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THE

CANADIAN NATURALIST

AND GEOLOGIST:

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CONTENTS.

THE

CANADIAN NATURALIST.

SECOND SERIES.

CONTRIBUTIONS TO THE CHEMISTRY OF NATURAL WATERS.

By T. Sterry Hunt, A.M., F.R.S.; of the Geol. Survey of Canada.

It is proposed to divide this essay into three parts, in the first of which will be considered some general principles which must form the basis of a correct chemical history of natural waters. The second part will embrace a series of chemical analyses of mineral waters from the paleozoic rocks of the Champlain and St. Lawrence basins, together with some river-waters; and the third part will consist chiefly of deductions and generalizations from these analyses.

I.

Contents of Sections.—1, atmospheric waters; 2, 3, results of vegetable decay; 4–7, action on rocky sediments; 8, action on iron-oxyd; 9, solution of alumina; 10, reduction of sulphates; 11, kaolinization; 12, decay of silicates; 13, origin of carbonate of soda; 14, Bischof's view rejected; 15, 16, porosity of rocks, and their contained saline waters; 17, saliferous strata; 18, action of carbonate of soda on saline waters; 19, origin of sulphate of magnesia; 20, 21, Mitscherlich's view rejected; 22, 23, salts from evaporating sea-water, composition of ancient seas, origin of carbonate of lime; 24–27, origin of gypsum, carbonate of magnesia, and dolomite; 28, waters from oxydized sulphurets; 29, origin of free sulphuric and hydrochloric acids; 30, of hydrosulphuric and boric acids; 31, of carbonic acid gas; 32, of ammoniacal salts; 33–35, classification of mineral waters.

§ 1. The solvent powers of water are such that this liquid is never met with in nature in a perfectly pure state: even meteoric waters hold in solution, besides nitrogen, oxygen, carbonic acid, ammonia, and nitrous compounds, small quantities of solid matters which were previously suspended in the form of dust in the atmosphere. After falling to the earth, these same waters become still farther impregnated with foreign elements of very variable nature, according to the conditions of the surface on which they fall.

§ 2. Atmospheric waters coming in contact with decaying vegetable matters at the earth's surface, take from them two classes of soluble ingredients, organic and inorganic. The waters of many streams and rivers are colored brown with dissolved organic matter, and yield, when evaporated to dryness, colored residues, which carbonize by heat. This organic substance, in some cases at least, is azotized, and similar, if not identical, in composition and properties with the apocrenic acid of Berzelius. The decaying vegetation, at the same time that it yields a portion of its organic matter in a soluble form, parts with the mineral or cinereal elements which it had removed from the soil during life. The salts of potassium, calcium, and magnesium, the silica and phosphates, which are so essential to the growing plant, are liberated during the process of decay; and hence we find these elements almost wanting in peat and coal. See on this point the analyses by Vohl of peat, peat-moss, and the soluble matters set free during its decay. *Ann. der Chem. und Pharm.*, cix, 185, cited in *Rep. Chim. Appliquée*, i, 289. Also Liebig, analysis of bog-water; *Letters on Modern Agriculture*, p. 44; and in the second part of this paper the analysis of the waters of the Ottawa river.

§ 3. At the same time an important change is effected in the gaseous contents of the atmospheric waters. The oxygen which they hold in solution is absorbed by the decaying organic matter, and replaced by carbonic acid; while any nitrates or nitrites which may be present are by the same means reduced to the state of ammonia (Kuhlmann). By thus losing oxygen, and taking up a readily oxydizable organic matter, these waters become reducing instead of oxydizing media in their farther progress.

§ 4. We have thus far considered the precipitated atmospheric waters as remaining at the earth's surface; but a great portion of them, sooner or later in their course, come upon permeable strata, by which they are absorbed, and in their subterranean circulation undergo important changes. The effect of ordinary argillaceous strata destitute of neutral soluble salts may be first examined. Between such sedimentary strata and the waters charged with organic and mineral matters from decaying vegetation, there are important reactions. The composition of these waters is peculiar. They contain, relatively to the sodium, a large amount of potassium salts, besides notable quantities of silica and phosphates, in addition to the dissolved organic matters and the earthy carbonates, and in some cases ammoniacal salts and nitrates or nitrites. The sulphuric acid and chlorine are moreover not sufficient to neutralize the alkalies, which are perhaps in part combined with silica or with an organic acid.

§ 5. The experiments of Way, Voelcker, and others have shown that when such waters are brought into contact with argillaceous sediments, they part with their potash, ammonia, silica, and phosphoric acid and organic matter, which remain in combination with the soil; while, under ordinary conditions at least, neither soda, lime, magnesia, sulphuric acid, nor chlorine are retained. This power of the soil appears from the experiments of Eichhorn to be in part due to the action of hydrated double aluminous silicates; and the process is one of double exchange, an equivalent of lime or soda being given up for the potash and ammonia retained. The phosphates are probably retained in combination with alumina or peroxyd of iron; and the silica and organic matters also enter into insoluble combinations. It follows from these reactions that the surface-waters charged with the products of vegetable decay, after having been brought in contact with argillaceous sediments, retain little else than sulphates, chlorids, or carbonates of soda, lime, and magnesia. In this way the mineral matters required for the growth of plants, and by them removed from the soil, are again restored to it; and from this reaction results the small proportion of potash salts in the waters of ordinary springs and wells as compared with river-waters. From the waters of rivers, lakes, and seas, aquatic plants again take up the dissolved potash, phosphates, and silica; and the subsequent decay of these plants in contact with the ooze of the bottom, or on the shores, again restores these elements to the earth. See a remarkable essay by Forchhammer on the composition of fucoids, and their geological relations, *Jour. fur Prakt. Chem.*, xxxvi, 388.

§ 6. The observations of Eichhorn upon the reaction between solutions of chlorids and pulverized chabazite, which, as a hydrated silicate of alumina and lime, may perhaps be taken as a representative of the hydrous double silicates in the soil, show that these substitutions of protoxyd bases are neither complete nor absolute. It would appear, on the contrary, that there takes place a partial exchange or a partition of bases according to their respective affinities. Thus the normal chabazite, in presence of a solution of chlorid of sodium exchanges a large portion of its lime for soda; but if the resulting soda-compound be placed in a solution of chlorid of calcium, an inverse substitution takes place, and a portion of lime enters again into the silicate, replacing an equivalent of soda; while, by the action of a solution of chlorid of potassium, both lime and soda are, to a large extent, replaced by potash. In like manner, chabazite, in which, by the action of a solution of sal-ammoniac, a part of the lime has been replaced by ammonia, will give up a portion of the ammonia, not only to solutions of chlorids of potassium and sodium, but even to chlorid of calcium. It results from these mutual decompositions that there is a point where a chabazite containing both lime and soda, or lime and ammonia, would remain unchanged in mixed solutions of the corresponding chlorids, the affinities of the rival bases being balanced.* Inasmuch, however, as the proportions of ammonia and potash in natural waters are usually small when compared with the amounts of lime and soda existing in the form of hydro-silicates in the soil, the result of these affinities is an almost complete elimination of the ammonia and potash from infiltrating waters.

§ 7. That the replacement of one base by another in this way is not complete is shown moreover by the experiments of Liebig, Dehérain and others, who have observed that a solution of gypsum removes from soils a certain amount of potash-salt, which was insoluble in pure water. In this way gypseous waters may also acquire portions of sulphate of soda, and perhaps of sulphate of magnesia, from silicates.

It is not certain that all the above reactions observed for chabazite are applicable without modification to the double hydro-aluminous silicates of sedimentary strata. Were such the case, important changes might, in certain conditions, be effected in the composition of saline waters. Thus in presence of a great amount of a hydrous silicate of lime and alumina, solutions of chlorid of

* Silliman's Journal [2] xxviii, 72.

sodium might acquire a considerable amount of chlorid of calcium; but it is probable that these reactions, however important they may be in relation to the soil, and to surface-waters with their feeble saline impregnation, have at present but little influence on the composition of the stronger saline waters. It is however not impossible that the action of the ancient sea-waters, holding a large amount of chlorid of calcium, upon the hydrated and half-decomposed feldspars which constituted the clays of the period, may have given rise to those double silicates which formed the lime-soda feldspars so abundant in the Labrador series.

§ 8. The reactions just described assume an importance in the case of waters impregnated with soluble matters from vegetable decay; and in this event, another and not less important class of phenomena intervenes, which are due to the deoxydizing power of the dissolved organic matter. By the action of this upon the insoluble peroxyd of iron set free from the decomposition of ferruginous minerals and disseminated in the sediments, protoxyd of iron is formed, which is soluble both in carbonic acid, and in the excess of the organic (acid) matter. By this means not only are great quantities of iron dissolved, but masses of sediments are sometimes entirely deprived of iron-oxyd, and thus beds of white clay and sand are formed. The waters thus charged with proto-salts of iron absorb oxygen when exposed to the air, and then deposit the metal as hydrated peroxyd, which when the organic matter is in excess, carries down a greater or less proportion of it in combination. Such organic matters are rarely absent from limonite, and in some specimens of ochre amount to as much as fifteen per cent.* The conditions under which hydrous peroxyd of manganese is often found are very similar to those of hydrous peroxyd of iron, with which it is so frequently associated; and there is little doubt that oxyd of manganese may be dissolved by a process like that just pointed out. A portion of manganese has been observed in the soluble matters from decaying peat-moss; and it seems to be generally present in small quantities with iron in surface-waters.

§ 9. There is reason to believe that alumina is also, under certain conditions, dissolved by waters holding organic acids. The existence of pigotite, a native compound of alumina with an organic acid, and the occasional association of gibbsite with limonite, point to such a reaction. That it is not more abundant in

* Geology of Canada, p. 512.

solution, is due to the fact, that, unlike most other metallic oxyds, alumina, instead of being separated in a free state by the slow decomposition of its silicious compounds, remains in combination with silica. The formation of bauxite, a mixture of hydrate of alumina with variable proportions of hydrous peroxyd of iron, which forms extensive beds in the tertiary sediments of the great Mediterranean basin, indicates a solution of alumina on a grand scale, and perhaps owes its origin to the decomposition of solutions of native alum by alkaline or earthy carbonates. Emery, a crystalline anhydrous form of alumina, has doubtless been formed in a similar manner. Silliman's Journal [2] xxxii, 287. The existence in many localities of an insoluble sub-sulphate of alumina, websterite, in layers and concretionary masses in tertiary clays, evidently points to such a process. Compounds consisting chiefly of hydrated alumina, are frequently found in fissures of the chalk in England. On the absence of free hydrated alumina from soils, see Müller, cited in Silliman's Journal [2] xxxv, 292.

§ 10. The organic matter dissolved by the surface-waters serves to reduce to the condition of sulphurets the various soluble sulphates which it takes up at the same time or meets with in its course. These sulphurets, decomposed by carbonic acid, which is in part derived from the atmosphere, and in part from the oxydation of the carbon of the organic matter, give rise to alkaline and earthy carbonates on the one hand, and to sulphuretted hydrogen on the other. In this way, under the influence of a somewhat elevated temperature, are generated sulphurous waters, whether of subterranean springs, or of tropical sea-marshes and lagoons. The reaction between the sulphurets thus formed and the salts or oxyds of iron, copper, and similar metals which may be present, gives rise to metallic sulphurets. The decomposition of sulphuretted hydrogen by the oxygen of the air, produces native sulphur; with which are generally found associated sulphates of lime and strontia. By virtue of these reactions, soluble sulphates of lime and magnesia may be completely eliminated from waters, the bases as insoluble carbonates, and the sulphur as sulphuretted hydrogen, free sulphur, or a metallic sulphuret. Moreover, as Forchhammer has pointed out in the paper already cited, sulphuret of potassium in the presence of ferruginous clays is also completely separated from solution, the sulphur as sulphuret of iron, and the alkali as a double aluminous silicate.

§ 11. We have thus far considered the composition of surface-waters as modified by the decay of vegetation, or by the reactions between the matters derived from this source and the permeated sediments. Not less important however than the elements thus removed by substitution from sedimentary strata are those which are liberated by the slow decomposition of the minerals composing these sediments.

It has long been known that in the transformation of a feldspar into kaolin, the double silicate of alumina and alkali takes up a portion of water, and is resolved into a hydrous silicate of alumina; while the alkali, together with a definite portion of silica, is separated in a soluble state. The feldspar, an anhydrous double salt formed at an elevated temperature, has a tendency under certain conditions to combine at a lower temperature with a portion of water, and break up into two simpler silicates. Daubrée has moreover shown that when kaolin is exposed to a heat of 400° C. in presence of a soluble silicate of potash, the two silicates unite and regenerate feldspar. These reactions are completely analogous to those presented by very many other double salts, ethers, amides, and similar compounds. The preliminary conditions of this conversion of feldspar into kaolin and a soluble alkaline silicate, however, still require investigation. It is known that while some feldspathic rocks appear almost unalterable, others containing the same species of feldspar are found converted to a depth of many feet from the surface into kaolin. This chemical alteration, according to Fournet, is always preceded by a mechanical change of the feldspar, which first becomes opaque and friable, and is thus rendered permeable to water. He conceives this alteration to be molecular, and to be connected with the passage of the silicate into a dimorphous or allotropic condition.*

§ 12. The researches of Ebelman on the alterations of various rocks and minerals have thrown considerable light on the relations of sediments and natural waters.† From the analyses of basaltic and similar rocks, which include silicates of lime, magnesia, iron, and manganese in the forms of pyroxene, hornblende, and olivine, and which undergo a slow and superficial decomposition under atmospheric influences, it appears that during the process of decay the greater part of the lime and magnesia is removed, together with a large proportion of silica. It was found moreover that in the case

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* Annales de Chimie [2] lv. 225.

† Ebelman, Recueil des Travaux, ii, 1–79.

of a rock apparently composed of labradorite and pyroxene, the removal of the lime and magnesia from the decomposed portion was much more complete than that of the alkalies; showing thus the comparatively greater stability of the feldspathic element. The decomposition of the feldspar in these mixed rocks is however at length effected, and the final result approximates to a hydrous silicate of alumina, or clay. This slow decomposition of silicates of protoxyd-bases appears to be due to the action of carbonic acid, which removing the lime and magnesia as carbonates, liberates the silica in a soluble form; while the iron and manganese passing to a state of higher oxydation, remain behind, unless the action of organic matters intervenes to give them solubility.

§ 13. It is to be remarked that apart from the peculiar and complete decomposition resulting in the production of kaolin, to which orthoclase, oligoclase, and some other feldspathides, as leucite, beryl, and perhaps also the scapolites and albite, are occasionally subject, orthoclase is less liable to change than the soda-feldspars, albite, oligoclase, and labradorite. Weathered surfaces of these become covered with a thin, soft, white, and opaque crust from decomposition, while the surfaces of orthoclase under similar conditions still preserve their hardness and translucency. The decomposition of feldspathides, and other aluminous double silicates, whether rapid and complete, or slow and partial, apparently yields the same results. A gradual process of this kind is constantly going on in the feldspathic matters which form a large proportion of the mechanical sediments of all formations; and in deeply buried *strata is not improbably accelerated by the elevation of* temperature. The soluble alkaline silicate resulting from this process is in most cases decomposed by carbonates of lime and magnesia in the sediments, giving rise to silicates of these bases (which are for the greater part separated in an insoluble state), and to carbonate of soda. *Only in rare cases does potash appear* in large proportion among the soluble salts thus liberated from sediments, partly because soda-feldspars are more subject to change, and partly from the fact that potash-salts would be separated from the percolating waters in virtue of the reactions mentioned in § 5. Hence it happens that apart from the neutral soda-salts of extraneous origin, waters permeating sediments containing alkaliferous silicates, generally bring to the surface little more than soda combined with carbonic and sometimes with boric acid, and carbonates of lime and magnesia with small portions of silica.

§ 14. This explanation of the decomposition of alkaliferous silicates and of the origin of carbonate of soda is opposed to the view of Bischof, who conceives that carbonic acid is the chief agent in decomposing feldspathic minerals.* The solvent action of waters charged with carbonic acid is undoubted, as shown by various experimenters, especially by the Messrs. Rogers,† but this acid is not always present in the quantities required. The proportion of it in atmospheric waters is so inadequate that it becomes necessary to suppose some subterranean source of the gas, which is by no means a constant accompaniment of natron-springs. A copious evolution of carbonic acid is observed in the vicinity of the lake of Laach, where the alkaline waters studied by Bischof occur.‡ The same thing is met with in many other localities of such springs, among which may be mentioned the region around Saratoga, where saline waters containing carbonate of soda, and highly charged with carbonic acid, rise in abundance from the Lower Silurian strata; but further northward, along the valleys of Lake Champlain and the St. Lawrence, similar alkaline-saline waters, which abound in the continuation of the same geological formations, are not at all acidulous. From this the conclusion seems justifiable that the production of carbonate of soda is a process, in some cases at least, independent of the presence of free carbonic acid. In this connection, it is well to recall the solvent power of pure water on alkaliferous silicates, as shown more especially by Bunsen, and also by Damour, who found that distilled water at temperatures much below 212° takes up from silicates like palagonite and calcined mesotype, comparatively large amounts both of silica and alkalies. (Damour, *Ann. Chim. et Phys.* [3] xix, 481.)

§ 15. Another and an important source of mineral impregnation to waters exists in the soluble salts enclosed in sedimentary strata, both in the solid state and in aqueous solution, and for the most part of marine origin. In order to form some conception of the amount of saline matters which may be contained in a dissolved state in the rocky strata of the earth, we have made numerous experiments to determine the porosity of various rocks; some few of the results of which may here be noticed. Fragments of the rocks were dried at a heat of 150° to 200° F., in a current of

* Bischof, Chem. Geol. ii, 181. † Silliman's Journal [2] v, 401.

‡ Bischof, Lehrbuch, i, 357-363.

dry air until they ceased to lose weight. They were then soaked in distilled water, and kept under it for many hours beneath an exhausted receiver. When thus saturated, they were wiped from adhering water, and weighed; first in air to determine the augmentation of weight from absorption, and secondly, in water to give, by the loss in weight, the volume of the specimens. These data furnish the means of determining the volume of water absorbed, which is given below for 100.00 parts of different rocks from the paleozoic strata of the St. Lawrence basin.

Potsdam	formation,	(sandstone)	3	specimens..	2.26—2.71
"	"	"	3	"	6.94—9.35
Calciferous	"	(crys. dolomite)	4	"	1.89—2.53
"	"	" "	2	"	5.90—7.22
Chazy	"	(argil. limestone)	4	"	6.45–13.55
Trenton	"	(grey crys. ")	4	"	1.18—1.70
"	"	(black impalp. ")	2	"	0.30—0.32
Utica	"	(black shale)	3	"	0.75—2.10
Hudson River	"	(arenac. ")......................			—7.94
Medina	"	(argil. sandstone)	2	specimens..	8.37–10.06
Guelph	"	(crys. dolomite)	3	"	9.34–10.60
Niagara	"	(impalp. ")	2	"	9.69–10.92

The above data might be much more extended, but sufficient have been given to show the porosity of the principal paleozoic rocks of the basin.*

§ 16. If we take for the Potsdam sandstone the mean of the first three trials, giving 2·5 per cent for the volume of water which it is capable of holding in its pores, we find that a thickness of 100 feet of it would contain in every square mile, in round numbers, 70,000,000 cubic feet of water; an amount which would supply a cubic foot (over seven gallons) a minute for more than thirteen years. The observed thickness of the Potsdam sandstone in the district of Montreal, varies from 200 to 700 feet, and the mean of 500 feet may be taken. To this are to be added 300 feet for the Calciferous formation, whose capacity for water may be taken, like the Potsdam sandstone, at 2·5 per cent. We have thus in each square mile of these formations, wherever they lie below the water-level, a volume of 490,000,000 cubic feet of water, equal to a supply of a cubic foot per minute for 106 years.

