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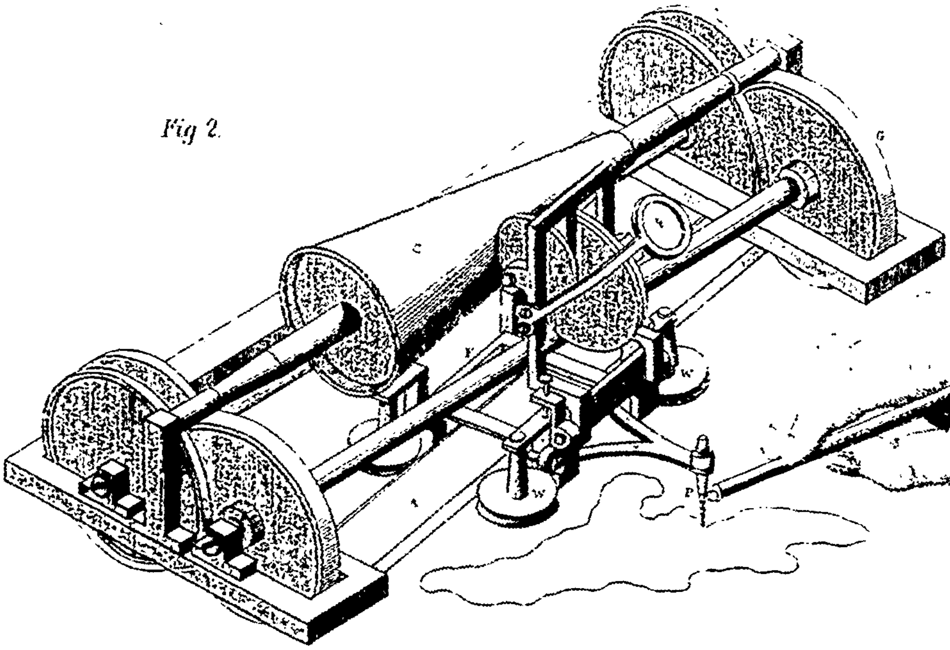

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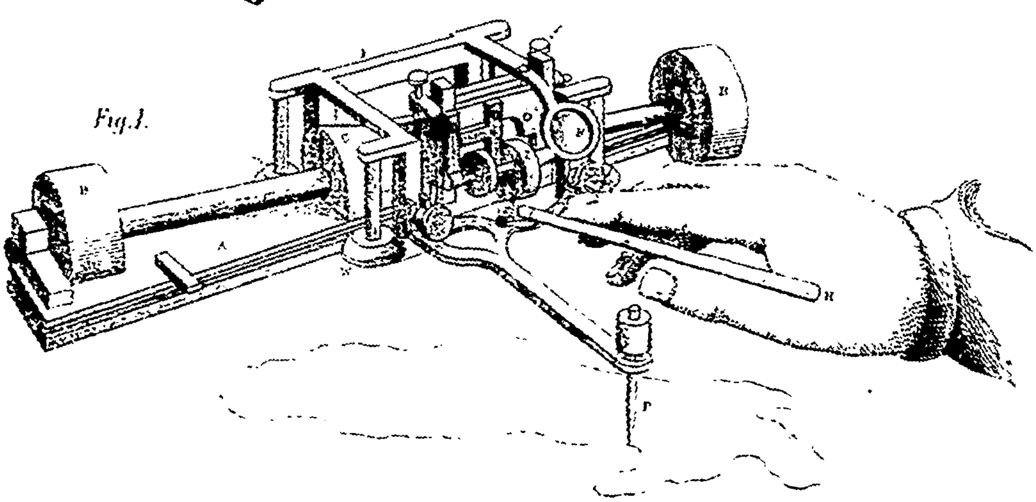


The Canadian Journal.

TORONTO, JULY, 1854.

On the Periodical Rise and Fall of the Lakes.

By Major Lachlan, *Montreal.*

Few countries can boast of objects of more imposing natural grandeur, or deeper philosophical interest, than are presented in Canada—in the vast extent and other striking peculiarities of its magnificent inland *fresh water* seas, and their noble connecting rivers and unrivalled cataracts, coupled with the singularly anomalous nature of its climate and seasons, compared with European countries in the same parallels of latitude; and an additional geographical interest may be considered as attaching to it, in the magnetic meridian passing through it—the line of "No variation" curving through part of its mediterranean waters.*

The investigation of the causes and effects of these great physical phenomena might well engage the attention of a whole life of patient observation and study; and such, doubtless, will at no distant day, be the case; but in the present state of things, in so young a country, all that can be expected is the occasional contribution of the unpretending philosophical *gleaner;* and, as such, I now venture to lay before the Canadian Institute the following desultory observations on the periodical rise and fall of our great Lakes, in the hope of strengthening the arguments adduced by me in the Paper which I had lately the honour of submitting to it, in advocacy of the establishment of a system of simultaneous meteorological and tidal observations throughout British America—as not only a great philosophical desideratum, but also likely to prove of substantial service to the country, were it only to make us better acquainted with the great benefits derived and derivable from the climatic influence of our mighty inland waters.†

In the introduction to my former paper, I was led to remark that it is now seventeen years since my attention was first attracted to these interesting philosophical subjects, by remarking the great difference in the newspaper reports of the temperature, direction of the winds, and state of the weather in different parts of the Province at the same time, as compared with each other, and by having at my residence on the banks of Lake Erie been for seven years in the habit of noticing the constant extraordinary fluctuations in the level of that noble Lake; at times consisting only of slight irregularly recurring oscillations; at others, showing a sudden change of level, apparently caused by the temporary impulse of passing storms; at others, evincing a longer continued state of elevation or depression, in evident accordance with the more enduring influence of winds blowing from the same quarter for days together; and at others, and more especially and unaccountably, of a longer maintained rise of several feet above the usual level, sometimes lasting for a whole season, or even more, as was the case during the memorable years, 1838-39—regarded at the time by some of my neighbours as the traditional seven years' flood.

Being much struck with these singular phenomena, and yet not being sufficiently at leisure, as well as feeling myself otherwise disqualified for attempting a scientific investigation of their causes, I nevertheless naturally felt a strong desire to ascertain what had been, or might, from time to time be written on the subject by more able philosophical observers; and I accordingly made a practice of taking notes from all such published works, and other sources of information, as referred to them, as they happened to fall in my way, until I had, in the course of years, accumulated a mass of miscellaneous memoranda—not to call it testimony—on the subject, of so conflicting a character as frequently rather to add to the perplexity than promote the elucidation of the object in view; and the consequence was, that, after vainly attempting to classify and reconcile the information therein contained, regarding the rise and fall of the Lakes generally, and comparing it with my own passing observations and enquiries respecting Lake Erie in particular, I came to the conclusion that there was still more room for further investigation, as all the Lakes did not appear to be always governed by simultaneous influences;* and, therefore, that the only chance of arriving at a correct knowledge of the state of the whole matter would be the adoption of some such course of long-continued meteorological and tidal observations throughout the country, as that which I ventured to propose in my last paper.

Having in that communication enlarged principally on the value of a wide-spread series of simultaneous meteorological observations, as the more important branch of the great object in contemplation, I propose to confine myself, on the present occasion, to the no less interesting, though minor, part of the undertaking—aiming at the institution of a simultaneous record of the daily variations in the level of the great Lakes, with the view of throwing light on, and, if possible, deciding the three following doubtful points: 1st, How far there is any foundation for the traditional report, that there is a septennial rise and fall in the waters of the Lakes, and if so, to what height; and whether such phenomenon takes place in all the Lakes simultaneously or otherwise. 2d, The amount of the better known annual variations in the level of the different Lakes; and how far these changes occur in each at the same time; and whether they are solely due to the annual amount of the rain and snow in the surrounding country, compared with that of the evaporation during the summer months, or to any other cause therewith combined. And 3d, How far the daily or other more frequent oscillations, or irregular tides, observable in the different Lakes, are general, and arise from the temporary force and direction of winds passing over their surface, or are peculiar only to certain localities; and whether they are in any sensible degree influenced by atmospheric pressure, or lunar attraction, or otherwise. All which, it is hoped, would in the course of time be satisfactorily decided, by a daily record of the actual level of the Lakes, combined with that of the prevailing winds and weather, at a

* To do justice to the subject treated of in this Paper, a good map of British America should be at hand to be referred to, and, above all others, that graphic "Map of the Valley of the St. Lawrence," constructed by T. C. Keefer, Esq., in which the striking connection of the whole system of Lakes is so well pourtrayed.

† As a remarkable instance of the *tempering* influence of the proximity of the Lakes, it may here be mentioned, that in the immediate vicinity of Cleveland, the temperature during 10 years has in no instance fallen below Zero, while at Colombo, Lunicella, and Cincinnati, from 120 to 150 miles farther south, it has frequently sunk to 5 deg. and 10 deg. below it; and that in Northern Ohio, generally, the tender vegetation is usually cut down within five days of the 25th October, whereas the Lake shore remains untouched for two weeks later; and during the winter, when deep snow falls elsewhere, there is comparatively little near the Lake.—American Journal of Science, 2d Series, vol. 13, pp. 215 to 219.

‡ This will be found patiently illustrated in a tabular view of the Rise and Fall of Lake Erie, incorporated in this paper.

fixed number of stations, at hours simultaneous with the other meteorological observations.

Taking it, at all events, for granted that such will be the case, I proceed, as an indispensable preliminary step, to take a discursive view of the yet debateable state of the question, as brought home to my mind by a comparison of the casual observations made by myself on Lake Erie, compared with the recorded opinions expressed by others, possessing either greater ability, or more leisure and better opportunities, for prosecuting such an enquiry,—as far as the very miscellaneous and disjointed memoranda accumulated by me will enable me to do so.

In accordance with this intention I may, in the first place, remark, that though the phenomena connected with the various periodical fluctuations in the level of the Lakes appear to have attracted the notice of philosophic travellers near two centuries ago, they remained altogether uninvestigated till very lately. The minor tides or oscillations were first alluded to by Fra. Marquette, the Jesuit, in 1673, and more particularly by the Baron La Hontan in 1689: and they were afterwards further noticed by Charlevois in 1721, and also by the British travellers, Mr. Carver in 1766, and Mr. Weld in 1796; but it was not till twenty years afterwards that the whole subject began to engage the particular attention of men of science in America, and especially of the talented individuals engaged in the Geological Surveys of the States of New York, Ohio, and Michigan—among whom I find them successively noticed by Colonel Whiting in 1819 and 1829, Mr. Schoolcraft in 1820, General Dearborn in 1826, and Governor Cass in 1828; and more particularly by Professors Hall and Mather, Colonel Whittlesley, Dr. Houghton, Mr. Higgins, and others, in their valuable official reports, from 1838 to 1842; as well as by various observant British officers and travellers, such as Captains Bayfield and Bonnycastle, and Messrs McTaggart, Macgregor, and others, the purport of all of whose observations will be found more or less glanced at in the sequel:—and yet, strange to say, these singular phenomena still remain involved in mystery!

It so happens that the observations of all the early writers on this interesting subject were confined to Lakes Superior, Michigan, and Erie, and were directed more to the daily fluctuations or tides remarked at particular places, than to the actual existence of the traditionary great septennial rise and fall of the waters of the whole Lakes. Thus, for instance, Baron La Hontan, on reaching Green Bay, at the northern extremity of Lake Michigan, at its conjunction with Lake Huron, remarks that where the Fox river is discharged into that Bay, he observed the waters of the the Lake swell three feet high in the course of twenty-four hours, and decrease as much in the same length of time. And he also noticed a contrariety and conflict of currents in the narrow strait which connects Lakes Huron and Michigan, which were so strong that they sometimes sucked in the fishing nets, although two or three leagues off. In some seasons it also happens that the current runs three days eastwards, two days westwards, and one day to the south, and four to the northwards, sometimes more and sometimes less.

Charlevois also noticed similar appearances; and supposes Lakes Huron and Michigan to be alternately discharged into each other through the Straits of Michillimackinac; and mentions the fact that in passing that Strait his canoe was carried by the current against a head wind.

But it was not till 50 years afterwards that we were indebted to that intelligent British traveller, Mr. Carver, for any great additional light on this mysterious subject, as well as for other particulars regarding the then unknown region of Lake Superior, from information acquired on the spot. But as his remarks are alluded to by a subsequent equally respectable and observant English writer, Mr. Weld, who visited Canada in 1796, we are content to refer to the interesting volume of the latter for the following (much condensed) appropriate observations.*

"It is confidently asserted, not only by the Indians, but also by great numbers of the white people who live on the shores of Lake Ontario, that the waters of this Lake rise and fall alternately every seventh year. Others, on the contrary, deny that such a fluctuation does take place; and, indeed, it differs so materially from any that have been observed in large bodies of water in other parts of the globe, that I am tempted to believe it is merely an imaginary change. Nevertheless, when it is considered, that, according to the belief of the oldest inhabitants of the country, such a periodical ebbing and flowing takes place, and that it has never been clearly proved to the contrary, we are bound to suspend our opinions on the subject. For instance: a gentleman who resides close upon the borders of the Lake, not far from Kingston, and had leisure to attend to such subjects, told me that he had observed the state of the Lake for nearly fourteen years, and that he was of opinion that the waters did not ebb and flow periodically; yet he acknowledged the very remarkable fact that several of the oldest white inhabitants in his neighbourhood declared, previous to the late rising of the Lake, that the year 1795 would be the high year; and that in the summer of that year the Lake actually did rise to a very uncommon height. He said, however, that he had reason to think that the rise on this occasion was wholly owing to fortuitous circumstances, and not to any regular established law of nature; and that its being greater than usual was more imaginary than real; and he formed this opinion from the circumstance that when the Lake had risen to its unusual height in 1795, he had questioned some of the oldest people as to the comparative height of the water on this and former occasions, when they affirmed that they had seen them equally high before." Now, a grove of trees which immediately adjoined this gentleman's garden, of at least thirty years' growth, was entirely destroyed this year by the waters that flowed amongst them; and if, therefore, the Lake had ever risen so high before, this grove would have been then destroyed; a circumstance militating stongly against the evidence as to the height of the waters, but which only proved that they had risen on this occasion higher than they had done for thirty years' preceding, and *not* that they had not during that term risen *periodically* above their usual level.*

* I take the opportunity of here remarking that I might easily have imparted a *seeming* greater degree of originality to this paper by continuing to make only occasional reference to parts of information derived from different writers, and connecting them with a few second-hand observations in my own language; but feeling myself already dissatisfied on that head, and being desirous of exhibiting the whole evidence on the question, independent of any opinion of my own, I have adopted a more equitable course, in, as much as possible, allowing my authorities to speak for themselves, in their own language. I may at the same time add, that, in perusing the following and other hurriedly copied extracts and *memoranda*, accumulated at uncertain intervals during a course of more than fifteen years, and frequently at times when opportunities of access to books were "like angels' visits, few and far between," it must be borne in mind that they were made without any view to publication, and simply for the purpose of furnishing the means of hereafter comparing the observations of different writers on an important philosophical question, in which I had long taken a deep interest; and that they will, therefore, perhaps often be found *neither* altogether verbatim nor regularly connected, and perhaps even betraying not

What Mr. Carver relates concerning this subject rather tends to confirm the opinion that the waters of the Lake do rise periodically. "I had like (he says) to have omitted a very extraordinary circumstance relative to these Straits (of Michillimackinac, between Lakes Michigan and Huron). According to observations made by the French, whilst they were in possession of the fort there, although there is no diurnal flood or ebb to be perceived in these waters, yet from an exact attention to their state a periodical alteration has been discovered. It was observed that they arose by gradual but almost imperceptible degrees till they had reached the height of three feet. This was accomplished in seven and a half years; and in the same space of time they as gently decreased, till they had reached their former situation. So that in fifteen years they had completed their inexplicable revolution. At the time I was there, the truth of these observations could not be confirmed by the English, as they had then been only a few years in possession of the fort, but they all agreed that some alteration in the limits of the Straits was apparent." "It is to be lamented (judiciously added Mr. Weld) that succeeding years have not thrown more light on this subject. . . . A long series of observations are necessary to determine positively whether the waters of the Lakes do or do not rise and fall periodically. It is well known, for instance, that in wet seasons they rise much above the ordinary level, and that in very dry seasons they sink considerably below it; a close attention, therefore, ought to be paid to the quantity of rain that falls, and to evaporation; and it ought to be ascertained in what degree the height of the Lake is altered thereby, otherwise, if it happens to be higher or lower than usual on the seventh year, it would be impossible to say with accuracy whether it were owing to the state of the weather, or to certain laws of nature, that we are as yet unacquainted with. At the same time great attention ought to be paid to the state of the winds, as well in respect to their direction as to their velocity—for the height of the water in all the Lakes is materially affected thereby. Moreover, these observations ought not to be made at one place only, but at different places at the same time. . . .

"It is also believed by many persons that the waters of Lake Ontario not only rise and fall periodically every seventh year, but that they are likewise influenced by a tide which ebbs and flows frequently in the course of twenty-four hours—as, for instance, in the Bay of Quinté, where it has been observed to rise fourteen inches every four hours. But there can be no doubt that this must be caused by the wind—no such regular fluctuation being observed at Kingston, and this Bay being a long crooked inlet, that grows narrower at the upper end; and therefore not only a change of wind up and down would make a difference at the upper extremity, but the waters, being concentrated there, would be seen to rise or fall, if impelled even in the same direction, whether up or down, more or less forcibly at one part of the day than another. . . An appearance like a tide must therefore be seen almost constantly at the head of this Bay, whenever there is a breeze. I could not learn that the fluctuation had ever been observed during a perfect calm; were the waters, however, influenced by a regular tide, during a calm, that would be most readily seen."

Reserving any comments on the foregoing pertinent extracts for a future page, I proceed to remark, that such continued to be the unsatisfactory amount of information on this interesting debateable philosophical question, till about 1819, when Capt. (afterwards Col.) Whiting, of the American Army, at length recurring to the exciting subject, made, at the request of Governor Cass, a series of *regular observations* upon these oceanic appearances, during seven or eight days, in the month of June, serving to show that at that remarkable inlet, Green Bay, there is a daily rise and fall, but that it is irregular as to the precise period of flux and reflux, and also as to the height which it attains;* and yet such was the variety of opinion among local residents on the fact, that he is compelled to state, in the course of his remarks, that being led to suppose that the winter would be the most favourable time for making such observations, when the superincumbent ice would nearly destroy the influence of the winds, and show the unassisted operation of the tide, he made enquiries as to its appearance during that season, when *one* gentleman informed him that *no* tide was then discernible, while another, equally intelligent, assured him that it was *very apparent*, and that there was a regular elevation and depression of the ice!

From all which conflicting circumstances (as judiciously observed by (I think) Mr. Schoolcraft in the same article) there was reason to conclude that a well-conducted series of experiments would prove that there are *no* regular tides in the Lakes; at least, that they do not ebb and flow twice in twenty-four hours, like those of the ocean; that the oscillating motion of the waters is therefore not attributable to planetary attraction; and that it is very variable as to the periods of its flux and reflux, depending upon the levels of the several Lakes, their length, depth, direction, and conformation, upon the prevalent winds and temperature, and upon other extraneous causes, which are in some measure variable in their nature, and unsteady in their operation.

