to dilute soda ley, 9·5 per cent. of its weight as soluble silica, while the residue had nearly the composition of a potash feldspar; analysis giving me silica 73·02, alumina 18·31, lime 0·93, magnesia 0·87, potash 5·55, soda 0·89 = 99·57. (See Report for 1857, p. 198.) It would appear that under the influence of the heat of the intrusive rock this argillaceous matter combines with lime, magnesia and oxyd of iron to form the silicate whose analysis has been given above, a portion of alumina being set free in a soluble form.

REVIEWS.

A New History of the Conquest of Mexico, in which Las Casas' Denunciations of the Popular Historians of that War are fully Vindicated. By Robert Alexander Wilson, Counsellor at Law, Author of "*Mexico and its Religion*," &c. Philadelphia: James Challen and Son. 1859.

The idea implied by the designation of a *new history* of the Conquest of Mexico is set forth in unmistakeable language in the volume now before us, ere we have even got the length of the preliminary chapter. It is a book written mainly to show the fallacy of Prescott's work on the same subject, though the author has a higher aim before himself than that of a mere eradicator of previous errors. He is prepared not only to displace, but to replace; and, having reduced the fancied Aztec civilization of Ancient Mexico to a fable, its sovereign cacique, Montezuma, to a mere Indian chief, and his Aztec hosts to a horde of Indians, little, if at all, in advance of the famous Iroquois league that withstood Champlain and the chivalry of France in the seventeenth century; he next proceeds to establish an ante-Columbian civilization in the New World, the direct product of Phœnician civilization, and consequently dating back to centuries far beyond the reach of Aztec or Toltec traditions. In a letter to his publishers, attached to the volume as "the Author's Explanation," he refers to the death of the distinguished historian of the Conquests of Cortes and Pizarro, and adds:—"The most kindly relations existed between us in his lifetime, though ever taking diametrically opposite grounds on all Spanish questions; he assuming that the books and MSS. sent to him from Madrid were reliable authorities, while I insisted on the lawyer's privilege of sifting the evidence—a labour he was incapable of performing from a physical infirmity." The assumption here made that, because from the temporary deprivation and long weakness of sight, which compelled Prescott to pursue his historical labours with the aid of a reader and amanuensis, he was therefore incapable of sifting the evidence on which his historical deductions were based, is a very extraordinary one, and will be acquiesced in by few among the admirers of the great American historian. But the feelings of dissent from the basis thus set forth for a relative estimate of the merits of the two histories of the Conquest of Mexico, will not be diminished by a critical perusal of the author's arguments; though in one respect he enjoys a great advantage over Prescott, in speaking of the incidents of the Conquest, with a personal knowledge of many of the localities where its chief events transpired. But Mr. R. A. Wilson has this grand qualification for "the lawyer's privilege of sifting the evidence," that he is a famous doubter. He disbelieves Cortes, he denies the very existence of Bernal Diaz, the most valuaable of hitherto accredited authorities; and as for Spanish bishops, priests, and missionaries, he can scarcely find words strong enough to express his contempt for them. Torquemada, Sahagan, and Herrera are alike "filled with childish trash," "monkish ideas distilled through Indian brains," and exhibitions "of the besetting sin of Spaniards, the monk's evil, lying;" and after describing the history of Fernando de Alva—whom he contemptuously styles the *quadroon*,—as only the counterpart of the fabulous picturings by Cortes, "with a few additions drawn from Scripture History, Moorish Romances, and the Arabian Nights;" he thus closes his critique on that ingenious native historian of Aztec civilization:—"We now take leave of Fernando de Alva de Ixtlilxochitl, with the remark that an epithet, too common at Mexico, cannot with justice be applied to him—*he lies like a priest;* for if he does state what he knew to be untrue, he has done it far more elegantly than any of the priestly historians whose works we shall discuss." Snch, it need scarcely be said, is a lawyer's mode of sifting evidence such as the historian of the "Conquest of Mexico" was incapable of performing, and however consistent with the partizan tone of a Counsel in his address to a jury, is not the most promising for the impartial verdict of the judge.

But besides this duty of a lawyer-like sifting of evidence, which our author specially takes credit for, he has the more valuable qualities of an eye-witness, and steps into the witness box to tell us what he has himself seen, amid scenes rendered famous by events which historians have located on the lofty table-lands of Mexico, and which owe some of their most characteristic incidents to the peculiar natural and artificial features of the country. An extract will best suffice to illustrate his mode of turning his own personal observations to account; and for this purpose we select his description of Cholula, because, as he says in diverse forms throughout the work, his faith was shaken at Tlascala, and Cholula extinguished it. It is surprising, indeed, to find how narrow a basis sufficed to furnish a firm footing for his original doubts. "The discovery of a common flint arrow-head," he remarks at page 78,—"an indispensable part of the usual weapons of a North American Indian—upon the pyramidical mound of Cholula, first aroused suspicion, and set the author upon this inquiry into the pretended civilization of Montezuma and his Aztecs. The investigation has resulted in his conviction that a large portion of the narrative of Cortes was designedly untrue, and written purposely to impose upon the Emperor; and, further, that all the subsequent additions to that author are pure fabrications. He was, moreover, led to believe that the narrative, bearing the name of Bernal Diaz, was written for the purpose of sustaining other histories already needing a more ample foundation than that furnished by Cortes. It is probably nothing more than the story of Gomora, with the absurdities pointed out by Las Casas partially deducted." The author repeats in a foot-note that his first suspicions of the civilization of the Indians of the Table-land was the discovery of this arrow-head. He is evidently not aware that flint arrow-heads are by no means rare at Marathon and elsewhere in Greece, occur on Italian sites, and have been found abundantly in France and Britain; or would he consider that such discoveries furnished equally cogent grounds for lawyer-like doubts about the civilization of any, and every prior historical period? This, however, is the mere starting point. The following extract combines historical criticism with the results of personal observation. Having stated his views of the Tlascalan war, he thus proceeds :—

The scene now shifts to an adjoining tribe, one bearing the familiar name of Cholula, in common with a mud-built village, and an immense earthen mound, which distinguished it, then, as now, among all the villages of the table-land. For once we shall follow the standard historians, and afterwards add our own observations. That famous cut-stone pyramid of Cholula, a print of which used to adorn every school geography of our country, had never other than an imaginary existence. The reality is an earthen mound, differing from the common sort only in its enormous size. We are indebted to fiction for all else that it possesses.

The Spanish inventors of Indian traditions made Cholula the Mecca of the Anahuac, where of old an annual fair was held, the resort of merchants and pilgrims from all parts of the table-land; there, say they, sacrifices were offered and vows performed, while exchange and barter engrossed a busy multitude in its bazaars, and at the foot of the great *pyramid.* Cholula, by these apocryphal traditions, was in the time of Indian *paganism!* sacred to Quetzolcoatl, "the god of the air," who, during his abode on earth, had taught mankind the use of metals, the practice of agriculture, and the arts of government. Other Spanish authors, presuming these traditions true, saw in them the mission of the Apostle Thomas to the Anahuac, and hence styled him the reformer of that people; and thus accounted for the cross, the Madonna, and the incense-burning, pictured on the temple-ruins of the hot country, Thus have hypotheses been piled upon each other, to account for the striking similarity that seems to have existed between antique paganism and Romish idolatry.

The account which Cortez gives of Cholula is even more extravagant than his description of Tlascala. According to him, the village of Cholula was a rich and opulent city of forty thousand houses. He says he counted "from a mosque, or temple, four hundred mosques, and four hundred towers of other mosques." He says, too, "the exterior of this city is more beautiful than any in Spain." Diaz, more moderate in the use of numerals, reduces the eight hundred to one hundred very high towers, the whole of which were *cues*, or temples, on which the human sacrifices were offered, and their idols stood. The principal *cu*, here, was even higher than that of Mexico, though the latter, he says, was magnificent, and very high. "I well remember when we first entered this town, and looking up to the elevated white temples, how the whole place put us completely in mind of Valladolid." Other historians go yet further, and represent Cholula not only as the Mecca and commercial centre, but also the seat of learning for the whole *Anahuac.* Here, say they, the Indian philosophers met upon a common footing with Indian merchants.

Its government, like that of Tlascala, was republican; so that upon these plains, according to Spanish authors, more than three hundred years ago there flourished two powerful republics, Tlascala and Cholula, the first the Lacedæmon, the second the Athens of the Indian world. When united, they had successfully resisted the arms of Montezuma; but Aztec intrigue was too powerful for the American Athens, and the polished city of Cholula was subdued by those arts with which Philip of Macedon won the sovereignty of Greece—a combination of intrigue and arms. Tlascala was left alone to resist the whole force of the Aztec empire, now aided by the faithless Cholulans. Yet Tlascala, undismayed by the new combination, did not readily listen even to the proposals of Cortez; and only after the terrible experience she received of his strength, did she admit the value of his alliance. Let us contemplate the simple truth.

The ordinary representations of the city and republic of Cholula are all in a style of magnificence commensurate with the foregoing outline. Such statements only had the author seen, when he undertook its survey. He had not then heard or read of the suggestion of Torquemada, though copied into one of the notes of Robertson. "The large mound of earth at Cholula, which the Spaniards dignified with the name of temple, still remains, without any steps by which to ascend, or any facing of stone. It appears now like a mound, covered with grass and shrubs, and possibly it was never anything more." The striking resemblance of this to the mounds scattered through the country of our northern tribes, satisfied us of their common origin, and that this, like the others, was but an Indian burying place, formed by the deposition of earth upon the top of a sharp conical hill, as often as fresh bodies were interred, and this is probably the fact. Its greater size is doubtless attributable to its situation in the midst of a most fertile plain, [*vega*] where from generation to generation a dense popolation must have dwelt, who used this as the common receptacle of their dead. The appearance of that structure, which Humboldt and other Europeans have considered a monument of antique *art*, is readily explained by opposing facts familiar only to Americans, to the scientific speculations of foreigners! But to this one there is now no question: an excavation having been made into the side of the mound, it revealed that truth which we only surmised. The only ruins at Cholula are those of several Spanish convents, abandoned by the *religious* for others in the more congenial, because more polluted atmosphere of *Puebla*, six miles distant. The village is a collection of *adobe* huts, such as it doubtless was in the time of Cortez, and all the appearance of art about "the pyramid" is the modern church upon its crest.

There is one reference here to which we would direct the reader's attention as of no slight importance. Torquemada, a Provincial of the Franciscan order, visited the New World about the middle of the sixteenth century, and was in close intercourse with many who had personally shared in the dangers and the triumphs of Cortez. He resided in the country for fifty years, and as the zealous chronicler of all that related to Mexican antiquities, he must have been an observant witness of any remarkable native monuments that came under his notice. If, then, the "suggestion of Torquemada" copied by Robertson, and repeated by our author, with careful references (Torquemada, Liber III., c. 19. Note to Robertson, No. 194,) be correct, there is an end to the matter as far as the pyramid of Cholula is concerned. If Torquemada, whose whole history is written to sustain the narratives of Cortes and Bernal Diaz, nevertheless admits that in the sixteenth century the Cholula pyramid was a mere earth-mound, it does not require the authority of a traveller of the nineteenth century to assure us that it is no more now. But, Torquemada's original volumes not being accessible, we have had the curiosity to refer to Robertson's notes. In one (note 37) the historian states the dimensions of the Cholula pyramid, on the authority of Torquemada, as above a quarter of a league in circuit at the base, and forty fathoms high ; and his reference substantially corresponds to the one given above : *Mon. Ind. Lib. III. c.* 19. But the quotation which accompanies this reference to ancient Spanish authority in the subsequent note, No. 39, gives the words—not of Torquemada, who wrote from personal observation, in the sixteenth century,—but of the modern author, a Scottish divine and historian of the eighteenth century, who did not pretend that he had ever seen the mound, or indeed crossed the Atlantic. In other words the author quotes at second hand, and furnishes a note of Robertson, written at Edinburgh, about 1777, under the belief that he is quoting what Torquemada wrote at Mexico before 1600! Whatever may be the "lawyer's privilege of sifting evidence," this must be confessed to be rather a loose way of exercising it.

Again, it does not seem to have occurred to the critical author that the modern Church, which is now the only appearance of art about the earth-mound of Cholula, may have something to do with the absence of art elsewhere. For if the Monks found that mound cased, like those observed by Stephens in Central America, with cut-stone steps and facings, there can be little doubt they would go no further to seek a quarry for their intended Church ; and if, moreover, the ruins of several Spanish Convents surround the modern Cholula, the only chance of finding traces of the ancient city, if it ever existed, must be in some stray sculptures and carvings betraying native art, on the materials built into the later Spanish structures. But it may be doubted if such evidence would be received by our author, for he tells us : "At Cholula, I was so fortunate as to procure one of the images of Quetzalcoatl, cut in stone, with curled hair and Caucasian features. This I afterwards compared with the great image found at Mexico, not without strong suspicions that both were counterfeits ; for in this country, even the most sacred records are open to such suspicion." This, it must be confessed, is carrying out the principle of doubting in a most impartial and uncompromising spirit. The zeal of the old Spanish conquerors in traducing the Indians was so great, that, according to our author, they actually invented and carved idols, to bury them, for the confounding of future generations by their discovery! This is an extent of critical suspicion it would be difficult to surpass.

Whilst, however, we thus indicate the tone of writing in this new History, as differing widely from that which we generally look for in the impartial and unprejudiced historian; and the authoritative criticism as carried out in a fashion very different from what we might justly expect in the work of a learned Counsellor at Law, who has undertaken to supplement the defects of Prescott, and sift the evidence which—literally as well as metaphorically,—he had *blindly* followed; nevertheless, while this "New History of the Conquest of Mexico," will not supersede Prescott's fascinating story of the triumphs of Cortes, there are points in it well worthy of the notice of the students of History. In testing the narrative of Cortes by the physical evidence which the scene of his chief triumphs and reverses supplies, Mr. R. A. Wilson has availed himself of the American Army Survey of the Valley of Mexico, and undertakes, on seemingly satisfactory ground, to demonstrate that the Mexico of Montezuma was not built on an island in the lake of Tezcuco, nor surrounded by its waters; but that it stood nearly as now, enclosed by marshy ground, through which its causeways were formed, merely by throwing up the earth from a ditch or canal on either side. This appears to be proved by the present relative levels of the lake and the surrounding country, which show that the water, if standing at a height sufficient to reach the city, would drown much of the land which formed the chief theatre of Cortes's deeds on *terra-firma*. Still further, our new historian discredits the possible existence of Montezuma's fabled capital, by affirming that no building of any magnitude can be erected in Mexico, in consequence of its marshy site, except on piles. Here is a specimen of the fashion in which he demolishes "the fables of Cortes and Bernal Diaz:"

"In the beginning of the dry season, November 8, 1519, Cortez made his formal entry into the city, and lodged in one spacious enclosure the whole of his little army. Here both Cortez and Diaz turn aside to paint wild figments of the magnificence of the capital of Montezuma. Oriental story, in its richest flights, has hardly ever reached the extravagance of their tales. Were either narrating a public reception of the Caliph of Cordova, in the zenith of his glory, or the triumphal entry of those of Bagdad, they could not have pictured scenes comparable to these described, as actually transpiring in their presence in this Indian metropolis. The enormity of the fiction is not, after all, its most striking feature. It lies rather in the credulity—not of the Spaniards, whose belief was regulated by authority—but in that of the whole civilized world, which credited these remarkable narrators without either scrutiny or evidence. The violation of natural laws, which their statements involved, may not have been readily detected when philosophy hardly existed as a science. But how shall we account for that blinking of the gross discrepancies between them? Is a love of the marvellous so inveterate in man that critics, even, shut their eyes to the most palpable contradictions?

"Could Mexico have then been seen as it now appears—a modern city, built on an antique pattern—our authors might well have painted it in oriental colours, and almost fancied, too, some lingering resemblance to the great cities of the Moorish caliphate within its time-marked palaces. As the occupants of some chamber upon a house-top, in the day season, they might dream themselves, perhaps, in such a capital as they have fabricated for Montezuma. Domes, and minarets [steeples], and elevated battlements cast strange shadows in the rarified atmosphere, by moonlight, and make a picture so unreal that the visitor of to-day might almost fancy the actual existence of such a world as Cortez only figured. Untrue in fact—untrue even in fancy—his wild assertions have grown almost realities by passing so long unquestioned. Generation after generation allowed their taste and their architectural plans to be influenced by an imagined resemblance to something that had graced the spot before, and uncontradicted fabrications thus became almost truths.

"This valley at the sea-level would have been for ever jungle, a dwelling-place for wild beasts, for the screech-owl and the bittern to enjoy unmolested; and that such a spot, perpetually on the verge of inundation,—where the difference between land and water can be measured by inches,—should be occupied by a large city, demonstrates both the purity of the atmosphere and the uniformity of evaporation, which for centuries has maintained this slight elevation, But the proximity of the two surfaces produces disagreeable results—stagnation and decomposition—the festering evils of an undrained valley, though neutralized in its lower levels by salt and sterility. Sewerage is necessarily upon the surface—the drains of the city cess-pools are its street ditches, or *canals.* All poetic illusion vanishes, when from moonlight on the housetop we descend to the sober reality of day. Since the time of Cortez, the resources of engineering have been exhausted in attempts to establish any material change, without tunnelling the mountain, so as to drain Tezcuco *laguna.* These very defects fulfilled the Indian idea of a stronghold, as they at all times insured them that security which a circumvallation of mud and water could not furnish. Beyond this, we will not affirm the famous capital of the Aztecs differed materially from an ordinary Indian village of the first class."

This may serve to illustrate our meaning in characterising the new Historian as a famous doubter. He doubts everything; and at times he carries his reader along with him in his doubts. "I have presumed," he says, "to doubt that water ever ran up hill; that navigable canals were ever fed by 'back-water;' that pyramids *(teocalli)* could rest on a foundation of soft earth; that a canal, twelve feet broad by twelve feet deep, mostly below the water level, was ever dug by Indians with their rude implements; that gardens ever floated in mud; or that brigantines ever sailed in a salt-marsh; or even that 100,000 men ever entered the mud-built city of Mexico by a narrow causeway in the morning, and, after fighting all day, returned by the same path at night to their camp; or that so large a besieging army as 150,000 men could be supported in a salt-marsh valley, surrounded by high mountains." Gaining courage as he proceeds, he doubts if human sacrifices were ever practised among the Mexicans. The whole is a mere lying version of the barbarian practise of the Red Indian torturing his prisoner. He doubts if picture-writing existed among the Mexicans; and regards the whole costly volumes published by Lord Kingsborough, as reprints of "pious frauds" of the priests. One of their collectors, Boturini, is "the very personification of imposture and credulity;" another, Veytia, is his match in credulity, and seemingly worse in morals; a high authority on Mexican History, Clavigero, is the interpreter of a mere valueless waif of "the manufactured antiquities;" Bernal Diaz, as we have already said, was "a myth," never fought, never existed, except by virtue of the creation of a lying Monk's pen. Dr. Robertson, the Historian, and "principal of the University [High School] of Edinburgh," takes "as his authority a Jesuitical author," and writes "unmitigated nonsense about the Iroquois." The bracketed explanation that the University of Edinburgh and its *High School*, are identical is also the author's own! And finally, he thus settles the merits of the greatest of America's Historians: "Thus stand the literary monuments Mr. Prescott has constructed. They are castles resting upon a cloud, which reflects an eastern sunrise upon a western horizon!"

So far, then, we see that Mr. R. A. Wilson is an unmitigated doubter; nay, an open and avowed unbeliever in all the canonized worthies of the Calendar of Letters. But it must not be supposed he is therefore devoid of all faith. On the contrary, he has a very decided creed of his own. He believes in an extinct Phœnician Empire in Central America; finds in the cruciform ornaments of the ruins of Palenque, the emblem of Astarte; in the Turtles sculptured at Uxmal, a Tyrian symbol; in the river-wall of Copan, a counterpart of the famous sea-wall of Tyre; recognizes in one of the sculptures figured in Stephens' Central America, "the patron of the city of Palenque, the Phœnician Hercules;" and in another, engraved by Dupaix, the "American Isis or Astarte;" and, in short, proves once more that nobody is so credulous as your unbeliever.

As a new History of the Conquest of Mexico, we cannot commend this volume of Mr. R. A. Wilson as one calculated in any respect to supersede the singularly fascinating work of Prescott. As a critique, however, upon that and other Mexican Histories, written by one who has explored the localities where the principal scenes of Cortes's triumphs and reverses took place, and who has reconsidered the unquestionably exagerated narratives of the earlier Spanish authorities, with reference to the possibilities and probabilities suggested by the actual scene of historical events: the book may be read with interest and profit by the historical student. Prescott by no means overlooks the exagerative spirit of even the best of his old Spanish authorities. In one passage, for example, when speaking of Tlascula, which Cortes, in his letter to the Emperor, compares to Granada, he adds:—"The truth is, that Cortez, like Columbus, saw objects through the warm medium of his own imagination, giving them a higher tone of coloring and larger dimensions than were strictly warranted by the fact." But the charm of Prescott's version of the old highly toned narratives leaves an impression of reality which is scarcely affected by such guarded warnings of their dubious character; and such a book as the one under review has its value in drawing attention, and giving weight and due importance to them. A less ambitious name than that of "A New History of the Conquest of Mexico," would have more correctly described what is in reality only notes and reflections of a Mexican Tourist, upon the History of the Conquest and the Antiquities of the country. Such a designation of the work would, moreover, have disarmed criticism, and have admitted of a fairer estimate of the actual merits of the work than it has hitherto received. As it is, the author cannot complain, if the comparison with the carefully elaborated, and singularly fascinating volumes of Prescott, lead to a depreciation of the New History, even by those who believe as we do, that with all his candour and laborious diligence in the recovery and collation of original authorities, the high colouring of Prescott's magnificent scenes of the Conquest, not unfrequently partakes of the seductive charms of romance.

D. W.

Geological Survey of Canada. Report of Progress for the year 1858. Montreal: Printed by John Lovell. 1859.

Our notices of the various Reports issued by the Geological Survey, may appear to distant readers to be somewhat after date; but these Reports, it must be observed, are not made public, at least in a complete shape, until after their formal presentation to the Legislature, a proceeding which necessarily involves a very considerable delay. Owing to this circumstance, however, portions of the Annual Reports are frequently published, in advance, in scientific journals, in order to claim priority for the discoveries and researches of their authors; and thus, our own Journal has been honoured, on more than one occasion, by communications of this kind from officers of the Survey.

Although the Report for 1858 is filled with numerous details of much local importance, it offers, perhaps, less matter of general interest than some of those which have preceded it; but, to be properly understood and appreciated, it must be considered in connexion with the earlier explorations and researches of the Survey, as well as with those which are now being carried on. In addition to an elaborate Report from the Director of the Survey, Sir W. E. Logan, it contains communications from Mr. Murray, Mr. Richardson, and Mr. Hunt; together with valuable lists, by Mr. D'Urban and Mr. Bell, of the animals and plants met with in special districts of the Lower Province. These, with other lists of the same kind previously published, although forming at present merely isolated contributions to our knowledge of the Fauna and Flora of the country, will be found ultimately of great use. We miss, in this Report, the usual communication of Mr. Billings; but the subject matter of the Palæontological Report for the year in question, comprising a monogram on the Devonian Corals of Western Canada, has already appeared in the pages of the *Canadian Journal*, and will be published, we understand, with additional matter, in one of the forthcoming issues of the Survey.

Sir William Logan's Report contains the details of an extended exploration of the bands of crystalline limestone in the counties of Argenteuil and Ottawa, examined by him, in part, during the preceding year. These details are chiefly, and necessarily, of local interest, but they contribute much to a correct knowledge of both the geographical and geological features of that portion of the Province. In addition, for example, to the accurate delineation of about twenty miles of the River Rouge, beyond the area at present surveyed, the position and form, to quote from the Report, of thirty-two tributary lakes of various sizes were determined, some being upwards of six miles in length. But nothing can demonstrate more effectively the value of our Geological Survey, than the following observations—

shewing, amongst other things, how large an expense may be avoided, by a preliminary examination of the geology of the country, in opening up roads in districts in which Laurentian rocks prevail :

"By this modification of the distribution of the limestone as given in the Report of 1856, a great addition is made to that part lying in Harrington and Wentworth in the neighbourhood of Gate, and Sixteen Island Lakes, a large portion of which supports a surface well adapted for the purposes of agriculture. The best present access to this agricultural tract is by the road which runs along the east margin of the calcareous outcrop on the west side of the trough. The site of this road is judiciously chosen, for while the calcareous valley affords a pretty even grade, it gives also much land capable of settlement along the line, and will thus facilitate the keeping of the road in repair. Some years since a road was opened by the Government to the limestone land in the north-west part of Wentworth, from the settlement on the West Branch River, in the front of the township. But a line having been chosen as near to a straight one as practicable, over the rugged surface of the gneiss, it happens that while the grades are difficult, there is little land fit for settlement along the road. The road, in consequence, is little used ; a second growth of timber will very probably be allowed to spring up on it, and the expense of opening it will be entirely thrown away. If a road is required on the west side of Wentworth, it is probable that a better line might be obtained along the limestone on the east side of the trough. In general, throughout the Laurentian region, the bands of limestone will be found to afford the best guide for the lines of roads."

At the close of Sir William Logan's Report, some valuable information is given respecting the copper deposits of the metamorphic region on the south side of the St. Lawrence. As so much attention is now being directed to this mineral district, we are induced to transcribe this portion of the Report in a complete form :

"In the Reports of the explorations made by the survey on the south side of the St. Lawrence, in 1847 and 1849, it was stated that indications of the pyritous and variegated sulphurets of copper were observed in many localities, usually in the vicinity of certain bands of dolomite, serpentine, soapstone, and other magnesian rocks, which in various forms characterise a group of strata lying at the top of the Hudson River formation, and intermediate between what have occasionally been called the Richelieu Shales and the Sillery Sandstones. They are equivalent to the rocks of Quebec and Point Lévi, and, affected by undulations, range through the country between Cape Rosier and Lake Champlain in a very irregular manner, being distributed in long, narrow, synclinal forms, which carry their outcrops in stretches backward and forward, in a general north-east and south-west direction, bending, however, in some parts, towards north and south, and in others towards east and west. Proceeding from the St. Lawrence, in a south-east direction, the formation is thus found to be repeated a great many times in a transverse distance, which, opposite to Quebec, would equal nearly fifty miles, whilst at each repetition the strata, which on the north-east are of a sedimentary nature and show characteristic fossils, become more and more crystalline, and ultimately lose all traces of their organic contents.

"When the indications of copper ore in these rocks could be traced continuously to any distance, they, in every instance that came under my observation, preserved a direction coinciding with the stratification. In three instances the quantity of ore appeared sufficient to justify the recommendation of crop trials, one being in Upton, another in Ascott, and a third in Inverness. In the first, which occurred on the fifty-first lot of the twenty-first range of the township mentioned, the copper ore, consisting of pure pyrites, was in a mass of greyish-white and reddish-grey, compact, sub-crystalline, yellowish-weathering limestone, which it intersected in reticulating veins of from one quarter of an inch to an inch in thickness, always inclosed between walls of highly crystalline calc spar, associated occasionally with a little quartz. These reticulating veins constituted bunches, and several of these bunches could be traced in succession in the strike of the limestone. These reticulating veins of copper pyrites did not differ essentially in their arrangement from the thin veins of quartz which vary frequently, and thin veins of titaniferous, specular, and magnetic iron ores which less often, have been found intersecting the magnesian limestones of this formation in various places, and, I presume, must be regarded as veins of segregation, filling up fissures which do not pass beyond the limits of the limestone.

"A bed of breccia or conglomerate, of which both the fragments and the matrix are calcareous, appears to overlie the greyish-white limestone, and, like it, is marked by copper pyrites. A reddish-grey limestone, quarried in the neighbourhood, is supposed to underlie the greyish-white rock, though not seen in contact with it. This, towards the top, was interstratified with yellowish-white beds, and towards the bottom with red shale: no copper ore was observed in the reddish-grey limestone. The breadth across the whole of the beds may be about a quarter of a mile. The general dip is towards the south-east, and the inclination varies from ten to twenty-seven degrees, but the data are not sufficiently clear to establish the total thickness.

"In one of the Reports in question, it was indicated that this band of limestone appeared to hold a course from its position in Upton, through the northern portion of Acton, into Wickham, where, on the twenty-sixth lot of the last range of the township, it was again marked by the occurrence of copper ore. The bearing of the band in this course would approach to north-east; and about ten miles south-eastward from it, another range of calcareous exposures exists in a nearly parallel course, one of the exposures occurring on the thirty-eighth lot of the seventh range of Acton, and another on the eighteenth lot of the ninth range of Wickham, where additional indications of copper ore exists. A third north-eastward run of the same description of limestone extends from the thirty-second lot of the third range of Acton, to the fourteenth lot of the tenth range of Wickham, and on both these lots the rock is again marked by copper ore, as well as on the thirty-second lot of the fifth range of Acton, which is intermediate between the other two positions. All these calcareous ranges, it was there explained, most probably belong to one and the same band—the first and third being on the opposite sides of a trough-like form, which stretches from the neighbourhood of the St. Francis River to Farnham; while the second is due to an anticlinal axis which divides this general trough into two subordinate synclinal parts. Other synclinals present themselves further to the south-eastward, a general description of which was given in the Reports.

"The existence of the copper ore on the thirty-second lot of the third range of Acton, was, I believe, discovered by Mr. H. P. Merrill; and at the request of Mr. Cushing, the proprietor of the land, Mr. Hunt visited the locality in August last. As then seen, before any excavation had been made, the surface presented an accumulation of blocks of copper ore, evidently in place, and covering an area of about sixteen paces in length by ten paces in width. The masses consisted of variegated sulphuret of copper, intermingled with limestone and silicious matter, without anything like veinstone, and evidently constituted a bed subordinate to the limestone, whose strike was about north-east, with a dip to the north-west at an angle of about forty degrees. In continuation of this bed for about seventy paces in either direction, the limestone was observed to hold little patches and seams of variegated ore and yellow pyrites, with stains of the blue and green carbonates of copper. The limestones in the immediate vicinity presented several veins of quartz crossing the strike, but containing only traces of copper.

"During Mr. Hunt's visit, a small amount of excavation was made with pick and shovel, and a further extent of work has been done since; but though this has not added materially to the information at first obtained, there can be no doubt, even should the limits of the deposit extend no further than those above indicated, that there is here an unusually rich bunch of copper ore.

"In the other two instances in which crop trials were recommended, the gangue was opaque white quartz, from one to two feet in thickness, in which was disseminated the pyritous sulphuret in Ascott and the variegated sulphuret in Inverness. The rock in both cases was described as chloritic and talcose slate.

"Subsequent explorations in the township of Inverness and Leeds, by different individuals, have led to the disclosure of a considerable number of localities marked by cupriferous indications. Several of them have been tested in various degrees, by the Megantic Mining Company and others, by shafts and excavations of moderate depths; and at the present time an efficient trial is in progress at Harvey's Hill, in Leeds, by the English and Canadian Mining Company, who are pushing their work with considerable vigour, under the management of Mr. Herbert Williams. At Harvey's Hill there occurs, on the seventeenth lot of the fifteenth range of the township, nine courses, composed chiefly of quartz, with various proportions of bitter spar, chlorite, and calc spar, and all holding in greater or less quantities the pyritous, variegated, or vitreous sulphurets of copper. The width of these courses varies from a few inches up to seven feet in the thickest part of some of them. In the trials on the surface, some of them, after yielding quantities of copper ore that seemed encouraging, have gradually thinned, both horizontally and vertically, and disappeared. To prove their character more thoroughly in a downward direction, an adit is now being driven on the north side of the hill, at a level which is thirty-seven fathoms below the summit. This will intersect nearly the whole of the courses, and until it is completed it would be premature to pronounce any positive opinion upon the success of the enterprise.

"The rock of the hill is such as has usually been called talcose slate; but though unctuous to the touch, analyses by Mr. Hunt of slates of a similar character in other parts of the vicinity of Harvey's Hill, have shewn that instead of magnesian they are aluminous, and that they should rather be designated micaceous, or, as he has called them from their lustre, nacreous slates. They are in general whitish, or light grey, and are often thickly studded with chloritoid. These slates are interstratified with bands of a darker colour, more resembling clay slates, and the darker appears to prevail over the lighter colour at the mouth of the adit. The dip of the strata appears to be from N. 10 W. to N. 65 W. with an average slope of between fifteen and nineteen degrees. The bearings of eight of the quartz courses are from N. 15 E. to N. 35 E. while one of them runs N. 75 W. They all underlie to the westward at angles varying from fifty to nearly ninety degrees, and it would thus appear that none of them coincide with the strata either in dip or strike.

"During the present year (1859), Mr. Cushing has made an arrangement for the working of the copper ore on his property, and under it Mr. Louis Sleeper, of Quebec (who has heretofore been engaged in mineral explorations in the County of Megantic, and in testing for different mining companies by trial-shafts and other excavations, various quartz courses marked by copper ore in the townships of Inverness and Leeds), commenced mining in the Acton copper ore, on the 23rd of September last. After several weeks had been spent in the excavations, I had an opportunity of visiting the mine, and of spending several days in the examination of the facts observable in the natural exposures of rock in the neighbourhood, as well as those brought to light by the excavations.

"The mine is just half a mile to the south of the Acton Station of the Grand Trunk Railway. The road to it is over a marshy piece of ground, and it is crossed by one or two low mounds of yellow sand. At the end of the road, a hill rises to the height of about 105 feet above the marsh, and descends to a marsh on the other side. It stands on a base of a quarter of a mile in width, and for nearly one half the distance is composed of a sub-crystalline magnesian limestone dipping to the north west, with an inclination varying from thirty to forty degrees. The limestone is light grey in fresh fractures, and weathers to a dull pale yellowish tint on the exterior. It is in some parts studded with concretionary nodules, consisting of concentric layers of carbonate of lime, with a transverse fibrous structure. The exterior of these is of a botryoidal form, and the layers are in some places partially replaced by chert, preserving the fibrous structure. These nodules very much resemble corals, but they also resemble some concretionary forms of travertine, and the occasional intercolation of magnesian layers in the nodules makes it probable they are the latter. As stated by Mr. Hunt, the limestone of the hill is intersected by several small veins of quartz; and one of them, more conspicuous than the rest, carries traces of the yellow sulphuret of copper and of galena. The mass of limestone visible, extending a short distance beyond the summit of the hill, has a thickness of about 270 feet. It is divided into heavy beds, in which irregular masses of chert are disseminated in unequal quantities in different places, being most abundant towards the bottom.

"The summit of the limestone from the north-eastern corner of the lot, proceeds south-westward for about thirty chains, and in the succeeding 300 yards turns gradually south, and ultimately a little to the east of south, before becoming concealed. In the other direction, after running some distance, it sinks beneath a marsh on the thirty-first lot of the third range, and again makes its appearance on the railroad, which it crosses about three-quarters of a mile to the east of the Acton Station, meeting and crossing the Black River about 220 yards north of it.

"The rock underlying the limestone is concealed, but that which immediately overlies it at the mine, appears, from partial exposures, to be a lavender-grey shale or slate, with a cleavage independent of the bedding. In this slate there appears to be irregularly distributed large masses of a harder rock, which is internally of a light olive-green, uniformly and finely speckled with darker green spots, looking like serpentine, many of which are surrounded with a bluish-grey film. The rock, under atmospheric influences, becomes light yellowish-brown on the surface, and, in its weathering, strongly resembles some of the serpentines of the eastern townships. Some of the masses measure fifty yards in length by twenty in breadth; and on the north side of the railroad there is one of twice those dimensions, apparently sunk into the top of the limestone. Thin layers of the rock occasionally appear to be interstratified evenly among the slates. In thick masses, spots of calc spar are sometimes disseminated, giving the rock a cellular and somewhat trappean aspect; but there is no evidence that it is intrusive, and it occasionally assumes the character of a sandstone, with small quartz pebbles running in the direction of the beds. In the speckled part of the rock, very thin partitions, of the same colour and hardness as the darker green spots, run in several directions. These partitions, on analysis, prove to be a ferruginous chlorite, and the whole rock may be described as a hydrous silicate of alumina, with much iron and magnesia.

"These slates and harder masses have a thickness of about eighty-five feet. They are succeeded by isolated masses of limestone of various sizes and somewhat rounded or lenticular forms, some of them attaining magnitudes of thirty yards in length by twenty in breadth, and even eighty yards in length by ten in breadth. As seen on the surface, they present a succession of protruding lumps, which run in a line parallel with the summit of the limestone, turning with it to the southward at the south-western part of the exposures. These calcareous masses consist of grey limestone, made up of irregular and apparently broken beds and rounded forms, and hold irregular and ragged pieces of chert in more or less abundance, with strings and spots of calc spar. The serpentine-like rock sometimes appears to surround these calcareous masses.