* A great many similar determinations will be found in a Report on Building Stones to the British House of Commons in 1839, by Barry, Delabeche, and Smith. See also Delesse, Bul. Soc. Géol. [2] xix, 64.

The capacity of the 800 feet of Chazy and Trenton limestones which succeed these lower formations, may be fairly taken at one half that of those just named. But it is unnecessary to multiply such calculations: enough has been said to show that these sedimentary strata include in their pores great quantities of water, which was originally that of the ocean of the p· leozoic age. These strata throughout the great Silurian basin of the St. Lawrence, are now for the greater part beneath the sea-level; nor is there any good reason for supposing them to have ever been elevated much above their present horizon. Wells and borings sunk in various places in these rocks show them to be still filled with bitter saline waters; but in regions where these rocks are inclined and dislocated, surface-waters gradually replace these saline waters, which in a mixed and diluted state appear as mineral springs. These saline solutions, other things being equal, will be better preserved in limestones or argillaceous rocks than in the more porous and permeable sandstones.

§ 17. But besides the saline matters thus disseminated in a dissolved state in ordinary sedimentary rocks, there are great volumes of saliferous strata, properly so called, charged with the results of the evaporation of ancient sea-basins. These strata enclose not only gypsum and rock-salt, but in some regions large quantities of the double chlorid of potassium and magnesium, carnallite; and in others sulphate of soda, sulphate of magnesia, and complex sulphates like blödite and polyhallite. Besides these crystalline salts, the mother liquors containing the more soluble and uncrystallizable compounds, may also be supposed to impregnate, in some cases, the sediments of these saliferous formations. The conditions under which these various salts are deposited from sea-water, and their relations to the composition of the ocean in earlier geological periods, are reserved for consideration in § 22. Infiltrating waters remove from these saliferous strata their soluble ingredients; which, together with the ancient sea-waters of other sedimentary rocks, give rise to the various neutral saline waters; while the mingling of these in various proportions with the alkaline waters whose origin has been described in § 13, produces intermediate classes of waters of much interest.

§ 18. I have elsewhere described the results of a series of experiments on the mutual action of the waters of these two classes.* When a dilute solution of bicarbonate of soda is gradu-

* Silliman's Journal [2] xxviii, 170.

ally added to a solution which, like sea-water, contains besides chlorid of sodium, the chlorids and sulphates of calcium and magnesium, the greater part of the lime separates as carbonate, carrying down with it only from one to three hundredths of carbonate of magnesia; a portion of lime however remaining in solution as bicarbonate. When the chlorid of calcium is wholly decomposed, the magnesian salt is attacked in its turn, and there finally results a solution in which the whole of the earthy chlorids are replaced by chlorid of sodium. A farther addition of the solution of carbonate of soda gives them the character of alkaline-saline waters; which moreover contain abundance of earthy carbonates.

The substitution of neutral carbonate for bicarbonate of soda in the above experiment does not affect the result, except in causing a somewhat larger proportion of magnesia to be thrown down with the carbonate of lime. The resulting liquid still retains large quantities of earthy carbonates in solution.*

§ 19. In the saline waters just considered, chlorids generally predominate, the sulphates being small in amount, and often altogether wanting. Some exceptions to this are however met with; for apart from waters impregnated with gypsum, whose origin is readily understood, there are others in which sulphate of soda or sulphate of magnesia enter largely. The soda-salt may sometimes be formed by the reaction between solution of gypsum and natriferous silicates referred to in § 7, or by the decomposition of gypsum by solution of carbonate of soda; while in other cases its origin will probably be found in the natural deposits of sulphates, such as glauberite, thenardite, and glauber-salt, which occur in saliferous rocks. A similar origin is probable for many of those springs in which sulphate of magnesia predominates. This salt also effloresces abundantly in a nearly pure form upon certain limestones, and is in some cases due to the action of sulphates from decomposing pyrites upon magnesian carbonate or silicate In by far the greater number of cases, however, its appearance is unconnected with any such process; and is, according to Mitscherlich, due to a reaction between dolomite and dissolved gypsum.

§ 20. In support of this view, it was found by the chemist just named that when a solution of sulphate of lime was made to filter for some time through pulverized magnesian limestone, it was decomposed with the formation of carbonate of lime and sulphate of

* Geol. Survey of Canada, Report 1853–56, p. 468.

magnesia. This reaction I have been unable to verify. A solution of gypsum in distilled water was made to percolate slowly through a column of several inches of finely powdered dolomite, and after ten filtrations, occupying as many days, no perceptible amount of sulphate of magnesia had been formed. Solutions of gypsum were then digested for many months with pulverized dolomite, and also with crystalline carbonate of magnesia, but with similar negative results; nor did the substitution of a solution of chlorid of calcium lead to the formation of any soluble magnesian salt. Solutions of gypsum were then impregnated with carbonic acid, and allowed to remain in contact with pulverized dolomite and with magnesite, as before, during six months of the warm season, when only inappreciable traces of magnesia were taken into solution. These experiments show that no decomposition of dissolved gypsum is effected by native carbonate of magnesia, or by the double carbonate of lime and magnesia, at ordinary temperature.

§ 21. I find however that hydrated carbonate of magnesia readily and completely decomposes a solution of gypsum when agitated with it, with formation of carbonate of lime and sulphate of magnesia; and the same result is produced with the native hydrate of magnesia when mingled with a solution of gypsum in presence of carbonic acid. Now there may be dolomites which contain an admixture of hydro-carbonate of magnesia, as there certainly are others which like predazzite, are penetrated with hydrate of magnesia. The reaction between solutions of gypsum and such magnesian limestones, (with the intervention, in the case of predazzite, of atmospheric carbonic acid,) would suffice to explain the results obtained by Mitscherlich, and the appearance in certain cases of sulphate of magnesia as an efflorescence on dolomites. In the experiments above described, the nearly pure crystalline dolomites from the Guelph and Niagara formations were made use of.

§ 22. When sea-water is exposed to spontaneous evaporation, the whole of the lime which it contains separates in the form of sulphate, gypsum being insoluble in a concentrated brine, and subsequently the greater portion of the chlorid of sodium crystallises out in a nearly pure state. The mother-liquor of specific gravity 1.24, having lost about four fifths of its chlorid of sodium, still contains a arge proportion of sulphate of magnesia. If the evaporation is continued at the ordinary temperature, till a density of 1.32 is attained, about one half of the magnesian sulphate separates, mixed with common salt; and by reducing the temperature to 6° C., a large portion of pure sulphate of magnesia now crystallizes out. The farther evaporation of the remaining liquor by the heat of summer causes the potassium-salt to separate in the form of a hydrous double chlorid of potassium and magnesium, an artificial carnallite.*

By varying somewhat the conditions of temperature, the sulphate of magnesia and the chlorid of sodium of the mother-liquor undergo mutual decomposition, with the production of sulphate of soda and chlorid of magnesium. Hydrated sulphate of soda crystallizes out from such a mixed solution at 0° C., and by reducing the temperature to —18° C. the greater part of the sulphates may be separated in this form from the mother-liquor of 1.24, previously diluted with one tenth of water; without which addition a mixture of hydrated chlorid of sodium would separate at the same time. If, on the other hand, the temperature of the mixed solution be raised above 50° C., the sulphate of soda crystallizes out in the anhydrous form, as thenardite. By the spontaneous evaporation during the heats of summer of the mother-liquors of density 1.35, a double sulphate of potassium and magnesium separates. These reactions are taken advantage of on a great scale in Balard's process, as modified by Merle,† for extracting salts from sea-water.

§ 23. *The results of the evaporation of sea-water would however* be widely different if an excess of lime-salt were present. In this case the whole of the sulphates present would be deposited in the form of gypsum at an early stage of the evaporation, and the mother-liquor, after the separation of the greater part of the common salt, would contain little else than the chlorids of sodium, potassium, calcium, and magnesium.

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* The hydrous double chlorid of potassium and magnesium (carnallite of H. Rose) occurs in large quantities in a stratum of clay overlying a great bed of rock-salt 100 feet thick, at Stassfurth in Prussia. It is associated with considerable quantities of sulphate of magnesia. According to Clemm, this sulphate of magnesia, to which the name of *kieserite* has been given, and which occurs also in Anhalt, contains but one equivalent of water, (MgO,SO_3+HO). It is not more soluble than gypsum, and unlike the ordinary sulphate of magnesia, loses the whole of its acid at a red heat in a current of steam, the acid passing off undecomposed. This salt is found in such large quantities as to be of economic importance. (Bull, Soc. Chim. de Paris, 1864, p. 297.)

† See my paper in Silliman's Journal [2] xxv. 361; also Report of the Juries of the Exhibition of 1862, class ii, p. 48.

§ 24. A consideration of the conditions of the ocean in earlier geological periods will show that it must have contained a much larger quantity of lime-salts than at present. The alkaline carbonates, whose origin has been described in § 13, and which from the earliest times have been flowing into the sea, have gradually modified the composition of its waters, separating the lime as carbonate, and thus replacing the chlorid of calcium by chlorid of sodium, as I have long since pointed out.* This reaction has doubtless been the source of all the carbonate of lime in the earth's crust, if we except that derived from the decomposition of calcareous silicates. (§ 12). In this decomposition by carbonate of soda, as already described in § 18, it results from the incompatibility of chlorid of calcium with hydrous carbonate of magnesia, that the lime is first precipitated, with a little adhering carbonate of magnesia; and it is only when the chlorid of calcium is all decomposed that the magnesian chlorid is transformed into carbonate of magnesia. This latter reaction can consequently take place only in limited basins, or in portions cut off from the oceanic circulation.

§ 25. It follows from what has been said that the lime-salt may be eliminated from sea-water either as sulphate or as carbonate. In the latter case no concentration is required; while in the former the conditions are two,—a sufficient proportion of sulphates to convert the whole of the lime into gypsum, and such a degree of concentration of the water as to render this insoluble. These conditions meet in the evaporation of modern sea-water; but the evaporated sea-water of earlier periods, with its great predominance of lime-salts, would still contain large amounts of chlorid of calcium; the insolubility of gypsum in this case serving to eliminate all the sulphates from the mother-liquor. Evaporation alone would not suffice to remove the whole of the lime-salts from waters in which the calcium present was more than equivalent to the sulphuric acid; but the intervention of carbonate of soda would be required.

§ 26. In concentrated and evaporating waters freed from lime-salts by either of the reactions just mentioned, but still holding sulphate of magnesia, another process, which I have elsewhere described, may intervene.† The addition of a solution of bicarbon-

* Canadian Journal for 1858, p. 202; Silliman's Journal [2] xxv, 102, and *Comptes Rendus*, June 9, 1862, p. 1191.

† Silliman's Journal [2] xxviii, 174.

ate of lime to such a solution gives rise, by double decomposition, to sulphate of lime and bicarbonate of magnesia. The former being much the less soluble salt, especially in a strongly saline liquid, is deposited as gypsum; and subsequently the magnesian carbonate is precipitated in a hydrous form. The effect of this reaction is to eliminate from the sea-water both the sulphuric acid and the magnesia, without the permanent addition to it of any foreign element.

§ 27. Gypsum may thus be separated from sea-water by two distinct processes,—the one a reaction between sulphate of magnesia and chlorid of calcium, and the other between the same sulphate and carbonate of lime. The latter, involving a separation of bicarbonate of magnesia, can, as we have seen, only take place when the whole of the chlorid of calcium has been eliminated; and if we suppose the ancient ocean, unlike the present, to have contained more than an equivalent of lime for each equivalent of sulphuric acid, it is evident that a lake or basin of sea-water free from lime-salts could only have been produced by the intervention of carbonate of soda. The action of this must have eliminated the whole of the lime as carbonate, or at least have so far reduced the amount of this base that the sulphates present would be sufficient to separate the remainder by evaporation in the form of gypsum, and still leave in the mother-liquor a quantity of sulphate of magnesia for reaction with bicarbonate of lime.

The source of the magnesian carbonate, whose union, under certain conditions, with the carbonate of lime, gives rise to dolomite,* may thus be due either to the reaction just described between bicarbonate of lime and solutions holding sulphate of magnesia, or to the direct action of carbonate of soda upon waters containing magnesian salts; but in either case the previous elimination of the incompatible chlorid of calcium must be considered an indispensable preliminary to the production of the magnesian carbonate.

§ 28. To the three principal sources of mineral matters in mineral waters already enumerated, viz., decaying organic matters, decomposing silicates, and the soluble saline matters in rocks, a few other minor ones must be added. One of these is the oxydation of metallic sulphurets, chiefly iron pyrites, giving rise to sulphate of

* Silliman's Journal [2] xxviii, 180–186; and further, Geol. Survey of Canada, Report for 1859, 214–218.

iron, and more rarely to sulphates of copper, zinc, cobalt, and nickel; and by secondary reactions to sulphates of alumina, lime, magnesia, and alkalies. This process of oxydation is necessarily superficial and local, but the soluble sulphates thus formed have probably played a not unimportant part. (§ 9.)

§ 29. Besides these last, which contain chiefly neutral and acid salts, there is another class of waters characterized by the presence of free sulphuric or hydrochloric acid, or both together. These acid waters sometimes occur as products of volcanic action, during which both hydrochloric acid and sulphur are often evolved in large quantities. This latter element generally comes to the surface as sulphuretted hydrogen, which by the oxydation of the hydrogen may deposit its sulphur in craters and fissures. In other cases, as shown by Dumas, the sulphur and hydrogen may be slowly and simultaneously oxydized at a low temperature, giving rise directly to sulphuric acid. Not less frequent, however, is probably the direct conversion, by combustion, of the sulphuretted hydrogen into water and sulphurous acid, which afterwards absorbing oxygen from the air is converted into sulphuric acid.

§ 30. The source of the hydrochloric acid and the sulphur of volcanoes is probably the decomposition of chlorids and sulphates at high temperatures. It is known that for the decomposition of earthy chlorids, water and an elevated temperature are sufficient; and at a higher temperature, chlorid of sodium is readily decomposed in presence of silicious and aluminous minerals, with the intervention of water. Another agency which probably comes into play in volcanic phenomena is that of organic matters, which, reducing the sulphates to sulphurets, enable the sulphur to be subsequently disengaged as sulphuretted hydrogen by the operation of water, either with or without the intervention of carbonic acid or of silicious and argillaceous matters. Even in cases where this reducing action is excluded, the ignition of sulphates in contact with earthy matters must liberate the sulphuric acid as a mixture of sulphurous acid and oxygen; and these uniting in their distillation upward through the strata, may give rise to springs of sulphuric acid.* To reactions similar to those just noticed, involving borates like stassfurthite and hayesine, or boric silicates like tourmaline, etc., are to be ascribed the large amounts of boric acid which are sublimed in some volcanoes, or volatilized with the watery vapor of the Tuscan *suffioni*.

* See the note to § 22, on kieserite.

§ 31. The action of subterranean heat upon buried strata containing sulphates and chlorids is then sufficient to explain the appearance of hydrochloric and sulphurous acids and sulphur, even without the intervention of organic matters, which are, however, seldom or never wanting; whether as coal, lignite, bitumen, and pyro-schists, or in a more divided condition. The presence of hydrogen and of marsh-gas, as observed by Deville among volcanic products, is an evidence of this. The generation of marsh-gas is, however, in most cases clearly unconnected with volcanic action or subterranean heat.

To the decomposition of carbonates in buried strata by silicious matters, with the aid of heat, is to be ascribed the great amounts of carbonic acid gas which are in many places evolved from the earth, and, impregnating the infiltrating waters, give rise to acidulous springs. The principal sources of this gas in Europe are in regions adjoining volcanoes, either active or recently extinct; but their occurrence in the paleozoic strata of the United States, far remote from any evidence of volcanic phenomena other than slightly thermal springs, shows that an action too gentle or too deeply-seated to manifest itself in igneous eruptions, may evolve carbonic acid abundantly. The sulphuric acid springs of western New York and Canada, to be described further on, are not less remarkable illustrations of the same fact.

§ 32. The frequent presence of ammoniacal salts in volcanic exhalations is here worthy of notice, especially when considered in connection with the rarity of nitric and ammoniacal compounds in natural waters, except in some local conditions, as in the wells of cities, etc., where they are sometimes observed in comparatively large amounts. The explanation of this is evident; for although nitrates themselves are not directly removed from the water, they are, by the reducing action of organic matters, converted into ammonia, which is retained by the soil. In consequence of this affinity, the argillaceous strata, whether of the present period or of older formations, hold in a very fixed form a considerable quantity of nitrogen. This, from the slowness with which it is eliminated in the form of ammonia under the influence of alkaline solutions, probably exists as an ammoniacal silicate. (§ 6.) The action of acids, however, as well as alkalies, may be supposed to liberate it from its combination, and thus generate the ammoniacal salts which are such frequent accompaniments of volcanic phenomena. The numerous experiments of Delesse show that ammonia, or at least nitrogen capable of being evolved by heat and alkalies in the form of ammonia, is present in the limestones, marls, argillites, and sandstones of former geological periods, in qualities scarcely inferior to those in similar deposits of modern times, amounting, for most of the ancient sedimentary strata, to from one to five thousands of nitrogen ;* from which it will be seen that the amount of this element thus retained in the rocky strata of the earth's crust is very great.†

§ 33. If we attempt a chemical classification of natural waters in accordance with the principles laid down in the preceding sections, they may be considered under the following heads:

A. Atmospheric waters.
B. Waters impregnated with the soluble products of vegetable decay.
C. Waters impregnated with the salts from decomposing feldspathic rocks, and holding a portion of carbonate of soda as a characteristic ingredient.
D. Waters holding neutral salts of sodium, calcium, or magnesium from strata where they existed as solid salts, or as impregnating brines.
E. Waters holding chiefly sulphates from decomposing pyrites; copperas and alum waters.
F. Waters holding free sulphuric or hydrochloric acid.

§ 34. The name of mineral waters is popularly applied only to such as contain sufficient foreign matters to give them a decided taste; and hence the waters of the divisions A and B, and many of the feebler ones of C and D, are excluded. Those of E and F have peculiar local sources; but those of C and D are often associated in adjacent geological formations, and their commingling in various proportions gives rise to mineral waters intermediate in composition. In accordance with these considerations, a classification of mineral waters for technical purposes was adopted by me in the *Geology of Canada*, p. 531, including only those of C, D, and F, which were arranged in six classes.

I. Saline waters containing chlorid of sodium, often with large portions of chlorids of calcium and magnesium, with or

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* *Ann. des Mines* [5], xviii, 151–523.

† For an exposition of the views put forward in the four preceding sections, see my paper in the Canadian Journal for 1858, p. 206.

without sulphates. The carbonates of lime and magnesia are either wanting, or present only in small quantities. These waters are generally bitter to the taste, and may be designated as brines or bitterns.

II. Saline waters which differ from the last in containing, besides the chlorids just mentioned, considerable quantities of carbonates of lime and magnesia. These waters generally contain much smaller proportions of earthy chlorids than the first class, and are hence less bitter to the taste.

III. Saline waters which contain, besides chlorid of sodium and the carbonates of lime and magnesia, a portion of carbonate of soda.

IV. Waters which differ from the last in containing but a small proportion of chlorid of sodium, and in which the carbonate of soda predominates. The waters of this class generally contain much less solid matter than the three previous classes, and have not a very marked taste until evaporated to a small volume, when they will be found, like the last, to be strongly alkaline.

Of these four classes, I corresponds to the division D, and IV to C, while II and III are regarded as resulting from the admixture of these in varying proportions. Sulphates are sometimes present in these waters, but never predominate; in their absence, salts of barium and strontium are often met with. The chlorids are generally, if not always, associated with bromids and iodids. Small quantities of potassium-salts are also present, while borates, phosphates, silicates, and small portions of iron, manganese, and alumina, are generally present. These various waters are occasionally sulphurous, and those of the last three classes may be impregnated with carbonic acid.

