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(From the Report of Alex. Murray, Esq. Assistant Provincial Geologist, dated Montreal, January, 1849.)

WESTERN AND HURON DISTRICTS.

Gypsiferous Limestone and Shale, and Corniferous Limestone.

There are no hard rock exposures of any kind on the coast south from the Rivière au Sable (north) for upwards of seventeen miles, or on the Sauguine River so far as we ascended it. The first discovery of such strata *in situ*, on our route in that direction, was at a point about seven miles nearly S. W. from the mouth of the latter stream, where an outcrop occurs displaying buff-coloured limestone, holding numerous organic remains, of which the forms were frequently replaced by hornstone. The beds were in no case at this place exposed above two feet over the level of the lake, and their approach to horizontality was so near that the eye could scarcely detect a slope. They came out at intervals along the shore, the surface of one bed being sometimes exposed for a considerable distance, and occupied altogether a space of four or five miles, beyond which another concealment occurs, continuing to within three miles of Point Douglas, where yellowish coloured calcareous sandstone skirts the coast line. Proceeding along the beach towards Point Douglas, we found this sandstone associated with calcareous beds holding a large amount of hornstone, with black bituminous shales and blue and drab-coloured limestones, one bed among which appeared to be hydraulic. The whole of these strata were devoid of fossils, but imperfect crystals of celestine or sulphate of strontian occurred, with quartz and calc-spar, lining drusy cavities or cracks in the rock, and numerous imbedded balls of hornstone were met with. A black band overlies the sandstone, and is of a coarse granular texture, appearing to be composed principally of an aggregation of imperfect crystals of calc-spar, while the black color results from the presence of bituminous matter, which exists in greater or less proportion in all the beds. Ascending in the section, which at Point Douglas displays a thickness of twelve feet, thin calcareous beds of a dark brown colour occur, separated by very thin layers of black bituminous shale; and over them the upper part of the cliff is occupied by thin bands of blue limestone and pale yellowish calcareous beds, sometimes over a foot in thickness, much marked by small brownish lenticular crystals of calc-spar. Between two of the beds there is a suture-like division; the two beds when separated present surfaces covered with inter-fitting tooth-like projections, the sides of which often display a fasciculated columnar structure, and a film of bituminous matter lies between the surfaces, and invests all the projections. One part or another of the non-fossiliferous section thus exposed at Point Douglas continues to occupy the coast to the southward, exhibiting gentle undulations, to a spot about half a mile beyond the Little Pine Brook, where fossiliferous beds, holding much hornstone, are seen overlying the highest of the strata already mentioned, in detatched isolated patches, for upwards of a mile, beyond which no ledge is exposed for upwards of twenty-five miles.

Where the line between the Townships of Ashfield and Colborne meets the lake, a little south of Maitland River, ledges come from beneath the high clay cliffs which face the water, and these ledges are seen at intervals along the shore for about a mile. The greatest section exposed does not afford a vertical thickness of more than six feet; the rocks resemble a part of those of Point Douglas; they are destitute of fossils, and consist, in ascending order, of gray calcareous and bituminous sandstones, cherty limestones, brown calcareous beds striped with thin bituminous shales, and pale yellow calcareous layers, sometimes three feet thick, with lenticular crystals of calc-spar, or cavities from which such have disappeared. Probably in the same relation to these rocks as the fossiliferous to the unfossiliferous of the vicinity of Point Douglas, there occur at the falls on the Ashfield River, about a quarter of a mile above the village, a set of thick-bedded dark gray calcareous sandstones and buff-coloured silicious limestones, both holding organic remains, which are more numerous in the latter. Beds similar to those on the Ashfield coast and river, probably a continuation of the same, were observed for the last time in a cliff on the Maitland River near Goderich. The following is a section of them in descending order:—

		ft.	in.
1.	Thin-bedded dark gray bituminous limestone holding organic remains; a suture-like bituminous division with tooth-like and occasionally columnar-sided projections, separate two of the beds	21	0
2	Measures concealed by clay and debris	12	0
3.	Pale gray or drab-coloured fine grained sandstone, with ferruginous spots and stripes and mottled with blue and yellow: no fossils	2	0
4.	An irregular bed composed of an agregation of imperfect crystals of calc-spar	0	1
5.	Dark brown fine-grained sandstone striped with bituminous layers, very soft and easily disintegrated until after exposure to the air, when it becomes hard	2	6