Colonel Whiting further remarks in another interesting article on the supposed tides and periodical rise and fall of the North American Lakes,† in which is given a table of observations kept at Green Bay, in six weeks, July and August, 1828, that an examination of that record would satisfy any one that planetary influence had little or nothing to do with the changes of elevation in the waters there noted; and that it was as certain that the fluctuations in some places appear to be independent of atmospheric as of lunar control; as, by consulting that table, there would probably not be found one instance where the time of high water tallies with the moon's southing, admitting the usual retardation. And further, that it would also be seen that the changes of elevation were independent of the course of the wind; for that the fluctuation continues, notwithstanding the winds remaining the same. He, therefore, came to the conclusion that, reasoning from our knowledge of the great inland waters of the other hemisphere, we should take it for granted that the North American Lakes have no sensible tides; the Caspian, Black, and Baltic Seas being said to have none worthy of observation, and even the Mediterranean being indebted to the sharp-sightedness of modern times for the knowledge of there being such a phenomenon on her wide-spread bosom.‡ Col. Whiting, however subsequently remarks, writing in 1830, with regard to what General Dearborn terms "the periodical increase of the whole volume of waters in the American Lakes," that it is the popular tradition on these Lakes that there has been a rise and fall once

a few verbal errors; but whatever their defects may be, compared with the originals, the reader may be assured that there was no intention to alter or distort the meaning or merits of the author, and that they may therefore be considered as a faithful epitome of more extended observations.

* The destruction of these trees would depend more on the length of time they were inundated, than on the mere fact of their having been temporarily flooded.—R. L.

† See American Journal of Science, Vol. 16, pp. 90 and 91.

‡ See American Journal of Science, Vol. 20, pp. 205 to 219.

§ See close of this article.—R. L.

in every fourteen years, or that its recurrence has been sufficiently precise to authorise the belief in its regularity; but that the New York Canal Commissioners state the intervals to be once in about eleven years; and that no actual observations appeared to have been made on the progress of the elevation, as to whether there were any preceding seasons of a character to produce it; and, therefore, after noticing various well-known periods at which remarkable elevations and depressions took place, such as in 1800, 1815, 1820, 1828, and 1830, by way of proof of the periodical return of that phenomenon being regular or otherwise, he was obliged to come to the conclusion that, as far as *facts* go, they are certainly in favour of the popular theory, but that it rests on these facts alone, and is in many other points of view improbable and absurd; and that we are therefore constrained to suppose, though destitute of the light of actual observation, that the fluctuations observed must have been caused by unusually abundant rains and snow, and that this abundance had been in fortuitous coincidence with certain *cycles* of time; for, improbable as this may be, it is less so than that nature should have departed from her ordinary course.*

Having, in a previous page, quoted largely from Mr. Weld, I now proceed to notice the judicious remarks on the rise and fall of the Lakes by another intelligent British observer, Mr. McTaggart, who, writing in 1828, sets out by at once *affirming* that "there are no tides in any of the Lakes—none, at least, from the moon's influence: but that the floods of spring generally raise them from three to four feet. It is said that Lake Ontario rises once in every seven years higher than usual by two feet. The people ascribe this to some supernatural cause. In the spring of 1827 it had one of these periodical tides, rising nearly three feet higher than it had done the previous year, and keeping high the whole summer. Being in the neighbourhood (observes Mr. McT.) I paid the utmost attention to the phenomenon, and found that there fell during that summer much more rain than had fallen for many years before; and that there was little sunshine throughout the season; and I, consequently, concluded that the exhalations from the Lake were not so copious. There was another circumstance that puzzled me. Lake Ontario, and indeed, all the Lakes were up to their very highest surface marks, *but the rivers flowing out of them were not.* Those surface marks were very obvious on the rocky shores of the Lakes, drawn like so many chalk lines by Nature herself.

"Rivers do not rise exactly from the same cause as Lakes. If in spring the snow melts off the country on a sudden, and the frozen swamps break up and disembogue their contents, then the rivers will rise to their utmost height as water pours into them on all sides; but when the sun has effected this, they begin to fall. Lakes swell, it is true, from the same cause, but not with the same comparative haste; their surface being of great extent, the floods can only spread over them by slow degrees; and if the sky keep cloudy and the weather moist, so that little evaporation goes on, the surface of the Lake will continue to swell, while that of the river will fall—as the country on either side is drained—nothing tending to keep up its flood but the mere discharge from the Lake. Rivers and Lakes are never at their utmost pitch of flood at the same time; neither are they ever at the lowest ebb at the same time; for when the floods of a river have subsided to a certain extent, the intense heat of the summer sun, setting upon the shelving sides of the rocky channels, and even upon the bed of the river itself, tends greatly to promote the absorption of the waters, whereas in the deep wide Lake this action cannot take place.

"The unusual rise of the waters of the Lakes in some seasons, which some observers state to be seven feet above the common level, seems to be only rationally accounted for by the absence of evaporation, and greater quantities of rain than generally prevail. Once in every seven years it is said to rise thus; but 7, like 3, is a number open to superstition,† not to be always relied on, and it would not be surprising if this flow were to happen once in six, or even in ten years. It will yet, likely, be discovered that when Lake Erie has its brim flood, the others have theirs also during the same season; and when powerful suns are excluded from drinking them up, by the intervention of drizzling clouds, and this exclusion extending over an immense surface, we shall cease to marvel at these wonderful septennial floods. It has also been remarked that the winters after these seasons have had little snow; but *meteorology on this score remains to be further prosecuted, ere the theory dare be advanced, that it is from the moisture absorbed in circumjacent regions* during summer that the snows of winter are supplied."

Passing from the borders of Lake Ontario to the regions of Lake Superior, I am next enabled to refer to some equally peremptory observations on the same subject, made by that eminent British hydrographer and geologist, Capt. Bayfield, on the spot, in the course of 1825-26; from whose valuable and interesting paper on the geology of the latter Lake I extract the following particulars:‡

"There is no regularly periodical rising or falling of the Lakes, as has been asserted, whether it be from the influence of the moon, or any other. They rise and fall from accidental causes; such as a very severe winter without the usual thaws. The springs are locked up all winter, and the whole accumulated snow remains until the spring, when the weather, becoming suddenly warm, dissolves it at once. Hence it will generally be found that after a very severe winter, the waters of the Lakes will be much higher than at other times. Heavy gales also raise the water in the upper parts of the Lakes, and also cause *currents* in various directions. The rise, however, in Lakes Superior and Huron, from this or any other cause, never exceeds a few feet. . . Whether a gradual diminution of the waters of Lake Superior is now going on, is a point on which no one is qualified to give an opinion; for no observations have been made or recorded to ascertain the interesting fact. Any diminution must be always imperceptibly gradual, and would require constant, accurate, and regularly recorded observations during a great number of years to render this indisputable. The streams which discharge into Lake Superior amount to several hundreds in number, and the quantity of water supplied by them is many times greater than that discharged at the falls of St. Mary, the only outlet. There is, however, no reason to imagine from this that the quantity of water increases; for it is absolutely necessary that there should be a supply very far exceeding the discharge, to replace the immense expenditure arising from the evaporation from so extensive a surface."

Adhering to my intention of reserving for the present any comments on the above, as of other quotations, I now revert to

* See American Journal of Science, Vol. 20, pp. 218, 219.

† It was stated by Professor Johnston, in his address at the New York Agricultural Society meeting at Syracuse, as a fact, that Holland is exposed, on the average of the last thirteen centuries, to one great sea or river flood, every seven years.—R. L.

‡ See Transactions of the Lit. and Hist. of Quebec. Vol. I., pp. 1 to 43.

the next American writer on this important subject, namely, General Dearborn, who, in the 16th volume of the American Journal of Science, already referred to, observes that "it is not sufficiently certain that tides may not be produced in the great chain of Lakes, in the same manner as they are in the ocean;" and in proof thereof quotes an elaborate theory of the distinguished Dr. Young (illustrated by three diagrams) which had at that time been sanctioned by the scientific for more than twenty years, not only presuming the possible existence of such tides, but furnishing the means of demonstrating that such is the fact in deep and broad lakes, and even going so far as, where the area and depth of a lake is known, to give a theorem by which the maximum rise and fall of the waters and the time of its oscillation, or in which a tide wave might pass over it, can be ascertained.* But the General at the same time admits, with regard to "the periodical increase and diminution of the whole volume of water in the Lakes," that he is in possession of no definite facts, save what was contained in a letter from Captain Dearborn, stating, that whilst stationed at the Sault Ste. Marie, on Lake Superior, he had himself observed for three successive days an ebb and flow of about one-and-a-half feet, in the course of about two-and-a-half hours each; but that he attributed it to the winds; and that he supposed that the rise and fall which takes place during periods of from three to seven years, to be possibly the effect of increased depth of water in the Lake, caused by an unusual amount of snow on its borders and tributary streams, or an uncommon rainy season; and that it even appeared from an extract from the *New York Advertiser*, that a gentleman just then (1828) returned from a tour to the West, had informed the editor that the waters of Lakes Ontario and Erie were then nearly a foot higher, while those of Lake Superior were considerably lower than ever known. The General was therefore led to suggest that, to obtain full and exact data as to the rise and fall of the different Lakes, tide-guages should be placed at a number of points on the shore of each, both in their narrowest and broadest dimensions, and the changes carefully observed for a whole year, or at least for several months, and accurate tables kept of the times and extent of each flux and reflux, in which the position, as respects the meridian and the phases of the moon, and also the course of the winds should be noted;—a plan which, it will be perceived, is very similar to that proposed by myself in my late paper on the establishment of simultaneous meteorological observations.

Such continued to be the state of the question, till the institution, by the American States, of those great patriotic works, the Geological Surveys of New York, Ohio, and Michigan, when the subject being taken up by the talented individuals employed in that duty, as far as their other immediate avocations would permit, with that spirit which ever distinguishes the lovers of science, I was enabled to glean many interesting additional particulars from their official reports, though, unfortunately, none sufficiently conclusive to solve the great philosophical problem so long under discussion. Among these I, of course, rank first the eminent American geologist, Professor Hall, from whose elaborate work, put forth under the enlightened auspices of the State of New York, I extract the following valuable remarks on the elevation and depression of the great Lakes:†

"The fluctuating level of the waters of these Lakes has long excited attention; and many speculations have been hazarded to account for the phenomenon. The somewhat general belief that the periodical rise and fall in their waters occupy seven years appears not to be founded on authentic observation. Sand bars and beaches, or the inlets of certain bays, are regarded as the landmarks; and these being liable to fluctuation, from accumulation and removal, it follows that no hypothesis, founded on such observations, can be of any value. . . It is nevertheless true that there are important fluctuations in the Lake levels, which are unconnected with the temporary influence of winds. The only rational explanation of these changes yet afforded is that depending on the waste and supply of water. From the immense surface exposed to the sun's rays, it is plain that the amount of water evaporated is immense; and if by any means the process becomes retarded, the water is elevated. Again, the greater quantity of snow falling during certain seasons has been considered a sufficient reason for explaining the increased elevation of the Lakes. If after such a season a summer follows when there is a small degree of sunshine, the amount of evaporation being thus diminished, the Lakes remain at a high point. These causes, though perhaps satisfactory, and without doubt true, at least to a certain extent, do not always appear sufficient to account for the fluctuations which have been noticed. Twenty-five or thirty years ago the beach of Lake Erie was a travelled highway beyond Buffalo; but at this time it would be quite impossible to travel along the same. . . .

"From the united testimony of persons residing along the margins of all the Lakes, and from other demonstrative proofs, it appears that for many years previous to 1838, all the Lakes had been rising, that about that time they attained their maximum, and have since (to 1842) been subsiding. I have no means of determining the time or degree of the minimum depression. Mr. Higgins, the State Topographer of the Geological Survey of Michigan, gives the rise of the Lakes as five feet from 1819 to 1838, and regards it as probable that the minimum period continues for a considerable length of time, while the maximum continues only for a year. . . A single individual has informed me that about 1788 or 1790 the Lakes were nearly as high as in 1838. . . .

"The *annual* fluctuations in the level of the Lakes are doubtless due to the nature of the seasons, depending on the quantity of rain and snow, and the amount of the evaporation; but it is not so satisfactorily demonstrated that for a series of twenty years the quantity of rain and snow has increased, or that evaporation has lessened uniformly throughout that period.

"The effect of winds in producing (*daily*) temporary elevations and depressions is very remarkable. A strong westerly wind will raise the water in the eastern end of Lake Erie several feet in a few hours, when a much larger quantity is driven down the Niagara; and although so rapid a stream below the Falls, the water frequently rises fifteen or twenty feet during a westerly wind. At the same time the water is diminished at the western extremity of the Lake, and a corresponding depression there takes place. The prevalence of a strong easterly or northerly wind in the same way drives the waters to the western and southern parts of the Lake, and a much smaller quantity flows down the Niagara during such period. The same effects take place in a greater or less degree in all the Lakes—the rising at one extremity and the sinking at the other, till the wind subsides, when it resumes its equilibrium, and in so doing presents a beautiful exhibition of the long swells which are observed in the ocean after the subsidence of a high wind."

* See American Journal of Science, Vol. 16th, pp. 78 to 94, and Young's Natural Philosophy, Vol. 1, p. 578, &c. See also pp. 41 and 46 of this article.

† See Hall's Geology of New York, pp. 408 to 410.

Professor Hall was well seconded by Professor Mather, afterwards chief director of the Geological Survey of Ohio, and subsequently (in 1845, 46, and 47) a resident on the shores of Lake Superior, observant of the meteorology and change of level of that Lake, from whose reports and other writings I extract the following hurriedly condensed particulars respecting Lakes Erie and Superior:*

"A tradition exists that there is a periodical rise and fall in Lake Erie, through a certain number of years. If it is true—and there are reasons for believing that it may be so, to a certain extent—it is evident that the present rise (1838) is higher than has occurred for many years before, for extensive tracts of forest are now overflowed, and timber killed in consequence, the trees of which indicate a long period of growth. The causes that may concur to produce such a variation in the level of the Lake are: —1st, An obstruction to the drainage to the usual quantity of water, in consequence of which, if the usual supply continues, the water must rise. 2d, The increased or diminished supply of water, dependent on the wetness or dryness of the season, the relative temperature, and amount of evaporation, both from the surface of the Lake and the country which receives its drainage waters, and the amount of water supplied by the Lakes above, as Lakes Huron, Michigan, and Superior,—the amount of water contributed by which is due to the same general causes, with the possible addition of an increasing water-way from the cutting down of their outlets, and pouring down an additional supply. 3d, Another possible cause may be taken into account in the varying level (or upheaval) of the solid earth itself—examples of which are mentioned in various works on geology, as to be seen in part of the coast of Sweden, where it is said to be slowly rising at the present time."

To this the Professor well adds:—"It is considered an object of great importance to determine what are the *causes* of this effect; and it was therefore intended, if the Legislature had made an appropriation corresponding to the estimate, and with provisions to the Bill which was reported last Session, *to have set in train a series of observations in several localities on the Lake coast*, and in different parts of the States, so that by the period for the close of the survey, a determination of the causes of the rise and fall of the Lake may have been attained. All the aid which the various branches of meteorology could have secured would also have decided the question as to the small *tides*, which are said to be very sensible in some places."

To the foregoing remarks of Professor Mather, I may be permitted to add that it is much to be regretted that any circumstances should have prevented his excellent suggestion from being carried into effect; but that such having unfortunately been the case, it now remains for the *British* province of Canada to have the credit of completing so desirable a work, on a far more extended scale.

Turning again to Lake Superior, I am happy to be able to quote the following (abridged) remarks by the same writer:†

"The great rise and fall of the level of the waters of the great Lakes, through a series of years has been long noticed. The cause is doubtless due to a greater quantity of snow and rain, or of a lower mean temperature and diminished evaporation during the period of rise, and the reverse during the time of fall of the water-level. During 1838-39, the waters were higher than they had been before for at least two centuries. This is demonstrated by the large tracts of land that were inundated which were covered with forest trees, many of them the growth of ages. These trees were destroyed by the overflow round Lakes Erie and Huron, and on the Ste. Marie river, between Point Detour and the Sault Ste. Marie.

"We have no accounts of Lake Superior at that time; but there are facts that indicate a marked variation within a few years. In 1845 a rock in the middle of the entrance of Eagle Harbour, showed itself only in the trough of the waves; and the narrow outlet between the west end of Porter's Island and the mainland at Copper Harbour, was of such depth that loaded boats could enter without touching the rocks. In 1846, the rock at the mouth of Eagle Harbour was one-and-a half feet above water; and boats could not get into Copper Harbour. In June, 1847, the rock above-mentioned was still more above water, and the outlet to Copper Harbour could be crossed by stepping on the projecting points of the reef, without wetting the feet; and during some depressions of the water by barometrical waves, it was laid almost entirely dry. From the 18th of June to the 6th of September there was a rise of full twelve inches. It has been observed on this Lake that the water is lowest in spring and highest in autumn. This is readily explained by the fact that in winter most of the ordinary supplies of water from the drainage of the surrounding country are cut off, by being converted into ice and snow; while evaporation from the surface of the Lake by the dry northern winds continues to carry away a very sensible quantity of water. During the spring, on the contrary, the snow and ice melt, and the accumulated stores of winter flow into the Lake in greater quantity than to compensate for the evaporation and the drainage at the outlet. . . During a century past the waters of Lake Superior cannot have been more than four feet above the level of 1847, for any considerable time, as is evident by the growth of trees of two feet in diameter at Porter's Island, which would have died had the ground around them been inundated for any great length of time."

To descend once more to Lake Erie. I am next indebted to Colonel Whittlesley, Topographer to the Geological Survey of Ohio for the following, confined to the annual and daily fluctuations in that Lake, with a variety of other acceptable details respecting particular sudden floods, as well as for a concise but imperfect tabular view of the *reported*, combined with the *known* annual variations in the level of its waters from 1796 to 1838.‡

"The general belief amongst navigators and residents on the Lakes appears to be uniform against the existence of any law by which these fluctuations are governed or may be predicted. The scanty information collected tends to the conclusion that these general elevations and depressions are *fortuitous*, and the result of accidental disorder in the seasons throughout the Lake country. It is, however, well established that there *is* in Lake Erie an *annual* tide, independent of the general state§ of the water, which rises from eight to fifteen inches in the mean. The minimum occurs about the time of the breaking up of the ice, late in winter, and the maximum late in spring or early in summer and fall. In the winter less change is perceptible; but early in spring it rises very fast, and with great regularity, till it reaches the maximum. All measurements should be taken subject to this change; but I am unable to fix a mean surface for the year,

* See Geological Report of Professor Mather for 1838.

† See Report of Geological Survey of Ohio for 1838-39; and an article in the American Journal of Science for July, 1848.

‡ See Colonel Whittlesley's Report for 1838-39.

§ *Stage* is the word used, meaning "*level*," I presume.—R. L.

or to give a probable error. . . The geographical position of Lake Erie in reference to the prevailing winds is the cause of irregularities in the *annual* rise and fall of its waters. Its general course being north-east and south-west, discharging at the north, the steady west wind of the fall accelerates the flow of water from this Lake, at the same time retarding its supply from the other Lakes.