"The copper ore appears to occupy a position immediately near the isolated masses of limestone, and very little of it to penetrate into the serpentine-like rock or the slate. Indications of it occur on both sides of the calcareous masses, and in some places can be traced as if surrounding them; but the chief part appears to be beneath them, and intermediate between them and the slates and the serpentine-like rock. The ore consists of the pyritous, variegated, and vitreous sulphurets of copper, the second species being the most abundant, and the third more abundant than the first. The green carbonate also occurs, but it must be regarded as a secondary product, formed at the surface and in cracks. The chief excavation has been made in a cross-cut, running S. 45 E., which is at right angles to the strike. The depth excavated is from four to eight feet, and the following is the succession of masses met with in the cross-cut, given in a descending order, and reduced to vertical thickness from horizontal measurement:

	Feet.
1. Limestone; this may be a boulder deeply sunk in the soil, but it is supposed to be in place, and to belong to one of the isolated masses of the stratification	3
Concealed	3
Limestone in place, belonging to one of the isolated masses; small irregular spots of the pyritous sulphuret of copper occur in the rock. This is probably part of the same mass as the first three feet, and the concealed three feet would also be a part, making the whole eight feet	2
2. Variegated sulphuret of copper, enclosing numerous angular fragments of limestone in irregular aggregations. This mass dipped with the stratification, but thinned out, and terminated downwards	2
3. Limestone broken into various sized angular fragments, by a number of reticulating cracks of from one quarter of an inch to three inches in width, and filled with variegated sulphuret of copper, with spots of white crystalline calc spar, and occasional crystals of transparent quartz.	15
4. Breccia or conglomerate, with a paste composed of variegated and vitreous sulphurets of copper, mingled with fine grained silicious matter, enclosing fragments of limestone, some angular and some rounded; some of them almost wholly calcareous, and others largely silicious. The sulphurets of copper run in parallel clouded streaks, the clouded character being occasioned by the presence of more or less silicious matter, mingled with the steel-grey and the purple of the two sulphurets	4
5. Limestone	2
6. Copper breccia or conglomerate, of the same characters as before	4
7. Limestone	3
8. Slate, with traces of copper (green carbonate on the surface)	12
9. Serpentine-like rock	14
10. Slate, with traces of copper (green carbonate on the surface)	25
Feet	93

"The thickness of fifteen feet given to the brecciated limestone of No 3 is deduced from a horizontal measurement of ten yards across the strike, and a supposed slope of thirty degrees, which is about the dip of the bed and of the strata where it can be made out in the vicinity. But no clear indication of bedding is visible in the body of the breccia, and as the excavation across it is yet only two feet deep, it may hereafter be proved that, by some irregularity, the slope is less than thirty degrees; in that case the thickness would have to be reduced in proportion to the diminution of the slope. If the slope should be eighteen degrees, the thickness will be ten feet.

"The two breccia or conglomerate beds, numbered 4 and 6, contain the great body of the copper ore. On the strike, these beds are exposed for about eight yards to the south-west. There is then an interruption, by the presence of a wall of the serpentine-like rock, which crosses the strike in the shape of a slender wedge, coming to a point north-westwardly, and gradually spreading out into the strata in an opposite direction. A farther quantity of copper conglomerate, however, exists on the opposite side of this wedge-shaped wall. The condition of the rock to the north-east of the cross-cut has not yet been sufficiently ascertained to give any description of it, except from an excavation at the distance of about forty-five yards. Here a mass of ore has been mined for about two fathoms on the strike, commencing with a breadth of nine feet, and irregularly diminishing to the north-westward. Beyond the excavation, it appears to diminish farther, and probably thins out. On the north-west side, this mass was limited by limestone belonging to the line of isolated masses; and on the south-east by a mass of the serpentine-like rock, the face of which stands in a nearly vertical attitude.

"In costeening pits, which have been carried across the strike of the upper part of the ore, at distances of about eighty yards on one side of the cross-cut and 110 yards on the other, indications of ore continue to exist in the stains of green carbonate and small masses of the sulphurets, but the work done is not sufficient to give facts that bear upon the mode in which the ore is connected with the rock.

"In so far as the facts ascertained by the present condition of the excavations enable an opinion to be formed, it appears to me probable that the copper ore, mingled with silicious matter, constitutes the paste of a breccia or conglomerate, the fragments of which have been accumulated in a depression in the surface of the argillaceous and silico-magnesian sediments forming the slates and their associated harder masses, while the sulphurets of copper have been deposited from springs bringing the metal in solution from some more ancient formation. The whole condition of the case appears to bear a striking resemblance to those of the copper deposits of the Urals, as described by Sir Roderick Murchison, except that in Russia the ores are carbonates instead of sulphurets.

"However this may be, there is no doubt the mass of ore is a very important one. Already, after but nine weeks' work, not far from 300 tons have been housed, supposed to contain about thirty per cent. of pure metal. The value of this quantity would be about $45,000 ; while, exclusive of lordship, the mining expenses and those necessary to carry the ore to market will be comparatively small. The quantity of ore excavated appears to have produced but a moderate impression on the total mass in sight.

"Whether such another bunch of copper ore will be met with, associated with the limestones, it is impossible to say; but even should one exist, it would perhaps be too much to expect that it would be found immediately at the surface.

"Many of the facts connected with the mode in which the copper ore of the conglomerate is related to the fragments, were ascertained by slitting a slab of the rock by means of a lapidary's wheel, and polishing the surface. The same test has been applied to a block of the Upton conglomerate, and it is found that there is some analogy in the two cases, except that the Upton ore is altogether pyritous sulphuret, and much more thinly distributed among the fragments.

While large blocks of the Acton conglomerate give thirty per cent. and upwards of pure metal, the best blocks obtained by me from the conglomerate of Upton do not yield more than five per cent. But this, if the quantity of rock with such a per centage were large, and the masses not too widely scattered, would constitute a valuable mine. It would, however, require a careful crop trial to determine whether the quantity is available.

"On a recent visit to the Harvey's Hill Mine, I was informed by Mr. Williams that, after sinking on the incline N. 80 E. <75°, on Fremont's lode, near the top of the hill, for forty-five feet, the underlie changed to S. 80 W. <75°, and the shaft being then sunk vertically for seventy-five feet more, a bed of three inches, holding disseminated copper ore, was met with at the depth of twenty-five feet; and another of six inches, of the same character, fifteen feet further down—the latter constituting the top of a six-feet bed of soapstone. In this an opening was made for thirty feet each way in the slope of the bed, which met Fremont's lode in the rise, and continued beyond it. At the bottom of the incline a level was driven in the bed for nearly thirty-two feet. The copper ore was continuous the whole of the distances, and may be said to have thus been proved over an area of nearly 2,000 square feet in the plane of the bed.

"The shaft being full of water at the time of my visit, I had not an opportunity of inspecting the work; but descending another shaft, at a distance of about ten chains from the last, in a direction which is nearly in the dip of the strata, I examined what there is little doubt must be another bed. This occurs at a depth of ninety feet from the surface; and allowing for the fall in the surface between the two shafts, its position would be very nearly twenty fathoms above the upper bed in Fremont's shaft. An opening has been made in the bed of about seventy feet in length by twelve feet in width, partially on the strike, but gradually turning up to the full rise of the strata. In this opening, the thickness of the bed, as measured by myself, varies from nineteen to thirty inches. The rock is a nacreous slate, and the copper ore is distributed in the bed in patches generally of a lenticular form. They are usually thin, but sometimes attain from one-half to three-quarters of an inch in the thickest part; and occasionally present in the section, lines of six inches or even a foot in length. These patches interlock, one overlapping another, with variable distances between, while many single crystals and small spots of ore are disseminated throughout the whole thickness. In some parts the pyritous, and in others the variegated sulphuret, prevails, and the quantity of metallic copper in the mass may range from about three to about five per cent, producing an average of about four per cent. The estimate, however, has been made by the eye and not by assays. Supposing the bed to average two feet in thickness, a cubic foot to weigh 180 pounds, the produce to be five per cent., and one-fifth of the copper to be lost in dressing the ore up to twenty per cent., then each square fathom of the bed would yield 1.10 tons of dressed ore of the above produce, the value of which in Swansea would be about $110. If the produce were four per cent., the value of a fathom would be $88; if three per cent., $66. It is only by an experiment on a large quantity of ore, in the way of dressing, that the true produce of the bed can be determined.

"The mode in which the copper ore is distributed in the nacreous slates of

Leeds, precisely resembles that in which it occurs in the bituminous slates of Germany, and it is only the circumstance that the facts known in connection with the Canadian deposits are yet too few to give entire confidence in the persistence of similar conditions over a great area, which should moderate the expectation of an important result. As the copper in the beds is probably contemporaneous with them, it would of course be antecedent to that associated with the courses of quartz, the fissures holding which, it is unnecessary to state, must have been formed subsequent to the strata in which they occur. The copper in the courses was probably derived from that in the beds, and though the former, not only in Leeds but in other parts, may in many cases prove to be economically unavailable, it may yet be serviceable as an index to the position of available beds, and materially aid in their discovery. The copper-bearing quartz courses, from contrast of colour, are much more conspicuous than the copper-bearing beds; and though the latter, from the undulations in the strata, might be brought to the surface in many places, they would not readily attract the eye, unless from marks connected with the strata more prominent than the copper ore itself, which at the surface will often have disappeared from the influence of the weather. At Harvey's Hill, the soapstone underlying the lower cupriferous bed, might prove a serviceable mark by which to trace the copper ore on the surface. The soapstone known to crop out at a certain distance beyond Fremont's shaft, though its accompanying ore has not been remarked, could, in all probability, be followed for a considerable distance on the strike, with very little difficulty. Should the cupriferous character of the upper part prove continuous, which appears to me very likely, the existence of a valuable copper ore deposit might thus be established as probable at a very small expense. Cupriferous beds would, of course, be subject to the accidents of dislocation affecting the strata in which they are enclosed. One of these appears to affect the Harvey Hill bed, where the lower shaft intersects it. At this spot the copper ore suddenly ceases, and a mass of quartz presents itself, cutting a part of the stratification in a nearly vertical direction; while a little to the eastward, the inclination of the copper-bearing bed suddenly increases from nineteen to thirty-nine degrees. These circumstances combined, appear to me to indicate a dislocation, with a down-throw to the northward.

"The discovery of copper ore, subordinate to the stratification of the magnesian group in Upton, Acton, and Leeds, of which the last two instances, and perhaps the first, afford quantities economically available, invest the traces so widely spread in connection with this group in Eastern Canada, with more importance than they previously possessed. These traces are not confined to the more crystalline and altered parts of the deposit, but extend to the portion which is so far unchanged as to be marked by characteristic fossils, and the ores being found to occur mingled with the original sedimentary matter of the beds, there is no geological reason why such traces may not lead to the discovery of economical quantities of the ore at Quebec and Point Levi, as well as in other parts. There are dolomites, however, in a lower part of the Silurian series than this group, and both these dolomitic groups are found to exist below Quebec, on the St. Lawrence,—the one on the north side, at Mingan; and the other on the south side, all the way to Cape Rosier, and in various islands near both sides; and the fossils being the only sure guide by which the one group can be distinguished from the other, the study of these becomes an important part of the investigation."

The Report furnished by Mr. Murray embraces the details of a very extensive examination of the coast of Lake Huron, with the back country, around the Bruce Mines. The wide area thus included in Mr. Murray's explorations, lies between the Thessalon and Mississagui rivers, and presents many features of geological interest. One of the most striking, perhaps, not only in a scientific, but probably also in an economic point of view, is the discovery of a large fault running roughly parallel with the Thessalon River, and probably with the coast line generally, between that stream and the mouth of the Mississagui. To quote from the Report,—

" Chert beds, very similar in aspect to those just described, are met with on the north-east side of the small lake which is tributary to Walker Lake. Between those and the nearest approach to the previous beds, [dipping N.E.,] there is a distance of no more than a quarter of a mile. They dip to the southwest with a slope of thirty-five degrees, and they might well be supposed to be the same beds on the opposite side of a synclinal axis. There is some suspicion, however, as will be seen from the sequel, that they are higher strata on the north side of a great downthrow fault.

"These beds, in the attitude above mentioned, are seen along the north-east side of the lake for a distance of a quarter of a mile; they are followed northward by a mass of greenstone, and that again by a great display of white quartzite, both running parallel with the chert beds. Three quarters of a mile south-eastward, chert beds again appear, dipping to the south-west, with greenstone coming out from beneath them, and in this relation they can be traced for two miles to the south-east. Here the chert beds are within eight chains of the south-west corner of Thessalon Lake, and the greenstone lies between them and the margin. This position is about half a mile from Salter's side-line, but the farther progress of the chert beds towards the side-line appears to be interrupted by a mass of white quartzite.

" The low ground on Salter's side-line, mentioned as occurring to the north of the chert ridge first described, forms a hollow of a few chains in width, beyond which the mass of white quartzite just alluded to rises pretty sharply, constituting a hill which fills the space between the hollow and the lake, with the exception of a narrow mass of greenstone at the waters edge, and overlooks the low ground on the south margin of Lake Thessalon to the east.

" On this low ground there is an interval of marsh, but beyond the marsh there is a point about half a mile above the outlet of the lake, where the strata make their appearance. They consist of yellowish chert interstratified with impure limestone, and they dip S. 37 W. $>$ 19°. The band is about a quarter of a mile wide, and it can be traced without much difficulty in a pretty straight line for upwards of eight miles down the river to the higher fall, dipping in the same direction and nearly at the same inclination the whole way. In this course the band obliquely crosses in succession the terminal edges of all the divisions which have been described on the south-east side of the river to the middle of the upper slate conglomerate, its relation to which has already been pointed out.

"At the point which has been mentioned on the south side above the exit of Thessalon Lake, the chert band proceeding north-westward enters the lake, but some uncertainty exists as to the position at which it leaves it. On the north-east side of the peninsula of Otter-tail Lake, there is at the base of the chert band a bed of a red and yellowish fine grained sandstone. A similar bed is seen at the upper end of Thessalon Lake with a bed of yellowish chert resting on it, and it is probably here that the band again enters upon the land; but the dip at the spot is irregular, and the band has not been traced beyond it. There is no doubt, from the sequence of the rocks beneath the band, that it is equivalent to the one overlying the white quartzite on Salter's side-line; and should it, on farther investigation, be found to continue westward from the upper end of Thessalon Lake, then the south-west dipping chert band which faces the first described one, would necessarily occupy a higher stratigraphical place, and would prove the continuance of the fault which no doubt reaches Salter's side-line. The extent of this downthrow is not quite certain, but it appears to me it cannot be less than 1500 feet at this part.

"The rock which would lie between these two chert bands is seen in a hill forming a point north of the south-west corner of Thessalon Lake. It occupies three quarters of a mile across the stratification and consists of white quartzite. A dip of eighteen degrees would give to this a thickness of near 1500 feet, to which, if 200 feet be added for the upper chert band, the dislocation would appear to approach even 1700 feet on Salter's side-line.

"The downthrow, however, if the dislocation result from a vertical movement, must be progressively much greater to the south-east, for the chert band terminating near the upper fall against the middle of the upper slate conglomerate, would there shew a displacement equal to the whole volume of strata between, which, according to the thicknesses given in the list of strata, would be 9,320 feet additional, or upwards of 11,000 feet. * * * * The examination of the area connected with the Mississagui has not yet been sufficiently extended to determine the relation between the copper-bearing veins of the Grand Portage and the physical form to which they are subordinate. The veins of the lower part of the river are evidently related to the anticlinal existing there. Those of the south part of Echo Lake also belong to an anticlinal; so do those of the Bruce and Wellington mines; and it would almost appear as if the importance of the metalliferous indications rose with the sharpness of the fold. But whatever be the cause of the dislocations in which metalliferous minerals are secreted, it would seem to be a probable supposition that in a metalliferous district the greater the dislocations the greater the chances of valuable metalliferous lodes. If this be the case, the great dislocation of the valley of the Thessalon would become invested with much importance. But though there is no doubt whatever that it is a master fault, it would, I fear, be a somewhat expensive affair to prove or disprove that it is a master lode, for although the proximate position of it has been more or less examined for upwards of fifty miles, never in any place have I been so fortunate as to find the rocks on the opposite sides of the fault in juxtaposition. On arriving at the spot where a junction was expected there was always a swamp, a marsh, prairie, river, lake, or some flat surface covered over with drift. The only mode of proving the matter would be by costeening, and it is probable that the thickness of the covering would cause this to be attended with much outlay."

The agricultural capabilities of the Huronian country, in the district examined by Mr. Murray, greatly surpass, we are happy to observe, the ordinary belief—large tracts of good land occurring in many of the more inland localities. Respecting this, Mr. Murray states :—

"It has been remarked in former Reports that the north coast of Lake Huron, in many parts picturesqne, appears too rocky near the margin to be suited for agricultural settlement, though likely in time to become of importance to the Province by the development of the metalliferous ores, which the geological formation of the region is known to contain. But while this description is applicable to the coast line and the margins of some of the rivers and larger lakes of the interior, it is by no means so to the country in general. On the contrary there are in many parts, especially in the valleys of the Thessalon and its tributaries, extensive tracts of the finest lands, covered with a luxuriant growth of hard wood interspersed with stately pine trees, probably equal in average size to any of the same species known in the Province.

"In the immediate neighbourhood of the Bruce and Wellington mines and thence to Portlock Harbour, the country is for the most part broken by low rocky ridges, the flat land between which is in general densely covered with thickets of spruce, balsam, or in marshy parts with tamaracks; but occasional patches display a stout growth of maple and white birch. In many parts the low gronnds open out into extensive prairies or marshes, usually well covered with wild grass, and prettily dotted with clumps and little groves of small tamaracks or bushy spruce. The timber on the wooded flats is certainly not such as in general is supposed to indicate a very fertile soil, but much of the surface is nevertheless susceptible of cultivation, and there can be little doubt that with successful mines to produce a market for surplus produce, farming to a considerable extent might be advantageously followed. Admirably adapted for grazing, the prairies might also supply an ample stock of winter fodder for cattle, while nearly all the ordinary spring crops might be raised from the arable portions of the land."

Mr. Richardson's explorations relate to the Gaspé peninsula, and form a continuation of his previous researches in that district. They extend over a wide area, comprising examinations of the valley of the Marsouin, the coast line between the Marsouin and the Great Metis, the valleys of the latter river, the Patapedia and the Restigouche, and the country between the Metis and the Rivière du Loup. Numerous details of local interest on the geographical features and geology of these localities, together with a useful map, are given in

Mr. Richardson's Report. The rock formations met with, comprise various beds belonging to the Lower, Middle, and Upper Silurian series, with the so-called Gaspé sandstone (a Devonian formation) the drift, and some eruptive rocks. The lowest recognised strata consist of graptolitic shales and sandstones of the age of the Hudson River Group. On the Patapedia river, the beds (probably Upper Silurian) exhibit well marked cleavage lines, independent of the bedding, and in places are greatly contorted. On the river Matanne in drift clay and sand, forming a terrace fifty feet above the sea level, *Mya arenaria*, *Tellina Grœnlandica*, and *Mytilus edulis*, were found. The same species were seen at a similar level on the east side of the Metis river, whilst on the west side, at a distance of about two miles, and at a height of about 130 feet above the sea, Mr. Richardson met with *Mya arenaria*, and *Saxicava rugosa*. Eight miles up the river Metis, also, he observed the latter species with *Natica clausa* and *Balanus Hameri*, 245 feet above the sea. Many terraces, containing shells of these and other existing species, were found likewise on the Ste. Anne river and to the east of the Rivière du Loup. The economic substances observed by Mr. Richardson in his explorations are described in the following extract from his Report :—

"The substances capable of economic application met with in the course of my investigations, were bog iron ore, wad or bog manganese, copper ore, chromic iron, serpentine, roofing slates, tile stones, flagstones, building stones, limestone for burning, mill stones, shell-marl, peat, and the water of mineral springs.

"*Bog iron ore.* This ore was abundant in the second concession of the seigniory of Green Island, on the land of Mr. Félix Avril. About the middle of his lot it occurred in patches of from three feet up to eight feet in diameter, and from twelve to twenty inches thick. Between these patches there were intervals of thirty or forty paces. With a breadth that was not observed to exceed a hundred yards, the length of the area over which these patches were disseminated extended across ten lots, in the bearing S. 27 W., and half a mile, in rather less abundance, in a contrary direction.

"In the seigniory of Cacouna at the village of La Plaine, on the lot belonging to Mr. Stanislaus Roy, a patch of the ore was seen, measuring fifty feet by fifteen feet, with a thickness of four inches. On the adjoining lot to the east, another patch of about the size of the previous one was met with ; yellow ochre occurred in the same place in small quantity.

"Another locality was in the seigniory of Villeray, about three miles west from Green Island River. On the land of Mr. Narcisse Marquis there is a patch of the ore about 270 feet long, and from twenty to thirty feet wide, with a thickness of from six to twelve inches. The ore was likewise observed on several adjoining farms in smaller quantities, but, from the information I obtained from the farmers, it appeared not unlikely that the spread of such patches of the ore is considerable in the neighbourhood.

"Traces of the ore were seen in several other places in the seigniories of Green Island, Villeray, Cacouna, and Rivière du Loup, as well as in the townships of Viger and Whitworth, but the quantity was too small to require particular mention. As a whole, the ore-bearing tract is about twenty-four miles east and west by about five or six north and south. Whether the ore can be found in sufficient abundance to warrant the establishment of a smelting furnace is perhaps, as yet, doubtful. From the wooded character of a great part of the country to the south of the tract, charcoal for smelting purposes could be procured easily for many years to come.

" *Wad or bog manganese.* This ore was found in the seigniory of Cacouna, on the lot of Mr. Stanislaus Roy already mentioned, in a patch measuring twenty-five feet by twenty feet; it occurs in nodules of from a half to a quarter of an inch in diameter, imbedded in sand, and forming a layer of the thickness of four or five inches.

" *Copper ore.* Notwithstanding the great area over which the limestones and limestone conglomerates of the same age as the copper-bearing rocks of Upton, Acton and Leeds were examined, the only traces of copper ore met with were near the mouth of the Great Capucin River. Here, as already has been mentioned, the pyritous sulphuret is disseminated in small specks in a bed of greyish green quartz, interstratified in red shale, while the green carbonate invests some of the cracks in the two inches of thickness containing the sulphuret.

" *Chromic iron.* On the summit of Mount Albert, near the second station established by Mr. Murray for his measurements, chromic iron was strewed in abundance on the surface among the fragments of serpentine. It occurred in loose masses, weighing from a few ounces to twenty pounds. It was almost all quite free from rock, and the masses, continuing for a little over half a mile in a bearing N. 44 E., gave indication that this was the probable direction of its run, though the bed itself was not seen. The loose masses were so abundant that in a few hours a ton of the ore might have been collected by a single person; and their cleanness leaves little doubt that there must be a rich deposit close to the surface beneath the moss and soil.

"About four miles to the north-east of this, a bed of the ore, of about one inch thick, was observed in the serpentine; but the ore was not so pure as the masses on the summit of the mountain. The bed was traceable in the strike of the serpentine for about fifty paces.

"*Serpentine.* The serpentine of Mount Albert, occupying an area of not less than ten square miles, would yield an inexhaustible supply of material capable of economic application. The rock appears to be unusually solid, and in several places vertical cliffs of several hundred feet in height shew nothing but bare serpentine; while masses of eight and ten feet in diameter, fallen from them lie at their base. The general colors, as far as observed, were green, or green mottled with red, and mahogany-brown striped with red; occasionally a blueish tint was mingled with the other colors. The distance of the locality from the St. Lawrence by the valley of the Ste. Anne River is thirty-four miles. By the valley of the north tributary branch of the Ste. Anne and the valley of the Marsouin the distance is twenty-four miles. In either direction roads could be easily constructed, while a great part of the way is well adapted for settlement.

"*Roofing slates, tile stones, and flagstones.* The best roofing slates were observed on Henley's Brook. The nearest exposure of the rock yielding them is about two miles and a half above the junction of the brook with the Marsouin, or about four miles from the St. Lawrence, and it prevails for a breadth of two and a half miles up the valley of the brook. The slates might be obtained in thicknesses varying from an eighth to a quarter of an inch, and in slabs of eight or ten feet square, with very smooth surfaces. Some parts of the rock gave thicker slabs, measuring from two to three inches, and would serve as excellent flagstones. The color of the rock is a dark blueish-grey or black. Some bands of the slate are calcareous, and these, for roofing purposes, should be avoided.

"The same rock comes out in the strike upon the Marsouin River, from seven to nine miles from the St. Lawrence, and would here give a material of much the same character.

"Allusion has already been made in the geological description to the flagstones of the Metis. They occur about twenty-six miles and a half from the mouth of the river, and consist of calcareous sandstones weathering to a light drab. Slabs might be obtained of two feet square, with thicknesses ranging from two to four inches.

"Another locality for flagstones is on the Awaganasees Brook, about thirty-four miles and a half from the mouth of the Patapedia. They so much resemble those of the Metis River that they are supposed to be of the same geological formation. The slates, however, were of larger dimensions, some of those seen being two feet square, and others four by eight feet, the thicknesses being from one to two inches. Another exposure about a mile lower on the Awaganasees would yield as large but thinner slabs, which would form excellent tile stones.

"Another locality of the same description of material was met with on the Patapedia, about seventeen miles and three quarters from the mouth. Here good tile stones might be obtained.

"On the Rimouski River below the fall, on the twenty fourth lot of the sixth range of Duquesne, flagstones might be obtained of a character so similar to those of the Metis, that they are supposed to have the same stratigraphical place. The dimensions observed, as already stated, were two by three feet, and four by six feet, with thicknesses varying from one to four inches.

"*Mill stones.* On Lake Matapedia the white sandstones which underlie the Gaspé limestones would answer the purpose of mill stones. When I passed the lake, Mr. Pierre Boucher shewed me a stone which he had prepared from the rock to be used in a mill about to be erected by him. The rock is undoubtedly hard and solid enough for the purpose, but wants the small cavities required for mill stones of the best description.

"*Building stones.* From the grey calcareous sandstones of group B, excellent building stones may be obtained, and so many localities in which these sandstones occur have been named in the geological description, that farther allusion to them is unnecessary. The more solid beds at the base of the Gaspé limestones, as they appear on the Middle Metis Lake and Lake Matapedia, would give good building stone.

"*Lime.* In the limestone conglomerates of group B masses of the rock are found, in most localities, which yield stone of sufficient purity for burning into quick-lime. At Metis a single boulder of dark grey limestone imbedded in one of the conglomerate bands was calculated to weigh twenty-five tons. It was being quarried for lime-burning at the time of my visit to the place. Pretty good stone for burning might be obtained from the base of the Gaspé limestones as far as they were traced.

"*Shell-marl.* About five miles below the Matanne River, just over the bank of the St. Lawrence, on the lot of Mr. Denis Gougé, there occurs a deposit of fresh-water shell-marl. It is at the outlet of a swamp, and where dug through it had a thickness of fifteen inches. I was informed that on an occasion when the swamp became dry in summer, the deposit had been seen in other parts of it. The swamp has an area of between fifty and sixty acres.

"The only other locality in which shell-marl was observed was on the Lower Lake Metis. In the upper part of this lake wherever the dredge was used it always brought up shell-marl, but the thickness of the deposit is uncertain.

"*Peat.* A large area in the seigniory of Rivière du Loup is covered with peat. The locality is called the Savanne de la Plaine. The exact boundaries were not ascertained, but the area cannot be less than nine or ten square miles. It stretches along both sides of the river from the third to the sixth mile, and to the eastward it has a length of three miles, diminishing to the breadth of a mile at the east end. Its length on the west side of the river I was not able to ascertain.

"Peat was observed in abundance on the first and second concessions of Green Island Seigniory, and from a point two miles below the Rimouski River there is a belt of it extending nearly all the way to Metis River, a distance of over twenty miles. The northern edge of the belt approaches in some places to within a quarter and in others to within half a mile of the St. Lawrence, and its width is from a quarter of a mile to a mile. The thickness of the deposit where observed was from one to six feet.

"The swamp which has been mentioned on the Rimouski, in the third range of Duquesne, is underlaid with peat; from within half a mile of the Rimouski it extends two miles to the east in Duquesne, and from one to two miles more in Macpes. Its breadth is about three quarters of a mile, and its thickness from five to twelve feet. Where tried by me, a pole was sunk in it nine feet; but I was informed by one of the inhabitants that a pole had been sunk in it to a depth of thirty feet on Bouchette's road."

The report of Mr. Sterry Hunt, comprises a series of communications of great scientific interest on the Intrusive Rocks of the Montreal and Grenville districts, respectively; together with analyses of chloritoid and epidote from the altered Silurian rocks of the Eastern townships; and the results of an examination of the green colouring matter of certain sandstones belonging to the Quebec group. This latter substance is found to be a hydrated silicate of alumina, protoxide of iron, magnesia, and potash: the alumina thus replacing, in great part, the oxide of iron of the green grains so abundant in many Cretaceous deposits. Mr. Hunt's Report concludes with a long and very elaborate review of the formation of magnesian limestones, in continuation of his previous communications on that subject. The results of various ingenious experiments, involving numerous analyses and a great amount of patient research, are given in connexion with this enquiry, one of the most important perhaps, undertaken of late years, in the department of Chemical Geology. As it is impossible to do justice to these contributions by mere extracts, we have inserted one of them in an entire form, in another part of the journal. The one selected is the first alluded to above, a paper of much value, on the trachytic and other eruptive compounds of Montreal and the adjoining metamorphic district south of the St. Lawrence. Apart from the interest attached to these rocks as remarkable examples of eruptive products occurring on Canadian soil, Mr. Hunt's investigation of their characters and composition tends greatly to clear up the obscurity which still prevails respecting the true relations and subdivisions of the intrusive rocks generally.

E. J. C.

SCIENTIFIC AND LITERARY NOTES.

GEOLOGY AND MINERALOGY.

ADDITIONAL FOSSIL TRACKS IN THE POTSDAM SANDSTONE OF CANADA.

The celebrated fossil foot-tracks of Beauharnois, Vaudreuil, and other neighbouring localities, constitute, it is well known, one of the most remarkable characteristics of our Potsdam formation. They have been referred by Professor Owen, under the generic name of *Protichnites*, to an unknown crustacean of which no other traces have been met with. During the course of last year, Dr. James Wilson of Perth (Canada West), discovered in some quarries of Potsdam Sandstone, in the vicinity of that town, some still more remarkable impressions. These, which are associated with the tracks of *Protichnites*, have been recently figured and described in full, in the *Canadian Naturalist*, by Sir W. E. Logan. They consist, to quote from Sir William Logan's description, "of a number of parallel ridges and furrows something like ripple marks, which are arranged (transversely) between two narrow continuous parallel ridges, giving to the whole impression a form very like that of a ladder, and, as the whole form is usually gently sinuous it looks like a ladder of rope." One of the impressions is about thirteen feet in length; and the average breadth of those at present obtained is about six inches and three-quarters. In some, a central ridge runs longitudinally between the two side ridges, but not always parallel with them.

Sir William Logan has bestowed upon these new tracks the name of *Climactichnites Wilsoni* in honour of their discoverer, Dr. Wilson of Perth, long known as one of our most zealous and successful labourers in the field of Canadian Geology. The generic appellation has reference to the ladder-like form of these remarkable impressions.—For figures and more ample details, the reader is referred to the *Canadian Naturalist* for August 1860, in which also will be found some valuable papers by Mr. Billings, Mr. D'Urban, and other writers.

SKETCH OF THE GEOLOGY OF HASTINGS COUNTY, CANADA WEST.—BY E. J. CHAPMAN.

The following brief notice was drawn up for publication in the Hastings Directory. Being intended for general readers, it contains in a condensed form, a few explanatory details that would otherwise have been omitted. These, it is thought, however, may prove serviceable also to some of the readers of our Journal.

The rock formations present in Hastings County, comprise, in an ascending order: (1) The Laurentian Series of Sir William Logan; (2) Some of the Lower Silurian rocks; (3) The Drift Formation; and (4) certain recent deposits of local occurrence.

1. *The Laurentian Formation*:—The rocks of this division constitute the most ancient deposits hitherto recognised on the continent of North America. They extend from Labrador along the North shore of the St. Lawrence, to within a short distance of Quebec, from whence they continue inland, and cross the Ottawa above the city of that name. West of this point, their outcrop sub-divides (so to say) into two branches, one of which passes towards the south-east, crossing the St. Lawrence at the Thousand Isles, and forming the wild district of the Adirondack Mountains in the state of New York. The other branch sweeps broadly towards the north-west, and its southern edge runs through the south limits of the Townships of Elzevir, Madoc, and Marmora, in Hastings County, and, continuing its course, strikes Georgian Bay near the mouth of the Severn.

The Laurentian rocks form also the greater portion of the north shore of Lake Superior, and cover an enormous area throughout the northern part of the Province generally. In popular language they are often, though incorrectly, called *granite*. True granite never occurs in beds or strata, but always in irregular, and generally intrusive masses, or in veins; whereas our Laurentian rocks are always stratified. They are looked upon as altered sedimentary deposits, and belong chiefly to the rocks known as micaceous and hornblendic (or syenitic) gneiss. Micaceous, or common gneiss, is composed of quartz, feldspar, and mica, and has usually a grey or red colour, but is sometimes almost black. Hornblendic or syenitic gneiss consists of quartz, feldspar, and hornblende, and possesses in general a well-marked green colour; or is, otherwise, red and green, or red and black. These rocks, in layers or strata of different colours, alternate with one another, and occasionally by the absence of feldspar, pass into mica slate and hornblende slate. They are frequently traversed by broad bands and veins of white quartz; and in some localities are interstratified with beds of white, pink, and greyish crystalline limestone or marble. A bed of this substance occurs at the village of Bridgewater, or Troy, in Elzevir Township; and others of fine quality lie in Barrie Township, a little beyond the limits of the county. Marble is likewise found in the Townships of Madoc and Marmora; but white quartz it should be mentioned is sometimes mistaken for it. Attempts have even been made by persons ignorant of the nature of quartz, to burn that substance into lime. It may not, therefore, be out of place to point out the more salient, distinctive characters of the two, as in the following table:—

Marble.	*Quartz.*
Dissolves with effervescence in diluted hydrochloric or nitric acid.* Does not scratch glass, but may be easily scratched by a knife.	Not attacked in any way by acids. Scratches glass easily, and does not yield to the knife.

These Laurentian or gneissoid rocks constitute also the great iron-holding rocks of Canada. This metal occurs in Hastings County in the form of the Black or Magnetic Iron ore, a compound of the oxide aad the sesqui-oxide of iron, containing in percentage values, Iron 72.4, Oxygen 27.6. This valuable mineral forms thick beds, interstratified with the gneiss, in the Townships of Madoc and Marmora; but the ore used at the Marmora smelting works, when these were in operation, came chiefly from the south shore of Crow or Marmora Lake, in the adjoining Township of Belmont. When the ore contains small shining specks or particles (Iron Pyrites) of a brass-yellow colour, it should be made up into heaps and roasted, and afterwards subjected for some time to the action of the atmosphere, before being taken to the furnace.—The masses of ore broken out of the rocks and mixed up with the Drift of this locality, are abundant in some places, and of excellent quality, the pyrites having become decomposed, or oxidized, by long exposure to atmospheric agencies.

In the north part of Elzevir Township, as well as in adjoining townships beyond the limits of the county, some of the green or hornblendic beds of gneiss, contain numerous garnets in well-defined twelve-sided crystals, or rhombic dodecahedrons, of a brownish-red colour. These, however, are only of value as mineralogical specimens.

The Laurentian rocks described above, occur in highly inclined strata, dipping generally (at least along their more southern outcrop,) towards the north-west. The succeeding or overlying Silurian strata, on the other hand, lie on the upturned edges of the Laurentian rocks, in almost horizontal beds. A good section, exhibiting these relations, may be seen on the river banks at Marmora village.†

Although, as a general rule, where Laurentian rocks prevail, the country is not favourably adapted for agricultural occupation, many acres of good and fertile

* Hydrochloric acid is the muriatic acid or spirit of salt of the stores. For testing limestone rocks it should be diluted with an equal bulk of water, and kept in a small bottle provided with a glass stopper.

† The reader interested in these details, may consult also a sketch of the stratification near the village of Bridgewater, in Elzevir Township, given in a paper by the writer of this notice, in the *Canadian Journal* for January, 1860, [New Series, vol. V.]

land occur upon this formation in Hastings County. The more rocky portions also, if useless in other respects, will probably constitute available grazing lands, as the country becomes gradually cleared.

2. *The Lower Silurian Formation:*—This formation is sub-divided from the upper part downwards, into the following subordinate groups:

5. The Hudson River Group.
4. The Utica Slate.
3. The Trenton Group. { The Trenton Limestone. The Black River Limestone. The Bird's-eye Limestone. The Chazy Limestone.
2. The Calciferous Sand Rock.
1. The Potsdam Sandstone.

In Hastings County, the three lower members of the formation are alone present; and of these, the Potsdam Sandstone and Calciferous sand-rock are more or less blended together, and are also but slightly developed. Their common representative appears to be a calcareous sandstone of a few feet in thickness, occurring immediately above the Laurentian rocks, or at the extreme base of the Silurian formation. This sandstone is of a light greenish colour above, passing into pale red, or pale red with irregular greenish spots below. It may be seen in horizontal position, or dipping almost imperceptibly toward the south-west, on the river banks at the village of Marmora, and also on the banks of the river Moira at Tweed village, in Hungerford township, as well as at other places near the outcrop of the Laurentian rocks. It is apparently destitute of fossils. The succeeding Trenton group, properly so called, is, on the other hand, largely developed, and constitutes the foundation rock of the whole of the South Riding of the County, and also of the southern portion of the North Riding. At its base in the North Riding a band of fine grey limestone, available as a lithographic stone, is met with. This is succeeded by (in general) a thick-bedded limestone, poor in fossils; and the latter is again followed, in ascending order, by thin-bedded and shaly limestones, containing fossils in very great abundance. A list of these fossils comprising various corals, brachiopods, &c., collected around Belleville, may be seen in a paper by the writer, published in the Canadian Journal for January, 1860, [New Series, vol. V.] The Trenton limestone is well displayed along the banks of the Trent, Moira, and Salmon Rivers, and in many places on the shores of the Bay of Quinté. It yields excellent lime; and building stones of good quality are obtained from some of the thick beds, as at Ox Point, near Belleville, and elsewhere. Some care, however, is required in their selection, as many of them are apt to crack from minute flaws; but properly selected blocks appear to resist the action of frost remarkably well.