At the bridge across the Maitland River, about half a mile from the village of Goderich, and at a short distance below the place where the above section was measured, the following unfossiliferous rocks were found exposed in a continuation of the s[illegible] cliff:—

		ft.	in.
2.	Dark gray bituminous and silicious limestone	4	0
	Brecciated, cherty and bituminous limestone	2	0
3.	Pale yellowish calcareo-arenaceous bed, with ferruginous stripes and spots	1	10
4	Bed composed of an aggregation of imperfect crystals of calc-spar	0	6
5.	Soft yellowish coloured sand-stone with bituminous and ferruginous spots	3	0
6.	Dark gray or brownish coloured bituminous limestone containing small lenticular crystals of calc-spar or cavities of the same form, some beds showing a large quantity of hornstone and thin partings of black bituminous shale	4	0

The lower and non-fossiliferous portion of the rocks thus described bears a strong resemblance in their mineral character

* In the August number of this Journal we published a Geological Map of a considerable portion of Western Canada, by W. E. Logan, Esq., F.R.S & G S., Provincial Geologist. We now propose to furnish monthly abstracts of those portions of the Geological Reports which describe the physical structure of the country comprehended within the limits of the Map. We are induced to adopt this method of disseminating information respecting the Geology of Canada, not only on account of its intrinsic value, but also because it is a matter of extreme difficulty to meet with copies of the earlier Reports, in consequence of the destruction of the reserve during those disastrous conflagrations which destroyed the Parliament Buildings at Montreal and Quebec.

and general appearance to that series of beds at the summit of the Gypsiferous formation of New York, which is known there as the Water-lime group, except that the beds do not contain organic remains, the total absence or very great scarcity of which is a feature that belongs, both in New York and the bordering part of Canada in the Niagara district, to the remainder of the formation. This analogy is farther supported by the fossiliferous portion of the Huron sections, in which several of the fossils seem to correspond with those figured by Hall and Vanuxem, as characteristic of the Corniferous limestone and the Onondaga limestone, which constitutes a passage to the Corniferous, and is in the western part of New York and its continuation into Canada, the formation overlying the Gypsiferous. These fossils are *Paracyclas elliptica*, *Delthyris undulata*, *Atrypa affinis*, with a *Cyathofillum* and a *Syringopora* belonging to the Onondaga limestone, neither of which have been specifically named, accompanying *Favosites gothlandica*; other species of *Delthyris* and *Atrypa* occur, with *Strophomena* and *Cypricardia*, and univalves resembling the genus *Platiceras* of Conrad. In addition to the corals mentioned, others are present, and there are also several species of Trilobites.

The Corniferous limestone extends over the greater proportion of all the western parts of the peninsula between Lakes Huron and Erie, but thick deposits of drift cover it up throughout the chief portion of the area it occupies. The only exposure of it met with in our excursion, in addition to those already mentioned, near the Sauguine, at Little Pine Brook, and on the Ashfield and Maitland Rivers, were at the Malden quarries, near Amherstburgh, at the very western extremity of the western district, where it displays thick beds of a pale yellowish limestone of a bituminous quality, abounding in fossils, and where, in addition to those kinds of remains already mentioned, it holds the bones of fishes.