"It has been asserted that there exists in the Lakes, as in the Ocean, a daily or *lunar* tide. Whether it is true when applied to Huron, Ontario, or other lakes, *is not perhaps entirely settled.* The observations I have been enabled to make on Lake Erie, and the uniform testimony of the waterman and harbour workmen coincide in denying the existence of any change resembling the Oceanic tide, and Mr. Davies, the Collector of Customs, writes decidedly: '*This is not the fact*; the examination of the tide-waiter kept at our office, and observations, made almost hourly since August last, enable me to assert, without fear of contradiction, that there is no tide upon Lake Erie.'"

It will be perceived that I already happen to possess more accumulated information on the vicissitudes of Lake Erie, to which my own attention and reflections had been more particularly directed, than of all the rest of our great Mediterranean seas put together; and I have now the additional satisfaction of turning to the investigations of my more immediate neighbours, the State Geologists of Michigan, and more especially of their talented chief, the lamented late Dr. Houghton, and his able assistant and topographer, Mr. Higgins.

From the first Report of the former, however, I can only venture to point to the following naked paragraphs, on the change of elevation in the waters of the Lakes, as equally applicable to Canada as to the American States.*

"The great interest which this subject possesses, in connection with our Lake Harbours, as well as with those agricultural interests situated upon the flat lands bordering the Lakes and Rivers, may be a sufficient apology for the introduction of the following facts and reflections upon the subject. An accurate and satisfactory determination of the total rise and fall of the waters of the Lakes is a subject, the importance of which, in connection with some of our works of internal improvement and harbours, can at this time scarcely be appreciated.

"Much confusion is conceived to have arisen in the minds of a portion of our citizens, in consequence of a confounding of the regular *annual* rise and fall to which the waters of the Lakes are subject, with that apparently irregular elevation and subsidence which only appears to be completed in a series of years; changes that are conceived to depend upon causes so widely different, that, while the one can be calculated with almost the same certainty as the return of the seasons, the other can by no means be calculated with *any* degree of certainty.

"It is well known to those who have been accustomed to notice the relative height of the water of the Lakes, that during the winter season, while the flow of water from the small streams is either partially or wholly checked by ice, and while the springs fail to discharge their accustomed quantity, the water of the Lakes is invariably low. As the spring advances the snow that had fallen during the winter is changed to water, the springs receive their accustomed supply, and the small streams are again opened, their banks being full in proportion to the amount of snow which may have fallen during the winter, added to the rapidity with which it may have been melted. The water of the Lakes, in consequence of this suddenly increased quantity received from the immense number of tributaries, commences rising with the first opening of the spring, and usually attains its greatest elevation—at least in the upper Lakes—sometime in the month of June or July. As the seasons advance, or during the summer and a large portion of the autumnal months, evaporation is increased, and the amount of water discharged by the streams lessened, in consequence of which the water of the Lakes falls very gradually until the winter again sets in, when a still greater depression takes place, from the renewed operations of the causes already mentioned.

"The *extreme variation* in the height of the water from winter to summer is subject to considerable change, according as the winters may vary from cold and dry to warm and wet; but during the past eight years it may be estimated at two feet.

"The annual rise and fall of the waters of the Lakes, dependent, as it manifestly is, upon causes which are somewhat uniform in their operation, must not be confounded with that elevation and depression to which the waters are subject, independent of causes connected with the seasons of the year. These latter changes, which take place more gradually, sometimes undergoing but little variation for a series of years, are least liable to be noticed, unless they be very considerable; but with respect to *consequences*, they are of vastly more importance, since they are subject to a larger and more permanent range.

"That the waters of the Lakes, from the earliest settlement of the country have been subject to considerable variation in relative height is well known. At one time the belief was very general that these changes took place at regular intervals, rising for a space of seven years, and subsiding for a similar length of time: a belief which would appear to be in consonance with that of the Indians, and with whom it, no doubt, originated. It is not wonderful that a subject, the causes of which are so little comprehended by our natives should be invested with an air of mystery, or that an error once propagated, in consequence of the long series of years required to bring about any considerable change, could scarcely be eradicated. While the idea of that septennial rise and fall must be regarded as founded in error, it is nevertheless true, that from the earliest records, the height of the Lakes has been subject to a considerable variation, usually rising very gradually and irregularly for a series of years, and after that falling in a similar, but more rapid, manner."

Dr. Houghton concludes a number of other excellent elucidatory remarks, by observing, with regard to the succession of previous cold and wet seasons which produced the great *rise* in 1838—that, "when we take into consideration, in connection with the causes enumerated, the *fact* that during the wet years evaporation must have been less than during the dry ones, it may be fairly presumed that sufficient apparent causes have existed to produce all the results noticed; and we may add, should such a succession of dry and warm seasons follow, we may look with certainty for a return of the Lakes to the former low level."

In consequence of the great length of the foregoing quotation, I must be content with giving only the following abridged and disjointed particulars on the same subject from Mr. Higgins' Reports of 1839 and 1841:—"That interesting question, the periodical rise and fall of the Lakes, has given rise to a variety of curious speculations. The inference drawn from the following data, it is presumed, will not be altogether inconclusive. Calcu-

* See Geological Report of Michigan for 1839, p. 20 to 22.

lations may be made sufficiently accurate to determine nearly the amount of surface drained; and if our climate, as is alleged, shows a successive series of cold and moist years, and of warm and dry ones, mutually following each other, variations in the volume of water cannot but be great. Taking into account only the central and upper divisions of the St. Lawrence valley, from Niagara to the North-west angle of Lake Superior, embracing all the country whose streams are tributary to the Lakes, the surface drained is calculated (as shewn by a table of sections) at 248,775 square miles, besides 86,700 square miles occupied by the Lakes; and it is further calculated that the enormous accumulation of water discharged through the River Detroit during high floods, allowing a current of only one mile an hour, is not less than 95,135,000 cubic feet per hour, or 1,585,558 cubic feet per minute. The floods on Lake Ontario, however, are generally the highest by about two feet; and for this obvious reason, that it receives the successive accumulations of all the Lakes, from the Niagara to the St. Louis Rivers, at the head of Lake Superior.

According to Mr. Mather's report for 1841, which is the next testimony to be adduced: "The preceding year (1840) was the second since the unusual elevation of the waters of the Lakes, since which time there had been a remarkable coincidence in the ratios of subsidence, the more unlooked for when taken in connection with the causes which tend to equalize the amount of falling water in the form of rain, snow, and dew, with the constant action of evaporation." * * * *

"The diminution in a given quantity of water exceeds by evaporation all the supplies which it receives from rain—*i.e.*, the average amount of falling water is equal per year to thirty-three inches; but the evaporation will reduce it to forty-four inches, when fully exposed to the sun and air. One season of extreme drought would, upon the expanse of these Lakes produce an extreme depression, while the contrary would produce a corresponding rise. It cannot then be matter of much astonishment that such expanded areas of water, subject to such influences should be greatly affected. The wonder is that they do not oftener present greater fluctuations. The equal and almost unvarying stage at which we find them is due to the conformity of the seasons, and the systematic order in which nature conducts all her works.

"The *semi-annual* alterations observable in summer and winter arise from other well known causes. In summer the supply is unchecked, and the consequence is an increase to the height of about thirty inches; when in winter these supplies are again checked, a consequent depression follows. Measures to ascertain exactly the semi-annual fluctuations have never been thought necessary. *Besides it is not uncommon for ice in large bodies to collect at the outlets of the Lakes, and for a time prevent the usual discharge, as was the case at the outlet of Lake Huron in connection with a west wind in 1824 and 1831, when the depth in the Detroit River opposite the City of Detroit was diminished over ten feet.*" * * * * *

"Besides all this, the effect of winds acts sometimes in favour as well as against the other irregularities. The geographical position of the Lakes is such as, that allowing them to prevail from the same point at the same time, over them all, *which is by no means always the case*, they produce a variety of results. A west wind forces the waters of Lake Erie into the Niagara River, at the same time that the waters from the foot of Lakes Huron and Michigan are forced into the straits of Michillimackinac, and there again are met by the waters of Lake Superior, through the straits of Ste. Marie. Hence the straits which connect Lakes Huron and Erie have all the indications of a tide, though irregular as to time, as well as to the amount of its elevation and depression; and it has often both risen and fallen in about the same proportion, and sometimes in the same periods as the lunar tides of those Rivers which empty into the Ocean. But when even these tides take place, either in the Lakes themselves, or in the straits connecting them, they are fortuitous, and the results of accidental disorder common throughout the Lake region.—Another feature may be observed of the Lakes, different in nothing from the ground swell of the Ocean—the reaction of the water—after having been pressed by the wind a few days or hours in one direction;—the most favourable point for noticing which is at an outlet or bay, and Lake Superior having the largest surface presents the most favourable traits of such reaction."

Having thus nearly exhausted my scattered extracts and notes, derived from American authorities, it now remains to refer to a few more memoranda on the same interesting subject, derived from British writers, such as Sir Richard Bonnycastle, Mr. McGregor, Mr. Talbot and others. Among these I turn first to Sir Richard's work on Canada, from which I find taken the following disjointed extracts.*

"The Lakes of Canada have not engaged that attention *at home*, which they ought to have had; and there is much information about them which is a dead letter in England. Their rise and fall is a subject of great interest. The great sinking of their levels of late years, which has become so visible, and injurious to commerce, deserves the most attentive observation. The American writers attribute it to various causes; and there are as many theories about it as there are upon all hidden mysteries. Evaporation and condensation, woods and glaciers, have all been brought into play. If the Lakes are supplied by their own Rivers, and by the drainage streams of the surrounding forests; and all this is again and again returned to them from the clouds, whence arises the sudden elevation or the sudden depression of such enormous bodies of water which have no tides? * * * Where do the Lakes receive that enormous supply which restores them to their usual flow? or are they permanently diminishing? I am inclined to believe that the latter is the case, as cultivation and the clearing of the forests proceed; for I have observed within fifteen years the total drying up of streamlets since the removal of the forest; and these streamlets had evidently once even been rivulets, and even rivers of some size, as their banks cut through alluvial soils plainly indicate. * * * Perhaps, whenever a *cycle* of years occurs, in which the north-east wind prevails during a year, or a series of years, the lakes lose their level; for the direction being north-east by south-west such is the usual current of the air, and therefore either north-east or south-westerly winds are the usual ones which pass over the surface. Whenever southerly winds prevail,—and in the cycle of the gyration of atmospheric currents this is certain, and will be reduced to calculations,—the great Lakes are filled to the edge; and whenever north and north-easterly winds take their appointed course, then these Mediterraneans sink, and the valley of the Mississippi is filled to overflowing. * * * But the most curious facts are that the different Lakes exhibit different phenomena: the Board of Works of Ohio having stated that in 1837-8, the water descending from the atmosphere did not exceed

* See Bonnycastle's Canada in 1840, pp. 276, 291 to 300.

one-third of that which was the minimum of several preceding years.

"Ontario, from the reports of professional men, has varied not less than eight feet; and Erie about five. Huron and Superior, being comparatively unknown, no dates are afforded to judge of them. But what vast atmospheric agencies must have been at work when such wonderful results on the smaller Lakes have been made evident!"

"*What a useful thing,*" further observes Sir Richard, *it would have been, if scientific navigators, or resident observers had registered the rise and fall of the Lakes in the years since Canada came into our possession.*"

Among other unconnected notes I find also some judicious remarks, extracted from McGregor's British America;* but from these I must be content to quote only the following, as referring to a collateral philosophical question of deep interest which may perhaps be touched on in the sequel: namely, the possibility of there being a subterraneous outlet to some of the great Lakes—a hypothesis which I have long been disposed to regard as not altogether irreconcilable with the geological formation of the basins of the middle and lower lakes, though perhaps not so with the structure of the Lake Superior regions; it being doubted whether, notwithstanding the great annual evaporation, the volume of water discharged by Lake Erie *does* sufficiently account for the vast united supply received by it from the immense triple resources of Lakes Superior, Michigan, and Huron.

"As the temperature of the climate in America depends chiefly on the winds, the formation of that continent is evidently the cause of the frosts being more intense than in countries in parallel latitudes in Europe; a consequence arising principally from the much greater breadth of America towards the poles. Winds change their character in America. North-east winds, which are cold and dry in Europe, are wet and truly disagreeable in America. North-west winds are, on the contrary, cold and dry, and are frequent during winter in America, much about the same period that north-easterly winds prevail in Europe. One great, if not the principal, cause of cold in America is the direction of the mountainous ranges and basins of country which conduct or influence the course of the winds. While the sun is to the south of the equator, the winds less under solar influence prevail from the north-west, following, however, the great features of the continent. The winds blowing over the vast regions of the north are always piercing and intensely cold. The return of the sun, again, by the diffusion of heat, agitates the atmosphere and alters the winds, which blow from a contrary direction, till the equilibrium is produced. This, however, does not appear to require much time, as no wind blows scarcely forty hours together from any one point.

"The comparative depths of the Lakes forms another extraordinary subject of enquiry. The bottom of Lake Ontario, which is 452 feet deep, is as low as most parts of the Gulf of St. Lawrence, while Lake Erie is only 60 or 70 feet deep; but the bottoms of Lakes Huron,† Michigan, and Superior, are all, from their vast depth, although their surface is so much higher, on a level with the bottom of Lake Ontario. This is certainly not impossible; nor does the discharge through the Detroit river—allowing for the full probable portion carried off by evaporation—appear by any means equal to the quantity of water which the three upper great Lakes may be considered to receive. All the Lakes are estimated to cover 43,040,000 acres. The great Lakes occasionally rise above their usual level from three to five feet. These overflowings are not annual nor regular. They have occurred about once in seven years, and are probably the effect of more rain and less evaporation during the seasons in which they take place. Sir George Mackenzie observed occasional overflowings of two to three feet in the Lakes north-west of Lake Superior; so that they are not peculiar to the Lakes of the St. Lawrence."

Having at length nearly exhausted my miscellaneous quotations and notes, I propose concluding that main branch of my task with the following appropriate remark, derived from a note at page 133 of the 1st volume of Talbot's Canada, as not only bearing on the now generally admitted influence of prevailing winds on the temporary fluctuations in the level of the Lakes, but also as adverting to the almost equally demonstrable fact, that the singular *severity* of our Canadian winters, and more particularly those of Lower Canada, compared with European countries in the same parallels of latitude, is altogether uninfluenced by the vast extent of our Lakes; on which subjects the author referred to, quoting an American author, states as follows:—

"Professor Dwight has proved that the height of the river (Niagara) both above and below the Falls, depends on the quarter from which the wind blows. Lake Erie, he says, is regularly raised at the eastern end, where the Fall commences, by every wind blowing between north-west and south-west. A strong westerly wind elevates its surface six feet above its ordinary level. The rivers must, of course, be proportionally elevated; and at the outlet must, when such a wind blows, be six feet higher than the *usual* water mark. . . On the contrary, when the wind blows from the north-east (the only easterly wind which in this region is of any importance), the waters of Lake Erie must recede of course, and fall considerably below their usual level, and the river be necessarily lower than at any other time."

The same author, in another part of his work (pp. 339 to 342), remarks as follows, with regard to the climate of Canada differing from that of European countries in a similar latitude:—

"The cause of this phenomenon appears to have eluded the most diligent and profound research. Many writers attribute the severity of the winter to the astonishing prevalence of north-west winds, and the amazing extent of the Lakes. That the severity of the weather in winter cannot with any propriety be attributed to the influence of the Lakes will appear evident to every man who reflects that the shores of those great inland seas enjoy a much milder climate than any other part of the country in the same parallels of latitude, however remotely situated from them. Fruit trees thrive well and bring their fruits to great perfection along the north-west extremity of Lake Ontario, in lat. 43 deg 30 min., and along the north shore of Lake Erie; and yet at 35 miles from the latter place, and in lat. 42 deg. 20 min., this fruit cannot be cultivated; and I have also seen snow three feet in depth a degree south of Lake Ontario, while at the same time it did not exceed six inches in the immediate vicinity of that Lake."‡

* See McGregor's British America, vol. 1, pp. 131 to 133.

† As an instance of our ignorance of the true depth of some of our Lakes, it is proper to note here that that of Lake Huron has, after all, been lately ascertained by the American Coast Survey to be not more than 420 instead of 860 feet!—R. L.

‡ See the letter introductory to my late paper on the establishment of a system of meteorological observations; and also the note at the foot of page 293 of this *Journal*.—R. L.

Leaving any further remarks on the foregoing for a future probable opportunity, I may here shortly observe, that I have long been persuaded that the severity of our winters is mitigated by the proximity of the Lakes, and is not so much owing to the prevalence of winds from the north-west, as a mere northerly point of the compass, or to the remarkable curve of the great isothermal line in this part of the globe, as to the winds alluded to sweeping down from a *more elevated region*, many parts of the extensive mountainous tract of country stretching in that direction being perhaps thousands of feet above the level of Lake Superior, and even the latter not being less than 600 feet above that of the ocean.

Nearly the whole of the conflicting evidence bearing on the various points at issue having been adduced, I proceed to state freely, yet as briefly as possible, the mode of proceeding adopted by me, in my endeavour to arrive at the convictions to which I have been thereby led with respect to each of the three questions to be determined.

To commence with the first of these, namely, the traditional report of there being a septennial rise and fall in the waters of the great Lakes, &c., I have to remark, that being unwilling to admit any assertions on so interesting and mysterious a phenomenon without thorough examination and comparison with facts, I, after much reflection, determined to attempt to form from the materials in my possession a general comparative tabular view of the positively known, and, failing that, generally acknowledged periods of elevation and depression throughout the whole of the Lakes during the longest ascertainable series of years; in the hope of thereby arriving at something like an approximation to the real state of the matter; but after labouring long and patiently at the unsatisfactory task, I was at last obliged to abandon it, and confine my synopsis to Lake Erie alone, and even then to leave a broad "Column of Remarks" for the insertion of any apparent coincidence, or otherwise, in the state of the other Lakes; and in this I continued to persevere till, after much labour, I so far succeeded, as is shown in the following copious yet imperfect Table, exhibiting not only the various progressive and retrogressive annual fluctuations in the level of that particular Lake during a course of sixty-three years, as vouched by the different highly respectable authorities named, but also proving, incidentally, how far that long-received traditional phenomenon, the rise and fall of the Lakes generally every seven years, is in accordance with the evidence furnished by recorded facts:—

COMPARATIVE VIEW OF THE RISE AND FALL OF THE WATERS OF LAKE ERIE,

FOR SIXTY-THREE YEARS, IN SUCCESSION, AS FAR AS ASCERTAINED FROM THE BEST SOURCES OF INFORMATION WITHIN REACH.