3. *The Drift Formation:*—An accumulation of clay, sand, and gravel, with rounded stones or "boulders," partly of limestone, but chiefly of the more northern gneissoid rocks, is spread over the surface of the greater part of the County. The same deposit extends indeed over the larger portion of the Province itself, and reaches far into the United States. Geologically, it is known as the Drift, or Drift and Boulder formation. Its age is much more recent than that of the under-

lying rocks. Between the deposition of the two, an enormous interval of time must have occurred—many intervening formations being absent. It is now universally conceded, that, after the deposition of our Palaeozoic rocks, this part of Canada was elevated above the sea in which these rocks were deposited, and that it remained dry land for many ages, whilst the succeeding members of the Palaeozoic series, with the Secondary and Tertiary rocks (properly so called) were under process of deposition in the seas, lakes and estuaries, of other localities. Then, a movement of depression ensued, and our Province was again covered or partly covered by the waters of the ocean. It is also inferred from perfectly trustworthy data, that this period was one of comparative cold. Vast glaciers were formed in northern regions, from whence numerous icebergs, laden with earth and stones, drifted southwards; and gradually melting, or becoming stranded on shoals and islands, deposited their rocky freights over the sea bottom. By the agency of these floating icebergs also, the limestone ridges were broken down, and the calcareous sediments, thus formed, were mixed with the more northern deposits. Proofs of this are seen in the polished and striated surfaces of our limestone strata in many localities; in almost all places, indeed, in which a recent removal of the Drift has been effected. The polished rock, when first exposed, is sometimes as smooth as a mirror; and the fine lines which cross it, and which are supposed to have been produced by stones and gravel frozen into the under side of the icebergs, have almost always a general north and south direction. The same effects of ice-action are seen also on most of the exposed gneissoid rocks in the northern part of the county. Finally, the ground must have been again slowly elevated above the sea; and many of our valleys and other surface inequalities were then produced, by the action of waves and currents on the yielding materials of the Drift and underlying strata. These latter, however, in various localities, had been extensively denuded prior to the deposition of the Drift.

4. *Recent Deposits*:—These are of very slight extent, and of local occurrence, only. They are due to causes which are now in action, or which have prevailed during comparatively recent periods. So far as regards the County of Hastings, they comprise a few beds of "shell marl," arising from deposits in swamps and partially dried up ponds and lakes. These consist of white and more or less earthy calcareous matter, filled with minute shells of *cyclas*, *planorbis*, and other freshwater genera of molluscs. A deposit of this kind occurs on the high ground above the west bank of the Moira at Belleville; also in the vicinity of Trenton; and at other places. Another recent formation consists of "calcareous tufa" deposited on twigs, moss, stones, etc., in many streams and springs; but frequently both shell marl and calcareous tufa, (properly so called) occur intermixed, and form but one deposit.

MEGALOMUS CANADENSIS.

Major Greet of Guelph, C. W., has recently shewn us some comparatively large specimens of *Megalomus Canadensis* obtained in the immediate vicinity of that town, a locality, we believe, in which this fossil has not hitherto been announced. The rock in which it occurs, is a somewhat porous and sub-crystalline limestone, an extension, of course, of the Galt beds.

IDOCRASE.

Crystals of Idocrase commonly exhibit a well-developed basal plane. In Heuland's celebrated "Catalogue" twenty-four distinct combinations are described, and for the greater part figured, by M. Lévy, in all of which the basal plane is present. The only crystals known to us in which this plane is absent, are the somewhat complex forms from the Ural, figured by Col. Von Kokscharoff. It may not be therefore without interest, to state, that a crystal over half-an-inch in length and of the ordinary simple form, *but without the basal plane,* has lately come into our possession. It exhibits simply the two vertical prisms and the fundamental octahedron, the latter measuring (by common goniometer, the faces being dull) 129°30′ over the polar edges. The colour of this crystal is olive or brownish-green. It was brought from Europe, but we do not know its exact locality. Persons interested in these matters, may see the specimen at the University, Toronto.

NEW BLOWPIPE-SUPPORT.

In the examination of substances by the blowpipe, it is frequently necessary to subject the assay-matter to the process technically termed "roasting," in order to free it from sulphur, arsenic, or other volatile ingredients. In this operation, charcoal is usually employed as a support; but, as, in travelling especially, it is often desirable to economise the stock of charcoal in the blowpipe case, pipe-clay supports, strips of mica, and other substances are sometimes used as a substitute. We have employed for some time, and with great success, for this purpose, small fragments of Meissen porcelain, broken from damaged crucibles, capsules, &c., such as can readily be procured from all importers of chemical apparatus. In roasting the assay we rarely require more than a low red heat, but these supports may be rendered white hot, if necessary, without flying; and the same fragment may often be used, moreover, more than once. The assay is crushed to powder, slightly moistened, and spread upon the surface of the porcelain; and afterwards removed by a small steel or other spatula. These supports are conveniently held by the spring forceps figured and described in Vol. III. of the *Canadian Journal*, page 213.

PUBLICATIONS RECEIVED.

On the Alloys of Copper and Zinc. By Frank H. Storer. *On the Impurities of Commercial Zinc.* By C. W. Eliot, and F. H. Storer.—These are reprints of papers communicated to the American Academy of Arts and Sciences. They give much valuable information, and contain numerous analyses of various compounds of zinc and copper, and of Silesian, Belgian, English, American and other spelters. Mr. Storer has obtained many distinctly crystallized samples of brass, containing variable proportions of the two metals; and as these specimens present the same form (monometric octahedrons,) he looks upon zinc as belonging to the Regular System. The same view, based however on the examination of merely a single specimen, has been adopted by Prof. Gustav Rose.

E. J. C.

CANADIAN INSTITUTE.

The following is the Address presented to the Prince of Wales, by the Canadian Institute, on the occasion of the recent visit of His Royal Highness to Toronto.

To His Royal Highness, Albert Edward, Prince of Wales, K.G., &c. &c. &c.

May it please your Royal Highness,—The President, Council, and Members of the Canadian Institute, incorporated by Royal Charter for the promotion of Science and Literature in this province, humbly approach your Royal Highness with loyal and affectionate greetings; and tender to you, with unfeigned respect, their welcome on this auspicious occasion.

While the energies of this province are chiefly directed to the development of its vast agricultural capabilities, and to the fostering of trade and commerce, as the essential sources of its material prosperity, the Canadian Institute specially devotes itself to investigations and researches such as lead to the discovery of abstract truths in Science, but which ultimately tend to the intellectual and social progress of man. While, therefore, uniting with their fellow subjects in this province of the Empire, in welcoming your Royal Highness with grateful and hearty loyalty, as the representative of their beloved Queen, and the heir apparent to the British Throne, they beg leave respectfully to tender their loyal congratulations unitedly as an Institute devoted to objects and pursuits specially fostered by Her Majesty's countenance, and to the furtherance of which the illustrious Prince Consort has extended his highest favour and influence.

Enjoying as they do all the priceless blessings derived from institutions by right of which Her Gracious Majesty rules over a free and united people; and sharing in the glories, and sympathising in all the interests of the empire,—of which this province forms no unimportant member,—they hail with loyal satisfaction the presence of your Royal Highness, on whom rest the future hopes of this Great Empire. Their earnest prayer is, that, endowed with all noblest graces and divine blessings, trained in sound learning, and gifted with a liberal love of Science and the Arts, you may be eminently fitted for the high trust of which you are the heir. May he who is the King of Kings, long spare to you, as to them, her who, while commanding honour from your filial heart, lives not less fondly in the affections of a willing people. On her sceptre, the virtues of their loved and gracious Queen have conferred a might more potent than ever ruler achieved by conquest. Under its genial sway, science and letters have accomplished triumphs which will render the Victorian era illustrious in all future ages; and while other nations are struggling to attain such privileges as her subjects freely enjoy, the British Empire—the sceptre of which they trust will hereafter be no less illustrious in your hands than in those of their beloved Queen—has girdled the world with a glorious confederacy of provinces, alike united in freedom, in intellectual progress, and loyal devotion to their Sovereign head.

In their united capacity, as an Institution incorporated by Royal Charter, and specially recognised by Provincial Parliament, as representatives of the interests of Science and Letters, the President, Council, and Members of the Canadian Institute renew their assurances of devoted loyalty to Her Gracious Majesty, and of cordial welcome to your Royal Highness.

D. WILSON, LL.D., *President.*

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—JUNE, 1860.

Latitude—43 *deg.* 39.4 *min. North: Longitude*—5 *h.* 17 *m.* 33 *s. West. Elevation above Lake Ontario,* 108 *feet.*

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	Mean.	Temp. of the Air. 6 A.M	2 P.M	10 P.M	ME'N	Excess of mean above Average	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resul't. Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Result'.	ME'N	Rain in inches.	Snow in inches.
1	29.487	29.513	29.596	29.5415	54.7°	68.8°	58.7°	60.83°	+ 3.88°	.325	.309	.273	.314	.76	.44	.55	.60	N w b N	N w b w	N N w	N 36° w	12.0	17.0	12.0	12.95	12.98	...	...
2	.642	.587	.538	.5885	59.4	73.1	56.9	63.92	+ 6.65	.242	.322	.271	.294	.47	.40	.58	.50	N w b N	s s w	N w b w	w	10.0	11.0	4.4	3.40	5.82	...	...
3	.503	.395	—	—	54.7	69.5	—	—	—	.358	.464	—	—	.84	.64	—	—	w s w	s	s w	s 30 w	1.2	8.6	5.0	5.37	5.66	...	...
4	.143	28.981	28.933	.0017	58.7	57.2	57.2	57.93	+ 0.08	.432	.415	.451	.439	.87	.88	.96	.91	s	N E b N	N E b E	N 58 E	2.6	6.4	2.8	3.77	4.83	0.375	...
5	28.981	29.089	29.238	.1142	62.7	64.5	56.9	60.98	+ 2.83	.481	.443	.384	.423	.84	.73	.83	.78	N N w	N w b N	N w b N	N 36 w	8.8	22.0	7.8	12.06	12.13	Inp.	...
6	29.268	.204	.138	.1952	55.1	62.7	54.4	57.85	— 0.60	.353	.390	.320	.358	.82	.68	.75	.74	N w b N	E b s	E N E	N 86 E	6.4	10.0	10.6	4.81	7.13	0.033	...
7	.109	.097	.210	.1378	53.6	69.5	54.4	58.08	— 0.67	.395	.403	.319	.365	.96	.55	.75	.76	N E b E	w b s	w	s 72 w	0.5	10.4	4.5	5.40	6.65	0.045	...
8	.164	.164	.252	.1968	55.1	60.5	52.6	56.18	— 2.88	.353	.351	.311	.344	.82	.65	.78	.76	w	w	w N w	N 74 w	8.5	20.5	20.8	15.95	16.84	0.015	...
9	.322	.408	.474	.4110	52.9	60.9	56.2	57.32	— 2.17	.307	.272	.264	.277	.76	.50	.58	.59	N w	N w	N w	N 41 w	19.5	27.5	13.5	20.44	20.61	...	...
10	.568	.530	—	—	50.0	63.0	—	—	—	.156	.142	—	—	.42	.25	—	—	N b w	N w b N	N w	N 39 w	14.0	23.5	7.5	14.56	14.71	...	...
11	.571	.508	.524	.5377	60.5	69.5	66.6	67.15	+ 7.17	.408	.480	.362	.393	.77	.66	.55	.60	N N w	s	N b w	N 40 w	6.5	7.5	12.4	4.83	8.27	...	...
12	.588	.580	.576	.5807	59.4	67.4	58.3	62.62	+ 2.35	.336	.393	.333	.371	.66	.58	.68	.65	N b w	E s E	N N E	N 74 E	0.8	6.5	3.0	2.66	4.10	...	...
13	.618	.613	.596	.6067	58.3	71.3	56.5	63.85	+ 3.27	.279	.277	.334	.299	.57	.36	.73	.53	N b E	E b s	E	N 59 E	5.0	7.6	2.0	4.33	5.54	...	...
14	.614	.563	.546	.5693	58.7	76.9	63.0	65.63	+ 4.80	.339	.335	.476	.395	.68	.36	.82	.64	N b w	s s E	N E b E	N 88 w	1.5	11.4	4.0	2.49	5.00	0.040	...
15	.558	.573	.620	.5887	64.1	65.6	64.1	64.95	+ 3.82	.447	.518	.459	.484	.75	.82	.76	.78	N N w	s s w	N b w	N 37 w	3.0	2.8	11.6	5.68	7.58	0.295	...
16	.679	.691	.727	.7032	58.0	63.7	59.4	60.70	— 0.65	.370	.440	.410	.400	.77	.74	.81	.75	N	N N w	N N w	N 19 w	8.4	8.8	8.0	7.79	7.85	...	...
17	.707	.713	—	—	61.2	73.8	—	—	—	.386	.502	—	—	.71	.60	—	—	N b w	s b w	s b w	s 36 w	8.0	6.5	2.0	2.53	3.44	...	...
18	.633	.509	.433	.5045	59.8	69.3	62.3	64.58	+ 2.63	.441	.476	.453	.463	.86	.66	.81	.76	w b s	E b s	E b N	s 79 E	2.5	6.5	2.8	3.91	4.35	Inp.	...
19	.328	.301	.335	.3195	62.3	66.3	59.4	63.62	+ 1.48	.497	.562	.399	.482	.88	.87	.78	.81	E b N	s w b w	w b N	N 75 w	2.8	4.0	1.2	5.23	6.32	0.475	...
20	.346	.361	.488	.4030	56 2	74.6	63.4	66.03	+ 3.58	.371	.467	.494	.461	.82	.55	.84	.73	w N w	N N w	E N E	N 25 w	9.5	9.8	1.2	5.01	6.59	Inp.	...
21	.564	.636	.721	.6540	59.8	59.0	57.2	58.55	— 4.12	.492	.410	.415	.434	.96	.82	.88	.88	N E	E b N	N E b N	N 50 E	6.0	9.5	6.5	7.72	7.98	0.005	...
22	.794	.843	.829	.8265	58.3	65.5	56.2	60.38	— 2.57	.401	.336	.279	.333	.83	.53	.62	.64	N E b N	E b N	E s E	N 79 E	8.8	9.2	1.0	4.35	5.24	...	...
23	.837	.813	.798	.8143	54.4	72.0	59.8	63.75	+ 0.60	.362	.472	.417	.432	.86	.60	.81	.73	N b w	s b w	s	s 13 w	2.6	9.5	1.8	1.90	4.23	...	...
24	.854	.859	—	—	59.5	77.8	—	—	—	.447	.477	—	—	.88	.49	—	—	N N w	s b E	E N E	s 87 E	1.2	4.2	2.8	3.56	4.40	...	...
25	.831	.773	.733	.7745	59.4	76.4	68.4	68.48	+ 4.93	.434	.567	.548	.512	.86	.62	.79	.74	E b N	s b w	s w	s 14 w	1.7	9.5	5.5	3.98	4.86	...	...
26	.727	.709	.750	.7305	65.4	75.3	66.6	68.80	+ 4.92	.539	.553	.479	.547	.86	.63	.73	.78	w	N w	N N w	N 24 w	0.4	8.5	6.5	3.76	4.70	0.063	...
27	.825	.787	.709	.7665	64.5	68.1	58.7	63.68	— 0.38	.454	.330	.339	.381	.75	.48	.68	.65	N b w	E	E	N 84 E	6.0	11.4	1.0	5.29	5.58	...	...
28	.653	.521	.409	.5172	58.7	81.1	70.4	71.23	+ 6.95	.373	.646	.592	.557	.75	.60	.80	.73	E	s	s w b s	s 16 w	3.5	10.4	7.2	7.02	7.96	0.040	...
29	.269	.281	.355	.3065	68 4	71.5	68.1	69.40	+ 4.95	.662	.694	.552	.624	.95	.90	.80	.86	s w b s	w b s	w	s 81 w	5.5	8.5	6.8	7.70	8.48	0.750	...
30	.495	.545	.610	.5543	60.0	74.2	60.9	65.70	+ 1.12	.279	.410	.379	.371	.53	.49	.70	.58	w b N	s	N w	N 72 w	9.5	8.2	4.8	6.63	8.56	...	...
M	29.5018	29.4865	29.5053	29.4978	59.17	68.65	60.25	63.16	+ 2.13	.399	.433	.397	.414	.78	.62	.75	.71	....	....	....	....	5.89	10.57	6.03	......	7.61	2.136	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JUNE, 1860.

Highest Barometer . . . . 29.859 at 2 p. m. on 24th. } Monthly range=
Lowest Barometer . . . . 28.909 at 7.30 p. m. on 4th, } 0.950 inches.

Self-register-ing Ther.:
- Maximum temperature . . . . 81°6 on p.m. of 28th } Monthly range=
- Minimum temperature . . . . 49°2 on a.m. of 10th } 32°4
- Mean maximum temperature . . 72°58 } Mean daily range = 17°24.
- Mean minimum temperature . . 55°33 }
- Greatest daily range . . . . . . 28°9 from a. m. to p.m. of 11th.
- Least daily range . . . . =2.0 from a. m. to p. m. of 21st.

Warmest day . . 28th ... Mean Temperature . . . 71°23 } Difference=15°05.
Coldest day . . . 8th ... Mean Temperature . . . 56°18 }

Maximum Radiation { Solar . . . . 98°4 on p. m. of 14th } Monthly range=
{ Terrestrial . . . . . . 36.0 on a. m. of 8th } 62°4.

Aurora observed on 2 nights, viz.: on 9th and 10th; possible to see Aurora on 17 nights; impossible on 13 nights.

Raining on 14 days; depth, 2·136 inches; duration of fall, 34.8 hours.

Mean of cloudiness=0.58; most cloudy hour observed, 2 p. m., mean=0.66: least cloudy hour observed, midnight; mean=0.44.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
2543.62	934.88	1003.41	2579.10

Resultant direction, N 44° W; Resultant Velocity, 3.13 miles per hour.
Mean velocity 7.61 miles per hour.
Maximum velocity . . . 30.8 miles per hour, from 2 to 3 p.m. on the 9th.
Most windy day . . 9th—Mean velocity, 20.61 miles per hour. } Difference 17.17
Least windy day . . 17th—Mean velocity, 3.44 do } miles.
Most windy hour, 2 to 3 p. m.—Mean velocity, 10.61 miles per hour. } Difference
Least windy hour, 3 to 4 a. m.—Mean velocity, 5.20 do. } 5.41 miles.

1st. Corona round the Moon 10 p. m.
4th. Fog from 7 to 10.30 p. m.
5th. Fire Flies first observed this season 9 p. m.
7th. Foggy 8 a. m. Thunderstorm from 4 to 5 p. m.
13th. Solar Halo at noon (very distinct.)
14th. Thunderstorm 2.30 to 5.50 p. m.
15th. Thunderstorm 7 to 8 a. m., and again from 11 a. m. to 2.30 p. m.
18th. Thunderstorm 10 to 11.10 p. m.
19th. Thunderstorm 11.20 a. m. to 10.40 p. m.
29th. Foggy 8 a. m. Thunderstorm 8 a. m. to 3 p. m.

Heavy dew recorded on 6 mornings during this month.

Pollen of plants fell with the rain on the 14th, 15th and 19th.

The Resultant Direction and Velocity of the Wind for the month of June, from 1848 to 1860 inclusive, were respectively N. 76° W., and 0.72 miles.

The month of June, 1860, was warm, dry and windy—the mean temperature was 1°8 above the average of 21 years. The depth of Rain recorded was 1.012 inches less than the mean of the same number of years, and the mean velocity of the wind 2.40 miles per hour above the average of 13 years, was absolutely the most windy June during that period.

COMPARATIVE TABLE FOR JUNE.

YEAR.	TEMPERATURE. Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant Direction.	Resultant Velocity.	Mean Velocity
	°	°	°	°	°					°		
1840	59.8	— 1.6	78.5	37.1	41.4	11	4.860	...	...	...	...	...
1841	65.6	+ 4.2	92.8	45.7	47.1	9	1.560	...	...	...	...	0.36 lbs
1842	55.6	— 5.8	73.9	28.0	45.9	15	5.755	...	...	...	...	0.31 "
1843	58.4	— 3.0	81.3	28.5	52.8	12	4.595	...	...	...	...	0.27 "
1844	59.8	— 1.5	82.8	33.1	49.7	9	3.535	...	...	...	...	0.19 "
1845	61.0	— 0.4	83.6	40.9	42.7	11	3.715	...	...	...	...	0.27 "
1846	63.3	+ 1.9	83.3	41.5	41.8	10	1.920	...	...	...	...	0.32 "
1847	58.4	— 3.0	78.3	36.7	41.6	14	2.625	...	...	...	...	0·30 "
1848	62.9	+ 1.5	92.5	38.3	54.2	8	1.810	...	...	N 61 W	1.90	4·51ms.
1849	63.2	+ 1.8	84.9	45.2	39.7	7	2.020	...	...	S 71 E	0.49	3.32 "
1850	64.3	+ 2.9	83.2	49.0	34.2	10	3.345	...	...	S 60 W	0.38	4.54 "
1851	59.2	— 2.2	79.2	41.2	38.0	11	2.695	...	...	S 2 W	1.26	4.42 "
1852	60.8	— 0.6	86.1	43.6	42.5	10	3.160	...	...	S 76 W	1.49	4.09 "
1853	65.5	+ 4.1	86.3	43.3	43.0	9	1.550	...	...	N 1 W	0.10	3.73 "
1854	64.1	+ 2.7	88.7	47.4	41.3	9	1.460	...	...	N 24 E	0.71	4.15 "
1855	59.9	— 1.5	90.7	40.6	50.1	17	4.070	...	...	N 69 W	1.33	5.70 "
1856	62.1	+ 0.7	82.6	48.3	34.3	13	3.200	...	...	S 21 W	0.90	5.30 "
1857	56.9	— 4.5	75.1	40.9	34.2	21	5.060	...	...	N 49 W	1.15	7.60 "
1858	66.2	+ 4.8	86.3	48.7	37.6	12	2.943	...	...	S 20 E	0.25	5.53 "
1859	58.3	— 3.1	85.2	33.9	51.3	16	4.085	2	Inp.	N 77 W	1.95	7.19 "
1860	63.2	+ 1.8	81.1	50.0	31.1	14	2.136	...	...	N 44 W	3.13	7.61 "
Mean	61.36	...	83.64	41.04	42.60	11.8	3.148	...	...	...	...	5.21

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—JULY, 1860.

Latitude—43 *deg.* 39.4 *min. North.* *Longitude*—5 *h.* 17 *min.* 33 *sec. West.* *Elevation above Lake Ontario,* 108 *feet.*

Days.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN.	6 A.M	2 P.M	10 PM	ME'N		6 A.M	2 P.M	10 P.M.	M'N	6 A.M	2 P.M	10 P.M	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M	2 P.M	10 PM	Resul't.	ME'N		
					°	°	°	°	°												°							
1	29.663	29.698	—	—	60.9	66.6	—	—	—	.402	.440	--	—	.74	.67	—	—	N N E	S E b S	W	N 57 E	7.0	7.5	6.0	2.63	6.60	...	...
2	.677	.644	.628	29.6547	59.8	71.3	61.9	65.27	+ 0.27	.392	.510	.451	.456	.76	.66	.82	.73	N	S	S b W	S 9 E	0.5	7.5	3.0	2.63	3.84	...	...
3	.572	.473	.453	.4985	61.9	64.8	61.9	63.67	— 1.48	.464	.515	.503	.498	.84	.83	.90	.84	S b W	N E b N	N E b E	N 56 E	2.8	6.2	5.5	4.01	5.40	0.115	...
4	.440	.397	.248	.3467	60.5	65.0	60.9	61.98	— 3.32	.496	.513	.503	.499	.94	.82	.94	.90	N E b N	E b N	E b N	N 53 E	4.4	9.2	13.5	7.53	9.28	0.870	...
5	.238	.394	.488	.4052	54.7	70.6	60.5	61.57	— 3.82	.380	.412	.449	.416	.89	.55	.86	.77	N b W	N	E S E	N 6 E	11.5	8.5	3.2	5.03	7.52	0.005	...
6	.582	.645	.683	.6405	56.5	66.6	59.8	61.52	— 4.08	.378	.376	.302	.348	.83	.57	.58	.64	N b E	E S E	N N E	N 66 E	4.8	9.4	6.6	5.39	6.53	...	...
7	.697	.676	.516	.6110	60.1	72.4	62.7	65.78	+ 0.08	.343	.413	.441	.408	.65	.52	.77	.65	N b E	S E	E N E	S 71 E	2.8	7.5	6.8	4.03	5.50	...	...
8	.398	.221	—	—	62.3	63.7	—	—	—	.446	.556	—	—	.79	.94	—	—	S S E	E N E	S W b S	S 30 E	9.0	2.8	4.5	4.03	6.65	0.480	...
9	.157	.357	.521	.3645	68.1	69.5	59.6	65.33	— 0.65	.666	.494	.408	.499	.97	.68	.80	.79	S W	W	W N W	S 88 W	7.3	16.8	5.5	12.19	12.43	...	...
10	.592	.566	.667	.6168	55.8	68.1	55.8	59.67	— 6.42	.400	.485	.333	.408	.90	.70	.74	.79	W b N	S b W	N W b N	N 52 W	1.2	5.0	9.4	3.67	5.15	...	...
11	.770	.781	.819	.7948	53.6	65.6	54.7	58.88	— 7.30	.308	.415	.272	.314	.74	.65	.64	.63	N N W	S b W	N W b N	N 40 W	8.0	6.0	8.5	4.75	8.07	...	...
12	.831	.821	.803	.8177	55.8	68.1	61.2	62.42	— 3.88	.280	.293	.446	.348	.62	.42	.83	.63	N W b N	N W	N W	N 27 W	7.6	12.5	5.8	8.52	8.72	...	...
13	.819	.742	.701	.7470	55.8	70.6	61.6	63.95	— 2.63	.365	.546	.405	.441	.82	.73	.74	.75	N N W	S b W	S b W	S 36 W	2.0	7.8	3.5	1.76	3.93	...	...
14	.722	.675	.626	.6730	56.5	75.3	60.1	64.70	— 1.72	.378	.497	.425	.446	.83	.57	.81	.74	N N W	S b W	S W b S	S 17 W	3.8	12.6	0.5	5.41	6.52	...	...
15	.636	.609	—	—	59.4	71.3	—	—	—	.434	.636	—	—	.86	.83	—	—	W S W	S S W	S W	S 42 W	0.8	6.0	4.5	3.46	4.81	0.075	...
16	.505	.394	.561	.4925	63.2	81.8	62.3	68.38	+ 1.80	.536	.484	.434	.482	.92	.44	.77	.72	S W b W	W b N	N W b N	N 65 W	2.1	29.4	8.4	8.75	11.49	0.013	...
17	.658	.667	.630	.6538	56.9	69.9	58.3	62.85	— 3.83	.408	.480	.390	.417	.88	.65	.80	.74	N W	S S E	S	S 7 W	4.0	9.2	0.5	3.46	4.45	...	...
18	.630	.567	.398	.5252	57.1	64.5	63.7	63.18	— 3.50	.382	.532	.570	.521	.82	.88	.96	.89	S	E S E	E N E	S 45 E	3.2	3.0	2.5	2.57	4.35	0.510	...
19	.391	.455	.575	.4860	68.8	85.8	68.8	75.00	+ 8.22	.656	.568	.501	.585	.93	.46	.72	.70	S W b S	W b N	N W	N 80 W	3.5	11.2	5.5	7.89	8.93	...	...
20	.629	.552	.393	.4992	61.9	76.5	65.9	69.58	+ 2.82	.401	.440	.554	.470	.73	.48	.87	.66	N W b N	S b W	S W b W	S 44 W	1.5	9.8	1.8	4.35	4.97	...	...
21	.215	.252	.473	.3237	68.1	71.0	58.7	66.93	+ 0.12	.579	.528	.252	.442	.85	.69	.51	.64	S W b W	N W	N W	N 58 W	4.0	24.6	12.5	14.70	15.47	0.475	...
22	.581	.510	—	—	57.2	66.6	—	—	—	.404	.315	—	—	.86	.48	—	—	N N W	S S E	S S E	S 73 E	5.0	7.0	1.5	3.59	5.12	Inp.	...
23	.198	.379	.556	.3842	58.0	63.4	48.2	57.68	— 9.20	.441	.278	.245	.323	.92	.47	.72	.66	S W	N W	N W b W	N 60 W	2.4	27.5	3.0	12.52	13.23	...	...
24	.546	.456	.584	.5322	53.5	73.1	60.9	63.25	— 3.62	.278	.276	.414	.323	.68	.33	.78	.57	N W b W	W S W	W b N	S 75 W	3.5	22.2	4.0	8.66	9.53	...	...
25	.671	.656	.594	.6435	57.2	68.1	61.9	63.20	— 3.77	.282	.433	.489	.417	.60	.62	.88	.71	W b N	E S E	E b S	S 11 E	0.8	4.6	2.0	2.39	4.06	...	...
26	.530	.500	.560	.5380	62.7	74.6	64.5	67.37	+ 0.40	.478	.608	.519	.535	.84	.70	.85	.80	S W b S	W	N W b N	N 62 W	5.2	11.5	8.0	5.58	7.87	0.160	...
27	.709	.731	753	.7355	59.0	64.8	57.2	60.00	— 6.98	.369	.326	.325	.330	.74	.53	.69	.64	N b W	S	N W	S 45 E	7.2	8.6	5.0	1.23	6.35	...	...
28	.764	.697	.538	.6785	55.1	65.9	63.0	62.43	— 4.53	.331	.209	.475	.343	.76	.33	.82	.62	N N W	E N E	N E b N	N 61 E	2.0	9.6	7.4	6.73	7.28	0.655	...
29	.383	.321	—	—	61.2	70.6	—	—	—	.524	.706	—	—	.97	.94	—	—	E N E	W S W	N W b N	N 39 W	6.0	5.0	6.0	4.07	7.27	0.935	...
30	.458	.472	.458	.4600	60.5	72.0	64.1	66.38	— 0.57	.442	.528	.512	.500	.84	.67	.85	.77	N W b N	S b W	Calm.	S 57 W	1.8	6.6	0.0	1.99	2.93	0.043	...
31	.417	.512	.660	.5418	61.6	68.4	53.6	61.27	— 5.68	.481	.327	.287	.346	.87	.47	.69	.64	W b S	N N W	N W b N	N 36 W	3.8	19.8	7.6	11.44	11.68	...	...
M	29.5568	29.5562	29.5745	29.5610	59.33	70.30	60.45	63.92	— 2.33	.420	.442	.419	427	.81	.59	.78	.72	....	....	....	....	4.18	10.80	5.26	......	7.29	4.336	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR JULY, 1860.

Highest Barometer .... 29.839 at 8 a. m., on 12th } Monthly range=
Lowest Barometer .... 29.174 at 8 a. m. on 21st } 0.665 inches

Self-regist'ing Thermom.
- Maximum Temperature .... 88°0 on p. m. of 19th } Monthly range=
- Minimum Temperature .... 43°8 on a. m. of 24th } 44°2
- Mean maximum Temperature .... 72°99 } Mean daily range=
- Mean minimum Temperature .... 55°85 } 17°15
- Greatest daily range .... 30°7 from a. m. to p. m. of 24th.
- Least daily range................. 8°2 from a. m. to p. m. of 3rd.

Warmest day......... 19th ... Mean temperature......... 75.00 } Difference = 17°32.
Coldest day........... 23rd... Mean temperature......... 57°68 }

Maximum Radiation. { Solar................................ 104°4 on p. m. of 19th } Monthly range=
{ Terrestrial........................ 33°2 on a. m. of 24th } 71°2.

Aurora observed on 6 nights, viz., on 11th, 12th, 17th, 19th, 21st and 27th.
Possible to see Aurora on 19 nights; impossible on 12 nights.
Raining on 13 days,—depth 4.336 inches; duration of fall 48.4 hours.
Mean of cloudiness = 0.43.
Most cloudy hour observed, 2 p. m., mean = 0.50; least cloudy hour observed, 6 a. m., mean, = 0.35.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
2043.62	1245.07	1111.50	2500.42

Resultant direction N. 60° W.; Resultant Velocity 2.15 miles per hour.
Mean velocity.......................... 7.29 miles per hour.
Maximum velocity .... 31.4 miles, from 3 to 4 p. m. on 16th.
Most windy day .... 21st......Mean velocity 15.47 miles per hour. } Difference=
Least windy day .... 30th......Mean velocity 2.93 ditto. } 12.54 miles.
Most windy hour... 4 to 5 p. m..................Mean velocity 11.57 ditto. } Difference
Least windy hour... 2 to 3 a. m. ....Mean velocity 3.72 ditto. } 7.85 miles.

4th.—Severe thunderstorm from 4 to 6 p. m.
10th.—Distant thunder and sheet lightning 5 to 8 p. m.
15th.—Sheet lightning from 8.30 p. m.
16th.—Thunderstorm from 7 to 8.30 a. m.
18th.—Thunderstorm from 10.40 to 11.40 p. m.
20th.—Very brilliant meteor passed from W. N. W. towards S. E. at 9.30 p. m.
21st.—Heavy thunderstorm from 9 to 10 a. m.
29th.—Dense fog from 8 a. m. to 1 p. m.
30th.—Solar Halo at 4 p. m. Lunar Halo 8.20 to 9.30 p. m.
31st.—Lunar Corona from 9 p. m.

Heavy Dew recorded on 11 mornings during this month.

The Resultant Direction and Velocity of the Wind for the month of July, from 1848 to 1860 inclusive, were respectively N 62° W, and 0.42 miles.

The month of July, 1860, was extremely cold, wet and windy.

The Mean Temperature was 2°99 lower than the average of 21 years; it was absolutely the coldest July during that period. The depth of rain recorded was in excess of the mean by 0.806 inches, and the mean velocity of the wind was 2.36 miles per hour above the average, which is considerably greater than we have recorded here during any previous July for the last 13 years.

COMPARATIVE TABLE FOR JULY.

Year.	Temperature.					Rain.		Snow.		Wind.		
	M'n.	Diff. from Aver.	Max ob'd.	Min. ob'd.	Range.	No. of days.	Inch's.	No. of days.	Inch's.	Resultant Direction.	Resultant V'y.	Mean Force or Velocity.
1840	° 65.8	° —1.1	° 79.4	° 48.2	° 31.2	6	5.270	...	...	...	...	....
1841	65.0	—1.9	86.3	43.2	43.1	10	8.150	...	...	...	...	0.27 lbs.
1842	64.7	—2.2	90.5	42.0	48.5	4	3.050	...	...	...	...	0.33
1843	64.5	—2.4	86.1	40.2	45.9	8	4.605	...	...	...	...	0.44
1844	66.0	—0.9	86.1	40.5	45.6	12	2.815	...	...	...	...	0.19
1845	66.2	—0.7	94.6	45.6	49.0	7	2.195	...	...	...	...	0.30
1846	68.0	+1.1	94.0	44.9	49.1	9	2.895	...	...	...	...	0.29
1847	68.0	+1.1	87.5	43.8	43.7	8	3.355	...	...	...	...	0.19
1848	65.5	—1.4	82.7	46.7	36.0	10	1.890	...	...	N 14° W	0.18	4.94 mls.
1849	68.4	+1.5	89.1	51.0	38.1	4	3.415	...	...	S 5° W	0.75	3.52
1850	68.9	+2.0	84.9	52.8	32.1	12	5.270	...	...	N 81° E	0.59	4.56
1851	65.0	—1.9	82.7	52.1	30.6	12	3.625	...	...	N 60° W	0.88	4.13
1852	66.8	—0.1	90.1	49.5	40.6	8	4.025	...	...	N 43° W	0.93	3.33
1853	65.6	—1.3	85.4	49.4	36.0	10	0.915	...	...	S 58° E	0.24	3.69
1854	72.5	+5.6	93.6	53.0	40.6	9	4.805	...	...	S 49° W	0.37	4.03
1855	67.9	+1.0	88.4	53.1	35.3	13	3.245	...	...	S 19° W	0.73	6.47
1856	69.9	+3.0	92.0	51.4	40.6	8	1.120	...	...	N 79° W	1.57	5.84
1857	67.8	+0.9	85.4	52.4	33.0	15	3.475	...	...	S 68° E	0.81	4.74
1858	67.9	+1.0	83.4	55.9	27.5	13	3.072	...	...	N 15° E	1.13	5.76
1859	66.9	...	87.7	50.5	37.2	12	2.611	...	...	N 56° W	1.48	5.81
1860	63.9	—3.0	85.8	47.5	38.3	13	4.336	...	...	N 60° W	2.15	7.29
M	66.91	...	87.41	48.27	39.14	9.7	3.530	...	...	....	...	4.93 Ml.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—JUNE, 1860.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M.D., LL.D.

Latitude—45 deg. 32 min. North. Longitude—73 deg. 36 min. West. Height above the Level of the Sea—118 feet.