As it appears probable from what has been said, that the fossiliferous rocks south of the Sauguine belong to the base of the Corniferous limestone, it may be inferred that the whole of the sand and clay covered space between them and the Rivière au Sable (north) is occupied by the Gypsiferous group, the upper members alone of which are brought into view on the shore of Lake Huron, and by a series of gentle undulations carried to Point Douglas and the other parts of the coast to Goderich. When the flatness of the strata, and the thick coating of the superficial arenaceous and argillaceous deposits in those parts of the country, are considered, it is not surprising that the mineral which in other parts renders the formation of economic importance should not have been met with. But as the district becomes settled and cleared, there is little doubt many fortunate exposures of it will be found between the mouth of the Sauguine and those spots where it is already turned to use on the Grand River. The position there occupied by the available masses of gypsum is in the middle of the formation, and wherever they have been observed in Canada, they are associated with green calcareo-argillaceous shales and thin beds of limestone. Below these shales and limestones, red marls are known to exist in Canada, not far from the Falls of Niagara, and also in New York, where that part of the formation becomes of importance as the salt-bearing rock of Onondaga. That the red marls are probably continued, in front of the Niagara limestones, to the coast of Lake Huron between the mouths of the Sauguine and Au Sable, appears to be indicated by the fact that Captain Bayfield on his map of the lake has represented a bottom of red clay to exist in soundings of 354 feet, at a spot bearing about W. by S. seventeen or eighteen miles from the mouth of the Sauguine, or about twenty-five miles in the same direction, from a point where the level of the lake would intersect the supposed probable outcrop of the marl on the land, and though it would require a slope of no more than fourteen feet in a mile to reach the red clay in the submerged locality, while the general inclination of the exposed strata is estimated at thirty feet in a mile, the difference is too small, and such a change in the dip as would be required to compensate it, too common an occurrence to make it any difficulty. With a slope of thirty feet in a mile, the total thickness of the formation, where it attains the mouth of the Sauguine, would be 300 feet.

The opinion that the economic masses of gypsum will be found to accompany the formation to which they belong to the coast of Lake Huron, is supported by the fact that such are known to exist in its farther extension on Burnt Island, not far northward of Michillimakinac, the rocks constituting the group of islands in the vicinity of which have been ascertained to belong to the gypsiferous series; and the value of gypsum in its applications to the soil renders it little doubtful that its presence will have a material effect upon the prosperity of such settlements as may be found to posses available quantities in their vicinity, but as the mineral is distributed in detached and isolated masses, varying greatly in size and extent, and not in continuous sheets among the strata, the discovery of workable parts can only be expected as the result of careful and persevering research, continued for some time.

In addition to gypsum, hydraulic lime is a material of economic value likely to result from this formation; a bed of it at Point Douglas has already been alluded to, which in the experiments tried with it, hardened rapidly under water, after having been burnt and pulverized, and the statements of a previous report show that considerable quantities of it exist in the formation, near Paris on the Grand River. Good common material for building purposes and limestone for burning are met with in both the Gypsiferous and Corniferous formation. At Goderich, about half a mile above the bridge across the Maitland River, a dark brown sandstone, soft in the bed, but hardening on exposure, has been used for coarse building purposes, and found useful in the construction of limekilns. At the same place there are limestones in the upper part of the bank, which make a good substantial building stone, but are unfit for any ornamental part of an edifice, in consequence of a tendency to become iron-stained. The body of the gaol and court-house at Goderich is built of such a stone, but the facings of the structure, I was informed, were brought from Malden. Rocks of a similar character to those above mentioned occur at the rapids on the same river near Papp's farm, about five miles from Goderich on the London road: the strata being nearly flat, are capable of being easily quarried. At Malden, near Amherstburgh, a limestone of a whitish gray, and sometimes of a buff colour, is extensively quarried for building stone; the beds, which lie nearly flat, are from one to two feet thick, in no case require more than two or three feet of soil to be stripped from them, and in some parts are attainable at the very surface. They give a very handsome building stone, and at the base of some of the sections exposed there is a compact layer of a buff colour, somewhat resembling lithographic stone in its appearance; but for lithographic purposes it seems to be too brittle. All the beds burn to a good white lime. When the beds of the Corniferous formation hold too much of the hornstone, (from the large disseminated quantities of which it derives its appellation,) to yield building materials, the rock then becomes applicable as road metal, for which it is well adapted; the hornstone prevails chiefly in the lower part of the formation.

