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THE CANADIAN JOURNAL OF INDUSTRY, SCIENCE, AND ART:

CONDUCTED BY

THE EDITING COMMITTEE OF THE CANADIAN INSTITUTE.

NEW SERIES.

VOL. VI.

TORONTO:
PRINTED FOR THE CANADIAN INSTITUTE,
BY LOVELL AND GIBSON, YONGE STREET.
MDCCCLXI.

CANADIAN INSTITUTE.

EDITING COMMITTEE, 1861.

THE CANADIAN JOURNAL.

NEW SERIES.

No. XXXI.—JANUARY, 1861.

NOTE ON STELLIFORM CRYSTALS, WITH SPECIAL REFERENCE TO THE CRYSTALLIZATION OF SNOW.

BY E. J. CHAPMAN,
PROFESSOR OF MINERALOGY AND GEOLOGY IN UNIVERSITY COLLEGE, TORONTO.

(*Read before the Canadian Institute, December 15th,* 1860.)

As this *Journal* is not addressed exclusively to the scientific reader, but to the members of the Canadian Institute at large, it is necessary to offer a brief explanation of the more important questions involved in the general study of crystal-forms, before adverting to the special object of the present communication.

The forms assumed by natural bodies are of two general kinds:—(1) *Accidental,* depending not so much on the actual nature of the body, as on surrounding conditions; and (2), *Essential or Regular.* Accidental forms are most rare (if indeed ever truly present) in Organic Nature. Every plant and animal, and each portion of a plant and animal, has its one fixed and determinate form, never really departed from, except in the case of monstrosities. Amongst minerals, on the other hand, accidental forms, or such as are common, under certain circumstances, to all minerals, are of frequent occurrence. The Mineral Kingdom, however, possesses also its definite or essential forms. These, whether transparent or opaque, are termed *crystals.*

So far, therefore, as regards the regular or essential forms of Nature, two form-producing powers appear to exist, *viz.,* vitality and crystallization. Forms which arise from a development of the vital force, exhibit rounded and confluent outlines; whilst those produced by crystallization, are made up of plane surfaces, meeting, in sharp edges, under definite (and for the same substance, under constant) angles.* Although crystals usually originate when matter passes slowly from the gaseous or liquid condition into the solid state, crystallization and solidification are not actually identical. Various substances, for example, such as silica in certain conditions—its hydrate (constituting the different opals)—gums,—certain resins, &c.,—appear to resist altogether the action of crystallization. Mr. Graham (the present Master of the British Mint) has suggested that these bodies may retain, or retain to a greater extent than crystalline bodies, the latent heat which they possessed before solidification.

The crystal forms and combinations met with in Nature, exclusive of those produced by the chemist in his laboratory, are exceedingly numerous, many thousands being known to exist. By the help of certain laws, however, and, more especially, by the aid of one, termed "the Law of Symmetry," we are enabled to resolve these multitudinous *combinations into six groups or systems. The forms of the same* group combine together, and may be deduced mathematically from each other; whilst those of distinct groups are unrelated. Thus, although the cube, the rhombic dodecahedron, and the regular octahedron, appear at first sight to be unconnected forms, yet by the Law of Symmetry their co-relations may be readily shown. This law, for instance, exacts one of three things, of which the most important is to this effect, *viz.*, that if an edge or angle of a crystal be modified in any way, all the similar edges or angles in the crystal must be modified in a similar manner. Now the cube has twelve similar edges and eight similar angles. Consequently, if one edge or one angle be truncated, or, to use a term more in conformity with the actual operations of Nature, if one of these be *suppressed* during the formation of the crystal, all the other edges (or angles) must be suppressed equally; and if the new planes which thus arise be extended until they meet, the rhombic dodecahedron on the one hand, and the

* This law is affected within slight limits by isomorphous replacements, and also by changes of temperature. The law itself appears to have been discovered by Nicolaus Steno (then a naturalized Florentine) as early as 1669, but its true importance was not appreciated until the re-announcement, or rather re-discovery of the law in 1772 by the French crystallographer, Romé de l'Isle. Many of the contemporaries of the latter—amongst others, the celebrated Buffon—attempted to deny its existence, but being susceptible of practical proof, its truth was soon established.

regular octahedron on the other, will result.* These forms, moreover, as well as their intermediate oscillations, *frequently occur* in the same substance: red oxide of copper may be cited as an example. But between the cube, a square prism, and a rhombic prism, no relations of this kind exist. Neither are these forms related physically: for their optical, thermal, and other physical relations are equally distinct. By considerations of this sort, therefore, we are able to establish six (or really seven) distinct Crystal Systems. These (named chiefly in accordance with the relations of their axes) are enumerated in the annexed tabular view.†

Crystal-axes of one length. Refraction. single		*The Monometric System* (including the cube, rhombic dodecahedron, octahedron, &c., with their various combinations.
Crystal-axes of two lengths. Refraction, double, with one neutral line or optical axis		*The Dimetric System* (including square-based prisms and pyramids with their various combinations.)
		The Hexagonal System (including regular hexagonal prisms and pyramids, rhombohedrons, &c., with their combinations.)
Crystal-axes of three lengths. Refraction, double, with two neutral lines or optical axes.	Axes at right-angles.	*The Trimetric System* (including right rectangular prisms and pyramids, rhombic prisms and pyramids, and combinations of these.
	One axis oblique.	*The Monoclinic System* (including oblique rectangular and rhombic combinations.)
	All the axes oblique.	*The Triclinic System* (including doubly-oblique combinations.)

* The Law of Symmetry, in its exact acceptation, may be thus expressed:

(1.) If an edge or angle of a crystal be modified, *all* the *similar* edges or angles must be equally modified.

Or (2.) *One-half* or *one-mth* of the corresponding angles or edges, in alternate positions, must be equally modified. *Example.*—Cube and Tetrahedron (Boracite; Arseniate of Iron.)

Or (3.) *All* the similar edges or angles must be modified by *one-half* or *one-mth* the normal or regular number of planes. *Example.*—Cube and Pentagonal Dodecahedron (Iron Pyrites.)

Conditions 2 and 3 produce *hemihedrons* or *part-forms*.

† See also Vol. V. of this Journal (New Series), pages 7–9.

In each of these Systems, it often happens that two or more crystals are united, forming the so-called twin or compound combinations. When four individuals are thus united, cruciform crystals usually originate; and stellate combinations frequently arise from the union of five or six individuals. Of these latter, the six-rayed stelliform crystals of snow must be familiar to all Canadian readers. These snow crystals have hitherto been referred, by almost universal consent, to the Hexagonal System of Crystallization—to which, indeed, at first sight, they naturally seem to belong. Now the object of my present communication is to shew that this generally received view, whilst unsupported by anything like actual proof, is opposed by much evidence of a more or less direct character. This evidence is based, first, on the occurrence of stelliform groups amongst minerals; and, secondly, on the results afforded by some experiments on the crystallization of dilute solutions of various salts.

Amongst the natural products of the mineral kingdom, stelliform six-rayed groupings and pseudo-hexagonal combinations occur (more especially) in Discrasite or Antimonial Silver, Chrysoberyl, Sulphate of Lead, Carbonate of Lead, Carbonate of Baryta, and Arragonite: all of which belong to the Trimetric System. To these must be added the curious stellate groupings of native copper from Bosgolowsk in the Northern Ural—described by Professor Gustav Rose, in his "Reise nach dem Ural," in 1829—the only example of a Monometric combination of this kind, hitherto made known. Stellate groupings amongst Hexagonal minerals (always omitting the doubtful snow-crystals) have not been recognised; although in the opalescence of certain corundums something akin to this structure may perhaps be admitted. Apart from this exceedingly indirect evidence, the assumed crystallization of snow receives therefore no support, but the very reverse, from what is known respecting mineral bodies of natural formation. Let us inquire if artificially-produced crystals will throw any additional light upon the question.

From time to time, during the last three or four years, I have been making a series of experiments on the crystallization of dilute solutions of various salts. These experiments have been made with the primary object of ascertaining whether the crystallizations, thus produced, do not follow certain definite laws in their arrangement; and although I have failed, up to the present, to establish anything very satisfactory in this respect, I still hope to succeed eventually; and my observations have shewn me several curious facts: amongst others, one that has led me to the present inquiry. I have found, for example, that compound stellate crystals, resembling exactly many of the star-crystals of snow, may be produced in salts belonging to various systems of crystallization—although I have not succeeded in obtaining them from Hexagonal salts: another fact—so far as it goes—against the assumed crystal system of snow. Omitting all doubtful and in any way unsatisfactory cases, I have obtained repeatedly these stelliform combinations in the five substances enumerated below; and the list, I have no doubt, will be ultimately much extended:

Monometric Substances.

Camphor = 20C, 16H, 2O. Star-crystals obtained from solution in alcohol. These crystals require to be examined as soon as formed, as they evaporate with great rapidity. Sal Ammoniac = Am Cl.

Trimetric Substances.

Sulphate of Magnesia = MgO, SO^3 + 7HO.

Monoclinic Substances.

Glauber Salt = NaO, SO^3 + 10 HO.

Bi-carbonate of Potash = KO, $2CO^2$ + HO.

Observed star-crystals of Camphor, Sulphate of Magnesia, and Glauber Salt are shewn, respectively, in figures 1, 2, and 3.*


Fig. 1.

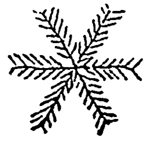
Fig. 2.

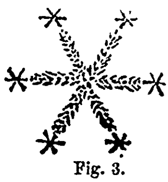
Fig. 3.

The production of six-rayed stellate crystals in Glauber Salt and Bi-carbonate of Potash, is a fact of some interest: since it has been supposed that Monoclinic forms could not occur in groupings of this kind. None it is true are met with amongst minerals of natural formation belonging to the Monoclinic System, but my results shew clearly that they are capable of occurrence.

Summary.—From the observations recorded in this communication, the following conclusions may be deduced:

(1.) Stelliform six-rayed crystals are common to various systems—

* These figures are very badly executed, but they will serve to show the general character of the crystallizations to which they refer.

occurring not only in the Trimetric and in the Monometric Systems, new examples of which (as regards the latter) are described above; but also in the Monoclinic System, in which until now, none have been announced; and in which, moreover, by some observers, these crystals have been thought of impossible occurrence.

(2.) Although thus shown to occur in various systems, none have yet been recognised, with certainty, amongst minerals or in artificial crystals of the Hexagonal System.

(3.) Hence—from the facts given in conclusions 1 and 2—the assumed Hexagonal crystallization of snow, if not disproved, becomes at least of very doubtful acceptation.

NOTICES OF BIRDS OBSERVED NEAR HAMILTON, C. W.

BY THOMAS MC'ILWRAITH ESQ.

To those who are aware of the many additions which have of late years been made to the list of American birds, as well as of the difference of opinion which still prevails among authors regarding the identity of certain species, it must be evident that our knowledge of this branch of our Natural History is by no means complete. Probably, the greatest difficulty in the way of getting anything like conclusive information on the points in dispute, arises from the migratory character of nearly all the birds of North America, and the remote regions in which they spend the interesting period of reproduction; so few indeed, can be called *resident*, that if we take any point on the continent and ascertain the number of species which reside there all the year round, we are astonished at the smallness of the list; in our own case it would not exceed a dozen species, and even of these, it is doubtful whether those we see in summer are not replaced by other individuals of the same species, coming from the north at the approach of winter.

Another perplexing subject to the ornithologist has ever been, the changes of plumage which birds undergo at certain periods of their lives, or at particular seasons of the year. This is most remarkable among our rapacious birds, many of which do not come to maturity in plumage till their 4th or 5th year, and having been found breeding in the immature dress, have frequently been described as distinct species.

The same cause has led to considerable confusion among our short winged summer birds, these arriving among us about the end of the first week in May in their full summer plumage, and uttering their characteristic notes are easily identified, but when they return again from the north in September, accompanied by their young, the change they have undergone is so great that no one unacquainted with the subject would be able to recognize them. As an instance of this I will only mention the male of the Scarlet Tanager, whose brilliant plumage, so conspicuous in the woods during the summer months, as soon as the breeding season is over, becomes like that of the female, a plain dull green; it is not then surprising that the earlier writers should have frequently described the same species twice under a a different name, indeed, in the absence of information from those who had opportunities of observing the birds while the changes were progressing, we do not see how it could have been otherwise.

Wilson no doubt felt these difficulties keenly, when commencing his great work on American birds, and seems, in his writings, to long for the opportunity of solving his doubts by personal observation. When describing the Black-throated Blue wood-warbler, which belongs to the migratory class referred to, he takes occasion to reproach the Canadian people for their want of interest in these subjects; he says, "I know little of this bird, it is one of those transient visitors which in the month of April pass through Pennsylvania on their way to the north; it is highly probable that they breed in Canada, but the summer residents among the feathered tribes, on that part of the Continent, are little known or attended to; the habits of the deer, the bear, and the beaver, are much more interesting to these good people, and for a good substantial reason too, because more lucrative, and unless there should arrive from England an order for a cargo of skins of warblers and flycatchers sufficient to make them an object worth speculation, we are likely to know as little of them hereafter as at present." Without doubting the truth of Wilson's remarks at the time they were written, I am satisfied that they no longer hold true, as there are now many people in Canada, devoting both time and means, in acquiring the information he so much desired, and there are, in some of our Canadian Cities, collections which would have been of great service to him when arranging the material for the American ornithology. When estimating the amount of Wilson's labors in this field of science, we should never overlook the peculiar difficulties he had to contend with; he had not the means, neither were there in his day facilities for making long journeys, at small expense, such as we now enjoy; his researches were therefore chiefly confined to the middle Atlantic States, yet within that limited space of what is usually termed North America, he described over 280 species of birds, many of which had been entirely overlooked by previous writers.

When referring to the few mistakes he made, we must also remember that he had not access to any library of Natural History, such as now exists in many of the American Cities, neither was there at that time any museum worthy of the name, to which he could repair with his doubtful species. To him, however, Nature's great Museum in the woods, was ever open, thither he went, gun in hand, in quest of his favourite birds, and the habits of such as came under his own observation, he has described with a truth and felicity which has never been excelled.

Audubon followed with all the enthusiasm peculiar to his countrymen, and by extending the field of his observations, and procuring specimens from distant parts of the continent, brought up the number of described species to about 500.

Since the time that the writings of these authors were submitted to the public, many influences have been in operation to bring the subject nearer to completion, foremost of which have no doubt been, the general diffusion of knowledge, and the attention which has been paid to education throughout the United States. A new field of observation has also been opened up by the annexation of Texas, New Mexico and California, where a great variety of birds are found which do not occur on the northern or eastern part of the Continent; these vast territories have been visited by various scientific men, who have published from time to time their notes and observations on the new species of birds met with, but owing to the great expense attending the getting up of such works with costly illustrations, they have never been much known to the public.

The American Government too, deserves all credit for the facilities it has granted, for collecting, arranging, and publishing, the most recent discoveries on this subject. With each of the exploring parties which have within the last few years traversed the western part of the Continent, for various purposes, officers have been sent, specially charged with making notes and collecting specimens of the natural history of the different regions through which they passed, and the most complete synopsis of North American birds which has yet appeared, is the 9th volume of a report of explorations for a route for a railroad from the Mississippi to the Pacific. The work is got up at the expense of the Government, and the volume referred to, which treats exclusively of Birds, has been prepared under the able superintendence of Dr. S. F. Baird, of the Smithsonian Institution. The new western species are therein minutely described, and for the sake of comparison, those already known on the eastern side of the continent, have also been introduced, which makes the work a complete exposition of all that is at present known of the birds of America north of Mexico. The total number of species described in this work is 716, and it is highly probable that many additions will yet be made of scarce species, which have escaped the notice of travellers. From the Hudson Bay territories we have yet much information to obtain, regarding many species which are familiar to us at certain seasons of the year, but spend the most interesting period of their lives in these remote regions. During the last year Mr. R. Kennicot, a Naturalist of considerable experience, has been sent out under the auspices of the Smithsonian Institution, for the special purpose of supplying the information wanted from this quarter, the result of his researches with the amount of new material already on hand, will be ample for a comprehensive work on this subject, which will, no doubt, appear in due time.

As regards the birds which frequent the vicinity of Hamilton, I would remark, that the changes consequent on the settlement of the country, have produced corresponding changes in the Fauna of this district, many species being now wanting, which were common 30 years ago, and others, which at that time were unknown, having now become quite plentiful.

The older settlers tell us that when Hamilton was but a village, and the farm houses but thinly set along the lake shore, the flocks of waterfowl, which frequented Burlington Bay, were so great as frequently to darken the light of the sun by day, and make the night hideous with their discordant cries. In those days, they say, when money was scarce, the speculative farmer, who wished to add a few waterfowl to the stock of produce he was making up for the Saturday's market, counted the cost of the ammunition before throwing it away; if sure of securing half a dozen ducks at a single discharge, the gun went off, but if only a less number could be got within range, it was taken back as it was, and set aside till a more favorable opportunity occurred. While this state of matters prevailed, the birds must have been little disturbed, and would, as a natural consequence, congregate in greater numbers, and making due allowance for the habit of veteran sportsmen exaggerating what happened in their young days, there can be no reasonable doubt, that Burlington Bay has long been a favorite resting place for the vast flocks of Ducks, Geese, and Swans, which *periodically pass to and from their great nursery* at the north, but which of late years occur at more uncertain periods, and in greatly reduced numbers. A moment's reflection will point to the causes which have produced the changes referred to, foremost of which is, no doubt the great amount of traffic which is now carried on with steam and sailing vessels during the summer season, besides which, we have on the one side of the Bay an establishment for making gunpowder, and on the other a city with a population of 25,000 inhabitants. among whom are a fair proportion of amateur sportsmen; these, though they may not much reduce the number of the birds, yet disturb them at their feeding grounds, and have driven them to seek for greater seclusion, among the extensive flats near Chatham, and along the river St. Clair.

Among the land birds, similar causes have been at work to produce changes in the habitats of different species. We are told that before the heavy timber was cut down, and the girdled trees were yet standing thickly in the cornfields, woodpeckers, of different sorts, were much more numerous than at present, the large *black log cock* being often seen, and the strokes of his chisel frequently heard reverberating through the woods. I am not aware of this species being seen in our neighbourhood for some time, the last specimen having been brought to the market by a farmer about five years ago as a great rarity: they are now found in Canada to the north and west of us, and *throughout the state of Michigan.*

As the dense forest became broken up, and the cultivated fields appeared, a new class of birds took the place of those which had left; no sooner had the early settler raised his log house and planted his fruit trees, than he was visited by the Cat bird, whose great delight seems to be to nestle near a log-house on the edge of a clearing; the merry jingling song of the Bob-o-link was also heard along the fences, and the Blue birds, who delight in the society of man, found a nesting place in the new settlement; several species of warblers also are now found farther north than the limits assigned to them by their historians, and as the country is better cleared, we may yet expect to find many species in our woods and gardens which at present do not come so far north.

Of the birds found in our vicinity *at present*, I may say that these first attracted my attention in the spring of 1856 while indulging in a series of morning rambles along the edge of the mountain, west of the city. Since that time I have devoted some of my leisure hours to preserving specimens, and have been able to identify all the sorts procured, though it may be worthy of remark, that at the time referred to, there was not even the beginning of a museum in the city, and the principal public library contained no book which could be of the least assistance to the amateur, in this branch of Natural History.

It will not be expected in a paper of this description that I can refer to each of the numerous species which frequent our woods and marshes: for the benefit of those who may be desirous of obtaining fuller information of this description I have prepared a list, which has already appeared in this Journal, of all that have come under my own observation, arranged according to the classification of Audubon in Families, Genera, and Species. I will now only refer to a few of the more remarkable species in the different Families.

Following the arrangement referred to, we find highest on the list, the Family *Falconidæ*, which includes all our Diurnal birds of prey, such as Eagles, Hawks, Buzzards, &c. These are distinguished by their short and powerful beaks, strong hooked talons, and the great length and breadth of their wings; this class is well represented in our woods, and along the Bay shore; the most conspicuous member of it being the *Bald Eagle*, whose grand circling flight makes him an object of interest wherever he appears. With us this species is seldom seen during summer, but at the approach of winter, when the fish hawk has gone south, and game gets scarce in the woods, a few pairs are usually observed about Land's bush, and along the beach, where they prey on musk rats, and feed on such animal matter as may be thrown up by the waters of the Lake. During the two past winters the fishermen residing on the beach have been offered a liberal price for a mature specimen of this bird, but so difficult are they of approach, that although individuals have been seen nearly every day during two months in each season, yet all the exertions of the hunters have been quite unsuccessful. Occasionally after the report of some heavily laden piece, a single broken feather has been seen winnowing its way downward, but as yet no mature specimen of the eagle has been procured. Latterly, the hunters being foiled in the chase, have resorted to stratagem, and have tried to poison the birds by putting strychnine into the body of a small animal, and leaving it near their usual haunts. By this means two or three individuals were obtained, but all of them have been young birds, which are of a brownish colour, more or less blotched with white. The only instance I have heard of the capture of the mature Bald Eagle. in this vicinity, occurred some years ago, but may be worth repeating as tending to illustrate the habits of the bird. A labouring man residing in the outskirts of the city, found that some depredator was levying black mail upon his chickens, and resolved to put a stop to it; at midnight he visited the roosts with his musket but all was quiet and no trace of mink or fox visible; about day break, however, there was a disturbance among the fowls, when, jumping up he was just in time to take a hurried aim at a large eagle, who was gliding off with a plump chicken clutched firmly in his talons. The shot took effect in the outer joint of the wing, which brought the spoil-encumbered marauder to the ground, pursuit and struggle then ensued, the eagle according to custom throwing himself on his back and fighting fiercely with his feet. In this curious engagement the gunner for a time had the worst of it, as owing to the hurried way in which he had been called into the field, he was ill prepared to contend with the sharp claws of his powerful adversary. On further assistance arriving from the house the eagle was secured alive, and brought into the city by his captor, who happened to be at work at the Goal and Court house, then in course of erection; here he was put for convenience into one of the cells, where he was visited by many of our citizens, some of whom gave expression to their wit, over the circumstance of the first prisoner confined in the Jail, being the rapacious symbol of American freedom.*

The young of this species differs from the adult so much in appearance that till within the last few years they were considered as distinct species, the former being described as the "*grey sea Eagle*," Wilson, who closely observed their habits, had suspicions that they were identical, but the fact was not proved till after his time.

* While the above was in type the writer procured a fine specimen of the adult animal, measuring three feet by six feet six inches.—January, 1861.

The same mistake was made with the *Golden Eagle* of Britain, the young of which was described as the *Ring-tailed Eagle*, till they have now been proved beyond doubt, to be the same. This species is also American, several specimens having during the past winter been found near Toronto. Besides the foregoing, there are various other species of Eagle said to be found on this part of the continent, one of which was discovered by Audubon and named by him after Washington, but from the real scarcity of the species, and the difference which exists among birds of different ages, we cannot at present speak of them with any degree of certainty.

The most interesting genus of the Falconidæ is that which includes the true falcons; these are distinguished from the other members of the family, by their comparatively short and hooked beak, long and pointed wings, by a tooth-like process near the tip of the upper mandible, and by the dash and courage they exhibit when striking their prey on the wing; there is probably no other bird so admired by the sportsman, or feared by the waterfowl, as the *Peregrine Falcon*. We have often heard those who periodically visit Long Point, or Baptiste Creek, to practise Duck shooting, speak with enthusiasm of the exploits of the Bullet Hawk, as he is termed by the gunners; he is described as flying at considerable height above the marshes, which are dotted with flocks of geese, ducks, teal, and widgeon, his quick eye marking every movement that is made below. While these keep the water, they are comparatively safe, as they can elude their pursuer by diving, but if, in the excitement caused by the presence of so dreaded an enemy, they should attempt to escape by flight, then is the time to witness the stoop of the falcon, who singling from the affrighted flying flock, the victim he has destined for his prey, descends with a rush, which the eye can scarcely follow, and strikes it to the earth in an instant. So suddenly does the bird fall on being struck, that it was long supposed the blow was given by the breast-bone of the hawk. This opinion has by close observation been proved incorrect, and specimens so prostrated, when picked up are found to be so lacerated on the back as to leave no doubt that the stroke is given by the feet. This noble bird is well known to the residents on Burlington Beach, where he has frequently been observed coursing along in quest of his favorite prey, but from the uncertain nature of his visits, and the rapidity of his flight, no specimen has yet been procured. A recent writer professes to have found specific distinctions between this, and the British bird of the same name, but these do not seem to be clearly made out, and the general opinion is, that it is identical with the the Peregrine Falcon, so much in favor when hawking was a princely amusement in Europe; with us he follows the full bent of his own wild nature, and unencumbered by hood or bell, roams the whole Atlantic coast, from Greenland to Cuba, and inland to the Rocky Mountains, and is known in the different districts he visits by the various names of Peregrine Falcon, Bullet Hawk, Duck Hawk, and Wandering Falcon.

Following Falcons in order come the *Owls*. Birds of this family are easily distinguished by the largeness of the head and eyes, and the forward direction of the vision; of this class I have noticed eight different species near the city, none of which are plentiful, yet from their strictly nocturnal habits, they may be more so than we are aware of. They are all migratory, and from sometimes meeting with two or three individuals in a single excursion, and again not seeing any during that season, we infer that they pass along in bands, keeping up the communication by their loud hooting, which is frequently heard at night during spring and fall. *The Snowy Owl,* styled by Wilson the "great northern hunter," is during some winters quite common around the shores of the bay, though in others only a very few are seen; during the winter of 1858—'59, I am aware of seventeen specimens having been brought to the market by fishermen and others, while during the last winter, only two individuals have been killed. All the birds of this class have the plumage remarkably full and soft, which enables them to skim noiselessly on their prey, and clutch it ere it is aware of the danger.*

Passing the *Goatsuckers*, of which we have two species, the Whip-poor-will and the Night Hawk, we come to the *Swallows*, of which we have five; in this group we have an instance of the way in which birds sometimes adapt their habits to suit particular circumstances. The republican or cliff swallow, which is but a recent addition to the fauna of this part of the continent, in its original character, builds its nest in caves, and under the overhanging ledges of perpendicular rocks; when lured to this district probably by the abundance of their favorite insect food, which is found along our marshy lands,

* It is worth noting, as an instance of adaption to circumstances, that the eyes of the Snowy Owl and the Hawk Owl, which migrate to the Arctic Regions, are so constructed, as to enable them to procure their prey by day as well as by night—an evident necessity where there is no night for six weeks.

and not finding rocks suitable for their purpose in the breeding season, they frequently choose, as a substitute, the end of a barn or other outhouse. I have seen such a republic in the country, where the upper part of the end of a barn was literally covered with clay, and perforated with numerous circular holes, out of which the full dark eyes and gaping bills of the callow inmates were frequently seen protruding; there must have been from two to three tons of clay used in the work, and the constant visits of the parent birds at this interesting season give the building at a short distance much the appearance of a great bee-hive.

In the habits of the *Swift or Chimney Swallow* is another deviation from the established custom. When we see these birds circling round in the air and dropping perpendicularly into our chimneys to roost and rear their young, the question very naturally arises, where did they build before the invention of chimneys? Naturalists tell us that their nesting place then was in hollow trees, broken off midway and open at the top, but that now, even where these can be had, the chimney is preferred. We can easily understand that in settled parts of the country, when their favourite trees are all cleared away, they must either leave the district, or change their abode, but why they should, in places where they have their choice, leave the open tree for the open chimney, is still, I believe, an unanswered question.

Next in order come the *Flycatchers*, birds of small size, but in their habits much resembling the birds of prey. These have the upper mandible overhanging and notched at the tip, and the voice, in most cases, harsh and discordant. The mode of taking their prey varies in different species, some, taking up a station on a post, or limb of a tree dart after the passing insect making the snapping of the bill distinctly heard, others more expert of wing, keep skipping about among the bushes, and take by surprise any thing suitable which comes in the way. A prominent member of this group, is the *King bird*, or tyrant flycatcher, well known on account of his depredations among hive bees; he is also remarkable for the courage he displays when guarding his nest and young, being known to drive even the Bald Eagle from his vicinity

Nearly allied to the flycatchers, but differing from them in form and habits, are the *Wood-warblers*. There is no class of small birds so much sought after by collectors as these, they are a numerous family, generally graceful in form, sprightly in manner, and brilliant in colour; they arrive here about the beginning of May, a month, which, above all others, is enjoyed by those who are fond of rambling in the woods. Their food seems to consist chiefly of insects, which they find lurking among the opening buds and blossoms of the trees. A few species remain with us during summer and rear their young, but the great body pass on farther north to breed, returning again in September, though from the trees being more full in leaf at that season, and the birds silent, they are not so much observed. I have noticed 22 species belonging to this family, in our woods, some of them of rather rare occurrence, among which I may mention the *Sylvia Maritima* or *Cape May Wood-warbler*. Wilson met with this species only once and Audubon mentions it as being exceedingly rare. I found it in the spring of 1857 along with others of the same family, while on their annual journey northward.

The Family of *Creepers* includes besides the tree creeper, (the type of the class) the Genus *Wren*, of which we have three species, viz. the *Marsh wren*, which builds in all the marshes round the Bay, the *Winter wren*, which is identical with the common wren of Britain, and the *House wren*, which seems to have discovered Hamilton only within the last two or three years. This little bird is strongly attached to the dwellings of man, and in the United States is frequently accommodated with a house fixed to a post or tree in the orchard, which is taken possession of as soon as the birds arrive from their winter quarters. During the past two summers several pairs of house wrens have raised their brood in our city gardens, though previous to that date, I have not heard of their being observed.

Of *Thrushes* we have five species, among which is an instance of the difference of habit which is frequently noticed even among birds which in many respects are closely allied to each other. The red breasted thrush or *Robin* is well known for his familiarity, frequently rearing his young close to our dwellings, yet his near relation the *Wood-thrush* is one of our most retiring songsters, and is seen only in the most secluded parts of the woods; perched on the highest twig of a tall tree his full sweet notes are frequently heard, but the moment he is aware of being observed he drops under the tree tops and glides off in silence.

This group includes our best songsters, some of whom make the very woods ring with their thrilling notes. I have frequently heard the remark that our Canadian birds, though gaudy in plumage, are quite deficient in song, my opinion of this matter is, that comparing the birds of North Britain with those of Canada, we have only to strike from the former list, the British Sky-lark, to be able to compete successfully, either as regards the number of performers, or the variety and sweetness of their notes. I have often imagined (but it may be only a fancy) that there is a strange harmony existing between the voices of birds and their particular places of resort; I have noticed this in winter in the short sharp note of the Nuthatch, who as he hurries about seems ever to say that he must bestir himself as the days are short. The lively twittering of the warbler seems to blend with the first fluttering of the young leaves; the shrill piping of the plover is quite in unison with the whistling of the sea breeze, which comes up over the treeless barren which they usually frequent, and surely if we had sought through the whole feathered race, for a tenant to our gloomy cedar swamps, we could not have found one more suitable than the great horned Owl, whose solemn aspect, and singular voice, makes the solitude of such places still more intense.