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—F.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone. t'nths	Rain in inches.	Snow in inches.	WEATHER, &c. A Cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.571	29.603	29.722	58.5	67.1	86.1	.423	.373	.279	.88	.54	.84	N	N E b N	E b N	153.50	2.0	...	...	Cu. Str. 8.	Cu. Str. 4.	C. C. St. 8.
2	758	580	609	44.9	76.7	58.9	211	470	358	72	52	73	S E	S S W	E b N	10.88	2.0	...	...	Fog.	Cum. 2.	Clear.
3	679	523	528	54.6	79.6	69.4	328	501	430	77	51	61	E S E	S b E	S b E	82.80	1.0	...	...	Heavy Dew, C	Clear.	Do.
4	420	301	281	64.1	84.7	69.4	373	476	430	62	42	61	S b E	S S E	S S E	114.10	1.0	...	...	Do.	Hazy.	Do.
5	242	271	406	66.4	69.2	63.2	451	402	478	78	66	83	S E b E	S S E	S b E	191.50	2.0	...	...	C. C. Str. 9.	C. C. Str. 10.	Cu. Str. 10.
6	468	396	438	60.0	79.2	67.0	456	405	463	88	47	71	N E b E	N E b E	N E b E	62.80	2.5	...	...	Clear.	Clear.	Clear.
7	399	304	312	62.9	78.9	63.0	379	507	478	66	52	83	N E b E	N E b E	W b S	126.60	2.0	...	...	Do.	Do.	Nim. 10.
8	322	314	384	59.0	68.6	89.1	410	457	410	82	69	82	S S W	S b W	S	215.70	2.0	0.562	...	Cu. Str. 10.	St. 2.	Clear.
9	419	417	471	55.0	69.9	57.0	370	456	359	84	63	73	S b W	W b N	N W	119.90	1.5	...	...	Do. 10.	Cu. Str. 4.	Cu. Str. 9.
10	499	537	624	53.1	89.5	56.6	321	433	357	80	85	79	N W	N W	N b W	124.60	4.0	Inap.	...	Do. 4.	Nimb. 10.	Do. 8.
11	641	628	724	54.1	73.5	62.4	335	338	453	80	41	80	N b W	N b E	N	134.10	1.0	...	...	Clear.	Clear.	Clear.
12	752	854	783	50.4	80.1	65.4	265	567	509	75	57	81	E b S	S	E S E	15.10	1.5	...	...	Do.	Do.	Do.
13	870	748	800	62.0	90.9	71.0	489	744	442	75	52	59	E b S	S E b E	S E	122.20	2.5	...	...	Do.	Do.	Do.
14	801	763	770	69.0	91.0	71.0	496	536	503	70	37	66	S W b S	S W	S W b W	37.00	1.0	...	...	Do.	Do. Sol. Halo.	C. Str. 2.
15	730	700	707	65.4	85.0	84.2	483	577	897	78	49	53	S S W	S W	W S W	10.50	1.5	...	...	Do.	Cir. 4 do.	C. C. Str. 4.
16	814	824	906	63.0	82.1	65.6	422	610	542	75	56	87	S E	N E b E	N E b E	84.90	2.5	Inap	...	Cu. Str. 4.	Cu. Str. 4.	Do.
17	884	914	986	64.0	89.4	61.2	483	894	464	73	64	77	N E b E	S E b S	S E b E	105.10	2.5	...	...	Clear.	C. C. Str. 2.	Cu. St. 2.
18	886	738	728	70.0	84.5	71.0	586	584	572	80	50	66	S E	S E	S E b E	28.70	2.0	...	...	Do.	Cu. Str. 4.	Do. 8.
19	604	601	614	66.0	78.4	59.1	542	664	439	87	69	88	S E b E	S S E	N E	0.50	2.0	0.403	...	Do.	C. Str. 2. d. th	Do. 10.
20	894	614	717	58.2	52.1	54.2	446	460	390	90	85	93	N N E	N E b E	N E b E	249.90	3.0	0.272	...	Cu. Str. 10.	Do. 10.	Rain.
21	914	924	941	52.7	72.9	60.1	328	390	367	83	50	71	N E b E	N N E	S E b E	157.10	3.5	0.600	...	Do. 8.	Clear.	Clear.
22	974	957	914	62.0	82.6	65.0	406	604	490	74	54	81	S S E	N N E	N W b W	33.10	2.0	...	...	Clear.	C. C. Str. 4.	Do.
23	904	900	30.000	61.5	77.2	63.0	449	587	517	85	63	91	W S W	E S E	S W b W	28.60	1.5	Inap.	...	C. C. Str. 10.	C. Str. 10. d. lt.	Cu. Str. 2.
24	30.114	30.101	104	64.1	85.5	66.1	464	570	502	77	47	78	S S E	S S W	S S W	13.80	1.5	...	...	Clear.	Clear.	Do. 4.
25	059	004	29.960	66.3	83.0	72.1	536	558	631	84	50	81	S S W	W S W	W S W	80.60	1.5	...	...	Do.	Do.	Clear, [Com.v.
26	29.847	29.899	897	69.3	79.7	68.6	635	606	483	80	60	78	W S W	W S W	N b W	76.35	3.0	0.597	...	C. C. St. 4.	C. C. Str. 4.	Cu. Str. 10.
27	30.021	940	501	60.3	79.7	61.6	426	644	390	82	64	74	N E	W	W S W	89.60	1.5	...	...	Clear.	Clear.	Do. 4.
28	29.807	745	543	64.2	72.8	71.1	464	355	572	77	32	76	S W	W S W	S S W	108.10	1.9	Inap.	...	Cu. Str. 4.	Cu. Str. 4.	C. C. Str. 4.
29	470	367	538	76.3	77.0	72.1	652	799	771	73	86	95	S W b S	W b N	S S W	149.90	3.5	0.116	...	Do. 10.	Do. 10.	Do. 4.
30	550	597	754	70.2	78.4	65.0	628	342	307	88	36	51	S W	W b S	W N W	158.30	2.0	...	...	Clear.	Clear.	Cu. St. 8.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—JULY, 1860.

(NINE MILES WEST OF MONTREAL.)

BY CHARLES SMALLWOOD, M. D., LL.D.

Latitude—45 *deg.* 32 *min. North. Longitude*—73 *deg.* 36 *min. West. Height above the Level of the Sea*—118 *feet.*

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—F.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone. (tenths)	Rain in Inches.	Snow in Inches.	Weather, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.867	29.817	29.866	61.0	74.1	60.6	.325	.568	.338	.61	.67	65	s w	w b n	w b s	34.64	1.0	...	...	Clear.	Cir. 4.	Clear.
2	899	822	841	52.6	81.6	63.2	354	638	386	90	83	67	w s w	n w b w	s b w	22.20	1.5	...	...	Do.	Do.	Cu. Str. 4.
3	794	693	635	65.0	86.3	71.0	389	448	592	63	36	76	s b w	s w	s b w	252.60	1.0	...	...	Do.	C. C. Str. 8.	Cirr. Str. 8. C.s.
4	697	712	687	61.1	76.1	59.0	413	273	317	77	30	62	E S E	E S E	s s E	83.40	1.0	...	...	Do.	Clear.	C.C. Str. 10. hy.
5	619	675	797	57.2	75.9	58.2	322	477	394	69	54	82	N E b E	s E b s	w s w	20.00	1.0	...	...	Cu. Str. 10.	C. C. Str. 4.	Str. 2.
6	895	814	876	65.1	83.2	62.7	366	376	416	60	33	72	s E b s	E S E	s E	97.00	1.5	...	...	Clear.	Clear.	Clear.
7	885	849	818	67.0	85.8	66.0	489	487	431	75	40	66	s E	s s w	s s E	45.00	1.5	...	...	Do.	Do. thunder.	Cirr. 4.
8	751	644	521	58.6	81.6	66.9	423	362	496	88	34	77	s s E	s s E	s b E	169.60	2.0	...	...	Do. heavy	Do.	Cu. Str. 6.
9	396	353	531	69.8	77.6	67.7	665	608	556	92	67	84	s s E	s w	w s w	231.20	3.0	0.330	...	Rain. [dew.	Cu. Str. 10.	Do. 8.
10	882	741	742	57.0	64.1	57.0	350	464	429	75	77	91	s w b w	w b n	w b s	224.70	3.0	...	...	Cu. Str. 8.	C. C. Str. 10.	Do. 2.
11	862	830	872	52.1	68.9	57.8	308	313	282	79	45	88	w n w	n w	n n w	233.60	1.5	...	...	Heavy dew,	Cu. Str. 2.	Do. 8.
12	940	917	944	56.0	77.1	63.7	370	422	471	84	46	81	n w b n	s w	w	45.80	1.5	...	...	Clear. [clear.	Clear.	Do. 2.
13	987	870	900	64.1	82.3	69.1	376	425	496	89	39	70	s s w	n b w	w s w	38.04	2.0	...	...	Do.	Str. 4.	Clear.
14	849	838	832	67.5	87.9	70.1	489	543	482	75	42	66	w s w	s w	s s w	96.10	2.0	...	...	Do.	Cirr. St. 4.	Do.
15	816	735	770	66.9	89.0	73.5	438	569	525	68	42	61	s w	s w	s w	65.60	2.0	...	...	C. C. Str. 4.	Clear.	Cu. Str. 9.
16	776	517	604	68.6	84.2	62.0	809	545	586	81	47	92	s w	w s w	w n w	79.50	1.5	1.880	...	Cu. Str. 4.	Cu. Str. 6.	Do. 9.
17	832	827	914	60.0	72.9	65.0	338	383	438	65	48	75	w n w	w b n	w b n	125.90	3.5	...	...	Clear.	C. C. Str. 4.	Clear.
18	821	784	690	62.3	84.2	69.2	399	470	503	72	40	66	s s w	s s w	s w	53.20	2.0	...	...	C. C. Str. 6.	Clear.	Do. Au. Bor.
19	688	594	680	70.2	88.4	74.6	621	650	497	85	49	59	s w	w b s	s s w	17.90	2.0	...	...	Cu. Str. 8.	C. C. Str. 8.	Cu. Str. 6
20	826	809	602	64.7	81.0	68.9	458	510	536	75	48	77	s s w	w b s	s w	78.80	2.5	...	...	Clear.	Clear.	Do. 4.
21	419	371	572	63.4	67.9	55.0	536	584	328	92	87	77	s s w	w	w b n	50.30	3.0	0.440	...	Rain.	C. Str. 4.	Do. 8.
22	748	777	676	50.9	71.4	60.3	302	503	345	82	66	68	w n w	w b n	w b n	220.40	1.5	...	...	Clear.	Clear.	Do. 9.
23	421	323	652	61.0	68.6	44.9	413	443	275	77	65	92	s b w	w b n	w	232.20	2.0	1.055	...	C. C. Str. 6.	Cu. Str. 6.	Clear. Au. Bor
24	612	566	739	51.0	64.2	55.8	296	403	365	79	68	76	s w	s w	s w	151.70	3.0	1.250	...	Clear.	Do. 8.	Do.
25	861	824	856	51.3	78.0	62.9	321	514	429	86	54	77	s w	s w	s s w	31.20	2.0	...	...	Fog.	Do. 4.	Do.
26	508	614	703	63.1	71.3	64.0	517	403	536	91	54	92	s s E	s s w	s s w	90.40	2.5	0.706	...	Cu. Str. 4.	Nim. 10.	Cu. Str. 10.
27	878	840	30.007	53.7	68.2	56.6	223	232	336	64	34	75	n b w	n n E	n b w	125.40	1.5	...	...	Clear. [dew.	C. C. Str. 6.	Do. 2.
28	991	967	29.976	47.5	74.2	63.0	291	568	388	89	67	69	w	s w	s w	18.30	1.0	...	...	Do. heavy	Clear.	Clear.
29	779	665	612	65.6	70.0	59.1	483	483	477	78	66	95	s s w	s s E	s s E	99.90	2.0	In'p.	...	Cu. Str. 8.	Cu. Str. 10.	Nim. 10.
30	626	601	698	64.2	80.3	62.4	461	599	399	77	59	72	w s w	s s w	w	78.80	1.0	...	...	Clear.	Do. 4.	Clear.
31	701	608	744	56.6	72.1	58.3	413	524	328	90	66	77	s s w	w s w	w	131.10	3.0	0.071	...	Do.	Do. 10.	Cu. St. 6.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR JUNE, 1860.

Barometer	Highest, the 24th day	30.114
	Lowest, the 4th day	29.231
	Monthly Mean	29.682
	Monthly Range	0.883
Thermometer	Highest, the 14th day	91°0
	Lowest, the 12th day	44°8
	Monthly Mean	68°15
	Monthly Range	46°2
Greatest intensity of the Sun's rays		101°2
Lowest point of Terrestrial Radiation		34°6
Mean of Humidity		.715
Amount of Evaporation		3.72

Rain fell on 10 days, amounting to 2.849 inches; it was raining 18 hours 15 minutes, and was accompanied by thunder on one day.

Most prevalent wind, the S. E. by E.

Least prevalent wind, the N.

Most windy day, the 20th day; mean miles per hour, 10.41.

Least windy day, the 19th day; mean miles per hour inappreciable.

Aurora Borealis visible on 1 night.

Solar Halo visible on 2 days.

The Electrical state of the Atmosphere indicated moderate and constant tension.

Ozone was present in moderate quantity.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR JULY, 1860.

Barometer	Highest, the 27th day	30.007
	Lowest, the 23rd day	29.323
	Monthly Mean	29.733
	Monthly Range	0.684
Thermometer	Highest, the 14th day	89°1
	Lowest, the 22nd day	43°8
	Monthly Mean	66°47
	Monthly Range	45°3
Greatest Intensity of the Sun's Rays		100°3
Lowest point of Terrestrial Radiation		37°1
Mean of Humidity		.679

Amount of Evaporation, 3.78 inches.

Rain fell on 8 days, amounting to 5.732 inches; it was raining 25 hours and 15 minutes, and was accompanied by thunder on two days.

Most prevalent wind, the S. S. W.

Least prevalent wind, the N. by W.

Most windy day, the 3rd day; mean miles per hour, 15.52.

Least windy day, the 5th day; mean miles per hour, 0.83.

Aurora Borealis visible on 3 nights.

Meteor in N. W. at 8.30 p. m. 21st day.

The electrical state of the atmosphere has indicated constant and moderate intensity.

Ozone was in moderate quantity.

Eclipse of the Sun visible on the 18th day.

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NOTES ON LATIN INSCRIPTIONS FOUND IN BRITAIN.

PART VI.

BY THE REV. JOHN McCAUL, LL.D.,
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26. In the University of Glasgow a monumental tablet is preserved, which was found many years ago in the Roman Station at Ardoch in Scotland. It is figured in Stuart's *Caledonia Romana,* (*ed. Prof. Thomson*, pl. v. fig. 5.) and the following explanation is given of the inscription:—

DIS MANIBVS
AMMONIVS DA
MIONIS * COH
I HISPANORVM
STIPENDIORVM
XXVII HEREDES
F · C

"To the shade of Ammonius Damion, Centurion of the First Cohort of the Spanish Stipendiaries, who served for 27 years, his heirs have erected this monument."

To this translation are subjoined notes to the effect, that others have regarded *Damionis* as governed by *filius* or *servus* understood; and that it would perhaps be more correct to join xxvii to *heredes,*—i.e. his twenty-seven heirs.

Horsley (*Britannia Romana*, p. 205) expresses his preference for considering *Damionis* as the nominative case, and compares such names as *Petilius Cerealis.*

It is not easy to discover where Stuart found any authority for the word *Stipendiaries*, which he introduces into his translation, for on the supposition that he mistook the meaning of *Stipendiorum*, we are then at a loss for the Latin denoting "who served for." Nor is it possible to reconcile *Ammonius* in the nominative with his translation—"of Ammonius Damion." Professor Thomson's suggestion to connect xxvii with *heredes* is so obviously unwarrantable, that it is surprising that any one could for a moment have entertained the idea. There is no doubt that the words—COH I HISPANORVM STIPENDIORVM XXVII HEREDES F·C·—mean "of the first cohort of Spaniards, of twenty-seven years' service, his heirs have caused [this memorial] to be erected;" and the only questionable point is as to *Damionis*. I am inclined to take it as the genitive case, F either being omitted, or perhaps obliterated by the fracture of the stone between S and C, where there seems to be sufficient space both for it and for >, the symbol of *centurio*.

27. In the year 1736, a fragment of a grave-stone was found in *Bath*, which, according to Dr. Stukeley (*Phil. Trans.*, 1748), bore the inscription :—

L·VITELLIVS·MA
NIAI·F·TANCINVS
CIVES·HISP·CAVRIESIS
EQ·ALAE·VETTONUM·CR
ANN·XXXXVI·STIP·XXVI
H·S·E

i.e. "*Lucius Vitellius Maximiani filius Titus Ancinus, civis Hispanus Cauriensis equitum alæ Vettonum Curator anno 46 Stipendiorum 26 hic sepultus est.*"

Mr. Warner (*History of Bath, Append.* p. 118) reads *Mantani* for *Maximiani*, *Tancinus* for *Titus Ancinus*, *Hispaniæ* for *Hispanus*, *centurio* for *curator*, and *hic situs est* for *hic sepultus est*. He translates the whole inscription thus: "Lucius Vitellius Tancinus, the son of Mantanus, a citizen of Caurium, in Spain, centurion of the Vettonensian auxiliary horse; who died in the forty-sixth year of his age, and the twenty-sixth of his military service."

The term *centurion* is explained on the supposition that the *ala*, "here spoken of was probably attached to the twentieth legion; in this Tancinus bore the office of centurion; a command somewhat analogous to the captaincy of a troop in our service." Mr. Scarth (*Proceedings of Somersetshire Archæolog.* and *Nat Hist. Society*, 1852, p. 102) remarks, that "the stone was erected on the place of interment of '*Lucius Vitellius Tancinus,* the son of Mantaus or Mantanus,' a citizen of Caurium, in Spain, a centurion of the Vettonensian horse, who died at the age of forty-six, having served twenty-six years." Both Mr. Warner and Mr. Scarth observe, in illustration, that Caurium was a town in Lusitania, and that the Vettones were a neighbouring people, who supplied the Romans with excellent heavy-armed horse.

There is no doubt that Mr. Warner's expansion is an improvement on that given by Dr. Stukeley, but it is far from being satisfactory. Of the suggestions which have been offered relative to MANIAI · F, I prefer Mr. Scarth's reading MANTAI · F; but perhaps we should substitute E for I, *i.e.* MANTAE.* The reading TANCINVS is supported by the inscription in Gruter, p. CMXVII, n. 8, cited by Mr. Warner; but HISPANUS, not HISPANIAE, is conformable to usage. The expansions EQVITVM for EQ· and CVRATOR or CENTURIO for C · R are unquestionably erroneous. EQ· stands for EQVES, and C·R for CIVIVM ROMANORUM. As to Mr. Warner's suggestion, that the deceased may have been a centurion in an *ala Vettonum* attached to the 20th legion, it is sufficient to observe that there is no authority for a centurion in an *ala*, nor for an *ala* being attached to a legion.

28. In the *Archæologia Æliana* (new series, vol. i. p. 261) a slab is figured, which bears the following inscription:—

DIISDEABVSQVESE
CVNDVMINTERPRE
TATIONEMORACV
LICLARIAPOLLINIS
COH·I·TVNGRORUM

Dr. Bruce reads and translates it thus:—

"DIIS DEABVSQVE SE-
CVNDVM INTERPRE-
TATIONEM ORACV-
LI CLARI APOLLINIS
COH[ORS] PRIMA TVNGRORVM.

"The first cohort of the Tungrians (dedicated this structure) to the gods and the goddesses, according to the direction of the oracle of the illustrious Apollo."

I have never seen an example of *Mantanus, Mantaus,* or *Manta.* The nearest approach to the name, which I have observed, is on an altar found at Clausentum. *Vide Journal of Archæological Association,* 1857, p. 210, fig. 2.

I have no doubt that I in CLARI stands, as is common, for II; and that CLARII is the well-known epithet which Apollo derived from *Clarus* (near Colophon, in Ionia), where he had a celebrated temple and oracle. It is scarcely necessary to cite illustrations from ancient authors. Amongst the most obvious are Virgil, *Æn.* iii. 360, "Qui tripodas, *Clarii* lauros, qui sidera sentis;" and Tacitus, *Ann.* ii. 54, "Relegit Asiam appellitque Colophona, ut *Clarii Apollinis oraculo* uteretur."

29. In the same work (p. 226) we find the following inscription on another slab:—

IMP · CÆSMAVR SEVE
RVSALEXANDERPIE
AVG HORREVMVETV
STATECONIABSVMM
COH IIASTVRVM S · A
ASOLORESTITVERVNT
PROVINCIA REG * * *
MAXIMO LEG * * * *
* AIMARTI * * * *

Dr. Bruce reads and translates it thus:—

"IMPERATOR CAESAR MARCVS AVRELIVS SEVE-
RVS ALEXANDER PIVS FELIX
AVGVSTVS · HORREVM VETV-
STATE CONLABSVM M(?)
COHORS SECVNDA ASTVRVM SECVNDVM ARTEM
A SOLO RESTITVERVNT
PROVINCIA REGNANTE
MAXIMO LEGATO........
KALENDIS MARTII .....

The Emperor Cæsar Marcus Aurelius Severus Alexander, the pious, happy, and august.—The second cohort of the Astures restored from the ground, in a workmanlike manner, this granary, which had fallen down through age, in the kalends of March ...., Maximus governing the Province as (Augustal) Legate."

Dr. Bruce's expansion and interpretation are in the main correct; but there are some points which require emendation. I regard M, at the end of the fourth line, as standing for MILITES, and COH II, of the fifth, for COHORTIS SECVNDÆ. This view is supported by the use of RESTITVERVNT instead of RESTITVIT. The expansion SECVNDVM ARTEM for S · A is, in my judgment, unsatisfactory. I regard the letters as standing for SEVERIANÆ ALEXANDRIANÆ. Orelli, n. 3395, furnishes an example of a similar use of them. The reading "PROVINCIA REGNANTE, governing the province," is unquestionably erroneous. Whether *provincia* be regarded as the ablative, or, as is most probable, as used for *provinciam*, there is no authority for the government of either accusative or ablative by *regnare*, nor for the application of the term to the government of a province by a legate or other Roman officer. I would suggest PROVINCIA[M] REG[ENTE]. Thus Tacitus, *Hist.* i. c. 48, "Vinius proconsulatu Galliam Narbonensem severe integreque *rexit*."

It may also be of importance to add, that Dr. Bruce's translation "happy" does not express the sense of *felix* as an epithet of the Emperors. It signifies what we mean by "fortunate," "lucky," and is expressed in Greek by εὐτυχής. It was first applied, as is well known, to Commodus, to mark his good fortune in being rid of Perennis, whose treasonable designs were abruptly terminated by his murder by the soldiers.

30. In the same work (vol. i. p. 251), a stone bearing a funereal inscription is figured :

C · VALERIVS · C · VOL ·
IVLLVS · VIAN ∗ MIL
LEG · XX · V · V

Dr. Bruce explains it thus :—

"The inscription may probably be read thus : Caius Valerius Caii (filius) Voltinia (tribu) Tullus vixit annos quinquaginta miles Legionis Vicesimæ Valentis Victricis. (In memory of) Caius Valerius Tullus, the son of Caius, of the Voltinian tribe, a soldier of the Twentieth Legion (styled) Valiant and Victorious (who) lived fifty years. Hodgson's reading is : Caius Valerius Caius Voltinius Julius vixit annos, &c. * * The age of the soldier has been cut upon a nodule of ferruginous matter, which has fallen out : there is not space for two letters, so that there is little doubt that the inscription originally had L."

Dr. Bruce's expansion is a great improvement on Mr. Hodgson's, but I am not satisfied with it. The position ot MIL · LEG · , &c., without any distinguishing mark between VI and AN,* lead me to be-

* In the original, as figured by Dr. Bruce, there are leaf-points after *Valerius*, C, *Vol*, and *Tullus*.

lieve that VIAN [N or A] stands for *Vienna,* his birth-place, especially as it is in the right position, according to the normal collocation. This conjecture is confirmed by the circumstance that all the natives of Vienna (scil. *Allobrogum*), mentioned in inscriptions, belonged to the Voltinian tribe ;* e. gr. Orelli, n. 445.

C · VALERI
VS · C · F · VOL
CAMPANVS
VIENNA MIL
L · XI · C · P · F ·
&c. &c. &c.

Vide also Horsley, *Brit. Rom. Yorkshire,* n. 8 ; Orelli, n. 453 ; Letronne, *Inscr. de l'Egypte,* Pl. xxxi. 3 ; &c.

I would read the inscription thus: Caius Valerius, Caii[filius], Voltinia [tribu], Tullus, Vienna, miles Legionis xx, Valeriæ (not *Valentis,* for which there is no competent authority†) Victricis. According to this reading, I regard the A in VIAN as a mistake either of orthography or of reading for E ; but it is possible that VIANA, a town of Rhætia or Noricum, may be intended, as Reinesius interprets the inscription, which he gives in Class viii. n. 38. It is worthy of notice, however, that the person named in that inscription also was of the Voltinian tribe.

31. In p. 261 of the same work, an altar is figured, which bears the following inscription :—

SOLI
APOLLINI
ANICERO.

---

* I do not mean to say that all the natives of Vienna were of the same tribe. There are examples which prove that some who had the same town as their birth-place were of different tribes. *Vide* Orelli, n. 3104 ; and Henzen, n. 6426.

† I regard VALEN · applied to the xxth Legion in Gruter, ccccxcii., 5, as a mis-reading. VALERIA is confirmed, (as Mr. Maughan, *Journal of the Archæological Institute,* xv. 159, remarks), by Dion Cassius, lv. 23, and by Spon's Miscellanea, p. 195, cited by Orelli. To these references add Henzen, nn. 6680, and 6871. The remark in the Journal, *l. c.* that " the title occurs in the form of VALERIANA, on an inscription in Bath " is, so far as I am aware, incorrect. I have not seen a copy of any inscription found there, in which the titles of the xxth Legion are given otherwise than V . V. Mr. Warner (*History of Bath, appendix,* p. 121,) gives VALERIANA as an expansion, but the stone has only V.

Dr. Bruce offers no explanation, but remarks :—

"It was found together with three others of Mithraic character, The third line is somewhat obscure, and the subsequent lines are nearly obliterated by the action of the weather. Mr. Thos. Hodgson has described this and the other altars found on the same occasion in the *Arch. Æliana*, vol. iv. p. 6."

On reference to Mr. Hodgson's description, I find that the only letters of the doubtful word, which he attempts to explain, are the first four ANIO. These he regards as "the dative case of ANIVS, who was the son of Apollo and Rhea," and he cites in illustration (apparently with approval!) one of Mr. Faber's wild speculations, that "Rheo" [thus Mr. F. calls the mother of Anius] "is the same as Rhea, a mere personification of the Ark; Apollo is the solar Noah; and Anius is also the great patriarch, under the title of *Aniun*, the *naval deity*."

It appears, from a comparison of the representations of the altar, as figured by Dr. Bruce and Mr. Hodgson, that it is doubtful whether the fourth letter is C or O; and that the last two, read by Dr. Bruce as RO, are not distinct.

I am of opinion that the true reading is ANICETO, and that the word is nothing more than the Greek ANIKHTΩ[I] in Latin characters, i.e. ἀνικήτῳ, *invicto*, the epithet so frequently applied to Mithras, Sol, and Apollo.

32. In the *Journal of the Archæological Association*, Vol. IX., p. 91, there is a description of various articles of the Roman period, which were exhibited by Mr. Gunston, who stated that he was informed that they had been found in London. In addition to the reasons which are there given for believing that the information communicated to that gentleman was incorrect, there seems to me to be in one of the inscriptions ground for suspicion that it was not found in Britain. The inscription to which I refer, is

L · AVTRONI
VRBANI · OL · II

The reading of this is evidently:—*Lucii Autronii Urbani ollæ duæ.* Now there is no example, so far as I am aware, of any British inscription mentioning the *ollæ*, which are so commonly noticed in stones found in Italy. The only sepulchral designations in inscriptions found in Britain, so far as I recollect, are *monimentum*, *tumulus*, and *memoria*. There is, however, a sepulchral stone, which, if my reading be correct, furnishes a term that I have never met with in any other inscription. As the examination of it may be of some interest, I shall devote the next article to the consideration of it.

33. In Horsley's *Britannia Romana* (*Yorkshire n.* 15) we have the following inscription:

DMS
CADIEDI
* IAE FO *
TVNA *
PIA·V·AX *

Mr. Horsley expands it thus: *Dis Manibus sacrum Cadiediniæ Fortuna Pia vixit annos decem.* Mr. Ward had previously read it: "*Cadillae Jeriae Piae Fortunata Pia,* all which names are in Gruter." It is obvious that Mr. Ward's reading should be at once rejected. According to the process which he adopted, almost anything could be made out of anything with the help of Gruter's Index. I am not satisfied, however, with Horsley's expansion. The chief objection, which I have to it, arises from the singularity of the names *Cadiedinia,* and *Fortuna Pia.* There can, I think, be no doubt that *pia* is not a name, but an adjective expressing the character of the deceased female. There are many examples of this use of *pius* and *pia* (not *pie*) e. gr. Renier's *Inscriptions de l'Algérie,* n. 2814:

D M S
SITTIA
MENOPHI
LA · PIA · VIX
ANXXV
H S E

i.e. Dis Manibus sacrum. Sittia Menophila. Pia vixit annis viginti quinque. Hic sita est.

If this view be adopted, it follows then that there are not two persons named in the inscription under consideration, but only one, whose second name is FORTVNA or FORTVNATA. The question then, is as to her first name. Adopting Horsley's conjecture, I would supply N as the first letter of the third line, but would limit the name to the letters EDINIAE, which I regard as used for the more usual form AEDINIAE by the ordinary substitution of E for AE. The name AEDINIA frequently occurs, e. gr. in Renier's *Inscriptions de l'Algérie*, *Ædinia Julia* in n. 1924, *Ædinia Lucilla* in n. 2598, *Ædinia Rogata* in n. 3015, and *Edinia* in n. 2802. In n. 195 we have *Ædia Fortunata*. From what has been advanced, it may, I think, be reasonably inferred that the correct reading of the inscription, omitting CADI, is *Dis Manibus sacrum Ediniæ Fortunæ* [*or Fortunatæ*]. *Pia vixit annis* X * But we have yet to examine CADI. I am inclined to suggest that it is a designation of the receptacle for the remains of the deceased. I am unable to cite an example from any other inscription, but Virgil, *Æn*. VI., v. 228, supplies the following authority:

"Ossaque lecta *cado* texit Corynæus aheno."

It is well known that *cupa* and *cupula*, both signifying barrels, are used as designations of receptacles of the dead, and to these I think *cadus* should be added, as denoting, perhaps, an earthen vessel of the form of a cask, used for the same purpose. Gutherius (*de jure Manium*, *Græv. Antiq*. XII, p. 1224) figures a *cupa* made of stone. As to the construction, *cadi* may be either in the nominative plural or in the genitive singular. It is not easy to decide on the construction on the latter supposition; but there seems to be no doubt that it was used—e. gr. Orelli, n. 4477:

D · M
LOCI IN QVO
CORPVS T · LV * *
SABINIAN LV
CIANI CREMA
TVM EST.

As it is not probable that the genitive is after *dis manibus*, we must suppose the omission of some such word as *signum* or *titulus*, indicating that the stone was the mark of the place or receptacle.

34. The discovery of inscribed stones has made a large addition to the number of the deities in the ancient Pantheon. Besides those noticed in Gruter's great work, Spon made a collection of inscriptions on altars *ignotorum atque obscurorum quorundam deorum;* and in De Wal's *Mythologiæ Septentrionalis monumenta epigraphica Latina*, we have notices of most of the northern deities, who were known up to the time of the publication of the volume in 1847, but no complete list

has yet been published. The most comprehensive catalogue, of which I am aware, is to be found in Henzen's *Index* to Orelli's Inscriptions, Vol. III, but even it, although very carefully prepared, and giving information up to 1856, is defective. There are some deities, named in inscriptions found in Britain, that are not mentioned in it. Amongst these is a god, whose name appears in three inscriptions found on the site of a Roman villa at Lydney, in Gloucestershire. The name in one is NODONTI, in the dative case; in another NVDENTE, which seems to be used for NVDENTI in the dative case; and in the third NODENTI, also in the dative case, and NODENTIS in the genitive case. The only explanation,* which I have seen relative to this deity, is contained in "The Romans in Gloucestershire," a Lecture by the Rev. Samuel Lysons, M. A., London, 1860. Mr. L. regards the name of the deity as NODONS or NODENS, and identifies him with Æsculapius, on the following grounds:

"The remains of a very considerable Roman building were discovered on an eminence in Lidney Park, on the forest side of our county, and carefully explored by the late Right Hon. Charles Bragge Bathurst. A very good series of interesting coins was then discovered, which is, I believe, still in possession of the present proprietor: but what adds great interest to that discovery was the finding of several votive tablets to a divinity, —which has caused no little speculation among antiquaries,—the god Nodens or Nodons. The difficulty was, to identify his name with the statues of the god himself, which were discovered at the same place, and bore all the characteristics of Æsculapius, viz. :—a dog, a cock, and serpents twining round a rod or staff, reminding one of Moses' contest with the magicians of Egypt. Pausanias relates that Æsculapius was represented in his temple at Epidaurus, as leaning on a serpent with a dog at his feet; and Plato, in his Phaedo, mentions the cock as sacred to the god of Medicine. * * * But a little reflection shows us how the Romans in their later occupation of this island had perverted Æsculapius' Greek attribute of *ἀνώδυνος*, the alleviator of pain (whence our term anodyne) into the deity, Nodons.'

The explanation offered by Mr. Lysons, does not commend itself to me. In the first place, there seems to be doubt as to the statues which were discovered. A learned correspondent, well versed in archæological investigations, informs me that the statues found there were terminal figures, one of Pan and the other probably of Diana. But,

* The inscriptions are, I believe, given in Lysons' *Reliquiæ*, but I am not able to consult that work.

however, independently of this, I am not aware of any authority for *ἀνώδυνος* or *νώδυνος* as an epithet of Æsculapius.

It is difficult to arrive at any definite conclusion relative to the god *Nodons*, *Nodens*, or *Nudens*,* and the only suggestion which I am able to offer on the point, is that the deity is the same as *Nodutis* or *Nodutus*, a rural god presiding over the *nodi culmorum*. As but very little is known of this deity, the following references may be found useful: Arnobius, *adversus gentes*, IV, p. 131, (ed. Leyden, 1651)—"*Nodutis* dicitur Deus, qui ad nodos perducit res satas." Augustine, *de civ. Dei*, IV, 8, p. 94, (*ed. Paris*, 1685)—"Præfecerunt ergo Proserpinaom frumentis germinantibus geniculis nodisque culmorum deum *Nodotum*." "Quando *Nodotus*, adjuvaret in bello, qui nec ad folliculum spicæ, sed tantum ad nodum geniculi pertinebat?" Another reading of the name is *Nodinus*, which more nearly approaches that in the inscriptions. *Vide* also Tomasinus, *de donar. ac tab. vot.* c. 26; Voss. *de Idololatria*, 11, 61; Lexicon Etymol. in *Nodus*; Rhodiginus, *Ant. Lect.* XXV, 30, and Struvius, *Ant. Rom.* 1, p. 151.

35. Of the three inscriptions noticed in the preceding article, the following seems to be the clearest:—

D · M · NODONTI
FL · BLANDINVS
ARMATVRA
V · S · L · M

which I read,—*Deo Magno Nodonti Flavius Blandinus armatura votum solvit libens merito*. The epithet *Magnus* suggests Mithras, but it is also applied to other deities. *Vide* Orelli, n. 3596.

For *armatura* in the sense of *miles*, *vide* Muratori, 801, 8; and compare Steiner, i. *Rhen*, n. 332, and n. 473; Henzen, n. 6794; and Borghesi (cited by Henzen), *Ann. Inst. Arch.* 1839, *Iscr. Renane*, p. 5. It is not easy to determine the characteristics of the *armaturæ*. They are mentioned by Vegetius, ii. 7, 15, 17; and Ammianus Marcellinus, xiv. 11; xv. 4 and 5; and xxvii. 2.

According to the former, they seem to have been younger soldiers, lightly armed; and according to the latter, body-guardsmen.

* The nominative may also end in *on* or *is*, as *Nodon* or *Nodontis*.

As light infantry, they may have been connected with a legion, as our light company is with one of our regiments. From the *Notitia*, it appears that there was a *cuneus armaturarum* in Britain, at *Bremetenracum*, possibly (as Böcking suggests) detached from the sixth Legion. According to this view, *armatura* in the inscription may be translated, a light-infantry soldier;* according to the other, a life-guardsman.

36. Another stone found at Lydney bore the inscription:

PECTILLVS
VOTVMQVOD
PROMISSIT
DEO NVDENTE
M DEDIT

which I read,—*Pectillus votum quod promisit Deo Nudenti magno dedit. Promissit* is used for *promisit*, and *Nudente* for *Nudenti*, by an orthographical irregularity not uncommon in epigraphy.

37. The most interesting, and most difficult, of the three Lydney inscriptions, is the following, which is engraved on a leaden or pewter tablet:—

DIVO
NODENTI SILVIANVS
ANVLVM PERDEDIT
DEMEDIAM PARTEM
DONAVIT NODENTI
INTER QVIBVS NOMEN
SENICIANI NVLLIS
PERMITTAS SANITA
TEM DONEC PERF * RA *
VSQVE TEMPLUM NO
DENTIS

* Some have regarded the *armaturæ* as cavalry; e.g. Camden (*Brit.* Gibson, p. 835) "those *armaturæ* were horse armed cap-a-pee, but whether they were *duplares* or *simplares* (Veget. 11, 7,) my author has not told us." Thus also *Vales*, in his note on Ammianus Marcellinus, xv. 5, citing Julian in Orat. 1, ad Constantium, p. 48 ed Spanh. and Orat. II. i. f. asserts—"Armaturas *equites* fuisse apparet; but the examination of the passages, cited by Vales, shows that they do not warrant his inference. The term *cuneus*, however, designating the body at *Bremetenracum* favours the opinion that they were cavalry, for *cuneus* in the *Notitia* is never applied, so far as I am aware, to infantry; although Vegetius iii. 19, defines it as "multitudo *peditum*."

Mr. Lysons (*Romans in Gloucestershire*, p. 54) reads and explains the words thus:

"*Divo Nodenti Silvianus annulum perdidit dimidiam partem donavit Nodenti: Inter quibus nomen Seneciani nullis permittas sanitatem donec perferant usque templum Nodentis.* It is, in short, nothing more or less than a hand-bill,* issued by a certain Silvianus, for the recovery of a ring which he had lost. He promises to give half its value, on recovery, to the god Nodens, and seems rather to insinuate that a certain Senecianus must know something about it, and threatens him with the loss of health until he shall bring it back to the temple of Nodens; thus identifying that deity with power over the diseases of the body."

To the reading of Mr. Lysons I see no objection, but his explanation does not at all satisfy me; nor can I understand what construction or translation he proposes for the words *inter quibus nomen Seniciani.* I am inclined to think that the circumstances under which this tablet was placed were these: Silvianus made a bet with Senecianus—whether it was a law-wager or not does not appear—he put down his ring, as was usual, as his stake, in lieu of the amount that he had bet, and vowed to the deity one-half of the sum that he expected to win, or one-half of the value of the ring. Senecianus won the bet, and, refusing to be bound by the vow of Silvianus, left the performance of it to him. Silvianus, to avert the anger of the god, erected this tablet in performance of his vow.

Let us now examine the inscription in detail.