V. The fifth class includes acid waters remarkable for containing a large proportion of free sulphuric acid, with sulphates of lime, magnesia, portions of iron, and alumina. These waters, which are characterized by their sour and styptic taste, generally contain some sulphuretted hydrogen.

VI. The sixth class includes some neutral saline waters, in which the sulphates of lime, magnesia, and the alkalies predominate, chlorids being present only in small quantities. These waters, like the last, are often impregnated with sulphuretted hydrogen.

The above classification, although adopted originally for the convenient description of the mineral waters of Canada, will, it is thought, be found to embrace all known classes of natural waters, with the exception of those included under E, and of some waters from volcanic sources holding muriatic acid. These may constitute two additional classes. In the first three of the classes above described, chlorids predominate; in the fourth, carbonates; and in the fifth and sixth, sulphates. The waters of the first, second, and sixth classes are neutral; those of the third and fourth, alkaline; and those of the fifth, acid.

The results of the chemical analysis of various waters of these classes, it is proposed to give in the second part of this paper.—*From Silliman's American Journal of Science*, No. 116, 1865.

ON THE RELATIVE POWERS OF GLACIERS AND FLOATING ICEBERGS

IN MODIFYING THE SURFACE OF THE EARTH.

By Sir Roderick I. Murchison.

Before I enter on the consideration of the new theory of the power of moving ice, let us take a review of the progress recently made in pointing out the extent to which ancient glaciers and their moraines have ranged within or on the flanks of the Alps. In the northern portions of the chain these phenomena long ago attracted the attention of some admirable observers. Originating with Venetz and Charpentier, the true active powers of glaciers were defined by Rendu, Agassiz, and Forbes, and subsequently by other explorers. In short, no doubt any longer obtains, that such was the powerful agency of the grand ancient glaciers, that blocks of crystalline rock were transported by them from the central Alps of Mont Blanc to the slopes of the Jura Mountains. When, however, we begin to seek for satisfactory explanations of the method of transport of these huge erratics, geologists (who are only geographers of another order) entertained different opinions. For my own part, I have had strong doubts as to whether the great blocks derived from Mont Blanc, and which lie on the slopes of the Jura, were ever borne thither by a vast solid glacier which advanced from the Lake of Geneva over the Cantons of Vaud and Neufchatel. Whilst fully believing in the great power of glaciers and their agency, my opinion was that these blocks were rather transported to their present habitats on the Jura on ice-rafts, which were floated away in water to the N.N.W., when the great glaciers melted, and the low countries were flooded. I founded this opinion on the fact, that in examining the Canton de Vaud, and particularly the tracts near Lausanne and the north side of the lake of Geneva, I never could detect the trace of true moraines. In that detritus I saw merely accumulations of loose materials, which had all the aspect of having been accumulated under running waters. But, even granting to the land-glacialists their full demand, and supposing that a gigantic glacier was formerly spread out in fan-shape, as laid down by *several geologists*, and *recently in the little map of Sir Charles* Lyell, in his work on the Antiquity of Man, and that it became eventually of such enormous thickness as to have carried up the great blocks on its surface, to lodge them on the Jura Mountains; there is still in it nothing which supports the opinion, as indeed Sir Charles has himself observed,* that the deep cavity in which the lake lies was *excavated* by ice.

The geologists who first embraced the view of the transport of the huge blocks on the Jura by a solid glacier, were of opinion that the great depressions and irregularities of the surface which we now see between the Alps and the Jura, including the lakes of Geneva and Neufchatel, were so filled up with snow and ice, that the advancing glaciers travelled on them as bridges of ice, the foundations of which occupied the cavities.

Let us now turn to the south side of the Alps, where a long incline accounts for the enormous extension of glaciers into the plains of Italy. Thus, in examining the remains of the old glaciers which once advanced into the valley of the Po, MM. Martins and Gastaldi show us, that one of these bodies extended from Mount Tabor to Rivoli, a length of fifty miles; and, therefore, was longer than any existing glacier described on the flanks of the Himalayas; † whilst those to the south of the Lago di Garda are shown to have had a much greater length. Demonstrating, along with many other authors, how these old glaciers had striated and polished the hard rocks through or on which they had advanced, these authors also clearly pointed out how the course of the glaciers had been deflected, so as to take a new direction, when they met with the

* See 'Antiquity of Man,' p. 312.

† Bull. Soc. Geol. de France, 1850.

obstruction of any promontory of hard rock. Further, M. Martins, being well acquainted with Norway, indicated that, just as in that country, the face of each rock in a valley was rounded off, polished, and striated where it had been opposed to the advancing mass of ice, and that its opposite or downward face, over which the ice had cascaded or tumbled, was left in a rough state; thus exhibiting the worn or "stoss-seite," and lee, or protected side, of the Scandinavian geologists. The subsequent works of M. Gastaldi on the geology of Piedmont, in 1853 and in 1861, bring within well-defined limits the phenomena of old moraines and ancient drift, and prove that the débris carried over each gorge and valley has been derived from the rocks which specially encase such depressions. He also clearly demonstrated that in many of these cases the gigantic boulders which are piled together and present the character of a cataclysmal origin, can all be accounted for simply by the power of advancing ancient glaciers. In these works M. Gastaldi very properly distinguishes between the erratic blocks which were evidently parts of old terrestrial moraines, and those which, associated with tertiary strata, are found in deposits with marine shells—the larger erratics in the latter, as in the Superga, having been transported in masses of ice which floated on the then sea.

Various other Italian authors have occupied themselves with glacial phenomena (particularly Omboni, Villa, Stoppani, Cornalia, Paglia, Parolini, &c.); the conclusion at which they have all arrived is, that there existed an enormous extension of the moraines sent forth by the ancient Alpine glaciers into the great valley of the Po. Geographers who have not studied the phenomena may well indeed be surprised when they learn, that the hills to the south of the Lago di Garda, and extending by Pozzolengo and Solferino to Cavriano,* or the very ground where the great battles of the year 1859 were fought (the hill of Solferino being 656 English feet above the sea), are simply great moraines of blocks and gravel, produced by the advance of former glaciers which issued from the southern slopes of the Alps.

Combining these observations with others of his own on the lake of Annecy, M. Mortillet suggested in 1862 a new theory, in attributing to the descent of the glaciers a great excavating power.

* See Paglio, 'Sulle Colline del Terreno Erratico all' estremità meridionale del Laga di Garda' (with map).

Believing, with all those who have been named, as well as with the most eminent of the Swiss and French geologists, that the last great up-heavals and denudations of the Alps had produced the irregularities of their surface, he inferred that before the glacial period began, the débris derived from the wear and tear of the mountains by watery action had, to a great extent, choked up the valleys and filled the rock-basins. He further believed that, in the cold period which followed, great glaciers, descending with enormous power, forced all such débris out of the original rock-basins, and left them to be occupied by the present lakes. It is proper here to state that M. Gastaldi was right, as well as M. Mortillet, who followed him, in presuming that great deposits of old water-worn alluvium or loose drift were accumulated before the formation of glaciers, inasmuch as the oldest moraines are seen to repose in many places on the former. It will presently be shown that this fact contains within it the proof that the glaciers were not and are not in themselves excavating bodies.

Preceding M. Mortillet, however, in reasoning upon the excavating power of former glaciers, my eminent associate, Professor Ramsay, had broached a much bolder theory. In his essay entitled "The Old Glaciers of Switzerland and North Wales," published in 1859, and republished with additions in 1860, he expressed the opinion that the excavation of deep hollows in solid rocks was due to a weight of superincumbent ice pressing and grinding *downwards and outwards*, over high, flat, and sometimes broad water-sheds and table-lands, during that period of intense cold which produced the old glaciers.* In 1862 he went still further; and whilst M. Mortillet was communicating his views on the continent, Ramsay, wholly unconscious of what M. Mortillet was doing, read a memoir to the Geological Society of London, showing that all the cavities occupied by lakes in Switzerland and the North of Italy had been excavated originally by the action of glacier ice. Whatever, therefore, be the fate of this ingenious view, Professor Ramsay has our thanks for having excited much useful enquiry, and for having compelled old geologists like myself to reconsider our conclusions.

If the view of M. Mortillet has been met with objections, still more is the theory of Ramsay opposed, and particularly in foreign

*See 'Peaks, Passes,' &c., (Alpine Journal, 1859,) and 'The Old Glaciers of Switzerland and North Wales,' London, 1860, p. 110.

lands. In this country it has indeed met with the most vigorous opposition on the part of Dr. Falconer, as recorded in our proceedings: and even Sir Charles Lyell, the great advocate of the power of existing causes, has stoutly opposed this bold extension of a most powerful *vera causa*.* Having explored the Alps, at various intervals, for upwards of forty years, I long ago came to the conclusion that their chief cavities, vertical precipices, and subtending, deep, narrow gorges, were *originally* determined by movements and openings of the crust, whether arranged in anticlinal or synclinal lines, or not less frequently modified by great transversal or lateral breaks, at right angles to the longitudinal or main folds of elevation and depression. Explorations of other mountainous regions, in various parts of Europe, have strengthened this conviction. I rejoice, therefore, to find that those geologists of Switzerland, who justly stand at the head of their profession, Professor Studer and M. Escher von der Linth, have sustained, by numerous appeals to nature, the views I hold in common with the great majority of geologists. Those Swiss explorers, who have labored for many years in their native Alps, and have constructed admirable geolological maps of them, must surely be well acquainted with the ruptures of the various rocks, the outlines of which they have sedulously followed. Now, they attribute most of those deep cavities in which the rivers and lakes occur, either to dislocations producing abrupt fissures, or to great foldings of the strata leaving openings upwards where the tension has been the greatest—openings which were enlarged by powerful denudations. Numerous geologists have recently expressed their concurrence in the generally adopted view, that the Alpine lakes occupy such orographic depressions; and by close researches, my accomplished friend, Mr. John Ball † has ably sustained this view, and has further shown how slight is the erosive power of a glacier even when issuing from its main source. No one of them in short, any more than Professor Studer and myself, doubts that the origin of these lakes is primarily due to other causes. Nor am I aware that any geologists of France and Germany, much as many of them have examined the Alps, have deviated from the opinion that the main diversity of outline in that chain was due to ruptures and denudations that occurred during the upheavals of the chain.

* See 'Antiquity of Man,' pp. 316 *et seq.*

† See 'Phil. Mag.' 1863.

On the other hand, I am bound to state that, although the new theory has met with little or no favor on the continent of Europe, it is supported by our able geologists, Jukes and Geikie. Again, whilst Ramsay extended his view to the great lakes of the Alps, the eminent physicist Tyndall speculated even upon all the Alpine valleys having been formed by the long processes of the melting of snows and the erosion of ice.* With every respect for the reasoning of my distinguished countryman, I rely upon my long acquaintance with the structure of the Alpine chain; and now that I see sound practical geologists, who have passed their lives in examining every recess of those mountains, rejecting this new theory, and pointing out in place of it, the proofs of ruptures and denudations in the chain, I adhere firmly to the view I have long entertained.†

Those who wish to analyze this matter, must consult the admirable essay of Professor Studer on the origin of the Swiss lakes.‡ They will find numerous proofs of the views sustained by the leader of Alpine geologists. He shows you, indeed, how many of the rivers now flow in fissures or deep chasms in very hard rocks of different composition; chasms which water alone could never have opened out, particularly in those cases where the river has left a softer rock, and, with very slight obstacles to its straight course, has availed itself of one of these deep transverse natural gorges, which have evidently been produced by a great former rent. My

* See Tyndall on the Conformation of the Alps, 'Phil. Mag.' vol. xiv, 1862, p. 169, and also Ramsay on the Excavations of the Alps, xvi, p. 377.

† Some remarkable facts have been mentioned to me in a letter by M. Escher von der Linth, as proving the inapplicability of the ice-erosion theory to the Swiss lakes. 1st. That the glacier of Rosenlaui, which descends from a great altitude, does not enter a low deep narrow gorge of the valley, but forms a bridge over it; and so it is to be inferred, that as the ancient glacier did not excavate this gorge, still less did it excavate the great valley in which the present glacier is embosomed. Again: he points out that, as the bottoms of many of the Swiss lakes are below the level of the sea, the glacier which is supposed to have excavated the hollow would have had to ascend considerable heights to emerge from the depression which it had excavated—an impossible movement, and contradicted by the existing operations of all glaciers.

‡ 'Origine des Lacs Suisses,' Biblio. Univ. et Revue Suisse (Arch. des Sci. Phys. et Nat.) xix, liv. de Février, 1864; also Phil. Mag., vol. xxvii, p. 481.

personal observations in the Alps, Carpathians, and Ural mountains enable me to confirm this view. As regards the continent of Europe, I should transport you to the Rhine, the Danube, and other great streams, which, flowing through flat countries with little declivity, never could have eroded those deep, abrupt gorges through which they here and there flow, and which are manifestly due to original ruptures of the rocks.*

In holding these opinions as to the small power of watery or glacial action, when not acting on an adequate incline, I do not doubt that glaciers have been, and still are, most important agents in modifying the outlines of mountains. Their summits are, we know, continually degraded by rains and melted snows, and torrents flowing down from them and carrying much detritus, are, doubtless, deepening their channels wherever sufficient slopes occur. But to whatever extent this agency has been and is at work, and to however great a degree a descending glacier may scratch and round off the rocky bottom on which it advances, I coincide with Professor Studer, and with many other observers, that the amount of erosion produced by these icy masses, particularly when they have advanced into valleys where there is only a slight inclination, must be exceedingly small. In valleys with a very slight descent it will presently be shown that, even in the Alps, no erosion whatever takes place, particularly as the bottom of the glacier is usually separated from the subjacent rock or vegetable soil by water arising from the melting of the ice. Again, in all the steeper valleys down which ancient glaciers have formerly descended, we do not find that either the sides or bottoms of the upper gorges afford any proof of wide erosion, but only exhibit the peculiar fashioning of the flanking surfaces of the rocks, or that rounding off and polishing, called *moutonné*, accompanied with striations. On the contrary, in gorges whence the largest glaciers have advanced for ages, we meet with islands of solid rock and little bosses still standing out, even in the midst of valleys down which the icy stream has swept.

With such proofs before us of what the frozen rivers called glaciers have done and are doing in the high valleys, how can we

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* The recent Russian exploration of Eastern Siberia has shown how the grand river Amur deflects suddenly at nearly right angles from its course in a comparatively low country, to take advantage of a deep natural rent in the mountains through which it escapes to the seaboard (see p. 201 of the present Address to the Royal Geographical Society).

imagine, as Dr. Falconer has forcibly put it, that the glacier which is supposed to have occupied the Lago Maggiore, for example, and had advanced its moraines into the plains of the Po, should have had the power to plough its way down to a depth of 2000 feet below the Mediterranean, and then to rise up along an incline at the rate of 180 feet per mile? Nor can I admit the possible application of this ice-excavating theory wherever I see that a depression in which a lake occurs is at right angles to the discharge of an old main glacier. This is remarkably to be noticed in the case of the Lake of Geneva, which trends from E. to W., whilst the detritus and blocks sent forth by the old glacier of the Rhone have all proceded to the N. and N.N.W.; or in direct continuation of the line of march of the glacier which issued from the narrow gorge of the Rhone. By what momentum, then, was the glacier to be so deflected to the west that it could channel or scoop out, on flat ground, the great hollow now occupied by the Lake of Geneva? And, after effecting this wonderful operation, how was it to be propelled upwards from this cavity on the ascent, to great heights on the slopes of the Jura mountains?

Still stronger objections exist to the application of the excavation theory to the Lake of Constance. There I have never been able to see on the northern flank of the Hohe Sentis, which presents its abrupt, precipitous, and highly dislocated and contorted jurassic and cretaceous rocks to the lake, with terraces of miocene deposits, at various heights,—there I have been unable, when with my indefatigable friend and companion, M. Escher von der Linth, who knows every inch of the ground, to trace the signs of the action of a great glacier, which could, in its descent, have so plunged into the flat region on the east and north, as to have scooped out the cavity in which the Lake of Constance lies. In this case, indeed, there are no traces whatever of those great old moraines from the relics of which we infer that glaciers have formerly advanced; the level country to the north of the lake being entirely free from them.

Great orographic depressions and deep cavities, sometimes dry, sometimes filled with water, occur in numberless countries where no glaciers ever existed. Thus, in Spain, as my colleague, M. de Verneuil assures me, the large depressions on either side of the granite mountains of the Guadarramma present exactly the appearance which a theorist might attribute to excavation by ice, and yet, however these cavities were formed, it is certain that no glacier has ever existed there. Nor, again, has ice ever acted on the sides of the steep mountains of Murcia, where deep excavations and denudations are seen upon the grandest Alpine scale.

If we 'transport ourselves from those southern climes to the northern latitudes of the Ural mountains, where doubtless ice and snow formerly prevailed to a greater extent than now, we do not there find any proof whatever of the action of glaciers; for the hills are much too low to have given propulsion to such masses. On the contrary, we know that great blocks of hard rocks have been transported to the foot of these hills from Lapland and Scandinavia, when, during the glacial period, a vast Arctic Sea watered the flanks of the Ural mountains, and when most parts of that low chain could then have been only slightly elevated above the waters. And yet on the sides of this chain, where no glaciers have ever so acted as to produce erosion, we meet with both longitudinal and transverse deep fissures in some of which lakes, and in others rivers, occur. Thus, all along the eastern flank of the Ural mountains we find a succession of depressions filled with water, without a trace, on the sides of the bare and hard rocks which subtend these lakes, of any former action of glaciers. Then, as to deep valleys in which rivers flow, let us take two out of the examples along the western flank of this chain, on which my companions De Verneuil and Keyserling, and myself, have specially dwelt in our work on Russia. The Serebrianka River, as it issues from a network of metamorphic schists, quartz-rocks, and marbles of Silurian age, exhibits on its rugged banks the extrusion of much igneous matter. This agency has split up the stratified deposits; and the necessarily accompanying movements have caused great openings, including the cavity in which the river flows. Or, when the geological traveller passes from the valley of the Serebrianka to that of its recipient, the Tchussovaya, still more is he struck with wonderment at the unquestionable evidences, amidst intensely dislocated rocks, of the ruptures by which the deep narrow chasm has been formed in hard crystalline rocks, in which a lazy stream flows, which, not descending from any altitude, has had no excavating power whetever, and, like our own meandering Wye, has flowed on through clefts in limestone during the whole historic and prehistoric period, without deepening its bed.*

* For a full description of the abrupt gorge of the Tchussovaya, see 'Russia and the Ural Mountains,' vol. i, p. 352 *et seq.*

But if rivers which are not torrential, and do not descend from heights, cannot possibly have produced, nor even have deepened, the natural hollows or chasms in which they flow, still it might be contended that, what water has not effected, may have been done by a river, when, in the compacter form of ice, it descended and advanced across the lower country. Unluckily for the supporters of the ice-excavating theory, the data which existing nature presents to us, as before said, are decisively opposed to their view. The examination of those tracts over which glaciers have advanced, and from which they have retreated, shows, in the most convincing manner, that ice has so much plasticity that it has always moulded itself upon the inequalities of hard rocks over which it passed, and, merely pushing on the loose detritus which it meets with, or carries along with it from the sides of the upper mountains, has never excavated the lateral valleys, nor even cleared out their old alluvia. This fact was well noticed by the Swiss naturalists, as evidenced by present operations, at their last meeting in the Upper Engadine, and has been well recorded by that experienced and sagacious observer of glacial phenomena, M. Martins.*

Since that time the able French geologist, M. Collomb, who was associated with Agassiz in his earliest researches on glaciers, and has been the companion, in Spain, of my colleague, M. de Verneuil, has recently put into my hands the results of his own observation upon the present and former agency of the glaciers of the Alps, which decisively show that ice, *per se*, neither has nor has had any excavating power.† None of the glaciers of the Alps cited by M. Collomb, viz., those of the Rhone, the Aar, the Valley of Chamounix, the Allée Blanche, and the valley of Zermatt, produce any excavation in the lower grounds over which they pass. That of Göerner, which, among others, is advancing, affects very slightly the surface of the meadows on which it proceeds, and does not penetrate into the soil. Again, where the glacier of the lower Aar pushes, on its front, upon accumulations of the débris of old moraines and gravel, it scarcely deranges these materials, but slides over them, leaving them covered with mud and sand, but not

* See 'Revue des Deux Mondes,' March, 1864. The former observations of M. Martins on Norway and on the Alps are of the highest importance.