The Family of *Finches* is one of our most comprehensive groups, it has been divided by Audubon into 18 different genera, and contains according to that author 55 species. Of these a fair proportion are found in our fields and gardens, where they render considerable service by ridding the ground of the seeds of such troublesome plants as the dandelion and the thistle. The greater number are summer residents only; a few remain all the year round, and one or two species visit us from the north only in severe winters; of the latter class a rare species has during the past winter been observed in considerable numbers round the city. I refer to the pine grossbeak, which was first observed about the 5th or 6th of January, in a garden in Merrick Street, feeding on the berries of the Mountain Ash. They attracted attention by the unsuspicious way in which they followed their occupation, almost within reach of the people who were passing on the side-walk, shewing clearly that they were little accustomed to the society of man. In small flocks, they continued to frequent the gardens where their favorite berries were to be obtained, till about the 23rd of February, when a strong west wind, accompanied by warm rain prevailed for a day and a night, after which they were no more seen. In the winters of 1856–1857 they paid a similar visit, but have not been observed in any other year. Nearly all those which visited this part of the country were either young males or females. The adult male was much sought after on account of his showy crimson plumage, but only a few of them were procured. It is worthy of remark, that the Grossbeaks are frequently, if not always, accompanied by true Bohemian Chatterers; which latter feed on the stem and pulp of the berries of the Mountain Ash, rejected and thrown down by their hard-billed fellow travellers.

(To be continued.)

NOTE ON THE OXALATE OF IRON.

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In a recent number (Nov. 3rd,) of the Chemical News among the extracts from foreign journals, (Comptes Rendus, 51–[illegible],) there appeared a short note on the so-called Quadroxalate of Iron, by Dr. Phipson, the formula being given as $FeO, 4\,C^2O^3$. The correct name representing its composition being given, it does not appear that there can be any typographical error in the formula, which would otherwise seem likely, from the excessive improbability of the existence of an anhydrous quadroxalate of a heavy metallic oxide. The absurdity of the formula becomes still more apparent if the method of preparation be considered, viz.: by precipitating ferrous sulphate by oxalic acid, or better by oxalate of ammonia. In this latter case these two neutral salts must so decompose each other as to produce a highly acid insoluble compound, and set free three equivalents of ammonia, by which the supernatant liquid must become strongly alkaline; a species of decomposition the writer believes to be as yet unknown in chemistry. $FeO, SO^3 + 4, NH^4O, C^2O^3 = FeO, 4\,C^2O^3 + NH^4O, SO^3 + 3\,NH^3 + 3\,HO$. It is scarcely necessary to say that nothing of the kind takes place. The salt is described as being yellow and giving with ferricyanide of potassium a green substance, owing to partial decomposition, a fact which is not altogether incomprehensible, when it is remembered that Cfdy K^3 gives a blue colour with salts of FeO, and that blue and yellow produce green.

It is a pity that Dr. Phipson, when writing on any subject, should not have previously made himself acquainted with facts which have been known for nearly five and twenty years,—the salt being nothing more than the ordinary oxalate of iron containing two equivalents of water, $Fe O, C^2O^3+2$ aq. This compound has been described by Vogel and Berzelius, its composition shown by Döbereiner and Rammelsberg, who appear to have proved that it differs from the rare mineral Humboldtite in containing half an equivalent more water, $Fe O, C^2O^3+1\frac{1}{2}$ aq and $Fe O, C^2O^3+2$ aq, or $\left.\begin{matrix}C^4O^4\\Fe^2\end{matrix}\right\}O^4+3$ aq and $\left.\begin{matrix}C^4O^4\\Fe^2\end{matrix}\right\}O^4+4$ aq, corresponding to the manganous oxalate. More recently it has been examined by Souchay and Lenssen, in their extended investigation of the oxalates.

In order to test the matter still further, the salt was prepared by my pupils, Mr. Ramsay and Mr. Thomson, in both ways indicated by Dr. Phipson, using a large excess of oxalic acid in the one case, and precipitating both from concentrated and from very dilute solutions, in both cases the precipitation takes place almost immediately.

The subjoined quantities of Fe O were obtained. It will be observed that the amount of Fe O is a little below the requisite quantity, both in these analyses and in those of Rammelsberg which are appended, owing to the salt retaining a certain amount of hygroscopic water, unless dried for a long time at 100°, and also to the fact that when heated it is not perfectly oxidized unless the heat be continued for a long time or the residue be moistened with nitric acid and again heated, as was done in No. I; No. IV was only air dried.

				Cal'd.	I	II	III	IV
Fe O	1	36	40		39·70	38·91	38·68	38·08
C^2O^3	1	36	40					
H O	2	18	20					
		90	100					

Fe O — Rammelsberg — 38·78 — 39·10 — 38·92 — 38·84 — 39·48

University College Laboratory, Dec., 1860.

The 17th number of the *Comptes Rendus* having come to hand, the writer is enabled to give the analyses on which the above formula is founded, viz:

Fe O	19·35	19·44
C^2O^3	80·65	80·56
	100·00	100·00

From the exact accordance of the analyses it is evident that the oxalic acid was not determined, but only calculated from the loss, and as the quantity of Fe O is exactly one-half of that obtained by other chemists, it seems probable that Dr. Phipson has made the ludicrous mistake of calculating the protoxide corresponding to the obtained peroxide as Fe O and not as Fe^2O^3, and considered all the remainder as oxalic acid.

ON THE TRUE AIMS, FOUNDATIONS AND CLAIMS TO ATTENTION OF THE SCIENCE OF POLITICAL ECONOMY.

BY THE REV. W. HINCKS, F. L. S.

Read before the Canadian Institute, March 10th, 1860.

The question may not unreasonably be asked how, after the numerous and excellent works published on Political Economy, it can be needful to enter here on discussions relating to its elementary principles or the grounds upon which it is entitled to attention. My reply is that, whatever may have been accomplished, which to many may appear important and satisfactory, Political Economy is still too new a science for its influence to have penetrated the mass of society, and has from various causes been exposed to so many attacks and so much misapprehension, that it may well be thought to demand the support of those who feel its value, and can hardly pretend to be removed from that field of controversy which may be expected occasionally to supply us with subjects, and is fairly open to all those who will venture themselves upon it. If I could suppose that we are all nearly agreed as to what are the well established truths of economical science, and as to the kind of authority which belongs to them, I should not have engaged in a superfluous labour; but having no doubt of the extended diffusion of opinions altogether opposed to those which seem to me to result from scientific inquiry, I would test the stability of the structure on which I am disposed to rely, by having its materials and foundations fairly examined. On this as upon all subjects, I seek real knowledge and hope to profit from cautious and candid inquiry. But it seems to me that there could be no useful discussion of specific questions in economical science without a previous consideration of the way in which its inquiries are carried on, and the ground upon which its principles may claim public attention. Let us in the first place guard against the mistake of attributing to the science a wider range and a greater power over human affairs than it can legitimately pretend to. The subject of political economy is *wealth,* under which name we include all objects of human desire which are capable of being appropriated. The object proposed by the science is to investigate the laws which regulate the production and distribution of wealth. It is hence obvious that political economy is one branch only of social science, which treats of whatever affects the condition of man as a social being, in order to determine the best means of promoting generally diffused happiness, In this are included government, jurisprudence, education, the treatment of criminals, sanitory regulations, the social position and rights of woman, and other topics of which the interest and importance are very great, but which, though connected together as branches of one great subject, and inviting attention in common, are yet sufficiently distinct in the kind of facts with which they are concerned, to admit conveniently of separate treatment. It is of course manifest in the first place, that if there are no absolute laws or necessary tendencies in respect to the acquisition and distribution of wealth, there can be no science of political economy. A natural law is a general expression of facts already observed, put forth as a guide for the future, in order that by adapting our conduct to it we may make every available use of forces in operation, and may avoid the injuries arising from vain attempts at resisting them. The operation of a natural law is sometimes modified or obscured by the simultaneous action of some other force besides that which we are considering, but it is not the less real or less useful to be known. The floating or rising feather seems to set at defiance the law of gravitation only because it is supported by the atmosphere or wafted by its agitations, and the philosopher feels the force of the general law as much whilst observing its apparent violation, as in contemplating its most striking illustrations. Where results depend much upon the actions of human beings, we know too well the variety of the motives influencing them, to expect perfect uniformity, but if we become acquainted with invariable tendencies belonging to certain circumstances, we already possess valuable guiding principles, and inasmuch as our conclusions are only partially involved with human motives and dispositions, depending much also on laws of the external world, they have really less uncertainty than might be supposed. Political economy is concerned with the conduct of men in reference to certain conditions of their being. It belongs to the superiority of man over the brutes, and to the powers with which he is endowed, that he does not consider merely the enjoyment of the moment, but looks forward endeavouring to provide means of future gratification, and is disposed even to submit to present restraint that he may be free from apprehension respecting the future. It follows from this that he is disposed to guard what he possesses or has the feeling of property, and that he is ready to barter a portion of what he has collected for other objects of desire not immediately within his own reach. The considerations that labour or effort of some kind is the means of obtaining whatever we desire, that what we obtain we regard as belonging to us, or as property, and that we are disposed to barter, to which may be added that what we have already secured makes our further exertions more effectual, lie at the foundation of all inquiries in political economy. We have to do with man as a being seeking means of happiness, and by the faculties he possesses led in its pursuit to labour, to appropriation, to accumulation and to barter. By reasoning on what belongs to our condition, and by experience, we learn the circumstances most favourable to the acquisition of wealth, the proportions in which it is naturally distributed among parties uniting in different ways for its production,—the natural laws regulating exchanges, and the effects of attempts at interfering with the natural course of things by governments. The rules at first laid down from notions of what would be desirable results, with imperfect observation, would be often erroneous, always rude, but time would clear away one error after another, truths would by degrees come to be viewed in their connections, and gradually a body of related principles would be elicited, forming a science, and fitted to afford useful practical guidance as well as enlightened general views of what is passing amongst our fellow men. Those who deny the conclusions of political economists, must either object to some specific principle as being a false deduction, in which case they have to show by fact and reasoning that it is not properly established, and is no part of the genuine science, or else they must maintain that there are no materials for constructing a science; that there is no uniformity of results in classes of cases; that there are no fundamental principles of human nature bearing upon the acquisition and distribution of wealth, and that no general results of experience can be obtained or applied. If a man takes the first course he may possibly be right, since there can be no pretensions to infallibility, and arguments that have any appearance in their favour should be weighed and their character fully tested, but if he is led to oppose the united opinions of the very able men who have been the founders and chief teachers of political economy in the important cases in which they are almost agreed, the presumption is greatly against him. If he takes the second course, I submit that he plainly manifests ignorance of human nature and social history to such a degree, as scarcely to be worthy of any attention. All history derives its interest and value from its exhibiting the common tendencies and dispositions of human nature, acting under varying circumstances and modified by the genius and education of the individual. The rejection of prevailing tendencies and generally operative motives would make the whole a mass of confusion, from which we could learn nothing, and which would cease to interest us,—and even the fiercest opponents of the conclusions of political economy have their own opposing theories, which they believe to be drawn from experience. The question is not, therefore, as to the existence of useful principles, but as to how they are to be sought, and where they are found. Now, what the political economist asks is, not that his special views shall be received as constituting a science, but that all the facts bearing on every doubtful question may be collected, compared and harmonised, so as to yield a consistent result—he proposes extended observation—possibly in some cases, experiment,—as the means of arriving at truth, and employing these under the guidance of reason, and with regard to well-ascertained common principles of human nature, he cannot despair of ultimate success, though misapprehensions or interested perversions of facts may cause obscurity for a time. There is another point of view from which it may be useful to regard the subject before we conclude. We often hear certain objections made to the science in general, or to some of its supposed results, which those who bring them forward seem to consider as sufficient to excuse their bestowing any further attention on the subject, and I would not pass these by without some notice. A favourite objection is that the political economist is a theorist, and that practical men are the proper judges on the questions upon which he undertakes to decide. I might answer that some of the most eminent political economists have been men extensively engaged in mercantile and monetary transactions, and who have specially manifested practical knowledge and skill; that others of them with great intelligence and sagacity, whilst free from the personal interests that may be conceived sometimes to warp the judgment, have had most eminent opportunities from intercourse with practical men in different countries and in different pursuits, of collecting the opinions best worth consideration, so as really to know much more of business transactions, and what affects them, than any ordinary merchant, manufacturer or dealer, however careful an observer within his own sphere, can pretend to; but it may be better to ask what is meant by theory, and what are its relations to every branch of human knowledge? Detached facts are of little use, and if conjectural relations among them are supposed, these constitute only an hypothesis, which may be useful in guiding further research, but can seldom be relied upon with any confidence. As knowledge increases we obtain, as the result of observation and reasoning, general expressions, forming principles or laws which show us in relation to the subject in hand what may be expected in certain circumstances—what consequents must attend given antecedents. These collected and arranged constitute the theory of the subject, and it is difficult to conceive how it can be otherwise than the proper and only safe guide to practice. It is quite true that the actual business of life often requires a union of considerations drawn from several different kinds of knowledge, and if a man studies one of them in his closet and applies its theories without regard for other branches equally necessary, he may make gross blunders, and you might possibly express their source by calling him a mere theorist; but is this any reproach to sound theory, or any proof that it is useless, or that we could do without it? A practical man is understood to mean one who has been placed, by circumstances, in a certain employment, and has acquired a certain facility in performing what it demands. From mere constant attention to an operation, with the desire to save himself trouble or increase his gains he may effect improvements, but not unfrequently attachment to the method he first learned, and the force of habit prevent his appreciating real improvements, and his attention is very apt to be confined to the routine of his own business, and to means of promoting his own immediate advantage, without extended inquiry, enlarged views, or fair consideration of the effect of what he desires on others. The practical man, as such, is not then precisely the authority we should resort to in seeking to make arrangements for the general good. He may add to his practical experience much acquired knowledge, much study and much talent, but he then unavoidably becomes a theorist. He has endeavoured to bring together all the important facts relating to the subject, to see them in their real relations and to understand what they teach. He has become a man of science—a theorist—and as such deserves respect for his opinions, which his habit of attending to details of business would by no means command. The theory of any subject is the precise and orderly expression of all the truths in relation to it, by due regard to which, we should act wisely and accomplish our purposes, so far as is possible and consistent with moral considerations. The cry against theory is a very common one, but it means a cry against knowledge and improvement. Another grand objection to political economy is founded on the alleged cold-heartedness and inhumanity of the conclusions to which it leads. I believe it may be the fact that political economists have shown, or supposed that they had shown, the inutility and even very injurious consequences of certain modes and kinds of charity which are popular and much esteemed. A question is thus raised whether such acts are really charitable. The impulse of a kind heart and sympathetic feelings is not always to be implicitly trusted. If we would do good, we must consider and use our reason. To do what will cause extended evil, in order to gratify our own momentary feeling, cannot be justifiable. If the reasonings of the economist are wrong, and not supported by facts, the alleged bad consequences are not chargeable on the science, but on the mistakes of individuals. If they are correct and well sustained, our object being the real and permanent good of our fellow creatures, we should be thankful for sound instruction, and correct our practice in accordance with juster views. Science enlightens and tends to good: ignorance and error are the sources of evil. If any conclusions fall under our notice which startle us, let us examine their evidence and see whether they are deserving of our confidence. Should they be found so we can but rejoice at having obtained better guidance for our conduct. To object to science because we do not like what it teaches, is to make feelings formed in connection with previous opinions the test of the soundness of new conclusions.

An objection to the science of political economy which undertakes to establish truths of general application, respecting commerce and the various branches of industry, is often founded on the assumption that different nations have essentially different interests, so that what would be beneficial to one might be injurious to another, and therefore that there really can be no general principles, but trial, experience, and the prudence of those interested must decide what is good in each particular instance. It may be replied that, even granting the interests of some nations to be naturally opposed, they must be so in consequence of certain circumstances of climate, productions, national character or mode of government, which may be understood and explained so as to bring the nations of the world into classes, the laws of economical science being definitely modified to meet the case of each class, and all sound opinions as to what is required for the general good, being still founded on a wide induction of facts, with proper care in tracing particular results to their real causes; but, I believe, the more we examine the more completely we shall be convinced that economical science is based upon what is common to mankind in all circumstances, and gives us rules of general application,—that the more we study it the more thoroughly we believe that, as producers and exchangers of produce, there is one plan which suits us all,—that in peaceful intercourse we may help, but cannot injure each other, and that the intercourse which we are disposed to hold is the appointed means for diffusing the enjoyment of the productions of all climates, and distributing the blessings which flow from arts and industry, as well as those which luxuriant nature freely pours forth. Political economy has substituted for the narrow policy and mutual jealousies of former times, the principle that an industrious nation needs wealthy customers, and that the more other countries flourish the more certain it is that we can be useful to them and they to us, so that mutual interests should make each nation rejoice in others' prosperity, and bind together the world in peace and harmony. This grand lesson of true science is becoming each day better and more widely understood, and will unite, we may hope, with more diffused sentiments of true religion, in checking the ravages of war, and disposing all the nations of men to kindly feeling and the interchange of benefits. Certainly the notions of necessary opposition of interests and natural enmities are as unphilosophical as they are unchristian, and an objection founded upon them will have no weight with liberal minds.

I will, in conclusion, point out in a few words the reasons why this science deserves general attention, and the claims it has on the especial study of large classes of society. Since the conditions favourable to the accumulation of wealth, the relations of capital and labour, the nature and principles of commerce, the effects of different modes of taxation which may be employed in raising the contributions required for the public service, the effects of attempts to direct industry into particular channels, or in any way to interfere with its freedom—the relation of different kinds of industry to the general good—the causes of poverty and the justice and utility of public action for its relief, are among the subjects of investigation belonging to this science, upon which it endeavours to throw the light of knowledge and reason so as to elicit principles that may guide our course, it would be difficult to say who those are, who are *not* concerned in such inquiries. Undoubtedly the statesman to whom his fellow-citizens have committed the immediate control of public affairs: the merchant and manufacturer who risk their capital in the production or conveyance of what they believe to be in demand: the tradesman who would take an enlightened and well regulated interest in the prosperity of his class: the clergyman who represents, and to some extent directs the charitable feeling of those to whom he ministers, and would desire to express and guide it wisely: the lawyer who looks at his profession in a philosophic spirit, and studies the effects of those social regulations with which he is obliged to be peculiarly acquainted, are all of them bound to endeavour to know what can be known of political economy, and are urged by powerful motives not to neglect its study. It may be supposed that their employments and the direction given to their thoughts, will necessarily make, at least the more intelligent and sagacious among them, good judges on the questions which may arise in their several spheres. The fact is on the contrary that their position exposes each class to peculiar prejudices and delusions, in order to dissipate which, a course of study is required which shall commence with first principles, consider the facts accumulated in their proper order and connection, unfold results argumentatively or historically, in cases where our selfishness cannot interfere, and deduce a series of well connected principles which may be taken as rules for action, to be authoritatively applied where immediate inclination or the feeling of the moment would lead us a different way.

It may possibly be the case that thus far very few from among the various classes referred to, have really engaged in these inquiries with any use of rational means and of the aids which are attainable. It may even be true that they often think they understand, and adopt very strong opinions when they have not endeavoured to collect various facts, and to systematise their knowledge, much less to estimate properly the views of the great men who have devoted their time and all their powers to the subject. If this be so, we have the less difficulty in understanding the prevalence of many social evils and the formidable checks to social progress; but having contended that there is a science awaiting our study, and that equally personal interest, patriotism and benevolence, urge us to apply to it, whilst the grounds upon which some profess to despise it, are utterly untenable, I have fulfilled my present purpose, and I fear more than sufficiently trespassed upon your patience and indulgence.

DESCRIPTIVE LIST OE THE PRINCPAL CANADIAN TIMBER TREES.

BY CHARLES ROBB, C. E.
HAMILTON, C. W.

In the present crisis in the history of Canada, the economic value of her various natural productions justly occupies a large share of public attention. As a slight contribution towards the general stock of useful knowledge on this head, the subjoined list of our principal timber trees has been drawn up.

It has been the aim of the compiler to exhibit in a concise and convenient form all the most interesting and valuable facts relative to the growth and distribution of the various trees—the purposes to which their respective products in the shape of timber or otherwise are or may be applied in the arts—and the nature and qualities of the timbers generally. It may be hoped that such an exposition of the value of our magnificent forests may conduce, in some measure, to a higher appreciation of their products—either as articles of export, by shewing the uses to which they may be applied in foreign countries—or as materials for our native industry, by pointing out the various applications of similar materials to the arts in other countries.*

Canada is said to produce about seventy kinds of timber trees, of which at present we make profitable use of not more than eight or ten, the rest being left to absolute decay. Her forests extend over about 360,000 square miles, and are unrivalled throughout the world for the variety of species, and more particularly for the size of the timber of full growth. Of sixty-four samples sent to the Paris Exhibition of 1855, by Mr. Andrew Dickson, of Kingston, one half were collected from an area of one hundred acres. The trees which we find most generally in our woods are, the oak, beech, maple, iron-wood, elm, birch, ash, pine, hemlock, tamarack, cedar, poplar and bass-wood. All these trees attain to a considerable size, and grow, to a greater or less extent, in all parts of Canada except on the coast of Labrador, where the only trees that thrive are the white birch, the fir, spruce, beech, and one of the varieties of pine. The trees of smaller growth common to all the country are the hickory, willow, alder, wild-cherry, dogwood, sassafras, and a few others. The black walnut, tulip-tree and chestnut are confined exclusively to the western peninsula. Oak and elm are more abundant and of better quality in Canada West than in the eastern part of the province; but all the other woods attain greater perfection in Canada East.

It is a lamentable circumstance that materials, which in Europe are so highly esteemed and valued, should in this, the country of their production, be burnt up as fire-wood or left to rot on the ground. Hickory, beech, maple, birch, bass-wood, and white-wood are unsurpassed by any other timbers for their various useful qualities; and yet the exports at Quebec consist almost exclusively of pines, oak, elm, ash and tamarack; the latter having only come into demand within the last few years. As a remedy for this state of things, the attention of parties interested is directed to the recommendations contained in the Hon. Mr. Taché's Report of "Canada at the Universal Exhibition of 1855."†

* The chief authorities consulted are Dr. Gray's "Manual of the Botany of the Northern United States," and Holtzapffel's Turning and Mechanical Manipulation;" supplemented by the author's practical knowledge of the subject.

† See Canadian Journal for 1857, page 37.

LIST OF WOODS.

N.B.—The relative values of a given bulk, say a cord, of the various descriptions of woods when used as fuel, are stated in reference to shell-bark hickory as the standard, equal to 100.

1. Apple Tree. *Pyrus coronaria.*

Nat. Ord. Rosaceæ. Sub. Ord. Pomaceæ.

Occurs in glades; not very common in Canada. The woods of the wild apple trees are in general pretty hard and close, and of red brown tints, mostly lighter than the hazel nut. The butt of the tree only is used. It is generally very straight and free from knots up to the crown, whence the branches spring. The apple tree splits very well, and is one of the best woods for standing, when it is properly seasoned; it is a clean-working wood, and being harder than chesnut, sycamore or limetree, is better adapted than they for screwed work, but is inferior in that respect to pear tree, which is tougher.

Specific gravity 0.65; weight of cubic foot 40 lbs.

Value for heating purposes 70.

2. White Ash. *Fraxinus americana.*

Nat. Ord. Oleaceæ.

A large forest tree, with grey furrowed bark, smooth greenish-grey branchlets and rusty colored buds; flowers in April and May; occurs commonly in all rich and moist woods. The timber is much valued for its toughness and elasticity; excellent for works exposed to sudden shocks and strains, as the frames of machines, wheel-carriages, agricultural implements, the felloes of wheels, and the inside work of furniture &c.; also for handspikes, billiard cues, fishing rods, hammer handles, rails for chairs, and numerous similar works, which are much stronger when they follow the natural fibre of the wood. The young branches serve for hoops for ships' masts, tubs, churns, &c., also for coarse basket work. There are six species of ash found in America, of which the white ash is by far the most valuable, and is yielded in much greater abundance in Canada than in any other part of the American continent. It grows rapidly, and the young wood is much more valuable than that of old trees. Ash soon rots when exposed to damp, or alternate dryness and moisture; but is tolerably durable in a dry situation.

Specific gravity 0.616; weight of cubic foot 40 lbs.

Value for heating purposes 77.

3. Red Ash. *Fraxinus pubescens.*

Nat. Ord. Oleaceæ.

A smaller tree than the white ash, of much more rare occurrence, and furnishing much less valuable timber, which, however, is applied to similar uses. The usual height is about 60 feet, with a straight trunk covered with bark of a deep brown color.

Specific gravity 0.7; weight of cubic foot 40 lbs.

4. Swamp Ash. *Fraxinus sambucifolia.*

Nat. Ord. Oleaceæ.

Tree rather small, occurs in swamps and along streams and commonly distributed. Timber not of much value; its soft tough wood easily separable into thin layers; used for coarse basket work, chiefly by the Indians.

It resembles the red ash so as often to be confounded with it. The timber posesses the property of being very durable under water.

Specific gravity 0.7; weight of cubic foot 40 lbs.

5. Basswood. *Tilia americana.*
Nat. Ord. Tiliaceæ.

This tree, which belongs to the same genus as that called the lime tree or linden in England, is highly ornamental, and grows abundantly in the rich woods of Western Canada. Flowers in May and June, and attains a great size. The wood is very light colored, firm and close in the grain, and when properly seasoned is not liable to warp or split. It is as soft as deal, and is used in the construction of piano fortes and other musical instruments, and for the cutting boards for curriers, shoemakers, &c., as it does not draw or bias the knife in any direction of the grain nor injure its edge. It turns very cleanly, and is much used for manufacturing bowls, pails, shovels, &c. It is also very suitable for carving, from its open texture and freedom from knots; and, like the white wood, is much used for the pannelling of carriages. The inner bark is very strong and is manufactured into ropes.

Outside wood contains 10 per cent.; inside 4 per cent. potash.

Specific gravity 0.48; weight of cubic foot 26 lbs.

6. White Beech. *Fagus sylvatica.*
Nat. Ord. Cupuliferæ.

A tree of large dimensions, often rising to the height of 70 or 80 feet. It is distinguished from the red beech by the size, the lighter color of the bark and wood. The wood is also of more difficult cleavage, of greater compactness and strength, and preferable both as timber and for fuel, for which latter purpose the beech is most extensively employed, though it, as well as the maple and hickory, seems to be much too valuable a material for other purposes to be sacrificed to this meaner use.

Specific gravity 0.672; weight of cubic foot 43 lbs.

Value for heating purposes 65.

7. Red Beech. *Fagus ferruginea.*
Nat. Ord. Cupuliferæ.

Mean dimensions of grown tree, 44 feet high and 27 inches diameter. It occurs commonly in all rich woods, flowering in May. The timber is not so much valued in America as in Europe, being mostly used here for piles in wet foundations, for which it is very well adapted, as also for firewood. It is well adapted, from its uniform texture and closeness of grain, for in-door works, as the frames of machines, common bedsteads, and furniture. It is much used for planes and other tools for carpenters; also for lathe-chucks, keys and cogs of machinery, shoe lasts, toys, brushes, handles, &c. It is also very suitable for carved moulds for picture frames, and for the large wooden letters used in printing. The wood is liable to be attacked by worms when stationary, as in framings; but tools kept in use are not thus injured. It is easily worked, and may be brought to a very smooth surface.

Specific gravity 0.672; weight of cubic foot 41 lbs. Outside wood contains 12 per cent.; heartwood 4 per cent., potash.

8. Blue Beech. *Carpinus americana.*
Nat. Ord. Cupuliferæ.

Called also American Hornbeam, or Water Beech; also, indiscriminately with No. 21, receives the name of Ironwood. Common along streams. Tree 10 to 20 feet high, with ridged trunk, and very hard whitish wood. Excellent for cogs of wheels, and any purpose requiring extreme hardness. Bark, light grey or ash-colored. The generic name *carpinus*, is derived from two Celtic words signifying *wood*, and the *head* implying wood fit for making yokes for cattle, to which use this timber is particularly adapted, being very fine grained, compact and hard. Sometimes called in Canada Yoke Elm. This wood is much esteemed as fuel, though much too valuable for this purpose.

Specific gravity 0.79; weight of cubic foot 47 lbs.

Value for heating purposes 65.

9. White Birch. *Betula alba (populifolia?)*
Nat. Ord. Betulaceæ.

A small slender very graceful tree; grows on poor soils; bark chalk white, separable into thin sheets like paper. Wood, fine-grained and very tough, but not durable. The bark is used by the Indians for their light canoes.

Specific gravity 0.5; weight of cubic foot 32 lbs.

Value for heating purposes 48.

10. Black Birch. *Betula nigra (lenta?)*
Nat. Ord. Betulaceæ.

A rather large tree, with reddish-brown bark, and compact light-colored wood. Occurs chiefly on low river banks. It is an excellent wood for the turner, being light colored, compact and easily worked. It is considerably used in furniture; some of the wood is almost as handsomely figured as Honduras mahogany, and when colored and varnished is not easily distinguished from it. It is not however very durable.

The bark is remarkable for being harder and more durable than the wood itself, being used by the Indians and backwoodsmen as tiles for roofs, shoes, hats, &c.. and for canoes and boats. Birch is used extensively by cabinet-makers and carriage builders, and is exported to Europe to a considerable extent. In frames of ships and for parts under water it is more used as it becomes better known. No wood is better adapted to sustain shocks and frictions than birch of good quality. This wood is much used in this country for firewood. Has a most extensive geographical range. Sap saccharine.

Specific gravity 0.65; weight of cubic foot 40 lbs.

Value for heating purposes 63.

11. Butternut. *Juglans cinerea (cathartica?)*
Nat. Ord. Juglandaceæ.

This tree belongs to the same genus with *Juglans nigra*, or the black walnut—which see. Grows commonly in rich woods. Flowers in May, and fruit ripe in September. Grows from 30 to 50 feet high, with grey bark, and widely spreading branches. Wood lighter colored than black walnut, and not so valuable, but resembles it in most of its qualities. From the bark is extracted an excellent cathartic. I am not aware to what extent walnut timber is exported, but I believe, that were its qualities better known in the mother country and throughout the world, it would be more highly appreciated. It does not work quite so easily as mahogany, but may be brought to a smoother surface, and it shrinks very little. Bark used in dying. Sap saccharine.

Specific gravity 0.426; weight of cubic foot 26 lbs.

Outside wood contains 4.42 per cent. potash; inside wood 1.42 per cent.

Value for heating purposes 51.

12. Cedar. *Thuja occidentalis.*
Nat. Ord. Coniferæ.

The species of cedar occurring in Canada and commonly called the white cedar, forming the "cedar swamps." It grows also on cool rocky banks. Tree, 20 to 50 feet high, straight with recurved branches, yielding a pungent aromatic oil; wood, light and soft and coarse grained, but exceedingly durable. It is much used in the framework of buildings, and the upper timbers of ships. When set in the ground as posts for fences or gates, &c., it is almost indestructible; and is most extensively employed for such purposes. For the same reason it is used for railway ties, but is objectionable on account of its softness and openness of fibre, preventing the firm adhesion of the spike. It is much esteemed for making split laths—known as cypress laths.

Specific gravity 0.453; weight of cubic foot 26 lbs.

Value for heating purposes 51.

13. Cherry. *Padus (Cerasus?) serotina.*
Nat. Ord. Rosaceæ. Sub. Ord. Amygdaleæ.

A fine large tree, growing sometimes to the size of 20 or 24 inches, but more frequently half that size. Grows commonly in all woods. It yields a hard close-grained timber, of a pale red-brown, and is valuable to the cabinet maker; when stained with lime, and oiled or varnished, it closely resembles mahogany. Is much used for common and best furniture, and chairs, &c. The Spanish American cherry-tree is very elastic, and is used for felucca masts. The bark has a strong bitter taste, and has been used in medicine as a tonic.

Specific gravity 0.56; weight of cubic foot 34 lbs.