DATE.	COMPARATIVE LEVEL.	AUTHORITIES.	MISCELLANEOUS REMARKS.
1790..	*1st maximum;* being 5 ft. 6 in. above lowest level.	Prof. Hall, Higgens, Whittesley, Mather, &c.	From 1788 to 1790, the Lakes generally, and Lake Erie in particular, stated to have been as high as in 1838, at which time, according to different authorities, compared with the lowest level known, it was estimated at 5 ft. 3 in., 5 ft. 4 in., and even 6 ft.; and Prof. Hall mentions evidence of a higher level than in 1838, in ridges and submerged trees.
91..			
92, 93, 94	*No information regarding these years.*		
95, 96	*1st minimum.* Level described as low, but not exactly stated.	Weld, Whittesley, &c.	During 1795 and 1796, *Lake Ontario* described as so high as to have drowned orchards near Kingston of 30 years growth, while the gravelly beach of Lake Erie near Cleveland was used as a road, and continued so for many years afterwards.
97, 98, 99	Rising, but amount not stated.	Do. do. do.	In 1798, Lake Erie reported as higher than in 1796.
1800, 1, 2	High. *2nd maximum.*	Higgens, Houghton, Whiting, &c.	Waters of Lake Erie, and of the others generally, high from 1800 to 1802; and the level loosely estimated as similar to that of 1827.
3, 4, 5	No information whatever.		
6..	Level low.	Whittesley, &c.	Level reported, in general terms, as low.
7, 8, 9	Rising. No information.		
1810, 11	*2nd minimum.* Reported as 6 feet below 1838.	Do. do.	The level of this year is compared with the floods of 1790 and 1838: which would give about 2 ft. 9 in. below the mean level.
12, 13, 14	Waters rising.	Houghton, Higgens, Dearborn, Whiting, &c.	Gen. Dearborn states, from personal knowledge, that *Lake Erie* was, in 1814, more than 2 feet higher than in 1813, and that the river Detroit was unusually high during that and the following year, and much land submerged; Dr. Houghton describes the Detroit as high in 1814 and 1815; and Mr. Higgens the Upper Lakes as full in 1814, and the central and lower Lakes in 1815.
15..	*3rd maximum,* but 2 ft. less than 1838.	Do. do. do.	In 1815, like previous year, Detroit and St. Clair Rivers unusually full, and the rise of Ontario regarded as generally about 2 feet higher than the other Lakes.
16..	Same as last year.		
17, 18	Falling.	Houghton, Higgens, &c.	In 1817 and 1819, an ebb and flow of from 14 to 18 inches, noticed at Green Bay by Major Storrow, and in 1820 by Mr. Schoolcraft, and in 1827 by Col. Whiting.
19, 1820	*3rd minimum,* or Zero.	Do., do., and Whittesley, Whiting.	In 1819 and 1820, the central and lower Lakes described by Messrs. Higgens and Whittesley as unusually low; while Col. Whiting and Dr. Houghton state that the *Detroit River* had resumed its usual level.
21..	Rising rapidly.	Do., do., do., Dearborn, M'Taggart.	Lakes Huron and Erie described as having resumed their usual level during this year.
22..	Do., but still low.	Do.	
23..	Up to average or mean.	Do.	This year a rapid rise of 2 feet, from 5 to 3 feet below 1838.
24, 25, 26	Gradually rising, to within 2 feet of maximum of 1838.		In 1824, ice for a time blocked up outlet of Lake Huron, and river Detroit in consequence fell rapidly 10 feet; and a great depression took place in Lakes Erie and Ontario, while the pent-up waters flowed back on Lake Huron. In other respects, the Lakes appear to have been in their usual state. In 1831, a similar occurrence.
27, 28	*4th maximum,* reckoned as high as in 1815.	Houghton, Higgens, Whiting, Dearborn, M'Taggart, &c.	In 1827 and 1828, Lake Ontario (and other Lakes) 2 feet higher than 1820; and yet, according to Mr. M'Taggart (who estimates extra height between 2 and 3 feet), the rivers flowing out of them did not appear to be affected thereby; while Gen. Dearborn states that, though Lakes Erie and Ontario were so high, Lake Superior was lower than ever known before. In 1830, the level of Lake Erie rated at 2 feet above 1819.
29	Still high.		
1830	As high as in 1828.		

DATE.	COMPARATIVE LEVEL.	AUTHORITIES.	MISCELLANEOUS REMARKS.
31..	Subsiding rapidly.	Whiting, &c.	This year Lake Erie fell temporarily between 3 and 4 feet. (See also 1824.)
32 33	*4th minimum*, though only down to average.	Whittesley, Higgens.	By *average* is meant the *mean*, or half-way between the two extremes—say 2 feet 9 inches below the maximum of 1838.
34..	Rising.	Houghton, Higgens, Mather, Whiting, Whittesley, Buffalo *Advertiser*, *Canadian Journal*, &c.	In 1835, Lake considered 1 ft. 8 in. higher than in 1819; and afterwards in 1842.
35..	2 feet 10 inches below 1838.		In 1836, level the same as in 1830, and subsequently in 1853, and 1 ft. higher than the previous year. *N.B.*—The figures in the "Comparative Level" column to 1838 from Mr. Higgens.
36..	1 " 8 " do.		
37..	0 " 9 " do.		
38..	*5th maximum.* 5 feet 3 inches above Zero.	*American Journal of Science*, Prof. Dewey, Buffalo *Express*, Niagara Fall's *Iris*, Chatham *Planet*, &c.	In 1838, Lake stated by Higgens to be 5 ft. 3 in. above 1819, and by Buffalo *Advertiser* 5 ft. 4 in. in June, and 5 ft. 9 in. in August; and according to Dr. Houghton, it might be 6 ft.: much land overflowed, and trees of 100 years growth killed. Lake Ontario said to be 6 ft. 10 in. above 1825, Lake Huron higher than for two centuries, Michigan 6 ft. higher than in 1820, and Superior said to be 3 ft. higher than usual, and 1 ft. above 1837. By February, 1839, Erie had fallen to 3 ft. 8 in. (see also 1827), and in 1840 it was higher than for 23 years before, with the exception of 1838. *N.B.*—The levels in figures from 1839 to 1851 from Buffalo *Advertiser* of April, 1851.
39..	3 " 8 " do.		
1840..	3 " 5 " do.		
41..	3 " 1 " do.		
42..	3 " 7 " do.		
43..	2 " 8 " do.	*N.B.*—In contrast to Lake Erie, from 1846 to 1852, Lake Ontario was as follows at mouth of Genessee River:—	In 1844, all the Lakes considered low; but during the night of 18th October, Lake Erie suddenly rose temporarily at Buffalo 13 ft. 8 in. above the harbour Zero, caused by a great storm. In 1845, a sudden rise and fall of Lake Ontario, caused (according to Prof. Dewey) by a tornado, with water-spout, thunder, and hail. In that year, however, Lakes Erie, Huron, and Michigan much lower than usual; and in Lake Superior, a rock at the entrance of Eagle Harbour appeared above water, and next year was 1½ ft. high, and in next year still higher. In 1846, Gull Island (a light-house station in Lake Ontario) reappeared, after having been submerged 7 years. In January, 1847, sudden flux and reflux of Lake Ontario near Cobourg, when the waters receded 350 ft., and returned in an unbroken wave 4 ft. high; repeated 7 or 8 times, till it gradually assumed its usual appearance. On 30th March, outlet of Lake Erie temporarily blocked up with ice, so as to leave the Table Rock at Niagara Falls, and 200 ft. beyond it, dry. On 18th April, a sudden temporary depression of Lake Erie at Buffalo to 22 in. below Zero, caused by a strong gale from the N.E. In 1851, *Lake Erie*, at Port Colborne, was 3 ft. higher than in 1850; and in 1852 very little change; and in 1853 level nearly the same as in 1838 and 1830. In 1852, *Lake Ontario* 1 ft. 2 in. higher than in 1851; and in 1853, 9 in. higher, and calculated to be the same as in 1830 and 1838, and 4 ft. 5 in. above the minimum of 1849. In 1853, the River St. Lawrence generally considered as very high.
44..	2 " 11 " do.		
45..	3 " 0 " do.		
46..	2 " 0 *5th minimum.*		
47..	2 " 6 " above Zero.	2 ft. 3 in. from top of dock.	
48..	2 " 2 " do.	1 1 do.	
49..	3 " 1 " do.	2 1 do.	
1850..	2 " 8 " do.	1 9 do.	
51..	2 " 11 " do.	1 5 do.	
52..	Rising rapidly.	1 11 in July, do.	
53..	*6th maximum;* very high, as in 1832.	1 2 do.	
54..			

General Remark.—It is estimated that the Lakes subside irregularly, between the great periodical floods, at the rate of about 1 ft. 4 in. per annum; but that the comparative rapidity of the *fall* is as about 2 years, to 5 of the rise; and that the waters remain for some time at the mean level. Mr. Murray observes of Lake Huron, in his Report of 1848, that its waters have sunk considerably below former (perhaps ancient) levels, as indicated by water-marks, to the extent of 4 feet 10 inches.

While leaving the details of the foregoing Table to speak for themselves, I may be permitted to superadd, that the column of "*Comparative level*," however imperfect, is as complete as my materials would furnish; and that the greater part of the names there registered will be found among the different writers to whom I have had occasion to refer, or quote from, in the course of the foregoing remarks, besides several other sources of information to which I may hereafter have to advert; and further, that I have, in the column of "*Miscellaneous remarks*," taken care to refer to all such information of a loose *comparative* nature as appeared too indefinite for being admitted into the column of "*Authorities*," though not altogether to be rejected as without value; as well as to note not only any remarkable temporary derangements in the usual flow of Lake Erie, but any coincidence of level, or other remarkable event, connected with the state of the other Lakes at the same time. From a careful perusal of all details, I am disposed to think it will, in the first place, be satisfactorily demonstrated that not only there is no *regular* septennial or other great flood in Lake Erie, or any other of the great Lakes, but that, though in 1838 the whole of our inland waters happened to be simultaneously at an extraordinary height, it is very problematical whether they will always be found in an elevated or depressed state at the same time. For instance, taking it for granted that 1789–90 was really a maximum year, it will be seen by a reference to the Table, that instead of an interval of 14 years, the next maximum took place in 10 years, or in 1800–1; and that the next great flood was fortuitously in 1815; but that the next was in 1828; the next in 1838; and the last in 1853; and that, as might be reasonably expected, the advent of the mean and maximum periods was still less to be depended on. I am therefore bound to coincide in the more rational, and now generally received *opinion*, that the intervals at which these extraordinary floods occur are, at the best, uncertain, and mainly dependent on the extra amount of rain and snow, and the less degree of evaporation during the summer months, in that particular year; and that though the rise and fall in the different Lakes may, under ordinary circumstances, be generally simultaneous, it does not follow that such will always be the case; or, in other words, that there may sometimes be a rise for a season, or part of a season, in one Lake, altogether independent of the others, arising from temporary obstructions at its outlet—a conclusion which I have arrived at, after much inquiry, observation, and reflection, in addition to the evidence furnished in the foregoing Table,—as will be found more particularly adverted to immediately.

2ndly. With regard to the *annual* variations in the level of the Lakes, and their general extent; and how far these also occur simultaneously, and are likewise owing to the amount of rain and snow compared with that of the evaporation; or what other cause:—I am free to confess that, *cæteris paribus*, and in accordance with the various authorities adduced, as well as all other information which I have been enabled to obtain, the same observation must apply to these variations as to the septennial fluctuations just noticed; but that while the extremes between the maximum and minimum range of the great floods may be rated at about 6 feet, the average difference of level during a single year may be between 2 and 3 feet; and that, as already stated, though the rise and fall in all the Lakes may usually be simultaneous, one may sometimes be low while the others are high. As, for instance, it will be seen by a reference to the column of "Miscellaneous Remarks," that in 1795-96, Lake Ontario was so high as to drown trees of many years' growth, while Lake Erie was described as so low that the gravelly beach near Cleveland was used as a public road; and that in 1814, "the upper Lakes were full," whereas "the centre and lower Lakes" were not so till the following year; and that in 1827 Lakes Erie and Ontario were between two and three feet above their usual level, while Lake Superior was lower than ever known before;—all which circumstances combined, with others yet to be noticed, have produced a conviction that each Lake is independently liable to irregularities of level peculiar to itself. I allude to the well-known, but little thought of, *fact*, that during the winter months large boulders, as well as smaller masses of stone and gravel, lying along shore, become firmly imbedded in the bordage ice, and on any rise of the waters, towards the close of the season, remain firmly attached to the moving floating masses, liable to be either dropt again in deep water, on the ice becoming what is called rotten, or to be removed to some distant part of the shore, if not to be carried along by the united wind and current towards the outlet of the Lake. Admitting such to be the case—for there is every year abundant evidence of the fact—it only remains to suppose that towards the end of winter, as frequently occurs, an accumulation of loaded drift ice takes place near the head of the Rapids in the neighbourhood of Buffalo, and becomes temporarily united by a fresh frost, and that a *jam*, as it is termed, then takes place, so as to leave a more contracted space than usual for the passage of the rushing volume of water below the broad roofing of ice, and that a further rise afterwards happens, coupled with a thaw, during which a deposition of the hitherto suspended rocky materials takes place at the bottom of the channel, it will be evident that a still more contracted space will be left for the discharge of the increasing flood; and the natural consequence will be, that after the breaking up of the ice, the general surface of the Lake will have assumed a higher level than would have otherwise been the case, proportioned to the thickness of the stratum of boulders and other rocky materials deposited at the bottom of the channel,—liable to remain for a longer or shorter time, until gradually removed by the action of the sweeping current: a process altogether dependent on the strength of the latter, compared with the degree of compactness and solidification acquired by the rocky barrier opposed to it: and which may therefore require a whole season, or even more, to be accomplished. Of the motive power of ice, I myself have had ample proof, in the frequent dislodgment of boulders of large size from one part of the Lake shore to another, near my own farm; but more particularly of a vast rugged mass of limestone rock moved from comparatively deep water, some distance out in the Lake, to a more shallow part, so near the shore, that a large tree, dislodged from the high bank above by the undermining fury of the waves, happened to fall over in such a manner that its stem formed a very convenient though giddy bridge, from the beach to the stranger rock, and thereby allowed the latter to be afterwards used as a pleasant fishing station by my children. There are also, to my own knowledge, many instances of the removal of boulders in the different parts of the Rapids near Montreal. And among many examples of the almost entire temporary obstruction of the outlets of Lakes Huron and Erie by the jamming of the ice, I shall append to this paper an account of one which took place in the Niagara River, between Buffalo and Fort Erie, in March, 1848, with which I was at the time so much struck that I was induced to write to a friend on the spot for further particulars, in hopes of elucidating my long-cherished hypothesis; and such I have no doubt would have been the case, had I been able to be present myself to compare facts. Independent of that, however, the particulars connected with the obstruction in the Niagara* alluded to, were of so extraordinary a character as to deserve being placed on permanent record.

With respect to the 3d debateable question—the daily oscillations or other irregular transient tides observable in the different Lakes; I may observe that, making allowance for a greater or less degree of barometrical pressure, I might perhaps be disposed to assent in few words to the now generally received opinion, that in other respects they may be ascribed to the influence of the prevailing winds upon their broad expanse, more or less modified by their peculiar form and direction, and the relative bearing and nature of their extremities, as well as by the often very jagged and irregular outline of particular inlets or bays, and other inter-peninsular localities, such as Kewenaw Bay on Lake Superior, Green Bay on Lake Michigan, Presque Isle Peninsula and Long Point on Lake Erie, and the Bay of Quinté on Lake Ontario. But it seems to me that in so doing I would be conceding too much, as, in my humble unscientific apprehension, I am disposed to think that though such may be the case to a general extent, it is not the less necessary to prove, by a long and regular course of minute observations, whether such be the fact or not, as well as how far the surface of such vast bodies of water may not at times be considerably influenced by barometrical pressure on the one hand, or by lunar attraction on the other, particularly at the times of the vernal and autumnal equinoxes; and the more so, considering that late observations of philosophers in Europe have not only decided that there is a perceptible tide in the Mediterranean, Euxine, and Baltic, as well as in other altogether close saline seas, but also that something like barometric and lunar influence, or both, is observable on the inland fresh-water lakes of Switzerland and elsewhere. In confirmation of this I would, as regards the latter, beg to refer to the writings of Dr. Young, alluded to in an early part of these remarks, in conjunction with a valuable paper on the Lakes of Switzerland, by Colonel Jackson of the Royal Geographical Society, which lately appeared in the *Canadian Journal*, incorporated in a series of interesting articles on the variations in the level of the Canadian Lakes, from the pen of its learned editor, in which those oscillations (there termed *seiches*) are said to amount to no less than five feet. Nay, so interestingly appropriate to the present question do I regard a portion of the article alluded to, that I am tempted, in spite of the already great length of this paper, to transcribe the following, as the conclusion at which a learned German Professor has arrived on the subject:—"1st. That the *seiches* of the Lake of Geneva are much more frequent than is generally imagined. 2d. That they happen at all seasons of the year, and at all hours of the day; but that they are generally most severe in the spring and in the autumn. 3d. That the state of the atmosphere seems to have a decided influence, it being remarked, that in proportion as that state is less changeable, so are the Seiches less frequent, and *vice versa*. The Seiches have always been considerable when the atmosphere has been loaded with heavy clouds, or when the weather, in other respects severe, has threatened to be stormy, and when the barometer has sunk. 4th. That though Seiches are more frequent in spring and autumn, they are more considerable in the summer, and, in particular, towards the close of the season. The highest that have been observed happened in the month of September. 5th. That the minimum of the Seiches has no precise term: their maximum seems to be five feet. 6th. That although the duration of the Seiches is very variable, the greatest extent seems not to exceed 20 or 25 minutes, but usually lasts a much shorter time. And 7th, That they are not peculiar to the Lake of Geneva alone; M. Vaucher having observed them on the Lakes of Zurich, of Annecy, and of Constance.

* The account of this singular phenomenon is unavoidably postponed till some future time.