DIVO NODONTI. *Divus* instead of *Deus* is unusual, but not unprecedented. ANVLVM PERDEDIT. The orthography of these words is not rare. Both *annulus* and *anulus* are written, and the use of E for I is common. As to the meaning, there can, I think, be but little doubt that the sense, which would at once suggest itself, is, *threw away a ring*, i.e., lost it, not accidentally but through his own fault. I do not mean to say that *perdo* is not sometimes used with the signification of *amitto*, but merely that that is not the sense which would first present itself on reading the words. If then the meaning be *threw away a ring*, the question is—in what way? The probable answer seems to be, by making a foolish bet. The ancient custom of using the ring in bets or wagers may be illustrated

* The only example which I have seen of a Latin advertisement of this kind is amongst the *graffiti* of Pompeii, and it does not at all resemble this inscription. *Vide* Wordsworth's *Inscr. Pomp.*, p. 26.

from the following passages: "Celebratior quidem anulorum usus cum fænore cœpisse debet: argumento est consuetudo vulgi ad sponsiones etiamnum anulo exsiliente."—Pliny, *Nat. Hist.* xxxiii. i. "Si quis sponsionis causa anulum accepit, nec reddidit victori."—Ulpian, *Dig.* xix. 5, 18. "Pono pallium, ille suum annulum opposuit.—Plautus, *Curcul.* ii. 3, 17.

DEMEDIAM PARTEM DONAVIT NODONTI. The construction of *donare* either with the accusative of the person and the ablative of the thing or (as here) with the accusative of the thing and the dative of the person is well known. The meaning of the words, according to my view, is—Silvianus, to obtain the aid of the deity in winning the wager, vowed that he would present to him one-half of it if the decision should be in his favour.

INTER QUIBVS SENICIANI NOMEN NVLLIS PERMITTAS SANITATEM. The construction from *quibus* to *sanitatem* is plain, and the sense is clearly,—grant health to none of those who bear the name Senecianus—*quibus Seniciani nomen* est. But *inter* remains unexplained. Probably the simplest suggestion is, that the construction is *inter* eos *quibus*, i.e. *permittas sanitatem nullis inter* eos *quibus Seneciani nomen* est. But I am not satisfied with this. Can it be that *inter* stands for *in termino*, i.e. *Nodenti in termino:* to Nodon, whose terminal figure stands here? This view is countenanced by the conjecture that one of the statues found on the site was that of Nodon, possibly that one regarded as representing Pan. It is also supported by the contrast between the neighbourhood *in termino,* and the distance denoted by *perferant usque templum.* It is proper, however, that I should add that I do not recollect ever having seen TER· used for TERMINVS. The prayer for bad health is not conclusive evidence that the reference is to Æsculapius, for every deity was supposed to have the power of visiting with sickness or other punishment. The special office of Æsculapius was restoration to health.

PERFERANT USQVE TEMPLVM NODENTIS. The selection of the words *perferant* and *usque* seems to indicate the distance of the temple, and the consequent labour in reaching it. The use of *usque* without *ad* is well known. The only question which now remains, is as to what they were to carry to the temple. According to my view it was the *dimidia pars* (either of the sum wagered or of the value of the ring), which Silvianus had presented to the deity by a vow, the obligation of which Senecianus refused to acknowledge.

OBSERVATIONS ON THE PHYSICAL GEOLOGY OF THE WESTERN DISTRICTS OF CANADA.

BY CHARLES ROBB, C.E., HAMILTON, C.W.

The investigation and illustration of the geological structure of the surrounding country, whether we regard it simply as a matter of scientific interest or of practical utility, must ever form one of the most prominent objects of such Associations as that of which this *Journal* is the organ. To those whose previous studies have given them a taste for, and aptitude in, such pursuits, no subject can possess greater interest, or add greater zest to the enjoyment of their excursions, whether of business or pleasure; while even to those whose acquaintance with geological science may be but superficial, the knowledge of those causes which have operated in determining the configuration of our coasts, and in producing the most prominent features of the scenery by which we are surrounded, must be a source of pure and elevating enjoyment. Again, as a striking instance of the benefit of such investigations in a utilitarian sense, I need only advert to the fact that both in Canada and in the neighbouring State of New York, before the deductions of geological science were brought to bear upon the public mind, large sums of money were squandered in abortive attempts to find coal in rocks below the carboniferous series. In exposing the absurdity of such attempts, and thereby rendering the resources thus wasted available in more profitable channels, the science of geology has conferred on this Province a service which will amply justify the expenditure of the sums granted by Government for the prosecution of these researches.

Sir Roderick Murchison computes that the money expended in England alone, before geology was understood, in searching for coal where it would now be considered madness to expect it, would be sufficient to effect a correct general geological examination of the entire crust of the globe.

I propose, in this and subsequent papers, to lay before the readers of the *Canadian Journal* the results of such investigations into the physical geography of the western districts of Canada as I have had it in my power to make during a residence of upwards of eight years in those parts of the Province. The region embraced in these explorations is that lying between the Niagara and St. Clair Rivers, and the object in view in undertaking and prosecuting them was chiefly the gratification of my own tastes, for which, however, professional engagements have afforded both opportunities and further stimulus. I lay but little claim to the merit of originality in the observations I shall have to record; the geological structure of the regions in question having been fully investigated and most ably reported on by our Provincial Geologists; and in stating my own observations I shall endeavour, as far as the nature of the subject will admit, to avoid repetition of the facts and phenomena which have been so fully chronicled by them, and to confine myself to such supplementary details and to such deductions and inferences as my own enquiries and studies may enable me to make. As illustrative of some of the most interesting peculiarities of structure in the region under notice, I propose also to reproduce the arguments of Sir Charles Lyell and other observers relative to the retrocession of the Falls of Niagara; in corroboration of which I have noted some additional facts which have not hitherto been recorded.

Section I.

GEOLOGICAL FEATURES OF THE NIAGARA AND GORE DISTRICTS.

General Description.—The range of high lands which we are accustomed to denominate "the Mountain" running eastwards far into New York State—maintaining throughout a nearly uniform elevation of about four hundred feet above the level of Lake Ontario, and forming a platform or table land, in a basin of which Lake Erie is situated—bends round the head of Lake Ontario and continues in a north-easterly direction till it gradually disappears in the neighbourhood of the Bay of Quinté. The same geological formations do not, however, occur throughout the whole of this distance, as I shall hereafter point out. Along the southern shore of the lake, the ridge runs at a distance varying from four to eight miles from the shore, and presents a nearly uniform precipitous escarpment on its northern flank. Around Burlington Bay it approaches still nearer the margin of the lake, and at East Flamboro' bends to the northward and loses for the most part its precipitous character, and recedes gradually further from the shore, being not less than twenty-four miles distant in the rear of Toronto, though again, as we proceed farther east, we find it approach within nine miles. With the exception of the Niagara River, no streams of any importance empty themselves into Lake Ontario throughout this region, as might naturally be expected from the proximity of the ridge to the shore; and that remarkable river itself, as I shall hereafter show presents anomalies and peculiarities perhaps nowhere else to be met with in nature.

The geological structure of this region is remarkably simple, exhibiting no faults or distortions of the strata; but it is far from being less interesting either to the geologist or the general observer on that account. The rocks immediately underlying the superficial deposits consist of various members of the Silurian or oldest fossiliferous strata. They belong to those divisions of the Silurian system called the Middle and Upper Silurian, corresponding to, and no doubt contemporaneous with, the Carradoc, Ludlow and Wenlock groups of England. Nowhere do we find a more interesting region in a geological point of view. Referring to it, or rather to the continuation of the same formations in New York State, Sir Charles Lyell remarks:—"If we wish to see in perfection the oldest monuments of the earth's history, so far at least as relates to its earliest inhabitants, we must look here. Certainly in no other country are these ancient strata developed on a grander scale, or more plentifully charged with fossils; and as they are nearly horizontal, the order of their relative position is always clear and unequivocal. They exhibit, moreover, in their range from the Hudson River to the Niagara, some fine examples of the gradual manner in which certain sets of strata thin out when traced to great distances, while others become intercalated in the series. Thus, for example, some of the limestones which are several hundred feet thick in the Helderberg Hills, near Albany, are scarcely forty feet thick in the Niagara district; and, on the other hand, the rocks over which the cataract of Niagara is precipitated, dwindle away to such insignificant dimensions when followed eastward to the hills south-west of Albany that their place in the series can scarcely be recognized." Sir Charles adds "that a comparison of the fossil remains found in those ancient strata with those of a corresponding age and position on the other side of the Atlantic, shows that while some of the species are identical the majority are not, and that however close the general analogy of the forms may be, there is evidence of the same law of varieties in space as now prevails in the living creation." Since Sir Charles wrote the above remarks it has been ascertained on a more minute investigation that the number of species common to the Silurian rocks on both sides of the Atlantic is between thirty and forty per cent.; and it is a most interesting fact that those which are identical are precisely those which are found most widely diffused both geographically and in the order of superposition, and consequently seem to have been most capable of surviving many successive changes in the earth's surface.

Professor Sedgwick, at the recent meeting of the British Association in Aberdeen, in speaking of this order of geological formations, characterized them by a figure quaint and graphic, though derived from modern feminine usages. He speaks of the limestone formations as a great girdle, or (in plain terms,) "hoop," over which Dame Nature had spread her "glorious palæozoic petticoat." Certainly nowhere on the face of the globe has this skirt attained a greater expansion, or been more gorgeously bedecked with the forms of ancient life, than in the locality now under notice.

Details of the Rock Formations.—A very complete and most interesting section of the strata in a line running north and south, is afforded by the cutting on the line of the Niagara Falls and Lewiston Railroad, and by the ravine itself through which the great river flows.* Taking the section at this most interesting locality as the basis of our future enquiries, I shall proceed to describe briefly the component parts, and shall take occasion while it is under review to recapitulate the arguments of Lyell and others, to prove the fact of the retrocession of the Falls from Queenston Heights to their present site.

The strata in ascending order consist, first, of a soft red shaley and purely argillaceous marl, partially striped and spotted with green, seen in the bank of the river at Queenston and extending thence to Lake Ontario, and attaining a height of about one hundred and ten feet at the escarpment at Queenston. This formation, which is entirely devoid of calcareous matter, is regularly stratified, and interspersed with thin veins of a light green rock of similar composition though somewhat harder, the colors being evidently derived from the presence of iron. The traces of organic remains in this bed are

* This section is represented graphically in Sir Charles Lyell's *First Visit to the United States*, 1841-2, Vol. I. page 36, to which we would refer our readers.

very obscure though not altogether wanting, and it is chiefly remarkable as forming the base of the system, and as occupying the entire area between the foot of the slope of the mountain and the lake shore for the whole distance from the Niagara River to Oakville.

The second stratum is a bed of very hard light grey quartzose sandstone, marked frequently with ferruginous spots, but forming an excellent building material, and quarried extensively at Lewiston, Hamilton, Dundas and other places. This bed is about fifteen feet thick at Queenston, and contains the remains of fuci or sea weeds. I have also observed it to be distinctly ripple-marked in some localities. Above this for a thickness of about sixty feet occur alternate layers of red shale or marl, similar to No. 1, and of sandstone or limestone, the former principally near the top of the formation. The harder rocks here are particularly rich in organic remains, some in a beautiful state of preservation, and all remarkably characteristic of the geological epoch to which these formations belong, consisting of corals, brachiopods of various species, tentaculites, encrinites and trilobites. Of the trilobites, a remarkable crustacean genus strikingly characteristic of the Silurian system all over the world, I have only detected a few fragments, but they are sufficiently unequivocal.

Next in succession is a grey and mottled sandstone about fifteen feet thick, forming the upper member of what is called by the New York State Geologists the Medina Sandstone group. Encrinites, corals and broken shells prevail in great abundance at the top. Overlying this bed is a band of light green shale five feet thick, turning into clay on exposure to the atmosphere. This stratum forms the lower member of the Clinton group of New Yor k, and is remarkable as being traceable for vast distances east and west in precisely the same relative position, and of identical mineral character. Next in order occurs a compact bed of light grey, very hard limestone, about sixteen feet in thickness, copiously charged throughout its entire mass, but chiefly towards the top with the bivalve shell *Pentamerus* (a genus also found extensively in a corresponding position in the Silurian systems of England and Russia) as also with a few species of *Atrypa*, a remarkable coral called *Favosites gothlandicus*, &c. This bed forms the upper member of the Clinton group, and wherever it is found is an exceedingly handsome and durable stone for building purposes. Owing to its hardness it forms a distinct escarpment wherever exposed for any length of time to the weather. Then follows the formation usually denominated Niagara shale, about eighty feet thick, consisting of a homogeneous stratified or laminated mass of bluish-grey, sometimes nearly black, argillaceous, arenaceous and calcareous slatey rock, hard and solid in the bed, but decomposing and crumbling when exposed to the atmospheric influences. It seems to be devoid of fossils, except towards its junction with the underlying hard limestone, where it is plentifully charged with *Pentamerus* and *Atrypa*.

Lastly. the escarpment is capped by the Niagara limestone, (so called) a massive and very hard dark blue or more nearly black rock, the lower portions being in very thick solid beds, while towards the top the partings occur more frequently. This rock is magnesian and silicious in mineral character, and is highly bituminous, being known in many places to emit inflammable gas through the seams. Occasionally it is cavernous in structure, and is copiously interspersed with druses or cavities containing calc-spar, gypsum and sulphate of Strontian. I have been uunable to detect any fossil remains in this formation, although I believe they are not altogether wanting. It is over this rock that the great cataract is precipitated, and it forms from its hardness a species of coat of mail or armour of proof to resist the too rapid erosions of the torrent.

Proofs of Retrocession.—It will serve at once to illustrate strikingly what may be called the mechanical properties of the strata we have been considering, and at the same time to show by a most remarkable example the value of geological evidence in regard to duration of time, if we take up at this stage the subject of the recession of the great Falls.

It has long been a well known fact, that behind the mighty cataract there existed a vast cavern formed by the action of the water and air set in violent motion by the descending torrent upon the soft shales underlying the Niagara limestones; and this fact must have suggested to an enquiring mind the idea, that as the soft material became gradually undermined or excavated, the weight of the superstructure and impetus of the water must have caused the harder superincumbent rock from time to time to give way, and thus occasion a recession of the Fall in its position. In accordance with this idea, it is found from historic evidence, (which unfortunately in this point affords less corroboration to geological theories than in questions relating to the old world), that changes of the kind referred to had actually taken place; and the appearance of the bank below the Falls where these changes had occurred within the memory of man is so precisely identical in character with the whole gorge for seven miles below, that a philosophical observer of the phenomena of nature would be irresistibly impelled to the conclusion that the great Fall formerly existed at Queenston, and that the river must have sawed its way through this whole distance—provided sufficient time were allowed for the completion of the work. Sir Charles Lyell concludes, after the most careful and repeated investigation of the recorded facts, as well as the varying nature of the strata, that the average recession was not more than one foot per year, and that consequently it must have taken 35,000 years for the retreat of the Falls from the escarpment at Queenston to the present site. It seems by no means improbable that such result would be no exaggeration of the truth, although we cannot assume that the retrograde movement has been uniform. At some points, owing to the greater softness of the strata and the lesser width of the ravine, it might be expected that quicker progress might be made; but on the other hand, it must be observed that at the commencement of the process the Fall must have been nearly twice its present height and consequently the amount of material to be excavated proportionally greater. This estimate of the time required for the scooping out of the gorge, as Hugh Miller remarks, is based upon exactly the same process of reasoning by which one would infer that a labourer who had cut a ditch two hundred yards long at the rate of ten yards per day and was still at work without intermission, had begun to cut it just twenty days previous.

This theory based upon historical, is amply corroborated by geological evidence. If we examine the structure of Goat Island, between the American and Horse Shoe Fall, we shall find that the superficial deposit consists of regularly stratified horizontal fresh water beds of gravel, sand and loam, in all about twenty feet thick, copiously charged with shells of the same species as now inhabit the waters of Lake Ontario and the Niagara river. These beds are entirely above the level of the water as it precipitates itself into the mighty gulf. Precisely the same formation will be found on the American side of the river exactly opposite, and extending for a considerable distance below the Falls on the top of the cliffs, and bounded towards the east by a distinctly traceable ancient river terrace cut out in the clay or drift formation which covers the whole country. This deposit, in which also the remains of a Mastodon have been found, occupies the place which the ancient bed, and alluvial plain of the Niagara would naturally have filled, if the river had extended farther northwards at a level sufficiently high to cover the greater part of Goat Island. At that period the ravine could not have existed, and the river must have been dammed back several miles lower down. The old river banks are distinctly traceable facing each other on both sides ot the gorge, at least as far down as the Whirlpool, and vary in width from about thirty to three hundred feet from the brink of the precipice. At the summit of the cliffs overhanging the Whirlpool on the American side, there occurs a deposit forty feet thick of fluviatile strata, precisely identical with those on Goat Island; and it must be borne in mind that nowhere do these deposits extend, or can they be traced, beyond the old river banks.

Here then we have the most unequivocal evidence that at a date comparatively modern in the geological epochs, though very remote as regards the history of our race, the great Falls must have been situated at least four miles below their present site; and in the absence of distinct traces of their existence still further northward we may reasonably and justly infer that they must have primarily been situated at the escarpment at Queenston. There is no ground for supposing that the excavation was assisted by an original rent in the rocks, and no appearance of a fissure occurs at the present site of the Falls.

The dip of the strata being twenty-five feet to the mile southward, and the slope of the river bed about fifteen feet in a mile northwards, these two inclinations combined have occasioned a diminution of forty feet in the perpendicular height of the Falls for every mile that they have receded southwards. When they were situated at the Whirlpool, the hard quartzose sandstone was at the base of the precipice, and here the cataract may have remained stationary for ages. Even now the obstruction occasioned by this ledge in the bottom of the river causes a partial damming back of the water, which, overleaping this barrier, rushes with still more fearful velocity down the gorge. This phenomenon, together with a remarkable break (which I shall afterwards advert to) in the continuity of the strata on the Canadian side at this point have no doubt given rise to the Whirlpool. In regard to the future retrocession of the Falls it is susceptible of clear proof that when they have travelled back two miles or opposite to the village of Chippewa, the massive Niagara limestone now at the top will then extend also to the base of the Falls, and its great hardness will probably arrest the excavating process, if it should not have been previously stopped by the descent of larger masses of the same rock from the cliffs above. In this latter case, instead of a fall we shall have a rapid of about the same slope as the present rapids above the falls, (fifty feet in three-fourths of a mile); but very much more broken and irregular owing to the greater size of the masses of rock forming the bottom.

The next question to which we are naturally led, relates to the origin of the Falls, but this subject I shall defer till the close of this article, when, after describing the principal geological features of the region bordering on the head of Lake Ontario, I shall attempt to indicate the succession of events which have produced them.

Strata traced Westwards.—The various members of the series of rocks already described, are also exposed in tracing the escarpment running parallel to the shores of the lake, from Niagara to Flamboro'. The strata lie nearly horizontally from east to west, but dipping slightly to the eastward, the dip of the lower standstone bed (called by the quarrymen the Gray band,) which rests immediately on the red marl, being at the rate of twenty-two inches per mile. An attentive observation of the section thus exposed will shew the remarkable manner in which certain of the beds thin out and die away as you follow them westwards; while others not to be discovered at the Niagara river are intercalated in the series, and as they are traced in a northwest direction attain to a great thickness, still retaining their distinctive characters. Thus the great deposit of dark shale, which at the Falls shews a thickness of eighty or ninety feet, is represented at Flamboro' by a bed of only five feet thick; while the encrinal and cherty limestone, which at Flamboro' occupy a most prominent place in the group, die out gradually and are scarcely to be detected at the Falls.* This same encrinal limestone, which at Flamboro' is only

* This phenomenon, which is not peculiar to the Silurian or to any other system, though nowhere perhaps more strikingly apparent than in this locality, may, I conceive, be accounted for in three ways: Either, 1st. That in the wide and deep ocean in which these deposits were made, certain of them never reached the deeper portions, but subsided along its shores; Or, 2nd. It may have been caused by certain portions being too shallow or even upraised above the surface of the water. Or, 3rdly. After the deposition of the stratum, it may have been uplifted so near to the surface of the sea, as to have been worn away by the waves, and thus have allowed a succeeding deposit to come directly upon one of preceding date.

about twenty feet thick, is observed to attain a thickness of one hundred feet in Eramosa, Nassagaweya and Caledon. This limestone, as well as the underlying Clinton limestone, is everywhere well adapted to form an excellent and durable building material, and is likewise of good quality for burning into lime. It forms wherever it crops out a bold escarpment (which may be called the Niagara ridge) owing to its solid and apparently unstratified character. This escarpment is distinctly traced from West Flamboro' eastward into Nelson, where it takes a sweeping turn to the north, and maintains a nearly straight course in that direction until it reaches Owen Sound near Sydenham village. The dark bituminous limestone which forms the upper member of the group follows the same course, which, however, is not so distinctly marked, owing to its being stratified in thinner beds, and occupies throughout from the Niagara River to Owen Sound, a breadth of country varying from eighteen to twenty or twenty-two miles.

The red marl which forms the base of our series of rocks is supposed to be about 614 feet thick. The bore which yields the mineral water at St. Catherines pierces it for a depth of nearly four hundred and seventy feet without passing through it, and the level at which the bore commences is one hundred feet below its upper surface. It seems geographically to come to an abrupt termination at the west bank of the Creek at Oakville, and is there succeeded by the Lorraine Shales, or Hudson River Group—an older formation consisting of alternate very thin beds of limestone and shale, which extend from this point along the north side of Lake Ontario to the River Rouge in the township of Pickering, immediately adjoining Scarboro'. A good section of this formation is exposed on the east bank of the Don at Toronto. A bore which was executed under my directions at the Toronto Station of the Great Western Railway, penetrated it for a depth of one hundred and fifty feet without change. The water which this bore yielded was salt and bitter, and a considerable quantity of carburetted hydrogen gas was evolved.

I may here remark in passing that in the spring of 1855 a great land-slide occurred on the slope of the mountain a little below Dundas Station, which displaced a portion of the track of the Great Western Railway, and was caused by the weight of the debris of the harder rocks above sliding along the face of the soft shales which, by exposure to the weather, resolve themselves into an unctuous sort of clay.

may also notice that in filling up the old channel of the Desjardins canal, enormous quantities of material were thrown in and disappeared, producing no effect in forming a bank, but forcing up the soft material in the original bottom of the marsh, to a considerable extent and height above the surface. This affords a good illustration on a small scale, of what the geologist often finds on a large scale, and may be puzzled to account for ; I refer to the displacement of strata, formed in horizontal position and thrown up into a highly inclined or even vertical position.

Waterlime and Ochre.—Before noticing the superficial deposits of this region, I shall direct attention briefly to the waterlime and ochre beds of Thorold, which are somewhat extensively worked for commercial purposes, and occur about three hundred feet above the level of the Lake, and close on the line of the Welland Canal at Thorold. The waterlime deposit consists of a series of thin layers (each layer not exceeding eight to ten inches thick) in all about three and a half to four feet thick, of very hard compact dark blue limestone, corresponding in position and probably identical with the Clinton group. These beds are in some places a perfect congeries of large bivalves, called *Pentamerus oblongus*, some of them measuring three and a half to four inches across, while the partings of the beds are beautiully marked with fucoids of various species. The limestone from this bed, when calcined and ground to powder, forms an hydraulic cement of the best quality; owing this peculiar property to the presence of a large proportion (over ten per cent.) of silica or silicates. Immediately underlying and overlying this bed, are thin layers of a softer stone, which, when calcined and ground, forms an excellent drab coloured pigment; a rich brown paint, said to be fireproof, is also manufactured at Thorold, from material found in the same quarries. Whether these peculiar products extend far to the east or west of the localities where they are at present quarried, I am unable to say ; but at Rochester there occurs an iron ore bed at the same place in the series, and Dr. Mack of St. Catherines has ascertained that the stone from the drab ochre bed contains forty per cent. of iron.

Superficial Deposits.—I shall now, as briefly as the subject will admit, direct your attention to the superficial deposits of this region, and the proofs of glacial action which they afford. It is now pretty generally conceded, and in fact cannot on any reasonable ground be denied, that the thick deposit of clay, sand, gravel and boulders which covers the Western districts of Canada, (in many places upwards of one hundred feet beneath the general surface, and along the shores of Lake Erie and elsewhere forming hills one hundred and fifty feet above the general level,) is due to what is called by geologists the glacial period, and the phenomena referable to this epoch, are precisely similar on both sides of the Atlantic. From well known cosmical laws, ice-bergs and fields of floating ice are constantly, in seas north of the fortieth parallel of latitude, passing from the Polar regions in a direction from N.E. to S.W. and are conveyed for hundreds of miles from their original birth-places; and these are frequently found to be charged with vast quantities of mud, sand and boulders, the debris of the granitic rocks which mostly occupy these regions. These ice-islands become stranded in seas too shallow to float them, and as the ice is melted, deposit their insoluble contents at random over the bottom of such seas, and the deposits thus formed would be stratified or unstratified according as the water was in a quiescent state or disturbed by currents. The slow passage of these ponderous masses, armed with such refractory materials, over the rocks forming the bottom of the seas, would grind down their upper surfaces, removing great quantities of their constituent materials, and producing grooves, furrows and scratches in the normal direction of their course. We have, on a small scale, an example near our own doors of the effect of ice in removing masses of rock. I refer to the fact that the isolated rock called Gull Island, between Cobourg and Port Hope, two miles from the northern shore of the lake, and on which the lighthouse is built, formed at the time of the early settlement of the country, an island of over two acres in extent, but is now only a sunken reef, owing doubtless to its having been as it were decapitated by the ice forming over and adhering firmly to its upper beds, which would be borne away with the floating ice during storms. The same process is continually going on upon a larger scale in Lake Superior, and the observations of navigators in the Arctic regions supply, on a still more extensive scale, all the "modern instances" requisite for the corroboration of the theory.

Now it is an interesting and important fact that the constituent materials of the clay, sand and gravel which cover the greater part of Canada West, are derived from granitic and trappean rocks; that the boulders embedded in the clay and strewed over the surface are, for the most part, fragments of the same rocks; that these rocks are found in their native beds invariably in a North-easterly direction, and that the surfaces of the harder rocks *in situ* in the peninsula, wherever exposed by the removal of the drift, are found to be smoothed, polished, furrowed and scratched in a direction from N.E. to S.W. Any one who has had occasion to visit Niagara Falls will see this phenomena strikingly developed along the top of the cliff on the American side, and at the excavation for the Hydraulic canal, about half a mile below the Fall. That this smoothing and scratching of the rocks could not be produced simply by the action of torrents of water carrying stones with it, may be satisfactorily proved by examining the rocks in the bed of the river, which, even where the current is most rapid, exhibit no analogous effect.

General Inferences.—In order to account for all the phenomena I have thus briefly sketched, we are irresistibly impelled to the conclusion that subsequently to this region having acquired its present geographical configuration, so far as relates to the outline of the older rocks, the land was submerged under the sea to a moderate depth, and that large ice-islands were driven by currents from the north, charged with mud, sand and boulders, which, as they grounded on the bottom, pushed along all loose materials of sand and pebbles, broke off all angular and projecting points of rock, and when fragments of hard stone were frozen into their lower surfaces, scooped out furrows and grooves in the subjacent rocks. When the icebergs melted, the soft and loose insoluble materials which they conveyed subsided into the bottom, filling up valleys in the ancient rocks, covering them under a mass of clay and sand where currents were powerful enough to reduce the deposits to a general level, and forming mounds and hillocks of the same, in places where such currents did not prevail. That this was actually the case is proved by independent evidence, namely, the occurrence of marine shells of recent species, in the drift formation at various heights above the level of the sea in the region drained by the St. Lawrence.

Burlington Beach and Heights.—Of this nature and origin I have no doubt are the remarkable formations of the Burlington Beach and Heights, which seem to have been expressly designed by Providence, the first as a natural rampart and breakwater to protect our magnificent harbour, and the latter as a bridge to facilitate our communications by land. The immense masses of clay and drift which conceal the older formations between Dundas and Copetown render it impossible to say with certainity whether the latter preserve the same precipitous and continuous character round the head of Burlington Bay as along its north and south flanks ; but there is the strongest reason to believe that they do. If then we conceive the rocks to have run continuously at the same elevation round the head of the valley, and at the same time imagine the sea to have covered them as explained before, we have here precisely the circumstances which would produce all the phenomena we now behold. A bay or basin would thus be formed entirely sheltered from currents, and into which large quantities of the floating ice-islands would be driven by the winds ; and thus would be produced that irregular, rolling and deeply indented surface which we find prevailing from the eastern limits of Hamilton to Copetown. A succession of ridges of sand and gravel, no less than seven in number, in some places more, and in others less distinctly marked, have been traced for great distances along the north shore of Lake Ontario, and as far east as the Montreal Mountain and the slopes of the White Mountains in Vermont ; each preserving, as far as the Lake Ontario region is concerned, a uniform level at their bases, and all nearly parallel to each other and to the present beach of the Lake; but the lowest of these is one hundred and ten feet above the Lake at its base, and hence there is no reason to believe that the Heights form any portion of an ancient sea beach, as the others unquestionably are.* It is asserted by Lyell, on what seems to be uncontrovertible grounds, that these beaches indicate the succession of levels of the sea as the country underwent a gradual and intermittent upward movement after the deposition of the boulder or drift formation, which was the last great change previous to the present era in the earth's history.

I may remark here that the deep notch or indentation formed by the Niagara river at the whirlpool on the Canadian side, is bounded by a formation consisting exclusively of clay, cemented gravel and sand, with boulders both of granitic and limestone origin, precisely similar to the formation at Burlington Heights ; and that there is an obvious connection between this break in the older strata and the opening in the escarpment at St. David's, indicating that here a deep

* In the year 1852 in excavating through the Burlington Heights for the Great Western Railway, a gigantic tusk of a Mammoth or *Elephas Primiginius* was exhumed, having been buried in the solid conglomerate at the depth of forty feet below the surface; and in the same cutting, the horn of a Wapiti or Canadian Stag was brought to light. This latter species is not yet quite, although rapidly becoming, extinct on this continent; and the occurrence of its remains, associated with those of a species which has been extinct previous to the historic period, forms an interesting link between the past and present geological epochs.

valley had originally existed, which, during the glacial period, was filled up with the materials peculiar to it.

The average depth of the clay over the area comprised between the foot of the slope of the mountain and the lake shore seems to be about twelve feet; but at the artesian well at St. Catherines it is forty feet thick. There is a remarkable break in the continuity of the red marl of the Silurian formation, commencing at the eastern limits of Hamilton and terminating at the west side of the old canal; the intervening space being filled to an unknown depth with laminated clay and sand. May not this be accounted for by the abrasion and grinding down of the older soft marl, produced by the agitation of the icebergs which I have supposed to be congregated and imprisoned in this locality? The clay has been pierced to a depth of from sixty to seventy feet at the passenger station of the Great Western Railway without passing through it.

Succession of Changes.—I shall now in conclusion give a brief general retrospect of the probable succession of events which have produced the geographical and physical configuration of the region under notice.

The first event to which we must recur is the successive deposition, at a time vastly and immeasurably remote, of the stratified rocks shewn in these sections. I have said that they belong to the oldest fossiliferous rocks, and probably they contain the records of the first of living forms. That they are of marine origin is indisputable from the sea weeds and deep sea shells which they contain, but no trace of fishes, of vertebrated animals or of terrestrial vegetation can be discovered in them, and it seems to have been for many ages a creation of molluscs, corals and crustaceans. These rocks remained nearly undisturbed and horizontal from the era of their formation to a comparatively modern period, during which interval the whole of the geological formations subsequent to the Silurian system were deposited in different parts of the globe; and the vast succession of species of animals and plants whose histories we find written in these rocks have flourished and perished and been slowly entombed. During this interval also, and while the rocks in question still remained submerged in the ocean, they were denuded by currents, that is, portions were worn off and transported away, so as to form irregularities of surface, such as the basins of our great lakes, and such valleys as those of St. Davids and the Welland Canal. They at length emerged slowly, and portions of their edges were removed by the action of waves and currents by which cliffs were formed at successive heights, such as those I have already adverted to around Flamboro' Heights. After this event another submergence under the sea occurred, and was followed by the glacial period, which it is to be remarked was of comparatively modern date. As soon as the table land between Lakes Erie and Ontario emerged, subsequently to the deposition of the drift and successive formation of the sea beaches, the River Niagara came into existence, the basin of Lake Ontario still forming part of the sea. The cataract would then be at Queenston, falling directly into the sea; and then would commence the retrograde course of the river, continuing uninterruptedly as already described, till the present time.

REMARKS ON THE CLASSIFICATION OF MAMMALIA.

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I will introduce the few remarks I have to submit on this subject, by referring to an attempt which I made, at one of the meetings of the Canadian Institute, to give an improved expression of the affinities of the different groups in the class Birds, on the principle of a central body especially typical, with deviations of structure to suit special tendencies or special conditions.

I then endeavoured to show that if the great body of Insessorial or perching birds, be considered as the truest representatives of bird structure, there would be found to be five principal deviations from it which have been deemed so important as to be regarded by most ornithologists as forming distinct orders:—Raptores or birds of prey, Scansores or climbers, Rasores or poultry and game birds, Grallatores or waders, and Natatores or swimming birds. I pointed out also that there are families among the Insessorial birds, of greater or less extent, approximating to each of these deviative groups; and that there are remarkable lateral connections between the deviative groups themselves. These views I endeavoured to render clear by the aid of a diagram.

Were I now going over the same ground I might somewhat modify the details, but on the whole, frequent reconsideration with the practical reference of plans to an extensive collection of specimens has confirmed me in the views I brought before you, and I have been led to extend their application to some other departments of Natural Science. Without doubt if my principle is good it will admit of very wide application, though there may be natural classes consisting entirely of a central group of families, without any considerable deviations of structure, and others formed by a circle of characteristic structures that might seem to have relation to some common central body, though none such exists, or is known to us. My object on the present occasion is to bring under your notice an application of the same principle of a typical central group, with deviations that admit of a circular arrangement to the class mammalia. Not to trouble you here with details of various systems, the Cuvierian arrangement of mammals as improved to correspond with the present state of knowledge gives us no less than twelve orders in that class:—1st. Bimana, for man only; 2nd. Quadrumana, monkeys and lemurs; 3rd. Cheiroptera, bats; 4th. Insectivora, moles, shrews and hedgehogs; 5th. Carnivora, cats, dogs, weasels, bears, and seals; 6th. Cetacea, whales and dolphins; 7th. Rodentia, squirrels, rats, beavers, &c.; 8th. Edentata, ant-eaters and sloths; 9th. Pachydermata, elephants, swine, horses; 10th. Ruminantia, antelopes, oxen, deer, &c.; 11th. Marsupialia, pouched animals, as opossums and kangaroos; 12th. Monotremata, the Echidna and Ornithorhyncus. Respecting the reality of these as so many natural groups, the great question is, whether the lower organisation of the brain and the reproductive system in the marsupialia and monotremata presents the kind of difference that should characterise orders. The settlement of this question depends on what we ought to understand by orders. One great philosophical naturalist whose authority stands deservedly high—Agassiz—in the introduction to his noble work recently issued, maintains that whilst "*classes* are natural divisions, characterised by the manner in which the plan of their respective great types is executed and by the means employed in the execution; *orders* are natural groups, founded upon the degree of complication of the structure.' Degree of development should, according to this view, be the principal test of the characters of orders, and whilst a common plan, and correspondence in certain important particulars are deemed a sufficient justification for uniting intestinal worms with anellida, and Epizoa Cirrhipeda and even Rotifera with Crustacea, it would afford no reason for combining the Sarcophagous Marsupials with Carnivora, the vegetable feeders with Rodentia, or the Monotremata with Edentata. I must confess that I look upon orders as minor classes; groups which are, like the classes and all other useful divisions, really marked in nature, so that in laying them down we are interpreting nature, but which differ from the classes rather in the extent and importance of the characters than in their essential qualities. If we look at examples amongst the best marked and most generally recognised orders, we shall, I think, find abundant justification for this view. I cannot consider the various tribes of mammals without being impressed with the feeling that if the received order Rodentia be placed in the centre, Insectivora, Cheiroptera, Edentata, and the Marsupial tribes corresponding to two of these, and to the tribes included in Rodentia, are all closely associated together, differing from each other only in the same degree as among birds the Dentirostres, Fissirostres and Tenuirostres differ from the Conirostres. Here then I find the great centre groups of mammals typically represented by the carnivorous and herbivorous Rodentia, and making approaches in various directions to the great deviative classes. Of these Quadrumana represent Scansores among birds; Carnivora Raptores; Ruminantia, Rasores; Pachydermata, Grallatores; Cetacea, Natatores. Within the great centre group Insectivora represent Dentirostres; Cheiroptera, Fissirostres; Edentata, Tenuirostres. The kangaroos in their intermediate position between the family Leporida of Rodentia and the Ruminantia, correspond well with Columbidæ among birds. The Camelida form a link between Ruminantia and Pachydermata of the same kind that the Ostrich forms between Rasores and Grallatores; and the Hippopotamus and the Manatida or sea-cows connect Pachydermata with Cetacea much as the Flamingo does Grallatores and Natatores. Unwilling to trespass on your time, and to trouble you with details that might prove tiresome, I confine myself here to a general statement of my plan, but it seems to me that whilst expressing the affinities of mammals more clearly and naturally than is done by the prevalent systems, there is no small advantage gained by the beautiful correspondence maintained between the arrangement of mammals and birds, and

I cannot but hope that improved knowledge of fishes and reptiles might enable us to range them also in corresponding groups.

The speculations of McLeay, Swainson, and their followers, respecting an absolute number of divisions naturally belonging to every department of organized nature, and repeated in each subdivision; though probably pushed to an extreme, and doubtless often erroneous in the details, may express their perception of an important fact, which, properly considered, may bring us at last to the most natural classification. Is it not true that each grand division of the animal kingdom expresses a certain idea of structure; a certain general character as compared with the other divisions? Is it not likewise true that the classes into which each branch or grand division resolves itself, when really natural and judiciously limited, consist of one eminently typical, and others making up the number of the other branches and exhibiting tendencies towards each of them? Each class has its orders, and do not these again give us either a central typical group with a set of deviations expressing the ideas of the primary branches, or else the latter without the former? The tribes again contained in each order often do, and, if we were better acquainted with their limits and positions, would more frequently, convey to us the same ideas, which are often repeated even in inferior groups. The plan of a central group peculiarly expressing the characteristic idea with deviations, each prominently exhibiting the character of one of the primary branches, has not perhaps, been sufficiently attended to, and as soon as we determine that we must find everywhere a peculiar number, we begin to run into forced combinations or separations; yet the fact of general correspondencies in the natural distribution of different classes, is too important to be overlooked, and may ultimately conduct us to general conclusions of the highest interest, which at present we can but dimly imagine. In the arrangements of birds and quadrupeds which I have brought before you, I have surrounded each central body with five deviative forms.