14. Chesnut. *Castanea vesca.*
Nat. Ord. Cupuliferæ.

A large tree, mean height 80 feet; diameter about 3 feet; is very long-lived and durable. Occurs in rocky or hilly woods; common. Flowers in June and July. It yields a light, coarse-grained wood, not unlike the white oak. The young wood is very elastic, and is used for the rings of ships' masts, hoops for tubs, churns, &c., and the old wood is considered to be rather brittle. The nuts are much esteemed, and those of the American variety are smaller, but much sweeter than the European. The wood is strong, elastic, light and very durable; well adapted for posts set in the earth, &c. A post of chesnut has been taken up out of the ground after having staid there 40 years. Chesnut is easily distinguishable from oak, in having no large transverse septa—though in every other respect the two woods are remarkably similar in texture and color. Unlike most other woods chesnut, when strained to its breaking pitch, gives way without any warning, more in the manner of metals than woods.

Outside wood contains 4.56 per cent. of potash; inside wood 2.73 per cent.

Specific gravity 0.5; weight of cubic foot 32 lbs.

Value for heating purposes 52.

15. Dogwood. *Cornus florida.*
Nat. Ord. Cornaceæ.

Called also Cornel—the name being derived from the Latin *cornu*, a horn, alluding to the hardness of the wood. Occurs in rocky woods, but rarely in our latitudes, more common southwards. Tree 12 to 30 feet high, flowers in May and June, very showy in flower, and scarcely less so in fruit. Wood very hard, but at the same time tough, and is used for making mallets (being also very heavy). It seems well adapted for many purposes for which boxwood is employed, as scales and measuring rules, paper cutters, &c.

It is so remarkably free from silex that splinters of the wood are used by watchmakers for cleaning out the pivot holes of watches, and by the optician for removing the dust from small deep-seated lenses. The trunk is covered with a peculiarly rough but soft bark, which is extremely bitter, and is used in medicine as a tonic.

Specific gravity 0.78; weight of cubic foot 50 lbs.

Value for heating purposes 75.

16. Rock Elm. *Ulmus racemosa.*
Nat. Ord. Ulmaceæ.

A small or middle-sized tree, with tough reddish wood and a very mucilaginous inner bark; flowers in March and April. Rare and valuable, being held in high esteem for piles. It is not liable to split, and bears the driving of nails and bolts better than any other timber, and is exceedingly durable when constantly wet; it is therefore much used for the keels of vessels, and for wet foundations, water-works, piles, pumps, and boards for coffins; from its toughness, elm is selected for naves of wheels, shells for tackle-blocks and sometimes for gunwales of ships, and also for many purposes of common turnery, as it bears very rough usage without splitting.

There are four species of elms indigenous to North America.

Specific gravity 0.59; weight of cubic foot 36.75 lbs.

17. Swamp Elm. *Ulmus americana.*
Nat. Ord. Ulmaceæ.

Grows in moist woods, especially along rivers in rich soil, and is very common. A large and well known ornamental tree, with spreading branches and drooping branchlets; flowers in April. Timber by no means so valuable as that of rock elm, though partaking of its characteristics. It is much sought on account of the mucilage of the inner bark.

The timber of the elm is perfectly durable when kept dry, but not when exposed to the weather. It twists and warps much in drying, and shrinks very much both in length and breadth. It bears the driving of bolts and nails better than any other timber. The American elm is preferred to the English by wheelwrights.

Specific gravity 0.54; weight of cubic foot 35 lbs.

Value for heating purposes 58.

18. HAWTHORN. *Cratægus tomentosa.*
Nat. Ord. Rosaceæ. Sub. Ord. Pomaceæ.

A tall shrub or low tree, growing commonly in thickets, flowering in May and June. None of the thorns exceed the height of 20 feet; consequently, as timber the wood is of little value. The generic name is derived from a Greek word signifying hard, on account of the extreme hardness of the wood of some of the species.

Specific gravity 0.75; weight of cubic foot 46 lbs.

19. HEMLOCK. *Abies canadensis.*
Nat. Ord. Coniferæ.

A large tree, when young the most graceful of spruces. Occurs in hilly or rocky woods; very common in Canada. It has a light spreading spray and delicate foliage, bright green above, silvery underneath. Timber very coarse grained and poor, but seems well adapted for resisting the effects of moisture, &c., for which reason it is used for railway ties. Attains a height of 70 to 80 feet, with a trunk unusually large in proportion, covered with a rough bark which is used extensively in tanning. This timber is not liable to be attacked by rats or other vermin.

Specific gravity 0.45; weight of cubic foot 26 lbs.

20. HICKORY. *Carya alba.*
Nat. Ord. Juglandaceæ.

A large tree, sometimes exceeding three feet in diameter; grows commonly in rich moist woods; flowers in May and sheds nuts in October. The old trunks very rough-barked; wood most valuable as timber and for fuel; while the fruit furnishes the principal hickory nuts of the market. The wood of young trees is exceedingly tough and flexible, and makes excellent handspikes, axe and pickaxe handles, and other works requiring elasticity. The bark of the hickory is recommended by Dr. Bancroft as a yellow dye.

There are seven species indigenous to North America. The wood of this species is also well adapted and sometimes employed for making the keels of vessels. It is the heaviest of all our woods, as will be observed by comparing the specific gravity with that of oak or any others of our list. Hickory contains of potash 20 per cent. in the inside, and 7.5 per cent. outside.

Specific gravity 0.929; weight of cubic foot 58 lbs.

Value for heating purposes 100.

21. IRON WOOD, OR HOP HORNBEAM. *Ostrya virginica.*
Nat. Ord. Cupuliferæ.

A slender tree, occurring not rarely in rich woods, varying from 20 to 40 feet high; bark brownish, and finely furrowed; foliage resembling that of the beech. Flowers in April and May, and fruit full grown in August, presenting a similar appearance to the hop. Wood very hard and heavy, used for making handspikes and levers, hence the name lever wood, sometimes applied to it. The bark is remarkable for its fine narrow longitudinal divisions.

The heartwood contains not less than 14.55 per cent. of potash.

ecific gravity 0.76; weight of cubic foot 47.5 lbs.

22. MAPLE. *Acer saccharinum.*

Nat. Ord. Sapindaceæ. Sub. Ord. Aceraceæ.

A large handsome tree; from its elegance, and from its abundance in Canada, the leaf of the maple has been adopted as the national emblem. Occurs abundantly in all rich woods; flowers in April and May, and attains a great size. The timber is very beautiful, and is distinguished as bird's-eye maple, and mottled or curly maple. The latter is principally used for picture frames, the former is full of small knots, that give rise to the name; the grain varies according as the saw has divided the eyes transversely or longitudinally; thus pieces cut out in circular sweeps, as chair backs, sometimes exhibit both the bird's-eye and mottled figures at different parts. Much sugar is made from this variety of maple. The less ornamental portions of the timber are much used for house-carpentry and furniture, while as fuel its quality is unsurpassed.

Potash in outer layers 8.77; in inner 4.21 per cent.

Specific gravity 0.6; weight of cubic foot 38 lbs.

The Curly Maple is properly *Acer rubrum*.

The Soft Maple, *Acer dasycarpum*, is a fine ornamental tree.

Value for heating purposes—hard maple 60; soft 54.

23. WHITE OAK. *Quercus alba.*

Nat. Ord. Cupuliferæ.

A well known and invaluable large tree, widely distributed in all rich woods; flowers in spring and sheds nuts in October. There are not fewer than eighteen species of oak found in North America, but of all these the timber derived from this species approaches nearest to the English oak, which is probably more durable than any other wood which attains the same size. This timber is largely exported to England and the West Indies.

It is a most valuable wood for ship-building, carpentry, frames to machines, and works requiring great strength or exposure to the weather; also for staves of casks, spokes of wheels generally, and naves of waggon wheels, trenails, and numerous small works. On account of its capability of resistance to atmospheric influences it is much used in Canada and the Northern States of the Union for railway ties. Bark useful in tanning and in medicine. This timber is very tough and pliable, but is difficult to work, and is very liable to warp and split in seasoning. It is less durable than British oak, but it is of much quicker growth.

Specific gravity 0.84; weight of a cubic foot 50 lbs., fully seasoned.

Potash obtained from outer wood, 13.41; from heartwood, 9.68 per cent.

Value for heating purposes 81.

24. RED OAK. *Quercus rubra.*

Nat. Ord. Cupuliferæ.

A good sized tree, with reddish, very porous and coarse grained wood, of little value as timber. Flowers and sheds acorns at same seasons as the white oak;

grows in rocky woods—common. It is a lofty, wide-spreading tree, about 70 feet in height, with a diameter of 3 or 4 feet. The bark is extensively used in tanning, and the wood is mostly employed as fuel. This tree grows very rapidly and the timber is light, spongy, and not very durable. Oak timber generally shrinks about one thirty-second part of its original width in seasoning, acccording to most accurate experiments.

The outside wood yields 20.5 per cent. and the inside 14.79 per cent. of potash.

Specific gravity 0.675; weight of cubic foot 40 lbs.

Value for heating purposes 69.

25. Swamp Oak. *Quercus discolor.*
Nat. Ord. Cupuliferæ.

A very handsome middle-sized tree; grows abundantly in low alluvial grounds and along streams; light and elegant foliage; the sinuses of the leaves reaching three-fourths of the way to the midrib. The timber is better than that of the red oak, but greatly inferior to the white. The specific name *discolor*, or *bicolor* as it is called by some botanists, is derived from the circumstance of the remarkable appearance presented by the rich and luxuriant foliage, which is smooth and green above, and downy white beneath.

Specific gravity 0.675; weight of cubic foot 40 lbs.

26. Yellow Pine. *Pinus mitis.*
Nat. Ord. Coniferæ.

A very well-known and valuable tree; grows in dry and sandy soils, common in all parts of the continent. Blossoms developed in spring, and cones commonly maturing in the autumn of the second year; the cones rarely exceed two inches long. Tree from 50 to 60 feet in height, producing a durable, fine-grained, moderately resinous timber, valuable for flooring and many other purposes in house carpentry and in cabinet making. It is also much used in America for ship-building purposes.

Specific gravity 0.52; weight of cubic foot 30 lbs.

Value for heating purposes 54.

27. Red Pine. *Pinus resinosa.*
Nat. Ord. Coniferæ.

The names commonly applied to the various species of pines refer to the colors of their respective timbers, which vary from white to dark red, according to the greater or less quantity of resinous matter or turpentine which they contain. The present species contains more than the yellow and less than the pitch pine. Grows in dry woods commonly; attains a height of from 50 to 80 feet, develops buds and cones same as the yellow pine. This species is commonly, though erroneously, called the Norway pine in this country. Bark smoother and of a clearer red than other pines. This pine affords a fine grained resinous timber, of much strength and durability, and highly valued in architecture. It is a very heavy material, and is apt to become brittle when very dry. On account of the resin which it contains, it is somewhat difficult to plane.

Specific gravity 0.66; weight of cubic foot 40 lbs.

Value for heating purposes 50.

28. WHITE PINE. *Pinus strobus.*
Nat. Ord. Coniferæ.

A fine, tall and handsome tree, occurring in cool and damp woods, northwards; attains frequently a height of from 120 to 160 feet, in a single straight column in the primitive forests, and is invaluable for its soft and light white or yellowish wood, which in large trunks is nearly free from resin. It is largely imported into England, where it is commonly called the "Weymouth pine." This is the most esteemed and generally useful variety of pine timber produced in this country, being admirably adapted for frames of buildings, bridges, and structures of all kinds. The large trunks are in great request for the masts of ships. The facility with which this wood is wrought to the required forms constitutes, together with its durability, its chief value. It is imported into England both in the form of planks and logs, chiefly the latter, which are often more than 2 feet square and 50 feet long.

Specific gravity 0.46; weight of cubic foot 29 lbs.

Value for heating purposes 45.

29. POPLAR. *Populus canadensis.*
Nat. Ord. Salicaceæ.

Called also cotton wood. A large tree, 80 feet high and upwards, occurring on the margins of lakes and streams. The timber is soft, light, easy to work, suited to carving, common turnery, and works not exposed to much wear. Is very durable when kept dry, and does not readily take fire. The wooden polishing wheels of the glass grinder are made of horizontal sections of the entire stem, about one inch thick, as from its softness it readily imbibes the polishing materials. The seeds are clothed with a white, cotton like down, which gives name to the tree. Buds sealed against the frost and rains with resin.

The well-known Lombardy poplar, *Populus dilatata* has been introduced from Europe as an ornamental tree, and is found in the vicinity of all old settlements. None of the species of poplars are fit for large timbers.

Specific gravity 0.4; weight of cubic foot 25 lbs.

Value for heating purposes 52.

30. SASSAFRAS. *Sassafras officinale.*
Nat. Ord. Lauraceæ.

Grows abundantly in Canada and in the Western States. Varies in height from 10 to 50 feet. Is of little value as timber, but sometimes used for light ornamental purposes on account of the fragrant odour. Every part of the tree has a pleasant fragrance, and a sweetish, aromatic taste, which is strongest in the bark of the root. These qualities depend upon an essential oil, which may be obtained by distillation, and which is highly valued in medicine, acting as a stimulant to the circulation, especially of the capillaries.

Specific gravity 0.6; weight of cubic foot 37 lbs.

Value for heating purposes 59.

31. SYCAMORE. *Platanus occidentalis.*
Nat. Ord. Platanaceæ.

Called also plane tree or button-wood, this latter name being derived from the shape of the heads of the flowers, which are produced in May. It occurs on alluvial river banks westwards, and is a very large and well known tree, with a white bark, separating easily into thin brittle plates. It yields a very clean wood, somewhat softer than beech, but rather disposed to brittleness. The colour of young sycamore is silky white, and of the old, brownish white; the wood of middle age is intermediate in color and the strongest. Some of the pieces are very handsomely mottled. Used in furniture, chiefly for bedsteads, and for piano-fortes and harps; cuts into very good screws, and is used for presses, dairy utensils, windlasses, wheels and blocks.

The plane-tree is by far the largest, (though not the loftiest) tree of the American forests. Trunks are sometimes found in the Western States measuring 40 to 50 feet in circumference.

Specific gravity 0.5; weight of cubic foot 28 lbs.

Value for heating purposes 52.

32. Tamarack. *Larix americana.*
Nat. Ord. Coniferæ.

A slender tree, with heavy, close grained wood and slender horizontal branches: height usually from 20 to 50 feet. Occurs in low wet lands, forming "tamarack swamps." The timber has not until of late years been much esteemed, but next to cedar seems best adapted for underground works. It combines lightness, strength, and durability to a remarkable degree. Called also *Hackmatack* and red spruce. This timber has recently come into great demand in England for many purposes in ship building, combining as it does the most valuable qualities of many others. The best oak is superior to it only for the outside work of a ship where it is exposed to violent shocks or friction. For knees, bends, garlands, &c. of a ship it cannot be surpassed.

Specific gravity 0.6; weight of cubic foot 35 lbs.

33. Black Walnut. *Juglans nigra.*
Nat. Ord. Juglandaceæ.

A large and handsome tree with brown bark, and valuable purplish-brown wood, turning blackish with age. Occurs in rich woods; flowers in May, fruit ripe in October. The timber is fine grained, beautifully veined, and perhaps the most valuable for furniture of any of the North American woods. The wood of another species, *J. regia*, which, however, does not occur in America, is that of which gun stocks are mostly made. The *Juglans nigra* is a common tree in the middle and western States of the Union, but is rather rare in Canada, being confined to the western districts. It rises 60 to 70 feet high, with a diameter of 3 or 4 feet. This wood is very durable and not affected by worms, and is strong, tough, and not liable to split. It is much used for furniture in the form of veneers.

Specific gravity 0.5; weight of cubic foot 30 lbs.

Value for heating purposes 65.

34. White Willow. *Salix alba.*
Nat. Ord. Salicaceæ.

A familiar tree, of rapid growth, attaining a height of 50 to 80 feet; originally from Europe. The timber is, perhaps, the softest and lightest of all woods, for which qualities it is most valuable for some purposes. The color is tolerably white, inclining to yellowish grey. It is planed into chips for hat boxes, baskets, and wove bonnets. It has been attempted to be used in the manufacture of paper, small branches are used for hoops of tubs, &c.; the larger wood for cricket bats. From its lightness it is sometimes used, in this country, for waggon axles. From the facility with which it may be bent without breaking, it is in demand for boxes for druggists, perfumers, &c.

Specific gravity 0.4; weight of cubic foot 24 lbs.

85. WHITE WOOD. *Liriodendron tulipifera.*
Nat. Ord. Magnoliaceæ.

Called also the Tulip tree, and sometimes, though erroneously, Yellow Poplar. A remarkably beautiful tree, probably, taking all the dimensions, the largest we have in the Province. It attains a height of 140 feet, and the trunk is sometimes found as large as 8 feet in diameter in the Western States. It is extensively diffused, occurring in rich soils, and is most abundant in the western peninsula of Canada. Flowers in May and June. Trunk nearly cylindrical, and of uniform thickness to the height of 60 or 70 feet. But for the difficulty of raising, this would form probably the finest ornamental tree we have. The timber is valuable for building and cabinet purposes, for the latter probably more used than that of any other tree except the white pine. From its cleanness and freedom from knots, and non-liability to warp or shrink, it is much used in railway car and carriage building, chiefly for the pannelling, being both easily wrought and durable and susceptible of a fine polish.

Specific gravity 0.5; weight of cubic foot 30 lbs.

Value for heating purposes, 52.

SELECTED ARTICLES AND TRANSLATIONS.*

REMARKS ON THE FAUNA OF THE QUEBEC GROUP OF ROCKS, AND THE PRIMORDIAL ZONE OF CANADA.

ADDRESSED TO MR. JOACHIM BARRANDE.

BY SIR W. E. LOGAN,
DIRECTOR OF THE GEOLOGICAL SURVEY OF CANADA.

[A question of great geological interest, relating to the occurrence in Canada, of a *Primordial Zone*—synchronous, or partly so, with that recognised by Barrande in Bohemia, by Angelin in the Scandinavian Peninsula, and by the Officers of the British Survey, under Sir Roderick Murchison, in England—has occupied for some time the attention of our leading Geologists. More than two years ago, the able Palæontologist of our Geological Survey, felt constrained to acknowledge, on

* Under this head we intend to insert in the *Journal*, from time to time, original translations of interesting papers, from the *Comptes Rendus*, the *Annales des Sciences Naturelles*, *Poggendorff's Annalen*, and other French and German periodicals; together with occasional articles extracted from the proceedings of the Royal Society and other sources of a less accessible kind.—E. J. C.

fossil evidence, the existence of the upper part of this primordial zone in strata previously referred to a higher place in the series; and this view was much confirmed, as well as forced upon the attention of others, by the subsequent announcement of *Oleni* in strata which seemed to be of the same horizon in Vermont. Descriptions by Prof. Hall, of these Trilobites (then referred to the upper part of the Hudson River group), will be found in Volume IV. of the *Canadian Journal*, page 491. When the knowledge of these forms reached Barrande, he boldly declared his conviction, that too high a position had been accorded to the rocks from which they were procured. If this assumed position could be maintained, the limits of his primordial zone became altogether broken up. Under these circumstances, the accompanying remarks addressed quite recently, by Sir William Logan to Mr. Barrande, and just issued as an independent publication, will be found of no ordinary scientific interest. In Bohemia, the genus *Paradoxides*, and in Sweden and England, *Paradoxides* and *Olenus*, constitute the more typical trilobitic forms of the primordial zone. These types, as yet, have not been recognised in Canada,—although *Paradoxides* has been met with in Newfoundland and Massachusetts, (*Canadian Journal*, Vol. II, *New Series*, p. 49,) and *Olenus* in Vermont. We may yet expect to find them, however, in the dark shales which underlie the Quebec group; and in this latter, Mr. Billings has already detected the genus *Conocephalites*, a marked type of the Bohemian zone, together with other related forms.—E. J. C.]

MONTREAL, 31st Dec., 1860.

MY DEAR MR. BARRANDE,

I am much indebted to you for your letter of the 6th August, which was accompanied by a copy of your communication to Professor Bronn of Heidelberg, dated 16th July. Agreeably to your request, I took an early opportunity of letting Mr. Hall have a copy of your communication to Professor Bronn, and he received it on the 11th or 12th September.

I am of course aware, from the correspondence you have had with my friend Mr. Billings and myself, how far you are acquainted with our discoveries at Quebec. On two occasions, just previous to the receipt of your last letter to Mr. Billings (received the 8th November), I devoted the short time I could spare from other engagements connected with the Geological Survey, to farther researches at Point Levi. I have satisfied myself, notwithstanding the conglomerate aspect of the bands of rock which contain our new fossils, that the fossils are of the age of the strata. Without entering at present on minute details of structure, I may say that the chief part of the specimens found up to this time, are from two parallel out-crops, which might be taken as representing two distinct layers. If they are such, they are comprehended in a thickness of about 150 feet; but the circumstances of the case, connected with the physical structure, make it probable that the one band is a repetition of the other through the influence of an anticlinal fold or a dislocation. Both out-crops dip to the south-eastward.

From the more northern out-crop (which we shall call A^2) we have obtained *Orthis* 1, *Leptæna* 1, *Camerella* 1, *Lingula* 2, *Discina* 1, *Agnostus* 3, *Conocephalites* 1, *Arionellus* 4, *Dikelocephalus* 6, *Bathyurus* 4. From the more southern out-crop (which we shall call A^3) we have *Dictyonema* 1, *Orthis* 2, *Leptæna* 1, *Strophomena* 1, *Camerella* *Cyrtodonta* (?) 1, *Murchisonia* 3, *Pleurotomaria* 7, *Helicotoma* 2, *Straparollus* 2, *Capulus* 2, *Agnostus* 1, *Bathyurus* 4, *Cheirurus* 2, *Amphion*. From a third out-crop, which is still farther southward, and supposed to be another repetition of tne same band (which we shall call A^4) we have *Orthis* 1, *Camerella* 1, *Asaphus* (*A. Illænoides*) 1, *Bathyurus* 1. Tracing A^2 or A^3 round the extremity of a synclinal, and finding occasional indications of the fossils of A^2 and A^3, we arrive at a position on the south side of the synclinal. We shall call the position P. Here the band A^2 or A^3 ends, but a bed of sandstone a little above it is traceable over an anticlinal to a junction with a conglomerate band lower than A^2 or A^3, shewing that A^2 or A^3 must merge into it. Call this A^1. In this we have *Asaphus* (*A. Illænoides*) 1, *Menocephalus* (*M. globosus*) 1. These two series occur in the same fragment of rock. Of all these fossils, 1 *Orthis* is common to A^2, A^3 and A^4; 1 *Leptæna*, 1 *Camerella*, 1 *Lingula*, 1 *Agnostus*, and 1 *Bathyurus*, are common to A^2 and A^3; 1 *Asaphus* is common to A^3 and A^1.

The dip at P is to the south-eastward, and therefore an inverted dip. North-west of this, and therefore above it, at such a distance as would give a thickness of between 200 or 300 feet, we have a band of shale with nodules of limestone, the nodules made up of other rounded masses in a matrix holding fossils, many of them silicified. From a few of these compound nodules we have obtained *Orthis* 11, *Leptæna* 1; this band we shall call B^1. A band like this occurs about half a mile or more to the south-westward. It may be a higher band, or it may be the same band, but we shall call it B^2. From this we obtain *Crinoidæa* (columns) 3, *Orthis* 1, *Camerella* 1, *Nautilus* 1, *Orthoceras* 1, *Leperditia* 1, *Trilobites* (2 genera undetermined) 2. In another position to the south-east, on the south-east of the same anticlinal previously mentioned, we meet with a conglomerate band supposed to be the same as B^2; but, in case it should be different, we shall call it

B^3. Here we have *Orthis* 3, *Pleurotomaria* 2, *Murchisonia* 1, *Ophileta* 1, *Helicotoma* 1, *Nautilus* 1, *Maclurea* 1, *Othoceras* 3 or 4, *Cyrtoceras* 1, *Bathyurus* 1, *Illænus* 2, *Asaphus* 1. Of all these fossils,—1 *Orthis* and 1 *Camerella* are common to B^1 and B^2; the same *Orthis* and *Camerella* with 1 *Leptæna* are common to B^1, A^4, A^3 and A^2.

To the north of all these exposures, and on the north-west side of a synclinal running parallel with the synclinal already mentioned, fossils have been obtained in a cliff of about 100 feet, composed of limestone conglomerate, thin bedded limestones and shales. Their equivalence is not yet quite certain, but the strata are supposed to be not far removed from A^1 and A^3. We shall call this cliff A. The fossils from it are *Tetradium* 1, *Orthis* 1, *Trilobite* (genus undescribed) 1, with a great collection of compound *Graptolidæ*, described and being described by Mr. Hall under the genera *Graptolithus* 25, *Retiolites* 1, *Reteograptus* 2, *Phyllograptus* 5, *Dendrograptus* 3, *Thamnograptus* 3, *Dictyonema*, 3.

I have given you these details of localities, because as the subject requires further investigation we do not yet wish to commit ourselves entirely as to the equivalency of separate exposures. But there is no doubt that the whole is one group of strata deposited under one set of alternating circumstances. The whole fauna, as known up to the present time, is composed of—

Articulata	36	species.
Mollusca	55	"
Graptolidæ	42	"
Radiata	4	"
	137	

Of this fauna not one species is found in the Anticosti group, where we have a gradual passage from the fauna of the Hudson River formation to that of the Clinton, and not one in any formation higher than the Chazy, Mr. Billings recognises one species, *Maclurea Atlantica* (Billings) as belonging to the Chazy, and six species as belonging to the Calciferous. They are *Lingula Mantelli* (Billings), *Cameralla* undescribed, *Ecculiomphalus* undescribed, *Helicotoma uniangulata* (Hall), *H. perstriata* (Billings), and one remarkable species of an undetermined genus, like a very convex *Cyrtodonta*, which occurs both at Mingan and Point Levi, All of the forms, particularly the trilobites, remind the observer of those figured by Mr. Dale Owen from the oldest fossilferous rocks of the Mississippi valley, while independent of the six species identical with Chazy and Calciferous forms, there are many others closely allied to those found in the latter formation in Canada.

From the physical structure alone, no person would suspect the break that must exist in the neighbourhood of Quebec, and without the evidence of the fossils, every one would be authorized to deny it. If there had been only one or two species of an ancient type, your own doctrine of colonies might have explained the matter, but this I presume would scarcely be applicable to so many identities in a fauna of such an aspect. Since there must be a break, it will not be very difficult to point out its course and its character. The whole Quebec group, from the base of the magnesian conglomerates and their accompanying magnesian shales to the summit of the Sillery sandstones, must have a thickness of perhaps some 5000 or 7000 feet. It appears to be a great development of strata about the horizon of the Chazy and Calciferous, and it is brought to the surface by an overturn anticlinal fold with a crack and a great dislocation running along the summit, by which the Quebec group is brought to overlap the Hudson River formation. Sometimes it may overlie the overturned Utica formation; and in Vermont, points of the overturned Trenton appear occasionally to emerge from beneath the overlap.

A series of such dislocations traverses eastern North America from Alabama to Canada. They have been described by Messieurs Rogers and by Mr. Safford. The one in question comes upon the boundary of the Province not over a couple of miles from Lake Champlain. From this it proceeds in a gently curving line to Quebec, keeping just north of the fortress; thence it coasts the north side of the Island of Orleans, leaving a narrow margin on the island for the Hudson River or Utica formation. From near the east end of the island it keeps under the waters of the St. Lawrence to within eighty miles of the extremity of Gaspé. Here again it leaves a strip of the Hudson River or Utica formation on the coast.

To the south-east of this line the Quebec group is arranged in long narrow parallel synclinal forms with many overturn dips. These synclinal forms are separated from one another on the main anticlinals by dark grey and even black shales and limestones. These have heretofore been taken by me for shales and limestones of the Hudson River formation, which they strongly resemble, but as they separate the synclinals of the Quebec group, they must now be considered older. I am not prepared to say that the Potsdam deposit in its typical form of a sandstone is anywhere largely developed above these shales, where the shales are in greatest force. Neither am I prepared to assert its absence, as there are in some places masses of granular quartzite not far removed from the magnesian rocks of the Quebec group, which require farther investigation; but, from finding wind-mark and ripple mark on closely succeeding layers of the Potsdam sandstone where it rests immediately upon the Laurentian series, we know that this arenaceous portion of the formation must have been deposited immediately contiguous to the coast of the ancient Silurian sea, where part of it was even exposed at the ebb of tide. Out in deep water the deposit may have been a black partially calcareous mud, such as would give the shales and limestones which come from beneath the Quebec group.

In Canada no fossils have yet been found in these shales, but the shales resemble those in which *Oleni* have been found in Georgia (Vermont). These shales appear to be interposed between eastward dipping rocks equivalent to the magnesian strata of the Quebec group, and they may be brought up by an overlapping anticlinal or dislocation. We are thus led to believe that these shales and limestones, which may be subordinate to the Potsdam formation, will represent the true primordial zone in Canada.

Mr. Murray has this season ascertained that the lowest rock that is well characterized by its fossils in the neighbourhood of Sault Ste. Marie, near Lake Superior, really belongs to the Birdseye and Black River group, and that it rests on the sandstones of Ste. Marie and Lacloche, the fossiliferous beds at the latter place being tinged with the red colour of the sandstone immediately below them. These underlying Lake Superior rocks may thus be Chazy, Calciferous, and Potsdam, and may be equivalent to the Quebec group and the black colored shales beneath. The Lake Superior group is the upper copper-bearing series of that region, and rests uncomformably upon the lower copper-bearing series, which is the Huronian system. The upper copper-bearing series holds nearly all the metals, including gold, and so does the Quebec group, each making an important metalliferous region. Each when unmetamorphosed holds a vast collection of red colored strata. The want of fossils in the Lake Superior group makes it difficult to draw lines of division, but if any part represents the primordial zone, I should hazard the conjecture that it is the dark coloured slates of Kamanistiquia, which underlie all the red rocks.

Professor Emmons has long maintained, on evidence that has been much disputed, that rocks in Vermont, which in June 1859 I for the first time saw and recognized as equivalent to the magnesian part of the Quebec group, are older than the Birdseye formation; the fossils which have this year been obtained at Quebec pretty clearly demonstrate that in this he is right. It is at the same time satisfactory to find that the view which Mr. Billings expressed to you in his letter of the 12th July, to the effect that the Quebec trilobites appeared to be about the base of the second fauna, should so well accord with your opinions; and that what we were last spring disposed to regard at Georgia, (Vermont) as a colony in the second fauna, should so soon be proved, by the discoveries at Quebec, to be a constituent part of the primordial zone.

I am, my dear Mr. Barrande,

Very truly yours,

W. E. LOGAN.

Mr. Joachim Barrande,
Rue Mézière, No. 6,
Paris.

ON A SECOND INSTANCE OF THE REPRODUCTION OF THE OSTRICH IN EUROPE.

COMMUNICATION ADDRESSED TO M. IS. GEOFFROY ST. HILAIRE, BY PRINCE DEMIDOFF.

(*Translated from the Comptes Rendus, of August* 17, 1860.)

My zoological establishment at San-Donato, has just afforded me a second example of the reproduction of the ostrich; and, this time, under conditions which speak decisively for the acclimation of this beautiful and useful bird. A pair which gave me two young ostriches in 1859, has just produced six more; and I think it a duty to indicate the phases of the incubation: since, with regard to novel facts, the least details are not without their interest.

A severe accident, which occurred to the male bird during the month of March, made us apprehensive of his loss. The ostrich drove its head with such force through the narrow bars of the fence which surrounds the park, that it was unable to withdraw it without causing a large wound upon its neck. Immediate assistance was rendered to the poor bird; and, although in general very quarrelsome during the breeding season, it suffered itself to be handled with great patience. Whilst its sickness lasted, it abstained from all food; but at the end of three weeks, it became perfectly restored to health, and sought its companion with renewed ardour.

The first egg was laid on the 11th of May, and, afterwards, the laying went on regularly, at the rate of an egg every other day, up to the 31st. On that day, after having deposited the eleventh egg, the female sat for a couple of hours. The male then replaced her, but only up to the night.