I cannot refrain from also quoting the following paragraph from the same paper, as much to the point:

"It appears unquestionable that the phenomenon of the Seiches is due to an unequal pressure of the atmosphere in different parts of the Lake at the same time, *i. e.*, to the simultaneous effects of columns of air of different weight, or different elasticity, arising from temporary variations of temperature, or from mechanical causes; and if such be the case, all Lakes of a certain extent, and even inland seas, must be subject to the same influence, and therefore present the same phenomenon; and I have little doubt that correct observations will verify the presumption."*

With respect to the irregular tides observable in the Baltic and Black Seas, and other great bodies of saline water of a similar character, it will be sufficient to give the following, regarding the first-named sea, from a standard geographical work, as bearing intimately on the subject under discussion:—"The Baltic being a close sea, is of course not subject to the phenomena of regular tides. But though such be wanting, a variation in the height of its waters, equal, frequently, to 3½ feet Swedish, is observed at irregular intervals. This occurs at all seasons, but chiefly in the autumn or winter, at the time of heavy rains, or when the atmosphere is charged with clouds, though unattended with falling weather. The water maintains its height frequently for several days, sometimes even for weeks. Prevalent winds, flooding rains, melting snows, and many other causes were assigned for this very remarkable phenomenon; but it continued to occur, independent of all these, till 1804, when Schulten, a Swedish physician, after having collected all the observations that had been made, found 'that the greatest height of the water corresponds with the greatest depression of the barometrical column; and conversely.' The almost total absence of oceanic action in this sea leaves the cause thus assigned to operate with full power; and if Schulten's hypothesis be confirmed, of which there is now but little doubt, it will, in all probability, serve to explain similar phenomena observed in other close waters, as the Caspian, Lake Balkai, and the Lake of Geneva, to which Saussure has assigned similar causes."†

To conclude. Having at last completed my retrospect of the state of the interesting philosophical questions which have so long engaged my attention, and having, in so doing, far exceeded the limits which I had prescribed to myself when I first ventured to press upon the Institute the establishment of a series of observations on the rise and fall of our noble Lakes, combined with that of a system of simultaneous meteorological observations throughout the country, it will not be wondered that I should bring my desultory remarks to an abrupt close. Reserving, therefore, any further expression of opinion until the fate of my proposal shall have been decided, I shall at present only add an earnest entreaty that, whatever may be the humble merits of the discursive review which I have taken of the important subject under discussion, it will at all events be received with indulgence; and that the Institute will be induced to take the trouble of patiently separating whatever *grains* of value there may be among the *chaff*, and manfully continue to do its duty to itself, to British Canada, and to the scientific world at large, until it shall have satisfactorily accomplished the indisputably laudable purpose in view;—ever watchfully bearing in recollection that, in the present singularly emulative age, the onward march of mind and enterprise, though fitful, is often found to advance with giant strides, more akin to the sudden movement of the whirling rail-car and the electric wire, than to the slow-paced action of by-gone times—as, witness the late rapid extension of networks of railroads through almost every civilized country, and the long doubtful completion of marine electric telegraphs in addition to those by land—the spanning alike of mighty rivers and yawning chasms with vast, yet airy, ribbon-like, suspension-bridges—the construction of a class of stately yet swift iron clippers, nearly equalling steamers in their speed, and of leviathan screw ships of 10,000, nay 20,000 tons burden, rushing through the waters at the astounding rate of upwards of 400 miles a day—the successful sounding of the great ocean at the depth of more than two miles—and, though last, perhaps not least in influence, the almost simultaneous discovery of gold-regions in different parts of both hemispheres, including even our own youthful favoured land! And therefore, while *Conventions* of learned and scientific delegates from among the chief nations of Europe are being assembled to adopt measures for the universal extension of "the science of Physical Geography," and the completion of a girdle of meteorological observations over the whole ocean, as well as every terrestrial region of the globe,‡ and our energetic and intelligent "go-a-head" American neighbours are being most forward in the noble mental strife, it would little redound to the credit of Canada to be found standing listlessly aloof, with folded arms, while so important a gap in the chain of philosophic research remains to be filled up at its very door. Let, then, the Canadian Institute, as a leading *British-American* Association, be "up and doing, while it is yet day," bearing in mind the remark of an eminent British soldier and statesman—that he that tries and *fails*, has at least the chances of war to urge in his defence; while he that is content with looking on at a distance and *doing nothing*, only registers thereby his own inefficiency and imbecillity.

* See Canadian Journal, Vol. II., pp. 27, 28, &c.

† See M'Culloch's Geographical Dictionary, Article *Baltic.*

‡ See the able and interesting address of Lieut. Maury, of the American Navy, at the late annual meeting of the New York Geographical and Statistical Society, held on the 10th of February last.

Description of the Platometer, an Instrument for calculating the Area of Figures drawn on Maps. Invented by Mr. John Sang.—With Plate.

The instrument is represented in Fig. 1 of the plate. It consists of a heavy brass frame A, carrying the journals of an arbor, on which are fastened the cone C, and the two rollers BB. The rollers are of equal diameter, so that when they are moved over the map, the frame A is carried forward or backward in a straight line. In the edges of the frame there are cut two grooves, which receive the rims of four friction wheels, two of which, W W, may be seen in the drawing. These friction wheels are journaled in a light frame F, to which the tracing point P is firmly attached; a handle, H, is also attached to the frame F, by means of a universal joint. A third frame, *f*, is connected with F, by means of a centre point hinge, and it carries the journals of an index wheel I, the very narrow edge of which, by means of two springs, is made to press on the cone. There is a ring of silver on the index wheel, divided by lines and figures, which are read off by a vernier and by a reading glass R, both fastened to the frame *f*. The frame *f* is also provided with two screws, the heads of which are shown in the figure (one of them near the letter *f*), giving the means of adjusting the height of the index wheel, so that the line in which it touches the cone is that line in which a plane parallel to the grooves of the frame A would intersect the cone; and with two binding screws to retain it at that height. The weights of all the parts are so arranged that the tracing point just presses lightly on the map without scratching it.

The effect of this construction is that a slight force applied to to the handle H, which is grasped in the hand like a common pen, may cause the whole instrument to roll along the paper forwards or backwards; or may merely cause the frame F, with the tracing point and index wheel to move sideways to the right or left; or may cause a combination of these motions, so that the tracing point may be guided along any line drawn on the map. When the tracing point is moved to the right or left, the rollers, B B, remaining stationary, the index wheel is merely carried along the edge of the cone without receiving any revolving motion. But when the tracing point is moved forwards or backwards, a forward or backward revolving motion is imparted through the rollers and cone to the index wheel. The ratio of this motion to the forward or backward motion of the tracing point is not uniform, but depends on the diameter of that part of the cone with which the index wheel happens to be in contact, which again depends on the distance from the apex of the cone. If we suppose the index wheel to be at the apex of the cone, and imagine a line to be drawn on the map through the tracing point and perpendicular to the axis of the cone, then as the tracing point and index wheel have the same lateral motion, it is obvious that the revolving motion of the index wheel will be in proportion to the backward or forward motion of the tracing point multiplied by its distance to the left of that line, which we will call the zero line. From this it follows that if the tracing point be guided completely round the boundary of any enclosure, the resulting forward revolving motion of the index wheel will be proportional to the area of that enclosure. This becomes more clear, if we imagine the enclosure to be divided into very narrow sections by lines parallel to the grooves of the frame A, and attend to the effect on the index wheel when the tracer passes over the ends of one of their sections. When the tracer passes over one of the ends, the index wheel revolves forward a distance proportional to the breadth of the section, multiplied by the distance of that end from the zero line; as it continues its journey round the enclosure, it reaches the other end of the narrow section, and in passing over it, the index wheel revolves through a distance proportional to the breadth of the section, multiplied by the distance of that end from the zero line; the motion is, however, now backward with respect to the former, so that the effect with regard to the section is that the index wheel has revolved forward through a space proportional to the difference between the distances of the ends of the section from the zero line (that is to say, the length of the section), multiplied by its breadth, which is the area of the section. And as the same thing happens with regard to each of the sections, into which we have conceived the enclosure to be divided, it follows that when the tracer has made a complete circuit, the sum of the forward and backward revolving motion of the index wheel is a forward motion proportional to the whole area of the enclosure.

This happens with regard to every enclosure, whatever its shape or however irregular its outline, so that in calculating an area by means of the instrument, we have only to make a small mark with the tracer on the outline, observe the reading of the index wheel, lead the tracer along the boundary of the enclosure till it again reaches the small mark, and again observe the reading of the index. The difference of the two readings is the area. In practice it has been found convenient to make the readings give square inches, tenths, and hundredth part of square inches. In the instrument represented in Fig. 1, a complete revolution of the wheel indicates 20 square inches, and in order to carry on the indications as far as 100 inches, a second toothed wheel T, is placed so as to receive motion from a pinion on the arbor of I. In manufacturing the instruments, the diameters of the index wheels are adjusted so that the divisions may accurately indicate square inches, by trying them frequently on the outline of an oblong figure of about 100 square inches engraved on a copper plate. The diameter of the wheels are slightly lessened at each trial, until at length they indicate precisely the area which had previously been ascertained by means of very accurate measurements with a standard scale under a microscope, to be that of the figure engraved on the copper. They are then ready to indicate in standard square inches the area of any other figure.

It is found that in passing the tracer over lines oblique to the machine, there is a slight retardation of the index wheel, so that the reading is a very little more or less than the true area, depending on the position in which the figure is presented to the instrument. This retardation is very small, and practically it is destroyed by turning the figure half round, and again tracing it and noting the area. The effect of the retardation is now equal, and contrary to that in the first tracing, and the average of the two is the true area; and this result was found on experiment to be a little more accurate than the results of very careful measurements made by scales and calculations in the ordinary manner. As a practical test of the value of the Platometer in this respect, an enclosure of an estate plan was measured very carefully by scale and calculations. It was then re-measured. The small difference between the two results was an indication of the degree of accuracy obtained. The same enclosure was then measured twice by the Platometer, and the difference between its results being in like manner an indication of their degree of accuracy, a comparison between the two differences gave the means of judging of the accuracy of the two methods. In an experiment made on a single enclosure, it happens sometimes that this indication is in favour of the scale, and sometimes in favour of the instrument; but the aggregate indications of a number of experiments was always found to be in favour of the instrument. Thus, in an estate plan containing 90 enclosures, each enclosure being measured separately, there was found:

	By Scale.		By Platometer.
Sum of the means of each pair	740·92	...	741·01
Sum of the differences	2·79	...	2·44
Greatest difference...............	·17	...	·09
Least difference.....................	·00	...	·00

This aggregate is in favour of the Platometer as 279 is to 244.

Many trials of this nature having completely shown the trustworthiness of the Platometer, and it being of great value in respect to the saving of time, experimental alterations were made in its form, with the view chiefly of doing away altogether with the retardation of the index wheel in passing over oblique lines. One of them is represented in Fig. 2. In this the rollers, B B, are lessened in diameter; and in order to make the lessening possible they are raised up on another pair of rollers, G G, instead of coming in contact with the map. As the space representing a square inch on the index wheel is inversely as the diameter of the rollers, by this means the divisions were increased in size, so that they read thousandths instead of hundredth parts of an inch. It was not found that advantages commensurate with the increased expense of the machine were obtained from this form.

But in the course of experiments it was discovered that the slight retardation was lessened, and for practical purposes obviated, by giving a certain proportion to the breadth of the edge of the index wheel and the tension of the springs (1-100th inch to 13 ounces). A construction, only differing from that of Fig. 1 in some details, was therefore adopted. This is represented in the woodcut, Fig. 3. In it the second toothed index wheel is dispensed with, the single index wheel being increased in diameter so as to read to 50 square inches, and in place of four there are only three friction rollers. Instruments of this description have an accuracy amply sufficient for all practical purposes, about double what has been noted above, and are of great value in measuring enclosures on maps, especially those which have very irregular wavy outlines, effecting both an increase of accuracy and a great saving of labour and time over the old methods.

Process for Printing copies of Plants, Materials, Lace, &c., from the originals, styled ("Naturselbstdruck") Natural Printing Process.

Under this term, Louis Auer, of the Imperial Printing Office at Vienna, has patented a process invented by himself in conjunction with Mr. Andrew Worring, overseer of the same establishment, "for creating, by means of the original itself, in a swift and simple manner, plates for printing copies of plants, materials, lace, embroideries, originals or copies, containing the most delicate profundities or elevations not to be detected by the human eye," &c. A pamphlet giving a description of this discovery and a series of specimens has reached us. The examples consist of an impression from a fossil fish, from agates, the leaves of trees, several plants, mosses, algæ, and the wing of a bat. These are all printed in the natural color of the objects they represent; and it is difficult to conceive anything more real than these productions. The general character of the process is told in the following pithy manner by Louis Auer, in the introductory paragraphs of his pamphlet:—

"*Query*—How can, in a few seconds, and almost without cost, a plate for printing be obtained from any original, bearing a striking resemblance to it in every particular, without the aid of an engraver, designer, &c.?—*Solution*—If the original be a plant, a flower, or an insect, a texture, or, in short, any lifeless object whatever, it is passed between a copper plate and a lead plate, through two rollers that are closely screwed together. The original, by means of the pressure, leaves its image impressed with all its peculiar delicacies,—with its whole surface, as it were,—on the lead plate. If the colors are applied to this stamped lead plate, as in printing a copperplate, a copy in the most varying colors, bearing a striking resemblance to the original, is obtained by means of *one single* impression of each plate. If a great number of copies are required, which the lead-form, on account of its softness, is not capable of furnishing, it is stereotyped, in case of being printed at a typographical press, or galvanized in case of being worked at a copperplate press, as many times as necessary, and the impressions are taken from the stereotyped or galvanized plate instead of from the lead plate. When a copy of a unique object, which cannot be subjected to pressure, is to be made, the original must be covered with dissolved gutta percha; which form of gutta percha, when removed from the original, is covered with a solution of silver to render it available for a matrix for galvanic multiplication."

This process is also applicable to the purpose of obtaining impressions of fossils, or of the structure of an agate or other stone. In all the varieties of agate, the various layers have different degrees of hardness; therefore, if we take a section of an agate, and expose it to the action of fluoric acid, some parts are corroded, and others not. If ink is at once applied, very beautiful impressions can be at once obtained; but for printing any number, electrotype copies are obtained. These will have precisely the character of an etched plate, and are printed from in the ordinary manner. The silicious portions of fossil and the stone in which they are imbedded may in like manner be acted upon by acid; and from these either stereotyped or electrotyped copies are obtained for printing from. We learn that Mr. Bradbury, of the firm of Bradbury and Evans, has availed himself of this invention, and that he is now preparing a series of Botanical specimens for publication,—so that, very shortly, the public will be in possession of examples of this beautiful process. It is not a little singular that the workers in German silver and Britannia metal, at Birmingham, have for some time been in the habit of ornamenting the surfaces of these metals by placing a piece of lace, no matter how delicate, between two plates, and passing these between rollers. In this way every fibre is most faithfully impressed upon the metal. We are not aware, however, that any attempts to print from these impressions have yet been made at Birmingham. The value set on the invention by the author may be judged by the following paragraph:—

"Russia has given up Jacobi's application of the Galvanoplastic in the year 1837, and France the Daguerreotype for general use in the year 1839; Austria has now furnished a worthy pendant to these two inventions."

On the Consumption of Smoke.—Experiments with Jukes's Patent Furnace. By Mr. A. Fraser.*

The author stated that it was not intended to enter on the various theories which have been advanced on the subject; or to discuss the many inventions before the public, still less to bring forward any new theory, but to give the "results of absolute work," in a successful attempt to remove the smoke nuisance from an extensive London brewery and its neighbourhood. Messrs. Truman, Hanbury, Buxton & Co. had tried most of the plans which previous to 1847 gave reasonable hopes of success. In 1847 the writer's attention was first drawn to Jukes's patent furnace, which consisted of a strong cast-iron frame of the full width of the furnace, and about three feet longer. The fire bars were all connected together, forming, when complete, an endless chain, and were made to revolve round a drum, placed at each end of the frame. The front of the frame was provided with a hopper, in which the fuel was placed, and a furnace door, which opened vertically with a worm and pinion. The height to which the door was raised by the stoker, regulates the supply of coal, which was carried into the fire by the gradual motion of the bars. This plan was first applied to an engine boiler—a cylindrical one, with two tubes—driving a 40-horse power engine; and having been successful, it was adapted

* See page 3_0. † From the London Athenæum.

* From the London Athenæum.

to a second boiler of the same kind. In the same year the probability of its success under a brewing copper was discussed. There was no doubt, from the former experiments, as to its capabilities for raising steam or for evaporation; but with a brewing copper provision had to be made for a process in the manufacture almost peculiar to it. The contents of the copper have to be turned out several times in the course of a brewing, rendering it necessary to "bank up" the fire thoroughly, to protect the bottom of the copper, until refilled with wort or water. It was feared that the machinery would interfere with this being done effectually: it was tried, and with the same success as with the steam boilers. The remainder of the coppers and boilers were afterwards altered. The total cost of the fourteen furnaces, including brickwork, had been about £3000. The consumption of coals in the establishment was 6000 tons per annum. The saving in the coal account, since the introduction of the patent to July 1st of the present year, had been £8338, from which must be deducted for casualities, and sundries, say £350. The above economy had not arisen from less weight of fuel consumed, but owing to the screenings or dust of coal only being required for the furnaces. It would appear at first sight that the wear and tear of a machine, apparently so complicated, must exceed the expense of the common fixed bars. This, however, had not been found to be the case, and it need not be so if ordinary care were given to the machine, and a periodical examination such as any other machine of equal value and producing equally important results would receive. Within the last week a set of bars, which had been in use since May, 1849, had been renewed, for the first time; and three-fourths of the old bars were being again used for another furnace, where the boiler was of less importance than the one from which they have been removed.

On preserving the Balance between the Animal and Vegetable Organisms in Sea Water.

By Robert Warington.*

In the published notices of my experiments of 1849, to maintain the balance between the animal and vegetable organisms in a confined and limited portion of water, the fact was demonstrated, that, in consequence of the natural decay of the vegetation, its subsequent decomposition and the mucus-growth to which it gave rise, this balance could be sustained only for a very short period, but if another member were introduced, which would feed upon the decaying vegetation and thus prevent the accumulation of these destructive products—a function most admirably performed by the various species of water-snail—such balance was capable of being continuously maintained without the slightest difficulty; and I may add, that the experimental proof of this has now been carried on, in a small tank in the heart of London, for the last four years and a half, without any change or disturbance of the water; the loss which takes place by evaporation being made up by rain or distilled water, so as to avoid any great increase of the mineral ingredients originally present. It follows then, as a natural deduction, from the successful demonstration of these premises, that the same balance should be capable of being established, under analogous circumstance, in sea water. And in a paper published in January, 1852,† I stated that I was, at that time, "attempting the same kind of arrangement with a confined portion of sea water, employing some of the green sea-weeds for the vegetable member of the circle, and the common periwinkle as the representative of the water-snail."

The sea water with which the experiments I am about to detail were conducted, was obtained through the medium of one of the oyster-boats at the Billingsgate fish-market, and was taken from the middle of the English Channel.

My first object was to ascertain the kind of sea-weed best fitted, under ordinary circumstances, for keeping the water clear and sweet, and in a sufficiently oxygenated state to sustain animal life. And here opinions were at variance, for one naturalist friend whom I consulted, advised me to employ the Rhodosperms; another stated that it was impossible to make the red weeds answer the purpose, as he had tried them, and strongly recommended the olive or brown colored Algæ; while, again, others thought that I should be more successful with those which had in theory first suggested themselves to my own mind, namely the Chlorosperms. After making numerous unsuccessful experiments with both the brown and red varieties of Algæ, I was fully convinced that, under ordinary circumstances, the green weeds were the best adapted for the purpose.

This point having been practically ascertained, and some good pieces of the *Enteromorpha* and *Ulva latissima* in a healthy state, attached to nodules of flint or chalk, having been procured from the shore near Broadstairs, several living animal subjects were introduced, together with the periwinkle. Everything progressed satisfactorily, and these all continued in a healthy and lively condition.