It is true that Cuvier rocognizes only four great sub-kingdoms or branches of the animal kingdom, and, if it is now acknowledged that his Radiata possessed too miscellaneous a character, still when the groups really belonging to the higher divisions are removed, the proposed sub-kingdom Protozoa can only contain Infusoria, properly limited, Rhizopoda and Porifera. The latter class, consisting of the sponges, many naturalists assume to be vegetable. Agassiz contends that Rhizopoda probably are so also, and argues from several known cases, some of them ascertained by his own observations, that the remaining Infusoria are embryonic forms of various worms. I must say that I very obstinately cling to the conviction of the animal nature of sponges. I can see no pretence for maintaining the vegetable nature of Rhizopods, and I believe that when all embryonic forms of other creatures, as well as all true vegetables, are withdrawn, the class Infusioria will still be sufficiently numerous; as, therefore, these groups cannot naturally be included in Radiata, and in the absence of a definite nervous system and of the distinct organs for the different functions are sufficiently distinguished from all others, I think Protozoa may safely be added as a fifth branch or sub-kingdom of the animal kingdom. Most naturalists now admit Amphibia as a fifth class of Vertebrata, and thus in these important cases the numbers are brought to correspond. Perhaps a reasonable combination and limitation of classes in Articulata and Mollusca might produce the same effect, and if we consider the position of Radiata and Protozoa we may see no cause to wonder at their presenting a reduced number of classes omitting the modifications of lower development found in the other divisions.

I have endeavoured to express by a diagram my idea so far as I have yet carried it out.* Several particulars, perhaps, claim fuller explanation and defence than I have given them, but I hope enough has been done to enable those who are interested in the subject to judge of the advantages arising from my plan. In these few remarks I have been chiefly anxious to show the completeness of the analogy as to all the leading divisions between mammalia and birds, but I wish the whole to be considered rather as suggestions thrown out for examination than as a carefully elaborated system which I am prepared to maintain in every particular.

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* It is not thought necessary to engrave this diagram, the nature of which will be understood from the preceding observations. In the long interval between the reading and the publication of this paper, in consequence of its having been mislaid, the author has given much attention to Owen's classification of mammalia, which he has studied with great pleasure and profit though without being induced to abandon the leading features of his own scheme.

A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

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(*Continued from page* 182.)

Our last paper of this series, inserted in the present volume of the *Journal*, pages 168–182, contained a tabular distribution, with brief descriptions, of all Canadian minerals of metallic aspect: these falling under sub-divisions *A* and *B* of the classification given on page 170. The present paper includes the minerals belonging to sub-division *C;* and in the next number, those of the fourth sub-division will be given, completing this portion of our subject.

C. Aspect, non metallic (*stony, glassy, etc.*) *Hardness sufficient to scratch glass*

C. 1—*Infusible. Very hard, not yielding to the knife.*

[Quartz is the only mineral of common occurrence, belonging to the present section. In colour, degree of transparency, and general appearance, this substance varies exceedingly; but its specific gravity is always under 2·9, whilst the other minerals (of Canadian occurrence) included in the section, exceed 3·0 in density. Feldspar is sometimes confounded by beginners with quartz; but the former in thin splinters, is more or less readily fusible. The two minerals may be distinguished also, at once, by the following characters: Quartz breaks with an uneven or conchoidal fracture, and never exhibits smooth cleavage planes. Feldspar, on the other hand, possesses a strongly-marked lamellar structure, and breaks easily in certain directions, so as to present a smooth, polished, and somewhat pearly fracture-plane.]

Corundum.—Red, blue, brown, greenish, black, &c. In small granular masses and hexagonal crystals. H. 9·0, and hence much above that of quartz; sp. gr. 3·9-4·1. Quite infusible. Corundum consists, normally, of pure alumina. The transparent red varieties constitute the *Ruby* of commerce, and the blue varieties the *Sapphire.* The coarser dull-coloured varieties are called *Adamantine spar;* and the opaque, black and dark grey varieties (often mixed with magnetic iron ore) form *Emery,* a substance used largely, from its great hardness, as a polishing material. Some of the finer kinds of corundum exhibit when cut, a beautiful opalescent six-rayed star. These are called *asteria sapphires, &c.*, according to their colour. Red (and blue) corundum occurs sparingly in the crystalline limestone (Laurentian series) of Burgess township, Lanark Co., C. W.

Spinel.—Red, blue, dull-green, black, &c. In small granular masses, but chiefly in regular octahedrons, simple or modified; figs. 29, 30. The latter figure represents a common twin-form, or combination of two octahedrons. Infusible, H. 8·0; sp. gr. 3·5-4·5. Spinel is an alumi-

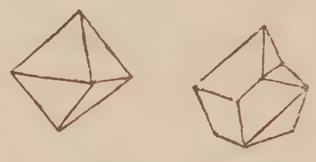

Fig. 29. Fig. 30.

nate of magnesia, but a portion of the magnesia is usually replaced by oxide of iron, as in the black varieties called *pleonaste*, more especially; or by oxide of zinc, as in the Swedish dark green variety called *Gahnite* or *automolite*. Normally, it consists of alumina 72, magnesia 28. The clear red varieties are employed in jewellery under the name of Spinel or Balas ruby. Well-crystallized black specimens occur in the Laurentian limestone of Burgess township, C. W.; and bluish specimens with clintonite (a chloritic, altered mineral,) in D'Aillebout, Joliette Co., C. E.

Magnetic Iron Ore.—Black with black streak, and in general, a sub-metallic lustre. Massive, or in octahedrons and rhombic dodecahedrons. *Strongly magnetic*, often with polarity. See *A* 4, above.

Chromic Iron Ore.—Black; chiefly massive, and usually with sub-metallic lustre. Streak, dark brown. Imparts a fine green colour to borax before the blowpipe. See *A* 4. above.

Quartz.—A substance of a vitreous or more or less stony aspect; colourless, or of various colours, as purple, brown, red, green, yellow, &c. Occurring in crystals and crystalline groups, figs. 31, 32, and also in nodular, botryoidal, and amorphous masses. The crystals are commonly six-sided prisms, streaked across, and terminated by a six-sided pyramid. H. 7·0; sp. gr. 2·6-2·7. Infusible; but melting (with great effervescence) with carbonate of soda, into

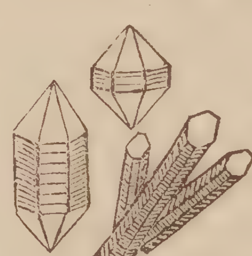

Fig. 31. Fig. 32.

a clear glass. Quartz consists normally of pure silica, the coloured varieties owing their tints to minute and accidental admixtures of sesqui-oxide of iron, bituminous matter, and other inessential ingredients. Special names have been applied by lapidaries and others to the leading varieties of quartz. Thus we have, *Rock Crystal* (including the so-called "Quebec diamonds," &c.); *Smoky Quartz,* a brown variety of rock crystal; *Amethyst,* a purple or violet-coloured quartz, in which the edges of the crystals are usually more deeply coloured than the other parts; Cairngorm, a yellow transparent quartz; *Rose Quartz; Milk Quartz,* a white translucent variety; *Calcedony* and *Cornelian,* grey, white, bluish, yellow, and red, uncrystallized translucent varieties of quartz; *Cat's-eye,* an opalescent or chatoyant calcedony; *Chrysoprase,* a light green translucent variety; *Heliotrope,* a dark green variety, sometimes with red spots and then called *Bloodstone; Plasma* and *Frase,* other green varieties, the latter often mixed with actynolite; *Agate, Onyx, Sardonyx,* &c., uncrystallized varieties of various banded colours; *Jasper,* coarse, opaque, red, brown, and other coloured specimens, often striped, and with dull lustre on the fractured surface; *Flint* and *Hornstone,* &c. Crystallized quartz occurs in various parts of Canada, more especially where Laurentian rocks prevail, and in the altered rocks of the eastern townships. Amethyst is found abundantly on Spar Island, where it forms a broad vein with calc-spar holding native silver, and at Thunder Bay and other spots on Lake Superior. Agates, also, in great variety, occur in the trap rocks and in the shingle beaches of that region (Michipicoten Isle, St. Ignace, Thunder Bay, &c.) A jasper-conglomerate, evidently an altered sedimentary rock, occurs on the north shore of Lake Huron. Agates and red and green jaspers occur also in Gaspé. Red jasper passing into jaspery iron ore, likewise near Sherbrooke; and, with veins of calcedony, on the river Ouelle (Kamouraska Co.) C. E. Silica often constitutes the fossilizing substance of organic remains, as in the Devonian corals of western Canada; and it is frequently found in crystal-groups in the inside of many fossil shells. Finally, it may be observed, quartz forms one of the essential components of granite, gneiss, and many other crystalline rocks. Sandstones also consist essentially of quartz grains cemented together, or consolidated by pressure; whilst in beds of sand and gravel we have the same substance in loose grains and pebbles, as explained more fully in Part III.

Zircon.—Red, brown, or grey, with resino-vitreous aspect. Chiefly in small crystals: (square-based prism-pyramids), fig. 33. H. 7 5; sp. gr. 4·0-4·7. Quite infusible. One hundred parts consist of: silica

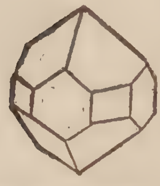

Fig. 33.

33·2, zirconia 66·8. The transparent, yellowish-red varieties are employed in jewellery under the name of *Hyacinth*. Small crystals, sometimes of good quality, occur in the crystalline limestone (Laurentian Series) of Grenville township, Argenteuil Co., C. E. Those which have come under our observation are simply interesting as mineral specimens, but Sir William Logan has obtained some of fine colour and transparency, "constituting veritable gems." (Esquisse géologique du Canada.)

Andalusite.—Chiefly grey or pale red; in granular masses, and in rectangular or rhombic prisms. The latter are sometimes compound, presenting a cruciform figure on the cross section. These constitute the variety *Chiastolite*, (fig. 34.) H. (normally) = 7·0-7·5, but often less by alteration or weathering; sp. gr. 3·1-3·2. Quite infusible. General composition: silica 37, alumina 63. In Canada, this mineral occurs in reddish crystals and small masses in micaceous schists (altered Silurian strata,) around Lake St. Francis in the counties of Megantic and Beauce. It may be distinguished from feldspar by its higher specific gravity, and also by its complete infusibility.

Fig. 34.

Staurolite:—Brown, red, greyish. Commonly in cruciform (Trimetric) crystals; otherwise in more or less simple, rhombic prisms. H 7-7·5, but sometimes less by alteration; sp. gr. 3·5–3·8. Quite infusible. General composition: silica, alumina, peroxide of iron. This mineral occurs sparingly in the metamorphic strata of the Eastern townships, although it is abundant in the mica slate of Maine, Vermont, &c.

Rutile:—In small crystalline scales and grains, and in flattened square-based prism-pyramids, of a red or orange colour, with semi-metallic lustre. H. 6·0-6·5; sp. gr. 4·15-4·25. Infusible. Forming with borax in a reducing flame a dark amethystine-blue glass, which by exposure to an intermittent flame, becomes transformed into a light-blue enamel. In Canada, Rutile, in a distinct form, occurs only in small quantities in the iron-ores of the Eastern metamorphic region, as in the townships of Sutton, Bolton and Brome; and with *Ilmenite* in the Laurentian rocks of Baie St. Paul, Canada East. It consists of Titanic acid (=Oxygen 39, Titanium 61.)

Condrodite:—Chiefly in small granular masses of a deep yellow colour, imbedded (usually with accompanying scales of graphite,) in crystalline limestone. H 6–6·5; sp. gr. 3·1-3·2. Infusible, but becomes white before the blowpipe. With borax, melts into a clear glass, which, if thoroughly saturated, may be rendered milky by flaming. This mineral is a silicate of magnesia, combined with a small proportion of fluoride of magnesium. It dissolves with gelatinization in hydrochloric acid. Condrodite occurs in some abundance in the crystalline limestones of our Laurentian rocks, more especially in the townships of South Crosby (Leeds Co.) C. W., and Grenville (Argenteuil Co.*) C. E. Also in St Jerome, (Terrebonne Co.) in the Lower Province.

Olivine:—In green, yellow, or brownish grains and granular masses (sometimes crystalline) in the eruptive rocks of Montreal, Rougemont, Montarville, etc., in Eastern Canada, as first recognised by Mr. Hunt of the geological survey. H 6·0-6·5; sp. gr. 3·3-3·5. Infusible, gelatinizes in hydrochloric acid. Composed of silica and magnesia, the latter usually in part replaced by protoxide of iron.

Tourmaline:—(Infusible varieties): yellow, green, etc., mostly in three or nine-sided prisms. This mineral is described under C 3, the Canadian varieties being (chiefly) fusible.

Feldspar (Including *Orthoclase, Albite, etc.,*):—In white, red, green, or greyish cleavable masses and crystals. Fusible in thin splinters. See Section *C* 3.

The following minerals may also be referred to, in connection with this group:—

Opal.—Hydrated silica. A vitreous, or resino-vitreous mineral of various colours, occurring only in nodular or amorphous forms. Sp. gr. 2·0–2·2. Gives off a little water in the bulb-tube. The iridescent varieties constitute the *noble opal;* the colourless glassy variety in botryoidal masses, forms the *hyalite;* whilst the opaque, or faintly translucent varieties, of white, grey, red, brown, and other colours, comprise the *semi-opal, milk opal, wood-opal,* &c. Although this mineral, at least in its coarser varieties, is exceedingly common in the old world, (chiefly in amygdaloidal cavities in trap and volcanic rocks,) it appears to be of very rare occurrence in North America.

Beryl.—Chiefly in six-sided prisms and columnar masses of a light green colour. Fusible with great difficulty, and only on the thinnest edges. H. 7·5–8; sp. gr. 2·6–2·8. Common in many parts of the United States. The clear bluish-green varieties are employed in jewellery under the name of *Aquamarine.* The rich, deep green varieties (chiefly from New Grenada) form the well-known *Emerald.*

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* This is incorrectly printed 'Addington Co.' at page 178, line 5.

Topaz.—Chiefly in yellow, colourless, or bluish crystals and rolled pebbles, easily distinguished from quartz by their facile cleavage in one direction. The crystals are combinations of rhombic prisms and pyramids (see figs. 16 and 18 in Part I.) H. 8·0; sp. gr. 3·4–3·6. In the United States, Topaz occurs in Connecticut and North Carolina.

Tin-stone or Cassiterite.—Brown, grey, black, etc. In granular masses, pebbles, and Dimetric crystals, the latter often in twin combinations. Very hard and very heavy, (H. 6·0–7·0; sp. gr. 6·3–7·0.) Infusible, but yielding tin globules before the blowpipe, especially with carbonate of soda. The lustre is often semi-metallic. This is the "ore" of tin, properly so-called. One hundred parts consist of: oxygen 21·38, tin 78·62. In the United States it occurs but sparingly, and no traces of it have as yet been found in any part of Canada.

C. 2. Infusible. Yielding easily to the knife.

Cyanite.—Chiefly in lamellar and bladed or broad—fibrous masses of a pale-blue, or pearl-grey colour, though often white, reddish, &c. Lustre somewhat pearly. The edges of the lamellæ scratch glass with ease, whilst the flat surfaces yield readily to the knife. Sp. gr. 3·5-3·7. Infusible before the blowpipe, and very slowly soluble in borax. One hundred parts consist of: silica 37, alumina 63. Not met with, apparently, in Canada, but it occurs in mica slate in Vermont, and is of frequent occurrence in other States.

Apatite or Phosphate of Lime:—Chiefly in six-sided prisms (often with rounded edges) of a light green colour; or in green and brownish cleavable and concretionary masses. H. 5·0; sp. gr. 3·0-3·3. Infusible (or in some specimens fusible with difficulty on the thinnest edges), but it dissolves readily in borax and in salt of phosphorus, yielding a glass which becomes opaque on cooling or when "flamed." By this character, as well as by its inferior hardness (as it scratches glass but feebly, and may readily be scratched by a knife,) *Apatite* is easily distinguished from *green feldspar* and *beryl.* It differs from *Fluor Spar* in being hard enough to scratch glass: also by its infusibility, crystalline form, &c. Apatite occurs in the crystalline limestones of our Laurentian rocks. Amongst its more important localities, we may cite the townships of Burgess and Elmsley, in Canada West; with Grand Calumet Island on the Ottawa, and Hull township, in Eastern Canada. In the township of Burgess it occurs in a red-coloured coarse-grained limestone in such abundance as to form, according to the estimate of Sir William Logan, about one-third of the mass. In North Elmsley, a fine locality has recently been discovered by Dr. James Wilson, of Perth. Small nodular masses of phosphate of lime, presenting a brown colour and shining lustre, occur also in the sandstones of the Sillery group (at the top of the Lower Silurian series) on the river Ouelle, and in the shales of Point Lévi in Canada East. These are supposed to be coprolites. It is perhaps needless to observe, that phosphate of lime, whether derived from inorganic or organic sources, constitutes an agricultural fertilizer or manure of the highest value.

In this group, may be placed also, the *Silicate* and *Carbonate of Zinc*, but these minerals have not been discovered as yet in Canada. The *Silicate of Zinc* occurs chiefly in white or yellowish crystalline aggregations, or in botryoidal and sometimes earthy masses, often of a dull brownish yellow tint from intermixed peroxide of iron, and occasionally also coloured green by silicate of copper. The crystals are pyro-electric, and are slightly fusible on the edges. Sp. gr. 3·3-3·5 ; H. 5·0. Gives off water in the bulb-tube, and dissolves in heated hydrochloric acid. Composition : Silica 25, oxide of zinc 65·5, water 9·5. *Carbonate of Zinc*, in colour, etc., resembles the silicate, but the crystals are rhombohedrous. H. 5.0 ; sp. gr. 4·0–4·4. Dissolves with effervescence in acids. Composition : carbonic acid 35·2, oxide of zinc 64·8. These minerals are frequently found intermixed. They constitute (with Red Zinc Ore) the essential "ores" of Zinc, properly so-called. See the remarks under *Zinc Blende, B* 3, (page 182) above.

C 3. *Fusible. Not yielding water in the bulb-tube.*

Garnet :—Colour, chiefly red of various shades, but also black, brown, green (both dark and pale,) yellow, and even white. Commonly in crystals (rhombic dodecahedrons and trapezohedrons, figs. 35 and 36) ; otherwise in granular and rounded masses, or amorphous, with lamellar structure. H. 6·5–7·5 ; sp. gr. 3·5–4·2. More or less easily fusible, the dark specimens yielding a magnetic bead. Composition, essentially silica and alumina, (or silica, alumina and sesquioxide of iron,) with either lime, or magnesia, or protoxide of iron or manganese, or several of these bases combined. (See a very complete series of analyses in Dana's "System of Mineralogy," vol. 2, pages 191–2.) Garnets are of comparatively common occurrence in the gneissoid rocks of the Laurentian formation, more especially in contact with beds of crystalline limestone. The mineral thus occurs in bands of gneiss properly so-called, quartz, hornblende rock, &c., along or near to the edges of the limestone beds in very many localities, although it is found also in various places more or

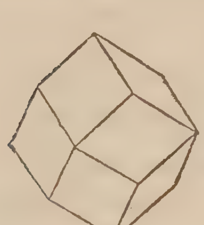

Fig. 35.

Fig. 36.

less remote from these beds. Briefly, amongst other Laurentian localities of Garnet, we may mention the following:—Various spots along the Muskoka river, as the Lake of Bays, &c.; the townships of Marmora and Elzevir, Hastings County, C. W.; Barrie and other townships in Frontenac County, C.W.; Hull, Ottawa County, C.E.; Chatham, Chatham Gore, and Grenville townships (dark red and hyacinth-red varieties) in Argenteuil County, C. E; the parish of St. Jérome in Terrebonne County, C. E.; Rawdon township, Montcalm County, C. E.; Hunterstown, Maskinonge County, C. E.; &c. In some of these localities, (St. Jérome especially, see Sir William Logan's Report for 1853) the garnets are sufficiently abundant to be available as a polishing material in place of emery. Amongst the altered strata south of the St. Lawrence, Mr. Hunt has discovered certain white or light-coloured beds which exhibit the composition of a lime garnet. In the township of Oxford, one of these consists of irregular rounded masses of white garnet.—H. 7·0; sp. gr. 3·536—associated with serpentine; and at the Falls of the River Guillaume in Beauce Couuty, the same substance forms a compact homogeneous rock (See Mr. Hunt's Report for 1856.)

Idocrase.—This mineral is identical with *Garnet* in composition and general characters, but differs in crystallization. It occurs in modified square-based prisms and pyramids of the Dimetric system, at least when crystallized. In other respects it cannot be distinguished from garnet. Idocrase has been found, associated with crystalline limestone, in Clarendon township Frontenac county, C. W.; Calumet Island on the Ottawa; and Grenville township, Argenteuil County, C. E.

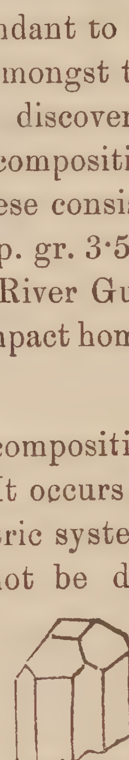

Fig. 37.

Tourmaline.—Of various colours, black, brown, yellow, green, blue, and pale red; sometimes colourless. The black variety is commonly known by the name of *Schorl.* Tourmaline occurs in modified three, six, nine, or twelve-sided prisms longitudinally striated, or in columnar or fibrous masses. The crystals are generally triangular on the cross fracture, owing to the predominance of three prismatic planes; and this character is usually sufficient to distinguish the mineral from other substances. H. 6·5–7·5; sp. gr. 3·0–3·3. The black, and most of the brown varieties fuse easily, the others, as a

Fig. 38.

general rule, being either infusible, or fusible on the edges only. Tourmaline presents a somewhat complex composition, but its essential constituents comprise: silica, boracic acid, alumina (or alumina and sesqui-oxide of iron) with lime or magnesia, or one of the alkalies, or several of these bases combined. Fine examples of this mineral occur in connection with the crystalline limestones of the Laurentian rocks at Calumet Island on the Ottawa (greenish-yellow crystals); in the township of Fitzroy, Carleton County, C. W.; in Clarendon township, Frontenac County, C. W.; in the townships of Bathurst and Elmsley, Lanark County C. W.; in Hunterstown, Maskinongé County, C. E.; at St. Jérome, Terrebonne County, C. E; and other localities. In addition to the general triangular form of its crystals and columnar concretions, tourmaline may be distinguished from hornblende and other minerals of this section, by exhibiting electrical properties when heated. The clear varieties moreover, are generally translucent when viewed transversely, and quite opaque when viewed longitudinally, even in the shortest fragments.

Sphene.—This mineral, as regards Canadian localities, occurs in small masses or little sharp-edged crystals of an amber-yellow colour in the crystalline limestones of the Laurentian series generally; and in the eruptive trap rocks of the eastern Province. H. 5·5; sp. gr. 3·4–3·6. Fusible on the edges with bubbling into a dark glass. Essential components: silica, titanic acid, and lime. Our best known localities comprise Grand Calumet Island on the Ottawa; Burgess township, Lanark County, C. W.; Grenville township in Argenteuil County (in crystalline limestone and also in trap); St. Jérome parish, in Terrebonne County, C. E.; and the eruptive rocks of Mount Johnson, Yamaska, &c., of the district of Montreal.

Epidote.—Chiefly in modified oblique prisms, and in fibrous and lamellar masses of a dark or light-green colour, passing into greenish-yellow, brown and grey. H. 6·0–7·0; sp. gr. 3·2–3·5, expands before the blowpipe into a slag-like mass, which melts upon its edges but resists further fusion. By this latter character it may be easily distinguished from hornblende, augite, idocrase, and other minerals of this section. Epidote occurs in many of our eruptive rocks, as in the greenstones of Lake Superior and the north shore of Lake Huron, and in some of the traps of Eastern Canada, although nowhere, apparently, in very prominent specimens. Mr. Murray, in his report for 1858, cites the east shore of Portage Harbour, Lake Huron, as a locality of this mineral.

Hornblende.—Dark or light-green, black, brownish, and sometimes light-grey or colourless. In prismatic crystals (of the Monoclinic System) figs. 39 and 40, or more frequently in amorphous masses of a fibrous or lamellar structure. The dark varieties are commonly known as *Hornblende* or *Amphibole;* the bright or light-green varieties, as *Actynolite*; and the greyish or colorless varieties, as *Tremolite,* H. 5·5–6·0; sp. gr. 3·0–3·4. Easily fusible, the dark specimens yielding magnetic beads. Composition: silica and magnesia, the latter in part replaced by protoxide of iron or lime; alumina being also sometimes present. This mineral forms one of the essential components of many metamorphic and eruptive rocks. It thus occurs in syenitic gneiss, hornblende-slate, &c., throughout the large area occupied by the Laurentian strata, and in the intrusive syenites associated with these—as in the township of Grenville, Argenteuil county, C. E., and other localities. It occurs also in crystals and fibrous masses in the beds of crystalline limestone belonging to this series. Amongst other Laurentian localities, we may enumerate, Grand Calumet Island (Tremolite, &c.); Blasdell's Mills, river Gatineau; Grenville, &c.,—in Canada East; with the neighbourhood of Perth, &c., in Lanark County, C. W. (the acicular variety termed "Raphilite"); Elzevir township, Hastings County (dark-green, and in places, black fibrous masses which have been taken for coal); Barrie and other townships in Frontenac County; the Muskoka river, the Falls of the Madawaska, &c.,—in Canada West. In the more modern metamorphic district south of the St. Lawrence, hornblende occurs largely as a rock constituent, as in Beauce and other counties. Also in crystals and crystalline grains in the eruptive masses of Shefford, Belœil, &c., of that district.

Fig. 39.

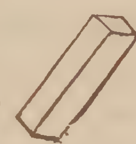

Fig. 40.

Augite.—This mineral in colour and all general characters, as well as in composition and blowpipe comportment, closely resembles *Hornblende.* The crystals belong likewise to the Monoclinic Sytem, but differ in aspect, as shown by fig. 41, one of the most common combinations. The front prism-angle (and the angle of cleavage-masses) = 124°30′ in *hornblende*, and 87°5′ in *augite;* but some of the lightcoloured (*diopside*) crystals belonging to the latter, occur in flat rhombic prisms like fig. 40 above, and give an angle of 141°21′*. Structure, lamellar or fibrous. H. 5·0–6·0; sp. gr. 3·2–3·5. Fusible, the dark varieties yielding magnetic globules. Composition, as in Hornblende: see above. The dark-green, black, and brown varieties commonly bear the name of *augite* (proper) or *pyroxene*; the clear green varieties, that of *sahlite;* and the white, greyish, or pale-green varieties, that of *diopside*—but many additional names have been bestowed on this mineral, in relation to locality, structure and other conditions. Both *hornblende* and *augite*, it should be remarked, offer a transition to *serpentine*: one stage in this transition producing the peculiar varieties, *asbestus* and *amianthus*. These are chiefly of a light-green or white colour, fibrous, silky, and flexible—often to such an extent as to admit of being woven into cloth. *Diallage*, described below, appears to be a transitional form of this kind. Augite occurs in the bands of crystalline limestone—and in some places as a rock component, forming, in admixture with *Wollastonite*, distinct beds—interstratified with the gneissoid rocks of the Laurentian Series, as in the counties of Argenteuil, Terrebonne, &c. In Argenteuil county, a green, granular variety (*Coccolite*) is also found. This mineral occurs likewise in the metamorphic schists of the eastern townships, and in crystals and granular masses in the eruptive rocks of Montarville, Rougemont, &c., belonging to that section of the Province.

Fig. 41.

Hypersthene. Bronzite. Diallage.—These are generally regarded as varieties of Augite. They occur in cleavable masses of a pinchbeck-brown, green or greenish-grey colour, usually with a pseudo-metallic lustre. Sp. gr. 3·2–3·5. Fusible more or less readily, the dark varieties yielding a magnetic bead. *Diallage* is of low hardness, and it yields almost always a little water in the bulb-tube, and hence will be referred to amongst the minerals of *D* 4 and *D* 5 below. In composition, these minerals, like augite, are essentially silicates of magnesia (or of magnesia and protoxide of iron.) Hypersthene

* If we denote the first prism in augite by V, this latter prism = $V\frac{1}{3}$. It is the most common form of the diopside prisms imbedded in our crystalline limestone.

occurs in small quantities in the feldspar bands of the Laurentian strata, as in the counties of Terrebonne, Lanark, &c. Also in foliated masses in a mixed feldspathic rock, in the parish of Château-Richer, (Montmorency County,) below Quebec, (T. Sterry Hunt: Report for 1854.)

Wollastonite (*Tabular Spar.*)—White or light-grey, (rarely red or brownish.) Chiefly in tabular masses with fibrous structure. H. 5·0; sp. gr. 2·77–2·9. Fusible more or less easily. Composition: silica 52, lime 48. Found principally in the Laurentian limestones, as in the parish of St. Jérome, and in Morin township, Terrebonne County, C. E.; in Grenville township, Argenteuil County, and other localities. Wollastonite forms also, in union with augite, a distinct rock belonging to the Laurentian metamorphic series, (See the "*Esquisse géologique du Canada*," by Sir W. E. Logan and T. Sterry Hunt.)

Orthoclase or Potash Feldspar.—This mineral occurs in white, red, pink, light-green, and greyish cleavable masses, and in crystals (frequently twins,) of the Monoclinic System, figs. 42 and 43. The cleavage planes meet at an angle of 90°. H. 6·0; sp. gr. 2·5–2·6. Fusible with difficulty, although the edges of a thin splinter become easily rounded. By this character, as well as by its lamellar cleavable structure, feldspar may be readily distinguished from quartz. Composition, essentially: silica, 64·8; alumina, 18·4; potash, 16·8. Feldspar is one of the component minerals of granite, syenite, gneiss and other eruptive and crystalline rocks—and, as such, occurs abundantly throughout the area occupied by the Laurentian deposits; and also amongst the eruptive masses of the more modern metamorphic region, including the district of Montreal, &c. Amongst special localities, we may cite the following:—Lanark County, C. W., where the beautiful "avanturine" variety termed "Perthite," and green and other specimens, occur. Grenville, and Chatham, in Argenteuil County: red and other crystals in porphyritic trap. Chambly, in the County of that name: large yellowish-white crystals in porphyritic trap. The Yamaska Mountain; &c. Feldspar yields by decomposition a white clay or earthy mass termed "Kaolin" or "porcelain clay," largely used in the arts.

Fig. 42.

Fig 43.

Albite or *Soda Feldspar.*—This mineral closely resembles common feldspar in colour and general characters, but differs in belonging to the Triclinic System, and by containing soda in place of potash. Its cleavage planes do not meet at right angles, but at inclinations of 93° 36′ and 86° 24′. It enters generally into the composition of trap rocks, and replaces the orthoclase of some granites and syenites. In Lanark County, C. W., a beautiful iridescent variety, the so-called "*peristerite,*" is met with.

Labradorite or *Lime Feldspar.*—Chiefly light or dark grey, greenish, or lavender-blue, with frequently a beautiful reflection of green, blue, orange, and other colours. Commonly in cleavable, lamellar masses, the cleavage planes (one of which is usually striated) meeting at angles of about 93½° and 86½°. H. 6·0; sp. gr. 2·67–2·77. Somewhat easily fusible in thin splinters. Composition: essentially—silica, alumina, and lime, with a portion of the latter replaced by soda. Labradorite (or a mixture of various triclinic feldspars,) forms one of the metamorphic rocks of the Laurentian series, interstratified with the gneissoid and other crystalline rocks of that age. Fine examples of the mineral occur in Lanark County, C. W.; and in St. Jérome, Morin, Abercrombie, and the seignory of Mille Isles, in Terrebonne County, C. E. Many of these examples are (externally) opaque-white, by weathering. Boulders containing opalescent feldspar masses, occur also abundantly in Grenville, &c., in the neighbouring County of Argenteuil.* Labradoritic rock (a mixture, according to Mr. Hunt, of labradorite and andesine,) occurs also in the parish of Château Richer in Montmorency County, C. E.; and opalescent specimens are cited from islands off the north-east shore of Lake Huron.

Note.—Mineralogists have established under the names of *Anorthite, Andesine, Oligoclase* &c., various additional species of lime feldspar. These are triclinic in crystallization, and more or less closely related. As a general rule, indeed, they are only to be distinguished by accurate chemical analysis. Practically, they may be classed with *Albite* or *Labradorite.* To Anorthite, the so-called *Bytownite* is referred. This is a greenish-white feldspathic mineral, found in boulders about Ottawa city. Another smoky or greenish-blue mineral, of a somewhat feldspathic character, from Perth, Canada West, is referred also to the same species.

Scapolite or *Wernerite.*—White, greenish, reddish, &c. Chiefly in lamellar and fibrous masses, and in crystals of the Dimetric System,

* A beautiful vase worked from one of these boulders may be seen in the Museum of the Geological Survey in Montreal.

of which an example is given in fig. 44. H. 5·5 (but much less in weathered specimens); sp. gr. 2·6–2·8. Easily fusible. Composition, essentially: silica 49, alumina 28, and lime 23, the latter in part replaced by a little soda. Scapolite occurs in the Laurentian limestone-bands, as in Calumet Island on the Ottawa; Grenville township, on that river, (Argenteuil County); Hunterstown in Maskinongé County, C. E.; and Golden Lake (with graphite, &c., Mr. Murray: Report for 1854) in Algona township, Renfrew County, C. W. A peculiar mineral, or rather rock, of a peach-blossom-red colour, occurring in Lanark County, C. W., and known as *Wilsonite*, (after Dr. James Wilson of Perth,) is an altered or semi-decomposed scapolite containing carbonate of lime and a little water.

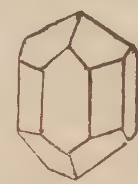

Fig. 44.

C 4.—Fusible. Yielding water in the bulb-tube.

Prehnite.—Green of various shades, generally pale, and sometimes colourless. Chiefly in botryoidal and globular masses with radiated-fibrous structure; or in closely aggregated, flat, prismatic crystals belonging to the Trimetric System. H. 6–6·5; sp. gr. 2·8–3·0. Fuses easily, and with continued bubbling; and yields from 4 to 5 *per cent.* of water in the bulb-tube. Composition: silica, alumina, lime, and water. Prehnite occurs most commonly in association with trap rocks, and is occasionally found in the veins which traverse the Huronian formation on the north shores of Lakes Huron and Superior. On the south (and also on the north-west) shore of the latter lake, it occurs in great abundance, often closely associated with the native copper of that region. At Isle Royale a beautiful variety occurs in small water-worn, nodular pieces of a rich green colour and radiated-fibrous structure. The fibres radiate from many central points, and these often consist of a nucleus of magnetic iron ore. This variety is commonly known by the name of Chlorastrolite (signifying green star-stone.) It is considered by some observers to be a distinct species, as its sp. gr. (2·98–3·20,) is somewhat higher, and its amount of water somewhat greater than that of prehnite. The former arises however from the intermixed iron ore (to the presence of which, also, the deeper colour is to be attributed,) and the latter I find to be exceedingly variable. Five specimens in selected fragments, yielded respectively the following per-centage of water;—4·86, 5·51, 4·11, 4·18, 4·60. Chlorastrolite forms, when polished, a handsome (though opaque) stone, fit for rings and brooches. In some directions, a slight chatoyance is observable.

Datolite.—Chiefly pale green or colourless, in botryoidal and fibrous masses, and in monoclinic crystals. H. 5·0–5·5 ; sp. gr. 2·95–3·0. Fusible with bubbling ; imparting a greenish tint to the flame ; and yielding in the bulb-tube about 5 or 6 per cent. of water. Composition : silica, boracic acid, lime, and water. Occurs with prehnite, laumonite, &c., in association with the traps of the north shores of Lakes Huron and Superior. Fine crystals are found at Isle Royale, and on the south shore of Lake Superior, in the copper region.

Thomsonite.—Chiefly in white or light-coloured acicular crystals and fibrous masses, in (or connected with) the traps of Lakes Huron and Superior. H. 5·0–5·5 ; sp. gr. 2·3–2·4. Fusible, with previous intumescence. If free from weathering, in which case it will be translucent, it yields about 13 per cent. of water in the bulb-tube. Composition : silica, alumina, lime, soda, and water.

Analcime.—Chiefly in trapezohedrons (fig. 45,) of a white or greyish colour, associated with the traps of Michipicoten Island and the shores of Lakes Huron and Superior. H. 5·0–5·5 ; sp. gr. 2·0–2·1. Fusible quietly, *id est,* without intumescence or bubbling. Yields in the bulb-tube from 8 to 9 per cent. of water. Composition : essentially, silica, alumina, soda, water.

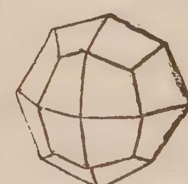

Fig. 46.

Apophyllite.—In lamellar masses and dimetric pyramidal crystals of a white or light colour, with pearly opalescence on the top or basal plane. H. 4·5–5·0 ; sp. gr. 2·32–2·37. Exfoliates before the blowpipe and fuses with bubbling. In the bulb-tube, yields about 16 per cent. of water. Composition : silica, lime, potash, and water. Found here and there in connection with the traps of Lakes Huron and Superior. Fine crystals come from the copper region of the south shore of the latter lake. Thomsonite, apophyllite, and other "zeolitic" minerals, occur also, it may be observed, both abundantly and in fine examples, in the trap rocks of Nova Scotia. These are sometimes red, greenish, &c., as well as colourless.

[*Wilsonite—Altered Scapolite.*—In columnar masses of a peach-blossom-red colour, from Lanark County, C. W. See under "Scapolite," *C* 3, above.

(To be continued.)

REVIEWS.

Historical Pictures retouched; a volume of Miscellanies. In two parts. *Part 1. Studies; part II. Fancies.* By Mrs. Dall, author of "*Woman's Right to Labor.*" Boston: Walker, Wise & Co. 1860.