On the 1st of June, the female sat from 8 A. M., to 3 P. M. The male then took her place, and continued to sit uninterruptedly until 10 A. M. on the 2nd. From this latter to the 3rd, the same course was followed.

On the 3rd, the nest received a twelfth egg; a thirteenth, on the 4th; and a fourteenth on the 5th—at which date the laying ceased.

Up to the 23rd of June, the incubation continued in the manner already indicated, the female sitting five hours, from 10 A. M. to 3 P. M., and the male continuing the incubation through a long sitting of nineteen hours, or until 10 o'clock the next morning.

Since the 14th of June, the temperature of the air had experienced several abrupt changes. Almost every day, a storm, accompanied by wind and rain, broke over the park. On the 17th there was a complete hurricane, with claps of thunder. At the first premonitory signs of this tempest, the female placed herself beside the male to assist him in covering the eggs, and, contrary to her usual custom, she remained on the nest until eight o'clock the next morning. As to the male bird, he did not quit his post before three in the afternoon: so that he remained without taking nourishment for twenty-four hours.

The weather again cleared up. On the 23rd of June, about three o'clock in the morning, M. Desmeure, who has charge of my establishment, was attracted by a peculiar little cry, which he knew, by the experience of the past year, to signalize the hatching of a young bird. The little-one was already running around its male parent, but the latter did not quit the nest during the entire day. M. Desmeure having observed the young bird to wander to some distance, and become entangled in a bush, made up his mind to enter the park. He replaced the "little stranger" under the wing of the male ostrich, and took advantage of the occasion to put within its reach a sufficient amount of food and water. Neither the male nor the female seemed to be disturbed by his presence. At this moment, three more young birds appeared, and precipitating themselves from the nest, commenced to peck at the food. This, as on the former occasion, was composed of a paste of finely chopped eggs, salad, and bread-crumbs.

On the 24th, the male still continued to sit, and the four young ones walked about with the mother. About two o'clock, however, he arose, and then a fifth young one was discovered. The latter quickly commenced to run about, pecking here and there. During twenty minutes, the male ostrich walked to and fro, took food, and caressed his little-ones. He then returned to the nest, where the female had replaced him. At night, the five young ones sheltered themselves under his wings.

On the 26th, at day-break, the young ostriches began to follow the female, who presided at a copious repast, of which she took her share. The male having left the nest for an instant, M. Desmeure went to inspect the eggs, and noticed a violent commotion in one of them. Knowing that this arose from the vain efforts of an imprisoned bird to get free, he opened the egg at the proper spot, and replaced it in the nest. A few moments after the return of the male, the young bird appeared. More feeble than the others, it could scarcely keep upon its legs, and rolled about, at first, like a ball; but in the course of a few hours it followed its elder brethren, pecking right and left.

From this time, the nest was pretty well abandoned. The male only took irregular sittings, and appeared restless and uneasy. This was evidently the effect of a storm, which was gathering in the atmosphere, and which burst upon San-Donato with extreme violence. Lightning-rods within a distance of about 164 yards from the ostrich-park, were twice struck. The brood, with the parent birds, having sought refuge within the covered shed appropriated to them, the eight eggs, which remained, were taken there, and placed in a nest of sand that had been prepared in case of any emergency requiring it; but the ostriches would have nothing to do with them. From the moment in which the storm broke over the park, the eggs were definitely deserted. Five of these were well advanced towards hatching, the rest were clear.

This second example of the reproduction of the ostrich, although presenting in its details the same general features as in the first recorded case, offers, nevertheless, certain traits by which it may be legitimately predicted that domestication will go on side by side with reproduction. On this latter occasion, for instance, the pair exhibited so little of their former savage disposition, that I was able during six or seven days together, to pass a quarter of an hour or so in the park, close to the nest, without disturbing the birds in any way. The one which sat betrayed no signs of agitation; and the other approached me evidently with pacific intentions. M. Desmeure, who has displayed on this occasion the same zeal as before, and who did not, so to say, lose sight of the ostriches, thinks that after three or four broods have been raised, this bird will reproduce itself as readily, and with as little trouble, as the common fowls of the farm-yard.

The two ostriches born in 1859, are magnificent birds, and are almost as large as their parents. Nothing as yet indicates their sex this only manifesting itself at the adult age.

I have just learned that the young bird which came last, and, in a manner, artificially, into the world, did not live beyond a few days. Only five young ostriches therefore remain as the produce of this year, but these are perfectly well-formed, and they commence already to assume the shape and character of their race, of which, it should be stated, not the slightest sign was apparent at their birth. On quitting the egg, for example, the young ostrich has both the neck and feet remarkably short.

In presenting the above communication of Prince Demidoff, M. Isidore Geoffroy-Saint-Hilaire re-called the fact, that two years previously he had had the honour to communicate a note, by M. le Maréchal Vaillant, on a reproduction of the ostrich obtained by M. Hardy, at Hamma in Algeria. M. Hardy has had since a great number of young broods, some of which have produced a second generation. Before the broods obtained, however, at Prince Demidoff's establishment at San-Donato, by the care of M. Desmeure, not a single example was known of the reproduction of the ostrich in Europe. In the north of France, and especially in the menagerie of the Paris Museum, ostrich eggs are frequently laid, but these, hitherto, have always been unproductive. In the south of France, at Méze near Montpellier, M. Moquin-Tandon proved in one case the fecundation of the egg, but this did not become hatched.

When M. Geoffroy-Saint-Hilaire, consequently, called attention to the advantages which might accrue from the acclimation in Europe of the so-called *oiseaux de boucherie*, he did not feel warranted in including the African ostrich amongst these, but confined himself to the recommendation of the Nandu, and of the Dromaius or Emeu of Australia—genera belonging to climates much less warm than that of Africa. As to the Emeu or so-called Cassowary of Australia, not only is that bird able to support the climate of France, but no species appears to be better fitted to withstand its changes. The Emeu is so robust and hardy, that it has been seen in the menagerie of the Paris Museum, to remain out of doors from one end of the year to the other, at night as well as during the day, without ever seeking the shelter of its lodge, even during the most rigorous weather. More than once, indeed, it has let itself, literally, be buried in the snow, without appearing to suffer from this in the least degree.

With regard to the facts also, mentioned in the interesting communication of Prince Demidoff, M. Geoffroy-Saint-Hilaire stated, that, likewise in Algeria, M. Hardy had seen the male ostrich occupy itself with the incubation of the eggs, much more fully than the female. On one occasion, even, the female limited her duties principally to the bare act of turning the eggs carefully over in the nest during the temporary absence of the male. At the Paris Museum, where the Emeu has re-produced itself, and where M. Florent Prevost noted down with the greatest care all the attendant circumstances, the male Emeu alone hatched the eggs, and took care of the young birds. The part of the female in the case recorded, was confined to the simple laying of the eggs. E. J. C.

NOTE ON THE QUESTION—CAN SODA REPI ACE POTASH AS A MANURE.

BY M. GEORGE VILLE.

[*Translated from the Comptes Rendus of September* 17*th*, 1860.]

For some years past, enormous and constantly increasing quantities of nitrate of soda from Peru, have been consumed for agricultural purposes in Great Britain. The good effects of this salt, attested at present by the most extended employment, were originally made known by the able researches of M. Kuhlmann,* and by those, more

* Expériences chimiques et agronomiques: 1847.

theoretical in their character, of MM. Bineau, Bonssingault, and G. Ville. Amongst the publications which have largely contributed also to our knowledge of the practical utility of nitrate of soda, we must not forget the numerous and very remarkable papers of Dr. Pusey.*

Chemists and agriculturists, men of science, and practical farmers, all seem to be at present unanimous in ranking nitrate of soda as one of the most efficaceous agents of vegetable production.

Before the unfortunate Leblanc had discovered the admirable process by which soda is readily obtained from sea-salt, advantage was taken, in the manufacture of this useful alkali, of the property possessed by marine plants of extracting and secreting in their tissues the soda contained in sea-water. The combustion of these plants furnishes an ash, of which carbonate of soda is one of the principal components. Amongst the vegetable matters fitted for the extraction of this alkali, the ash of the Barille, a plant cultivated on the coasts of Spain, yields from 20 to 50 *per cent.* of carbonate of soda. Although less rich in alkalies, the ash of the varech affords also considerable quantities. The abundance of soda in the ashes of these vegetables, joined to the disappearance of plants containing soda in the interior of continents (at least when the soil is destitute of salt,) indicates clearly the fact that soda is essential to their existence. Now, considering the close relationship between soda and potash, it is not without interest to inquire how far these alkalies are capable of replacing one another; and, in addition, whether a substitution of this kind affects in any way the development of vegetable life.

M. Payen relates that the leaves and branches of *Mesambrianthemum cristallinum*, collected at the Island of Teneriffe for the extraction of soda, are dotted with glands containing a solution of the oxalate of that alkali; whilst, in passing inland from the coast, these glands are found to contain oxalate of potash.

The venerable M. de Gasparin cites also, another vegetable species, in which potash appears to replace soda in a still more complete manner, without detriment to the vigour of the plant. This is the *Salsola tragus*, collected as a "soda plant," in the district between Frontignan and Aigues-Mortes. This species extends far up the valley of the Rhone, and, according to M. de Gasparin,† is of equally vigorous growth in its most inland station, as in the neighbourhood of

* Journal of the Royal Agricultural Society of England, vols. xiii, xiv, and xv.

† Cours d'Agriculture; 3e. édition, T. 1, p. 106.

the sea. Only, in the former, the plant contains potash—the soda having entirely disappeared.

From these two examples, consequently, it would seem that potash can sometimes replace soda, without ill effects accruing from the substitution. The inverse of this problem remains now to be considered: *i.e.*, the question as to whether soda can be substituted for potash in certain vegetables, and what may be the effects of this replacement. With regard to wheat, the answer is complete and peremptory. Soda employed to the total exclusion of potash, hinders most materially the development of the plant, and greatly lessens the amount of grain. In support of this assertion, I may cite two experiments, performed under different conditions, and confirmatory one of the other.

A soil (that of the Landes) naturally free from potash, was employed in these experiments. It was treated with 10 grammes of phosphate of lime, and 0.110 grm. of nitrogen—present, in the one case in nitrate of potash, and in the other in nitrate of soda.

With phosphate of lime and nitrate of potash, an active and flourishing growth takes place. The wheat succeeds admirably: the stalks are firm, the ears well formed, and filled with large and heavy grains.

On the other hand, when the nitrate of potash is replaced by nitrate of soda, the vegetation has quite another character: the growth is slow, the stalks incline in all directions, and the ears, when formed, contain but a few grains, and those of poor quality.

These statements are confirmed by the following table, embodying the results of the experiments in question. The amount of wheat sown in each experiment was 20 grains.

A. Soil treated with phosphate of lime and nitrate of potash:		*B.* Soil treated with phosphate of lime and nitrate of soda:	
Straw and roots.12gr. 14	14·92.	Straw and roots...7gr.085	7·41.
140 grains of wheat.2gr.78		20 grains of wheat.0gr.325	

The weight obtained in the first experiment, it will be observed, almost doubles that obtained in the second. Soda, consequently, cannot without detriment be substituted for potash.

Another set of experiments was instituted by adding four grammes of silicate of potash to each of the mixtures described above. This had the effect of equalizing the results. The addition of the silicate rendered the nitrate of soda almost as efficaceous as the nitrate of potash. If it be asked, why, under these conditions the two nitrates produce the same effects or nearly so—we reply, because they act, in this case, simply by their nitrogen; the soil being already liberally supplied with potash by the addition of the silicate.

The following table exhibits these results, and shews the amount of influence due under these new conditions to the potash of the nitrate. The grains of wheat sown, amounted, as before, to twenty.

A.		*B.*	
Soil treated with phosphate of lime, nitrate of potash, and silicate of potash.		Soil treated with phosphate of lime, nitrate of soda, and silicate of potash.	
I.		I.	
Straw and roots... 17gr.70	grms.	Straw and roots... 15gr.25	grms.
215 grains of wheat.. 5·35	23·05	220 grains of wheat.. 4·45	19.70
II.		II.	
Straw and roots... 17gr.08	21·73	Straw and roots... 16gr.14	grms.
207 grains of wheat.. 4·65		201 grains of wheat. 4gr.90	21.04
Mean.		*Mean.*	
Straw and roots... 17gr.39	grms.	Straw and roots... 15gr.70	grms.
211 grains of wheat.. 5·00	22·39	210 grains of wheat.. 4·67	20·37

From the experiments described above, the following conclusions may be deduced:

1. So far as regards wheat, soda cannot be employed as a substitute for potash: nitrate of soda associated with phosphate of lime, constitutes a manure of little efficacy.

2. An addition of potash imparts to the mixture an immediate activity.

3. If in practice, nitrate of soda has shown itself to be beneficial, this arises from the natural presence of potash in the soil.

E. J. C.

"NOTE ON REGELATION."

BY MICHAEL FARADAY, D.C.L., F.R.S., ETC.

[*From the Proceedings of the Royal Society · Read April 26th,* 1860.]

The philosophy of the phenomenon now understood by the word Regelation is exceedingly interesting, not only because of its relation to glacial action under natural circumstances, as shown by Tyndall and others, but also, and as I think especially, in its bearings upon molecular action; and this is shown, not merely by the desire of different philosophers to assign the true physical principle of action, but also by the great differences between the views which they have taken.

Two pieces of thawing ice, if put together, adhere and become one; at a place where liquefaction was proceeding, congelation suddenly occurs. The effect will take place in air, or in water, or in vacuo. It will occur at every point where the two pieces of ice touch; but not with ice below the freezing point, *i. e.* with dry ice, or ice so cold as to be everywhere in the solid state.

Three different views are taken of the nature of this phenomenon. When first observed in 1850, I explained it by supposing that a particle of water, which could retain the liquid state whilst touching ice only on one side, could not retain the liquid state if it were touched by ice on both sides; but became solid, the general temperature ramaining the same.* Professor J. Thompson, who discovered that pressure lowered the freezing-point of water,† attributed the regelation to the fact that two pieces of ice could not be made to bear on each other without pressure; and that the pressure, however slight, would cause fusion at the place where the particles touched, accompanied by relief of the pressure and resolidification of the water at the place of contact, in the manner that he has fully explained in a recent communication to the Royal Society‡. Professor Forbes assents to neither of these views; but admitting Person's idea of the gradual liquefaction of ice, and assuming that ice is essentially colder than ice-cold water, *i. e.* the water in contact with

* Researches in Chemistry and Physics. 8vo. pp. 373, 378.

† Mousson says that a pressure of 13,000 atmospheres lowers the temperature of freezing from 0° to —18° Cent.

‡ Royal Society Proceedings, vol. x. p. 152.

it, he concludes that two wet pieces of ice will have the water between them frozen at the place where they come into contact.*

Though some might think that Professor Thompson, in his last *communication, was trusting to changes of pressure and temperature* so inappreciably small as to be not merely imperceptible, but also ineffectual, still he carried his conditions with him into all the cases he referred to, even though some of his assumed pressures were due to capillary attraction, or to the consequent pressure of the atmosphere, only. It seemed to me that experiment might be so applied as to advance the investigation of this beautiful point in molecular philosophy to a further degree than has yet been done; even to the extent of exhausting the power of some of the principles assumed in one or more of the three views adopted, and so render our knowledge a little more defined and exact than it is at present.

In order to exclude all pressure of the particles of ice on each other due to capillary attraction or the atmosphere, I prepared to experiment altogether under water; and for this purpose arranged a bath of that fluid at 32° F. A pail, surrounded by dry flannel, was placed in a box; a glass jar, 10 inches deep and 7 inches wide, was placed on a low tripod in the pail; broken ice was packed between the jar and the pail; the jar was filled with ice-cold water to within an inch of the top; a glass dish filled with ice was employed as a cover to it, and the whole enveloped with dry flannel. In this way the central jar, with its contents, could be retained at the unchanging temperature of 32° F. for a week or more; for a small piece of ice floating in it for that time was not entirely melted away. All that was required to keep the arrangement at the fixed temperature, was to renew the packing ice in the pail from time to time, and also that in the basin cover. A very slow thawing process was going on in the jar the whole time, as was evident by the state of the indicating piece of ice there present.

Pieces of good Wenham-lake ice were prepared, some being blocks three inches square, and nearly an inch thick, others square prisms four or five inches long: the blocks had each a hole made through them with a hot wire near one corner; woollen thread passed through these holes formed loops, which, being attached to pieces of lead, enabled me to sink the ice entirely under the surface of the ice-cold water. Each piece was thus moored to a particular place, and, be-

* Proceedings of the Royal Society of Edinburgh, April 19, 1858.

cause of its buoyancy assumed a position of stability. The threads were about 1½ inch long, so that a piece of ice, when depressed sideways and then left to itself, rose in the water as far as it could, and into its stable position, with considerable force. When, also, a piece was turned round on its loop as a vertical axis, the torsion force tended to make it return in the reverse direction.

Two similar blocks of ice were placed in the water with their opposed faces about two inches apart; they could be moved into any desired position by the use of slender rods of wood, without any change of temperature in the water. If brought near to each other and then left unrestrained, they separated, returning to their first position with considerable force. If brought into the slightest contact, regelation ensued, the blocks adhered, and remained adherent notwithstanding the force tending to pull them apart. They would continue thus, even for twenty-four hours or more, until they were purposely separated, and would appear (by many trials) to have the adhesion increased at the points where they first touched, though at other parts of the contiguous surfaces a feeble thawing and dissecting action went on. In this case, except for the first moment and in a very minute degree, there was no pressure either from capillary action or any other cause. On the contrary, a tensile force of considerable amount was tending all the time to separate the pieces of ice at their points of adhesion; where still, I believe, the adhesion went on increasing—a belief that will be fully confirmed hereafter.

Being desirous of knowing whether anything like soft adhesion occurred, such as would allow slow change of position without separation during the action of the tensile force, I made the following arrangements. The blocks of ice being moored by the threads fastened to the lowest corners, stood in the water with one of the diagonals of the large surfaces vertical; before the faces were brought into contact, each block was rotated 45° about a horizontal axis, in opposite directions, so that when put together, they made a compound block, with horizontal upper edges, each half of which tended to be twisted upon, and torn from the other. Yet by placing indicators in holes previously made in the edges of the ice, I could not find that there was the slightest motion of the blocks in relation to each other in the thirty-six hours during which the experiment was continued. This result, as far as it goes, is against the necessity of pressure to regelation, or the existence of any condition like that of softness or a shifting contact; and yet I shall be able to show that there is either soft adhesion or an equivalent for it, and from that state draw still further cause against the necessity of pressure to regelation.

Torsion force was then employed as an antagonist to regelation. The ice-blocks, being separate, were adjusted in the water so as to be parallel to each other, and about 1½ inch apart. If made to approach each other on one side, by revolution in opposite directions on vertical axes, a piece of paper being between to prevent ice contact, the torsion force set up caused them to separate when left to themselves; but if the paper were away and the ice pieces were brought into contact, by however slight a force, they became one, forming a rigid piece of ice, though the strength was, of course, very small, the point of adhesion and solidification being simply the contact of two convex surfaces of small radius. By giving a little motion to the pail, or by moving each piece of ice gently in the water with a slip of wood, it was easy to see that the two pieces were rigidly attached to each other; and it was also found that, allowing time, there was no more tendency to a changing shape here than in the case quoted above; if now the slip of wood were introduced between the adhering pieces of ice, and applied so as to aid the torsion force of one of the loops, *i. e.* to increase the separating force, but unequally as respects the two pieces, then the congelation at the point of contact would give way, and the pieces of ice would move in relation to each other. Yet they would not separate; the piece unrestrained by the stick would not move off by the torsion of its own thread, though, if the stick were withdrawn, it would move back into its first attached position, pulling the second piece with it; and the two would resume their first associated form, though all the while the torsion of both loops was tending to make the pieces separate.

If when the wood was applied to change the mutual position of the two pieces of ice, without separating them, it were retained for a second undisturbed, then the two pieces of ice became fixed rigidly to each other in their new position, and maintained it when the wood was removed, but under a state of restraint; and when sufficient force was applied, by a slight tap of the wood on the ice to *break up the rigidity, the two pieces of ice would rearrange* themselves under the torsion force of their respective threads, yet remain united; and, assuming a new position, would, in a second or less, again become rigid, and remain inflexibly conjoined as before.

By managing the continuous motion of one piece of ice, it could be kept associated with the other by a flexible point of attachment for any length of time, could be placed in various angular positions to it, could be made (by retaining it quiescent for a moment) to assume and hold permanently any of these positions when the external force was removed, could be changed from that position into a new one, and, within certain limits, could be made to possess at pleasure, and for any length of time, either a flexible or a rigid attachment to its associated block of ice.

So, regelation includes a flexible adhesion of the particles of ice, and also a rigid adhesion. The transition between these two states takes place when there is no external force like pressure tending to bring the particles of ice together, but, on the contrary, a force of torsion is tending to separate them; and, if respect be had to the mere point of contact on the two rounded surfaces where the flexible adhesion is exercised, the force which tends to separate them may be esteemed very great. The act of regelation cannot be considered as complete until the junction has become rigid; and therefore I think that the necessity of pressure for it is altogether excluded. No external pressure can remain (under the circumstances) after the first rigid contact is broken. All the forces which remain tend to separate the pieces of ice; yet the first flexible adhesions, and all the successive rigid adhesions which are made to occur, are as much effects of regelation as those which occur under the greatest pressure.

The phenomenon of flexible adhesion under tension looks very much like sticking and tenacity; and I think it probable that Professor Forbes will see in it evidence of the truth of his view. I cannot, however, consider the fact as bearing such an interpretation; because I think it impossible to keep a mixture of snow and water for hours and days together without the temperature of the mixed mass becoming uniform; which uniformity would be fatal to the explanation. My idea of the flexible and rigid adhesion is this:—Two convex surfaces of ice come together; the particles of water nearest to the place of contact, and therefore within the efficient sphere of action of those particles of ice which are on both sides of them, solidify; if the condition of things be left for a moment, that the heat evolved by the solidification may be conducted away and dispersed, more particles will solidify, and ultimately enough to form a fixed and rigid junction, which will remain until a force sufficiently great to break through it is applied. But if the direction of the force resorted to can be relieved by any hinge-like motion at the point of contact, then I think that the union is broken up among the particles on the opening side of the angle, whilst the particles on the closing side come within the effectual regelation distance; regelation ensues there and the adhesion is maintained, though in an apparently flexible state. The flexibility appears to me to be due to a series of ruptures on one side of the centre of contact, and of adhesion on the other,—the regelation, which is dependent on the vicinity of the ice surfaces, being transferred as the place of efficient vicinity is changed. That the substance we are considering is as brittle as ice, does not make any difficulty to me in respect of the flexible adhesion; for if we suppose that the point of contact exists only at one particle, still the angular motion at that point must bring a second particle into contact (to suffer regelation) before separation could occur at the first; or if, as seems proved by the supervention of the rigid adhesion upon the flexible state, many particles are concerned at once, it is not possible that all these should be broken through by a force applied on one side of the place of adhesion, before particles on the opposite side should have the opportunity of regelation, and so of continuing the adhesion.

It is not necessary for the observation of these phenomena that a carefully-arranged water-vessel should be employed. The difference between the flexible and rigid adhesion may be examined very well in air. For this purpose, two of the bars of ice before spoken of, may be hung up horizontally by threads, which may be adjusted to give by torsion any separating force desired; and when the ends of these bars are brought together, the adhesion of the ice, and the ability of placing these bars at any angle, and causing them to preserve that angle by the rigid adhesion due to regelation, will be rendered evident; and though the flexible adhesion of the ice cannot in this way be examined alone, because of the capillary attraction due to the film of water on the ice, yet that is easily obviated by plunging the pieces into a dish of water at common temperatures, so that they are entirely under the surface, and repeating the observations there. All the important points regarding the flexible and rigid junction of ice due to regelation, can in this way be readily investigated.

It will be understood that, in observing the flexible and rigid state of union, convex surfaces of contact are necessary, so that the contact may be only at one point. If there be several places of contact, apparent rigidity is given to the united mass, though each of the places of contact might be in a flexible and, so to say, adhesive condition. It is not at all difficult to arrange a convex surface so that, bearing at two places only on the sides of a depression, it should form a flexible joint in one direction, and a rigid attachment in a direction transverse to the former.

It might seem at first sight as if the flexible adhesion of the ice gave us a point to start from in the further investigation of the principle of pressure. If the application of pressure causes ice to freeze together, the application of tension might be expected to produce the contrary effect, and so cause liquidity and separation at the flexible joint. This, however does not necessarily follow; nor do I intend to consider what might be supposed to take place whilst theoretically contemplating that case. I think the changes of temperature and pressure are too infinitesimal to go for anything; and in illustration of this, will describe the following experiment. Wool is known to adhere to ice in the manner, as I believe, of regelation. Some woollen thread was boiled in distilled water, so as thoroughly to wet it. Some clean ice was broken up small and mixed with water, so as to produce a soft mass, and, being put into a glass jar clothed in flannel that it might keep for some hours, had a linear depression made in the surface, so as to form a little ice-ditch filled with water; in this depression some filaments of the wetted wool were placed, which, sinking to the bottom, rested on the ice only with the weight which they would have being immersed in water; yet in the course of two hours these filaments were frozen to the ice. In another case, a small loose ball of the same boiled wool, about half an inch in diameter, was put on to a clean piece of ice; that into a glass basin; and the whole wrapped up in flannel and left for twelve hours. At the end of that time it was found that thawing had been going on, and that the wool had melted a hole in the ice, by the heat conducted through it to the ice from the air. The hole was filled with the water and wool, but at the bottom some fibres of the wool were frozen to the ice.

Is this remarkable property peculiar to water, or is it general to all bodies? In respect of water it certainly seems to offer us a glimpse into the joint physical action of many particles, and into the nature of cohesion in that body when it is changing between the solid and liquid state. I made some experiments on this point. Bismuth was melted and kept at a temperature at which both solid and liquid metal could be present; then rods of bismuth were introduced, but when they had acquired the temperature of the mixed mass no adhesion could be observed between them. By stirring the metal with wood, it was easy to break up the solid part into small crystalline granules; but when these were pressed together by wood under the surface, there was not the slightest tendency to cohere, as hail or snow would cohere in water. The same negative result was obtained with the metals tin and lead. Melted nitre appeared at times to show traces of the power; but, on the whole, I incline to think the effects observed resulted from the circumstance that the solid rods experimented with had not acquired throughout the fusing temperature. Nitre is a body which, like water, expands in solidifying; and it may possess a certain degree of this peculiar power.

Glacial acetic acid is not merely without regelating force, but actually presents a contrast to it. A bottle containing five or six ounces, which had remained liquid for many months, was at such a temperature that being stirred briskly with a glass rod, crystals began to form in it; these went on increasing in size and quantity for eight or ten hours. Yet all that time there was not the slightest trace of adhesion amongst them, even when they were pressed together; and as they came to the surface, the liquid portion tended to withdraw from the faces of the crystals; as if there were a disclination of the liquid and solid parts to adhere together.

Many salts were tried (without much or any expectation),—crystals of them being brought to bear against each other by torsion force, in their saturated solutions at common temperatures. In this way the following bodies were experimented with:—Nitrates of lead, potassa, soda; sulphates of soda, magnesia, copper, zinc; alum; borax; chloride of ammonium; ferro-prussiate of potassa; carbonate of soda; acetate of lead; and tartrate of potassa and soda; but the results with all were negative.

My present conclusion therefore is that the property is special for water; and that the view I have taken of its physical cause does not appear to be less likely now than at the beginning of this short investigation, and therefore has not sunk in value among the three investigations given.

Dr. Tyndall added to one of his papers*, a note of mine "On ice of irregular fusibility" indicating a cause for the difference observed in this respect in different parts of the same piece of ice. The view there taken was strongly confirmed by the effects which occurred in the jar of water at constant temperature described in the beginning of the preceding pages, where, though a thawing process was set up, it was so slow as not dissolve a cubic inch of ice in six or seven days. The blocks retained entirely under water for several days, became so dissected at the surfaces as to develop the mechanical composition of the masses, and to show that they were composed of parallel layers about the tenth of an inch thick, of greater and lesser fusibility, which layers appear, from other modes of examination, to have been horizontal in the ice whilst in the act of formation. They had no relation to the position of the blocks in the water of my experiments, or to the direction of gravity, but had a fixed position in relation to each piece of ice.

ADDENDUM:—The following method of examining the regelation phenomena above described may be acceptable. Take a rather large dish of water at common temperatures. Prepare some flat cakes or bars of ice, from half an inch to an inch thick; render the edges round, and the upper surface of each piece convex, by holding it against the inside of a warm saucepan cover, or in any other way. When two of these pieces are put into the water they will float, having perfect freedom of motion, and yet only the central part of the upper surface will be above the fluid; when, therefore, the pieces touch at their edges, the width of the water-surface above the place of contact may be two, three, or four inches, and thus the effect of capillary action be entirely removed. By placing a plate of clean dry wax or spermaceti upon the top of a plate of ice, the latter may be entirely submerged, and the tendency to approximation from capilliary action converted into a force of separation. When two or more of such floating pieces of ice are brought together by contact at some point under the water, they adhere; first with an apparently flexible, and then with a rigid adhesion. When five or six pieces are grouped in a contorted shape, as an S, and one end piece be moved carefully, all will move with it rigidly; or, if the force be enough to break through

* Philosophical Transactions, 1858, p. 228.

the joint, the rupture will be with a crackling noise, but the pieces will still adhere, and in an instant become rigid again. As the adhesion is only by points, the force applied should not be either too powerful or in the manner of a blow. I find a piece of paper, a small feather, or a camel-hair brush applied under the water very convenient for the purpose. When the point of a floating, wedge-shaped piece of ice is brought under water against the corner or side of another floating piece, it sticks to it like a leech; if, after a moment, a paper edge be brought down upon the place, a very sensible resistance to the rupture at that place is felt. If the ice be replaced by like rounded pieces of wood or glass, touching under water, nothing of this kind occurs, nor any signs of an effect that could by possibility be referred to capillary action; and finally, if two floating pieces of ice have separating forces attached to them, as by threads connecting them and two light pendulums, pulled more or less in opposite directions, then it will be seen with what power the ice is held together at the place of regelation, when the contact there is either in the flexible or rigid condition, by the velocity and force with which the two pieces will separate when the adhesion is properly and entirely overcome.

NOTES ON THE APPARENT UNIVERSALITY OF A PRINCIPLE ANALOGOUS TO REGELATION, ON THE PHYSICAL NATURE OF GLASS, AND ON THE PROBABLE EXISTENCE OF WATER IN A STATE CORRESPONDING TO THAT OF GLASS.

BY EDWARD W. BRAYLEY, ESQ., F.R.S., &c.