My first trials were conducted in one of the small tanks which had been used for fresh water; but as it was necessary, during the unsuccessful experiments with the brown and red sea-weeds, to agitate and aerate the water, which had been rendered foul from the quantity of mucus or gelatinous matter generated during the decay of their fronds, until the whole had become oxydized, and the water rendered clear and fitted for another experiment, it was, therefore, for greater convenience, removed into a shallow earthern pan and covered with a large glass shade to protect the surface of the water, as much as posssble, from the dust and soot of the London atmosphere, and at the same time impede the evaporation. In this vessel then I had succeeded perfectly in keeping a large number of beautiful living specimens in a healthy condition up to the close of 1852. I therefore gave instructions for the making of a small tank, as a more permanent reservoir, and one more adapted for carrying on my observations and investigations on the economy and habits of the inhabitants.

From the experience I had obtained in my experiments with the freshwater tank, I was induced to modify slightly the construction of this vessel; thus, at the back, or part towards the light, the framing was filled with slate in the same way as the ends and bottom; for I had found that the glass originally employed, very soon became covered with a confervoid growth which had an unpleasing appearance to the eye, and in consequence of which I had been obliged to paint the glass on the exterior, to prevent this growth from increasing to too great an extent. It was also an unnatural mode of illumination, as all the light should pass through the surface of the water. The

* Communicated to the *Athenæum* by the Author, having been read at the Hull Meeting of the British Association.

† Gardeners' Botanical Magazine and Garden Companion, January, 1852.

front towards the room and the observer was constructed of plate-glass, the whole being set in a stout framework of zinc, and cemented with what is known under the name of Scott's cement, and which I have found to answer the purpose most admirably. Within this tank were arranged several large pieces of rock-work, thrown into an arched form, and other fragments were cemented in places against the slate at the back and ends, and at parts along the water line, so that the creatures could hide themselves at pleasure; a short beach of pebbles was also constructed in order that shallow water could be resorted to if desired. The whole tank was covered with a light glass shade to keep out the dust and retard evaporarion.

With the sea water obtained in January, 1852, I have been working without cessation up to the present time, agitating and aerating when it became foul during the unsuccessful experiments on the sea-weeds, but since then it has been rarely ever disturbed; the loss which takes place from evaporation being made up, as before stated, with rain or distilled water.

For a considerable period, after commencing these experiments, I was much troubled to obtain living subjects in a healthy condition, but having alluded to this, and the success of my investigations, in a short notice appended to a paper published in the "Annals of Natural History" for October, 1852, my friend, Mr. P. H. Gosse, who was then sojourning at Ilfracombe for his health, offered in the kindest manner to supply me with materials, and from that period he has always most heartily responded to my wants. It must not be imagined for a moment that the beautiful creatures I have thus received have all been preserved alive or always quite healthy. In experimental investigations this would be unreasonable to expect, as the very fact of experimenting implies a disturbance of the then state of things. Besides which, from want of a sufficient knowledge of natural history, from want of forethought and experience, and other causes, I have lost many very fine specimens; and as the detail of these losses may prevent the occurrence of the like annoyances to others, I shall venture to occupy your time for a short period with their history.

My greatest loss arose from too great anxiety to transfer the collection I had preserved in healthy condition to the end of December, 1852, into the new tank. As soon as it arrived from the maker's I lost no time in introducing my numerous family to their new abode, and dearly I paid for my precipitancy, for on the next morning I found many of my most beautiful specimens dead; thus I lost two fine Holothurias (*H. Pentactes*), a small freckled Goby (*Gobius minutus*), a beautiful little Pipe-fish (*Syngnathus lumbriciformis*), and several others, and on opening the door of the case the cause of this mortality was at once evident,—an iridescent film of oily matter was floating on the surface of the water, arising from the paint with which the angular joints and edges of the small tank had been colored not having become sufficiently hardened.

Another source of loss arises from the several creatures attacking and devouring each other, and therefore it becomes a point of great importance—and highly necessary to be carefully observed, where their preservation is an object—to ascertain what varieties may be safely associated in the same tank; as, for instance, I have found that the Shrimps, and Prawns attack, and very soon devour, all the larger varieties of Corallines and Polyps, Sabellæ, Serpulæ, Rock-bores, Cirrhipeds, some of the Annelids, many of Bivalve and Univalve Mollusks that are unprotected by an operculum, or have no power of closing their valves. The instances which have come under my own immediate observation have been the destruction of the *Pholas dactylus*, *Saxicava rugosa*, *Cypræa Eruopæa*, and several specimens of Sabellæ, Serpulæ, *Coryne sessilis* and many others.

The common Crab (*Cancer Manœs*) is likewise a most destructive agent; and the tribe of rock-fish, the Blennies, Gobies, &c., are also most voracious, devouring all the varieties of Cirrhipeds, Corallines, Polyps, Annelids, &c.; they will also also attack the shrimps and prawns, and even seize upon the horns of the periwinkle, which they bite. If the mollusks do not keep a very firm hold of the rock or tank sides, they are rapibly turned over by these fish on their backs and lie helplessly exposed to their attacks.* It is doubtless their seeking food of this kind which causes these little fish to be so generally found in the shallow rock-pools of the coast, in consequence of these ravenous propensities I have been obliged to establish several small tanks, and imitation rock-pools, so as to separate these various depredators from each other: thus in one I have varieties of *Actinia*, Shrimps, Nudibranchs, Holothurias, and some Annelids; in a second the rock-fish, as the Blennies, Gobies, Cottus, with Crabs and *Actiniæ*; in a third Corallines, Annelids, Polyps, Rock-borers, Sabellæ, Serpulæ, Holothurias, and *Actiniæ*.

Another curious instance of loss I may detail which has quite recently occurred, and which may prove interesting; it was in a small rock-pool containing Blennies, Gobies, Crabs, &c. I had procured two live oysters for the purpose of feeding my numerous small fry in these Vivaria, and one of these having proved ample for the purpose of one meal, the other was placed on the sandy bottom; on the second day after this, the oyster was observed to have opened the valves of his shell to a great extent, which were afterwards seen closed, but a small *Gobius Niger*, inhabiting the pool, could no where be seen. The day after this the oyster was opened for the general feeding, when lo! within the shell was found the unfortunate *Gobius*, quite dead. Whether this little gentlemen had been attracted within the trap by curiosity or the ciliary motion of the oyster, it is impossible with certainty to say; but that he must have seized on some sensitive part of the oyster is more than probable, so as to have caused such a rapid closing of the shell as could entrap so active a burglar.

Another important point is the gravity of the sea water; this should be very carefully regulated, for it must be borne in mind that many of the marine creatures are supplied by a permeation of water through their tissues or over their delicate and beautiful organs. The specific gravity should not rise above 1026 at 60° Fahr., and a small hydrometer should be introduced at short periods to ascertain that this point is not exceeded, particularly during the hot months of summer. The reduction to this gravity can be readily effected by the addition of rain or distilled water. Many of the creatures will of themselves afford

* Since the reading of this paper at Hull I have received a Blenny of larger size, being about 3½ inches in length, and although it has become so tame that it will allow itself to be touched by the hand and takes its food from the fingers, yet its destructive propensities are so great, that it very soon killed four small Crabs; and to save three others of rather a larger size, I have been obliged to remove the Blenny to a rock-pool in association with his own species and a few *Actiniæ*. The only refuge the poor Crabs had was to bury themselves in the sand, and whenever they attempted to move out of their refuge they were immediately pounced upon and only escaped by burrowing rapidly again.

indications of this increase of destiny; some of the *Actiniæ* will remain closed and become coated with a white slimy covering within which they remain for a length of time, and if the specific gravity of the water be lowered this is very soon ruptured by their expansion, thrown off, and the tentacula become soon extended.

All putrescent matter or excess of food or rejecta of the *Actiniæ* should be carefully removed from the water, as the noxious gaseous compounds generated by the decay of such matters appear to diffuse themselves rapidly through the water, act as a virulent poison, and speedily destroy the vitality of the occupants. Thus many beautiful subjects were lost in a few hours from the introduction, into a small glass jar of a large Pecten shell, encrusted with corallines, which had become loaded with putrescent matter by a partial submersion in a foul muddy bottom.

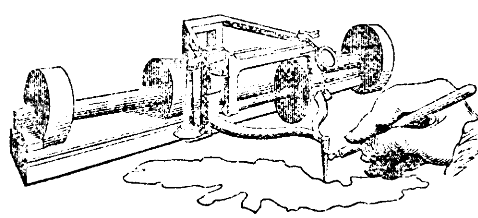
Great care should also be taken in moving the *Actiniæ*, that the foot or sucking disc with which it attaches itself to the rocks, stones, or mud, be not injured, as, when this occurs, they rarely survive, but roll about without attaching themselves, and gradually waste away and die.

With these exceptions then, everything has gone on very satisfactorily, care being always taken not to overload the water with too large a proportion of animal life for the vegetation to balance, as whenever this has been inadvertently attempted, the water has soon become foul, and the whole contents of the tank, both animal and vegetable, have rapidly suffered, and it has required some time before the water could be restored to its former healthy condition.

In one of the numbers of the "Zoologist" of last year, I stated that besides the *Ulvæ*, *Enteromorphæ*, and *Cladophoræ*, I had found the *Zostera marina* a very useful plant for oxygenating the sea water; but this observation has reference only to the case of a tank supplied with a ground where its roots will find a sufficiency of food for its growth, as in a clear shingle or sand it soon decays; and it should be associated with such animals as delight in a ground of this nature, as many of the Annelids, Crabs, burrowing Shrimps, &c. There are several interesting observations which have been made from time to time connected with this subject, which I hope to lay before the natural-history world as soon as I can find leisure time for the purpose.

Sang's Platometer, or Self-acting Calculator of Surface.

In this number we publish a description (see page 305), accompanied with plate, of an exceedingly ingenious instrument



for computing the areas of irregular figures. One of these instruments has recently been imported from England for the service of an engineering establishment in town, and we have been favoured with an opportunity of examining its mechanism and testing its accuracy.

By the usual and well known method of dividing the figure to be measured into a number of triangles or trapeziums, carefully ascertaining the base and altitude of each, and taking the sums of the products, the area may be discovered with great accuracy; but as it is necessary to revise the calculations several times, both for the purpose of obviating fault in the arithmetical part of the work, and in order, by taking the average of a few independent measurements, to increase the probable accuracy of the result, this method of calculation, especially when the figure is irregular, entails a considerable amount of labour of an irksome kind. Attempts have been made to avoid this by cutting the figure from the sheet of paper, and weighing it in a delicate balance against weights, consisting of part of the same paper of determinate sizes; but this method—at first sight simple and practical—is rendered of little use by the impossibility of obtaining paper of uniform thickness throughout the sheets, the variations of thickness, and hence of weight, being greater than the amount of error that could be allowed in the results.

The platometer indicates the area of any figure, however irregular, on merely carrying the point of a tracer round its boundary; and, besides the advantage of not injuring the drawing, it possesses that of speed and accuracy.

From the peculiar construction of the instrument, it is apparent that if the tracer be moved forward, it will cause the index to revolve, not simply in proportion to that motion, but in proportion to the motion of the tracer multiplied by the distance of the edge of the index wheel from the apex of the cone; and that the revolving motion of the index wheel will be positive or negative, according as the tracer is carried backwards or forwards. Hence, if the tracer be carried completely round the outline of any figure—on arriving at the end of its journey, the index wheel will show the algebraic sum of the breadth of the figure at every point, multiplied by the increment of the distance of the points from the apex of the cone; that is to say, the area of the figure.

As pointed out in the general description of the instrument, the exact amount of any errors which may arise from imperfections in mechanism or adjustment can easily be discovered, by simply reversing the paper and moving the tracer a second time over the boundary of the figure; if the results of both trials be alike there can be no error; but if they vary [the errors in one case being positive, and in the other negative], an average between the two is the exact area of the figure, and is more to be depended on than the results of measurements made by scale and calculation in the usual way. A careful operator, in using the platometer, will always take the average of two tracings as described; but when he experiences the rapidity with which this may be done, he will find the trouble as nothing in comparison with the harassing labour of calculating by scale and multiplication.

Sang's Platometer, like most other really valuable inventions, possesses great simplicity of construction, and is not liable to get out of order with ordinary care.

It can be ordered from the inventor through Messrs. Hearn & Potter, mathematical instrument makers, Toronto.

The Greenwich Observatory.*

The Annual Visitation of the Royal Observatory took place on Saturday last, when the Board of Visitors inspected this national establishment. The Astronomer Royal, in his Report, states that he trusts to be able to report at a very early date, the conclusion of the very important operation of determining the longitude difference between the observatories of Greenwich and Paris.

In his last report, Mr. Airy alluded to the erection of a time signal ball at Deal, to be dropped every day by a galvanic current from the Royal Observatory. The ball has now been erected by Messrs. Maudslay & Field, and the galvanic connexion with the Observatory, through the telegraph wires of the South Eastern Railway, is perfect. The automatic changes of wire communications are so arranged that, when the ball at Deal has dropped to its lowest point, it sends a signal to Greenwich to acquaint Mr. Airy, not with the time of the beginning of its fall (which cannot be in error), but with the fact that it really has fallen. The ball has several times been dropped experimentally with perfect success, and some small official and subsidiary arrangements alone are wanting for bringing it into constant use.

No step has yet been taken for the galvanic determination of the longitude of the Oxford Observatory, but the necessary preparations within that building are now complete.

The normal clock, with its small adjusting apparatus, has been in constant use. It drops the Greenwich ball and the Strand ball; it sends daily signals along several railways, and it maintains in sympathetic movements various clocks by galvanic currents. Among other clocks thus moved, one is in the chronometer-room, one at the Observatory entrance gate, and one at the South-Eastern Railway offices, London Bridge.

The barrel apparatus for the American method of transits, has been practically brought into use, not, however, as Mr. Airy states, without having met with a succession of difficulties which happily have been overcome. Still Mr. Airy considers the apparatus troublesome, consuming much time in the galvanic preparations and other details. But its high astronomical merits of general accuracy render the method very far superior to the former mode of observing by the eye and ear.

The beautiful system of registering magnetical and meteorological changes by means of photography continues to be employed, and efforts have been made to multiply copies of the Photographic Registers. After many experiments, it was found that, by the agency of sunlight upon the back of an original photograph, whose face was pressed closely, by means of a glass plate, upon proper photographic paper below, there would be no difficulty in preparing negative and inverted secondaries, and, from them, positive tertiaries. Thus, beyond the trouble which the process involves, Mr. Airy anticipates that it will be easy to multiply copies to any extent which may be desired.

The changes among the Observatory instruments have been so trifling during the past year as not to require definite notice. A fire-proof room, for the preservation of valuable documents will shortly be constructed, a sum having been granted by the Admiralty for that purpose.

Under the head of "General Remarks," the Astronomer Royal thus concludes his Report:—"The past year has, on the whole, been felt as a laborious one. This has arisen from accumulation of several perfectly distinct causes. The order of our printing has been disturbed, and this has produced great disarrangement of all our ordinary daily work. The establishment of our galvanic system, and its application to American transits, to public time-signals, and more especially to the longitude determination, has caused to the establishment in general, and to myself in particular, a great consumption of time. The preparation of the Observatory Regulations, and of the description of the Transit-Circle, and the closing of the business of the Standard Commission, have required a great amount of writing which could be entrusted to no one but myself. I may confidently hope that in the next following years several of these causes will not be in action. Still I am impressed with the feeling that the strength of our establishment is now loaded to the utmost that it can bear. A brief review of the progress of the science of Astronomy and of the arts related to it will show that this must be expected. The number of known planets has been largely increased: and I cannot think that in this National Observatory the neglect of any one of the bodies of the Solar System is permissible. The American method of transits adds to our labours; but it appears likely to contribute to accuracy, and it will give facilities for the record of the observations made at other Observatories, upon our registering barrels; and if these advantages are established by experience, the method must be maintained. The public dissemination of accurate time brings some trouble; but it is a utilitarian application of the powers of the Observatory so important that it must be continued. The galvanic determination of difference of longitude brings with it a mass of work in negotiations, in preparations, and in calculations; but it produces results of such unimpeachable excellence, and of such value to astronomy and geodesy, that it must in anywise be preserved as part of our system. Time is consumed in experiments for the improvement of our photographic process, and in measures for the multiplication of copies; but these are worthy objects of attention, which it would be wrong to neglect. All these are additions to the labours of the Observatory as they existed a few years ago, unbalanced by any corresponding subtraction."

* *Athenæum.*

Notices of Books.

The Book of Nature, an elementary introduction to the Sciences of Physics, Astronomy, Chemistry, Mineralogy, Geology, Botany, Zoology, and Physiology, by Friedrich Shoedler, Ph. D.; translated from the Sixth German Edition, by Henry Medlock, F.C.S.; illustrated by 679 engravings on wood—pp. 691, 8vo; Philadelphia, Blanchard and Lea, 1853.

A very complete and exact popular exposition of Natural Science: well printed, well illustrated, and supplied with a valuable and copious glossary of Scientific terms. The Book of Nature has met with an extensive circulation in Germany and England, and is not only well suited to the higher schools, but is particularly to be recommended to that numerous class whose occupations do not permit them to devote a large share of their time to books. We can imagine no better companion for the winter evening study of intelligent farmers, and none which will be so constantly furnished with practical lessons and examples in their daily walk of life.

THE ANGLO-AMERICAN MAGAZINE—Maclear & Co., Toronto.

The first number of the fifth volume of this well-sustained publication appears in a new dress. The change is a very decided improvement, and augurs well for the success of the enterprising publishers. The engraving of the Cedar Rapids is admirably executed. We are both encouraged and pleased at witnessing so marked a progress.

PHYSICAL GEOGRAPHY, *by* MARY SOMERVILLE; *American Edition by* W. S. W. RUSCHENBERGER, M.D.—Philadelphia; Blanchard and Lea, 1854.

The accomplished Author of the Connexion of the Physical Sciences has sufficiently indicated the importance and scope of Physical Geography in the first paragraph of the work before us. "Physical Geography is a description of the earth, the sea, and the air, with their inhabitants, animal and vegetable, of the distribution of these organized beings, and the causes of that distribution."

As a general view of the earth with its inhabitants, Mrs. Somerville's Physical Geography has acquired a wide and well deserved reputation. It will, however, be very easily understood that in a so comprehensive a work many inaccuracies occur in the first edition which are not expected to appear in the second or third. It is even more reasonable to suppose that an American edition, professedly well supplied with notes and emendations by its American editor, would be especially precise and exact in the physical geography of this continent.

Anxious to ascertain how far the "New American from the third and revised London edition," kept pace with modern discoveries and knowledge of facts within the ken of every college boy in the United States and Canada, we bestowed particular attention upon those portions of the work which described the region of the Great Lakes—naturally supposing that Dr. Ruschenberger would also have given *his* attention to this part of the work. On page 264 we find the following:—

"The American lakes contain more than half the amount of fresh water on the globe. The altitude of these lakes shows the slope of the continent: the absolute elevation of Lake Superior is 672 feet; Lake Huron is 30 feet lower; Lake Erie 32 feet lower than the Huron, and Lake Ontario is 331 feet below the level of Erie. The river Niagara, which unites the two last lakes, is 33½ miles long, *and in that distance* it descends 66 feet; it falls in rapids through 55 feet of that height in the last half mile, but the upper part of its course is navigable. The height of the Cascade at Niagara is 162 feet on the American side of the central island, and 1,125 feet wide—on the Canadian side the fall is 149 feet high, and 2,100 feet wide—the most magnificent sheet of falling water known, though many are higher. The river St Lawrence which drains the whole, slopes 234 feet between the bottom of the cascade and the sea."—(*Page* 264.)