† I may add that M. Collomb expresses that which I believe to be the opinion of Elie de Beaumont, d'Archiac, De Verneuil, Daubrée, and of all the leading French geologists.

excavating them. Also, the glacier of the Rhone, the principal part of which can be so conveniently studied, advances on a gravelly substratum, in which it does not form a channel. Such being the facts as regards glaciers now advancing, M. Collomb cites equally strong, if not still stronger, cases, in support of his view, as derived from the observation of retiring or shrinking glaciers in the valleys of the Alps. Examining last year with M. Daubrée the glaciers of the Valley of Chamounix, he was attracted to that named Bossons, which he had not seen for five years. During that time the glacier had shrunk very considerably, both in altitude and length, and yet upon the surface of the ground from which it had retired there was not the smallest sign of excavation.

Viewing a glacier as a plastic body, we know that it is pressed onwards by gravitation from the increasing and descending masses of snow and ice behind it in the loftier mountains, and, being forced to descend through narrow gorges, it naturally acts with the greater energy on the precipitous rocky flanks of these openings; striating and polishing them with the sand, blocks, and pebbles which it holds in its grasp. But, as before touched upon, the narrowness of many of those channels through which glaciers have been thrust for countless ages, is in itself a demonstration that the ice can have done very little in widening the gorge through which it has been forced, and where, of necessity, it exerted by far its greatest power. In other words, the flanking rocks of each gorge have proved infinitely more stubborn than the ice and its embedded stones, which have merely served as gravers and polishers of the granites, quartz rocks, porphyries, slates, marbles, or other hard rocks, among which the frozen river has descended. And, if such has been the amount of influence of advancing glaciers in the higher regions, where the body descends with the greatest power, how are we to believe that when this creeping mass of ice arrived in low countries (as for instance in the depressions occupied by the Lakes of Geneva and Constance) it could have exerted a power infinitely greater than that which it possessed in the higher regions?

When we turn from modern glaciers to the remains of those of ancient date, the proofs are equally decisive, that, whatever might be their extent, those gigantic bodies exercised no excavating power. I am reminded by M. Collomb, as well as by M. Escher von der Linth, that in many parts of the Alps, vast old moraines repose directly on incoherent and loose materials of quaternary age; the old drift of the Alps containing *Elephas primigenius* and

Rhinoceros tichorhinus. Well may we then ask, how is it that the ancient and larger glaciers, which were supposed to have had such enormous excavating power as to have scooped out deep valleys in hard rocks, should not have entirely destroyed the loose accumulation of gravel over which they have been spread? Or, if glaciers excavated the Lago di Garda and Lago Maggoire, why did they not produce any such effect at Ivrea, in the Valley of Aosta, down which we know that enormous masses of ice travelled; or at Rivoli, in their march from Mount Cenis towards Turin?

Leaving it to physical philosophers, such as Forbes, Faraday, Hopkins, and Tyndall, to show what is the real measure of the abrading power of masses of moving ice, I simply form my opinion from what glaciers are accomplishing, or have accomplished. Judging from positive data, I infer that if, as agents, they have been wholly incapable of removing even the old and loose alluvial drift which encumbered the valleys, infinitely less had they the power of excavating hard rocks. At the same time I know that, in every mountain tract which I have examined, there have been quite a sufficient number of rents and denudations to account for all inequalities. These openings have doubtless been greatly increased by the atmospheric agencies of ages, and particularly in all those situations where water has acted with great power, during the melting of glaciers. * * * * * * * * * * * *

Whilst I was reading this Address to the Geographers in London, that sound practical geologist, Principal Dawson, was performing a similar duty at the Annual Meeting of the Natural History Society of Montreal. Having received a copy of his Address in time for insertion of a Postcript, I am glad to have the opportunity of stating that he also is a vigorous opponent of the theory which refers the striation of the North American rocks, and the excavation of the great lake-basins of that country, to the action of terrestrial glaciers. He shows indeed that the great striation of a large portion of the continent from N. E. to S. W. was from the ocean to the interior, against the slope of the St. Lawrence valley, thus disposing at once of the glacier theory; for it is impossible to imagine that a glacier travelled from the Atlantic up into the interior. Admitting that in limited tracts of Eastern America there may have been local glaciers, Mr. Dawson believes, as I do, that the rocks of the chief countries in question were striated when the land lay beneath the sea.—*From his address as President at the Anniversary of the Royal Geographical Society, London*, 1864.

ORIGIN OF OUR KITCHEN-GARDEN PLANTS.

By Harland Coultas,
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For a long time it was thought to be impossible to discover the origin of those nutritive species of plants commonly cultivated by man; some writers maintaining that their primitive habitat had been destroyed, that they originated on lands over which the ocean now rolls its waters; whilst others, equally fanciful, supposed a miraculous intervention of the Deity, and that man received directly from the gods the first seeds of the cerealia and other plants, which he cultivates as sources of food. The prevailing opinion upon this great question, even among enlightened persons, and so late as the commencement of the present century, may be gathered from the following passage from Humboldt's Essay upon the Geography of Plants (*Essai sur la Géographie des Plantes*, 1807, p. 28):—

"The country in which originated the vegetables most useful to man is a secret as impenetrable as the first dwelling-place of our domestic animals. We are ignorant of the country in which the grasses first originated which furnished nutriment to the Mongolian and Caucasian races. We know not in what country our cerealia grow spontaneously—our wheat, oats, and rye. The plants which constitute the natural riches of the inhabitants of the tropics, the banana, papaw, cassava, and maize, have never yet been found in a wild state. The potato presents the same phenomena."

Since the time when the above passage was written by this illustrious author, the wild potato has been found growing in the greatest abundance in South America; the papaw, by Marcgraaf, in the forests of Brazil; and Olivier and Bruguières, in travelling through Western Asia—the cradle of the European race—have found wild rye and barley. Thus year by year the progress of geographical and botanical researches conduces to more certain and simple ideas on the origin of cultivated plants, so that our best naturalists now, instead of supposing, as formerly, miraculous phenomena, or revolutions in the physical geography of the planetary surface, are all agreed that it is highly probable that all our cultivated plants have originally descended from some wild form;

and that probably some day, at no very distant period, we shall know in a spontaneous state the immense majority, perhaps the totality of our cultivated species.

M. Alphonse de Candolle gives a list of 157 plants, which he selects, because most commonly cultivated by man, and of these eighty-five have been found wild—that is to say, identical with the cultivated plant, or at least with some of its varieties. If to these species are added those which are most probably wild, or about which hardly a doubt remains, we may consider 117 as having been identified in a spontaneous state. In short, the species which we historically know to have been first cultivated in Europe, have been found wild in Europe; and those cultivated species of which the wild form has not yet been found, are all foreign plants cultivated abroad, and in countries which have not yet been explored.

Having made these introductory remarks, we now confine ourselves to an inquiry into the origin of the kitchen-garden plants of the United Kingdom. We select for this purpose such vegetables as are in ordinary use during winter; in fact, our common Christmas vegetables will furnish an abundance of interesting material for discussion.

Our kitchen-garden plants may be sub-divided into—1. Those plants which are cultivated for the nutritive material in their rhizome, as the potato, parsnip, carrot, turnip, and horseradish. 2. Those plants which are cultivated for their stems, leaves, and flowers, as celery and the different varieties of the garden cabbage. We begin with that well-known vegetable,

The POTATO (*Solanum tuberosum*, L.)—This plant belongs to the natural order Solanaceæ, and is closely related to the tobacco-plant, belladonna, henbane, nightshade, and other poisonous narcotics. But although the same poisonous principle exists in the potato-plant, it is confined to its stem, foliage, and fruit, and is wholly absent from its roots or underground tubers, the part of the plant used as food. When potatoes still attached to the growing plant become exposed to the light, the epidermis assumes a greenish color, and the poisonous principle then develops itself. Such potatoes are totally unfit for human food. The potato-plant has a stem from one and a half to two feet high, with interrupted pinnate leaves, which are composed of from five to seven pairs of lanceolate oval leaflets, having lesser ones between them; the flowers are bluish-white, with orange yellow, slightly cohering anthers, which are succeeded by a green globose berry, about half an inch in diameter. The tubers or potatoes produced by the plant are simply subterranean branches, arrested and thickened in their growth, in place of being elongated. The common idea that all the subterranean portions of a plant are roots, is quite erroneous; for the production of leaf-buds or leaf-scars is the distinguishing characteristic of a stem wherever situated; and that the tuber or potato is a true stem is proved by the eyes on its surface, which are true leaf-buds. Hence the potato is propagated by cutting the tuber into pieces, when each piece, provided it has an eye, wil grow and become an independent plant.

The potato is a native of South America, and is found in abundance wild in the mountainous regions of Chili, Peru, and the neighborhood of Buenos Ayres. Its presence in Mexico, Virginia, and the Carolinas, where it was subsequently found, is probably not very ancient. It is thought that it may have been introduced there from South America by the first Spanish settlers. The potato was first grown by Sir Walter Raleigh, at Youghal, in Ireland, in 1586. The samples planted came from the Carolinas. The gardener who planted the tubers thought that the green potato apples were the potatoes, and carried them to his master, expressing his great disgust at such produce. Sir Walter, pretending to sympathize, told him to dig up the useless weeds, and throw them away. The gardener, in rooting out the plants, found the true potatoes, more than a bushel of them, and hurried back to his master in a very different humor, to show him the samples, and make known his discovery.

The soil and climate of Ireland are very favorable to the growth of good potatoes, and the plant appears to have rapidly grown into favor in Ireland, and was cultivated there as food long before its value was acknowledged in Great Britain.

In both England and Scotland, a prejudice against it existed owing to the poisonous character of the plants of the natural order to which it belongs and the resemblance of its flowers to those of the woody nightshade (*Solanum dulcamara*), an extremely common plant, well known to be poisonous. Almost everywhere the same prejudice prevailed, in France especially; and it was not until a time of great scarcity during the Revolution, that its culture in that country became general.

For more than a century and a half after its cultivation by Sir Walter Raleigh in Ireland, the potato was cultivated in flower gardens only, in both England and Scotland. Even in 1725 the few potato-plants in the gardens about Edinburgh were left in the same spot from year to year. No attempt was made at a more extended culture. In 1728, however, a Scotch day-laborer, named Thomas Prentice, living near Kilsyth, Stirlingshire, carefully cultivated the potato as food, and, after supplying the wants of his own family, sold the remainder of the produce to his neighbors, who very willingly paid him his own price, being convinced by his example that potatoes were wholesome and nutritious. Prentice was frugal and industrious, and soon found himself in possession of £200, no small fortune in those days. He now sank his capital in an annuity at a good interest, upon which he lived independently in his old age, dying in the year 1792, at the advanced age of eighty-six (potatoes evidently agreed with him), having been sixty-four years a happy witness to the effects of the blessing which he had been instrumental in conferring on his country.

The potato appears to have been taken into favor much earlier in England, as appears from a report of a meeting of the Ray Society, held March 18th, 1662, when a letter was read from Mr. Buckland, a Somersetshire gentleman, recommending the planting of potatoes. This was referred to a committee, who reported favorably, and Mr. Buckland received the thanks of the Society. From this time the field-culture of the potato commenced, and rapidly extended as its excellent qualities became more known. A strange objection was made by the Puritans, who denied the lawfulness of eating potatoes, because the plant was not mentioned in the Bible! Whether or no, a plant so nutritious, and whose culture is adapted to almost every soil and climate, must be regarded as amongst the choicest gifts of Providence. Our countrymen have since done ample justice to this plant; for now, wherever the Englishman seeks a home, he always strives to naturalize the potato-plant, and, even when surrounded by the luxuries of tropical lands, remembers the simple vegetable which was so long struggling into notice in his own country.

The Parsnip (*Pastinaca sativa*, L.)—This plant belongs to the natural order Umbelliferæ, and is closely related to the carrot, celery, and parsley, which belong to the same natural order. It is a native of Britain, and of different parts of Europe, and is usually most plentiful on dry banks or on a chalky soil. It is difficult to say whether it is to cultivation or importation that we are indebted for this root. Most likely the former, as it is undeniable that the wild plant, grown for two or three years in rich garden soil, acquires all the characters of the cultivated form; and that when the garden-plant escapes into uncultivated ground, it speedily reverts back to its originally wild and degenerate condition. Parsnips appear to have been very early reclaimed from a wild state, for Pliny tells us that parsnips were cultivated on the banks of the Rhine, and were brought from thence to supply the tables of the Roman emperors.

The stem of the parsnip is herbaceous, upright, and furrowed; the leaves pinnate, sheathing the stem at the base, and composed of oval, slightly lobed and incised leaflets. The flowers are small, yellow, and disposed to umbels, the fruit dividing into two seed-like pieces, as is usual with umbelliferous plants. The root of the wild plant is spindle-shaped, sweet and mucilaginous, but nevertheless somewhat woody, and with a slight degree of acrimony which it loses by cultivation. In the wild plant the leaves are downy, but when cultivated they become smooth.

The parsnip is one of the hardiest plants of the kitchen garden, as it remains uninjured in the severest weather; indeed, by many, the parsnip is not esteemed until it has been frost-bitten. There is generally a great consumption of parsnips in Catholic countries along with the salt-fish eaten during lent.

The CARROT (*Daucus carota*, L.)—The wild form of this plant is found plentifully in Europe and in Great Britain, where it is indigenous, and in the United States where it has been extensively naturalized. Although the large root is wanting in the wild variety, yet there is little else to distinguish it from the cultivated species; for the leaves, flowers, and even the fruit of the wild carrot are exactly similar to that of the cultivated plant.

The carrot is a biennial, with a stem rising to a height of two feet, leaves compound pinnatifid, flowers white, succeeded by rough hispid seed-vessels, the supporting stalks of which are inflected inwardly, so that the cluster of compact umbels does not look unlike a bird's nest. The root of the wild plant is white, dry, woody, and strongly flavored. Cultivated, the root becomes succulent, and of a red-yellow or pale straw color, showing, in a remarkable way, the improvement which may be effected by cultivation.

The carrot was cultivated at a very early epoch even by the Greeks and Romans. The cultivated garden variety has been most probably derived from the wild form. It is difficult to say how its nutritive character was discovered. We know, however, by the experiments of M. Vilmorin, that the wild carrot sown in good land becomes similar to the cultivated species at the end of some generations; and inversely that the cultivated carrot returns to the wild form, if planted in bad land, in the course of a few generations.

The CELERY (*Apium graveolens, L.*)—This plant is a hardy biennial, indigenous to Great Britain and different parts of Europe; it has even been found by Hooker in the southern hemisphere, and by Nuttall in California. Wild celery grows by the side of ditches, near the sea, where the water is brackish. Radical leaves, on channelled petioles, green or purplish, stem leaves, ternate, on short petioles, flowers in umbels, axillary, and greenish white. The wild plant is rank, coarse, and suspicious in its appearance, but cultivation transforms it into one of the sweetest and most wholesome of our esculents.

Celery is grown in trenches, and as the plants grow their stems are covered with earth; the light is thus excluded, the stems are blanched, or turn white, and are thus rendered edible. Celery appears to have been first cultivated in Italy, for the word itself is of Italian origin, it having been formerly called Ache in England, which is, in fact, its true English name.

There are in the natural order Umbelliferæ two active principles, the narcotic and the aromatic; the former develops itself when these plants are found in moist grounds, and renders them poisonous; the latter principle predominates when the Umbelliferæ grow in dry ground. This may help to cause the difference between wild and cultivated celery, which always grows best in a rich, well-drained soil. The process of blanching also doubtless assists in rendering the poison peculiar to the wild plant inert, as the active principles of the leaves of plants are rarely developed when they are deprived of the light.

The PARSLEY (*Petroselinum sativum*).—The parsley is so well known, that a description of it is perfectly unnecessary. It is a hardy biennial, a native of Sardinia, and was introduced into England in 1548. It has naturalized itself in some parts of England on old walls and rocks, usually near the sea. It was used by the Romans as a pot-herb, and was also known to the Greeks. The curled variety of parsley is most common in the gardens, and is the safest to cultivate, as from the beautiful curl of its foliage it cannot be mistaken for the poisonous fool's parsley (*Ethusa cynapium*, L.).

The CABBAGE (*Brassica oleracea*, L.)—This plant belongs to the natural order Cruciferæ, (*crux*, a cross; *fero*, to bear,) in allusion to the petals of the flowers, which are four in number, and arranged in the form of a Maltese cross. The horseradish, cress, mustard, and the different variety of cabbage and turnip all belong to the same natural order. This plant grows wild on European sea-shores, and various places on the English coast—for instance, at Dover and Penzance, where the shores are rocky. The leaves of the wild cabbage are gyrate, glaucous, wavy, the plant occasionally growing from one to two feet in height; flowers light yellow; pods erect. In spring the sea-cabbage may be gathered and eaten. It was no doubt resorted to as food by the early inhabitants of Great Britain long before any attempt was made at cultivation. The Latin word *Brassica* is derived from the Celtic *Bresic*. There is no plant which has produced, by cultivation, a greater number of varieties than the *Brassica oleracea*. The opinion is generally entertained by botanists, that the white and red cabbage, savoy, borecoles, cauliflower, and brocoli, have all originally sprung from the wild cabbage of the sea-coasts. Now when varieties reproduce themselves permanently, they become races, and there is evidence that some of these races have been cultivated in other countries from the earliest times of which we have any record. Take for example the permanent variety of the red cabbage (*Brassica oleracea*, var. *rubra*), now chiefly used for pickling, which was known to the Romans. As the primitive inhabitants of the different European nations had very little communication with each other, it is probable that the wild cabbage (*Brassica oleracea*), which grows on the shores of Denmark, France, and the Mediterranean, furnished in every instance the cultivated varieties of those countries. The cabbage was most likely first grown in Great Britain by the Saxons. It was such a favorite with them, that they called the second month of the year *Sprout-kale*.

Two leading sub-divisions may be effected of nearly all the varieties of the garden cabbage. These varieties are either — 1. Headless cabbages (*Brassica oleracea*, var. *acephala*), such as the borecole, the leaves of which continue expanded, never forming a head; or, 2. Close-headed cabbages (*B. O.*, var. *capitata*), such as the white and red cabbage and the savoy, whose concave leaves are densely imbricated over each other, and form a close compact head before flowering. The word cabbage is, in fact, derived from the Latin *caput*, a head, through the French *cabus*. Brussels sprouts (*B. O.*, var. *subdanda*). This is only a variety of the savoy, with an elongated stem, from the sides of which spring out small green heads like cabbages in miniature. If the stem be examined, these sprouts will be found invariably to start just above the scars left by the fallen outer leaves. The cauliflower (*B. O., cauliflora*). In the cauliflower we eat the fleshy flower, stalks, and undeveloped buds, which are crowded together into a compact mass. It was a favorite saying of the great lexicographer, Dr. Johnson—"Of all the flowers of the garden, I like the cauliflower the best!" a sentiment worthy of that learned epicure. The cauliflower was first brought from the Isle of Cyprus, about the beginning of the seventeenth century. *Brocoli.*—The name is Italian. This is only a sub-variety of the cauliflower, distinguished from it by the dark green or purple color of the head. It is also a much hardier plant, and stands the winter.