[*From the Proceedings of the Royal Society: Read April 26, 1860.*]

1. Recent experimental investigations, and the reasoning founded upon them, have elevated the designation of an observed property of ice to the character of a principle in physics. The growth of crystals of camphor and of iodide of cyanogen, by the deposition of solid matter upon them from an atmosphere unable to deposit like solid matter upon the surrounding glass, except at a lower temperature; and that of crystals in solution, by the deposition of solid matter upon them which is not deposited elsewhere in the solution, have been adduced by Mr. Faraday to illustrate the extension of the principle of action which is manifested in regelation; and "many such like cases," he remarks, "may be produced." In his reasoning on the

nature of that principle, he also rests on the fact, that ice has the same property as camphor, sulphur, phosphorus, metals, &c., which cause the deposition of solid particles upon them from the surrounding fluid, that would not have been so deposited without the presence of the previous solid portions.*

In reflecting on these indications of the universality of the cause, whatever it may intrinsically be, which is operative in the phenomena alluded to, it occurred to me that the known fact of the incorporation of two or more plates of glass into one block, presented a curious parallel to the incorporation of two or more slabs or separate portions of ice into one mass; and to determine in what manner these subjects were related to each other appeared to deserve careful investigation. Towards this the following suggestions are offered:—

Certain substances, both elementary and compound, appear to present, in what we term the solid state, phenomena corresponding to those which are presented by others in the liquid and solid states and the transitions from one to the other collectively regarded, and indicating the existence of a condition of matter which may be termed arrested liquidity, but yet is not, in the most perfect sense, solidity. Of these bodies glass is one. The fact in question, which exemplifies in a striking manner the property here alluded to, appears to have been first noticed as a subject of scientific importance by MM. Pouillet and Clement Desormes.† It is the incorporation, into one mass, of two or more plates of the kind of glass manufactured for mirrors, and called *plate-glass*, the polished surfaces of which have been placed, and have remained for some considerable time, at common temperatures, in close contact with each other, the entire area of one plate being in contact with the entire area of the contiguous one,—extensive mutual surfaces of contact being thus supplied. Under these circumstances, two, three, or four, or even a greater number of plates become converted into one block of glass, which it is impossible to separate into the original plates, and which may be worked, and even cut with a diamond, as if the whole had originally been a single mass. In some specimens which I have examined, with the surface of one plate were incorporated portions of another, the surfaces of fracture of

* Exp. Res. in Chemistry and Physics, pp. 380, 381.

† As far as my reading extends, it was first recorded by Pouillet in his 'Elémens de Physique,' liv. vi. ch. ii. 2me édit. Paris, 1832, tome iii. p. 41 (Bruxelles, 1836, p. 292). In the fourth edition, Paris, 1844, it appears to be omitted, together with other and established facts relating both to glass and to metals.

which were alone exposed, its substance having been torn through in the effort to separate the united plates by mechanical force.* The same effect took place in some experiments by Clement Desormes.

I assume it to be highly probable that the process by which the two plates of glass become one, is, in reality, analogous to that of regelation in ice, and finally dependent on the same principles, whatever their true character may be conceived or shall ultimately be determined to be. To this it may be objected, however, that there is no evidence, in the case of the glass, of the previous liquefaction, or even approach to liquefaction, of the surfaces which become united so as entirely to disappear (or, more properly speaking, to be altogether obliterated), and that the phenomenon is referable simply to the homogeneous attraction of the molecules of one plate for those of the contiguous one, the evenness of the two polished surfaces allowing them to be brought within a very minute distance of one another. But two remarkable facts greatly diminish the weight of this objection, if, indeed, they do not entirely remove it. First, unpolished plates of glass have no tendency to unite; the hard and compact siliceous film, to which Prof. Faraday, regarding glass "as a solution of different substances one in another," long ago referred its power of resisting agents generally,† and which previously bound together the outer molecules of each plate, must be removed by grinding and polishing, so as to render the actual surfaces of contact those of portions of the glass, the chemical nature and condition of which are such as readily to admit of their rapid mutual action and union into one mass. Secondly, the polished plates sometimes have the forms and configurations of the surfaces of straw and other packing-materials impressed upon them (portions of straw, paper, &c., sometimes adhering inseparably to the glass, after having been taken to hot climates),‡ *in consequence of the soft nature of the substance* exposed by the polishing, or of its nature being such as readily to soften by a temperature very much below that of the proper fusion, or even softening, of the glass in its integrity. The state of the interior portions of a plate of plate-glass appears, therefore, to be similar

* These and other facts of a similar nature I adduced as illustrative of the physical nature of glass, in lectures on that substance delivered before the Pharmaceutical Society of London in the year 1845. See Pharm. Journ. vol. v. (Oct. 1845) pp. 157–160.

† Phil. Trans. 1830; Exp. Res. in Chem. and Phys. p. 282.

‡ These particular facts were communicated to me by Mr. Tite, F.R.S., who had himself observed them.

to that of glass in general at certain temperatures much below its fusing-point, when it presents such remarkable characters of plasticity, tenacity, and ductility.*

Is it possible that a lowering of the melting-point of glass, or of the exposed interior portions of it, by pressure, is concerned in the union of the two plates? The effect of the mere pressure of the atmosphere, ensuing upon the exclusion of the air from between the closely apposed plates, would of course be insignificant in depressing the temperature of fusion of the glass; but the pressure occasioned by the cohesive force—exerted, it will be remembered, through a very small thickness only of the material,—which finally unites two or more plates into one block, would probably be adequate to any conceivable effect of this nature which can be required for the production of the phenomenon observed.

It may appear at first sight, that the fact that glass belongs to that class of bodies which contract on passing from the liquid to the solid state, and the melting-point of which, therefore, would be elevated—not depressed—by pressure, is opposed to this possibility. The objection would be a valid one were we now concerned with glass in a crystalline state. But we are treating of that substance in its familiar and ordinary condition, into which it passes from liquidity by a continuous gradation of temperature, through equally continuous states of softness into the solid form, like melted phosphorus and selenium.

I am now tempted to ask, in conclusion of this part of the subject, Are all cases of the union of two apparently solid surfaces of the same substance by cohesive attraction, cases of melting and regelation, an infinitesimally thin film of liquid being momentarily produced and as instantly solidified? Will two surfaces of perfectly dry ice, at temperatures much below 32°, but under favourable mechanical circumstances, unite by mere apposition and pressure (which ought to follow from Prof. James Thomson's theory), and thus prove the identity of the acting principle in the two cases of ice and plate-glass?

The negative of the last question does not appear to be proved by

* We are reminded by these facts of the view taken by Person, and adopted by Prof. Forbes, of the similarity of the liquefaction of ice to that of fatty bodies or of the metals, "all which in melting pass through intermediate stages of softness or viscosity;" and Sir J. F. W. Herschel (Art. "Meteorology," par. 119, Enc. Brit. eighth edit.), when he terms regelation "a sort of welding," appears to concur in this view.

the fact cited by Faraday and Tyndall, that dry, hard-frozen snow has not the property of becoming compacted into a snow-ball. The cases seem not to be comparable, because the brittleness of the constituent crystals of snow when in this state, its porous nature as a whole, and its being consequently pervaded by air, will prevent the required apposition of surfaces. Nor, as I conceive, is it proved by Prof. Tyndall's most instructive experiment of crushing a ball of ice, cooled by carbonic acid and ether, into white and opaque hard fragments ; for in this also the required apposition of surfaces would be wanting. Further, it may be asked, whether this very experiment does not demonstrate the limitation of the lowering of the melting or freezing-point by pressure? and if so, there can be no tendency to union at 100° below freezing.

In discussing the philosophy of the union of two surfaces of glass, I have alluded to the theory of regelation enunciated by Prof. J. Thomson; but I wish to be understood as not adopting, exclusively, in these notes, any existing theory on the subject. Admitting the operation of cohesive attraction and consequent pressure in the first instance, the phenomenon, with respect to glass, readily admits of explanation by the original view of Mr. Faraday, which is, "that a film of water must possess the property of freezing when placed between two sets of icy particles, though it will not be affected by a single set of particles." If we regard the two apposed surfaces of glass, each consisting of a thin stratum of particles, taken together, as representing the film of water, then the other strata of particles in contact with them respectively, and making up the entire thickness of the plate on each side, will correspond to the two sets of icy particles, the action of which by freezing the film of water effects the union of the two portions of ice, and the phenomenon may be consistently explained in the terms of Mr. Faraday's theory. And here we seem to find points of coincidence between cohesive force, as ordinarily considered, the principle of regelation, and that particular view of the former which has been announced by Mr. Faraday in accounting for the phenomena presented by and connected with the latter.

2. But we are led by the preceding facts and considerations to some further inferences, if not indeed to a definite hypothesis, upon the subject of the molecular constitution or physical nature of glass. Mr. Faraday's view of it has been cited already; he regards glass,

it will be remembered, "as a solution of different substances one in another." Prof. Maskelyne has suggested to me, in conversation, that the physical nature of glass most probably nearly resembles that of a solution of a crystallizable salt in water, immediately before crystallizing. These views are evidently coherent, and they harmonize with Prof. Graham's, who defines glass, chemically, as "a mixture of silicates."* But they all relate to the varieties of glass in common use, while we are concerned, at present, with the abstract vitreous condition of matter, such as it is represented by the phosphoric and boracic acids, probably by the heavy optical glass of Faraday, by the simplest glasses of felspar and peridote obtained by Charles Deville, by the glassy condition of silica, natural and artificial, and still more perfectly, perhaps, by the glassy form of sugar.

Bearing in mind then the homogeneous, or comparatively homogeneous, nature of these glasses, and considering the uniformity of texture which the acoustic as well as the optical characters of perfect glass in general evince, especially when contrasted with that of crystalline plates in the acoustic researches of Savart, and how strongly distinguished that texture is from a crystalline texture or structure,—a nearer analogy than that of a solution ready to crystallize, I think, will be found in the condition of water cooled below the freezing-point but still remaining liquid, until by a tremor, or the percussive contact of a solid body, or the mere contact of a crystal of ice, its temperature rises to 32° and it becomes ice. If so, glass will be a substance in which this state of arrested liquidity, or potential solidity, is permanent. And this inference will harmonize with known facts. Gregory Watt proved that heat is evolved when mineral glasses crystallize or become (permanently and truly) solid.† The preparation of sugar called barley-sugar is the vitreous condi-

* These views of Mr. Faraday, Mr. Maskelyne, and Mr. Graham, are confirmed by the experimental evidence of the structure of glass obtained by Leydolt, to whose researches Professor W. H. Millar of Cambridge had the kindness to direct me. By etching the surface of glass, he found it to have a porphyritic structure, consisting of crystals imbedded in an amorphous substance. But the peculiar characters of glass, especially its relations to sound and light, evince, as indicated in the sequel, that it is not a congeries of ready-formed crystals, though in all probability crystals will always be found on its surface. The amorphous substance recognized by Leydolt will answer, nearly, to what I shall call "simple glass." Other facts which he observed are perfectly in harmony with our previous knowledge of the dependence of the texture of glass upon the rate of cooling. See Comptes Rendus, tome xxxiv. (1852, April 12) p. 565.

† Phil. Trans. 1804, pp. 285-290.

tion of that body, already taken as a type of simple glass; while granular sugar, and more perfectly sugar-candy, exhibit its crystalline state. Prof. Graham has shown that, at a certain temperature, by mechanical means the former may be converted into the latter, the temperature quickly rising 70° on the transition of the sugar from the glassy to the crystalline state. This and similar facts induced him to refer the peculiar constitution and properties of glass in general to the permanent retention of a certain quantity of heat in a latent state, which becomes sensible on its crystallization; and this will take place on its being preserved in a soft state at certain temperatures.

There are some remarkable and instructive parallels between the phenomena of the crystallization of water, and that of glass and some other bodies. It follows from the experiments and inductions of Gregory Watt already cited, that during the crystallization of glass a higher temperature must be communicated to the interior than that existing over its surface, by the evolution of heat at the points where the crystalline form is assumed, which will be gradually conducted throughout the mass. So that, in the express words of Faraday, in relation to ice, "by virtue of the solidifying [crystallizing] power at points of contact, the same mass may be freezing and thawing at the same moment;" and the "freezing process in the inside may be a thawing process on the outside," and thus contribute to the slowness of the cooling, and allow the crystallization therefore to be the more perfect. We here seem to have the explanation of the well-known fact, that in bodies which crystallize from a state of igneous fusion, the most perfect crystalline state is produced when the longest time intervenes between the commencement of solidification (now using that term in its ordinary sense) and the complete cooling of the melted mass. The cases cited from Mr. Faraday at the beginning of this paper, of the growth of crystals (including those of ice in ice-cold water) in solutions, all have their exact parallels in the accretion of crystals in cooling melted glass. "Crystals of ice," Mr. Faraday observes, "which could not be colder than the surrounding fluid, exhibited the phenomena of regelation." —that is, of incorporation into one—"when purposely brought in contact with each other." The same thing happens with melted glass slowly cooling, in which crystalline spherules, often forming spontaneously and independently, continue to form and to increase, even after the glass has become solid as such, by the operation of a principle in this view analogous to regelation, until the entire mass has become crystalline.*

3. No crystalline body has been longer or more extensively subject to human observation, than crystallized water, or ice. Its natural history and properties, as science has advanced, have been investigated with increasing generality and precision; and they have finally become objects of that systematic and exact research which characterizes the present era of physical inquiry,—as is evinced by the discussion on regelation, to which these notes are intended to be supplementary. A most remarkable deficiency, however, still remains, apparently, in our knowledge of this substance:—*Water in the vitreous condition—Ice-glass—has never been observed.* While we know the antithetical vitreous state of so many different crystallized substances—minerals produced by heat, salts deposited from aqueous solution, neutral bodies of organic origin—and have great reason to believe that that antithetical condition to crystallization is universal, we have no knowledge of it in relation to water or ice. My own attention has been awake to the subject, without success, for many years. It would seem to be scarcely within the bounds of possibility that the glassy state of water, if possessing what we term solidity, should not, ere now, either have been observed in nature, or have occurred and been recognized in experimental research.†

* If we should prefer to adopt Mr. Maskelyne's suggestion in a formal manner, and regard glass as resembling a solution about to crystallize, its analogue, agreeably to the preceeding views, will be a saturated solution of a salt in hot water, allowed to cool undisturbed, and remaining fluid, until its cohesion is affected, when its temperature rises, and the salt crystallizes. Specimens of glass are common which have the aspect and distribution of parts of a crystallized salt in the mother-liquor; opaque crystallized spherules appearing in the midst of a transparent mass. To these correspond, among natural glasses, pitchstone and many examples of porphyritic obsidian, consisting of a vitreous base in which crystals have been formed and are imbedded.

But at the same time the view I have taken of the subject, and Mr. Maskelyne's may be equally tenable; for the state of water remaining liquid at temperatures below 32°, and that of saline solutions remaining uncrystallized at temperatures below those of solidification, are evidently closely analogous.

Should I return to this subject, I shall refer to my friend Mr. Sorby's observations on the nature of glass, which I had not read when these notes were communicated to the Royal Society, but which are in entire agreement with the views I have suggested.—See Quart. Journ. of Geol. Soc. vol. xiv. p. 465.

† The crushed fragments of the ball of ice cooled in carbonic acid and ether, in Prof. Tyndall's experiment already mentioned, which "remained *white* and *opaque* as those of crushed glass," were still, he informs me, perfectly crystalline, resembling fragments of quartz.

The "points of analogy between the molecular structure of ice and glass" noticed by

I now venture to submit the inquiry, Does this apparent deficiency in our knowledge exist because—to use language recently introduced into physical science—the *homologue* of the glassy state of water is not what we ordinarily term solid—because the state of water cooled below 32° but still liquid is in fact the state which corresponds to the vitreous condition of other bodies, and to the physical nature of perfect ordinary glass? Is the one simply a case of potential solidity, and the other of the confluent or equivalent state of arrested liquidity?

It may be said that the homology which is here endeavoured to be established between liquid water below 32° and glass, is a forced one. That, in relation to each other, these are extreme cases is perfectly true; but intermediate terms of the series are not wanting, and some of them are supplied by sulphur and phosphorus, and in a remarkable manner by selenium. All these bodies, when melted, may be cooled many degrees below their freezing-points and yet remain fluid. Sulphur presents, in its viscid form, an approach to the glassy condition; but it may be obtained in the crystalline form on passing from a state of fusion, and when cooled below freezing, instantaneously crystallizes, like water, by mechanical disturbance.

In phosphorus also there is the viscid state; and when cooling after fusion, it passes gradually, like glass, from the liquid to the solid condition without crystallizing, though crystals are deposited from some of its solutions. Selenium presents a state resembling the viscid state of the preceding substances; but when melted, and left to cool remains fluid below its melting-point, and solidifies very gradually in its amorphous state (in which it has some of the characteristic properties of glass), and a thermometer immersed in it during the cooling does not remain stationary at any point, or indicate any temperature at which heat is evolved by molecular change in the substance, —as if the selenium passed continuously from the liquid glassy state to that of solid glass. At ordinary temperatures it retains this condition for a long time—as common glass does at higher, and as water and sulphur will at lower temperatures; but when heated again, between a certain temperature and its melting-point it becomes cry-

Mr. Drummond (Phil. Mag., August 1859, S. 4. vol. xviii. pp. 102—103) do not involve the physical condition of those bodies, but relate merely to the resemblance of one crystallized substance (ice) to another (Reaumur's porcelain), and of both to a third body (bottle- and window-glass), which, from its optical characters, is inferred—I thing inconsequentially—to have assumed a state preparatory to crystallization.

stalline and gives out great heat.* When glass is raised to a certain temperature, and by its maintenance is preserved in a soft state, it does the same.

In sulphur, phosphorus, and selenium, therefore, the fluid state below the temperature of solidification—the intermediate condition between fluidity and solidity—the viscid state long retained—the solid state of selenium which evolves heat on crystallizing—all appears to be homologues, at once, of liquid water below 32°, and of the glassy state of matter.

Should this hypothesis be verified, water below 32°, or rather, perhaps, from the temperature of maximum density downwards through that of freezing, may have to be regarded as the type of the vitreous condition of matter; and the causes of the peculiar characters of that condition, its effects on the transmission of the vibrations of sound and light, the conchoidal fracture, &c., may have to be discovered by researches on its molecular nature.

SCIENTIFIC AND LITERARY NOTES.

MINERALOGY AND GEOLOGY.

TABLES FOR CALCULATING THE THICKNESS, ETC., OF INCLINED STRATA.

In our last series of Notes (Vol. V., p. 544,) we gave a method of calculating approximately the thickness of inclined strata when the dip does not exceed five degrees.† The annexed Tables were drawn up to accompany the note in question, but were omitted from want of space. The angles of dip from 1° to 89° are contained in column *A*. The second column, *B*, shows the thickness in feet, corres-

* These properties of selenium are here stated on the authority of Hittorff, cited in Graham's "Elements of Chemistry," second edition, vol. ii. pp. 688, 689.

The case of vanadic acid strongly resembles that of selenium, but extends this series of concurrent phenomena to a range of temperatures nearly approaching those which govern the molecular changes of glass. It fuses at a red heat, and crystallizes on cooling, but remains fluid below its freezing-point. At the moment solidification commences, it again becomes red-hot, and remains so as long as crystallization continues.

The crystallization of glass, it has been seen, takes place at a high temperature, from the ordinary state of solidity, heat being evolved. So the glassy varieties of gadolinite (like glass, a silicate with a compound base), when its temperature is elevated above redness, remains solid, but evolves heat (becoming incandescent), and crystallizes: while the crystalline variety merely fuses and intumesces when similarly treated.

† The words "when the dip does not exceed 5°", were accidentally omitted in the note referred to. The reader is therefore requested to insert them after the word "strata" in the first line. (vol. v., page 544.)

ponding to the dip in column *A*, for each mile of distance. If, therefore, a set of strata, dipping at 23°, measure six miles across the strike, the thickness will be 12378 feet (= 2063 × 6). The third column, *C*, gives the thickness in parts of a foot for each foot of distance (or in parts of a yard for each yard, etc.); and the fourth column, *D*, shows the depth (in parts of a foot, yard, etc., for each foot, yard, or other unit of measurement), at which an inclined bed will be reached by vertical sinking at a given distance from its outcrop.† The figu s in these two last columns are, of course, nothing more than the sines and tangents respectively of the corresponding degrees of dip in column *A*.

A.	B.	C.	D.	A.	B.	C.	D.	A.	B.	C.	D.
Dip in Degrees.	Thickness in feet per mile.	Thickness in parts of a foot per foot.	Depth from Surface. See above.	Dip in Degrees.	Thickness in feet per mile.	Thickness in parts of a foot per foot.	Depth from Surface. See above.	Dip in Degrees.	Thickness in feet per mile.	Thickness in parts of a foot per foot.	Depth from Surface. See above.
1°	92 15	·0174	·0174	31°	2718·4	·5150	·6008	61°	4618·0	·8746	1·804
2	184·27	·0349	·0349	32	2798·0	·5299	·6248	62	4661·9	·8829	1·880
3	276·33	·0523	·0524	33	2875·7	·5446	·6494	63	4704·5	·8910	1·962
4	368·32	·0697	·0699	34	2952·5	·5591	·6745	64	4745·6	·8988	2·050
5	460·18	·0871	0874	35	3028·5	·5735	·7002	65	4785·3	·9063	2·144
6	551 91	·1045	·1051	36	3103·5	·5877	·7265	66	4823·5	·9135	2·246
7	643·47	·1218	·1227	37	3177·6	·6018	·7535	67	4860·3	·9205	2·355
8	734·83	·1391	·1405	38	3250·7	·6156	·7812	68	4895·5	·9271	2·475
9	825·98	·1564	·1583	39	3322·8	·6293	·8097	69	4929·3	·9335	2·605
10	916·86	·1736	·1763	40	3393·9	·6427	·8391	70	4961·6	·9396	2·747
11	1007·5	·1908	·1943	41	3464·0	·6560	·8692	71	4992·3	·9455	2·904
12	1097·8	·2079	·2125	42	3533·0	·6691	·9004	72	5021·6	·9510	3·077
13	1187·7	·2249	·2308	43	3600·9	·6820	·9325	73	5049·3	·9563	3·270
14	1277·3	·2419	·2493	44	3667 8	·6946	·9656	74	5075·5	·9612	3·487
15	1366·5	·2588	·2679	45	3733·5	·7071	1·000	75	5100·1	·9659	3·732
16	1455·3	·2756	·2867	46	3798·1	·7193	1·035	76	5123·2	·9703	4·011
17	1543·7	·2923	·3057	47	3861·5	·7313	1·072	77	5144·7	·9743	4·331
18	1631·6	·3090	·3249	48	3923·8	·7431	1·110	78	5164·6	·9781	4·704
19	1719·0	·3255	·3443	49	3084·9	·7547	1·150	79	5183·0	·9816	5·144
20	1805·9	·3420	·3639	50	3987·7	·7660	1·191	80	5199·8	·9848	5·671
21	1892·2	·3583	·3838	51	4103·3	·7771	1·235	81	5215·0	·9876	6·313
22	1977·9	·3746	·4040	52	4160·7	·7880	1·280	82	5228·6	·9902	7·115
23	2063·0	·3907	·4244	53	4216·8	·7986	1·327	83	5240·6	·9925	8·144
24	2147·6	·4067	·4452	54	4271·6	·8090	1·376	84	5251·1	·9945	9·514
25	2231·4	·4226	·4663	55	4325·1	·8191	1·428	85	5259·9	·9961	11·430
26	2314·6	·4383	·4877	56	4377·5	·8290	1·482	86	5267·1	·9975	14·300
27	2397·1	·4540	·5095	57	4428·2	·8386	1·539	87	5272·8	·9986	19·081
28	2478·8	·4694	·5317	58	4477·7	·8480	1·600	88	5276·8	·9993	28·636
29	2559·8	·4848	·5543	59	4525·8	8571	1·664	89	5279·2	·9998	57·290
30	2640 0	·5000	·5773	60	4572·6	·8660	1·732				

E. J. C.

MISCELLANEOUS.

NORTH-WEST TERRITORY.

In the last number of the Journal, (Vol. v. page 545 *et seq*,) we inserted an interesting article from the American Journal of Science and Arts, on the recent Canadian expeditions to the North-west Territory. A foot-note in this article, in reference to the late astronomer David Thompson, reads as follows:

"Thompson was from 1790, over 30 years in the employ of the Hudson's Bay

* This necessarily supposes the surface level to remain unchanged. If the one spot be lower or higher than the other, the difference must be deducted from, or added to, the depth obtained.

Company, and he reports of his explorations, (37 vols.) are deposited in the Archives of this Company. From fragments of them, it appears that Thompson possessed a great knowledge of the country, but it is doubtful whether these reports will ever be accessible to such as are not connected with the Company. Hitherto, the company has kept them back."

We now learn from ANDREW RUSSELL, ESQ., of Quebec, Assistant Commissioner of Crown Lands, that copies of Thompson's field-books of his explorations, are in the records of that Department. Mr. Russell has also obligingly furnished us with some extracts from Thompson's "Narrative" of his Expeditions. These will be published in an early number of the Journal. From some remarks prefixed by Mr. Russell to the extracts in question, it appears that Thompson was in the employment of the Hudson's Bay Company for thirteen years; and afterwards, for a period of fifteen years in that of the North-west company. He was, subsequently, for ten years, as Astronomer and Surveyor, on the Commission relative to the boundary between the British Possessions and the United States.

IRON-CASED FRIGATES.

The great experiment of iron-cased ships, now being carried on by the respective governments of Great Britain and France, will probably prove the inauguration of a new era in naval warfare. Few questions are attracting so large a share of public attention in those countries; and, so far as British interests are concerned, the subject is one, indeed, of paramount importance. Hence the accompanying article from an English journal, drawn up by one of practical acquaintance with the subject on which he writes, may not be thought an unworthy addition to our pages.

Another re-construction of the British navy is now imminent. It is not many months since it was announced in the Queen's Speech that the navy was to be re-constructed, and screw steamers have since that time superseded the old sailing three-deckers. No sooner has this great change been affected than we are again doomed to the mortification of hearing that all this additional expense has been thrown away; for in the words of the Secretary of the Admiralty, at the close of last session, "The French are building ten iron-cased ships, while we are only building four iron-cased frigates." We cannot permit the Emperor of the French, though he discourses at Marseilles so eloquently about "the olives of peace," to be ahead of us in this matter; for if ten iron-cased ships are necessary for the protection of France, which has a landed frontier for more than half of its extent, at least half as many more are necessary for the defence of our sea-girt island, putting altogether out of question any consideration of our colonies. Iron-clad ships are therefore a necessity. Economists may protest against the great expense which they will involve, and poets may sigh over the abandonment of our "wooden walls," and sailors may no longer sing, "The hollow oak our palace is;" but, if "our heritage" is to be the sea, ships in armour must be its guardians. Massive Goliaths, defiant in their strength and conscious of their comparative invulnerability, must form part of our Channel fleets for the present, and in a short time be the only sentinels to guard our coast. Three of these mail-clad vessels now float upon French waters, and, like the champion of the Philistines, are said to laugh to scorn the sling and the stone of our unprotected three-deckers and frigates. *La Gloire, Pallas,* and *La Normandie* are already "great facts" on the other side of the Channel; the *Magenta* and the *Solferino* are on the stocks at Brest and L'Orient; the *Jennapes* is in process of conversion, and five others are far advanced. *La Gloire* has, it is said, succeeded admirably. She made 13½ knots upon her trial trip, is said to be very steady, and the experiment is pronounced in every respect satisfactory. She can carry seven days' coal, 500 rounds per gun, and her portholes are six feet clear of the water in an ordinary seaway. The *Normandie* will soon be ready for launching and steaming from Cherbourg, and the *Pallas* is being fitted out with great activity. The *Jennapes*, like the *Gloire* and her sister ships, is merely an old hull covered with iron plates, but instead of having the plates wall sided, like our floating batteries, and which can be pierced by the balls from the Armstrong or Paixhan heavy guns, she will have her sides built on a curve, and fluted at intervals, so that the shot will rarely strike on a flat surface. Of the *Magenta* and *Solferino* all that is permitted to be known of them is, that below water their hull is similar to that of ships on the old model, and their scantling is that of our 80-gun ships. The novelty consists in the form of the cutwater, which forms a straight line up to the surface of the water, forming an acute angle with the keel; it then recedes with a backward curve, and joins the bows, to which it is firmly attached by stout iron-cased timbers. The angular extremity of the cutwater, which is about fifteen feet from the bows, is of oak, and is to be fitted with a large conical spur in wrought iron. Of these vessels a French journal states that "Two of them placed on the coast of Ceuta would completely paralyse the guns of Gibraltar, and would be masters of the pillars of Hercules." This may be taken not merely as an opinion of the formidable qualities of these ships, but of the purposes to which they may probably be applied.

To meet this new description of vessels we have, at the present moment, four iron clad ships in hand, and a fifth, which is about to be commenced at Chatham. We have six iron floating batteries, which were built during the Russian war, but the French have the same number, and some of these saw actual service at Kinburn, while ours have not had the same good fortune. They are the ugliest and clumsiest looking craft afloat, they are barely floating, certainly not sailing, batteries; their movements are of the slowest description, and in a rough sea they would founder, but they are practically invulnerable. They present but a small surface to the enemy, and are fitted with ordnance of the largest calibre. They would, no doubt, be serviceable in the Medway, where they are at present stationed, in the event of any hostile fleet attempting to steam up the Thames. The French have, it is true, got a little start of us, inasmuch as they have three iron-cased ships afloat, one of which has been equipped for sea. This advantage, however, is only a temporary one; for fortunately for this country, ships of this class, to be really efficient and permanent, required to be built entirely of iron, while the French vessels are really nothing more than old wooden hulls, with iron plates attached to them. *La Gloire* is but the old *Napoleon*, with her upper decks taken off, and her sides plated. The four ships which we have on hand are new throughout, iron built, and the frigates will be the fastest ships in the navy. The *Warrior* and the *Black Prince* are now fast approaching completion; the former is being built at the works of the Thames Ship Building Company, the other at the Clyde, by Messrs. Napier and Company. The *Warrior* was commenced in the month of June, 1859. and it is expected that she will be ready for launching on the 15th of December, though it is not improbable it may be a few weeks latter.* The ship, as well as the sister one in course of construction by Messrs. Napier on the Clyde, is not intended, as many persons suppose, like the ancient galleys, with power increased a thousand-fold, to run down anything which floats on the water, and is rash enough to be an opponent. It was originally intended to have built these two vessels of such a form and strength as to have made them available as "rams." As originally designed the bows of the ship were drawn after the outline of the lower part of the neck and breast of a swan when swimming, so that the point which would strike an enemy's vessel would be the breast which was under the water-line. The bows in this case would have formed an obtuse angle, the point of which would have been almost level with the water, and receding back at a rather sharp slope. This arrangement was to have been concealed with the usual figure-head and forward gear, as it was thought the enemy might be deceived by its appearance, and imagine it was nothing more than an ordinary ship. This notion, however, was soon abandoned; a trick of this sort was considered hardly worthy of being resorted to, even if it could have been for a moment successful. It would not have been easy to have deceived any naval man, who had any amount of experience or common sense, by the mere ornament of a figure head, as to the real character of a ship of more than 6,000 tons, nearly 400 feet long, and carrying only a broadside of 18 guns on her main deck. This idea as therefore soon abandoned, and the *Warrior* will appear honestly and fearlessly as an iron clad frigate, or corvette, carrying 36 main deck and two pivot guns. She is throughout an iron steamship, of most unusual strength, however, formed of plates ⅝ of an inch in thickness. She has an even keel, and the plates at the bottom are 1¼ inch in thickness. Her length over all is 420 feet, about two thirds the length of the *Great Eastern*; her length between perpendiculars is 380 feet, extreme breadth 58 feet, extreme depth 42 feet. Her tonnage is 6,117 tons, and she will have screw engines of 1,250 horse-power, and these, with the boilers and armaments, will give a total weight of considerably more than 10,000 tons. The lines upon which this frigate have been built are exceedingly fine, both fore and aft, and there is no reason whatever for supposing that she will not make fourteen knots an hour. Assuming that the performance of the *Gloire* has been correctly reported, and that she really made 13½ knots and not miles, the *Warrior* would still be a faster ship. One point of superiority of the *Warrior* over the French ship is that the portholes are nine feet above the water, those of the *Gloire* being only six feet, and in a rough sea could not be worked. This is a very important feature in favor of our frigates; added to this fact that the *Warrior* and *Black Prince*, and the two steam rams, are built entirely of iron. There will be no trouble in these ships with respect to unseasoned or unsound timber, and the effects of the shot will not tell upon them

* Recent English papers convey information of the actual launch of the *Warrior* on the 29th of that month.

so severely as in the case of the wooden-plated ships of the French. An examination recently made of the *Trusty*, one of our iron-plated floating batteries, upon which experiments were tried, has shown that her timbers have been very much injured by the great shaking she underwent from the concussion of the shot from the Armstrong guns. The *Sirius*, also, upon the sides of which some plates were fixed for the purpose of experiment, before finally deciding upon the form to be given to those of the *Warrior*, also affords unmistakeable evidence of the shock to her timbers. The plates fixed on to the *Sirius* were fired at with old 68-pound shot, and at a short range the plates stood the shock well, and many persons supposed that a ship cased with this would have been perfectly protected against the fire of the heaviest sea ordnance. A close inspection of the interior, however, has thoroughly dispelled any such notion. Where the shot penetrated and passed through the iron plate as well as the vessel's side, the injury done has been actually less than when the penetration was less complete. In those parts where the plates have successfully resisted the shot, the timbers behind are driven into lathwood, the bolts are drawn, and the massive timber knees of the vessel were snapped asunder by the shock on the plate. So complete has been the destruction of the timber-work, that the vessel could not be repaired except in a dock, and until thoroughly repaired, a ship so struck would leak like a sieve and rapidly sink. The outer covering being of iron, it is, of course, impossible to repair her from the outside, while it would be hopeless to attempt to patch up her shattered timbers inside. The hurry with which the old French ships have been covered with iron plates may, after all, illustrate the fable of the hare and the tortoise in the old proverb, "The race is not always to the swift."