The sum of the differences between the levels of Lake Ontario and Superior would give, according to the above statement, 393 feet, which subtracted from 672 feet, the altitude of Lake Superior above the sea, gives 279 feet or the height of Lake Ontario above tide level—whereas a few lines lower down the true altitude of 234 feet is given.

Every Canadian familiar with the majestic scenery of the Falls of Niagara will recognize the misconception which is apparent in the quotation given above, and which the American Editor should not have overlooked. The introduction of a few words will render the passage clear, and remove the arithmetical absurdity which also exists in the numbers given, and their sum. The descents in the Niagara river are as follows:—

Black Rock to head of Rapids	15	feet.
Rapids to Cascade	52	„
Cascade	160	„
Cascade to Lewiston,	104	„
	331	feet.

The description of the Forests of Canada is decidedly novel. They consist chiefly of "black and white Spruce." We give the author's own words:—

"The Canadas contain millions of acres of good soil, covered with immense forests. Upper Canada is the most fertile, and in many respects is one of the most valuable of the British Colonies in the west: every European grain, and every plant that requires a hot summer, and can endure a cold winter, thrives there. The forest consists chiefly of black and white spruce, the Weymouth and other pines—trees which do not admit of undergrowth: they grow to great height, like bare spars, with a tufted crown, casting a deep gloom below. The fall of large trees from age is a common occurrence, and not without danger, as it often causes the destruction of those adjacent; and an ice storm is awful."—(*Page* 126.)

The passage given above is modified in other portions of the "Physical Geography," but, perhaps, not in a manner which will suit the ideas Canadians are accustomed to form of their own magnificent forests. On page 364 we find the following:—

"Boundless forests of black and white spruce, with an undergrowth of reindeer moss, cover the country south of the arctic region, which are afterwards mixed with other trees; gooseberries, strawberries, currants, and some other plants thrive there. There are vast forests in Canada of pines, oak, ash, hickory, red beech, birch, the lofty Canadian poplar, sometimes 100 feet high, and 36 feet in circumference, and sugar-maple: the prevailing plants are Kalmias, Azaleas, and Asters, the former vernal, the latter autumnal; Solidagos and Asters are the most characteristic plants of this region.

"The splendour of the North American flora is displayed in the United States; the American Sycamore, chesnut, black walnut, hickory, white cedar, wild cherry, red birch, locust-tree, tulip-tree, or liriodendron, the glory of American forests; liquid-ambar, oak, ash, pine-trees of many species, grow luxuriantly, with an undergrowth of Rhododendrons, Azaleas, Andromedas, Geradias, Calycanthus, Hydrangea, and many more of woody texture, with an infinite variety of herbaceous and climbing plants."

A little more attention to the Physical Geography of this continent on the part of the American Editor, in several other instances which we could point out, would have rendered this valuable and instructive work doubly interesting to the Canadian reader..

Miscellaneous Intelligence.

ON THE GLUTEN OF WHEAT.—M. Millon, compelled by his high military position to rather a nomadic life, has for some years suspended the fine researches which he had undertaken—researches on the oxydized compounds of nitrogen, chlorine, mercury, nitric ether, also on vegetable physiology, etc., which had given him a high rank among men of science. Removed from his laboratory and sent to Africa, for political reasons, he has found the means of carrying on some important investigations without a chemical laboratory, and he has just now brought before the Academy a series of papers which he proposes to present, containing the results of some researches on wheat.

In his first memoir, he brings out the important fact that there are some kinds of wheat, of good appearance, *that contain no gluten*. His attention was called to the subject by the wheat of Guyotville (Algeria), which although appearing well, was nearly destitute of this important ingredient. He was thus led to examine a quantity of the wheat poor in gluten, and he found it to be a mixture of rich grains with others containing none of this albuminoid substance. Dough made from the wheat of Guyotville without gluten is worked with more difficulty than ordinary dough, and the bread is swallowed with some difficulty, like that which is dry or stale. The nitrogenized substance of this wheat is soluble in water.

In a second memoir, M. Millon takes up the chemical composition of different varieties of wheat, and he deduces from his results a distribution of the wheats—using terms already in use—into *tender wheat*, and *hard wheat*, the characters of which are as follows:—

Tender Wheat,—Fracture white, opaque, farinaceous, the starch and escaping more or less abundantly; a more or less complete replacement of the gluten by a soluble albuminoid principle varying widely in the proportion of nitrogen.

Hard Wheat,—Fracture horny, semi-translucent, without a starch-like appearance; all the nitrogen existing under the form of gluten and the weight of it always a little superior to the quantity of albuminoid principal represented by the nitrogen; only small variations in the proportion of nitrogen, the amount of which is large. This last characteristic does not serve to *distinguish the hard wheat, since it* is not rare to meet with tender wheat containing as much nitrogen as the hard wheat, or even more.

Wheat intermediate between these two varieties, M. Millon names *semi-hard* wheat, which he describes as follows:—

Fracture close and less horny than in hard wheat; whitish when crushed; a proportion of gluten mixed with the albuminoid principle; a large proportion of nitrogen, and this nearly constant.

These descriptions are completed by a mention of the external characters, taken from the volume, color, integuments, etc. His facts are derived mainly from the wheat of Algeria and those of the north of France, and it remains to make the results general, and applicable to wheat of whatever origin.—*Correspondence of Silliman's Journal.*

On the Proximate principles of Bran of Wheat.—Some years since, M. Millon, as a result of long labor, arrived at the conclusion that bran is an alimentary substance; that bran bread and pilot bread ("pain de munition") was more healthy and more nutritious than white bread. This opinion has been contested, and Millon has been ironically attacked for not conforming to the regimen he recommends. But the opinion is now sustained by Chevreul, who declared his views on the occasion of a memoir of M. Mourier on this subject. It is known too that according to Magendie's experiment, dogs could live on bran bread whilst they died on white bread. This fact which appeared so singular, is explained through the researches in question.

The inner surface of bran is covered with azotized principles which like diastase will disolve starch, changing it into dextrine and sugar. These principle differ somewhat from diastase; still it is demonstrated that the bran acts as a ferment in fermentation, and consequently in a similar manner in digestion.

On forming Vessels of Gold by the aid of Phosphorus.—The property of phosphorus, of precipitating certain metals from their solution has long been known: and gold is among the number. M. Levol has used this process in forming gold vessels useful in chemical research. He takes the perchlorid of gold, and places in it, at the ordinary temperature, some phosphorus, moulded of a form convenient to serve as a nucleus for the vessels of gold. To give the phosphorus the desired shape, it is melted in a water bath near 60° C. in temperature, within a vessel of glass having the form required. After cooling it, the phosphorus is taken out solid, from its envelop, breaking it, if it be necessary. The precipitation of the gold or the construction of the vessel is then begun; and it finally remains only to remove the phosphorous by remelting it and washing by the aid of boiling nitric acid until the last traces are removed.

New Planets:—*Bellona* (28), (Comptes Rend., xxxviii, 455, 561).—On the first of March, 1854, Mr. Luther, Director of the Observatory at Bilk, discovered a new planet, which has received from Mr. Encke the name *Bellona:* it is of the tenth magnitude. Its position, March 6d 10h 27m 30s, M. T. Hamburg was R. A. 180° 35′ 38″ and Dec. + 7° 47′ 34″. Mean daily motion in R. A. 10′ 7″ decreasing, in Dec. 9′ 26″, increasing.

Amphitrite (29), (Compt. Rend., xxxviii, 429, 645).—Mr. Albert Marth, at the Regent's Park Observatory in London, discovered another planet near *Spica Virginis*, on the morning of the second of March. It appears as a star of the tenth magnitude. Mr. Bishop has proposed for it the name *Amphitrite.* The following elements of its orbit were calculated by M. Yvon Villarceau, according to the method given in the *Connaissance des Temps* for 1852, from 16 observations made at Paris during the month of March.

Epoch 1854, March 0·00, M. T. Paris.

Mean anomaly, - -	114° 36′ 51″·58	
Long. perihelion, - -	64 50 22 ·81	Mn. Eqnx. Mar. 0·0, 1854.
" asc. node, - -	356 20 34 ·94	
Inclination, - -	6 6 19 ·69	
Angle of eccentricity, -	4 34 47 ·01	
Mean daily motion, -	864″·3666	
Semi-axis major, - -	2·5637300	
Period of revolution, -	4yrs. 104962	

This planet was discovered independently by M. Chacornac, assistant observer at the Observatory of Paris on the third of March. He also on the fourth of February, at Marseilles, noted a star of the tenth magnitude which is now wanting in that place, and which is shown to have been the body first recognised as a planet by Mr. Marth.

New Comet I. of 1854, (Comptes Rend., xxxviii, 648).—The comet which was visible to the naked eye on the twenty-ninth of March last and the few following days, was seen on the same day in Paris. The following elements were computed by Mr. James Ferguson (Astron. Journ., No. 71), from the Washington observations of April 3, 7 and 11.

Perihelion passage, 1854, March 24·0581, M. T. Berlin.

Long. perihelion, - - -	214° 52′ 52″·0	Mn. Eqnx. Apr. 7·0, 1854.
" asc. node, -	316 19 58 ·2	
Inclination, - - -	83 30 35 ·4	
Log. perihelion dist., -	9·441070	
Motion, - - -	Retrograde.	

This comet was seen in the east on the morning of the twenty-third of March by Mr. Alfred de Menciaux near Damazan in France.—*Cor. Sill. Jour.*

Proportion and Properties of Metallic Aluminum.—St. Clair Deville has communicated a memoir on aluminum which contains some new facts but which does not add enough to our positive knowledge to justify the extraordinary flourish of trumpets with which the communication was made and received. The metal was prepared by Wöhler's method, namely, by heating the chlorid with sodium, and afterwards fusing the globules into one mass under the mixture of common salt and chlorid of aluminum. As thus prepared it was silver white, malleable and ductile, and had the fusing point of silver. Its hardness was increased by hammering but it again became soft on heating. Its density was 2·56; it was a good conductor of heat and could be fused and poured out in the air without becoming sensibly oxydized. Aluminum is completely malleable in dry air or moist. Sulphureted hydrogen, hot and cold water, nitric acid weak or concentrated, and dilute sulphuric acid have no action upon it. Its true solvent is muriatic acid with which evolves hydrogen, sesquichlorid of aluminum being formed. Heated to redness in muriatic acid gas it yields dry and volatile sesquichlorid. The author stated that the chlorid of aluminum was acted upon by common metals at high temperatures and hoped that further experiments would point out a simple and a cheap method of procuring in large quantities and at a low rate a metal so likely to be useful in the arts. The Academy unanimously voted that a sum of money should be placed at the disposal of M. Deville to aid him in the prosecution of his experiments.—*Comptes Rendus, Feb. 6th,* 1854.

Detection of Manganese.—Solids to be examined for manganese are finely powdered; fluids require no preparation. The smallest portion of either is mixed with a drop of a solution of pure caustic potash, and heated over a gas-flame. On boiling the alkali to dryness and raising the heat, the characteristic green colour of manganate of potash will appear. The best support is a slip of silver-foil, two or three inches long, and a-half-an-inch wide. In this manner manganese has been detected in a single drop of a solution, containing one grain of solid sulphate in ten thousand of water. The presence of other oxides does not interfere.—*Artizan.*

Zinc applied to Ship-Building.—A sloop built of zinc, with iron framing and wooden decks, called the "Comte Ldhon," has been constructed at Nantes, France, by Mr. Gulbert, and named after one of the directors of the Vieille Montagne Company. She is elegant in form, draws but little water, and is considered in every respect a first-rate vessel. The command was given to Captain Jouanna, of Lorient, and her first voyage was to Rio Janeiro, from which place she has returned. The captain reports that the experiment has been highly satisfactory: she has proved an excellent sea-boat in repeated gales, which she had to encounter: and one fact is stated of much importance—that her compasses had never been in the slightest degree affected, a circumstance which often happens on iron ships, by which serious casualties have occurred.

Glaciers.—In a letter to Arago, M. De la Rive attributes the sudden appearance of vast glaciers in divers parts of Europe to a temporary refrigeration produced at the period of the elevation of the most recent European strata, by the evaporation of the water with which they were previously covered. If evaporation takes place more rapidly from water mixed with sand, earth, or any similar substance than from a surface of clear water, it becomes natural to conclude, that the cold produced by evaporation from the recently-elevated and still humid strata, must have been greater than that resulting from the evaporation of the sea or fresh-water lake which covered them previously to a great depth.—*Bibliothcque Universelle, April,* 1853.

Monthly Meteorological Register, at the Provincial Magnetical Observatory, Toronto, Canada West.—May, 1854.

Latitude, 43 deg. 39.4 min. North. Longitude, 79 deg. 21. min. West. Elevation above Lake Ontario, 108 feet.

Magnet.	Day.	Barom. at temp. of 32 deg. 6 A.M.	2 P.M.	10 P.M.	Mean.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	M'N.	Tension 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.	Wind. 6 A.M.	2 P.M.	10 P.M.	Mean Vel'y	Rain in Inch.	Snow in Inch.
						°	°	°	°														
a	1	29·515	29·460	29·488	29·487	40·2	55·8	45·2	46·75	0·222	0·265	0·235	0·246	·90	·62	·80	·78	W N W	S	S E b S	3·79	...	...
a	2	·411	·355	·428	·405	47·4	53·5	42·8	47·52	·276	·368	·255	·289	85	91	93	88	Calm	E S E	S	3·02	0·265	...
a	3	·399	·503	·594	·506	43·8	52·4	43·4	46·62	·267	·295	·230	·265	94	77	83	85	N W	N b E	N W	7·32	0·025	...
b	4	·600	·659	·444	·519	48·4	58·6	46·0	51·53	·236	·266	·261	·261	83	55	85	71	N b E	S b W	S b W	3·16	...	...
a	5	·376	·184	·554	·476	45·2	53·8	39·5	46·78	·252	·226	·188	·231	85	55	78	74	E b S	N W b W	N W b W	10·59	...	...
a	6	·625	·611	·670	·638	33·9	38·9	28·4	33·63	·127	·101	·118	·119	65	48	73	63	N N W	N N E	N W b N	11·67	...	...
a	7	·654	·590	—	—	31·6	49·9	—	—	·118	·199	—	—	66	56	—	—	N N W	N N W	—	9·81	...	...
b	8	·648	·612	·575	·601	34·5	56·6	49·9	47·80	·143	·168	·227	·196	72	37	92	68	N W b N	S S W	Calm	4·39	...	...
b	9	·481	·360	·351	·333	49·9	54·9	41·3	45·83	·201	·229	·187	·211	79	54	73	69	Calm	E S E	E S E	3·20	...	...
—	10	·295	·259	·368	·306	47·0	53·5	48·5	50·53	·262	·368	·296	·314	82	91	88	85	E	S E b E	N N W	4·19	0·235	...
b	11	·501	·462	·548	·505	42·4	55·2	50·4	50·72	·221	·279	·285	·263	82	64	80	73	N N W	S W b S	W S W	6·72	Inap.	...
b	12	·734	·738	·758	·743	49·4	61·5	54·4	55·07	·213	·311	·251	·264	61	58	61	62	Calm	S E b E	N E b E	5·05	...	...
a	13	·780	·710	·620	·696	57·4	68·6	60·4	62·43	·234	·459	·381	·384	61	67	75	69	E	E	S E b E	8·14	0·040	...
ac	14	·593	·481	—	—	55·3	58·2	—	—	·346	·444	—	—	81	93	—	—	E	Calm	—	3·72	0·455	...
c	15	·576	·517	·564	·557	53·5	57·8	57·7	56·70	·312	·377	·318	·347	78	80	75	76	W	S W b S	S W	6·48	Inap.	...
c	16	·677	·636	·507	·596	48·4	59·4	52·1	54·72	·267	·350	·308	·316	83	70	80	76	N N W	S E b E	E	7·15	...	...
b	17	·298	·089	·201	·183	54·6	66·6	53·0	59·13	·377	·431	·360	·401	90	68	91	82	E b N	E b S	S W b S	6·35	0·015	...
a	18	·276	·316	·412	·353	53·1	63·2	49·6	55·38	·362	·235	·295	·318	91	41	85	76	S E b S	S W b S	S W	8·45	...	...
b	19	·549	·434	·548	·515	50·0	58·5	45·0	50·12	·283	·333	·268	·288	80	69	90	80	S b E	E b S	S S W	5·41	0·505	...
d	20	·547	·534	·598	·567	46·3	54·2	44·6	49·03	·283	·296	·235	·287	91	73	81	83	S b E	W N W	Calm	4·55	0·275	...
c	21	·636	·646	—	—	49·0	51·3	—	—	·286	·323	—	—	83	88	—	—	S S W	S S W	—	4·74	0·315	...
a	22	·822	·878	·918	·876	43·2	55·6	43·4	48·28	·228	·242	·250	·257	83	79	90	81	N W b N	S b W	S	3·78	Inap.	...
a	23	·969	·940	·853	·917	41·1	58·7	41·9	50·38	·217	·307	·231	·260	81	64	78	73	S	S E b S	S E	3·80	...	...
b	24	·799	·656	—	—	49·7	63 0	—	—	·235	·377	—	—	67	67	—	—	E b N	S E b E	—	3·71	0·765	...
c	25	·445	·442	·562	·481	54·7	67·5	59·9	61·15	·372	·469	·475	·459	89	71	94	87	S W b S	S S W	N N W	4·03	0·835	...
b	26	·675	·656	·661	·665	55·5	66·0	54·4	58·63	·385	·463	·343	·392	89	74	82	80	N b E	S W b S	Calm	3·63	...	...
b	27	·716	·700	·650	·687	56·0	68·9	52·4	59·93	·312	·382	·309	·314	71	56	80	69	S	E S E	S E	2·62	...	...
a	28	·624	·626	—	—	54·6	66·7	—	—	·363	·298	—		87	46	—	—	N E b N	S E	—	1·44	...	...
a	29	·634	·620	·564	·601	56·3	68·0	55·6	60·88	·381	·348	·315	·331	86	52	72	65	Calm	E S E	E b N	5·36	...	...
b	30	·526	·528	·669	·586	59·7	63·2	53·1	58·55	·289	·331	·179	·254	56	59	45	51	N E	S	N E b E	5·78	...	...
c	31	·830	·858	·886	·858	48·0	55·2	42·4	49·03	·151	·229	·159	·184	46	54	59	54	N E b.	S E b E	S E b S	4·78	...	...
																		Miles.	Miles.	Miles.	Miles		
—	M	29·574	29·548	29·577	29·566	47·93	58·67	28·41	52·20	0·236	0·312	0·269	0·288	73	64	79	74	4·54	7·85	3·73	5·38	4·630	0·0

Highest Barometer...... 29·986, at 8 a.m. on 23rd } Monthly range:
Lowest Barometer...... 29·066, at 4 p.m. on 17th } 0·920 inches.