These varieties of the cabbage illustrate in the most striking manner the changes which are produced in species by cultivation, and the permanence of some varieties or races. They also give us instructive lessons in the economy of vegetable life.

The TURNIP (*Brassica campestris*).—This plant is found wild in many parts of England, by the sides of rivers, ditches, and marshes, but is probably an only introduced plant. It grows spontaneously over all Europe, from the Baltic to the Caucasus. The wild form has hispid, lyrate root-leaves; those of the stem are smooth amplexicaule or stem-clasping. The flowers are yellow; the pod cylindric. The turnip, like the cabbage, has produced several varieties, the result of long cultivation, as for example the common cultivated species of turnip (*B. C.*, var. *Rapa*), and the Swedish turnip (*B. C.*, var. *Rutabaga*), the root of which is yellowish and sub-globose. This last variety, which is the most valuable to the British farmer, has long been grown in Sweden and Germany, and was probably known to the ancients. It was first cultivated in England in 1781, having been brought over originally from Gottenberg. Besides these there is another valuable variety (*B. C.*, var. *oleifera*, DC.), which is largely cultivated in France and other European countries for the oil contained in its seeds, which, under the name of Colza oil, is used for lamps, giving a very brilliant light. The idea of cultivating these plants for the oil contained in their seeds could only originate in those countries where the olive was not introduced, or yielded uncertain crops. Colza oil has been used for more than two centuries in the north of France, and its use probably dates back to a still more ancient period. The Greeks and

Romans, the Celts and Germans, cultivated the turnip; its original country is doubtful on account of the facility with which it becomes naturalized outside of cultivated ground. M. Fries says that *Brassica campestris* and *Brassica rapa* grow spontaneously in the Scandinavian peninsula; and within the last few years the explorations of the French naturalist, M. Ledebow, in northern and eastern Europe, have shown that both these plants are spontaneous through the whole of Russia and Siberia.

The HORSERADISH (*Cochlearia Armoracea*, L.)—This is the last of the crucifers whose natural history we shall discuss. It is cultivated for its root, the merits of which are well-known in connection with the "Roast Beef of Old England." We shall not occupy the time of our readers with a botanical description of this well-known plant, the cultivation of which is of undoubted antiquity, as it was used in the time of Pliny, the Roman historian. When planted in gardens it is very difficult to eradicate, as the rhizome is furnished with many eyes, each of which will give rise to a new plant. The horseradish is very frequently found growing outside of cultivated ground, on the banks of rivers, and in most situations, but it is very doubtful whether it is indigenous in England. It is, however, a native of many parts of Europe. The root owes its qualities to the presence of a volatile oil which is dissipated by drying. There is no difference between the wild and cultivated plant, except that the root of the former is smaller and more stringy if it happens to grow in a poor soil; but if the soil should be moist and rich in which it is found, then the root of the wild plant is equally good.

We would recommend our readers, if they have leisure, to prosecute this inquiry, as it will be found most interesting in connection with the early periods of human history. It is also an important inquiry, because it has a direct bearing on those formidable questions as to the "Origin of Species," as to the amount of variability of which species are susceptible, and the causes by which that variability is produced: and lastly, as to the geological epoch at which existing species were first introduced—questions which the best naturalists find it so difficult to answer, and which will only be understood when natural history is much more advanced, and the links discovered which unite the present plant-forms with those which have preceded them.

We have historical evidence that existing species have not varied for several thousand years, and the reason is plain enough, because the external circumstances in which they have been placed have not varied. For all practical purposes, therefore, the characters on which species are found may be assumed to be constant; and a minute and careful description of a plant will suffice, not only for the present, but for many succeeding generations of naturalists. But we have no warrant from nature to assume that such specific, or even generic, characteristics either have been, or will continue to be, permanent for an unlimited period of time, that they will survive all future changes in the physical geography of the planetary surface. We know that great changes may be effected in a brief space of time in the organization of plants by cultivation; and why should not an organic change be brought about in plants when their external circumstances are altered by nature in the course of ages? This world, what is it but a great and ancient theatre where the scenery of life is ever changing? Look at that majestic and venerable tree; its present form appears to be fixed, yet that very form is in reality as fleeting and evanescent as all the other forms through which that tree has passed from its first life movement in the seed; and what is true of that tree, which is a part of nature, is true of the whole of nature. The present appearance of nature now is no more unalterable than at any other geological epoch. It is the last of the many phases of creation, and equally fleeting with all the others.—*Popular Science Review.*

ON THE GRAPTOLITES OF THE QUEBEC GROUP.

By Professor James Hall.

[This long-expected monograph* is now before us, and has grown in magnitude under the delays which have attended its publication, until, instead of one decade, it contains no less than twenty-three admirable plates, with one hundred and fifty pages of letter-press.

Prof. Hall gives to the *Graptolitidæ* the rank of a family, including fifteen genera, of which no less than eleven occur in the Quebec group, this being, so far as known, the period of the greatest development of these curious organisms. The species

* Decade II of Canadian Organic Remains, issued by the Geological Survey of Canada. Dawson Bros., Montreal; Balliere, London, New York, and Paris.

occurring in the Quebec group of Canada, and described in this memoir, are fifty-three in number.

The affinities of the graptolites have been a subject of much discussion. Prof. Hall, after noticing the various opinions which have been entertained, shows good reasons for the view that they were Hydroids, approaching to the modern *Sertularidæ*, a view which General Portlock has also maintained. We quote somewhat at length the statements bearing on this point, referring our readers to the work itself for the details of structure and systematic descriptions.—EDS.]

Until recently the graptolites were, with two or three exceptions, known only as simple, straight, or slightly-curving linear stipes or stems, usually lying in the same plane upon the slaty laminæ in which they were imbedded. Nearly all these were evidently fragmentary, and, though varying somewhat in their proportions, rarely exhibited anything that could be regarded as the commencement or termination of their growth or development. These bodies, in their flattened condition, present a range of serratures either on one or on both sides of the stipe; and seldom preserve more of their substance than a carbonaceous or corneous film or test of extreme tenuity. Under more favorable circumstances, these serratures are discovered to indicate the apertures of cellules, symmetrically arranged in reference to each other, and to the axis of the linear stipe. Others show parallel entire margins, with transverse indentations across the central portion of the stipe. This appearance we now know to be due to the direction of the pressure upon the body exerted at right angles to the cellules, and which will be explained in the sequel.

The earliest opinion regarding these fossils was that they were of vegetable origin; and they have been thus considered by some authors even at a very late period. Subsequently, they were referred by Wahlenburg, and after him by Schlotheim, to the Cephalopoda, being regarded as extremely slender orthoceratites. This opinion may have received support from specimens in such condition as *G. scalaris*, where the indentations are limited on each side by a continuous margin; but in such as present a single or double series of marginal serratures, the analogy seems very remote. Professors Geinitz and Quenstedt advocated the same view at a much later date; though it has since been abandoned by these authors, from more extended investigations.

Professor Nilsson first suggested that graptolites were Polypiaria, belonging to the family Ceratophyta. Dr. Beck, of Copenhagen, regarded them as belonging to the group Pennatulidæ, of which the Linnean *Virgularia* is the most nearly allied existing form. Sir Roderick Murchison has adopted this view of the relations of the graptolites, in his Silurian System.* General Portlock has fully recognized the graptolites as zoophytes, and has pointed out their analogy with *Sertularia* and *Plumularia*.

The relations of graptolites with the Cephalopoda had already been fully disproved by M. Barrande (in the first chapter of his *Graptolites de Bohême*), before the abundant materials for the refutation were discovered in the graptolites of the Quebec group; and most naturalists were already agreed in referring these bodies to the class of Polypi, to which they doubtless belong.

More recently, Mr. McCrady, of South Carolina, has published a paper on the "Zoological Affinities of Graptolites,"† in which he has endeavored to show the similarity of the graptolitic forms with the Echinoderm larvæ, as illustrated by Muller. There is certainly much resemblance between the enlarged figures of that author, and some forms of graptolites in the shales of the Hudson River valley; while some of the figures with central discs have a more remote analogy with certain forms from the Quebec group. Some of the toothed rods of the Echinoderm larvæ likewise bear a resemblance to the graptolites figured by Mr. Suess;‡ and there are still further analogies pointed out by Mr. McCrady, which, however, may not be regarded as of equal value by the greater number of naturalists.

For my own part, although admitting the similarity of form and of some of the characteristics which were very kindly pointed out to me by Mr. McCrady, long before his publication, I cannot recognize the analogy sought to be demonstrated. The establishment of the fact that these toothlets or serratures are the extensions of true cellules, each one having an independent aperture,

* Silurian System, page 694; and letter of Dr. Beck, pp. 695-6.

† "Remarks on the Zoological Affinities of the Graptolites, by John McCrady, made before the Eliot Society of Natural History of Charleston, S. C., at the meeting of July 15, 1857." [Extract from the Proceedings, vol. i.]

‡ Naturwissenschaftliche Abhandlungen. Vierter Band. Tab. viii and ix.

and communicating with a common canal, should offer a convincing argument against these bodies being other than polyp-bearing skeletons. But in following the extensive series of forms now presented to us, we have much evidence to show that some of these were attached to the bed of the ocean, or to other bodies; while the greater proportion of the species and genera appear to have never been attached to the sea-bottom.

It may not be easy to determine precisely the family to which these graptolitic forms should be referred; nor is it certain that the extensive series now presented can all properly be referred to a single family. General Portlock has suggested that these bodies may constitute "several genera belonging even to more than one order."* That they are true Polypi, I believe we shall be able to show, both from analogies already established by various authors, and also from their mode of development or reproduction as exhibited in some of the species.

The specimens which have usually been observed or represented are simple disconnected stipes, doubtless the dismembered or fragmentary portions of fronds, which, presenting in the different species great varieties of form and aspect when entire, are nevertheless composed of parts so similar that these fragments, though indicating specific differences, offer little clue to a knowledge of the entire form.

The name *Graptolithus* was established by Linnæus in the first edition of his "*Systema Naturæ*," 1736, and applied by him to the straight or curved forms which are serrated (celluliferous) upon one side only, of which *G. sagittarius* has been regarded as the type.† The propriety of this term is more readily perceived in its application to the fragments of the stipes of monoprionidian forms than to the central portions of the body of the same. In the spirally-enrolled forms, or those with four or more stipes uniting in the central disc, as well as in the variously-branching forms, the analogy is not so perceptible.

1. The Solid Axis.—All the graptolites proper have been found to be provided with a slender solid axis,‡ while this feature has

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* Geological Report on Londonderry, &c., p. 318.

† I shall elsewhere endeavor to show that *G. scalaris* is a diprionidian form exhibiting only one margin.

‡ In those species with a single series of cellules, M. Barrande has ascertained that this axis is solid and cylindrical, its diameter not exceeding ¼ millimetre, and its structure apparently fibrous. (*Graptolites de Bohême*, page 4.)

not been satisfactorily proved in regard to *Dictyonema*, and to some other forms.

In those species having a single series of cellules, this axis is upon the back of the stipe, or on the side opposite to the celluliferous margin; and in the branching forms it follows all the ramifications. In all the specimens where it has been observed, it is a slender cylindrical or flattened filiform solid body. In some extremely compressed specimens, this axis appears as a slender elevated ridge along the back of the stipe; and where the substance of the body has been removed, it leaves a narrow groove along the margin of the impression.

In the examination of large numbers of specimens of the monoprionidian species, we have never found the axis prolonged beyond or denuded of, the cellules; as shown in *G. colonus*, by Barrande, in his Graptolites of Bohemia.

In all the specimens where the extremities of the stipes are entire, (as represented in plates i, ii, and iii of the memoir,) there is never any extension of the axis beyond the last partially developed cellule; and the number of specimens in this condition is considerable.

In the graptolites with two series of cellules, the solid axis is very frequently seen extending beyond the celluliferous portion of the stipe at its outer extremity; while the radicle appears like the continuation of the same below the base. The axis thus appears to be the foundation on which the other parts are erected. In those specimens, however, which present so great an extension of the solid axis beyond the stipe, the cellules may have been removed by subsequent causes.

I am able to corroborate to some extent the observations of M. Barrande in regard to the apparent double character of this axis. In some extremely compressed specimens it is marked by a longitudinal groove or line of division;* while in others, a double impression has been left by the removal of the substance.

2. The Common Canal.—In all graptolites with a single series of cellules, there is, between the bases of these cellules proper and the solid axis on the back of the stipe, a continuous sub-cylindrical space or canal, which has been occupied by the body of the polyp,

* The aspect presented by the axis, when marked by a longitudinal groove, is precisely that which a hollow cylindrical body would have if extremely compressed.

from which the buds, with their calycles forming the cellules, take their origin, and are thrown off at regular intervals.

All the specimens which I have examined confirm this view; and in some of the species where the extremities are apparently entire, we observe the incipient development of the young cell from the common body. In those specimens filled or partly filled with the substance of the surrounding rock, this canal is easily distinguished; while in compressed specimens there is always a flattened space between the bases of the cell-partitions and the solid axis.

In those graptolites with two ranges of cellules, we have apparently a duplication of those with the single series, the two solid axes being joined together, leaving a common canal or body on each side at the base of each series of cellules. If however the common body were thus divided, it would be by the solid axis, becoming a flattened plate. This appears to be true of some species, while in others there is only a simple filiform axis visible. In this case, of course, there is not an entire division in the common canal after the manner of the other species. This will app ar further on, under the illustrations of the structure of these bodies.

3. The Calycles or Cellules; their form and mode of development.—Since a large proportion of the specimens of graptolites which come under our observation for the purposes of study or otherwise, are fragmentary, it becomes of much importance to know the general characters of form and mode of development of the cellules.

In the preceding section it has been shown that the cellules, or the inhabitants of these cellules, are not independent, but all have their origin in a common body, which fills the longitudinal canal, and that they remain in constant connection with the same throughout their existence.

The calycle or cellule is formed by budding from one side of the common body, not unlike many of the Sertularians, except that the cellules are generally close together at their origin. They are usually more or less oblique to the direction of the axis, as is clearly indicated by the cell-partitions; and the degree of obliquity often indicates specific distinction. The cellules are for the most part contiguous at their origin, and they sometimes remain in contact throughout their entire length; but in the greater number of species there is a small portion of each one free on one side towards the aperture. This character is shown in numerous examples.

In some forms the cellules are contiguous in their lower portions, while the entire upper or outer part becomes free, as seen in *G. Clintonensis*, while in one of the bi-celluliferous species from Iowa, the cellules are distant from each other at the origin, and the upper extremity of one scarcely reaches to the base of the next in advance, and they are therefore not properly in contact in any part of their length. The same is more emphatically true of *Rastrites*, where there is a large interval between the bases of the cellules, which are often nearly rectangular to the axis.

Although we regard the cellule as limited by the cell-partitions, yet in well-preserved specimens there is sometimes a swelling of the test of the common body below the cellule, indicating an enlargement of the parts at the bases of the buds. In one species there is an evident undulation of the axis, corresponding to this enlargement of the parts in the common body.

In the diprionidian species, the cellules on the two sides of the stipe are alternating, so that the bases or the apertures are opposite the space between two others.

In much the larger proportion of species, the body of the graptolite and the cellules are so extremely compressed, that they appear only as serratures along the margin, with distinct impressed lines marking the cell-divisions. The exterior margin of these serratures indicates in an approximate degree the outline of the aperture; and the frequently-occurring mucronate extension at the extremity of the cellule is produced by the continuation of the cell-partition, or sometimes by an outgrowth from the margin of the stipe above or below the aperture.

Were the cellules isolated, their prevailing form would be that of an elliptical tube or sac, the length of which is greater than either of the two diameters. When they are in juxtaposition, however, the contiguous sides are flattened, while the lateral or external surfaces are usually more or less curved, particularly near the aperture. In a larger proportion of the species, the calycle becomes slightly expanded towards the aperture; but in a few examples there is a distinct contraction above the middle, and the aperture is smaller than the base. Generally, however, the smaller diameter is just at the junction with the common body, or at the junction of the cell-walls with the walls of the common canal.

In a single diprionidian species, where the specimens are not distorted by pressure, a longitudinal section of the stipe in the direction of its greatest diameter shows the cellules scarcely narrowed at their origin with the common body; while in a lateral view of the specimen, the base of the cellule is seen to be much wider than the orifice.

In many of the species a transverse section of the cellule near the base is quadrangular, becoming more rounded towards the aperture; and when the upper part of the cellule is free, the aperture is round or elliptical, and in some specimens the calycle is elliptical or cylindrical throughout its entire length. We have examples of the quadrangular cellules in *G. extensus* and *G. octobrachiatus*, as well as in two species of *Phyllograptus*. Where the cellules are more nearly isolated, they approach more and more to the cylindrical form. As examples of cellules contracted towards the aperture, we have *Graptolithus priodon*, Barrande, and *G. Clintonensis*, Hall. * * * * * * *

In 1858, I laid before the American Association for the Advancement of Science a notice, with some illustrations of graptolite stipes, bearing what I then regarded, and do still regard, as the reproductive cells or ovarian vesicles. These cells first appear as small ovate buds upon the margins, projecting but little beyond the regular cellules, and, becoming enlarged, form elongated sacs with swollen extremities, which are finally dehiscent; and then, as I suppose, discharging the ovules or germs, are gradually absorbed or dissipated.

Although these sacs are distinctly defined, they have scarcely any apparent substance, except along the lateral margins, which are limited by a filiform extension resembling the solid axis of a graptolite. There are likewise numerous fibres of this kind traversing the sacs; and these sometimes remain attached to the original stipe after the other parts are separated. In one example we have conclusive evidence that they are connected with the solid axis of the parent stipe.

In one specimen the ordinary cellules are removed, and the fibres are still seen joined to the axis, showing the origin of the reproductive sacs. In most specimens bearing these sacs, the cellules of the stipe are so obscure that the species cannot be determined; but in one case we find them attached to a well-marked type of *G. Whitfieldi*.

This mode of reproduction in the graptolites shows much analogy with the Hydroidea, and would indicate the sertularians as their nearest analogues.*

Upon the surfaces of the slate where these bodies occur, there are numerous graptolitic germs, or young graptolites of extremely minute proportions, ranging from those where the first indications of their form can be discovered, through successive stages of development till they have assumed the determinate characters of the species.

In several examples, these minute germs have been detected near to and in contact with the reproductive sac; and in one case, there is but a hair's-breadth between one of the fibres of the sac and one of the oblique processes at the base of the germ. It cannot be said that we have detected the germ actually within the sac; but the numerous young individuals lying near them, and upon the surfaces of the same laminæ, offer very good arguments for supposing that they have been thus derived.

The earliest defined form which we observe in the young graptolites consists of the initial point or radicle; a diverging process of similar character on each side, but not quite opposite; a longitudinal axis of greater or less extent; and a sac-like covering, or thin pellicle of graptolitic test, which has scarcely assumed the form of cellules, but which is most extended in the direction of the common body along the solid axis. This little sac contains the germ of the zoophyte, which, extending itself as the common body in its canal along the axis, gives origin to the budding which develops the successive cellules and the gradual building up of the stipe. * * * * * * * *

The numerous individuals of entire or nearly entire fronds illustrated in this memoir, as well as large numbers of others examined, serve to give a pretty clear idea of the general form of

* In the recent *Sertularia* and *Campanularia* we find ovarian vesicles, in which a number of ovules may be enclosed in a common envelope. These vesicles are developed along the side of a stipe or branch, and the ovules are often arranged along a central axis, each one communicating with the common axis of the zoophyte. [Jas. J. Lister, *Philosophical Transactions*, 1834, pp. 365-388, pl. ix. Cited also by Dana, "*Structure and Classification of Zoophytes.*"]

Prof. McCoy has stated (*British Palæozoic Fossils*, p. 4) that he has found near the base of the cellules of graptolites, a transverse partition or diaphragm, similar to what may be observed in some sertularians and which he regards as proving similar relations; but I have not discovered in any American specimens evidence of such cell-diaphragms.

the true graptolites, as well as of their congeners of the same family. Notwithstanding the presence of the radicle or initial point observable in so many species, it does not afford evidence of attachment to the sea-bottom or to some other substance, at least in the mature condition. In all the monoprionidian forms, however much or little extended the radicle may be, it is always smooth, and tapering to a point. In many of these, and more especially in those with a central disc, this radicle is reduced to a minute protuberance, and is often scarcely or not at all perceptible.