The shell of the *Warrior* and of the *Black Prince* is built, as we have stated, entirely of wrought scrap iron. The keel, or portion to which the ribs are bolted, is formed of immense slabs of 3ft. 6in. deep, and are 1½ inch thick. The ribs, which spring from this are wrought iron T-shaped beams, made in joints of 5ft. in length by 2ft. in depth. They are placed 3ft. 8in. apart, except for a distance of 10ft. on each side of the keel, where they are bolted at half this distance apart. The main and upper decks are of iron, covered with timber, and the orlop deck is of timber. The decks are supported by rolled wrought iron girders of enormous strength. Along the entire length of the vessel, from stem to stern, there are solid wrought iron beams placed at intervals of 5ft. inside the ribs, and these again are strengthened by cross girders. The bows and stern of the ship are divided into twenty-seven water-tight compartments, and are shut off from the engine room and fighting portion of the ship by wrought iron transverse bulkheads. As the armour is not intended to cover the whole of the ship, these compartments will afford increased security to the ship. They may be riddled with shot in every direction without affecting the safety of the ship, nay, even the bows and stern may be shot clean away and the centre would still remain a floating battery 210ft. in length, 27ft. in depth, and 58ft. wide. The rig of the *Warrior* will be that of an 80-gun ship, and she will be armed with Armstrong's heaviest guns. The armour of the frigate consists of plates of hammered iron four-and-a-half inches in thickness. One cause of the delay which has occurred in the completion of the ship has been the experiments which have been made in order to decide upon the best form and material for the outer covering. The tests which were applied to the plates furnished by the builders of the *Warrior* were of the most trying character, as shown by the effects of the *Sirius*, already referred to. Some plates were fired at with 68-pounders, at 200 yards' range, and were literally cut in half by balls fired one after another, on a line drawn on the surface, each ball striking immediately below its predecessor. Upon some other plates the ball made a circular indentation upon the surface, nearly as deep as the plates, exactly of the form of the projectile, and as though a mould had been taken of it in some soft and yielding substance. It was only after repeated trials that it was decided that the plates should be of annealed scrap iron. The labour involved in building up these plates is enormous. In the first instance small scraps of iron are thrown into the fires, and when in a state of red heat, are subjected to severe hammering, under the steam hammer, until the whole is beaten and amalgamated into a solid mass of about half a ton weight. This lump is then placed on the top of a similar mass, the whole made red hot, and hammered and welded together. Repeated additions of this kind are made, until about five tons of metal are thus welded together in one huge shapeless body. This is then brought to a glowing white heat, placed under the huge hammer, the thundering blows of which gradually reduce it into shape. Again and again the enormous slab is put into the furnace and hammered into one piece of fifteen feet long, three wide, and 4½ inches thick. From ten to a dozen men are engaged in the work of moving these ponderous masses of iron, which are moved about apparently with the most perfect ease. Powerful cranes swing the molten mass from the furnaces to the hammer, a nicely adjusted balance is provided by a massive iron lever, one end of which is welded into and forms part of the metal, and this is provided with a dozen or more of horns or handles, by which the iron can be turned in any direction; for the plates are not only hammered on the broad surface, but at the sides, and at the top and bottom. The plates, after having been roughly formed into shape, are completely planed and squared. Planing machines of enormous size hug these plates in their resistless arm, and bear them slowly and silently under the sharp cutting edges of the tools, and thin shavings of the metal, which, as they are cut, coil up in long bright ringlets of iron, attest the tremendous power of these noiseless and all but omnipotent machines. When the edges and surfaces are made perfectly smooth as the finest work of the cabinet maker, the plates are placed on an end, gripped firmly by a mortising machine, and as they travel slowly backwards and forwards in the framework, against a small tongue of steel, a groove of about an inch in width and depth is formed, into which the corresponding projections formed on the side of another plate will fit with the most perfect accuracy, the plates being all *made to dovetail* on each of the four sides.

The cost at which this armour-clad ship will be built is not much more than would be the cost of an oak timber-built ship of the same tonnage. The price at which the contract was taken was £40 per ton, the cost of an ordinary 80-gun timber ship is £37 17s. 6d. per ton. Not only is the *Warrior* an iron-built ship from stem to stern, but she is covered with 18 inches of teak timber over nearly

12,000 square feet of surface, and it is upon this bed of timber, itself reposing upon the iron sides of the ship, that the armour plates are to be fixed. These outer plates will be secured by iron bolts thirty-seven inches in lingth, which pass through the 4½ inches of iron plates, 18 inches of teak, five-eighths of an inch of iron forming the shell proper of the ship; and, finally, about nine inches of timber, which forms the inside lining of various portions of the structure. To the cost of the hull is to be added that of the engines of 1,200 horse power; these, however, will cost no more than would the engines of an ordinary screw line-of-battle ship, viz., about £72,000, at the rate of £60 for each horse power. The cost of the engines and ship will be about £300,000. The ordnance and stores probably about the same as an 80-gun ship, as all the guns will be Armstrong's, of the heaviest calibre. If the *Warrior* accomplish what may fairly be expected of her, she will be the cheapest ship in the navy. The Thames Shipbuilding Company, by whom she is built, have now adapted their machinery to the work required, and a sister ship would no doubt be built in half the time which has been taken up in constructing the *Warrior*. It is stated that the Government have ordered an iron-plated ship to be commenced forthwith at Chatham, in the royal dockyard, and it would be curious to ascertain whether a ship of this class can be constructed more cheaply there than in a private yard. The Admiralty have appointed four inspectors, who narrowly watch the progress of the works, and examine every portion of the iron work and timber before it is put into the ship. Mr. Hardy, the superintendent of the works, and Mr. Ash, the company's chief draughtsman, have devoted great time and attention to the work, and the ship, when completed, will, without any doubt, serve to keep up the high reputation which the Thames works have already acquired. It is a matter of regret that a second ship of the same class is not now in progress in the same yard, as while the outer plates are being performed, portions of another ship might be proceeded with.

What may be the value in a naval engagement of ships of this class can only be really tested in action. This much, however, is clear, that ships like the *Warrior* can successfully resist those destructive shells, of which a gallant officer recently said, "For God's sake keep out the shells." That at least is something done so far as these ships are concerned. But ships of the *Warrior* class can still throw shells filled with molten iron, or with liquid fire, or charged with powder which may explode on concussion with the sides of a wooden ship, while at the same time they are practically invulnerable to the heaviest shot that can be delivered by their opponents. Whitworth's gun may punch a hole in the iron cuirass of these ships with its flat-headed shot, within a limited range, but unless followed by a succession of such shots, or pierced with shells, the mail-clad *Warrior* may reel for an instant beneath the blow, but will not be seriously affected. In the case of shot piercing the sides, there is a covered way provided all round the ship for men to pass and plug up the holes. If struck either in the fore part or stern, the water-tight compartments will still keep the ship in safety. At those immense long ranges of Mr. Whitworth's, of which we have heard so much, there would be great dificulty in hitting the ship at all, and if struck the shot would fall harmless upon her. The great speed of the *Warrior* will give her immense advantages over any other ship afloat. She could steam away from a broadside, or bear down upon a slower ship and deliver a concentrated fire of the heaviest guns, and receive no harm in return. It is only when the *Warrior* and *Black Prince* meet with ships of equal speed, power, and armament, that we shall be able to ascertain what is the progress which science has made in the art of maritime warfare.

The British Government have decided upon building two more ships, similar in almost every respect to the *Warrior* and the *Black Prince*, and tenders for their construction have been invited from the Thames Iron Ship Building Company, Messrs. Napier and Co , of the Clyde, and some other large ship building firms.

THE RECENT EXPEDITIONS OF THE "BULLDOG" AND THE "FOX."

(Condensed from an article in the London Times).

The expeditions sent out during the late summer by the British Government and the promoters of the North Atlantic Telegraph, respectively, for the purpose of examining into the practicability of the proposed scheme for carrying a line of telegraph from Europe to America *via* Faroe, Iceland, and Greenland, have at length returned, having successfully accomplished their arduous mission. Although the season was severe, and in every respect the most unfavorable for the route that has occurred for nearly half a century, the difficulties encountered, were not such as could prevent or retard the successful establishment of the line. It will be remembered that Her Majesty's ship, *Bulldog*, under the command of Sir Leopold M'Clintock, left England for the purpose of examining the depths of the sea between the various stations on the proposed route The depths from his careful examination have proved altogether more favourable for the laying of a cable than those on which the former American cable was successfully submerged, the water being 400 fathoms less in its deepest parts. The *Bulldog* left the north of Scotland on the 1st of July for the Faroe Islands, taking soundings about midway, where, according to the charts, the depth was 680 fathoms, but finding soundings readily in 254 fathoms with a favorable bottom—a depth in which the laying of almost any kind of cable would be a matter of certainty. The *Bulldog*, after visiting several places among the wild and beautiful islands of the Faroe group, sounded across to Ingolfs Hofde, in Iceland. In this section of the route no difficulties were experienced, the average depth being under 300 fathoms, and the bottom being mostly of a favorable character. Sir Leopold M'Clintock subsequently visited and examined Faxe Bay, on the north-west coast of Iceland, which, notwithstanding the popular belief to the contrary, is as free from ice and icebergs as the shores of the Isle of Wight. From Iceland to Greenland, across what is technically called the Greenland Sea, the soundings were, as had been expected, found by the *Bulldog* to be deeper than on the Iceland and Faroe section of the route, but still the greatest depth was nearly 900 fathoms less than the deepest portion of the direct route. It is a remarkable fact, as showing the erroneous impressions which have prevailed even among scientific men respecting this region, that no ice was found away from the shore where the charts of Manby and Scoresby represent the sea as impenetrably covered with it. The *Bulldog* being a paddle-wheel steamer, unadapted to such navigation, did not pass through the drift ice so as to land on the east coast of Greenland, so long considered inaccessible to ships. She stood, however, along the coast, sounding occasionally, nearly as far as Prince Christian Sound, when a gale of wind compelled her to stand off shore.

From the time of this date, (July the 19th, to the 18th of August,) Sir Leopold M'Clintock was unable to proceed with his soundings in consequence of continued gales of wind, which drove out the drift ice from the bays and fiords, and prevented the *Bulldog*, on account of her paddles from approaching the coast. After attempting to enter several of the more southern ports, Sir L. M'Clintock entered Godhaab, towing in with him the vessel containing the coal intended for his ship. The weather had been most stormy, no less than eight gales of wind having been experienced during the preceding fortnight. The quantity of loose drift ice on the coast was greater, according to the information of the Danish residents, than had been seen for many years. The *Bulldog*, after having surveyed the harbor, coasted southward to Cape Farewell, as far as the prevalence of drift ice would permit. From that point, at some distance from the land, a line of soundings was carried to Hamilton Inlet, on the coast of Labrador. The depths between the two points were very regular, the greatest being 2,032 fathoms, 400 fathoms less than the direct route across the Atlantic. The examination of Hamilton Inlet made by Sir Leopold was necessarily a hurried and imperfect one, but very little ice was seen on the Labrador coast. On the return voyage a second series of soundings were carried from Hamilton Inlet to South Greenland, where the *Bulldog* anchored, in Julianshaab, on the 29th September. The weather she had experienced during her voyage from Labrador was most severe; she encountered no less than five gales of wind in eight days. After a cursory examination of some of the deep fiords which run inland for a considerable distance—several of which are deemed admirably adapted for the reception of the cable—the *Bulldog* left Julianshaab, on her return to Iceland, on the 3rd of October, and suffered some injury to her paddle floats and cutwater from the floe ice, which prevailed at the entrance of the fiord in larger quantity than had been known for nearly 30 years.

The *Bulldog*, up to this time, had obtained no information whatever respecting the *Fox*, and many began to entertain serious apprehensions that she had been beset upon the east coast of Greenland. Though made at the most unfavorable season, the examinations were said to be most satisfactory. In the channel of the various fiords a most considerable depth of water is almost universally found. On the 8th of October the *Bulldog* again approached the coast of Greenland, close to the entrance of Prince Christian Sound, at the extreme south end of Greenland, and found so very little ice that Sir Leopold M'Clintock commenced taking a line of soundings in towards the fiord. His intention, however, was frustrated by the springing up of one of those terrific easterly hurricanes which occasionally sweep the coast of Greenland. For 50 hours the wind blew with such terrific violence that no canvas could withstand its force for one moment, and the *Bulldog* had to lie to under "bare poles," keeping the engines going, in case of falling in with ice. For three days the vessel gradually drifted southward and clear of the land. After the abatement of the gale, the *Bulldog* continued her line of soundings back to Reikiavik, in Iceland, but was subject to almost continuous interruptions from gales of wind. But the few soundings which could be made were of the most satisfactory character, a depth of only 748 fathoms being found where it was expected to find 2,000. The return soundings of Sir F. L. M'Clintock were of a peculiarly interesting character, in a scientific point of view, inasmuch as they set at rest the long disputed question of the existence of animal life at great depths in the ocean. Several starfish were brought up from the depth of 1,260 fathoms. At Reikiavik, information was obtained respecting the *Fox*. She had left that port for Greenland at the end of August. The *Bulldog* left Reikiavik on the 28th of October, experiencing on her homeward voyage a constant succession of foul wind, with frequent very heavy gales, which retarded, and in some instances completely prevented her sounding operations. Sir Leopold M'Clintock carried his line of soundings into the Rockall-bank, and on the 9th November obtained bottom in 1,340 fathoms, about mid-channel between it and the Vidal-bank. The wind still continuing adverse, and the coal being nearly exhausted, Sir F. L. M'Clintock was obliged to put into the port of Killybegs, county of Donegal.

The expedition of the *Fox* was fitted out at the expense of the promoters of the undertaking, and was intended not only to co-operate with the *Bulldog* in the sounding and general survey of the seas which intersect the various stations on the route, but also to fix upon and examine the precise localities for the landing of the cables, as well as to explore and fix upon the overland route through Iceland and Greenland. The expedition was commanded by Captain Allen Young, who accompanied M'Clintock in the celebrated voyage of the *Fox* in search of the Franklin expedition. Her cruise, like that of the *Bulldog*, was in her main results entirely successful, though her operations were retarded, and in some measure prevented, by the almost unparalleled succession of gales which prevailed with but little intermission from the time of her departure till her return to England. The *Fox* sailed from Cowes Roads on the 20th of July last, and after calling in the Downs, on the following day proceeded through the North Sea with a fair wind and calm weather. On the morning of the 24th, when off Whitby, the moderate breeze changed to a hard gale from the north—of course, dead ahead,—and for the two succeeding days the *Fox* could do little but hold her own against the wind and sea, which ran very high the whole time. During the 27th the sea was calm, and the winds, though light, were fair, so that by the morning of the 28th Aberdeen was reached, and in the evening, the *Fox* finally took her departure for the Faroe Isles. On the 29th and 30th, the wind continued still to blow stiffly ahead, which so far retarded the progress of the ship that it was midday on the 21st before the wild and rocky islands of the Shetland group were passed. For the two succeeding days the weather was squally, but the wind was generally sufficiently favourable to allow the ship to lay her course, "close hauled" to the wind, so that about twilight (10 p.m.) on the 2nd of August the lofty precipitous cliffs of the Faroes were sighted, distant 45 miles. From daylight on the morning of the 3rd a line of soundings was carried from a distance of 20 or 30 miles out into Thorshaven, Stromoe Island, the capital of the Faroe group. The depths were found to vary from 800 to 30 fathoms, with a generally shelly or muddy bottom, and in every respect most favourable for the reception of a telegraph cable. On the afternoon of the following day the *Fox* again got under way, steaming through Hestoe Fiord, a wild and romantic channel, inclosed between the high mountains of Stromoe Island and the lofty basaltic cliffs of the islands of Nailso, Hestoe, and Coultra, for Heldervig, on the north side of Stromoe. The wind increased to a gale during the afternoon, she again anchored for the night in the small harbour of Westmanshaven, near the end of the fiord. The weather continued stormy and wet during that night and next day, so that it was late in the afternoon of the 5th of August before the *Fox* could again get under way. After getting clear of the land and outside the fiord, a severe gale of wind again sprang up, with a heavy sea, both setting the ship dead towards the stupendous basaltic cliffs, some of which rose perpendicularly from the sea to a height of 2,000 feet. While beating the ship out of this unpleasant position, an accident occurred which might have caused the loss of several of the crew. While the men were reefing, the foretopsail yard snapped in the middle, leaving the men clinging to the pieces, which dashed violently against the mast with every roll of the ship, threatening momentarily to fling them off into the sea, from which it would have been impossible to rescue them. They were all, however, eventually rescued from their perilous position; but five of them were more or less injured. The wind shortly afterwards fell again light; but the sea continued to drift the ship into unpleasant proximity to the cliffs, and it was not without some difficulty that she succeeded in rounding the north point of Stromoe, and reaching Heldervig Fiord.

On the evening of the 6th of August, the party under Dr. Rae, who had left the ship at Thorshaven for the purpose of making an examination of the island of Stromoe, arrived, and on the afternoon of the 7th, the damages having been repaired, the *Fox* started for Iceland, taking a line of soundings from the mouth of the fiord to about 20 miles out to sea, the depth varying from about 30 to 200 fathoms, with a bottom generally of a nature favourable to submarine lines. On the morning of the 8th it again blew a strong gale of wind from the north-east, with a heavy sea, which obliged the ships to lay to until the following morning, when the wind again fell light, but, the swell being heavy, little distance could be made by aid of the steam. In the afternoon a sounding was obtained, somewhat to the southward of the proposed line of cable, in 624 fathoms. The 10th was another day of light variable winds, during which but little progress could be made. At midnight, though some considerable distance from land, soundings were obtained in 60 fathoms' water. At daylight on the morning of the 11th, the high and beautiful mountains of the east coast of Iceland were plainly visible above the clear horizon, but they were soon obscured by one of those dense fogs which so frequently prevail in the North Atlantic during the summer. The ship was consequently obliged to come to an anchor for the day, under the lofty headland of Oster Horn. At daylight on the morning of the 12th of August, the fog having again lifted, the *Fox* got under way for Beru Fiord, standing northward along the coast, here rising in one beautiful chain of lofty and rugged volcanic mountains, the dark and barren sides of which are occasionally relieved by snow-covered peaks and streams of glacier ice. At noon the anchor was dropped on the wild, mountainous inlet of Beru Fiord, close to the factory station. The day was beautifully fine and clear—a most unusual circumstance on that coast. The five following days were occupied in sounding and surveying the fiord and the various inlets and bays, many of which were found to be most favourable for the reception of a cable.

On the afternoon of the 15th, the party under Dr. Rae's superintendence left for the purpose of exploring and laying down the route for the landline across the island, intending to join the ship again at Reikiavik. On the evening of the 17th, the soundings and survey being complete, the *Fox* left Beru Fiord with a fair wind, and on the morning of the 19th reached the Westmanna Islands, off the south coast of Iceland. Having communicated with the shore, the *Fox* stood on her way to Reikiavik, those on board just catching a glimpse of Hecla, which was partially covered with clouds, in the distance. Passing the rugged lava streams of Cape Reikianæs during the afternoon, the *Fox* arrived in Reikiavik on the evening of the 20th. During the succeeding ten days, every part of the neighbouring coast which seemed to afford a favourable landing-place for a cable, was examined and thoroughly sounded; and several places, in every respect eligible for the reception of the cable, were discovered. On the 29th, Dr. Rae and his party returned, having successfully accomplished the difficult journey across the island, a distance of nearly 450 miles, in fourteen days.

From this date to the 9th of September, heavy gales and unfavorable weather kept the ship from making much progress westward; but on the 10th and 11th of that month, the weather having moderated, the progress made toward the Greenland coast was considerable, and yet no ice, nor, indeed, any indications of its presence were encountered, though in the chart of Manby, the whole sea over which the *Fox* had been sailing for the previous three days is laid down as perpetually covered with an impassable barrier of it. At 6 p.m. on the 11th, when distant 130 miles from Cape Valloe, East Greenland, a sounding was obtained in 2,135 fathoms. At daylight on the morning of the 12th the first ice and the supposed inaccessible east coast of Greenland were sighted. The land, which then, probably, for the first time, was seen from a ship, was of a high, mountainous, and generally precipitous character. Being short of water, Captain Young made the ship fast to a large floe of ice, from portions of which the tanks were soon replenished. Having obtained soundings, bearings, and angles, the ship coasted southward along the land, the ice lying closely packed along the coast; and the ship in the afternoon, being closely surrounded with floe pieces, was kept away to the margin of the ice. At daylight on the following morning, the 13th of September, the weather being fine and clear, the *Fox* again stood through the ice toward the land to within three miles off the high mountainous island called by the natives Omenarsuk. Some closely packed, heavy ice lay along the coast, and there being no opening for the ship to get in, and no prospect of an off shore wind to disperse it, the vessel was kept along the end of the land southward, looking out for a harbor. Views of the land angles and bearings for fixing positions were obtained. The appearance of open water in some of the fiords led to the hope that the ship might reach the coast, but during the afternoon the wind freshened from the S. S W. As the weather was threatening, Captain Young was compelled to stand off the land to the south-eastward for the night. On the 14th the *Fox* was about 60 miles east of Prince Christian Sound, having been led off the land with the ice, which appeared to have accumulated in most unusual quantity round Cape Farewell. Soundings were obtained in 1,120 fathoms gravel and sand, and again on the following day, 75 miles north-west of Cape Farewell, in 1,230 fathoms.

On the following day, September 15th, a violent gale sprung up from the north and north-west, which blew almost without intermission to the 20th, during which, on several occasions, Captain Young had penetrated into the ice in order to ascertain if the coast was sufficiently clear to admit of surveying operations in the southern fiords being carried on. On the 20th the high land about Cape Farewell was made at daylight, about 40 miles distant, the late gales having blown the ice into a compact part filling up the intervening space. As the sun rose the tops of the lofty mountains could be plainly discerned to be surrounded by a dense vapour, which looked like the smoke of a volcano, but which subsequently proved to be the effects of a violent hurricane whirling the snowdrift from the lofty summits of the mountains. The wind at the time was blowing stiffly from the northward so the *Fox* was hove to till the afternoon, under the lee of the ice. On the morning of the 21st the ice was found to be considerably loosened by the gale, leaving open lanes of water between streams of ice. Through one of these openings the *Fox* beat against a strong northerly wind till the afternoon, when, the weather moderating and the main body of the ice being sufficiently open to sail through, the *Fox's* course was shaped direct for the Channel, leading between the islands to Julianshaab. Night, however, coming on, Captain Young made the ship fast to an iceberg. The night was beautifully calm and the sea as smooth as glass; there was no moon, but the few black clouds which occasionally flitted across the sky served by contrast, to render the light of the aurora doubly brilliant. For the first portion of the night the ship lay as quiet as if in a dock,—a most inexpressible relief to those on board, who for the previous three weeks had been buffeted about amid an almost continuous succession of gales. A sounding was taken, and, though not more than 36 miles from land, a depth of 1,550 fathoms was found. As the night wore on the quiet which all enjoyed was disturbed by a slight swell, which caused the floe pieces to grind together with an ominous noise. After midnight the sky became overcast, the ship was uneasy, and the watches were almost constantly employed in resetting the ice-anchors. The barometer, which had stood very high, began to fall rapidly; at 3 o'clock a.m. a sudden gust of wind tore away all the ice-anchors while some of the hands were employed in resetting them, and the ship rapidly drove away from the berg, leaving the men behind. The steam was immediately got up, and by its aid, and that of the fore and aft sails, the men were recovered from the ice; but by the time this was accomplished the full force of a south-east hurricane had burst upon the ship. The sky was covered with a uniform dark mass of scud, from which the rain drove in torrents, freezing as it fell upon the rigging and upon the deck until everything was crusted with ice. The staysail was set, but immediately blown away, the storm staysail and trysail were bent, but the wind had increased to such violence that no canvass could withstand its force.

The position of the *Fox* was at this time most perilous. Hove to under bare poles, the force of the wind was yet so great that she drifted with fearful rapidity, surrounded in all directions by loose pieces of ice. The spray was torn from the top of the waves, filling the lower stratum of air with eddying clouds like snow-drift, which blew with blinding violence into the faces and eyes of those on deck. The ship was in an almost helpless condition ; the clouds of spray hid the pieces of ice from view until the ship was upon them, while the intense roar of the wind drowned every other sound, the ship driving helplessly before the wind avoiding many pieces of ice, but striking others with a force which would have immediately proved destructive to any other ship less strongly constructed. At 12 noon the ship ran stem on to a piece of ice with such force that even the power of the wind was insufficient to disengage her ; other pieces of ice were driven astern, and for a few minutes the lives of all on board did not seem worth 10 minutes' purchase. The fore trysail was loosened and immediately split, but the impetus given was sufficient to clear her, and she glided from between the pieces as they closed. Throughout the remainder of the day the wind continued to blow with increased violence and the barometer to fall, and the bulwark stanchions on the starboard side were carried away by the sea and ice. The water in the engine-room increased so fast that at six p.m., it extinguished the fires, and the engines stopped, thus removing the last chance of steering the ship clear of the floe, pieces and bergs as they appeared Night was also coming on, so that the preservation of the ship and those on board seemed little less than miraculous, as human exertions could do no more. At half-past seven p.m., the barometer, which had fallen an inch and a-half, showed a decided tendency upwards, and in half-an-hour the violence of the squalls was perceptibly less ; from this time till 11 30 p.m., the wind continued to fall off until it so far abated that the ship could be hove to with the staysail set. At daylight on the 23rd sail was made, and the ship stood to the north-east with a fair wind. But so totally had the ship been driven out of her reckoning by the prevailing storm that she was found at noon to be nearly a degree to the northward of her supposed position, and according to the charts and chronometers, absolutely sailing upon the land; the former were, however, found ultimately to be incorrect. Very little ice was to be seen, the storm having, as is usually the case, effectually scattered and destroyed it. On the afternoon of the 23rd it again threatened, and in the evening again blew with such violence that the ship was hove to under storm staysail. During the succeeding eight days the *Fox* encountered nothing but a succession of foul winds and such heavy gales that it was impossible to reach Fredrickshaab for the purpose of refilling and obtaining water.

On the 2nd of October, after great difficulty, the above harbour was reached. Soon after her arrival, the ice from the southward again made its appearance, and as the reports concerning its extent were contradictory, a boat expedition was organized to examine it, and, if necessary to proceed to Julianshaab, about which district the principal examination would be necessary. After proceeding southward one day's journey, the ice was seen close in shore, but the sea far out was apparently free. On the 12th of October the boats returned to the ships, and next day the vessel proceeded, with a strong northerly gale, through the Torsukalak Channel to Julianshaab, where she arrived on the 22nd of October. Having completed a survey of the port and the adjacent fiord, the Fox proceeded to the examination of a deep and romantic fiord called Tgalika Fiord, into which large icebergs never enter, and in the channel of which sufficient water was found effectually to prevent the grounding of the largest ever seen. Captain Young, after returning to Julianshaab, sounded the estuary of the fiord out to sea, and found that a uniform channel, 160 fathoms deep, could be depended on—a depth, it is needless to mention, considerably greater than that of any iceberg ever seen upon the coast. The winter had now fairly set in, and for weeks past quantities of ice had formed upon the surface of the bays and fiords; continually breaking up before it attained any considerable thickness; so Captain Young determined to return to England at the earliest apportunity, the season being over for proceeding with the examinations of either the Greenland coast or that of Labrador. But, at the beginning of November, the fiord through which Dr. Rae's party would have to pass on their return to the ship from their inland examination, was found to be frozen 16 miles from the head, and it was not without considerable difficulty that a sledge party reached them on the 6th of November, and informed them that a boat awaited their arrival at the open water. On the 8th of November the *Fox* sailed from Julianshaab, and after a rapid run of 15 days she entered Portland Roads. The results of the cruise are universally considered by those who accompanied the expedition to be most satisfactory. Colonel Shaffner's statements as to the existence of long deep fiords, in which the water was so deep as to preclude the remotest possibility of a cable being injured by ice or icebergs is fully confirmed. The existence of drift ice along the south coast is in reality no difficulty; it only prevails at the commencement of the season, unless in an exceptional year such as that recently experienced. Even when thickest its movements with various winds are so perfectly understood, that, under the command of experienced captains, many frail ships, totally unadapted to ice navigation, annually visit and return from all parts of the coast in safety. With regard to the American terminus of the line, now that the Greenland difficulty has been removed, when once the line has been carried to the latter in the 50th par. of western longitude, the landing on the opposite shore can be selected on any point within some hundreds of miles without materially increasing the length of the circuit.

IRON TRADE OF MARQUETTE: LAKE SUPERIOR.

We extract from a Marquette Journal, the following notice of the rise and progress of the iron trade of that district. On witnessing the activity displayed at the Marquette mines, during a visit to Lake Superior last summer, we could not help regretting most acutely that our Canadian ores of Marmora and the adjacent townships should be lying idle, purely for want of a railway or teamway to the front. The distance of Marmora from the Lake shore, is not greater than that between Marquette and the ore-beds of that region; and there are no engineering difficulties to render the construction a costly one. In matters of this kind, our enterprising neighbours leave us certainly far behind.

Much obscurity rests upon the early history of the Marquette iron trade. Previous to 1857, scarcely a trace of it can be found. And, indeed, previous to that year, there was but little of system in it, operations were desultory, and results small. But, from that time, the business has been systematized, and prosecuted with vigor from year to year, until it has grown to its present proportions. The following table will exhibit the increase of product from the epoch above mentioned, down to the present time:—

	TONS.		TONS.
Product of iron ore in 1857....	27,000	Product of iron ore in 1860 ...	150,000
" " 1858....	30,327		
" " 1859....	80,000	Total in the four years...	287,327

And next year's increase will be fully equal to that of the last.

	TONS.		TONS.
Product of pig iron in 1858....	2,000	Product of pig iron in 1860.....	5,000
" " 1859....	6,000		
		Total in three years....	13,000

CASTINGS.

Our two foundries have been in operation a little over two years, and their product is as follows, or very near it:—Product of Marquette foundry, 2,000 tons; product of Lake Superior foundry, 1,500 tons. Total, 3,500 tons.

There were also 300 tons of blooms shipped in 1857, and how much previously we do not know. That branch of the manufacture, however, has been abandoned.