Highest temperature.. 71°·4, at p.m. on 13th } Monthly range:
Lowest temperature... 25°·2, at a.m. on 7th } 46°·2.

Mean Maximum Thermometer............. 61°·82 } Mean daily range:
Mean Minimum Thermometer............. 37°·90 } 23°·92.

Greatest daily range......... 32°·2, from p.m. of 30th to a.m. of 31st.

Warmest day....... 13th. Mean temperature ..... 62°·43 } Difference,
Coldest day......... 6th. Mean temperature...... 33°·63 } 28°·80.

Sum of the Atmospheric Current, in miles, resolved into the four Cardinal directions.

North.	West.	South.	East.
1281·43	1111·95	1358·85	1289·14

Mean direction of the Wind, E 24° S.
Mean velocity of the Wind, 5·38 miles per hour.
Maximum velocity, 21·6 miles per hour, from 3 to 4 p.m. on 6th.
Most windy day, the 6th; mean velocity, 11·67 miles per hour.
Least windy day, the 28th; mean velocity, 1·44 " "
Raining on 11 days. Raining 39·7 hours: depth, 4·630 inches.
During the very heavy rain from 4·05 to 4·25 p.m. on the 25th, there fell 0·765 inches on the surface.
Snow, none. Hailstones fell on the 20th and 21st.
Thunderstorms on the 10th, 11th, 17th, 20th, and 25th.
Rainbows observed on the 8th and 11th.
Splendid meteor observed at 9 p.m. on the 12th: course, from S.W. to N.W.; time of flight, about 8s.
Sun eclipsed from 3·45 p.m. to 6·14 p.m. on the 26th.
Aurora observed on 6 nights.
Possible to see Aurora on 17 nights.
Impossible to see Aurora on 8 nights.

13th. Humming-bird seen near the top of the College Avenue.
14th. Wild strawberries in blossom.
17th. Plum-trees generally in full blossom.
20th. Wild cherry-trees in full bloom.
28th. Snake seen in the College Avenue.
30th. Chestnut-trees in the College grounds in blossom.
31st. Lilac-trees in bloom.

Comparative Table for May.

Year.	Temperature. Mean.	Max. obs'vd.	Min. obs'vd.	Range.	Rain. D's.	Inch.	Snow. D'ys	Inch.	Wind. Mean Vel'y.	
	°	°	°	°						
1840	53·8	74·5	30·8	43·7	9	4·150	0	...	...	
1841	50·5	76·2	26·6	49·6	11	2·350	1	Inap.	0·35	lb.
1842	49·1	74·3	30·0	44·3	7	1·275	0	...	0·53	lb.
1843	49·1	79·6	28·9	50·7	5	1·570	0	...	0·52	lb.
1844	53 6	77·7	29·0	48·7	14	5·670	0	...	0·30	lb.
1845	49·6	76·6	29·4	47·2	8	2·300	0	...	0·55	lb.
1846	55·5	78·1	34·3	43·8	9	4·375	0	...	0·46	lb.
1847	51·4	72·5	27·8	44·7	12	2·040	0	...	0·29	lb.
1848	54·1	78·5	31 9	46·6	13	2·520	0	...	4·93	Miles.
1849	48·0	72·5	32·7	39·8	16	5·115	0	...	5·33	Miles.
1850	47·6	76·3	31·1	45·2	7	0·545	1	Inap.	6·32	Miles.
1851	51·3	73·2	28·7	44·5	12	2·950	1	0·5	6·34	Miles.
1852	51·4	73·3	34·5	38·8	7	1·125	1	Inap.	4·00	Miles.
1853	50·9	78·4	38·4	40 0	17	4·420	1	Inap.	5·14	Miles.
1854	52·2	69·0	27·6	41·4	11	4·630	0	0·0	5·38	Miles.
									0·43	lb.
M'n.	51·41	75·38	30·78	44·60	10·5	3·002	0·3	0·03	5·35	Miles.

Monthly Meteorological Register, St. Martin, Isle Jesus, Canada East.—May, 1854.

NINE MILES WEST OF MONTREAL.

BY CHARLES SMALLWOOD, M.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° Fahr.			Temp. of the Air.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Velocity in Miles per Hour.			Rain in	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.	Inch.	6 A.M.	2 P.M.	10 P.M.
1	29·468	29·558	29·617	41.2	53·0	42·0	·263	·310	·243	·91	·73	·85	W b S	W	W S W	2·14	1·11	4·62	0·903	Str. 10.	Cir. Str. 10.	Cum. Str. 9
2	·690	·558	·551	41·0	59·0	51·0	253	338	315	92	66	81	S W	S W b W	S S W	0·76	4·01	1·83		Hazy.	Cir. Cum. Str. 8.	Cir. Cum. 8.
3	·636	·612	·671	44·2	61·0	49·2	223	304	216	73	56	60	N E	N E	N E	10·91	4·33	14·75		Cir. Str. 4.	Clear.	Clear.
4	·751	·677	·622	46·5	71·0	51·0	210	435	315	64	57	81	N E	S E b E	S S E	13·83	2·19	0·65		Clear.	Do.	Do. Aurora Bo.
5	·521	·381	·505	55·0	66·2	38·6	312	373	173	70	58	70	W S W	W S W	N W	1·60	5·50	16·30		Do.	Cir. Cum. Str. 10.	Cir. Str. 6.
6	·603	·566	·581	26·0	29·0	28·0	135	110	126	83	61	73	N b W	N W b W	N W b W	15·55	27·84	25·56		Str. 4.	Cum. Str. 4.	Cum. Str. 10.
7	·582	·485	·552	26·2	43·2	37·7	129	233	199	80	79	81	W N W	W N W	N W	29·05	21·08	16·66		Do. 10.	Cir. 2.	Cir. Str. 3.
8	·709	·575	·631	36·0	57·9	48·0	192	327	242	83	66	69	W b N	N W b W	N W	2·12	8·16	9·76		Do. 9.	Clear.	Clear.
9	·678	·614	·549	35·7	69·0	59·5	203	461	466	91	65	90	S W	S b W	S b W	Calm	Calm	Calm		Clear.	Do.	Str. 10.
10	·545	·500	·410	57·6	73·1	59·0	376	530	458	79	66	96	N N E	S E b E	S S E	0·37	0·10	0·15	0·007	Do.	Str. 10.	Cum. Str. 9.*
11	·596	·635	·694	57·0	70·1	56·5	376	568	287	79	78	62	W b S	W S W	S S W	3·41	8·73	9·81		Do.	Clear.	Cir. Cum. 9.
12	·880	·881	·935	58·5	73·8	58·6	274	380	308	55	47	63	W	W S W	W	5·31	3·12	3·37		Do.	Do.	Clear.
13	30·080	30·076	30·011	47·0	77·0	61·1	262	435	332	77	47	61	N E b E	N E b E	N E b E	Calm	2·71	1·15		Do.	Do.	Do.
14	30.024	29·856	29·704	63·0	75·2	64·0	411	530	520	71	62	85	S b E	S S E	S b E	4·11	13·88	18·20		Do. [do.	Str. 8.	Str. 10.
15	29·647	·711	·816	68·8	77·7	64·2	449	414	379	72	45	63	W b N	W S W	W S W	2·50	0·68	Calm	Inap.	Shower in night	Do. 2.	Do. 4.
16	·824	·801	·82	61·9	74·0	60·7	397	458	361	71	55	68	W S W	W S W	E N E	Calm	10·31	Calm		Do.	Clear.	Clear Aur. Bo.
17	·800	·635	·580	55·6	84·0	69·4	343	660	486	74	57	69	N E	S b E	S b E	0·22	9·25	19·12		Cir. Cum. Str. 4.	Do.	Str. 4.
18	·583	·572	·527	62·9	62·5	59·2	516	499	478	90	89	94	W b S	S b E	S S E	18·50	2·94	Calm	1·033	Str. 10. Rain at 3	Showers.	Do. 9.
19	·741	·677	·679	58·1	75·9	60·1	389	407	441	79	47	84	W S W	S b W	W S W	Calm	0·88	0·44		Cum. Str. 4. [a.m.	Clear.	Do. 2.
20	·780	·758	·785	53·9	74·1	58·0	337	485	346	81	52	70	W S W	S W b S	W b S	7·37	1·47	2·77	Inap.	Do. 4.	Cir. Str. 4.	Cum. Str. 4.
21	·858	·842	·795	57·6	60·9	52·2	316	330	349	66	63	87	W N W	N W b N	N W b N	3·62	2·17	Calm	0·366	Clear.	Do. 8.	Rain at 8·10
22	·900	·939	30·012	53·0	55·7	47·9	361	331	302	87	74	86	W	W b N	W b N	0·18	1·80	4·15	0·530	Rain in the night	Showers.	Clear. [p.m.
23	30·089	30·072	30·018	51·4	62·3	51·4	293	297	293	76	53	76	N W b W	Calm	S S W	Calm	Calm	0·08		Clear.	Cir. Cum. 2.	Do. Aurora Bo.
24	·040	29·850	29·758	58·5	76·1	61·1	367	368	362	75	64	66	Calm	S W	S b E	Calm	Calm	0·53		Do.	Clear.	Do.
25	29·672	·523	·542	60·0	59·9	57·0	441	467	461	81	90	98	S	S b E	N W b W	2·51	4·59	3·77	0·559	Cum. Str. 9. Rain	Cum. Str. 10.	Str. 2.
26	·639	·671	·804	55·0	73·0	56·2	341	534	408	76	65	89	N	N E b E	E N E	9·37	10·00	8·19		Clear. [at 10·45.	Str. 8.	Clear. Aur. Bo.
27	·916	·804	·663	57·3	77·0	60·0	376	594	467	79	66	89	N E b E	E N E	S S W	5·38	3·03	3·76		Do.	Clear.	Do.
28	·777	·758	·784	63·1	75·1	57·2	516	607	276	89	71	79	S W	E b N	E N E	0·10	3·93	0·52		Do.	Cum. Str. 4.	Do. Aurora Bo.
29	·887	·718	·686	50·1	75·8	53·2	304	523	293	81	61	70	E N E	W b S	N b W	7·40	1·25	1·62		Do.	Clear.	Do.
30	·730	·700	·921	53·1	66·8	40·4	207	317	179	49	49	67	E b N	E	N E	0·62	5·64	8·95		Do.	Cum. 4.	Do.
31	30·045	·912	·942	50·0	68·6	51·0	199	339	263	53	49	69	E b N	S W b W	S E	1·00	2·14	3·62		Do.	Do. 2.	Do.

Barometer	Highest, the 23rd day	30·089
	Lowest, the 5th day	29·381
	Monthly Mean	29·731
	" Range	0·708
Thermometer.	Highest, the 17th day	84°·9
	Lowest, the 6th day	24°·2
	Monthly Mean	57°·17
	" Range	60°·7
	Mean Humidity	·723
Greatest Intensity of the Sun's Rays		128°·0

Amount of evaporation, 4·13 inches.
Rain fell on 8 days. Raining 32 hours; amounting to 3·418 inches.
Most prevalent Wind, W S W. Least prevalent Wind, S.
Most Windy Day, the 6th day; mean miles per hour, 23·98.
Least Windy Day, the 23rd day; mean miles per hour, 0·03.
Frogs first heard 2nd May.
Aurora Borealis visible on 5 nights. Might have been seen on 15 nights.
Annular eclipse of the sun on the 26th day, at 4h. 11m. 3s.
The electrical state of the atmosphere has been marked by feeble intensity, except on the 10th, 20th, and 22nd day, when it indicated a high tension of a positive character.

* Showers at 3·40 p.m.

Monthly Meteorological Register, Quebec, Canada East.—April, 1854.

BY LIEUT. A. NOBLE, R.A.

Latitude, 46 deg. 49·2 min. North; Longitude, 71 deg. 16 min. West. Elevation above the level of the Sea, — Feet.

Date.	Barometer corrected and reduced to 32 degrees, Fahr. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temperature of Air. 6 A.M.	2 P.M.	10 P.M.	MEAN	Elasticity of Air. 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.	Velocity of Miles. 6 A.M.	2 P.M.	10 P.M.	Rain in inch.	Snow in inch.
					°	°	°	°																
1	29·476	29·215	29·341	29·344	32·0	39·2	35·0	35·40	·181	·226	·168	·192	00	95	83	93	E S E	Calm	E S E	3·8	...	10·1	0·25	...
2	29 637	29·877	30·120	29·878	23·3	31·3	17·2	23·93	113	139	087	113	87	79	87	84	E S E	W N W	W N W	5·2	8·8	7·2	...	...
3	30·316	30·176	30·192	30·228	8·3	35·8	23·2	22·43	054	134	109	099	79	65	86	76	W N W	W N W	W N W	6·2	7·2	8·0	...	...
4	30·106	30·012	30·080	30·076	26·0	44·2	36·2	35·47	130	172	155	152	91	60	73	75	Calm	W	W	...	8·0	7·2	...	...
5	30·039	29·846	29·662	29·849	34·3	47·6	41·5	41·13	158	178	193	176	79	54	76	69	Calm	Calm	W	...	...	3·8	...	...
6	29·547	29·370	29·276	29·398	41·2	52·2	43·3	45·57	236	281	253	257	92	73	91	89	Calm	W S W	W S W	...	3·8	3·8	0·24	0·2
7	29·683	29·846	30·060	29·863	32·2	37·3	25·3	31·93	164	129	135	143	91	68	96	82	N N W	W N W	N	10·1	8·0	7·2	...	...
8	30·111	30·032	29·920	30·021	23·0	36·0	28·3	29·10	108	175	136	140	86	82	97	88	E N E	E N E	E	8·0	8·8	8·8	...	0·3
9	29·856	29·800	·700	29·785	30·0	36·2	32·3	32·87	134	208	160	167	80	89	88	86	E	E	E	8·0	8·8	13·9	...	0·3
10	·507	·491	·668	·522	31·0	39·8	31·2	37·00	165	186	155	169	95	77	89	87	E	E	E	11·3	10·1	5·2	...	...
11	·717	·776	·775	·756	30·8	36·0	27·0	31·27	159	192	123	168	98	91	82	89	N	E	Calm	8·8	8·0	...	...	...
12	·788	·720	·865	·791	23·3	50·0	38·3	37·20	112	194	228	178	86	55	94	78	W	W	Calm	8·8	9·6	...	...	...
13	30·070	30·143	30·257	30·157	25·0	27·5	...	...	122	131	...	...	88	86	...	...	E	E	N N W	10·1	11·3	12·4	...	...
14	30·202	30·175	30·131	30·190	11·0	33·8	29·5	24·77	063	169	139	124	82	88	84	85	N N W	W S W	W S W	11·3	10·1	6·2	...	...
15	30·055	29·930	29·888	29·958	21·8	32·0	26·0	29·93	094	127	132	118	78	70	92	80	Calm	E	E	...	5·2	5·2	...	...
16	29·956	·989	·980	·975	15·8	31·8	24·5	27·37	082	158	111	117	87	88	82	86	E	E	E	3·8	5·2	3·8	...	...
17	·992	·873	·740	·872	15·6	33·5	29·5	26·20	075	145	131	117	81	78	80	80	Calm	E	E	...	20·2	11·3	...	...
18	·711	·680	·609	·634	30·3	36·5	30·0	32·27	132	188	134	151	78	87	80	82	E S E	E S E	E S E	11·3	8·0	6·2	...	...
19	·582	·507	·420	·506	29·8	50·8	41·0	40·53	130	183	172	162	78	50	67	·65	W	W	S	6·2	7·2	8·0	...	...
20	·517	·514	·596	·552	34·2	48·6	38·8	40·53	167	175	153	165	85	62	66	68	S	S	S S E	7·2	4·2	5·2	...	...
21	·720	·727	·749	·732	33·0	42·0	31·3	35·43	150	142	141	144	79	54	81	71	N W	E N E	E N E	6·2	5·2	5·2	...	...
22	·762	·649	·593	·668	29·8	44·0	34·0	35·93	134	159	161	151	80	56	81	72	E N E	E N E	E N E	6·2	6·2	6·2	...	...
23	·668	·744	·794	·735	38·0	40·0	34·0	37·33	138	129	094	120	61	53	48	54	E N E	Calm	Calm	13·9	...	...	...	...
24	·835	·711	·584	·710	28·5	50·5	41·0	40·00	120	153	163	146	75	43	64	61	W S W	W S W	W S W	5·2	5·2	6·2	...	...
25	·548	·546	·554	·549	34·0	54·7	43·0	43·90	...	...	...	...	...	...	...	...	W S W	W S W	Calm	8·6	6·2	...	...	...
26	·546	·416	·303	·422	33·8	46·0	39·0	39·60	140	261	195	199	72	83	83	83	S	Calm	Calm	3·8	...	...	0·4	...
27	·450	·685	·803	·646	37·3	37·0	35·0	36·43	158	170	151	162	72	80	74	79	N	N	Calm	3·8	8 0	...	...	1·5
28	·996	30·166	30·205	30·102	32·8	38·8	34·0	35·20	169	178	161	169	91	79	81	84	E	E·	Calm	10·1	13·4	...	...	1.0
29	30·240	30·246	30·081	30·189	33·8	39 6	36·0	36·13	164	166	175	168	85	65	82	77	E	E	E	11·3	16·0	21·2	1·1	...
30	30·000	29·930	29·812	29·914	36·3	38·5	37·0	37·27	169	220	191	193	79	95	87	87	E	E	E	22·1	19·7	21·2	0·9	...
M	29·8243	29·7887	29·7792	29·7974	28·73	40·82	33·19	34·23	139	176	155	156	86	76	81	81				7·02	7·48	6·28	3·89	3·3

REMARKS.

2nd. Aurora visible, faint arch and dark segment underneath, at 10h. 15m. Bright streamers shot out suddenly.

10th. At 2 p.m. the clouds were arranged in and parallel to the magnetic meridian. The early part of the night hazy, and a very fine lunar halo, 40° in diameter, visible from 8 to 12. A magnificent Aurora observed: great magnetic disturbance.

17th. At 2 p.m. a remarkable bunch of cirrous clouds at right angles to magnetic meridian, right across the sky.

23rd. Aurora visible immediately after sunset, and as soon as stars of the first magnitude.

24th. The ice opposite Quebec gave way, but that at Cape Rouge still firm.

25th. Swallows seen.

26th. Wheel carriages employed in the town.

Maximum Barometer, at 6 a.m. on the 3rd.............. 30·316 } Monthly Range, 1·101 in.
Minimum Barometer, at 2 p.m. on the 1st.............. 29·215 }

Maximum Thermometer, on the 25th...................... 55°·0 } Monthly Range, 49°·0
Minimum Thermometer, on the 2nd....................... 6°·0 }

Mean Maximum Thermometer.............................. 41°·0 } Mean Daily Range, 17°·7
Mean Minimum Thermometer.............................. 23°·3 }

Greatest Daily Range, on the 12th...... .... 31°·0
Least Daily Range, on the 14th.. .... 2°·8

Warmest Day, the 6th; mean temperature............ 45°·57 } Climatic Difference, 23°·14
Coldest Day, the 3rd; mean temperature.............. 22°·43 }

Possible to see Aurora on 17 nights.
Aurora visible on 16 nights.