The same is essentially true of the greater number of diprionidian forms examined. In these the solid axis is sometimes extended beyond the base of the stipe, and terminated as if broken off abruptly; while there is often a slender oblique process on each side of the base.

In *Retiograptus* and *Phyllograptus* there is not the same evidence of completeness at the base of the radicle. The lower termination, when it can be fully examined, is broken, as if there had been a further continuation of this part, though it exhibits no enlargement. I have inferred that all these, like the example of *Retiograptus eucharis*, have constituted parts of a similar compound body, and are but the separated stipes of the frond. If this be true, their mode of existence is not unlike the other species with compound fronds and a central disc.

In *G. bicornis* the extension of the solid axis below the base of the stipe is not always preserved; but when it is entire, we find two strong diverging and slightly-curving processes or spines from the base, having smooth terminations. Sometimes a disc or bulb, of the same substance as the stipe, extends between these spines, and in the compressed condition envelops a few of the lower cellules.

The expansion at the base of this species has the same general appearance as the central disc of *G. Logani*, *G. Headi*, and others; showing that this sort of development of the substance is not alone characteristic of those forms having several stipes united at the base. In other examples this basal expansion is contracted in such a manner as to give a crescent-form to the lower extremity; but in all these gradations, the margins of this part are entire and unbroken.

We have seen that the youngest forms of the diprionidian graptolites, those which we may suppose had but recently escaped from the reproductive sac, are furnished with the minute radicle-like appendage or extension of the solid axis, as well as the oblique lateral processes like tentacula; and the condition of these parts does not seem to have been essentially changed during any subsequent period of their growth. While the extension of this slender solid axis does not seem to have sufficient strength to have formed the base of attachment to the sea-bottom, it may have been sufficient to maintain connection with other parts of a compound frond.

For all those species with a single range of cellules, as well as for some with a double range, including *Retiolites*, *Retiograptus*, and *Phyllograptus*, I conceive that we have already shown a similar plan of development and a uniform mode of existence; and we are constrained to believe that all these forms, in their mature condition, were free floating bodies in the Silurian seas.

In regard to another group, including *Dendrograptus*, *Callograptus*, *Dictyonema*, as well as one or two other forms, we have some evidence indicative of a different mode of existence. The stems of *Dendrograptus* are enlarged towards their base, and sometimes present a sudden expansion or bulb, which I have inferred may be the base or root, once attached to another substance or imbedded in the mud. The general form of the species conduces to the belief that they were fixed to the sea-bottom, though possibly this basal expansion may have resembled that of *Graptolithus bicornis*. In most of the species described, the lower extremity is imperfect, and its termination unknown.

In those which I have termed *Callograptus*, the bases of the fronds are imperfect, but indicate, according to analogy, a radicle or point of attachment like *Dendrograptus*. In the more nearly entire forms of *Dictyonema* known, we have not been able to observe the base; but from their similarity in form and mode of growth to *Fenestella* and *Retepora*, we have inferred their attachment either to the sea-bottom or to foreign bodies.

Nearly all these forms occur in rocks where there are few of the larger fossils of any kind except the graptolites; so that there is little chance of finding their bases attached to shells and corals, as we do those of the bryozoans, even if they had thus existed. The *Dictyonemæ* of the Niagara, Upper Helderberg, and Hamilton groups do occur in strata which contain large numbers of other fossils; but we have no evidence of their having been attached. It is only from their general form therefore, and from their analogy with other bodies, that we infer that these genera may have been attached to the sea-bottom or to some objects during their growth.

We admit therefore that the family of Graptolitidæ, as now extended, may include both free and fixed forms.*

A FEW NOTES ON THE NIGHT-HERON.

By Henry G. Vennor.

While our little hawk-owl (*Surnia ulula*) ranks as an intermediate species between the hawks and the owls proper, our NIGHT-HERON shares partly the structure of both heron and bittern; its habits, food, and color of eggs are however decidedly those of the heron. It is called night-heron from its nocturnal habits, and has been thus described:—"Bill black; crown, hind head, back, and scapulars, glossy blackish green; from the hind head proceed three long, rounded, pure white feathers or plumes; wings, rump, and tail, light ash-color; neck, and lower parts, a white, with the most delicate tinge of cream-color; iris, fiery red; legs, yellow? Length of the adult bird, from twenty-six to twenty-eight inches; extent four feet." The young bird has not the head-plumes. About the middle or end of March, numbers of these birds leave their winter-quarters in the Southern United States (where many remain all the year round), and proceed northward, settling down in squads, —some along the Atlantic coast, others on the river-shores and marshes of the Middle States, while a small number reach the borders of Canada, about the middle of April. At the foot of the Lachine rapids, in the St. Lawrence, is Nun's Island, on the upper part of which, and hardly out of hearing of the city noise, many rare and beautiful birds spend their breeding-season in peace and quiet, and among others the night-heron. I have tried, in vain, to discover the period when these birds first visited and built in this island. From all accounts, and judging from the appearance of the heronry, it is very ancient. It is a well-known habit of these birds to return year after year to their favorite breeding-grounds; and it is only when the trees have been felled, or they have been unusually persecuted, that they will forsake an old locality. Not only do they frequent

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* Several papers on the Graptolites will be found in the previous volumes of this journal. See especially the volume for 1858, pp. 139, 161.

yearly the same locality, but often the same pair return to the same nest; and as their numbers increase, the new-comers build nests for themselves. The heronry at Nun's Island may have been commenced by only two or three pairs of birds; but as old and young returned year after year, the number of nests has thereby greatly increased: during the summer of 1864 I estimated the number of breeding birds at from eighty to one hundred pairs. Having visited it for several successive years, I have seen the birds in every stage of plumage. So like are the male and the female that the most practised eye cannot tell the one from the other. Like the male, the female has the long, white occipital plumes on the hind head. These are in most cases three in number, but specimens are often found with four perfect plumes. Many mistakes have been made by collectors respecting the male, female, and young, of this species; the one being often taken for the other. The young of the first year may easily be known by the following general description:—" The upper parts light brown, streaked with reddish white, the lower parts being dull ashy-white, variegated with grayish, and dusky."—Public and private collections would be doubly valuable, in a scientific point of view, were they to have a young bird of each species placed beside the adult male and female. Great difficulty has been experienced in determining certain species of eagles, hawks, and falcons, owing to the diversity in plumage of the different sexes, and at various stages of growth.—But to return to our subject. The trees in the heronry above alluded to are not scattered far apart, but they may be enclosed by a circle of about one hundred and fifty or two hundred yards in diameter. The nests are built often two and three on the same tree; and in many cases side by side with those of the American crow. Their nests are not unlike one another, that of the crow being however smaller. The heron's nest is composed of sticks thrown together very loosely and carelessly; often indeed with so slight a hollow, as to endanger the safety of the eggs and young. Many eggs are thus destroyed: after a high wind, the ground is often strewed with the broken shells. The eggs, so far as I have observed, are always four in number, and of a light blue-color,—agreeing in these respects with those of the night-heron of Europe. During the day, the male birds roost on lofty trees near the water's edge, uttering from time to time their harsh croak,—the females meanwhile keeping to their nests. When approached, they rise in the air with a great uproar, and watch the intruder, but take care to keep at a respectful distance. No sooner has night set in, than, leaving their roosts, they scatter along the shore or around the marsh in search of food. This consists chiefly of small fish, water and marsh insects, and reptiles—as water-newts, lizards, and small frogs. Their flesh, though seldom forming a table-dish in Canada, is esteemed excellent, having the flavor of the hare. We hope, however, that these birds may long continue to breed in our midst, and quietly accomplish their useful mission of keeping down the undue increase of injurious reptiles, protected by naturalists, and undisturbed by pot-hunters.

Let us now look at its variety—if variety it be—occurring in Europe. Our American bird, as we have before noted, is from twenty-six to twenty-eight inches in length. In India, we find that what we suppose to be the same species is only twenty-four inches in length; while in Europe it measures only twenty-two inches. Looking at the habits of this bird in these different places, we note, that in America it chooses, whenever possible, lofty trees to build upon, and these always near good feeding-grounds. In India and in Europe however, where marshes are not bordered by such trees, the heron at once selects either a small tree or bush for its nest, and in many cases even builds on the ground.

How then are these differences in size and habits to be accounted for, if we maintain that the herons found in these different places are of one species? From observing the habits of these birds, we have come to the conclusion that the heron, in fixing upon its breeding-ground, is chiefly influenced by the suitableness of the locality for its favorite food. Rarely do we find heronries at any great distance from good feeding-grounds. Is it out of the way, then, that we should find this bird, where there are no trees, choosing a bush or even the ground? We should not infer, because it builds in a bush or on the ground, that this is its natural habit, but rather a turning out of its regular course so as to be within easy reach of its food. This circumstance explains, we believe, not only the slight difference in habit, but also the diversity in size. For we would ask, where are these birds most at home? Where may observers note their natural habits? We have seen that the night-heron of America is larger than that of Europe or of India; that in America they build and breed together in large companies, and always choose lofty trees, where such are to be had near their feeding-grounds; and that though some individuals in America build among bushes and even on the ground, they are few in number and exceptions to the general rule. Is not America, then, their natural place of abode? We find, on turning to Europe and India, these birds decreasing in size, and building their nests in the best situation the locality affords;—and just as we see them thus as it were forced out of their natural choice of breeding-grounds, so we find them suffering in consequence, and becoming smaller; though their plumage and general characters remain unchanged, agreeing precisely with our American species. Next to that of the continent of America, we would place the heron of India, and lastly the smaller bird of Europe, where I think it is not at all at home.

In closing these few notes, I would ask, are there not many birds of other continents, differing but slightly in form and habits with similar species on our own, set down and named as distinct species? and might not a careful investigation into their habits and necessities, enable us to fix upon their natural home, and set down many as one species, though, like the night-heron, they may be found in a greater or less variety of form?

[Prof. Baird, one of the best authorities on American ornithology, considers the night-heron of America distinct from the European species. At the same time it is unfortunately too common for American authors to attach undue importance to minute points of difference between birds inhabiting the eastern and western sides of the Atlantic. There are many birds, *e. g.* the osprey and the crow, respecting which a similar parallel to our author's case might be drawn; and we have little doubt that, with extended knowledge, many more species than is usually supposed will be found to inhabit both continents. We would suggest the necessity of carefully comparing a large series of European and Indian skins with American specimens, before passing final judgment on this oft-mooted question. The size of specimens from any locality varies much; and, as far as we remember, the night-heron in England usually breeds in trees.—J. F. W.]

ENTOMOLOGICAL SOCIETY OF CANADA,

QUEBEC BRANCH.

The first annual meeting of the Society was held in the rooms of the Literary and Historical Society, on Thursday, 5th January, 1865, at half-past seven o'clock, p. m., the President, Mr. F. J. S. Dore, in the chair.

The minutes of the previous meeting were read and confirmed.

The Rev. L. C. Wurtele, B.A., of Actonvale, C. E., and Mr. R. P. Davis, of Quebec, were elected members of the Society.

The following donations to the cabinet were announced:

From A. L. Russell, Esq.

45	specimens	Coleoptera,	comprising	27	species.
9	"	Hemiptera,	"	6	"
4	"	Orthoptera,	"	4	"

From G. J. Bowles, Esq.

24	specimens	Lepidoptera,	comprising	22	species.
2	"	Neuroptera,	"	2	"

From W. Couper, Esq.

203	specimens	Lepidoptera,	comprising	143	species.
170	"	Coleoptera,	"	130	"
29	"	Hymenoptera,	"	18	"
3	"	Orthoptera,	"	3	"
173	"	Diptera,	"	40	"
13	"	Neuroptera,	"	9	"
34	"	Hemiptera,	"	25	"

From R. H. Browne, Esq.

12	specimens	Lepidoptera,	comprising	12	species.
1	"	Orthoptera,	"	1	"

From the Abbé Brunet.

25 specimens Coleoptera, comprising 16 species.

A number of entomological pamphlets were also presented to the library by different members.

Mr. Couper exhibited eleven new species of Canadian Coleoptera, and presented for publication the several descriptions.

The following report of the retiring Council was then read by the president:

The Council of the Quebec Branch, Entomological Society of Canada, in presenting its First Annual Report, would congratulate the members on the success which has attended this the first attempt to promote the study of entomology in Quebec. A year ago, the students of the science in this city were very few; but the establishment of this Branch has already nearly tripled their number, and an interest has been awakened, which argues well for the progress in Lower Canada of this interesting department of Natural History.

The founders of this Society considered, that instead of forming a distinct organization, it would be more advantageous to unite themselves with the Entomological Society of Canada, located at Toronto. They therefore made certain proposals to that Society, resulting in an arrangement which your Council believes will tend to the prosperity and stability of this Branch, and to the advancement of Canadian Entomology. The members of this Branch enjoy the privileges of membership in the parent Society, with the additional advantages of having their own officers and by-laws, and of holding meetings among themselves. It is satisfactory to notice that the entomologists of London, C. W., have perceived the benefits of a similar arrangement, and have united with the society at Toronto, under the name of the "London Branch." No doubt this course will be followed by the students in other parts of Canada, and a strong society thus be formed, which will successfully carry out the study of the insect-fauna of Canada.

An agreement was also made with the Literary and Historical Society of Quebec, which will prove mutually beneficial,—in lessening the necessary expenses of this Branch, and in providing for the museum of that Society a good collection of our insects.

This Branch now numbers ten members, and two gentlemen were proposed at the last general meeting of the year. Considerable progress has been made in the formation of private collections; but as the majority of the members are beginners, only four papers have been presented to the Society during the year. Two of these have been published in the "Canadian Naturalist," Montreal, and the third and fourth will appear in its next issue. The titles of these papers are—

On the larva of *Attacus polyphemus*, by W. Couper.

On the occurrence of *Pieris rapœ* in Canada, by G. J. Bowles.

On a gall-producing Hymenopter, taken upon *Triticum repens*, Linn., by W. Couper.

Descriptions of eleven new species of Canadian Coleoptera, by Wm. Couper.

Mr. Couper has also published a list of the Coleoptera and Diptera taken in the vicinity of Quebec, and in other parts of Lower Canada; and is preparing a continuation of this list, of species determined since. Both of these articles are contributed to the transactions of the Literary and Historical Society.

The Council would also notice, that the Vice-President and Curator of this Branch recently paid a visit to the United States, where they had interviews with many of the eminent entomologists, and did much to create a friendly feeling between the students of the science in that country and in Canada.

The Literary and Historical Society has, according to agreement, provided a handsome cabinet, which is now ready for specimens. Your Council solicits donations, and trusts that a large collection may be made during the coming year.

With respect to the future working of the Society, your Council beg leave to offer one or two suggestions.

Last season, the London Branch had weekly excursions; the members leaving early in the morning, and returning about noon, so as not to interfere too much with business. Your Council would recommend this Branch to adopt a similar plan, if it could possibly be carried out. The vicinity of Quebec is, in many respects, a new field for the entomologist, and these excursions would yield much useful information, as well as healthful pleasure to the students of the science.

It is also desirable that the practical value of entomology should be made known to the public. Your Council would therefore suggest that a few short articles on the insects injurious to agriculture should be prepared for publication, in both languages, in the newspapers of this city. The Society at Toronto has a column in the "Canada Farmer" set apart for such articles.

The Secretary-Treasurer's books and vouchers have been examined, and found correct.

The whole respectfully submitted,

FRED. J. S. DORE, *President.*

Quebec, 5th Jan., 1865.

Resolved: That the report be received, adopted, and forwarded to the "Canadian Naturalist" for publication.

The suggestions of the Council with regard to excursions, and the publication of articles on noxious insects, were discussed and approved of by the meeting. It was also proposed that the Council should publish a small pamphlet giving directions for capturing and preserving insects, as the best means of obtaining specimens from the Lower St. Lawrence and Labrador coasts.

The following were then elected officers for the current year:—President, F. J. S. Dore; Vice-President, the Abbé Brunet, Prof. Botany, Laval University; Secretary-Treasurer, G. J. Bowles; Curator, W. Couper; Members of the Council, R. H. Browne, A. L. Russell, and G. C. Gibsone.

A number of rare and beautiful insects were on the table for inspection by the members. Among these were *Melitæa phæton*, *Saturnia maia*, *Thecla mopsus*, *Thecla falacer*, *Arctia parthenos*; *Cicindela macra*, *Cychrus marginatus*, *C. stenostomus*, *Carabus vinctus*, *Dicœlus sculptilis*, *Megasoma thersites*, *Prionus laticollis*, *Callichroma splendidum*, *Saperda oreata*, *Saperda Fayi*. The ten last-named species are from the United States, and belong to Mr. Couper. The Abbé Brunet exhibited two cases of French Coleoptera.

DESCRIPTIONS OF NEW SPECIES OF CANADIAN COLEOPTERA.

By William Couper, Quebec.

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1. Amara pygmea.—Black; thorax margined, longitudinally channeled in the centre; with a double impression and interspersed punctures near the posterior margin. Elytra with nine punctured striæ, punctures profound on the dorsal region, but obscure laterally and posteriorly. Sutural striæ slightly bent towards the region of scutellum; second stria (composed of about ten punctures) joins the third, and runs obliquely towards the sutural stria, but does not join it; the sixth stria shortest posteriorly. Antennæ, palpi, legs, and underparts of body chestnut. Length ¼ inch. Quebec; rare.

Similar in form but much smaller than *Amara avida*, Say. In the latter the thoracic discoidal channel is deeper, and the punctures near the posterior angles are more diffused. The first or sutural striæ of elytra are abbreviated, and join the second; while in *A. pygmea* the first elytral stria is entire, and the tibiæ are very spinose, especially the anterior pair.

2. Gyrinus fraternus.—Head, antennæ, and thorax black, highly polished, the latter margined anteriorly with a single row

of fine punctures which may be traced on the lateral and posterior margins. Scutellum distinct. Elytra black, polished, each elytron having eleven rows of fine shining punctures—the first lateral row terminates where the second and third take the form of a crescent on the margin of the apex; the fourth and fifth are joined; the sixth, seventh, tenth, and eleventh join near the sutural margin, and the eighth and ninth are the shortest, and like the fourth and fifth join at their termination. There is a stria on each side of the suture, and the latter has a golden tinge. Body beneath and epipleuræ chestnut, but the legs are of a brighter color. The posterior tarsi are much larger than the anterior pair. The abdomen is longer than the elytra, and rounded at tip. Length $\frac{4}{10}$ inch. Common in ponds near Quebec, June and July.

Dr. LeConte has expressed a doubt regarding the above. On the strength of his knowledge of the species already catalogued, I describe it as an addition to the list of Canadian Coleoptera. Kirby describes two species, neither of which agree with the above. The descriptions of the *Gyrinidæ* in "Fauna Boreali Americana" are imperfect:—*G. impressicollis*, Kirby, and *G. ventralis*, Kirby, have not the row of punctures on the anterior margin of thorax. The northern species described by Say and others, are almost all identified by Dr. LeConte.