It will be seen that the product of pig iron has fallen off the last year. That has been owing to temporary causes, considerable time having been taken up in repairs, and in introducing improvements with a view to increased product in future years. The prospect now is, that next year's product will reach 10,000 tons, if not a higher figure. But two stacks have been in blast at all the past year, except the three or four weeks' run of the new furnace at the Chocolate, whereas next year there will be four at least in blast, and five, if both stacks of the Pioneer Company are fired up; and the new impulse given to the iron trade will be likely to bring all the available facilities of production into requisition.

The blast furnace at Wyandotte last year, with only eight feet *bosh*, turned out thirty-five hundred tons of pig. At the same ratio of production, our five furnaces, should they all be in operation, ought to turn out fifteen to twenty thousand tons, worth, say $400,000.

The aggregate amount of ore brought down by the Marquette and Bay de Noc Railroad the present season for the different iron companies, is as follows, viz.:—

	TONS.
Jackson Company....	62,980
Cleveland Company....	47,889
Lake Superior Company....	39,395
Total....	150,263
Pig iron for Pioneer Iron Company....	3,050
" for S. R. Gay....	933
" for S. R. Gay by teams....	876
Northern Iron Company....	150
Total....	5,000

CANADIAN INSTITUTE.

SESSION—1860-61.

FIRST ORDINARY MEETING—*1st December*, 1860.

Professor DANIEL WILSON, LL.D., President, in the Chair.

I. W. H. Ellis, Esq., Civil Engineer, elected provisionally by the Council during the recess, was balloted for, and declared duly elected:—

II. *Donations received since the last meeting of the Institute, were anounced. (See Annual Report.)*

III. *The following paper was read:*

By the Rev. Professor W. Hincks, F.L.S.

"Remarks, Historical, Critical, and Explanatory, on the structure and arrangement of Ferns."

SECOND ORDINARY MEETING—*8th December*, 1860.

Professor DANIEL WILSON, LL.D., President, in the Chair.

The following Gentlemen were elected Members.

RICHARD BULL, Esq., Hamilton, C. W.
WILLIAM KINGSFORD, Esq., Toronto.
DOCTOR WOODS, (Army Medical Staff,) Toronto.
THOMAS BURNS, Esq., (Junior Member,) Toronto.

II. Professor Hunt, of the Canadian Geological Survey, made an interesting verbal communication on the Laurentian System of Canada and Scotland.

The following paper was then read:

By Professor Daniel Wilson, LL.D.

"On some of the traces of Ancient Arts and Civilization in the Valley of the Ohio."

III. The requisite nominations for the election of office-bearers for the ensuing year, were made; and the President announced the annual general meeting to be held on the 15th instant, to receive the Report of the Council, to elect office-bearers and members of Council for the ensuing year, and for other business.

ANNUAL GENERAL MEETING—*15th December*, 1860.

Professor DANIEL WILSON, LL.D., President, in the Chair.

The following Gentleman was elected a Member:

DOCTOR AGNEW, Toronto.

II. *The following donations for the Library and Museum were announced, and thanks of the Institute voted to the donors:*

FOR THE LIBRARY.

From Thomas Devine, Esq., Crown Lands Department, Quebec, (By the Hon G. W. Allan, M.L.C.)

Government Map of Canada, from the Red River to the Gulf of St. Lawrence, mounted and bound, 1859.

From T. C. Wallbridge, Esq., Toronto.

Sedgwick and Murchison, on the distribution of older or Palaeozoic Deposits of the North of Germany and Belgium, and their comparison with formations of the same age in the British Isles.

FOR THE MUSEUM.

From J. F. Smith, Junior. Esq., Toronto.

Sixty specimens of fossils from the Upper Green Sand of Dorset, England.

III. A ballot having been taken for Officers of the Institute, for the ensuing year, the following gentlemen were declared duly elected, viz:

President	Prof. D. Wilson, LL.D.
1st Vice President..........	Rev. Prof. W. Hincks, F.L.S.
2nd "	James Bovell, Esq., M.D.
3rd "	Rev. Prof. G. C. Irving, M.A.
Treasurer..................	D. Crawford, Esq.
Recording Secretary.........	P. Freeland, Esq.
Corresponding Secretary.....	Rev. Prof. E. Hatch, M.A.
Librarian..................	Prof. H. Y. Hind, M.A.
Curator....................	J. F. Smith, Junior, Esq.
Council....................	Hon. G. W. Allan, M.L.C.
"	Prof. J. B. Cherriman, M.A.
"	Prof. H. Croft, D.C.L.
"	T. C. Keefer, Esq., C.E.
"	Sandford Fleming, Esq., C. E.
"	Prof. E. J. Chapman.

IV. The report of the Council for the year 1859-60, was read and adopted on motion of Rev. Professor Hatch, seconded by G. Evans, M. A.

V. *The following Paper was read:*

By Professor E. J. Chapman.

"On some new facts regarding Stelliform Crystals, with special reference to the crystalization of snow.

ERRATUM.

Canadian Journal, No. XXX. (Vol. V. page 544). In "Simple Rules for Calculating the Thickness of Inclined Strata," add—after the word *strata* in the first line—" when the dip does not exceed 5°."

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—OCTOBER, 1860.

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

Day.	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Average	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Result.	ME'N	Rain in Inches.	Snow in Inches.
1	29.738	29.603	29.698	29.6722	43.9	49.3	48.6	47.20	− 3.22	.273	.323	.302	.301	.95	.91	.88	.92	E b S	Calm.	NWb N	N 44 E	3.4	0.0	5.4	1.42	2.38	0.325	...
2	.726	.724	.826	.7663	46.4	52.9	50.0	50.25	+ 0.32	.278	.274	.345	.307	.88	.69	.96	.85	Calm.	Calm.	Calm.	N 27 W	0.0	0.0	0.0	1.11	1.11	..	...
3	.900	.882	.796	.8460	50.8	57.3	51.8	53.93	+ 4.40	.319	.290	.332	.320	.85	.61	.86	.77	NW b N	S b W	N E	S 84 E	0.5	4.0	5.4	2.19	4.88	0.040	...
4	.669	.650	.694	.6705	51.8	57.6	54.4	54.60	+ 5.57	.375	.410	.362	.380	.97	.86	.86	.89	E	S E b E	Calm.	S 63 E	4.0	2.5	0.0	1.09	1.14	0.005	...
5	.700	.669	.772	.7222	52.2	62.3	44.6	52.97	+ 4.35	.369	.324	.226	.306	.94	.57	.77	.76	S E b E	NWb N	N W	N 29 W	0.5	12.5	6.0	8.42	9.08	...	...
6	.912	.868	.838	.8697	32.7	44.3	35.6	37.77	−10.45	.156	.194	.186	.176	.84	.67	.89	.78	N b E	S S W	S S W	N 78 W	1.8	7.5	2.6	0.87	4.20	...	...
7	.692	.892	—	—	35.6	47.3	—	—	—	.177	.220	—	—	.85	.66	—	—	N b E	N E b E	Calm.	N 81 E	0.6	1.0	0.0	1.31	2.78	0.115	...
8	.097	.224	.328	.2347	52.6	49.0	42.1	46.38	− 0.77	.322	.198	.204	.227	.80	.55	.76	.70	N W	N W	W N W	N 46 W	16.0	32.0	16.0	17.87	18.13	...	...
9	.293	.264	.337	.3010	39.2	47.9	42.1	42.97	− 4.10	.199	.240	.241	.224	.83	.71	.89	.80	W N W	W b S	Calm.	N 79 W	4.5	10.8	0.0	5.42	5.51	Inp.	...
10	.292	.115	.059	.1445	41.7	58.7	53.3	51.80	+ 5.02	.228	.351	.333	.303	.83	.71	.82	.77	S W b W	S S W	S W b S	S 39 W	0.6	14.0	6.5	10.02	11.28	...	...
11	.138	.419	.655	.4302	48.6	45.7	33.4	42.27	− 3.98	.231	.174	.140	.178	.67	.56	.74	.65	W b N	N W	NWb W	N 59 W	16.8	19.2	5.2	11.07	11.38	...	...
12	.685	.682	.748	.7110	28.4	44.1	36.3	37.45	− 8.52	.134	.178	.157	.158	.86	.61	.74	.71	W N W	W b S	W N W	N 86 W	4.6	16.7	9.0	7.01	7.27	Inp.	...
13	.784	.813	.854	.8212	31.3	45.7	41.4	39.33	− 6.23	.161	.202	.187	.176	.86	.66	.72	.73	NWb W	S b E	N	N 39 W	0.5	8.2	6.8	1.57	5.37	...	Inp.
14	.922	.930	—	—	39.2	46.4	—	—	—	.216	.212	—	—	.90	.67	—	—	N	E b S	N b W	N 24 E	8.8	6.0	7.0	4.23	6.27	...	...
15	.818	.751	.716	.7575	38.1	47.9	37.4	41.57	− 3.28	.187	.230	.170	.198	.81	.69	.80	.75	N N W	S b W	SW b W	S 82 W	11.0	8.0	5.0	4.75	6.38	...	...
16	.659	.531	.577	.5862	36.7	54.9	51.1	47.98	+ 3.45	.188	.286	.347	.271	.86	.65	.92	.79	W S W	S S W	NWb N	S 75 W	4.2	15.0	4.5	3.94	10.29	0.190	...
17	.742	.844	.940	.8575	41.0	48.2	40.3	43.42	− 0.82	.246	.216	.158	.199	.96	.64	.63	.71	N b E	N b E	N	N 7 E	13.0	11.8	9.2	10.69	10.83	...	...
18	.962	.952	.958	.9610	39.6	45.7	46.1	44.20	+ 0.17	.210	.183	.273	.220	.87	.60	.87	.79	N	N N E	N	N 20 E	7.8	5.0	3.2	3.80	3.91	...	...
19	.953	.900	.820	.8908	43.5	51.1	45.0	47.08	+ 3.30	.250	.278	.240	.261	.89	.74	.83	.81	N	S	N b W	N 10 E	1.2	3.5	9.8	4.29	6.23	...	...
20	.792	.785	.807	.7978	46.4	52.2	46.1	47.50	+ 3.93	.212	.222	.204	.246	.67	.56	.94	.75	N N E	N E	N E	N 47 E	9.0	11.2	10.2	11.20	11.37	0.173	...
21	.657	.549	—	—	46.4	49.3	—	—	—	.308	.345	—	—	.98	.98	—	—	E b N	E N E	E b N	N 70 E	11.5	17.5	11.0	12.08	12.13	0.220	...
22	.595	.605	.643	.6153	48.2	50.8	49.3	49.20	+ 6.23	.328	.346	.344	.339	.97	.93	.98	.97	E b N	E	E N E	N 85 E	6.7	7.4	5.9	6.41	6.45	0.115	...
23	.557	.462	.455	.4895	48.6	51.1	49.3	49.18	+ 6.43	.342	.342	.332	.335	.100	.91	.94	.96	E	E b S	E b S	S 77 E	2.8	2.0	2.0	1.83	3.12	0.095	...
24	.505	.511	.584	.5105	43.4	54.7	46.4	48.45	+ 5.95	.269	.343	.275	.300	.96	.79	.86	.87	W b N	W b S	W N W	S 75 W	4.1	7.4	1.0	2.72	3.10	0.105	...
25	.602	.472	.523	.5300	41.7	55.1	49.0	48.65	+ 6.37	.264	.331	.287	.294	.100	.76	.82	.86	W N W	E b S	NWb W	N 70 W	3.3	8.0	3.4	1.98	5.33	...	..
26	.608	.718	.870	.7463	41.7	50.8	35.3	43.02	+ 1.03	.228	.243	.181	.223	.86	.65	.88	.80	W b N	N N W	N b W	N 41 W	7.0	9.2	1.5	6.90	7.28	...	..
27	.932	.928	.870	.9097	33.8	45.0	46.8	42.70	+ 0.92	.157	.219	.273	.233	.81	.83	.85	.83	N b W	E b N	E b N	N 74 E	4.8	12.4	14.0	11.10	11.66	...	..
28	.790	.665	—	—	46.4	54.0	—	—	—	.278	.324	—	—	.88	.78	—	—	E	E b N	S b W	S 69 E	5.9	15.0	6.2	5.45	9.21	0.225	..
29	.716	.802	.856	.7095	51.8	58.0	47.5	52.13	+10.87	.375	.394	.276	.341	.98	.82	.84	.87	S W	W b S	S Wb W	S 84 W	8.5	6.8	2.4	3.78	6.12	...	..
30	.742	.753	.710	.7430	51.8	61.3	54.4	55.55	+14.60	.363	.456	.385	.393	.94	.84	.91	.89	E N E	E	S E	N 88 E	6.0	9.2	2.5	5.21	5.81	0.010	..
31	.692	.683	.723	.7060	55.1	63.7	56.2	58.03	+17.28	.409	.440	.406	.415	.94	.75	.90	.87	S E b E	S b W	S b W	N 33 W	4.5	3.6	5.2	0.63	4.84	Inp.	..
M	29.6592	29.6522	29.6917	29.6711	43.74	52.06	45.70	47.25	+ 2.21	.262	.286	.269	.272	.88	.71	.85	.81	....	....	....	....	5.61	9.27	5.38	......	6.93	1.618	Inp

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR OCTOBER, 1860.

Highest Barometer .... 29.982 at 8 a. m., on 18th } Monthly range=
Lowest Barometer .... 29.019 at midn't on 16th } 0.963 inches

Self-registering Thermom.
- Maximum Temperature .... 68°0 on p. m. of 31st } Monthly range=
- Minimum Temperature .... 28°4 on a. m. of 12th } 39°6
- Mean maximum Temperature .... 53°65 } Mean daily range=
- Mean minimum Temperature .... 41°58 } 12°06
- Greatest daily range .... 23°2 from a. m. to p. m. of 6th.
- Least daily range.................. 3°4 from a. m. to p. m. of 22nd.

Warmest day......... 31st ... Mean temperature......... 58.03 } Difference = 20°58.
Coldest day......... .. 12th .. Mean temperature......... 37°45 }

Maximum { Solar.................................. 84°5 on p. m. of 6th } Monthly range=
Radiation. { Terrestrial.......................... 19°0 on a. m. of 12th } 65°5.

Aurora observed on 0 nights,
Possible to see Aurora on 10 nights; impossible on 21 nights.
Snowing on 1 day; depth inap. ; duration of fall 0.2 hours.
Raining on 15 days,—depth 1.618 inches ; duration of fall 66.6 hours.
Mean of cloudiness = 0.70.
Most cloudy hour observed, 6 a. m., mean = 0.77; least cloudy hour observed, midn't, mean, = 0.64.

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

North.	South.	East.	West.
2274.68	807.70	1595.50	1823.79

Resultant direction N. 9° W.; Resultant Velocity 2.00 miles per hour.
Mean velocity.............................. 6.93 miles per hour.
Maximum velocity .... 32.4 miles, from 1 to 2 p. m. on 8th.
Most windy day .... 8th......Mean velocity 18.13 miles per hour. } Difference=
Least windy day .... 2nd... ..Mean velocity 1.11 ditto. } 17.02 miles.
Most windy hour... noon to 1 p. m............Mean velocity 9.56 ditto. } Difference =
Least windy hour... 9 to 10 p. m. ....Mean velocity 5.34 ditto. } 4.22 miles.

2nd. Foggy from 4.30 p. m. to midnight. 5th. Foggy from 6.45 to 7.30 a. m.
6th. Indistinct solar halo at 5 p. m. 10th. Slight dew at 6 a. m.
13th. Particles of snow at 8 p. m., depth inappreciable, (first of the season.)
19th. Fog at 6 a. m. 22nd. Dense fog from 8 p. m. to midnight.
23rd. Dense fog nearly all day. 24th. Imperfect rainbow at 4.30 p.m.; fog at midn't.
25th. Dense fog till 10 a. m.; thunderstorm and vivid lightning from 9 to 10.45 p.m.
26th. Heavy dew at 6 a. m. 27th. Perfect lunar halo from 6.20 to 9 30 p. m.
31st. Imperfect lunar halo at 11 p. m.; this was the warmest 31st October during the last 21 years.

The Resultant Direction and Velocity of the Wind for the month of October, from 1848 to 1860 inclusive, were respectively N 56° W, and 1.72 miles.

October, 1860 —The Mean Temperature of this month was 1°88 above the average. The depth of rain was 0.892 inches below the average. The mean velocity of the wind was 1.08 miles per hour above the average; and the amount of cloudiness was 0 09 above the average.

The month was, therefore, comparatively warm, dry, windy and cloudy; it was also remarkable for the very dense fog which continued, with a few intervals, from the 22nd to 25th inclusive.

COMPARATIVE TABLE FOR OCTOBER.

Year.	Temperature.					Rain.		Snow.		Wind.		
	M'n.	Diff. from Aver.	Max. ob'd.	Min. ob'd.	Range.	No. of days.	Inch's.	No. of days.	Inch's.	Resultant Direction.	Resultant V'y.	Mean Force or Velocity.
	°	°	°	°	°							
1840	44.4	−1.0	68.5	23.9	44.6	13	1.860	3	...	...	...	....
1841	41.6	−3.8	58.3	20.3	38.0	6	1.360	2	...	...	...	0 41 lbs.
1842	45.1	−0.3	68.5	30.0	38.5	8	5.175	0	...	...	...	0.35
1843	41.8	−3.6	65.7	24.5	41 2	12	3 790	4	2.5	...	...	0.54
1841	43.3	−2.1	69.6	17.8	51.8	7	Imp.	4	12.0	...	...	0.43
1845	46.4	+1.0	62.7	20.0	42.7	11	1.760	1	Inp.	...	...	0.26
1846	44.6	−0.8	69.7	20.7	49.0	14	4.180	2	Inp	...	...	0.44
1847	44.0	−1.4	65.0	20.3	44 7	13	4.390	2	Inp.	...	...	0.19
1848	46.3	+0.9	62.2	26.4	35.8	11	1.550	0	0.0	N 54° W	1.24	4.60 mls.
1849	45.3	−0.1	59.2	25.5	33.7	13	5 965	1	Inp.	N 12° W	1.27	4.76
1850	45.4	0.0	66.6	24.8	41.8	10	2.085	0	0.0	N 66° W	1.10	5.30
1851	47.4	+2.0	66.1	25.0	41.1	10	1.680	2	0.3	S 72° W	1.06	4.39
1852	48.0	+2.6	70.7	29.8	40.9	12	5.280	0	0.0	N 5° E	1.19	4.47
1853	44.4	−1.0	64 7	25.5	39.2	10	0 875	2	Inp.	S 88° W	1.74	4.77
1854	49.5	+4 1	74.2	29.8	44.4	15	1.495	3	Inp.	N 45° W	1.52	4.57
1855	45.4	0.0	64.3	28.0	36 3	14	2.485	5	0 8	N 82° W	4.91	9.88
1856	45.3	−0.1	70.1	23.3	46.8	10	0.875	2	0.1	N 76° W	2.15	6.07
1857	45 4	0.0	63 5	27.7	35.8	10	1.040	2	0.2	N 19° W	2.93	6.24
1858	48.8	+3.4	76.3	34.2	42.1	17	1.797	1	Inp.	N 34° W	0.36	5.96
1859	43.0	−2.4	68.4	22.3	46.1	11	0.940	4	Inp.	N 68° W	5.04	8.12
1860	47.3	+1.9	63.7	28.4	35.3	15	1.618	1	Inp.	N 9° W	2.00	6.93
M	45.37	...	66.57	25.15	41.42	11.5	2.510	2.0	0.88	....	...	5.85 Ml.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—NOVEMBER, 1860.

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

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Average.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resul't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10 P.M	ME'N		6 A.M	2 P.M.	10 P.M	M'N	6 A.M	2 P.M	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.		6 A.M.	2 P.M.	10 P.M.	Re-sult'.	ME'N		
					°	°	°	°	°												°							
1	29.794	29.759	29.773	29.7772	53.3	62.3	60.5	58.88	+18.42	.366	.459	.481	.434	.89	.82	.92	.87	N b W	N E	E	N 55 E	12.2	11.2	10.0	10.77	11.71	...	...
2	.786	.715	.675	.7220	57.2	59.4	56.2	57.37	+17.10	.404	.363	.360	.373	.86	.71	.80	.79	E N E	E b N	E N E	N 78 E	21.0	19.2	15.8	15.52	16.36	0.125	...
3	.564	.510	.393	.4817	52.6	52.2	47.9	51.02	+11.02	.386	.369	.311	.347	.97	.94	.93	.92	E b N	S E	E S E	S 7 E	14 2	8.0	2.8	3.71	8.43	0.412	...
4	.385	.413	—	—	41.0	47 5	—	—	—	.192	.162	—	—	.75	.48	—	—	W S W	S W	SW b W	S 56 W	5.0	22.0	12.5	15.05	15.35	0.050	Inp
5	.327	.401	.506	.4245	42.8	45.0	37.4	40.87	+ 1.38	.152	.128	.179	.155	.55	.42	.80	.61	S W	S W b W	W S W	S 67 W	15.5	15.0	9.8	9.02	9.10	...	...
6	.520	.529	.654	.5775	32.0	42.8	34.2	36.33	— 2.83	.151	.186	.152	.158	.83	.67	.77	.73	W S W	W S W	W N W	N 81 W	3.2	10.2	9.0	7.81	8.45	..	...
7	.752	.790	.880	.8170	29.1	39.2	32.7	33.67	— 5.33	.146	.155	.135	.149	.92	.61	.73	.78	W N W	W N W	W N W	N 63 W	6.5	7.0	4.0	7.66	8.04	...	...
8	.906	.850	820	.8545	31.3	38.9	33.1	34.30	— 4.38	.136	.159	.160	.152	.77	.67	.84	.77	N b W	E S E	E b S	N 40 E	5.2	3.5	5.2	3.28	4.35	...	...
9	.731	.573	.304	.5172	36.0	41 7	38 8	38.95	+ 0.55	.182	.218	.220	.203	.76	.82	94	.85	N E	N E b E	N E b E	N 50 E	10.5	14.8	22.7	14.93	15.14	0.818	...
10	.214	.217	.346	.2698	39.2	39.6	39.6	39.45	+ 1.37	.223	.219	.219	.219	.94	.90	.87	.90	N E b N	N b W	N W b N	N 13 W	14.0	12.5	10.0	11.15	11.98	0.065	...
11	.406	.390	—	—	39.2	43.5	—	—	—	.216	.240	—	—	.90	.85	—	—	N W b N	N W b N	N W b N	N 30 W	11.8	12.0	3.0	9.07	9.17	...	...
12	.406	.428	.611	.4920	37.8	49.0	37.8	41.28	+ 3.78	.199	.217	.183	191	.87	.61	.80	.74	N W b N	N W	N N W	N 33 W	1.5	15.0	4.0	10.37	10.48	...	...
13	.681	.724	.781	.7388	34.5	46.8	38.1	39.45	+ 2.27	.181	.216	.204	.199	.90	.67	.88	.82	N N W	N W b N	N W b N	N 29 W	11.6	10.0	4.5	7.36	7.45	...	...
14	.774	.821	.808	.8138	31.3	47.5	39 9	38.97	+ 2.07	.152	.255	.181	.190	.88	.77	.73	.78	N W b N	S W b W	W S W	N 72 W	7.5	6.4	3.8	3.14	4.16	...	...
15	.816	.806	.881	.8338	32.7	47.2	39.2	39.32	+ 2.82	.171	.239	.297	.204	.92	.74	.86	.85	N W b N	N W b N	N W b N	N 31 W	0.2	10.2	6.5	5.59	5.65	...	...
16	.850	.810	.739	.7935	38.5	42.1	41.4	40.58	+ 4.38	.190	.204	.232	.213	.81	.76	.89	.84	N b W	E N E	N E b E	N 36 E	5.0	1 8	2.0	1.91	2.19	...	...
17	.615	.420	.298	.4332	41.4	45.2	43.5	43.22	+ 7.42	.250	.280	.268	.264	.95	.93	.95	.94	N E b E	E N E	N b W	N 14 W	3.0	4.2	4 5	2.49	3.12	0 150	...
18	.156	.038	—	—	39.6	3?.9	—	—	—	.219	.164	—	—	.90	.66	—	—	W N W	S W b W	S S W	S 43 W	3.5	12.0	22 0	12.61	13.37	0 055	...
19	28.844	28.909	.078	28.9568	40.7	42.1	36.3	39.33	+ 4.25	.223	.187	.134	.176	.87	.69	.62	.71	S W b S	W S W	W b S	S 69 W	9.3	18.5	11.5	13.15	13.36	...	...
20	29.132	29.286	.456	29.3075	34.2	36.0	27.3	32.25	— 2.52	.152	.130	.133	.136	.77	.61	.89	.75	W b S	W N W	W	N 81 W	9.2	23.0	7.5	13.68	13 90	...	Inp.
21	.491	.478	.578	.5225	25.5	34.9	31.3	30.45	— 3.93	.125	.139	.151	.140	.91	.68	.86	.83	W	W b S	W b N	S 89 W	6.2	10.0	10.0	8.72	8.88	...	Inp.
22	.638	.600	.538	.5873	33.1	38.9	37.1	36.33	+ 2.25	.167	.168	.158	.166	.88	.70	.71	.78	S W b W	S W	S b W	S 27 W	11.5	18.5	9.0	14.27	14.87	0 200	...
23	.354	.268	.047	.2042	36 3	40.7	39.6	39.17	+ 5.50	.210	.204	219	.213	.93	.80	.90	.89	S S W	S W b S	S S W	S 38 W	15.6	19 0	8.5	14.45	15.31	0 132	Inp.
24	.089	.083	.304	.1743	19.0	21.2	16.5	17.93	—15.33	.073	.092	.064	.074	.76	.81	.68	.74	W S W	W S W	W S W	S 67 W	27.7	25.0	23.0	27.40	27.45	...	Inp
25	.516	.699	—	—	15.8	19.4	—	—	—	.060	.048	—	—	.66	39	—	—	W b S	W b S	W b S	S 74 W	31 5	21.5	12 0	18.38	18.40	...	...
26	.959	.753	.491	.7115	16.8	26.6	36.0	26.97	— 5.60	.073	.134	.196	.138	.78	.93	.93	.88	W S W	E S E	S	S 12 E	7.2	12.7	15.4	9.01	11.56	0.180	1.5
27	.376	.607	.790	.6107	39.9	34.2	29.5	33.87	+ 1.68	.233	.135	.106	.157	.96	.69	.65	.78	S W	W b N	W b S	S 83 W	11.5	25.6	7.0	13.74	14.21	...	...
28	.760	.721	.625	.6947	25.1	33.8	28.8	28.82	— 3.07	.108	122	.108	.113	.80	.63	.68	.71	W N W	S W b S	S W b W	S 60 W	2.2	10.0	4.5	4.94	5.31	...	...
29	.445	.232	.169	.2678	30 9	42.5	34.5	36.27	+ 4.77	.157	.182	.164	.162	.90	.66	.92	.76	S W b W	S W b S	S W b W	S 46 W	1.5	13.5	2 6	7.36	7 47	0.290	Inp.
30	28.989	23.896	.107	.0033	34.2	37.1	24.8	31.60	+ 0.52	.187	.192	.099	.153	.94	.86	.73	.83	S W b W	N W	N W b N	N 34 W	4 2	12.8	23.3	15.18	15.39	0.092	0.4
M	29.5309	29.5072	29.5251	29.5226	35.59	41.80	37.00	37.95	+ 1.80	.192	.206	.193	.195	.86	.74	.81	.80	...	...	...	...	9.63	13.54	9.57		11 02	2.569	1.9

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR NOVEMBER, 1860.

Highest Barometer . . . . . . 29.959 at 6 a. m. on 26th. } Monthly range=
Lowest Barometer . . . . . . 28.844 at 6 a. m. on 19th, } 1.115 inches.

Self-registering Ther.
- Maximum temperature . . . . 64°5 on p.m. of 1st } Monthly range=
- Minimum temperature . . . . 13°2 on a.m. of 25th } 51°3
- Mean maximum temperature . . 43°23 } Mean daily range = 9°70.
- Mean minimum temperature . . 33°53 }
- Greatest daily range . . . . . . 25°0 from a. m. to p.m. of 26th.
- Least daily range . . . . 2.3 from a. m. to p. m. of 10th.

Warmest day . . 1st ... Mean Temperature . . . 58°88 } Difference=40°95.
Coldest day . . . 24th ... Mean Temperature . . . 17°93 }

Maximum Radiation { Solar . . . . 81°5 on p. m. of 1st } Monthly range=
{ Terrestrial . . . . . . 7.5 on a. m. of 26th } 74°0.

Aurora observed on 1 night, viz.: on the 4th; possible to see Aurora on 12 nights; impossible on 18 nights.
Snowing on 8 days; depth, 1.9 inches; duration of fall, 20.9 hours.
Raining on 12 days; depth, 2.569 inches; duration of fall, 82.4 hours.
Mean of cloudiness=0.70; most cloudy hour observed, 4 p. m., mean=0.78: least cloudy hour observed, midnight; mean=0.63.

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

North.	South.	East.	West.
2139.31	2210.83	1165 38	4743.40

Resultant direction, S 89° W; Resultant Velocity, 4.95 miles per hour.
Mean velocity 11.02 miles per hour.
Maximum velocity . . . 33.6 miles, from 6 to 7 a.m. on the 25th.
Most windy day . . 24th—Mean velocity, 27.45 miles per hour. } Difference 25.26
Least windy day . . 16th—Mean velocity, 2.19 do } miles.
Most windy hour, noon to 1 p. m.—Mean velocity, 14.07 miles per hour. } Difference
Least windy hour, 11 p m. to midnight—Mean velocity, 9.29 do. } 4.78 miles.

1st. Very mild day, being the warmest 1st November for 21 years.
3rd. Very perfect rainbow from 1.50 to 4 30 p.m.
4th. Brilliantly coloured aurora from 6 to 9 p.m.
6th. Hoar frost and thin ice at 6 a. m.
23rd. Rapid descent of temperature from
23rd, midnight = 33°.6
24th, 8 a. m, = 10 1

Range in 8 hours = 23.5

24th and 25th. Very cold, stormy days.
27th. Well-defined lunar halo, from 7 to 9 p. m.; lunar corona from 9.40 p. m.
28th. Very perfect lunar halo from 9 to 11.30 p.m.
29th. Imperfect lunar halo from 8 to 10 p.m.

The Resultant Direction and Velocity of the Wind, for the month of November, from 1848 to 1860 inclusive, were respectively N. 78° W., and 2.34 miles.

The mean temperature of November, 1860, was 1°23 above the average of 21 years, and the mean velocity of the wind 3.52 miles per hour in excess of the average of 13 years; the depth of rain and snow recorded, were both in defect of their respective means, the former by 0.513 and the latter by 1.19 inches.
The month was consequently warm, dry, and very windy.