In noticing the contents of a volume, confessedly a miscellany, we shall best satisfy the taste of that class of readers to whom a popular work chiefly appeals, by selecting one of its themes in illustration of the whole. Yet while speaking of this volume as one appealing to its readers by popular elements of incident and biographical narrative, as well as by inventive fancy, it would be a grievous misrepresentation of its author's aim to convey the idea that it is written merely for the purpose of beguiling a passing hour. The authoress is one of that class of American ladies who believe that their sex is wronged by the present conventionalities, usages, and habits of thought, of our civilized social life. In her previous volume, "Woman's Right to Labor," she has handled, with equal earnestness and delicacy, one of the most difficult subjects that can engage a woman's pen; and the aim of the present volume is, chiefly by the example of distinguished women in other countries and ages, to show how much wider is the sphere of woman's labour, than society is willing to allow. The subject is one of the great questions of the day, which meets us in many and very diverse forms. It suggested the theme of Elizabeth Barrett Browning's, elder "Drama of Exile," as well as of her later and better "Aurora Leigh." It is the subject of Tennyson's playful yet earnest and beautiful "Princess;" and is begetting a host of works, from Miss Agnes Strickland's "Queens" and Dr. Anderson's "Ladies of the Covenant," to Mrs. Oliphant's "Women of the Times." Like some other great questions of the day, this one of "Woman's Rights" does not owe its rise to the writings of its zealous phalanx of advocates. It is with it, as with slavery, intemperance, and other social evils. The current had silently set in the direction of reform, and public opinion, though undefined and ill-informed, was already striving to grapple with the complex difficulties of the question, before it was consciously presented as a subject of controversy, by skilful, earnest advocates; and also by unskilled, one-sided, though not less earnest special pleaders. Into the broad question of woman's rights, or her social duties and privileges, we have no thought of entering. We doubt not it will right itself, under the same divine guidance which can be traced through all the social changes, by means of which we now see on our own American Continent the contrasting pictures of the Indian savage, with woman as the tiller of his fields, the bearer of his burdens, his meek uncomplaining slave and household drudge; and on the other hand woman in the happy domestic circles of English and American social life, the sunshine of his hearth, and the true helpmate of man. We are well content to leave woman to work out her destiny, with all the aids that philanthropy and the earnest, wisely directed christian zeal of womanhood can bring to bear on a cause best left in such hands:

> Let her make herself her own,
> To give or keep, to live and learn, and be
> All that not harms distinctive womanhood.
> For woman is not undeveloped man,
> But diverse. Could we make her as the man,
> Sweet love were slain. His dearest bond is this,
> Not like to like, but like in difference.

In the "Studies" which occupy the larger part of this volume, we have critical and biographical sketches of "The Women of the House of Montefeltro," "of the Women of Bologna," and of various remarkable selected examples of noble womanhood, from Aspasia to Madame de Stael and Margaret Fuller. Let us select one example from the fair and gifted daughters of Italy, to whom so large a share of the volume is devoted.

The name of *Properzia dei Rossi* is not now introduced for the first time to English readers. A brief notice of the learned Isotta Nogarolo, of Bologna, concludes in this characteristic fashion: "When one of the Foscarini became Podesta of Verona in 1451, Isotta entertained the learned company around her with a discussion upon the comparative guilt of Adam and Eve. Her thesis, which proved Eve to have been the seduced rather than the seducer, was printed a century after her death. She never married. Lady Morgan says it was to show her contempt for that sex of which Adam was an example; but a masculine critic wickedly suggests, that the countenance which hangs in the library at Bologna could never have found many admirers. She died about 1466,—it is generally thought at an early age; and left a large number of manuscripts, chiefly orations and epistles, in Latin."

Our authoress then proceeds :—

It is after praising the eminence to which Isotta attained that Vasari introduces to us the name of Properzia dei Rossi, "a maiden of rich gifts, who, equally excellent with others in the disposition of all household matters, gained a point of distinction in many sciences, well calculated to arouse the envy, not of women merely, but of men." Alidosi calls her the daughter of Martino Rossi of Modena; but, if she was not born in Bologna, it was there that she grew up, and there that she exercised her talents.

Properzia was distinguished by remarkable beauty of person. She sang and played better than any woman of her time in Bologna; and to satisfy an exuberant fancy, began her life as an artist by carving peach-stones. More fortunate than many children of more modern times, she found among her immediate friends warm and appreciating admirers. No one said, "A foolish fancy, that: she had better be taking care of the house." And when she finally completed, on this small surface, a sculptured Crucifixion, containing many heads besides those of the executioners and the apostles, no one added, "It is but a womanish trick of art, after all." The true lovers of beauty, beside and around her, said, "See what better you can do." So encouraged, she executed numerous arabesques in stone, of flowers, animals, and so on, for the principal chapel of Santa Maria del Baracano.

Just at this time, the superintendent of the Cathedral was authorized to ornament with marble figures the three doors of the principal façade of San Petronio. For a portion of this work, Properzia now applied; and here occurs an inconsistency in her biographer, which we cannot explain by any authors within our reach. At the beginning of the Life, Vasari says, "she was a maiden of rich gifts:" he now says that she applied to the superintendent of this work through "her husband;" and again, that she succeeded in a certain piece of sculpture all the better for a *disappointment in love*, all the more grievous to bear, because, with this exception, she was perfectly successful in all things.

However she applied, she was commanded to produce a specimen of her work as a proof that she was capable of what she undertook; and, for this purpose, she executed from the life that admirable bust of Count Guido Pepoli, now preserved in the Church of San Petronio. Upon this, she was entrusted with the execution of two groups. She chose the wife of Pharaoh's steward and the Queen of Sheba for her subjects, and delighted the whole city by her eminent success. But there was one critic whom she could not please,—a certain Maestro Amico Aspertini, who is elsewhere described as having his head full of vapour and vain-glory; who never spoke well of any one, yet was always full of babble and gossip; and who had so little true love of art, that, when he made any fortunate discovery, he immediately destroyed all traces of it, lest some other person should by chance derive some benefit from it.

Properzia was a woman, and she did not care to struggle with this incarnation of the evil passions. Having finished several noble works already undertaken, she turned her attention to copperplate engraving, wherein she soon established an enviable reputation. The rumor of her lofty genius spread through Italy, and reached the ears of Clement VII. Having crowned Charles V. at Bologna in 1530, he sought out Properzia. She had died that very week, and been buried, at her own request, in the Spedale delle Morte.

Vasari describes in highest terms of admiration the drawings of this gifted and versatile artist; and specimens of her sculpture and exquisite minature carvings remain to attest her singular genius. On a peach-stone, still preserved in the Florentine Cabinet, there is a "Glory of the Saints," carved by Properzia, on which more than sixty heads may be counted. Our authoress repels with just scorn some vulgar slanders associated by modern Italian cicerones with this gifted woman's name; but she is, perhaps, disposed to look with scarcely less favour on so undignified an episode in the life of one whom genius had so elevated above the capacities common to either sex as "a disappointment in love;" and remands to a foot note the romantic incidents, vaguely glanced at by biographers, but which chiefly touched the tender poetical sympathies of the gentle authoress of "the Records of Women." "The simple fact," says our authoress, "appears to be, that she loved and was beloved by a man greatly her superior in rank; that her eyes opened too late, when she found in what manner he sought her, and her woman's heart broke with a grief too heavy for the artist's pride."

Felicia Hemans took hold of a diverse art-tradition better suited to her vein of thought, and the tremulous, tearful sympathies which her own life-drama had intensified, in a peculiarly tender womanly nature. A painting by Ducis represents the fair Bolognese sculptor showing her last work, a basso-relievo of Ariadne, to a Roman Knight, the object of her unrequited affection, and while she looks wistfully in his eyes to read the impression which the poetry of her chisel produces, he regards it with cold indifference. It may be the mere romance of the painter's pencil, eked out by a confused tradition; but gifted men, and women too, have been even so o'ermastered; nor would we willingly believe that the intensifying fire of genius quickens the intellect of woman at the expense of her susceptibilities to those deep loving emotions of lover, sister, wife, and mother, on which the authoress of "The Records of Women" dwelt perhaps too fondly. In her poetical picturing of Properzia Rossi, the soul's lofty gifts have proved vain to quench its haunting thirst for happiness. The Knight has looked coldly on the marble which glowed with all her genius and her passion; and what to her is the world's empty mockery of fame?

The world will see
Little of this, my parting work, in thee,
Thou shalt have fame! Oh mockery! give the reed
From storms a shelter,—give the drooping vine
Something round which its tendrils may entwine,—
Give the parch'd flower a rain-drop, and the meed
Of love's kind words to woman! Worthless fame!
That in *his* bosom wins not for my name
Th' abiding-place it asked! Yet how my heart,
In its own fairy world of song and art,
Once beat for praise!—Are those high longings o'er?
That which I have been can I be no more?—
Never oh! never more; tho' still thy sky
Be blue as then, my glorious Italy!
And tho' the music, whose rich breathings fill
Thine air with soul, be wandering past me still,
And tho' the mantle of thy sunlight streams,
Unchanged on forms, instinct with poet-dreams;
Never, oh! never more! Where'er I move,
The shadow of this broken-hearted love
Is on me and around! Too well *they* know,
Whose life is all within, too soon and well,
When there the blight hath settled;—but I go
Under the silent wings of peace to dwell;
From the slow wasting, from the lonely pain,
The inward burning of these words—"*in vain.*"

But such is not the phase of womanly character that the authoress had in view in retouching her historical pictures; and in justice to her, we must let her speak for herself. In closing her selections of female portraiture from the Galleries of Bologna, she remarks:

Whoever writes in the present day can hardly remain neutral with regard to the responsibleness of women toward women. Upon this subject let us say, in closing, a few words. Let every conscientious woman beware, lest an unlucky witticism, a smart saying, or a careless slur, injure for ever a reputation of which she knows nothing with certainty. Public opinion is a mingled stream, flowing from a thousand nameless sources.

An example will show how really liberal and right-thinking women may swell the current of popular prejudice.

Lady Morgan, whose merits no one can appreciate more highly than ourselves, since she has always preserved, through the remarkable honors and distinctions to which genius has raised her, her unaffected, sprightly, democratic air; Lady

Morgan, whose books are so crowded with incident and literary gossip, that we forgive the awkward air with which recent acquisitions seem to sit upon her,—says above, "that erudition is in England, in 1820, a greater female stigma than vice itself." Yet in the same chapter, in speaking of the Institute at Bologna, she says, "The anteroom of the Library has an interest of its own, from being covered with the portraits of the learned; among which, *strange to say*, the ladies hold a distinguished place. *At the head, as* '*chef de brigade*,' *stares* Isotta da Rimini. 'Le due Isotte,' as they are called, and Madam Dacier, compose a group that *can never be mistaken for that of the Graces.* They are indeed *fearful examples*, to convince the most indigo-blue stockings, that the waters of the Pierian springs are not among the most *efficacious cosmetics*."

Does this prove that a bold courtesan stands at the head of literary women in Italy, or that learned women are never beautiful? Yet how strongly it implies something of the sort!

In a note, she says Cassandra Fedele was far too "pretty for a pedant;" and farther on, that, "*in woman*, genius and abstruse learning never yet went together." She reckoned without her host; though it is perfectly true, that in herself genius has supplied the *want* of abstruse learning.

Trivial as such remarks may seem, every one who adds without cause to the number does something to lower the popular estimate of women. It was because of the almost infinite power of *light words* that our Saviour said, "Let your conversation be as Yea, yea."

Let every true-hearted woman speed all other women striving for honorable distinction; and so, in good time shall come a happy emancipation.

What is implied in such "happy emancipation" varies widely according to the speaker or writer by whom it is employed; but what true-hearted woman strives for as an honourable distinction, true-hearted men need not fear her attaining to. Noble aspirations never beget unworthy results; and as it has been the triumph of Christianity to elevate woman to her true place as the helper and equal companion of man, so must we expect, as civilization progresses, that she will claim her due place and share in every advancement he achieves. D. W.

A Summary of Canadian History, from the time of Cartier's Discovery to the present day. By J. A. Boyd, B.A. Toronto: James Campbell, 1860.

The author of this little unpretending volume has accomplished, with complete success, the difficult task of compressing into the compass of little more than a hundred pages an accurate and connected relation of the chief incidents connected with Canadian history from the time of Cartier's discovery to the present day. It is written in a pleasing and attractive style, and not only comprehends an interesting notice of such leading events in the history of the Province as are to be found in the various bulky volumes already written on the subject; but our examination satisfies us that the author has gone for his materials to the original sources; and his facts and dates are not only well arranged and placed in an attractive form for reference, but he has also corrected errors which have been repeated by one writer after another, in volumes of much greater pretension. Mr. Boyd's historical sketch has been prepared expressly for the use of schools, and for the instruction of our Canadian youth in the history of their country. For this it is admirably fitted. The only regret which the teacher must feel is, that after guiding his pupil through so excellent a summary of the History of Canada, he must be at a loss where to direct him for the larger and more comprehensive History to which such a volume should be the fitting introduction. We should be glad to learn that the same pen which has been so well employed on this little summary, was engaged on a full critical survey of the interesting story of Canadian discovery, settlement, and progress, through all the interesting events of its three historic centuries. D. W.

Palæontology, or a Systematic Summary of Extinct Animals and their Geological Relations. By Richard Owen, F.R.S. Edinburgh: Adam and Charles Black, 1859.

It is somewhat singular, that, whilst few studies in England can compete with Palæontology in popularity, the English language should be still without a really comprehensive treatise on the subject, properly adapted to the student's wants. We possess, it is true, many isolated monographs of the highest authority on special departments of the science, quite equalling, in this respect, the palæontological literature of any country; and we have also sundry popular works of general treatment; but we possess nothing, for example, of the systematic and comprehensive character of the *Lethœa geognostica* of Bronn, or the *Traité de Paléontologie* of Professor Pictet. For a work of this description we must still wait; but, in the meantime, the student may welcome, with much satisfaction, the reproduction in a convenient form of Professor Owen's article on Palæontology, published in the late edition of the *Enclycopedia Britannica.* This, with a few modifications, has been reprinted in the form of an octavo volume, containing all the original illustrations, together with a classified index, and other additional matters.

The work, as implied by the author in its title, is essentially of a synoptical character—the treatment indeed, within the scope of a single volume, of so extended a subject as that of palæontology, must necessarily be so—but the condensation has been performed with no ordinary judgment, and a far greater amount of information is contained in the volume, than one might at first thought be led to expect. This applies more especially to the *Vertebrata,* to which series about three-fourths of the work are devoted. In his introductory remarks to the class of fishes, Professor Owen takes exception to the whole (and strong exception to the greater number) of Pander's new genera from the Silurian formations of Russia. The so-called "conodonts," considered by Dr. Pander to be fish teeth, appear to Professor Owen (as the result of careful microscopic examination) to be the hooklets or denticles of naked mollusks or annelids. But whatever the fossil bodies in question may prove to be, all earnest inquirers must agree with Professor Owen in his remarks, that, "the formal publication of these minute ambiguous bodies of the oldest fossiliferous rocks, *as proved evidences of fishes* is much to be deprecated." Sooner or later, palæontologists will be forced to unite and adopt a fixed resolution to disallow all determinations (with their consequent nomenclature) whether referring to higher groups or to genera and species, founded on fragmentary or incomplete evidence. Without some united action of this kind, that daily-augmenting evil, the accumulation of synonymes, bids fair to acquire, before long, unmanageable proportions; whilst the false reasonings and deductions flowing from these uncertain determinations, and widening as they flow, constitute, if possible, a still more serious obstacle to true progress. Talleyrand's celebrated admonition—"pas de zèle" should, in one sense at least, be admitted as an axiom into palæontological inquiries.

The class Reptilia is subdivided by Professor Owen into thirteen orders (including the batrachians,) in accordance with his recent views, as developed in a paper on the subject before the meeting of the British Association at Aberdeen*. This classification, although at first sight a somewhat complicated one, will be found greatly conducive to a just conception of the relations existing between the varied forms of reptilian structure. It commences with the order

* See the present volume of the *Canadian Journal,* page 73.

Ganocephala, in which is manifested an intermingling, as it were, of the fish and reptile organizations; and it terminates, properly, with the *Chelonia*—each order foreshadowing more or less distinctly, the one above it. By this arrangement, however, admirable as it is in its details, the batrachians are thrown out of position, being placed unavoidably at the end of the series, or between the chelonia and the next succeeding class, the birds. The limits of the work forbid any very minute treatment of this succeeding class, and of the mammalia; but of the obscurer mesozoic forms of the latter, a sufficiently copious analysis is given, together with various able generalizations embodying the leading points of interest belonging to the other types. The reader consequently, who may desire a compendious view of the present state of Palæontology, will find, in Professor Owen's treatise, a work exactly suited to his wants. E. J. C.

Handbuch der Mineralchemie. Von C. F. Rammelsberg, Leipsig: Engelmann, 1860.

Original investigators are not, in the way of authorship, proverbial for great industry. Professor Rammelsberg, however, forms a remarkable exception to the class. In addition to constant communications to scientific journals, scarcely a year elapses without the emanation from his fertile pen, of some learned treatise or useful manual. His latest production of this kind is a closely printed octavo, of over a thousand pages, bearing the title placed at the head of this notice. This title, however, is somewhat inappropriate, and likely to lead to misconception regarding the true character of the book: the present volume being strictly a treatise on *chemical mineralogy,* comprising a detailed view of the chemical characters and composition of all known minerals, with some introductory remarks on classification, mineral formulæ, isomorphism, and other cognate subjects. It is therefore, if not actually, at least essentially, a revised edition of the "*Handwörterbuch des chemischen Thiels der Mineralogie*" brought up to the present state of the science. The author, in his preface, claims for the work the character of an entirely independent production, and this is so far true, inasmuch as the earlier work has been entirely rewritten; but in general plan, and treatment of subject, the two are essentially alike. The present work contains (with a few accidental omissions) all the new analyses published since the issue of the last supplement of the Handwörterbuch in 1853. The older analyses, moreover, have been re-calculated, and the formulæ are arranged throughout in accordance with modern views. The atomic constitution of *silica*, $Si\ O^2$, as now universally accepted in place of $Si\ O^3$, is thus adopted; and that of zirconia is made $Zr\ O^2$, in place of the older $Zr\ {}^2O^3$. Zircon itself, in the classification, is removed from the Silicates, and placed with Rutile and Cassiterite amongst the Oxides. Some other changes of this kind might also have been appropriately carried out, not perhaps in the body of the work, but in the tabular outline of the classification. Mere chemical formulæ in themselves, it cannot be too strongly insisted upon, are no true exponents of natural affinities—witness, for example, the collocation of molybdenite with iron pyrites, and the wide separation of magnetic pyrites from the latter, as adopted by the author in his present work according to the orthodox but very artificial system so generally in vogue. There is some unknown quantity, as it were, within these formulæ-relations which at present eludes our grasp. The true part sustained by water in the constitution of hydrated minerals, for instance, remains still wrapped in impenetrable obscurity. Professor Rammelsberg discards the idea that this water is in any part basic; and he appears disinclined to allow the union of hydrates with other compounds, as usually admitted in the case of the serpentines, &c. In malachite and blue carbonate of copper, nevertheless, not to mention other examples, the admission of a union of this sort appears more natural than to suppose in these allied compounds the existence of two dissimilar carbonates. In malachite we have two atoms of copper oxide, one atom of carbonic acid, and one of water; in the blue carbonate, three atoms of copper oxide, two of carbonic acid, and one atom of water. If we do not admit the presence of the hydrate of copper oxide in these minerals, the above numbers yield, respectively: $2\ CuO, CO^2 + HO$; and $3\ CuO, 2\ CO^2 + HO$. But if we admit the presence of the hydrate, these formulæ become $CuO, CO^2 + CuO\ HO$; and $2\ (CuO, CO^2) + CuO\ HO$—each containing a carbonate of like composition. This is the usually received view. The true constitution, however, may be in no way represented by these more or less imperfect guesses.

The nature of this laborious treatise, as will readily be perceived, necessarily precludes any attempt at extract or extended analysis.

We must content ourselves therefore, with the present brief statement of the general plan and character of the volume. As a work of reference it will prove indispensable, for many years to come, to all engaged in mineralogical investigations.* E. J. C.

SCIENTIFIC AND LITERARY NOTES.

GEOLOGY AND MINERALOGY.

ON THE FORMATION OF MOUNTAIN RANGES. BY PROF. JAMES HALL.

Mountain ranges, as well as surface inequalities generally, are usually considered to have been produced by the direct agency of elevating forces, or by that of denudation; or, in certain cases, by the two combined. Professor Hall, whilst admitting the action of these forces to some extent, maintains the existence of a third cause in the production of the results in question—viz., the unequal deposition of sedimentary matter; or, in other words, the special accumulation of sediments, by currents, along certain lines or tracts of country. In our notice of the first portion of the "Geology of Iowa" in the present volume of the *Journal*, we fear that we may not have done entire justice to the author's particular views in this respect—having been under the impression that his arguments were couched principally against the supposed influence of elevating or disturbing forces in the formation of mountain chains, as opposed to the effect of denudation. Nevertheless, if we admit with Professor Hall, that (in certain cases,) mountain elevations have arisen from the cause he advocates—denudation, it is evident, must be looked upon in connection with this cause, as an accessory power of no inconsiderable moment. The occurrence of outliers, for example, (and that of synclinals on ridge-summits, as mentioned by Prof. Hall, below) shews clearly the influence of this action; and the opponents of the "special accumulation theory" might argue with some show of fairness, that in many instances, the diminished thickness or the absence of particular strata at a given spot, was caused to a certain extent, or perhaps wholly, by denudation also. Be this, however, as it may, we are happy to lay before our readers the following summary of some observations on this subject, made by Professor Hall at a recent meeting of the Albany Institute:—

"Mr. Hall began by stating that the views which he should bring forward were the result of many years of personal observation and investigation upon the older strata of the North American continent. It was ten years since he had first propounded similar views, though with hesitancy, hoping that the questions involved would be discussed by others. Farther examination and reflection had only tended to strengthen the opinions then entertained, and in his address at Montreal in 1857 he had put forth more strongly the same views.

* The right of translation, we observe, as regards France and England, is reserved by the publisher under the present international arrangement.

After some preliminary observations upon the laws governing the distribution of sediments, and the accumulation of calcareous materials in geological formations, Mr. Hall proceeded to show that throughout the entire interval from the older Silurian to the end of the Coal period, the accumulation of sedimentary matter along the line of the Appalachian chain had been far greater than west of it. He showed that in tracing some of these formations westward, they thin to one-tenth or even one-twentieth of their thickness in the east.

During all this accumulation of 40,000 or 50,000 feet of sediments in the line of the Appalachian chain, there were evidences of shallow sea, in the fucoidal markings and mud cracks upon the strata. This great accumulation, therefore, could only have taken place by a sinking of the ocean bed during the period of deposition; and this in accordance with what we know from the established laws, that the translation or removal of large amounts of matter from one part of the earth's crust to another, will cause a depression of that part beneath which the accumulation takes place.

He farther showed that such depression, occurring along a zone of two hundred miles in width and many hundreds in length, corresponding to the zone of accumulation, could not take place in a simple curve, but that the sediments, the laminæ of which would slide over one another to a very limited extent, must become folded and contorted during the process, and that these foldings and plications, which would constitute numerous synclinal and anticlinal axes, would have their longitudinal direction corresponding with the line of accumulation, or the line of the ancient transporting current. That these foldings and plications would gradually diminish in force with their distance from the centre of the line of accumulation, and gradually die out with the thinning of the beds; this thinning depending on the original transporting force, which, gradually diminishing on either side of the great current, allowed the beds gradually to thin out. * *

Subsequently these folded strata were subjected to the denuding action of water; and the foldings of the anticlinals, having broken or weakened their outer beds, made them subject to more extensive and extreme denudation, till these original ridges are now often the valleys, while the synclinals are the summits of the mountain ridges.

In all the Appalachian chain it was shown that nowhere any evidence exists of the elevation of the mountain ranges by action or elevation from below. The crystalline or metamorphic condition of the strata was due to other causes, and he had shown that this metamorphism was coincident with the line of original accumulation; and in greater or less degree coextensive with the folded and plicated beds; its incipient stages being visible in the first gradual or gentle foldings of the strata outside the great disturbed and crystalline zone.

In the Mississippi valley, where there is no important folding or plication, we have outliers of these strata, or mounds, as they are termed, measuring one thousand feet of elevation above the Mississippi valley, the fundamental rock there being the Potsdam sandstone. In the Appalachian chain we find no rock of older date than the Potsdam sandstone, and this is seen only on the flanks of the chain, or rarely elsewhere, but the mountains rise to four, five, or six thousand feet above the sea. In the Mississippi valley the measurement of elevation is the thickness of the strata; in the Appalachians the elevation of the mountains is not more than one-fifth or one-tenth even in many places, so that these mountains do not give an elevation equal to the thickness of the original accumulations had the latter been left undisturbed and simply cut by ravines or watercourses. * *

Mr. Hall proceeded to say that he regarded the present relations of these mountain chains, as well as others, to be not due to elevation along certain lines, but that the whole country, whether mountains or plains, is a continental elevation; and that the more elevated portions at the present time are due to a larger amount and greater thickness of sediment along certain lines,—in other words, that mountain elevations are due to original accumulations of sediments along the lines of the more powerful transporting currents; and that the direction of these mountains has been determined by the original course of these currents, which themselves were determined by a pre-existing cause,—that the foldings of the strata and the production of synclinal and anticlinal axes have been produced in the instances cited, and doubtless in many or all others occurring on an extensive scale, by the subsidence consequent on the great accumulation of material;—that this subsidence and the attendant influences have produced the metamorphism which characterizes the strata forming these mountain ranges, and which is everywhere coincident with their extent.*

Mr. Hall expressed his belief that the facts before stated as the result of extended observations upon a series of strata, and essentially a single mountain chain, would be found applicable to many others; and he regarded the laws here set forth as applicable to all similiar examples, and as affording a natural and simple explanation of these phenomena, for the solution of which unknown and unexplained forces had been appealed to as the active agents."

SIMPLE RULES FOR CALCULATING THE THICKNESS OF INCLINED STRATA.

BY E. J. CHAPMAN.

The following simple rules for calculating the thickness of inclined strata, if copied into a blank leaf of the field-book, may prove useful, at times, to some of our geological and engineering readers. The results come out in all cases within a few inches of the truth.

Given the angle of dip, and the distance across the beds (i. e., *at right angles to the line of strike,*) *required the thickness of the strata.*

(1.) Multiply the dip by 92·15, and multiply the product of this by the distance in *miles:* the resulting product will be the thickness in *feet.*

Or, for short distances:

(2.) Multiply the dip by 0·01745, and multiply the product by the distance in *feet:* the resulting product will be the thickness in *feet.*

Or, when the dip is less than 1°.

(3.) Divide the constant value (as given above) by the fraction of the degree

* The author does not deny the influence of other causes acting upon the crust of the earth, as contraction, etc., but he considers the effect usually attributed to such agencies, to be far too great.

constituting the dip; and multiply the quotient by the distance. The resulting product will give the thickness in feet.

Examples:—(1.) Let the angle of dip $= 2°$, and let the distance be 8 miles: $92{\cdot}15 \times 2 \times 8 = 1474{\cdot}40$ (feet).

(2.) Let the angle of dip $= 5°$, and let the distance be 5 chains or 330 feet: $\cdot01745 \times 5 \times 330 = 28{\cdot}79$ (feet).

(3.) Let the dip $= 20'$, and let the distance be 10 miles: $\left(\frac{92{\cdot}15}{3}\right) \times 10 =$ $307{\cdot}16$ (feet.

The above rules, it will of course be understood, pre-suppose the non-existence of foldings, or other irregularities, in the strata to which they are applied.

CANADIAN EXPEDITIONS TO THE NORTH-WEST TERRITORY.

We extract the following very favorable notice of the recent expeditions to the Red River, &c., from the September Number of the American Journal of Science and Arts. Dr. Petermann, from whose Journal the notice is condensed, ranks as a well known authority amongst geographers:—

"The interest which has been manifested in the Report of the Pallisser expedition, leads us to condense and translate from Dr. Petermann's excellent *Mittheilungen* (January, 1860) an account of the explorations of the Red River which were made in 1857 and 1858 by Gladman, Dawson, Hind, and Napier. We regret that we cannot reproduce the admirable maps which accompany the article. The writer in Petermann's Journal remarks substantially as follows:

Although the Canadians had long endeavoured to direct the attention of the British Government to that vast portion of British North America, which stood until very recently under the immediate supervision of the Hudson's Bay Company, and had tried to induce them to effect a revision of the claims of that mercantile body, it was nevertheless, not until 1856, when gold was discovered in Fraser's and Thompson's rivers, that the British government took the matter into serious consideration, and in 1857 sent out an expedition (Pallisser's expedition) and declared in 1858 New Caledonia, as it was called under the above mentioned company, an independent colony, to be known in future by the name of British Columbia. At the same time it was urged that the government of Canada might be empowered to incorporate adjacent portions of land, particularily the so-called Saskatchewan district, east of the Rocky Mountains. This expedition accomplished its chief object, to find a passage across the Rocky Mountains, and also reported favorably in regard to future settlements in the Saskatchewan district, which may be called the intermediate district between the settled portion of British North America and the new gold region in British Columbia. At the same time with Palliser's expedition, another expedition was started directly by the Canadian goverment, and it is our object in the present paper, after having presented a few general remarks on the country, to give a brief synopsis of the course of this latter expedition.

The Saskatchewan district between the Red River and the Rocky Mountains has already, since the beginning of the present century, been the object of many explorations, the most prominent of which are those of Astronomer Thompson,* Lefroy, Richardson, Lord Selkirk, Blodget, and others. They all agree that the Saskatchewan district is well adapted for cultivation. It comprises an immense area, and as early as 1805, Lord Selkirk said that it could give bread to at least 30 millions of people. In regard to the climate, Blodget, who is most thoroughly acquainted with the subject, says that the average temperature in winter is not below that of St. Petersburg and Moscow; in summer it equals that of northern Italy and New York. The temperature increases, just as in Europe, as you go from east to west. Spring commences at all points almost at the same time. There is no want of rain; grass, forests and buffaloes abound. Useful timber is abundant; coal is found in many places, but particularly rich deposits exist at the foot of the Rocky Mountains, and near the Little Sauris River. The country is level and appears so even, that Blakistone remarked that for the construction of a railroad nothing was required but to put down the rails. Its numerous lakes and rivers can easily be connected for internal communication, and afford even now the only means of transport between the different stations of the Hudson's Bay Company. The Saskatchewan district can also be easily connected with the new gold region by means of commodious roads through Palliser's passage across the Rocky Mountains. This new colony will, by reason of its very favourable situation, its beautiful harbors, but particularly by reason of its wealth in gold, surely rise as speedily as Southern California; and, as it is less capable of agriculture, would naturally become the great market for the products of its eastern neighbors, in the Saskatchewan district.

We may therefore well be justified in prognosticating for this district a prosperous future in regard to agriculture, but we cannot agree with such opinions expressed some time ago in the Montreal *Pilot*, that by a regularly established road from Lake Superior to Lake of the Woods, Red River, Lake Winnipeg, Saskatchewan River, across the Rocky Mountains to the rivers of British Columbia, thence to Pacific, all commercial intercourse between Europe and China, Japan and India would take this route. A road which changes so often between land and water can never become a general commercial road for such a distance, not to mention the almost insurmountable difficulties for vessels of a larger draught, such as sudden bends, rapids, falls, shallow waters, etc., and the entirely uncultivated state of the country,

After these few remarks we return to our subject proper. We can give but a brief synopsis, and refer those who desire a detailed account of the Canadian expedition, to the "Reports on the exploration of the country between Lake Superior and Red River Settlement." A still more minute account is given in the "Papers relative to the Explorations of the Country between Lake Superior and the Red River settlement, presented to both Houses of Parliament,

* Thompson was from 1790, over 30 years, in the employ of the Hudson's Bay Company, and the reports of his explorations (37 vols.) are deposited in the Archives of this Company. From fragments of them it appears that Thompson possessed a great knowledge of the country, but it is doubtful whether these reports will ever be accessible to such as are not connected with the Company. Until now the Company has kept them back.

London, 1859." Three charts by Hind (one a reprint of Thompson's) and a sketch of the regions which Dawson travelled through, by himself, appeared at the same time.

The members of the Canadian expedition landed July 21, 1857, at Fort William, and started in boats along the usual route of the Hudson's Bay Company for Lake Winnipeg, in order to ascertain the practicability of the route. To this end surveys of rivers were made and a very minute determination of levels. Napier estimates the whole length of the route to be 747 miles, viz: from Lake Superior to Rainy Lake 335 miles; thence to Rat Portage at the northern extremity of Lake of the Woods 176 miles; from this point to Fort Garry on the Red River 236 miles. Of these three portions only the middle one, upon Rainy Lake, which is at an average 460 feet wide and 6 feet deep, forms a continuous water road. Its falls (Chaudière falls near Fort Francis, 22 feet,) may, according to Dawson, easily be made harmless by two water gates. The two remaining portions of the route can only be travelled by land, unless one prefers the tedious transport from one little river to another. The Kaministiquoria on the first portion of the route cannot be navigated, as its rapids, shallow water places, and falls (Kakabeke falls, 119 feet,) are too numerous. From Little to Great Dog Lake, a distance not over a mile, this river falls 348 feet, and yet the portage in this place has still an elevation of 142 feet over Great Dog Lake. This is the steepest descent on the whole route. The passage upon Dog River is partially obstructed by rocks and sandbanks, and on Prairie Portage, between Lake Superior and Lake Winnipeg, it leads mostly through swamps. The difference of elevation between Lake Superior and Prairie Portage, 54 miles distant from one another, is, after Dawson, 879 feet, according to Napier 887 feet; that between Prairie Portage and Lake Winnipeg (325 miles) is calculated by Dawson 892, by Napier 870 feet. Thus the descent towards the east is much more rapid than towards the west. The canoe route from Savannah River to Rainy Lake has too many portages, and the Rivière la Seine is, by reason of the numerous difficulties in its course, entirely objectionable. But the Winnipeg River, from Lake of the Woods to Lake Winnipeg, was by all declared to be the most difficult and impracticable on the whole route. The canoe route on the Pigeon River, from Lake Superior to Rainy Lake along the boundary, is the shortest, but it has 29 portages, of which many lead through United States territory. Another route to the Red River, which is still used by the Hudson Bay Company, commences from Fort York, near Hudson's Bay, and goes up Hays River, through Knee and Holy Lake, Wepinapanis River, White Water Lake and Sea River, down to Lake Winnipeg; but it requires three weeks of hard work to travel it; besides, the access to Fort York through Hudson's Bay, is only open about two months during the year. But the most commodious and most frequented road to the Red River over St. Paul and Crow Wing leads entirely through United States territory. In the English possessions the best connection between Lake Superior and the Red River would be established by country (?) roads, the one from Lake Superior to Rainy Lake, the other from Lake of the Woods to the Red River. In regard to the first, however, nothing has as yet been done, and only in the latter district have explorations been made with this view. When Gladman had arrived at Fort Garry (September, 1857,) he sent out engineers Napier and Dawson to reconnoitre this hitherto entirely unknown district, which explorations were continued by Gaudet and Wells during the winter of 1857–1858.

The whole country between the Red River and Lake of the Woods appeared perfectly level, although it actually descends toward the east nearly 400 feet. Dry prairies change alternately with wooded districts and extensive swamps, the latter being particularly frequent toward the north. The establishment of a road through this district seemed to them an utter impossibility.

Hind went up the Assiniboine River, explored the Great and Little Rat river, examined the valley of the Red River up to Pembina, and followed the Reed Grass or Roseau river up to a great swamp, which separated this stream from a lake of the same name. Unfortunately Hind could not survey this river up to its sources, but all the Indians who lived there agreed that a swamp of 9 miles in extent existed between Roseau lake and Lake of the Woods. This swamp sends the Reed river, 30 miles long, to the latter lake, and another little rapid river, about 40 or 50 miles long, to lake Roseau. From the Great Muskeg morass goes a little river westward into an extensive swamp, from which the Rat river issues.

Gladman was relieved from his post as chief in April, 1858, and Napier was also recalled about this time. But Hind went the same spring again with Dickinson, Fleming and Hine on another expedition known as the "Assiniboine and Saskatchewan expedition." Their object was to explore the region west of the Red River and Lake Winnipeg up to the Saskatchewan river. Before they arrived at Fort Garry, Dawson, Wells and Gaudet had already made some new surveys, around the Red River, Lake Winnipeg, and the lower Assiniboine, and had just left for the lake district. This latter party went by way of Lake Manitobah and Lake Winnipegosis, over Mossy Portage toward Cedar or Bourbon lake to the grand rapids of the Saskatchewan river. At Mossy Portage they separated; Wells went over Lake Winnipegosis, Lake Dauphin, Lake Manitobah, the Little Saskatchewan river, which he found to be 8 to 12 feet deep, 250 yards wide, free from rapids and throughout adapted for steam navigation, thence over Lake Winnipeg to the Red River. The rest of the party followed Swan river to Fort Pelly, and thence went down the Assiniboine river.

Dawson considers the whole alluvial plain east of the Pasquia and Porcupine hills and Dauphin mountains, where the large lakes are situated, well adapted for settlements. It is partly prairie land, for the most part, however, thickly wooded. North of Lake Dauphin wood predominates; south of it the country becomes more open, and toward the Assiniboine an apparently endless prairie commences. Wheat gives abundant harvests near Lake Manitobah and the Little Saskatchewan river, and near the latter even Indian corn may be cultivated. The valley of the Swan river is particularly fertile, and climate equals that of the Red River district. The Red Deer river district has also a good soil and fine climate, as its maple tree forests plainly show. Coal is said to be found in the Porcupine hills and the Duck mountain; Dawson himself found samples of lignite near Snow river. The great alluvial valley of the Assiniboine and its branches will, in his opinion, hereafter become one of the finest wheat growing districts upon earth.