3. Boletobius bimaculatus.—Head black; thorax testaceous, polished and darker on the disc. Elytra testaceous, smooth-margined on the suture, and having a black spot on each elytrum. Mouth and legs testaceous. Margin of abdominal rings chestnut, posterior one black, acute. Length $\frac{4}{10}$ inch. Quebec; rare.

This species can be easily known from the conspicuous oblong black spot on each elytron. The spots join the epipleuræ, which are black. It is also finely punctured underneath.

4. Athous affinis.—Color cinnamon; finely punctured. Head short, eyes black, round, occupying almost the entire side of the head. Thorax oblong, about three times the length of head, almost parallel with the eyes, but narrower than the elytra. Length $\frac{7}{10}$ inch. Quebec; common.

The above is unknown to Dr. LeConte. I have compared it with his *Corymbites pyrrhos*, which belongs to an allied genus, and cannot detect sufficient specific difference to separate them. The latter was pronounced by the Ent. Soc. Philad. to be *pyrrhos*, Lec.; however, I am satisfied, since Dr. LeConte has seen the insect, that the specimen was not properly determined.

5. Telephorus armiger.—Maxillæ, palpi, and front of head to base of antennæ yellow, the latter 11-jointed;—2nd joint shortest. Head black; thorax with two black elevations; lateral margin yellow—posterior angles acute; anterior and posterior margins black, slightly reflexed. Elytra black, minutely granulated, with two longitudinal ridges. Coxæ and joints of the legs yellow. Body beneath, black. Length $\frac{5}{16}$ inch. Quebec; uncommon.

The mandibles of the above are long and acute. It differs from *Telephorus* (*Cantharis*) *fraxini*, Say, (Jour. Acad. Nat. Sci., Phila., 3, 181,) in not having "confluent, slightly impressed punctures, forming irregular transverse lines."

6. Podabrus simplex.—Mouth, palpi, and front of head to base of antennæ, yellow; tips of palpi black. Posterior portion of head black, narrow where it joins the thorax. Eyes large, globular. Antennæ 11-jointed—first joint longest, second and third shortest and of equal length, the remaining five uniform and black. The two basal joints of antennæ, thorax and anterior pair of legs and coxæ yellow. Thorax almost square, longitudinally elevated on each side posteriorly. Scutellum large, triangular. Elytra black, slightly granulated, polished, with short scattered whitish hairs. Body beneath, and posterior legs black. Length $\frac{4}{10}$ inch. Quebec, June.

About twenty-five American species are known to Dr. LeConte, and I am assured by him that my species has not been heretofore described.

7. Mycetochares bicolor.—Head, eyes, thorax, elytra, and the two posterior segments of abdomen, black. Antennæ, legs and anterior segments of abdomen ferruginous. Head and thorax minutely punctured, the posterior margin of the latter transverse. Elytra striate, and densely punctured in the striæ; sutural striæ abbreviated; the fourth and fifth shortest posteriorly, terminating together. Length $\frac{5}{16}$ inch. Quebec; uncommon.

This is the first of the genus found in Lower Canada. Other species may occur in the Ottawa country. Dr. LeConte says he has "four species, of which *M. binotata*, Say, is the only one described."

8. Cistela quadristriata.—Head black. Thorax and elytra smooth, testaceous, minutely punctured, the latter having two abbreviated striæ on the posterior margins of suture. Antennæ, palpi, legs and body ferruginous. Length $\frac{4}{16}$ inch. Quebec; uncommon.

Easily identified from the double sutural striæ occurring on the posterior half of elytra.

9. POLYDROSUS ? ELEGANS.—Nose black; head, thorax, under part of body, lateral and sutural margins of elytra covered with white decumbent hairs. The five central ridges of elytra are covered with yellowish hair blending with the white on the shoulders. A mixture of the two colors occurs on the disc of thorax, presenting a white longitudinal line on the sides of the thorax. Legs reddish, covered with white hairs; tarsi triangular, with a single claw to each. The latter character alone will serve to determine this beautiful insect. Length $\frac{5}{10}$ inch. Quebec; rare. Dr. LeConte is not satisfied that the above is a true Polydrosus.

10. GRYPIDIUS VITTATUS.—Mouth obtuse; antennal groove forms the segment of a circle; head channeled, minutely punctured; thorax densely punctured, and parallel with the eyes. Entirely covered with short erect white and yellowish hairs, which in certain lights are richly bronzed. White longitudinal vittæ obscure on the centre, but visible on each side of the thorax, commencing behind the upper part of the eye and connecting with 5th, 6th, 7th, and posteriorly on part of the 4th and 3rd elytral ridges. The three marginal ridges are white. Elytra striate. Abdomen composed of five visible rings, the 3rd and 4th of equal width, the last equal to the 2nd. Legs ferruginous, and pubescent. Length $\frac{3}{16}$ inch. Quebec; common in fields during the summer.

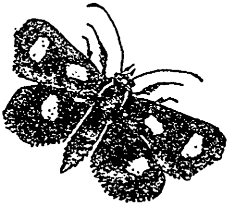
11. MICRORHOPALA INTERRUPTA.—Black. Head, thorax and elytra densely punctured. A reddish-yellow stripe near the lateral margin of the thorax is continued on half the elytra, occupying the distance of thirteen punctures, where it terminates,—but the stripe occurs again on the same lævigated ridge, posteriorly for the length of five punctures. A yellow mark occurs at the termination of the next lævigated ridge in the region of the suture and near the apex, on the sides of which are three punctures. Length nearly $\frac{3}{16}$ inch. Taken at the Hermitage, north of Quebec; June.

The form is that of *M. Pluto*, Newman, or *M. Xerne*, Newman (?) taken in the same locality. The above species is however differently marked from either. *M. Pluto* is entirely black, and the yellow stripe on the elytra of *M. Xerne* is continued to within a short space of the apex, and occupies a distance of twenty-four punctures, while the inside mark occupies less than three.—*Read before the Quebec Branch*, 5*th January* 1865.

DESCRIPTION OF A NEW SPECIES OF ALYPIA.

By WILLIAM COUPER, Quebec.

ALYPIA LANGTONII.—Antennæ filiform, longer than Kirby's *A. MacCullochii*—the tips slightly bent outward, having white bands on the upper part, which can be traced for half their length; the bent part dark velvety. Palpi black, cream-colored in the centre; head and eyes black, the latter with a cream-colored stripe on their inner margin, and a small spot of the same color on the top of the head. Thorax black, margins and anterior portion underneath cream-colored. Abdomen, anterior and posterior wings indigo-black, the latter fringed. Two cream-



Alypia Langtonii, Couper; nat. size.

colored spots on the anterior wings: a semi-triangular spot runs longitudinally between the anterior and interior margins, and a larger kidney-shaped one is placed transversely opposite the posterior margin. One cream-colored semi-triangular spot on the posterior wings; the spot is straight anteriorly, and rounded posteriorly, with a faint longitudinal black line running through its anterior margin. The four anterior tibiæ are densely fringed with orange hair. Expanse of anterior wings, including thorax, 1¼ inch. Quebec; rare. [In the cabinet of the Quebec Branch Ent. Soc. of Canada.]

This beautiful insect is very distinct from *Alypia MacCullochii* (Fauna Bor. Am., page 301, plate iv, figure 5), which has " three very white spots " on the primaries, and " also three white spots" on the secondaries. The only resemblance to it is its black color, and " the four anterior legs (*tibiæ* in my species), externally covered with long orange-colored hairs, characters peculiar to the genus." In my species the apex of abdomen is acute, while in Kirby's it is obtuse. Three specimens taken in the neighborhood of Quebec did not present any variation of wing-spots. The larva is unknown to me. For further information regarding the genus *Alypia*, see "Notes on the Family *Zygænidæ*," by A. S. Packard, jr., in the Proceedings of the Essex Institute, Salem, Mass., April 1864.

I have much pleasure in dedicating this species to John Langton, Esq., President of the Literary and Historical Society of Quebec.

MEETING OF BRITISH ASSOCIATION.

ACROSS THE ROCKY MOUNTAINS.

Mr. Markham read a paper, by Viscount Milton and Dr. Cheadle, entitled, "An Expedition Across the Rocky Mountains into British Columbia, by the Yellow Head or Leather Pass." In the Spring of 1862, Viscount Milton resolved to investigate for himself the nature of the country between the Red River Settlement and the Rocky Mountains; and to penetrate, if possible, by the shortest route, direct to the gold-regions of Cariboo; an enterprise hitherto unattempted.* He was fortunate enough to secure as his companion in this attempt, his friend Dr. Cheadle, of Cain's College, Cambridge, to whose energy and enterprise, Viscount Milton says, "the success of the enterprise is mainly to be attributed." After recording the circumstances that preceded their arrival at Edmonton, the paper continues:—

Before proceeding further with the account of our journey. I must allude very briefly to the magnificent country which extends from Red River almost to the base of the Rocky Mountains. It has been well described by Captain Palliser and Dr. Hector, and I would add my testimony to the fertility of its soil, and to the extent of its resources. It is peculiarly well adapted for settlement; rich prairies, which are ready for the plough, being interspersed with woods which would furnish timber for building and fencing. The climate is the climate of Canada; the spring, however, according to Dr. Hector, setting in a month earlier than it does on the shores of Lake Superior. Grain of all kinds grows here with the greatest

* Excepting of course by the employés of the Hudson's Bay Company. Also by a party of young men from Upper Canada, headed by a Mr. Jessup of Orillia, C. W., who crossed the continent in 1859: they followed the canoe-track to Red River, thence to Tête Jaune Cache by the plains, descending Fraser River as best they could to British Columbia.—Eds.

luxuriance, and the root-crops are certainly finer than any I have ever seen in England. The pasturage is almost endless in extent, and so nourishing that the horses turned out in the snow at the commencement of winter, and then thin and in wretched condition, when brought up in the following spring were exceedingly fat, and fit to set out at once on the journey before them. Coal-beds of large size exist on the Saskatchewan, Battle, and Pembina Rivers. Clay iron-stone in large quantities was discovered by Dr. Hector, and miners were engaged in washing gold in the river above Edmonton during our stay there. Yet this glorious country, estimated, I believe, by Dr. Hector at forty millions of acres of the richest soil, is, from its isolated position, and from the obstructions put in the way of settlement by the governing power, left utterly neglected and useless, except for the support of a few Indians, and the employés of the Hudson Bay Company. Could communication be established with Canada and British Columbia, this district would, I imagine, become one of the most valuable of the British possessions. After remaining three weeks at Fort Edmonton for rest and preparation, the travellers and their party set out on their journey across the mountains, following the trail between Lake St. Anns and Jasper House; a day's journey on the road generally consisting of continual floundering through bogs, varied by plunges and jumps over the timber lying strewn, crossed, and interlaced over the path, and on every side. Between Lake St. Anns and the foot of the mountains the forest is almost unbroken—a distance of nearly three hundred miles. After the lapse of twenty-six days from leaving Fort Edmonton, the travellers found themselves fairly in the Rocky Mountains. They followed the course of the Athabasca for some time, but afterwards followed the valley of the Myette, and eventually reached the height of land so gradually that they would hardly believe they had gained the water-shed of the Pacific. A few days after, they struck the Fraser River, already a stream of considerable size. From this point up to the almost perpendicular sides of the narrow valley in which we were shut in, this portion of our journey was the most harassing we had yet experienced. The path lay almost entirely through water up to the horse's girths, the only change being to swamps, embarrassed with fallen timber of very large size. When we reached Moose Lake, an expansion of the Fraser, about fifteen miles long, and two or three wide, our difficulties increased. The trail along the beach was now under water, and we were frequently obliged to ascend the steep mountain-side, when the accumulations of drift-wood barred the passage along the shore. Numerous mishaps occurred, the horses perversely going out into deep water, and floating about, to the great detriment of flour and pemmican. Two rolled down the mountain side, and had to be unpacked, and their loads carried up to enable them to re-ascend. We found no place to rest during the day; and when night came on we had not reached the end of the lake, and were obliged to camp in a bare sandpit, without any feeding-ground for our weary animals, who ranged restlessly to and fro until the morning. The road continued almost as difficult all along the valley of the Fraser, and at one point was a narrow ledge of a few inches along the face of a cliff of crumbling slate, rising perpendicularly a tremendous height above us, and a steep descent of above two hundred feet to the river below. On the fourteenth we crossed a great number of small streams, many probably mouths of the Moose River, an important tributary of the Fraser flowing from the north. This grand fork of the Fraser is at the foot of a very high mountain, which has received the name of Robson's Peak (and is the original Tête Jaune Cache), so named from being the spot chosen by us. After journeying thus, meeting greater difficulties still, the travellers left the Cache and kept the emigrants' trail, which they followed into the dense forests until it came to an end at a place where there had been two large camps, and where, from all they saw about them, they concluded that the whole band of emigrants had given up in despair the idea of cutting through forests so dense and encumbered, and had built large rafts, in order to drop down the river to Kamloops. This plan our travellers had no means of following, and after difficulties and disasters which the paper describes, they at length managed again to come on a trail, and were soon after encouraged by hearing a crow, a sure sign of more open country, and eventually they reached Kamloops. The paper concludes as follows :—

In conclusion, I must venture a few general observations upon the nature of the country through which we passed, from Fort Edmonton, on the eastern side, to Kamloops on the west of the mountains, with regard to the practicability of a road or a railway being taken across by that point. Our party being, I believe, the only one which has passed through this region entirely by land, the testimony has some value, as being all that is known of a very considerable portion of the distance. In the first place, I may safely state, that, with the exception of one or two rocky and precipitous bluffs,—few and trifling obstructions, compared with those which have been already so successfully overcome in making the road along the Fraser River,—there are no engineering difficulties of any importance. On the other hand, however, for almost the whole distance, the road would require to be *made*, there being no open country until reaching the lower portion of the valley of the North Thompson. From Edmonton to Jasper House the surface is slightly undulating; and the lower ground universally swampy, even where covered with thick forest. From Jasper House to Tête Jaune Cache, the pass through the main ridge of the Rocky Mountains, the valley is, for the most part, wide and unobstructed, except by timber, which is generally of large size; the rivers small and mostly fordable, even at their highest. The ascent to the height of land is very gradual, and, indeed, almost imperceptible; and the descent, although much more rapid, neither steep nor difficult. From the Cache to the first opening out of the valley of the Thompson, about eighty miles north of Kamloops, the only route lies along that river, running through a succession of narrow gorges shut in on each side by lofty and inaccessible mountains. The whole of this portion is obstructed by growing and fallen timber of the largest size; but the fact of our being able to bring horses through without any previous track being cut open, proves sufficiently that there are no serious obstacles in the way of an engineer. No great ascents or descents occur, the bottom of the ravine being generally level, except where the transverse ranges of hills come down close to the water's edge. Many of these are, indeed, rocky, but consist generally of broken fragments of no great size. No bluffs of solid rock appear until the last forty miles, where the country is generally open, and otherwise little obstructed. The flooding of the river by the melted snows of the mountains does not interfere with the passage along the valley, we having traversed it in the middle of the summer when the waters were at the highest. A road might possibly be made more direct to Cariboo than by continuing on to Kamloops, by following the north-west branch of the North River, which comes in about sixty miles south of Tête Jaune Cache, or the Canoe River, some fifteen miles below that place; but, from the rugged nature of the country to the west, such a road could only be made by great labor and outlay. The easiest line would, I apprehend, be from the junction of a small river which flows into the Thompson, about twenty miles north of the Clearwater, or about eighty north of Kamloops. This stream, the Indians informed us, came from the Cariboo Lake, and passes through a totally open region. The most serious difficulty to the adoption of a route by Jasper House would be the want of pasturage for cattle. The patches of open country are few on the eastern side, rather larger and more numerous within the mountains; but after leaving the Cache, on the western side, the forest is unbroken for above a hundred miles, and in no portion of the whole six hundred or seven hundred miles from Edmonton to the Clearwater, except at Jasper House, is there sufficient food for any large number of animals. The advantages of this route would be—1st. That it lies far removed from the boundary-line, well within British territory. 2nd. That it passes entirely through a country inhabited only by friendly and peaceable Indians. 3rd. That it offers the most direct communication from Canada to the gold-regions of British Columbia; and from it the Sewshwap and Okanagan districts, as well as the road on the Fraser, are easily accessible. These considerations are, I think, of sufficient importance to require that the question whether this more northern pass does not, from its directness and the security which it offers, possess more solid advantages than those lying further south, should be carefully and fairly weighed. The more southern passes lying within the British line are far more steep and difficult than the one by Jasper House, and are in unsafe proximity to the United States territories. The only advantages to be claimed for them appear to be that they communicate with more open country on either side, that pasturage is plentiful along the road, and that, from their more southerly latitude, they are likely to be blocked with snow for a shorter period. But whichever be the one selected, I would urge most strongly the necessity for immediate action in the matter, and hope, though not with confidence, that the New Hudson Bay Company will cast off the prejudices and lay aside the obstructiveness which degraded the policy of the old one, and promote, to the utmost of their power, that scheme, which is of such vital importance to the advancement of all the British possessions in North America.

The President spoke highly of the value and interest of the paper, and eulogised the conduct of Viscount Milton in leaving the ease and luxury of a home like his for the true advancement of science. He had more successfully than any other traveller, faced the dangers and difficulties of a most difficult and inaccessible country.

Dr. Cheadle, in the course of some supplementary remarks, said that throughout British Columbia, except a few isolated portions, no farming-land was to be found. Though it was possible by irrigation to produce certain crops in a few years, yet they must soon cease, for there was nothing but sand, the only vegetable mould being supplied by the decay of grass. In most parts the land was so light that it was impossible to irrigate it. But this country, so rich in minerals, was only separated by the Rocky Mountains from the rich and productive country on the other side, showing the necessity for opening-up a communication between them.

Lord Milton, in the course of a few observations, expressed his great obligations to Dr. Cheadle, and said that the Red River Settlement was the best colony England had for farming purposes, but nowhere was farming less understood. One man there, after sowing eleven crops of wheat in succession on the same land, began to inquire the reason why his crops had failed. This showed at once the richness of the soil, and the ignorance of many who cultivated it.

The President said, so convinced was he of the value of the paper that had been read, that he should claim on the part of the Royal Geographical Society, that it should be placed upon the permanent records of the Association.

REVIEWS.

Proceedings of the Portland (Maine) Society of Natural History.—We have received with pleasure the first number of the Journal and of the Proceedings of the Portland Society of Natural History.

The Journal is occupied by one of the most elaborate papers we ever remember to have seen on such a subject, on the terrestial Pulmonifera of the State. Too much praise can hardly be given to the patient manner in which the microscopic details of the species have been worked out. Careful drawings are given of the buccal plates and lingual ribbons of nearly all the molluscs described, and of other interesting peculiarities whether in the animal or in its shell. The nomenclature of all the species is utterly changed, and Mr. Morse divides the twenty-six Helices of the State into four subfamilies! We are not disposed to agree with our author in considering the American varieties of *Helix pulchella* and *H. chersina* and *Zua lubrica* as sufficiently distinct from the European types.

The first paper in the Proceedings is a catalogue of the flowering plants of Maine, by G. L. Goodale. The list appears to have been prepared with great care, is very complete, and is evidently the work of a sound critical botanist. To this succeed catalogues of the mammalia and birds of the State, which we have no doubt will prove interesting to the student of Zoology in Canada. Most of the mammals of Maine are also well known to inhabit this colony, but as yet very little critical attention seems to have been paid to the higher animals in Canada. The following Maine species, so far as we know, have not yet been recorded, at any rate as inhabiting Lower Canada, and have probably been overlooked:

Vespertilio Carolinensis, Geoffroy (common brown rat). *Sorex Forsteri*, Rich. (Forster's shrew). *Sorex Richardsonii*, Bach. (Richardson's shrew). *Sorex platyrhinus*, Wagner (Eared shrew). *Sorex Thompsoni*, Baird (Thompson's shrew). *Blarina brevicauda*, Gray (Short-tailed mole shrew). *Vulpes Virginianus*, Rich. (Grey fox). *Putorius Richardsonii*, Bonaparte (Little ermine). *Putorius nigrescens*, Aud. and Bach. (Little black mink). *Hesperomys leucopus*, Wagner (White-footed mouse). *Hesperomys myoides*, Baird (Hamster mouse).