COMPARATIVE TABLE FOR NOVEMBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	No. of days.	Inches.	No. of days.	Inches.	Resultant Direction.	Resultant Velocity.	Mean Velocity
1840	35.9	— 0.8	54.4	20.5	33.9	5	1.22	8	...	...	...	...
1841	35.0	— 1.7	63.2	7.6	55.6	8	2.450	5	...	...	...	0.91 lbs.
1842	33.3	— 3.4	50.6	7.6	43.0	9	5.310	10	...	...	...	1.22 "
1843	33.5	— 3.2	51.2	14.4	36.8	10	4.70	7	1 2	...	...	0.59 "
1844	34.9	— 1.8	49 8	12.0	37.8	8	imp.	4	8.0	...	...	0.48 "
1845	36.8	+ 0.1	58.8	7.6	51.2	7	1.105	4	5.0	...	...	0.53 "
1846	41.3	+ 4.6	55.5	18.2	37.3	12	5.805	2	0.4	...	...	0.64 "
1847	38 6	+ 1.9	58.2	7.8	50.4	14	3.15	3	Inp.	...	...	0.36 "
1848	34.5	— 2.2	49.3	16.5	32.8	9	2.020	3	1.4	N 81 W	1.81	4.81ms.
1849	42.6	+ 5.9	56.7	28.4	28.3	10	2.815	2	1.0	N 39 W	1.55	4.78 "
1850	38.8	+ 2.1	62.3	18.1	44.2	7	2.955	1	Inp.	N 42 W	1.43	5.27 "
1851	32.9	— 3.8	50.1	16.5	33.6	5	3.885	6	6.7	N 50 W	1.25	4.70 "
1852	36.0	— 0.7	50.4	18.7	31.7	7	1.775	3	2.0	N 59 W	1.53	6 50 "
1853	38.7	+ 2.0	54.1	14.4	39.7	15	2.425	6	2.7	N 9 W	0.55	5.52 "
1854	36.8	+ 0.1	54.9	15.1	39.8	13	1.115	4	1.3	W	3.44	7.54 "
1855	38.6	+ 1 9	54.1	18.7	35.4	8	4.590	6	3.0	N 66 W	3.18	10.81 "
1856	37.4	+ 0.7	56.4	22.8	33.6	10	1.375	9	9.5	S 85 W	2.95	8.75 "
1857	33.5	— 3.2	57.8	-2.3	60.1	14	3.235	9	6.9	S 61 W	5.45	9.25 "
1858	34.2	— 2.5	52.0	20 5	31.5	12	3 879	13	4.0	N 25 W	3.14	8.87 "
1859	38.9	+ 2.2	61.0	24.1	36.9	12	5.193	9	0.6	N 81 W	3.39	9.65 "
1860	37.9	+ 1.2	62.7	14.0	48.7	12	2.569	8	1.9	S 89 W	4.95	11.02 "
Mean	36.67	...	55.40	15.30	40.11	9.9	3.082	5.8	3.09	...	...	7.50

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—AUGUST, 1860.

(NINE MILES WEST OF MONTREAL.)

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

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

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—F.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone. (tenths)	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.854	29.826	20.954	50.0	68.8	59.2	.258	.319	352	.71	.47	70	W	W S W	S W b S	166.90	2.5	...	...	Clear.	Clear.	Clear.
2	972	859	990	52.5	80.6	66.0	282	445	407	74	43	63	S W	S W	S W	4.80	1.0	...	...	Do.	Cumb. 2.	Cirr. 2.
3	907	783	851	56.0	88.2	77.0	315	530	639	71	40	69	E b S	S S E	W b S	80 20	1.0	...	...	Do. h'vy dew	Clear.	Cu Str. 9.
4	717	741	705	73.0	85.0	70.2	725	603	523	88	49	72	S W b W	W b S	N W	113.40	2.0	0.487	...	Cu. Str. 8.	Cu. Str. 6.	Str. 2. Au Bor.
5	809	811	900	68.0	83.5	67.8	393	597	489	59	53	75	N E	W	W b S	119.60	1.5	...	...	Clear.	Clear.	Clear. Au Bor.
6	904	809	785	64.3	93.2	72.4	464	710	559	77	46	72	S b W	S S W	S W	13.80	1.0	...	...	Do.	Do.	Cu. Str. 6.
7	705	583	604	70.3	90.2	75.2	551	699	745	75	54	86	S b E	W	N N W	41.70	0.5	...	...	Do.	Hazy.	Do. 9. d.th. v.l.
8	720	616	594	71.1	87.2	73.2	572	664	728	76	52	79	W b S	W	S b W	30.40	2.5	...	...	Do.	Clear.	Str. 2. Au. Br.
9	585	614	708	73.2	79.0	65.8	393	574	516	85	58	84	S S W	S S W	S b W	63.50	2.5	0.300	...	Do.	C. Str. 8. thu.	Clear. do.
10	699	608	701	64.2	92.2	68.0	464	556	437	77	57	63	S S W	S b W	W	32 60	2.0	...	...	Do.	Do. 2.	C. Str. 9. ligt.
11	851	907	957	54.1	83.2	54.5	335	558	355	80	50	80	N	N E b E	S b E	59.30	2.5	In'p.	...	Cu. Str. 10.	Clear.	Clear. Au. Br.
12	824	786	811	46.1	80.9	66.2	262	624	502	84	59	78	S E b E	S	S S W	60.70	1.0	...	...	Fog.	Do.	Do. do.
13	444	140	735	63.8	65.0	60.8	543	583	462	94	94	91	S b E	N E	W N W	59.40	4.0	0.929	...	Rain.	Rain.	Cu. St. 9.
14	914	911	925	53.6	66.9	56.7	376	468	420	88	71	94	W	S W	S W	36.50	2.5	0.011	...	Cu. Str. 8.	Cu. Str. 6.	Do. 9.
15	995	30.070	30.057	54.5	72.0	64.2	328	397	464	77	52	76	W b N	N b W	W b S	149.40	1.5	...	...	Do. 6.	Clear.	Clear.
16	30.018	29.880	20.960	50.1	78.6	63.9	250	443	503	71	46	86	W S W	S W	S S W	82.30	1.0	...	...	Clear h. dew.	Str. 2.	Cu. St. 2. Au. B.
17	29.867	740	711	61.4	85.0	67.3	466	507	489	85	43	75	W S W	W S W	S S W	116.90	1.0	...	...	Do.	Clear.	Clear.
18	751	571	719	62.9	70.6	63.7	517	651	536	91	88	92	W S W	S S W	W N W	55.10	3.0	0.900	...	Nimb. 9.	Rain.	C. Str. 4. Au. B.
19	814	794	880	61.7	70.7	68.4	466	612	443	85	62	65	E b N	S E	S E b E	134.39	2.0	...	...	Cu. Str. 8.	Cu. Str. 4.	Do. 6.
20	826	766	851	67.6	77.4	68.9	626	705	671	95	81	96	S S E	S S E	S S W	174.71	3.0	0.430	...	Rain.	Do. 9.	Clear.
21	799	857	861	67.3	88.0	67.0	598	565	591	92	57	89	S S W	S W	S	101.20	2.5	0.230	...	Cu. Str. 8.	Do. 2.	Do. Au. B.
22	857	834	918	62.3	83.7	67.2	523	514	571	94	45	50	S b W	S W	S S W	54.20	3.0	...	...	Do. 10.	Cumb. 2.	Do. Au. B.
23	856	803	824	65.6	80.2	72.2	362	511	566	87	41	74	S S W	N E b E	N N E	90.60	2.5	...	...	Clear h. dew.	Clear.	Rain.
24	874	711	735	84.2	68.8	66.1	576	642	604	92	92	91	S E b E	S b E	S b E	136.00	3.0	4.095	...	Rain. Dis. th.	Cu. Str. 10.	Cu. Str. 8.
25	606	484	526	65.0	77.6	62.1	618	678	498	1.00	73	91	S	S S E	W b S	72.80	4.0	0.500	...	Cu. 4.	Do. 8.	Do. 6. L ra.
26	534	606	711	62.3	75.8	63.0	530	590	422	97	68	75	W	N W	W	251.60	3.0	...	...	Cu. Str. 8	Clear.	Clear.
27	682	621	646	52.2	75.6	57.3	361	476	407	94	59	87	S S E	W	S W	71.80	2.0	0.473	...	Clear.	Cu. Str. 8.	Cu. Str. 6.
28	634	666	692	53.9	61.4	57.3	396	583	378	96	71	81	S S W	S W	S W	199.50	1.5	0.181	...	Cu. Str. 4.	Slight Rain	Do. 4.
29	733	715	809	55.5	76.4	59.2	298	541	439	90	60	88	S W	S W	S W	181.50	1.5	In'p	...	Do. 6.	Showers.	Clear.
30	755	568	459	54.4	78.9	65.0	390	564	420	94	61	68	S W	W b S	S W	157.30	1.5	...	...	Clear.	Clear.	Do.
31	468	480	514	56.1	72.1	60.2	391	600	456	87	78	88	S W	W N W	W b N	138.10	2.5	0.070	...	Cu. Str. 10.	Cu. Str. 4	Cirr. St. 2.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—SEPTEMBER, 1860.

(NINE MILES WEST OF MONTREAL)

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

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

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.—F.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Horizontal Movement in Miles in 24 hours.	Mean of Ozone. Units	Rain in inches.	Snow in inches.	Weather, &c. A Cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	29.748	29.786	29.833	53.0	70.1	50 5	.380	.397	.283	.94	.52	.78	N N W	w b N	N W	41.10	2.0	...	...	Clear.	Clear.	Cu Str. 2.
2	916	944	30.073	45.6	64.6	53.9	280	243	370	88	42	81	w b N	N W	w b s	0.00	2.0	...	...	Do	C. C. Str. 4.	Clear.
3	30 212	30.208	130	42.9	72.3	59.2	237	263	358	88	31	73	w N w	w b N	w s w	98.60	2.0	...	...	Slight frost.	Clear.	Do.
4	114	037	29.974	44.0	83 4	67.7	258	630	550	87	54	8'	S S E	S W	S W	45.40	1.5	0.300	...	Clear.	Cir. St. 4.	Cu. Str. 8.
5	29.916	29.804	843	66.2	82.3	70.2	604	650	621	94	59	81	S E	w b s	w b s	128.10	3.5	...	...	Rain.	Clear.	Clear.
6	839	845	957	63.3	80.3	59.7	536	599	380	82	59	76	w b s	w s w	w b s	17.20	2.0	...	...	Cirr. Str. 4.	Do	Do. An. Bor.
7	918	812	752	63.5	81.4	69.9	369	585	82.	90	56	75	S W	S W	S W	162.00	2 5	...	...	Clear.	Do.	C. C. St. 9.
8	935	941	947	51.3	58.0	44.2	368	336	224	96	72	79	N E b E	N b E	N b w	223.10	2 5	...	...	Cu. Str. 8.	Cu. Str. 9.	Clear.
9	998	960	993	48.5	62.6	48.0	285	370	251	85	66	74	N E b E	N b E	N W	123.40	1.0	...	...	Clear.	Do. 6.	Do. [Bor.
10	902	785	307	48.0	64.2	55.0	214	403	328	95	67	77	w b s	w b s	w b s	103.70	1.0	0.800	..	Slight frost.	Do. 8.	Cu Str. 9. Au.
11	802	701	677	35.9	64.4	53.0	293	403	375	96	67	93	w s w	w s w	S E	62.00	2.5	2.466	...	Clear h'y dew	Do. 10.	Rain.
12	699	726	747	45.6	44.8	46.3	297	275	293	98	92	96	N E b E	N N E	N	227.10	3.5	...	...	Rain.	Rain.	Cu. Str. 9.
13	800	889	770	47.3	71.4	35.0	199	371	31	90	49	93	N b w	w b N	w b s	234.30	1.5	...	...	Clear.	Clear.	Clear.
14	30.094	30.099	30.100	37.1	71.7	62.0	298	307	485	92	52	86	w b s	w b s	w b s	104.20	2.0	...	...	Do.	Do.	Do.
15	107	017	29.970	47 4	81.9	66.7	273	617	496	85	58	77	w b s	w b s	S W	50.00	2.5	Inap.	...	Do.	Do.	Do. Au. Bor
16	29.970	29.916	876	42.0	70.1	65.1	492	516	549	79	70	89	S W	S S W	S W	1.00	2.0	0.300	...	C. Str. 6.	C. Str. 10.	C. Str. 10 [B
17	700	815	897	62.8	72.3	62.2	549	489	429	97	62	77	S S W	W	S W	166.20	1 5	...	...	Do. 8.	Do, 4.	Do. 9. Au.
18	949	946	962	67.0	80.1	65.0	291	638	420	89	62	68	S W	S S W	S E b E	27.80	2.0	Inap.	...	Fog.	Clear	Clear.
19	860	853	871	42.0	73.0	63.8	368	614	556	95	68	92	S E b E	S E b E	S S E	6.60	2.0	0.640	...	Clear.	Cu. Str. 6.	Do. Au. Bor.
20	679	642	596	51.7	69.3	65.0	321	678	849	87	97	89	S S E	S S E	W	261.30	3.0	0.600	...	Cu. Str. 10.	Rain.	Cu. Str. 4.
21	498	566	790	52 3	63.9	48.3	334	422	326	86	75	70	w s w	w s w	S W	138.90	2.0	0.400	...	Do. 10.	C. Str. 6.	Clear.
22	854	725	863	42.0	61.4	54.6	251	413	390	96	77	93	S W	S E	w s w	118 11	4.5	...	...	Clear.	Do. 2.	Cu. Str. 9.
23	963	30.017	999	39.7	60.0	47.2	225	242	256	91	48	81	S w b w	S S W	S E	46.00	2 0	1.300	...	Do.	Clear.	Clear. [thun.
24	742	29.609	654	54.8	76.3	61.2	355	548	473	84	62	88	S S E	S E	S E b E	302.40	2 0	3 643	...	C. C. St. 6.	Cu. C. Str. 2.	Cu. Str. 10.
25	467	378	438	56.0	62.8	51.0	413	453	3..	90	80	89	S S E	w s w	w s w	284.80	3.5	0.400	...	C. Str. 9.	Do. 4.	Do. 8.
29	584	738	889	49.0	52.9	44.8	292	302	254	82	76	80	w s w	w s w	W	397.80	2 5	...	...	Do. 8.	C. Str. 2.	Do. 8.
27	30.045	975	979	33.7	40.7	41.8	102	223	228	84	64	87	W	w s w	S W	316.04	2.0	0.437	...	Clear frost.	Do. 2.	C. C Str. 6.
28	29.667	940	30.225	39.7	47.0	34.2	210	280	170	86	88	87	N b w	N W	w b N	77.60	3.0	...	...	Cu. Str. 10.	Do. 8.	C. C. Str. 6.
29	30.106	30.155	224	31.6	44.2	34.2	149	196	155	84	68	79	w s w	w b s	N w b w	225.40	1.5	...	...	Clear frost.	Do. 10.	C. Str. 10.
30	317	324	335	31.0	48.4	34.0	130	236	175	74	70	89	w s w	w s w	S	48.00	2.0	...	...	Do.	Clear.	Clear.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—OCTOBER, 1860.

(NINE MILES WEST OF MONTREAL.)

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

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

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapour.			Humidity of Air.			Direction of Wind.			Horizon'l Movem't in 24 hrs. In miles.	Mean of Ozone. (tenths)	Rain in Inches.	Snow in Inches.	Weather, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	30.202	30.161	29.912	27.0	42.8	39.6	.129	.209	.232	.88	.75	.95	E	s	s s E	67.70	2.5	1.039	...	1st frost, clear	Rain.	Rain.
2	29.973	29.992	30.026	39.0	49.0	43.8	232	297	209	95	84	93	w s w	w s w	w b N	14.42	2.5	...	...	Cu. Str. 10.	Cu. Str. 6.	Cu. Str. 10.
3	30.119	30.188	140	43.1	53.9	49.0	261	288	315	95	70	89	w s w	w	w b w	8.30	1.0	...	...	Do. 9.	Do. 9.	Do. 9.
4	084	29.981	29.955	45.6	46.8	46.0	293	305	286	95	96	92	N E b E	N E b E	N E b E	333.20	1.5	0.480	...	Rain.	Rain.	Do. 10.
5	29.903	789	868	46.5	53.7	45.0	305	341	275	96	83	92	s b E	w s w	w N w	158.70	2.0	0.051	...	Cu. Str. 4.	Cu. Str. 8.	Clear.
6	980	956	30.105	36.0	48.7	35.6	170	253	156	80	74	75	NW b w	NW b w	W	345.20	1.5	...	...	Cirri Str. 4.	Clear.	Do.
7	923	752	29.564	36.4	50.3	49.0	184	254	315	85	65	89	s s w	s w	s E b E	17.90	2.0	0.010	...	Clear.	C. C. Str. 6.	Cu. Str. 10.
8	220	218	833	41.4	49.3	[illegible]	251	247	188	96	71	77	N E	W	W	321.90	3.0	0.800	...	Rain.	Do. 6.	Clear. Au. Bo.
9	334	441	467	37.9	47.7	[illegible]	193	267	197	85	81	78	w b s	w b N	N b E	411.90	1.5	...	...	Cu. Str. 10.	Cu. Str. 8.	Cu. Str. 10.
10	479	446	434	37.6	53.0	52	193	251	294	86	63	79	s w	s	s b E	130.60	1.5	...	...	C. C. Str. 4.	Cir. Cum. 8.	Do. 8.
11	198	633	765	52.0	51.2	39.0	321	252	195	86	68	82	s b E	W	W b N	414.70	1.0	Inap.	...	Cu. Str. 6.	C Str. 10.	Do 2. Au.Bo.
12	820	785	893	32.4	50.0	41.0	168	258	212	95	71	82	w s W	s s w	s W	78 80	1.0	...	...	Clear. w frost.	C. C. Str. 8.	Clear, Ft. A.B.
13	950	900	30.100	31.6	51.4	38.1	149	296	186	84	79	81	W	w s w	s w b W	76.30	1.0	...	...	" "	Clear.	Do. do.
14	30.300	30.185	124	30.5	52.0	40.6	148	208	197	89	53	78	w s w	s w	s	105.70	1.0	...	...	" "	Cu. Str. 6.	Cu. Str. 10.
15	29.985	29.894	29.878	57.0	38.1	36.2	164	165	197	76	77	95	N E	N E	w s w	50.70	2.5	0.100	1.10	Cu. Str. 10.	Rain.	Do. 10.
16	865	750	798	34.1	57.5	51.0	182	302	302	95	66	82	w s w	w s w	w b s	164.40	3.5	0.196	...	Clear, w frost.	Cu. [illegible] . 4.	Rain.
17	964	30.074	30.184	40.3	54.2	41.0	210	308	241	86	74	95	E N E	N E b E	N E b E	156.00	2.0	...	...	Cu. Str. 4.	Do. 8.	Cu. Str. 2.
18	30.229	224	216	36.2	58.2	43.0	191	394	254	90	82	92	N E b E	N E b E	s b E	105.20	1.5	...	...	C. C. Str. 8.	Clear.	Clear.
19	095	069	140	36.0	63.7	47.9	179	416	280	87	72	88	s	s W b s	N E b N	64.50	1.0	...	...	Clear, w frost.	Cu. Str. 2.	Do.
20	263	200	274	36.3	49.3	39.2	170	175	180	80	50	77	N E b E	N E b E	N E b E	339.50	1.5	...	...	C. C. Str. 4.	Do. 4.	Cir. Cum. 2.
21	080	29 989	29.930	35.3	54.2	40.6	160	308	241	78	74	95	N E b E	N E b E	N E b E	232.80	2.5	2 522	...	Do. 6.	Rain.	Cu. Str. 10.
22	29.919	954	978	44.0	47.2	45.6	289	225	299	1.00	70	99	N E b E	N E b E	N E b E	254.80	4.0	...	...	Cu. Str. 10.	C. Str. 10.	Clear.
23	986	814	756	44.4	54.2	48.7	289	335	310	1.00	80	92	N E b E	N E b E	N b W	138.60	4.5	...	...	Hazy.	Do. 10.	Cir. Str. 10.
24	660	657	752	43.4	54.6	50.0	254	362	335	92	87	93	s W	W s W	s W	110.20	2.5	...	0.17	Cu. Str. 10.	C. C. Str. 4.	C. C. Str. 8.
25	800	814	825	49.7	59.1	51.2	341	317	350	96	62	90	s s W	s s w	s E b s	42.00	1.5	...	...	Do. 00.	Do. 6.	Clear.
26	673	756	976	49.3	54.2	40.3	341	231	203	96	55	82	s E b s	w b N	N N W	14.50	2.0	0.843	...	Rain.	Cu. Str. 10.	Do.
27	30.103	30.156	30.339	32.6	55.0	37.0	162	349	190	89	81	84	w	s s w	s E b E	69.60	1.0	...	...	Clear, w frost	Clear.	Do.
28	313	214	168	32.7	51.0	46.8	162	283	256	89	78	81	N E b E	N E b E	s s E	191.50	1.5	...	...	Cu. Str. 4.	Cu. Str. 8.	Cu. Str. 10.
29	031	026	048	45.3	51.6	50.5	293	368	354	96	96	96	s w	s w	w b N	218 40	4.0	0.746	...	Rain.	Do. 10.	Do. 6.
30	168	122	098	46.1	55 0	50.6	305	355	354	97	84	96	E b s	N E b E	N E b E	60.70	3.0	...	...	Cu. Str. 10.	Do. 10.	C. C. Str. 6.
31	080	063	060	49.9	70.1	62.0	335	469	549	93	67	97	E b s	E b s	E s E	144.40	1.5	...	...	C. C. Str. 6.	Do 6.	Clear.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—NOVEMBER, 1860.

(NINE MILES WEST OF MONTREAL.)

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

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

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Horizon'l Movem't in 24 hrs. In miles.	Mean of Ozone. (tenths)	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.					6 A.M.	2 P.M.	10 P.M.
1	30.097	30.114	30.176	61.3	68.4	62.6	.498	.513	.523	.91	.79	.94	S E b E	E S E	E	70.80	2.0	Inap	...	Cu. Str. 10.	Cu. Str. 10.	C. C Str. 6.
2	121	205	189	54.5	54.3	48.2	411	362	310	97	87	91	N E b E	N E b E	N E b E	268.50	2.5	...	...	Do. 10.	Do. 10.	Cu. Str. 4.
3	168	29.901	29.871	46.0	66.1	55.3	280	536	403	80	84	93	N E b E	N E b E	E N E	145.90	1.5	...	...	Do. 10.	Do. 4.	Do. 10.
4	29.442	624	715	50.5	53.3	43.2	354	244	231	96	60	83	SW b W	W	W S W	317.00	3.0	0.903	...	Nim. 10.	Do. 4.	Clear. Aur. Bo.
5	599	617	721	39.0	52.7	41.6	201	232	241	86	60	84	W	W	E S E	178.50	1.5	...	...	Clear.	C. C. Str. 6.	Cu. Str. 10.
6	691	656	679	41.5	42.3	38.1	235	199	208	91	74	91	S E	E N E	W S W	48.70	3.0	0.546	...	Cu. Str. 10.	Rain.	Rain.
7	770	796	947	36.0	38.6	33.3	191	186	164	[illegible]	80	85	W	W N W	W b N	365.70	3.5	0.211	...	Rain.	Cu. Str. 10.	Clear.
8	30.000	979	30.000	31.3	45.6	40.0	155	218	201	89	66	86	W S W	W S W	N E b E	106.70	1.5	...	...	Clear, w frost.	C. C. Str. 8.	Cu. Str. 9.
9	29.997	886	29.845	37.1	47.5	33.3	206	242	168	95	74	90	W	S W	S W	17.20	2.0	...	...	C. C. Str. 10.	Clear.	Clear.
10	784	664	500	34.0	44.6	39.1	183	189	216	90	64	91	N E b E	N E b E	N E b E	251.76	3.5	...	...	Do. 6.	C. Str. 10.	Rain.
11	463	456	426	39.1	49.4	40.1	216	297	254	91	85	92	E	N N E	N	296.60	2.5	0.536	...	Cu. Str. 6.	Do. 10.	Cu. Str. 10.
12	515	513	614	39.0	47.3	45.3	208	267	269	90	82	88	W b N	W	NW b N	62.50	2.0	...	...	C. C. Str. 8.	Do. 4	Do. 9.
13	795	812	887	42.1	46.2	37.3	244	285	199	91	84	89	W b N	W b N	N W	115.70	1.5	...	...	Do. 6.	Do. 2.	Clear.
14	950	950	991	30.1	47.0	34.2	145	232	167	89	73	88	W	W b S	W N W	70.60	2.0	...	...	Clear, w frost.	Clear.	Do.
15	895	917	30.006	33.1	44.2	38.9	143	240	201	70	83	86	NW b W	S W b W	S S W	81.40	2.5	...	...	Cu. Str. 4.	C. C. Str. 10.	Cu. Str. 10.
16	30.045	30.034	055	35.4	41.0	31.8	169	154	155	84	61	89	N E b E	S S W	S	7.40	2.0	...	...	C. C. Str. 6.	Cu. Str. 6.	Str. 1.
17	29.900	29.859	29.697	29.2	36.4	32.7	142	129	162	88	61	84	E N E	N N W	N b W	49.80	2.5	...	...	Do. 4.	Do. 6.	Cu. Str. 10.
18	280	218	323	31.1	35.9	33.4	155	177	168	89	85	89	N E b E	N b E	N E b E	74.30	3.5	Inap	0.15	Snow.	Do. 10.	Do. 10.
19	165	174	230	34.5	38.9	35.2	190	201	199	95	86	96	N E b E	N E b E	S S E	63.60	3.5	0.372	...	Nim. 10.	Do. 10.	Do. 10.
20	180	320	422	36.0	39.3	33.8	186	173	162	86	73	84	S S E	W b N	W N W	238.40	4.0	0.140	...	Cu. Str. 10.	Do. 10.	Do. 9.
21	600	621	801	27.0	30.9	28.7	129	124	146	88	84	90	W S W	W S W	S b W	130.40	2.5	...	...	Do. 4.	Do. 10.	Do. 9.
22	879	869	868	22.4	35.0	32.0	095	162	149	79	80	84	W S W	S W	S W	101.30	2.5	...	...	Do. 8.	Do. 10.	Do. 10.
23	867	797	604	35.0	40.4	37.5	183	203	214	90	82	95	S b W	S E b E	S E b E	228.50	3.0	...	Inp	Do. 10.	Do. 10.	Do. 4.
24	907	135	232	39.1	27.6	22.1	227	105	179	99	70	65	W S W	W S W	W S W	720.00	3.0	3.190	...	Rain.	Sleet.	Do. 6.
25	465	659	972	20.4	21.1	23.2	075	076	106	70	71	86	W b N	W b N	W S W	710.00	2.0	...	...	Cu. Str. 10.	Cu. Str. 6.	Do. 10.
26	30.183	30.142	30.054	13.4	24.7	26.3	057	120	123	72	89	87	W S W	S b W	S S E	546.00	2.5	...	...	Clear.	Do. 6.	Do. 10.
27	29.665	29.580	29.851	32.3	41.0	32.6	162	212	162	89	82	89	S b W	W S W	[illegible]	314.00	2.5	...	3.54	Snow.	Do. 6.	Clear.
28	894	890	851	20.8	28.3	19.6	091	129	081	85	82	77	W	N N W	W S W	110.00	2.5	...	...	Clear.	Do. 8.	Do.
29	571	594	502	20.4	34.4	32.0	082	169	169	74	84	88	S W	S W	W	57.10	2.0	...	...	C. C. Str. 4.	Sleet.	Cu. Str. 10.
30	400	314	225	32.1	35.4	33.0	143	160	168	79	87	89	W	W	N E b E	69.10	2.0	Inap	Inp	Cu. Str. 10.	Snow.	Sleet.

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

Barometer	Highest, the 27th day	30.330
	Lowest, the 11th day	29.198
	Monthly Mean	29.919
	Monthly Range	1.141
Thermometer	Highest, the 31st day	70°.1
	Lowest, the 1st day	26°.1
	Monthly Mean	45°48
	Monthly Range	44° 0
Greatest Intensity of the Sun's Rays		85°.0
Lowest Point of Terrestrial Radiation		22°.2
Mean of Humidity		.839
Amount of Evaporation		1.32

Rain fell on 11 days, amounting to 6 787 inches; it was raining [illegible] hours and 44 minutes.

Snow fell on 2 days, amounting to 1.27 inches; it was snowing 11 hours.

Most prevalent wind, the N. E. by E.

Least prevalent wind, the E.

Most windy day, the 11th day; mean miles per hour, 16.88.

Least windy day, the 3rd day; mean miles per hour, 0.23.

Aurora Borealis visible on 4 nights.

The Electrical state of the Atmosphere has indicated high tension.

Two distinct and smart shocks of an earthquake were felt here at 5.55 a.m. on the morning of the 17th day, the wave passing from E. to W. The sound wave was distinctly perceptible after the passage of the earth wave.

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

Barometer	Highest, the 2nd day	30.205
	Lowest, the 24th day	28.950
	Monthly Mean	29.730
	Monthly Range	1.255
Thermometer	Highest, the 1st day	71°.4
	Lowest, the 26th day	12°.0
	Monthly Mean	37°.59
	Monthly Range	59°.4
Greatest Intensity of the Sun's Rays		82°.1
Lowest Point of Terrestrial Radiation		12°.0
Mean of Humidity		.839

Rain fell on 10 days, amounting to 5.898 inches; it was raining 48 hours 29 minutes.

Snow fell on 4 days, amounting to 3.69 inches; it was snowing 7 hours and 5o minutes.

Most windy day, the 24th : mean miles per hour, 29.35.

Least windy day, the 16th . mean miles per hour, 0.33.

Most prevalent wind, the S. W.

Least prevalent wind, the E.

Aurora Borealis visible on 1 night.

The Electrical state of the Atmosphere has indicated constant and moderate intensity.

The Symmetrical wave was well marked during the month.

Snow birds (*Plectrophanes Nivalis*) first seen on the 3rd day.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR AUGUST, 1860.

Barometer	Highest, the 15th day	30.670
	Lowest, the 30th day	29.459
	Monthly Mean	29.760
	Monthly Range	0.611
Thermometer	Highest, the 10th day	92°2
	Lowest, the 12th day	39°2
	Monthly Mean	69°29
	Monthly Range	52°9
Greatest Intensity of the Sun's Rays		110°6
Lowest point of Terrestrial Radiation		31°1
Mean of Humidity		.740

Amount of Evaporation, 3.02 inches.

Rain fell on 13 days, amounting to 9.361 inches; it was raining 51 hours and 44 minutes, and was accompanied by thunder and lightning on two days.

Meteor in E. 5th day, at 8.45 p. m.

Meteor in S. 12th day, at 8.30 p. m.

Solar rainbow 19th day.

Lunar Rainbow at 8 p. m. 25th day.

Most prevalent wind, the S. W.

Least prevalent wind, the S.

Most windy day, the 26th day; mean miles per hour, 10.70.

Least windy day, the 2nd day; mean miles per hour, 0.20.

Aurora Borealis visible on 10 nights.

The electrical state of the atmosphere has indicated high intensity.

Solar Halo visible on 16th day at 9.30 a. m.

Slight frost on the morning of the 12th day.

REMARKS ON THE ST. MARTIN, ISLE JESUS, METEOROLOGICAL REGISTER FOR SEPTEMBER, 1860.

Barometer	Highest, the 30th day	30.335
	Lowest, the 25th day	29 376
	Monthly Mean	29.885
	Monthly Range	0.959
Thermometer	Highest, the 15th day	83°9
	Lowest, the 30th day	25°5
	Monthly Mean	56°40
	Monthly Range	58°4
Greatest intensity of the Sun's rays		105°6
Lowest point of Terrestrial Radiation		20°1
Amount of Evaporation		2.90
Mean of Humidity		.777

Rain fell on 13 days, amounting to 11.236 inches; it was raining 58 hours 36 minutes, and was accompanied by thunder and lightning on two days..

Solar Halo 14th day.

Lunar Corona and imperfect Halo 27th day.

Very slight snow fell on the 29th day. Inappreciable, the first of the season.

Sharp frost on the mornings of the 29th and 30th days.

Morning Rainbow on the 20th day.

Most prevalent wind, the W. S. W.

Least prevalent wind, the N.

Most windy day, the 26th day; mean miles per hour, 18.86.

Least windy day, the 2nd day ; mean miles per hour 0.00

Aurora Borealis visible on 5 nights.

The Electrical state of the Atmosphere has indicated moderate intensity.