Near Moss or Dauphin river, a fine navigable stream, the Indians grow maize, melons and potatoes. Vines, hops, and vetches grow naturally in abundance.

Hind and his companions went (June 14, 1858,) from Fort Garry in a westerly direction over Fort Ellis toward the missionary station near Qu' Appelle lake, (July 18) where he divided his corps into three parties: Dickinson travelled on the Qu' Appelle river up to its mouth, thence on horseback to Fort Pelly; Hine surveyed Long lake northwest of the Qu' Appelle mission, then went over land to Fort Pelly to meet Dickinson, and to explore with him the Dauphin mountains; Hind and Fleming followed the Qu' Appelle river up to its source, went over to the elbow of the southern arm of the Saskatchewan or Bow river, on which they travelled down until they reached Fort â la Corne (August 9.) The Qu'-Appelle and Bow rivers have no connections as Dr. Hector believes. The latter (southern arm of the Saskatchewan) has down from its elbow for a distance of about 100 miles, a width of 300 yards to half a mile, then it becomes narrower and straighter in its course, its sand and mud banks disappear, and finally it hurries through a narrow and deep valley, with a strong current toward the northern arm of the Saskatchewan, with which it unites, forming one river (Saskatchewan,) which now goes toward Fort à la Corne through Pine and Cedar lakes into Lake Winnipeg. Fleming followed this course from Fort à la Corne into Lake Winnipeg, along its western coast, until he reached the Red river. Hind made a land voyage along Long Creek, then turning southeast went over Touchwood hills to Fort Ellis, where he met Dickinson, with whom he returned over White Mud river to Fort Garry (September 4.)

But Hind and Fleming soon started on another excursion (September 18). They went in boats along the western shores of Lake Winnipeg, up to the mouth of the Little Saskatchewan, hence (September 29) into Lake Manitobah, and by means of Water Hen river and a lake of the same name reached Lake Winnipegosis where they examined the salt springs, which had been imprudently exhausted by the Indians. From thence they started for Lake Dauphin, ascended the Dauphin mountains (1700 feet high), and navigated Lake Manitobah in different directions. Hind stayed four days on a little island there, which was much revered by the Indians as the seat of the "Manitou," or fairies. On its northern side were limestone cliffs about fifteen feet high, which by the beating of the waves emitted sounds very similar to chimes from a number of church bells, ringing at a distance. From Oak Point, at the southern extremity of the lake, the party went over land to Fort Garry, where they arrived the 31st of October, 1858.

Hine, while sojourning on the Red River during the fall months, took photographic views of landscapes, churches, Indians, etc. Dickinson made excursions in the district east of the lower Red River, and in the regions between the Assiniboine and the U. S. boundary, but particularly along Rivière Sal through the Pembina mountains and Blue hills.

Some Canadian journals have blamed this Expedition for not having made any determination of points and for giving generally but little positive information, although $50,000 to $60,000 had been expended for the purpose. They said that the country had been much better explored by the late astronomer Thompson. This, however, is an unjust imputation. Astronomical observations of points, although very valuable, cannot be the main object of explorers, who have to run through a great number of districts in a comparatively very short time, and who must give us the general features of the country; moreover, as here a great number of such fixed points already exist, a careful survey of routes by dead reckoning is perfectly sufficient. The reproach that the country had been much better explored by Thompson is most unjust. Thompson's reports where undoubtedly as little accessible to the members of the Canadian expedition as they were to the rest of the world; besides, if we compare Thompson's chart with that of the expedition of 1858, we perceive that our knowledge of the country between Lake Winnipeg and Bow river is more accurate and more complete than Thompson's.

The expedition has achieved much. They made very comprehensive levellings, effected numerous measurements of width, depth and rapidity of rivers and lakes, made geological observations, inquired into the climate, forests, quality of soil, etc, made surveys and discoveries between Lake of the Woods and the Red River, between the Assiniboine river the U. S. boundary, along the upper Assiniboine and Qu' Appelle rivers, in the district of the great lakes etc. A comparison of their charts with the older ones of these districts will at once show that the money was not thrown away.

This expedition has moreover excited the curiosity of the people more than that of Capt. Palliser. Thus a society was formed at St. Paul in Minnesota, who, under the direction of Col. Nobles, left this city in June, 1859, with the object to explore the valleys and sources of the Saskatchewan and Columbia rivers. Their plan was, to start from the elbow of Bow river toward the Rocky Mountains, to explore carefully the region of their eastern foot up to the Edmonton House, thence to go over Arthabaska Portage between Mount Hooker and Mount Brown toward the sources of Thompson's river, and here to disperse in different directions. Col. Nobles intended to start for the source of Columbia river, and to return over Lewis and Clarke's Passage, the Missouri Falls, the valley of the Milk river, Fort Mandan, Big Stone Lake, and Fort Ridgley to St. Paul. Dr. Goodrich accompanies them as physician, and the Smithsonian Institution sent Dr. C. L. Anderson, of Minneapolis, to make scientific observations and collections.

The "Board of Trade" in St. Paul offered a reward of $1000 for the first steamer that should ply on or before the first of June on the Red river, and the "Anson Northup" really commenced her voyages in June. She carries, besides passengers, 100 to 150 tons of cargo, and is intended to do the post service between the mouth of the Shagerme river and Fort Garry, and thus to connect St. Paul, (which sustains a post wagon up to the Shagerme River) directly with the Red River.

Another company in Canada intend to put four steamers on Rainy lake, Red River and Lake Winnipeg. Even the settlers on the Red River themselves show an active spirit of progress.

PUBLICATIONS RECEIVED.

Government Map of Canada, from Red River to the Gulf of St. Lawrence, compiled by THOMAS DEVINE, P. L. S., Head of Surveys, Upper Canada Branch. This is, without exception, the most useful map of the Province that has yet appeared. It is on a scale of thirty miles to the inch; and in addition to the ordinary topographical matter, it conveys much valuable information in the shape of lists of townships, distances, &c. All the new roads and townships are laid down; and the engraving and getting up of the map leave nothing to be desired.

Contributions to the Palæontology of Iowa, by JAMES HALL. This publication is in the form of a supplement to the author's Report on the Geology of Iowa. It contains descriptions and figures of various new crinoids from the Carboniferous formations of the West. The described species belong in great part to the genus *Actinocrinus;* but new forms of Poteriocrinus, Forbesiocrinus, &c., are also announced. A new genus is likewise instituted under the name of *Trematocrinus*. This belongs to the family of the CYATHOCRINIDÆ, and is more or less closely related to both the *Rhodocrinus* of Miller, and the *Acanthocrinus* of Rœmer. Probably, however, these allied genera, with some other near-lying forms, may eventually be united, by an extension of the type-characters of the older genus. The following is the generic formula of Trematocrinus, as given by Professor Hall:—Basal plates, 5; sub-radial plates, 5; Radial plates, 3×5; Supra-radials, or Radials of the second order, 3 (or 4)$\times 10$. Anal plates, 12 to 17 or more. Inter-radials, 12 to 15 or more. Arms, five, bifurcating. Pores or ambulacral openings, 10.

E. J. C.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—AUGUST, 1860.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 m. 33 s. West. Elevation above Lake Ontario, 108 feet.

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Result't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M.	2 P.M.	10 P.M.	ME'N		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M.	2 P.M.	10 P.M.	Result'.	ME'N		
					°	°	°	°	°												°							
1	29.743	29.749	29.737	29.7382	50.4	65.4	59.0	59.98	— 6.98	.299	.307	.380	.333	.81	.49	.76	.66	N N W	S b W	S W b S	S 10 W	4.6	8.0	2.8	3.67	4.90	...	...
2	.762	.731	.700	.7280	52.6	70.2	60.9	62.67	— 4.18	.342	.552	.441	.451	.86	.75	.82	.81	N W b W	S W	E b N	N 81 E	2.0	5.6	4.2	1.47	4.16	...	...
3	.638	.516	.453	.5290	60.9	65.9	67.0	65.03	— 1.77	.465	.581	.585	.543	.87	.91	.88	.87	N E	S E b E	S W	S 25 E	5.4	9.4	2.6	1.79	4.58	0.125	...
4	.446	.497	.603	.5332	68.4	81.8	65.2	71.85	+ 5.05	.646	.483	.510	.522	.93	.44	.81	.70	S W b W	W b S	N W b N	N 74 W	5.4	15.0	3.4	7.79	8.85	...	...
5	.681	.701	—	—	63.0	71.0	—	—	—	.500	.406	—	—	.86	.54	—	—	N b W	E	E	N 81 E	4.1	7.5	3.0	4.01	4.62	..	...
6	.673	.642	.521	.6058	63.4	73.1	65.9	67.83	+ 1.07	.457	.612	.581	.560	.78	.75	.91	.82	N b E	S E b E	Calm.	S 88 E	2.5	3.8	0.0	2.25	2.36	...	...
7	.513	.422	.478	.4640	67.4	77.8	71.1	73.82	+ 7.13	.589	.822	.676	.698	.88	.86	.89	.84	N b W	S S W	Calm.	N 74 W	2.0	4.5	0.0	2.74	4.39	Inp.	...
8	.477	.456	.432	.4555	68.4	79.6	69.1	72.08	+ 5.42	.494	.440	.580	.476	.71	.43	.81	.62	N W b W	S b W	N N W	N 83 W	3.8	5.5	5.5	3.56	6.16	0.265	...
9	.443	.487	.508	.4852	62.1	74.6	65.6	67.87	+ 1.32	.539	.564	.454	.529	.96	.65	.72	.78	S E	S S W	W	S 43 W	7.0	8.0	2.6	3.56	4.27	0.035	...
10	.480	.417	.615	.5135	60.9	79.2	58.0	65.08	— 1.48	.465	.596	.283	.463	.87	.60	.58	.72	W	S W	N W b N	N 65 W	0.8	11.6	14.2	7.14	10.41	...	...
11	.712	.693	.669	.6907	52.9	62.7	54.4	58.42	— 8.0	.296	.354	.341	.339	.74	.62	.80	.69	N N W	S b E	E b S	S 22 E	8.0	8.0	5.0	1.55	6.09	...	...
12	.608	.553	—	—	60.9	69.9	—	—	—	.388	.541	—	—	.73	.74	—	—	N W b W	S E b E	N b W	N 9 W	4.5	5.5	2.0	2.60	6.39	0.675	...
13	.525	.558	.677	.5963	54.0	64.5	53.3	57.32	— 8.92	.390	.355	.323	.346	.93	.58	.79	.75	N b W	N W b N	N W b N	N 36 W	8.1	11.8	11.0	10.22	10.28	0.185	...
14	.777	.796	.831	.8047	52.9	63.4	53.3	56.47	— 9.77	.327	.457	.323	.366	.82	.78	.79	.79	N N W	S b W	N N W	N 21 W	4.0	7.2	7.5	4.56	6.33	...	...
15	.881	.882	.884	.8792	51.1	66.3	56.5	59.23	— 6.92	.320	.456	.356	.384	.85	.70	.78	.76	N b W	S b E	S b E	S 18 E	9.8	8.0	3.0	3.14	4.49	...	...
16	.841	.795	.717	.7802	52.6	64.8	58.3	60.07	— 5.97	.353	.386	.436	.403	.89	.62	.90	.78	S S E	E b S	E	S 68 E	5.8	7.0	4.0	3.48	4.34	...	...
17	.693	.614	.533	.6035	57.2	73.8	65.5	66.03	+ 0.07	.415	.382	.506	.461	.88	.46	.80	.73	N N E	S S W	E	N 82 W	2.0	6.5	2.0	0.69	3.93	0.127	...
18	.495	.473	.527	.4990	64.6	75.3	63.7	68.73	+ 2.90	.479	.663	.428	.535	.78	.76	.72	.75	N b W	S b W	N W b N	N 47 W	7.8	5.5	4.2	3.15	5.53	...	...
19	.573	.585	—	—	60.5	67.0	—	—	—	.389	.526	—	—	.74	.80	—	—	N b W	W S W	W b S	S 70 W	1.2	0.5	5.0	2.45	3.04	0.303	...
20	.548	.548	.625	.5760	64.8	77.4	62.7	68.85	+ 3.30	.582	.681	.466	.551	.95	.72	.82	.79	S b W	S b W	N N W	N 85 W	1.8	7.2	0.5	1.99	4.20	...	...
21	.673	.650	.673	.6607	60.1	73.1	66.3	67.47	+ 2.03	.461	.599	.508	.529	.89	.74	.78	.79	N N W	S	N b W	S 86 W	3.0	7.2	8.0	1.27	4.66	...	...
22	.713	.679	.640	.6705	59.4	71.0	65.2	65.98	+ 0.63	.410	.432	.510	.453	.81	.57	.81	.71	N b W	E	E	N 79 E	3.2	6.0	3.8	3.33	4.66	...	...
23	.587	.538	.496	.5327	66.6	77.1	69.5	71.02	+ 5.88	.557	.639	.632	.601	.86	.69	.88	.80	E b N	E b S	N b W	N 71 E	4.2	6.4	5.5	3.96	6.37	0.890	...
24	.441	.408	.401	.4223	64.1	72.0	62.7	66.03	+ 1.13	.551	.613	.517	.557	.92	.78	.90	.87	N b E	E	N W b W	N 15 W	2.2	6.5	5.5	0.87	4.94	0.350	...
25	.367	.369	.469	.4087	61.9	70.4	62.7	64.80	+ 0.07	.515	.466	.466	.478	.93	.62	.82	.78	N W b W	N W b W	W N W	N 53 W	3.8	19.0	12.8	11.58	11.67	...	...
26	.516	.483	—	—	56.2	72.8	—	—	—	.406	.517	—	—	.90	.64	—	—	N W	S	S W	S 50 W	0.7	9.2	4.5	3.24	4.55	Inp.	...
27	.493	.445	.561	.4997	54.7	66.6	52.9	58.80	— 5.52	.358	.491	.306	.365	.84	.75	.76	.74	N W	S W	W b N	N 81 W	1.4	12.5	8.2	8.28	9.20	0.062	...
28	.598	.582	.620	.6032	47.1	64.3	53.6	56.67	— 7.47	.269	.345	.276	.306	.83	.57	.67	.67	N W b W	S S W	N W b N	N 53 W	4.0	5.8	2.8	2.96	4.13	...	...
29	.668	.657	.626	.6482	52.2	67.4	58.3	60.58	— 3.23	.295	.385	.367	.358	.75	.57	.75	.68	N W b N	S	S W b W	S 20 W	2.8	9.5	2.5	3.70	4.26	...	...
30	.582	.430	.211	.4007	53.6	72.4	65.6	64.83	+ 1.22	.351	.523	.505	.489	.85	.65	.79	.79	Calm.	S b W	W b N	S 49 W	0.0	15.5	5.5	4.98	7.82	0.375	...
31	.324	.387	.460	.3932	58.0	71.7	59.0	62.78	— 0.53	.416	.374	.403	.403	.86	.48	.81	.72	W b N	W N W	N W	N 63 W	11.0	10.8	5.4	6.93	8.29	0.013	...
M	29.5960	29.5711	29.5804	29.5825	58.60	71.18	61.68	64.46	— 1.30	.431	.502	.450	.463	.85	.65	.80	.76	......	......	......	......	4.09	8.21	4.74	.....	5.80	3.405	..

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR AUGUST, 1860.

Highest Barometer . . . . 29.903 at 8 a. m. on 15th. } Monthly range=
Lowest Barometer . . . . 29.211 at 10 p. m. on 30th, } 0.692 inches.

Self-registering Ther.:
- Maximum temperature . . . . 87°0 on p.m. of 8th } Monthly range=
- Minimum temperature . . . . 46°8 on a.m. of 28th } 40°2
- Mean maximum temperature . . 73°73 } Mean daily range = 17°46.
- Mean minimum temperature . . 56°27 }
- Greatest daily range . . . . . . 24°4 from a. m. to p. m. of 11th.
- Least daily range . . . . 8.5 from a. m. to p. m. of 3rd.

Warmest day . . 7th ... Mean Temperature . . . 73°82 } Difference=17°35.
Coldest day . . . 14th ... Mean Temperature . . . 56°47 }

Maximum Radiation { Solar . . . . 101°8 on p. m. of 7th } Monthly range=
{ Terrestrial . . . . 36.8 on a. m. of 28th } 65°0.

Aurora observed on 8 nights, viz.: on 6th, 8th, 9th. 10th, 11th, 13th, 18th and 22nd; possible to see Aurora on 19 nights; impossible on 12 nights.

Raining on 14 days; depth, 3.405 inches; duration of fall, 40.4 hours.

Mean of cloudiness=0.43; most cloudy hour observed, 2 p. m., mean=0.50: least cloudy hour observed, 8 a. m.; mean=0.30.

Sums of the components of the Atmospheric Current, expressed in Miles.

North.	South.	East.	West.
1659.14	1185.64	698.76	1977.24

Resultant direction, N 70° W; Resultant Velocity, 1.83 miles per hour.
Mean velocity 5.80 miles per hour.
Maximum velocity . . . 22.2 miles per hour, from 4 to 5 p.m. on the 25th.
Most windy day . . 25th—Mean velocity, 11.67 miles per hour. } Difference 9.31
Least windy day . . 6th—Mean velocity, 2.36 do } miles.
Most windy hour, 2 to 3 p. m.—Mean velocity, 8.56 miles per hour. } Difference
Least windy hour, 6 to 7 a. m.—Mean velocity, 3.93 do. } 4.63 miles.

3rd. Sheet lightning in S. E. at 10 p. m. and midnight. 4th. Fog to 6.45 a. m. 7th. Thunderstorm and slight rain 1.50 to 11 p. m. 8th. Sheet lightning in N. W. and N. at midnight. 9th. Thunderstorm, vivid lightning and heavy rain 4.30 to 6.20 a. m. 12th. Slight thunderstorm from 9 p. m.; heavy rain during the night. 15th. Large and remarkable meteor fell from zenith to N. W. horizon at 9 p. m. 16th. Very large meteor fell in a S. S. W. direction, emitting sparks and a long train at 8.30 p. m. 17th. Thunderstorm, lightning and heavy rain at intervals from 6 p. m. to 2 a. m. of 18th; rainbow at 7 p. m. 19th. Severe thunderstorm, vivid lightning and moderate rain from 11 p. m. to 9 a. m. of 20th. 21st. Sheet lightning round horizon from 7 p. m. 23rd. Sheet lightning from 6 p. m. to midnight. 24th. Severe thunderstorm, intensely vivid lightning, heavy rain, and large hailstones, from 1.45 to 4 a. m.; another thundestorm passing from N. to S., 4.30 to 6 p. m. 30th. Thunderstorm, incessant lightning, and moderate rain, from 10.30 p. m., continuing during a portion of the night.

Heavy dew recorded on 18 mornings during this month.

The Resultant Direction and Velocity of the Wind for the month of August, from 1848 to 1860 inclusive, were respectively N. 61° W., and 0.90 miles.

The month of August, 1860, was cold, wet and windy—the mean temperature having been 1°59 below, the rain 0.455 inches above, and the mean velocity of the wind 0.56 miles per hour above their respective averages.

COMPARATIVE TABLE FOR AUGUST.

YEAR.	TEMPERATURE. Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant Direction.	Resultant Velocity.	Mean Velocity
	°	°	°	°	°					°		
1840	64.7	— 1.3	80.1	47.4	32.7	12	2.905	...	...	...	...	...
1841	64.4	— 1.6	83.5	46.7	36.8	9	6.170	...	...	...	...	0.19 lbs
1842	65.7	— 0.3	80.7	45.3	35.4	6	2.500	...	...	...	...	0.30 "
1843	66.4	+ 0.4	85.5	44.4	41.1	4	4.850	...	...	...	...	0.12 "
1844	64.3	— 1.7	82.5	44.3	38.2	17	imp.	...	...	...	...	0.16 "
1845	67.9	+ 1.9	82.5	44.4	38.1	9	1.725	...	...	...	...	0.19 "
1846	68.4	+ 2.4	86.3	50.4	35.9	9	1.770	...	...	...	...	0.17 "
1847	65.1	— 0.9	83.1	44.9	38.2	10	2.140	...	...	...	...	0.19 "
1848	69.2	+ 3.2	87.5	49.3	38.2	8	0.855	...	...	S 21 E	0.98	4.55 ms.
1849	66.3	+ 0.3	79.5	51.4	28.1	10	4.970	...	...	N 71 W	0.60	3.76 "
1850	66.8	+ 0.8	84.2	43.0	41.2	13	4.355	...	...	N 15 E	0.35	4.46 "
1851	63.6	— 2.4	79.8	43.6	36.2	10	1.360	...	...	N 63 W	0.40	4.63 "
1852	65.9	— 0.1	81.2	46.7	34.5	9	2.695	...	...	N 70 E	0.56	3.30 "
1853	68.6	+ 2.6	91.6	47.6	44.0	11	2.575	...	...	S 36 E	0.30	4.26 "
1854	68.0	+ 2.0	98.1	47.0	51.1	5	0.455	...	...	N 64 W	1.76	4.60 "
1855	64.1	— 1.9	82.1	44.9	37.2	7	1.455	...	...	N 63 W	1.04	6.97 "
1856	63.6	— 2.4	81.3	44.0	37.3	12	1.680	...	...	N 50 W	2.88	7.03 "
1857	65.3	— 0.7	85.3	50.1	35.2	13	5.265	...	...	N 77 W	1.51	6.36 "
1858	67.6	+ 1.6	83.4	45.4	38.0	11	3.890	...	...	N 69 W	1.57	6.50 "
1859	66.6	+ 0.6	81.4	46.2	35.2	11	3.990	...	...	N 36 W	1.62	5.96 "
1860	64.5	— 1.5	81.8	47.1	34.7	14	3.405	...	...	N 70 W	1.83	5.80 "
Mean	66.05	...	83.88	46.39	37.49	10.0	2.950	...	...	...	...	5.24

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—SEPTEMBER, 1860.

Latitude—43 deg. 39.4 min. North. Longitude—5 h. 17 min. 33 sec. West. Elevation above Lake Ontario, 108 feet.

Days.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Average	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N
1	29.557	29.630	29.745	29.6502	50.8	63.4	48.2	54.43	− 8.60	.293	.243	.245	.255	.78	.42	.72	.62
2	.829	.861	—	—	48.2	64.1	—	—	—	.226	.313	—	—	.65	.53	—	—
3	.935	.917	.808	.8813	49.7	65.9	59.4	59.47	− 2.97	.308	.449	.363	.386	.86	.70	.71	.76
4	.815	.732	.672	.7345	53.5	69.2	65.2	65.07	+ 2.93	.356	.593	.577	.532	.78	.83	.92	.84
5	.681	.681	.666	.6737	64.5	74.2	70.2	69.75	+ 7.92	.573	.642	.651	.617	.94	.77	.88	.85
6	.719	.728	.743	.7248	64.5	72.2	62.3	66.15	+ 4.72	.342	.400	.459	.429	.56	.62	.82	.67
7	.693	.576	.531	.5915	55.8	72.0	65.6	66.57	+ 5.42	.343	.556	.586	.492	.78	.70	.90	.75
8	.653	.631	.777	.6835	60.1	52.2	59.8	54.13	− 6.60	.488	.337	.272	.360	.94	.86	.73	.83
9	.849	.837	—	—	45.7	60.5	—	—	—	.249	.227	—	—	.81	.43	—	—
10	.718	.622	.638	.6537	47.5	60.1	52.2	53.93	− 6.12	.255	.331	.305	.293	.77	.63	.78	.71
11	.559	.438	.565	.5225	46.4	55.1	44.6	49.60	−10.05	.240	.386	.190	.284	.76	.89	.64	.77
12	.694	.724	.812	.7525	44.3	52.6	41.7	46.37	−12.87	.194	.196	.218	.191	.67	.48	.82	.62
13	.856	.836	.855	.8513	43.5	64.8	49.3	54.00	− 4.85	.231	.314	.270	.270	.82	.51	.77	.65
14	.902	.865	.836	.8565	45.7	68.8	58.0	59.62	+ 1.28	.288	.371	.394	.378	.94	.53	.82	.76
15	.795	.694	.671	.7118	49.3	70.2	65.2	63.92	+ 6.00	.313	.510	.497	.473	.88	.69	.79	.79
16	.631	.548	—	—	62.3	64.1	—	—	—	.522	.499	—	—	.93	.83	—	—
17	.562	.592	.668	.6163	51.5	66.6	56.5	57.85	+ 0.85	.334	.441	.390	.386	.87	.67	.85	.80
18	.724	.706	.681	.7032	48.9	64.1	55.8	57.07	+ 0.45	.319	.423	.365	.372	.91	.70	.82	.80
19	.627	.578	.553	.5788	54.0	67.7	59.8	60.98	+ 4.87	.401	.529	.428	.462	.96	.78	.83	.86
20	.459	.294	.431	.3942	57.2	56.2	47.7	53.42	− 2.18	.404	.428	.283	.363	.85	.95	.86	.88
21	.433	.491	.620	.5262	42.8	58.3	42.1	47.80	− 7.32	.251	.226	.233	.239	.90	.46	.86	.74
22	.473	.455	.604	.5412	52.2	65.5	51.8	55.98	+ 1.35	.315	.317	.311	.321	.80	.50	.80	.73
23	.791	.693	—	—	39.6	54.4	—	—	—	.227	.318	—	—	.94	.75	—	—
24	.390	.387	.344	.3667	56.2	60.1	60.1	58.68	+ 4.93	.393	.448	.372	.384	.87	.86	.71	.78
25	.254	.233	.490	.3432	51.1	61.6	46.8	53.32	+ 0.08	.353	.264	.234	.279	.91	.48	.74	.69
26	.644	.760	.885	.7748	41.6	55.2	41.4	47.08	− 5.65	.219	.169	.214	.204	.83	.35	.81	.66
27	.910	.806	621	.7692	43.5	49.7	41.0	45.00	− 6.22	.240	.255	.227	.244	.85	.65	.88	.79
28	.738	.843	30.041	.8902	41.4	47.9	38.5	42.47	− 9.37	.232	.183	.120	.175	.89	.54	.52	.64
29	30.038	30.044	30.042	30.0307	35.2	43.7	40.7	39.90	−11.42	.128	.147	.195	.151	.62	.51	.77	.61
30	30.134	30.106	—	—	28.7	40.3	—	—	—	.109	.140	—	—	.69	.56	—	—
M	29.6744	29.6505	29.6923	29.6733	50.17	61.53	52.64	55.34	− 2.15	.313	.369	.336	342	.83	.64	.79	.74

Days.	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Resul't.	ME'N	Rain in Inches.	Snow in Inches.
1	N W b W	N W b W	N W b N	N 36° W	6.0	15.5	4.0	7.86	8.06	...	...
2	N W b N	S	Calm.	S 27 W	3.6	8.2	0.0	1.73	2.64	...	...
3	W N W	E b N	N E	N 65 E	0.5	8.0	3.0	4.65	4.93	...	...
4	N N E	S b E	S b E	S 23 E	2.0	8.0	0.5	2.63	2.83	Inp.	...
5	S b E	S b W	S W b W	N 48 W	1.8	4.5	1.5	2.21	5.45	Inp.	...
6	N b W	S b W	N b W	N 35 W	8.0	5.5	8.6	1.45	4.33	...	...
7	N b W	S E	S S W	N 43 E	4.2	1.5	1.2	1.37	3.45	0.020	...
8	N E b N	N N E	N	N 9 E	6.5	11.0	3.2	6.77	7.09	0.520	...
9	N b W	N W b W	N b W	N 24 W	10.0	5.0	8.0	4.54	5.77	...	...
10	N W	S b W	W b N	S 64 W	4.9	8.0	2.5	3.32	4.92	...	...
11	W b N	S W b W	N W b N	N 59 W	1.0	9.0	10.2	8.39	10.92	0.170	...
12	N W	N W	Calm.	N 9 W	8.8	17.5	0.0	10.47	10.55	...	...
13	N W b W	W b N	Calm.	N 67 W	8.0	9.6	0.0	3.80	3.91	...	...
14	Calm.	S	S	S 3 W	0.0	8.4	0.4	3.59	3.67	...	...
15	Calm.	S b W	S W b S	S 18 W	0.0	10.6	0.5	5.54	5.64	0.610	...
16	S S W	S	S W b S	S 29 W	4.2	9.5	5.0	4.30	4.65	0.057	...
17	Calm	S S W	N N W	S 80 W	0.0	3.8	0.5	1.63	1.8	...	...
18	N b W	E S E	Calm.	S 79 E	1.0	2.8	0.0	0.75	1.05	...	...
19	Calm.	S S E	N N W	N 16 W	0.0	2.0	7.5	2.13	2.59	...	...
20	N W b N	N W	W S W	N 73 W	4.4	11.0	5.2	6.20	7.76	0.060	...
21	W S W	W	Calm.	S 80 W	6.0	17.5	0.0	7.93	8.46	Inp.	...
22	S S W	S W b W	N b W	S 60 W	15.5	16.2	2.5	7.36	8.77	0.017	...
23	Calm.	E b S	E N E	N 81 E	0.0	8.8	5.5	4.21	4.57	.	...
24	S S W	S W b S	W	S 48 W	7.0	7.6	16.2	5.72	6.20	0.130	...
25	Calm.	W	W b N	N 86 W	0.0	18.0	15.5	11.82	12.29	0.005	...
26	W b S	N W b W	W N W	N 76 W	1.2	25.0	0.5	8.89	8.96	...	...
27	N W b W	S E b E	Calm.	N 74 W	3.4	2.0	0.0	3.03	4.70	0.080	...
28	W b N	N W b N	N W b N	N 44 W	7.0	18.8	2.8	10.49	10.68	..	...
29	N N W	S b W	Calm.	S 12 W	0.5	5.0	0.0	1.09	1.88	...	...
30	N N E	E b S	N E	N 74 E	2.8	8.2	5.0	4.75	5.13	0.290	..
M	....	....	....	....	3.94	9.55	3.66	....	5.79	1.959	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR SEPTEMBER, 1860.

Highest Barometer .... 30.170 at 10 a. m., on 30th } Monthly range = 0.937 inches
Lowest Barometer .... 29.233 at 2 p. m. on 25th }

Self-registering Thermom.
- Maximum Temperature .... 75°8 on p. m. of 5th } Monthly range = 47°1
- Minimum Temperature .... 28°7 on a. m. of 30th }
- Mean maximum Temperature .... 63°12 } Mean daily range = 15°83
- Mean minimum Temperature .... 47°29 }
- Greatest daily range .... 28°2 from a. m. to p. m. of 13th.
- Least daily range.................. 3°2 from a. m. to p. m. of 16th.

Warmest day......... 5th ... Mean temperature......... 69.75 } Difference = 29°85.
Coldest day......... 29th... Mean temperature......... 39°90 }

Maximum { Solar................................ 96°0 on p. m. of 5th } Monthly range = 73°2.
Radiation. { Terrestrial .... 22°8 on a. m. of 30th }

Aurora observed on 6 nights, viz., on 6th, 8th, 10th, 15th, 19th and 25th.
Possible to see Aurora on 22 nights; impossible on 8 nights.
Raining on 14 days,—depth 1.959 inches; duration of fall 36.2 hours.
Mean of cloudiness = 0.48.
Most cloudy hour observed, 4 p. m., mean = 0.60; least cloudy hour observed, 10 p. m., mean, = 0.35.

Sums of the components of the Atmospheric Current, expressed in miles.

North.	South.	East.	West.
1587.41	972.69	456.31	2246.36

Resultant direction N. 71° W.; Resultant Velocity 2.63 miles per hour.
Mean velocity .... 5.79 miles per hour.
Maximum velocity .... 29.2 miles, from 5 to 6 p. m. on 25th.
Most windy day .... 25th...... Mean velocity 12.29 miles per hour. } Difference = 11.24 miles
Least windy day .... 18th...... Mean velocity 1.05 ditto. }
Most windy hour... 1 to 2 p. m................ Mean velocity 9.84 ditto. } Difference 6.88 miles.
Least windy hour... 2 to 3 a. m. .... Mean velocity 2.96 ditto. }

5th. Distinct Solar Halo at noon. 8th. Imperfect rainbow at 5.30 p. m. 14th. Ground fog 6 to 7 a. m. 15th. Ground fog 6 to 7.30 a. m. 16th. Heavy thunderstorm 3 to 5.30 a. m. 19th. Dense fog from 5 a. m.; sheet lightning in S. E. at 7 p. m. 21st. Thin ice on shallow pools at 6 a. m. (*first of season.*) 22nd. Perfect solar rainbow 5.35 to 5.55 a. m. 23rd. Hoar frost and thin ice, 6 a. m. 24th. Slight thunderstorm, noon to 1 p. m.; halo round the moon 6.30 p. m. 25th. Very perfect double rainbow, 5.15 to 5.45 p. m. 26th. Hoar frost 5.30 a. m., very perfect Lunar Halo from 7.30 p. m. 27th. Sheet lightning in N. W. at 8 p. m. 28th. Thin ice at 6 a. m. 30th. Hoar frost and ice one-eighth inch thick: this frost was very destructive to tender vegetables and fruit.

Heavy Dew recorded on 7 mornings during this month.

The Resultant Direction and Velocity of the Wind for the month of September, from 1848 to 1860 inclusive, were respectively N 61° W, and 1.11 miles.

The month of September, 1860, was cold, dry and windy.
The Mean Temperature was 2°51 below the average of 21 years. The depth of rain recorded was 2.032 inches below the average of 20 years, which is less than half the mean amount; and the mean velocity of the wind was 0.35 miles per hour above the average of 13 years.

COMPARATIVE TABLE FOR SEPTEMBER.

Year.	Temperature.					Rain.		Snow.		Wind.		
	M'n.	Diff. from Aver.	Max ob'd.	Min. ob'd.	Range.	No. of days.	Inch's.	No. of days.	Inch's.	Resultant Direction.	Resultant V'y.	Mean Force or Velocity.
1840	54.0°	−3.9°	70.2°	29.4°	40.8°	4	1.380	...	...	...	...	....
1841	61.3	+3.4	79.9	37.5	42.4	9	3.340	...	...	...	...	0 26 lbs.
1842	55.7	−2.2	83.5	28.3	55.2	12	6.160	...	...	...	...	0.45
1843	59.1	+1.2	87.8	33.1	54.7	10	9 760	...	...	...	...	0.57
1844	58.6	+0.7	81.5	29.6	51.9	4	Imp.	...	...	...	...	0.26
1845	51.0	−1.9	78.8	35.3	43.5	16	6.245	...	...	...	...	0.34
1846	63.6	+5.7	84.0	39.0	45.0	11	4.595	...	...	...	...	0.33
1847	55.6	−2.3	74.8	38.1	36.7	15	6.665	...	...	...	...	0 33
1848	54.2	−3.7	80.9	29.5	51 4	11	3.115	...	...	N 71° W	2.38	5.81 mls.
1849	58.2	+0.3	80.6	33.5	47.1	9	1 480	...	...	N 75° W	0.69	4.23
1850	56.5	−1.4	76.0	31.7	44.3	11	1.735	...	...	S 65° W	1.02	4.78
1851	60.0	+2.1	86.3	33.4	52.9	9	2.665	...	...	N 14° E	1.03	5.45
1852	57.5	−0.4	81.8	36.1	45.7	10	3.630	...	...	N 77° W	0.53	4.60
1853	58.8	+0.9	85 4	36.1	49.3	12	5.140	...	...	N	1.06	4.33
1854	61.0	+3 [illegible]	93.1	36.3	56.8	14	5.375	...	...	N 22° W	1.33	4.04
1855	59.5	+1.6	81.7	36.1	45.6	12	5.585	...	...	N 20° E	1.29	7.61
1856	57.1	−0.8	77.3	37.4	39.9	13	4.105	...	...	S 79° W	1.98	6.53
1857	58 6	+0.7	81.4	34.1	47.3	11	2.610	...	...	N 63° W	1.61	5.55
1858	59.1	+1.2	80.1	36.8	43.3	8	0.735	...	...	S 74° W	1.53	5.69
1859	55.2	−2.7	73.8	35.7	38.1	15	3 525	...	...	N 44° W	1.60	6.36
1860	55.3	−2.6	74.2	23.7	45.5	14	1.959	...	...	N 71° W	2.63	5.79
M	57.85	...	80.62	34.08	46.54	11.0	3.991	...	...	....	...	5.44 Ml.

INDEX.

ERRATA AND ADDENDA TO VOL. V.

Page 171, line 6 in foot-note, *for* our ordinary pea, *read* an ordinary pea.
" 175. *To* localities of *Chromic Iron Ore, add* Mount Albert in Gaspé.
" 178, line 5, *for* Addington Co., *read* Argenteuil Co.
" 294, line 16, *for* 1849, *read* 1859.
" 307 (in note on Calceola), *for* Prof. Stafford, *read* Prof. Safford.
" 320, line 2 from bottom, make the same correction; and *for* identified, *read* identical.
" 388, line 15, *for* palumbarius, *read* columbarius.
" 389, line 15, *for* Musicapa, *read* Muscicapa.
" 389, line 17, *for* crenita, *read* crinita.
" 389, line 27, *for* Mylodoctes, FLYCATCHER, *read* Myiodioctes,—FLYCATCHING.
" 389, line 41, *for* vinus—Vine-, *read* pinus—Pine-.
" 389, line 43. *for* Varus, *read* Parus.
" 390, line 15, *after* Philadelphia, *insert Mourning Warbler.*
" 390, line 21, *for* Minotilta, *read* Mniotilta.
" 390, line 28, *for* hymenalis, *read* hyemalis.
" 392, line 26, *for* roots, *read* roost.
" 392, in foot-note, *for excurbitoroides*, *read excubitoroides.*
" 393, line 42, *for* CROKE, *read* CRAKE.
" 393, line 36, *for Ruffled*, *read Ruffed.*
" 394, line 24, *for Red-headed*, *read Red-breasted.*
" 394, *after* Genus Scolopax, *insert* Genus Microptera, WOODCOCK.
" 471, line 6 from bottom, *for* north-west, *read* north-east.
" 519, line 7, *for Cornelian*, *read Carnelian.*
" 520, line 1 from bottom, *for Condrodite*, *read Chondrodite.*
" 540, line 6 from bottom, *for Thiels*, *read Theils.*
See also pages 22 and 237.

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