Prof. Hitchcock gives a careful and detailed description of the Devonian and Upper Silurian rocks of part of the State. Three new species of Devonian plants are described by Principal Dawson, from the 'plant-bed' at Perry. The State geologist then gives localities for various interesting fossils, calls attention to a peculiar arrangement of boulders near Bethel, and lastly gives an account of the post-tertiary clays of Maine, and compares the fossils which they contain with the lists (published in the *Can. Nat.*) of the organisms procured from the drift of the St. Lawrence valley. A large proportion of the marine invertebrates are common to the post-pliocene deposits of Maine and Canada East; and where differences exist, it appears to us that they are very similar in character to those which obtain in the existing fauna of the two coasts. Dr. Foggs' "List of the Reptiles and Amphibians found in Maine" has also its special interest to Canadian naturalists. We know but little of the geographical distribution of these creatures in Canada, much less even than of the mammals. Of the eleven species of snakes found in Maine, we have determined eight of the species as also inhabiting Lower Canada. Of the turtle family, all the Maine species have been detected in Canada East, with the exception of the mud-turtle (*Ozotheca odorata*, Ag.) and the box-turtle (*Cistudo Virginea*, Ag.). The newts and lizards have been very little explored: eleven species are known in Maine, and at present but five in the neighborhood of Montreal. Dr. Dawson describes some new plants from the Upper Devonian of the vicinity of the Perry River, in addition to those already alluded to. These fossils bear a striking resemblance to the plants of the coal-period, and most of the genera, *e. g.* Stigmaria, Calamites, Dadoxylon, Cordaites, Sphenopteris, and Hymenophyllites, range upwards into that formation. The student of the fossils of the Quebec group and of the Lower Silurian rocks generally in Canada, will find Prof. Hitchcock's paper on the fossils of the Potsdam group well worthy of perusal. Lastly, Mr. Billings contributes an important article on Silurian and Devonian fossils from various parts of Maine. He describes and illustrates several new species of shells (principally brachiopods), also seven new trilobites.

This journal, judging from the first numbers, bids fair to rank high among the scientific periodicals of the United States, and clearly proves that the study of Natural History in Maine has not been neglected. The illustrations are artistic, and the numbers on the whole are well got up. J. F. W.

ICONES MUSCORUM, OR FIGURES AND DESCRIPTIONS OF MOST OF THOSE MOSSES PECULIAR TO EASTERN NORTH AMERICA WHICH HAVE NOT BEEN HERETOFORE FIGURED; BY WILLIAM S. SULLIVANT, LL.D., etc., etc. With one hundred and twenty-nine copper-plates. Cambridge, Mass. 1864.: Sever & Francis. London: Trubner & Co. Imp. 8vo.—This book, by a corresponding member of our Society, and one of the ablest living Bryologists, is thus noticed by Prof. Gray in the November number of Silliman's Journal: "We briefly announced this work in the September number of this Journal, in terms of unqualified admiration—which were intended to apply as well to the scientific character of the volume as to the rare perfection of the typography and the plates. One hundred and thirty species are illustrated, a full plate (with one or two exceptions), and commonly two pages of letter-press, being devoted to each. The detailed descriptions are in Latin, as also the explanation of the plates; the habitat and the general remarks are in English. The plates represent the Moss of the natural size, as magnified, and with an ample series of exquisite analyses; for the most part there are as many as twenty figures to each plate. The drawings are placed to the credit of Mr. August Schrader, who has had a long training for such work under Mr. Sullivant's direction. They were engraved by Mr. Wm. Dougal, of Washington, who executed the plates of *Musci* of Wilke's Pacific Expedition. Probably upon no work of the kind has an equal amount of labor, knowledge, and expense been lavished. Only a small edition has been printed, and it is published at a price ($10 in gold) which, however considerable at present, will, it is understood, be very far from covering the cost."

NATURAL HISTORY SOCIETY.

The ordinary monthly meeting of the Society took place on Monday evening, Jan. 30, and was fairly attended. It was determined that the Society's annual Conversazione should take place towards the latter end of February, and a committee was appointed to make the necessary arrangements. Various donations were announced, the following being the more important:

TO THE MUSEUM.

Specimen of the mottled owl (*Scops asio*, Bonaparte), from Mr. W. Boa; the Cape-May warbler (*Dendroica tigrina*, Baird), from Mr. P. Kutzing; twenty-three species of beetles (named), from Washington, South Carolina, and California, from Mr. W. Couper, Quebec; fine crystal of amethyst, from the north shore of Lake Superior, presented by the Literary and Historical Society, Quebec; specimen of Cooper's hawk (*Accipiter Cooperii*, Bonaparte), and thirty species of Canadian insects, from Mr. W. Hunter.

NEW MEMBERS.

Messrs. D. R. McCord and T. Reynolds were elected members of the Society.

PROCEEDINGS.

Mr. D. R. McCord read a paper on the well-known Canadian fern, *Cystopteris bulbifera* of Swartz. This little "bladder fern" has the peculiarity of bearing small bulbs, usually near the angles formed by the junction of the mid-rib of the frond, and those of some of the pinnæ. The microscopic character of these bulbs was shown in detail, and was illustrated by careful drawings on the black-board. The peculiarities of their germination were also elaborately explained. The author of the paper stated, that, after careful microscopic investigation into the fructification of ferns, he was inclined to think that the views usually promulgated with regard to the impregnation of these plants were untenable. Considerable discussion followed after the reading of this paper, in which the Right Rev. the Lord Bishop, Mr. Barnston, and Dr. Dawson took part. Dr. Dawson stated that this little fern, like many flowering plants, appeared to have two distinct means of propagation. The spores of course were the strict analogues of seeds, while the bulbs appeared to be undeveloped buds, in which phenomena took place similar to the ordinary budding-process.

A paper by Mr. R. J. Fowler "On Shells taken from the Stomachs of Flounders," was next read by the Recording Secretary. It is, and has long been, well known that many fishes—such as the cod, and many of the flat fishes—often feed upon marine shells; and many rare deep-water molluscs have only been procured from the stomachs of fishes. In the winters of 1861-62 and 1862-63, very large flounders (said to have been taken at Portland, Maine, U. S.) were sent to the Montreal markets, frozen and uncleaned. The stomachs of nearly all these contained marine shells, often of considerable size. During two winters, about thirty or forty species were procured from this source, some of considerable rarity, and these sometimes in great numbers. About 100 magnificent specimens of the rare *Yoldia thraciæformis* (a large sub-arctic bivalve shell) were taken, and two specimens of another bivalve (a species of Neœra) which has never before been taken on the North American coast. This last shell is probably identical with a rare British species, occasionally taken at Loch Fyne and a few other Scottish localities.

Dr. Dawson then exhibited and made some remarks upon a collection of fifty-seven species of plants made in Newfoundland in the autumn of 1864, at the instance of Mr. A. Murray, of the Geological Survey of that Island. Amongst the most interesting plants collected we notice *Calluna vulgaris* (see this journal, 1864, page 459), *Lychnis alpina*, *Hedysarum boreale* (which occurs also on the mountains of Vermont and on the Alleghanies), *Epilobium latifolium*, *Cornus suecica* (found also in Norway), *Aster graminifolius* (a White Mountain species), *Gentiana acuta*, and *Pleurogyne rotata*. A remarkable variety of the common harebell or bluebell of Great Britain, which was known to occur about Lakes Huron and Superior, and which, by some, has been elevated into the rank of a species, under the name of *Campanula linifolia*, has been also found in Newfoundland. Its very limited distribution in North America is quite remarkable. Dr. Dawson remarked that the plants of Newfoundland appear to be of a boreal or sub-arctic type, that the flora was of a decidedly Scandinavian character, and that many of the species were identical with plants found in Great Britain and in various other parts of Northern Europe. J. F. W.

ANNUAL CONVERSAZIONE.

The third annual Conversazione of the Society was held at the rooms, University Street, on the evening of Monday, Feb. 21st, on which occasion the museum and library were thrown open, and crowded by a concourse of our most respectable and influential citizens, a large number of ladies being present. In the library were a number of microscopes of great power, exhibited by Messrs A. S. Ritchie and F. Cundill, which attracted a constant succession of the curious, many of the specimens being deeply interesting. In the lecture-room were laid out a number of illustrations and illustrated works, in connection with various departments of Natural History; Mr. D. R. McCord's collection of Canadian Ferns; a series of De La Rue's photographs of the Moon; and microscopes exhibited by Messrs. J. Ferrier, jun., and Thomas Rimmer. The visitors having entertained themselves with inspecting the various objects of interest, or in listening to the fine strains of the band of the 63rd Regiment, stationed in the gallery of the museum, finally assembled in the lecture-room, to listen to an address from Principal Dawson.

PRINCIPAL DAWSON said that although the members of the Natural History Society were not a speaking people, he desired to say a word on what they aimed to accomplish, as well as on the various objects exhibited that evening. The object of the Society was three-fold: first, industrial or economic; second, educational; and third, scientific, which might be termed their object proper. In the economic department, their aim was to collect objects illustrating the products of the country, as well as to diffuse information as to anything in relation thereto which had an injurious tendency: he believed they had already done something in this way. Their educational object was to diffuse among young people a taste for something more than ordinary light or frivolous pursuits, and for this purpose they had collected a number of objects illustrative of various departments in natural history, and endeavored to create an interest in such studies by popular free-lectures, which, he trusted, would do something to diffuse a taste for such pursuits. In years gone by they had done something in this direction; but of late their means and appliances had been much improved, which was due in a great measure to the care and exertion of Mr. Whiteaves. The objects in the Society's Museum generally, had been better arranged; and any person by looking over the collection might obtain a considerable amount of information. Lastly, in regard to the scientific department, he must observe it was less popular; they had, nevertheless, been trying to make original discoveries in geology and other branches. These had been discussed in their journal and at their monthly meetings, as most people who knew anything of the Society's proceedings were aware. By means of the journal, too, information had been diffused in other countries as to what was doing here. In all these ways they had been trying to advance the cause, and they invited those present here this evening, in order that they might take an interest in the Society, and give it such countenance and support as they were able, this being the principal object of the entertainment. In regard to the objects exhibited, an illustration would be given of the electric telegraph; as well as of the fire-alarm telegraph, which he hoped would alarm no one. Dr. Smallwood had also swung a long pendulum by which he intended to show that the earth still moves, and spins round with all its weight of civilization as merrily as ever. Upon the table in front of the platform was an ancient Canadian fossil (the *Eozoon Canadense*), an example of the humble organic structure which ushered the dawn of life into the world; and beside it was the cast of a skull found in a cave in Belgium with the bones of extinct species of mammoths, with which it was believed to be contemporaneous. The old gentleman in question might have dined with Methuselah; and some thought that he might even have existed before Adam,—which, however he (Dr. Dawson) did not believe. It was an ordinary long-headed skull of the Celtic type. A number of persons had also contributed microscopes with many objects not easy of collection. Mr. McCord had exhibited his collection of Canadian Ferns; and a series of water-color drawings of Canadian Fishes had been received from Mr. Fowler, who, it was hoped, would continue his labors in this direction. Behind him were a number of photographs of the moon, which we were apt to believe a spotless orb, but we were surprised to find her face full of blemishes presenting an appearance somewhat like an ancient cinder, instead of the poetical attributes usually attributed to her. These were a few of the objects before them, of which it was desirable those present should avail themselves, and he trusted the result would be that many would connect themselves with the Society. In conclusion, he would state that the Sommerville lectures, and the scientific monthly meetings, were all open to ladies, and, as he knew many of them were given to the study of scientific subjects, they would be glad to have them present on these occasions. He hoped that all would separate mutually satisfied with the instruction they had received; and Dr. Smallwood would now proceed to show them his little experiment relative to the rotation of the earth.

Dr. Smallwood now proceeded to explain by means of a large pendulum suspended from the ceiling, the experiment alluded to; tracing in some remarks, the history of the discovery of the earth's motion from the time of Galileo, and was listened to by those present with much attention.

The numerous visitors, having amused and instructed themselves with the various objects provided for their entertainment, gradually dispersed; carrying with them, there is little doubt, a greater interest in the welfare of the Society.—*Newspaper Report.*

MONTHLY MEETING.

The ordinary meeting of the Society was held on Monday evening, March 6th, the President, Principal Dawson, in the chair.

Among the more important donations to the Museum and Library during the past month are the following:—

TO THE MUSEUM.

The Arctic puffin (*Mormon Arctica*, Linn.), and the gannet (*Sula bassana*, Linn.), both from the Lower St. Lawrence; presented by Mr. Pierre Fortin.

Fine specimen of the rare cinereous owl (*Syrnium cinereum*, Baird), shot on the Island of Montreal; from Mr. Alex. S. Ritchie.

Twenty-one species of fossils from the Carboniferous Limestone of Ireland and Nova Scotia; presented by Principal Dawson.

TO THE LIBRARY.

Embryology of the starfish, by Alex. Agassiz; from the author.

PROCEEDINGS.

Mr. A. S. Ritchie then read a paper "On the structure of Insects." He commenced with a sketch of the history of Entomology from the time of Linnæus and still earlier authors, down to the present day. He then briefly reviewed the methods of classifying insects which have been suggested by different authors; some of whom founded their systems on the more or less perfect changes which insects undergo, others on the peculiarities of the structure of the wings, or of the other organs of locomotion, some on the mouth and the organs surrounding it, and so on. An account was given of a few of the insects which are regarded with superstitious dread by the ignorant, as the death-watch and the death's-head moth. Attention was then called to the enormous numbers of insects which are known to science, the number of species being estimated at somewhere near 300,000 The microscropical anatomy of these creatures was dwelt upon in minute detail. The tracheæ or air-tubes were first described: these run the whole length of the body, and branch off to every part, the tubes being kept expanded by an elastic spiral filament somewhat like the spiral vessels in plants. These tubes have outlets along the sides of the thorax and abdomen, called spiracles, which are usually fringed with hairs to prevent impurities passing into the delicate breathing-apparatus. The structure of the antennæ of various kinds of insects was then explained. They seem to be organs of sensation, touch, and perhaps of hearing. The compound-facetted character of the eye in insects was next dwelt upon. These facets are often very numerous: in the ant they are said to amount to fifty, in the house-fly they number 4,000, in the dragon-fly 12,000, and, according to Geoffroy, the eye of a butterfly contains upwards of 34,000 lenses. The various parts of the mouth were then detailed, and after these the peculiar arrangement of the legs and feet in various insects. Having described the various organs of insects in the abstract, the lecturer proceeded to illustrate how they varied in different kinds of insects. From the beetles three species were selected—the *Cicindela campestris*, a carnivorous ground-beetle; the *Dyticus marginalis*, a large aquatic species; and the *Melolontha vulgaris*, more commonly known as the cockchafer. The sharp scythe-like jaws of the tiger-beetle were described, also its large prominent eyes; its predatory habits were dwelt on at some length, also the habits of the larva. The boat-like shape of the Dyticus, and its oar-like feet, and various other organs, were next considered. Like the Cicindela, it is predacious in its habits, and has been known to devour fishes and frogs far larger than itself. The cockchafer is purely vegetarian in its habits; its mouth seems more adapted for grinding its food, than cutting it, and its sluggish shape contrasts strongly with that of some of the carnivorous ground beetles. It is said that poisons have no effect upon the grub of this beetle, but alkalies seem fatal to it. Further examples were then taken from the order to which the locusts and crickets belong. The various peculiarities of the house-cricket were described, particularly its remarkable gizzard, covered internally with scales or horny points. The mechanism by which the chirrup of the grasshoper is effected, was explained at considerable length, as were also various points of structure in the mole-cricket and the cockroach. The dragon-fly and the *Urocerus gigas*, an insect very destructive to pine-trees, were also described in detail, particularly the curious ovipositor of the latter; and the last illustration selected was one of the saw-flies. The lecturer concluded by remarking that all these curious contrivances were 'ently made to adapt each insect for its special functions in the economy of nature, and that it afforded one of the many proofs of the harmonies to be observed in the material world. The paper was illustrated with a number of microscopical preparations of various parts of insects, and with a large series of magnified drawings.

After some remarks upon the paper by Principal Dawson, by the Right Rev. the Lord Bishop, the Rev. A. F. Kemp and others, the thanks of the meeting were voted to Mr. Ritchie for his paper.

J. F. W.

Mr. Watt presented to the meeting:—

1. A very full catalogue of Canadian plants, by Mr. A. T. Drummond of London, C. W., including not only that gentleman's own collections throughout the Province, but also a reference to nearly all that has been published on Canadian Botany. His list of Lichens is particularly full, embracing about 150 species.

2. An elaborate catalogue of the Flora of the county of Hastings, C. W., by Mr. Macoun of Belleville, which includes many rare and interesting plants. Mr. M.'s list of Carices is especially interesting, and extends to nearly ninety species. His list of mosses includes one very interesting new species,—*Neckera Macounii*, Sullivant, MS. Canadian Muscology offers an inviting field for assiduous exploration.

3. A catalogue of the collections of Dr. J. G. Thomas, in the vicinity of Quebec and of Rivière-du-Loup, C. E. Credit is due

to this botanist for having been the first to observe the true *Woodsia alpina* in Canada, a specimen of which in good fruiting condition was exhibited. The plant found by Mr. Bell in Gaspé, and referred by Dr. Lawson to *W. glabella* (see this Journal, 1864, page 288), and by Prof. Eaton to *W. alpina* (ditto, page 4), appears to have been immature, and consequently difficult of determination. Dr. T. has also found the normal *W. glabella*, and his station (the upper falls of the Rivière-du-Loup) is the only thoroughly reliable Canadian one known to us for that rare variety. A specimen of the *Botrychium Lunaria* of Swartz of unusual size and in a perfect fruiting state, found by Dr. T. at Rivière-du-Loup, was also shewn. This fern proves to be general throughout Canada;—its apparent rarity may be accounted for by its inconspicuous mode of growth.

Dr. Thomas says (in a letter to the Editor), "The flora of this interesting region (Rivière-du-Loup) is semi-arctic, the plants of Labrador and thence northward being found along with natives of central Canada. Among the Gentianaceæ we have *Pleurogyne rotata* (a decidedly Labrador plant) and *Gentiana acuta* (Michaux), growing almost side by side with *Halenia deflexa* and other gentians of lower latitudes. * * * * Around Quebec, the hay-fields are white during summer with the flowers of the common ox-eye daisy (*Leucanthemum vulgare*, Lam.); but below Quebec it gradually becomes scarcer, until at L'Islet it stops, and is not seen below. The plant is introduced enough, as nearly all the hay-seed sown by the farmers is brought from Quebec. The corn-cockle (*Agrostemma Githago*, L., usually a too common weed) is extremely rare here. I have found no representations of the Goose-foot family (Chenopodiaceæ), which is remarkable. Our specimens of *Saxifrega Aizoon* are peculiar. The scape (or rather stem in this case) is decidedly leafy; the leaves are alternate, and resemble those clustered at the root, which are thick, spatulate, and sessile, with cartilaginous margins, and are slightly smaller than the radicle leaves. Among the Scrophulariaceæ, I collected *Veronica Chamædrys*, L., at Lévis in 1859 (where it is not common), with its leaves decidedly petioled, and not sessile as in the British plant; the petiole is not long—about $\frac{1}{8}$ to $\frac{1}{16}$ of an inch, but still a petiole." W.

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