Hamilton Group.

In a low cliff on the west side of Cape Ipperwash or Kettle Point, there is displayed a vertical amount of about twelve to fourteen feet of black bituminous shale, which splits into very thin laminæ, and weathers to a dull lead colour, marked in many places by extensive brown stains from oxyd of iron, while patches of the exterior in such parts as are not washed by the water of the lake, are encrusted with a yellowish sulphurous looking powder.* Many nodules and crystals of iron pyrites are enclosed in the shales, and many peculiar spherical concretions. On the east side of the Point the upper beds of the section are concealed by debris, but the lower come out from beneath the bank, exposing their surfaces a little above the level of the water, studded by the spherical concretions, over an area of several square acres. The resemblance these concretions bear in many instances to inverted kettles has probably been the origin of the name commonly applied to the Point; they are of all sizes from three inches to three feet in diameter, and while many of them are nearly perfect spheres, others are flattened a little, generally on the under side; sometimes they present one sub-spherical mass on the top of another, the upper of which is smaller than the under, giving a rude resemblance to a huge acorn; the masses split open with facility, both vertically and horizontally, and when double forms occur they are readily divided horizontally. These concretions are all composed of a dark gray crystalline limestone, presenting in many cases a confused aggregation of crystals in the centre, from the nucleus formed by which slender elongated prisms radiate very regularly throughout the mass to the circumference. In the nucleus are sometimes met with small disseminated specks of blende, but these were not observed to extend to the radiating prisms, which both in their terminations on the exterior of the sphere, and in their filiform aspect in the radii on fractured surfaces, give the mass very much the semblance of a fossil coral, for which it might readily be mistaken.

The shale is fossiliferous, and among the remains a fucoid resembling the *Fucoides cauda galli* of Vanuxem is very abundant, chiefly in the lower beds. Stems of plants supposed to be species of *Calamites*, in some instances seven to eight feet long with a breadth of three inches, are frequently seen about the middle of the section, and in these are sometimes remarked patches of a thin coating of coal, which no doubt when freshly exposed, invested the whole plant. In one place a *Lingula* (but neither of the two species represented by Mr. Hall as belonging to the Genesee slate,) was found associated with plants, in addition to what appears to be a number of minute orbicular microscopic shells.

The whole of the beach where these bituminous shales occur, appears to have been overrun by fire, which is rumoured by the Indians and others acquainted with that section of country, to have originated spontaneously, and to have continued burning for several consecutive years. That rocks containing so much bituminous matter, once ignited, should not cease to burn for months or even years, is very probable; but it is difficult to ascertain satisfactorily whether the fire was the result of natural causes or of accident. Spontaneous combustion is known to be of frequent occurrence near collieries, where bituminous shale is thrown up in heaps as refuse resulting from the working of the coal, when the shale is of a crumbling nature, and is accompanied by iron pyrites, a mineral present in most coal seams. It is not in my power to explain the phenomenon clearly, but it is supposed to be connected with the decomposition of the pyrites; but in the case of Kettle Point the same materials, bituminous shale and pyrites are present together, and it is not unreasonable to suppose that their action on one another may have originated the ignition. We observed that on digging a foot deep or more into the shingle, a faint and almost colourless vapour immediately arose from the opening, which, gradually increasing in volume and density, in the space of two or three minutes, became a distinct smoke, emitting an odour very similar to that produced by the combustion of a sulphurous coal, and evolving at the same time a considerable heat. The shingle of the beach, which is almost exclusively derived from the formation, is of a bright red colour wherever the fire has extended, the bituminous matter having entirely disappeared.

The black colour and inflammable nature of the bituminous shales of Kettle Point have suggested to some persons, as in the case of the bituminous shales of the Utica slate in other parts of the Province, the possibility of their proximity to available coal seams. But the formation to which they belong is well known in the State of New York, where useless and expensive experiments were made in it, before the institution of the State Geological Survey, in a vain search for mineral fuel; the formation has the name of the Hamilton Group, at the base and at the summit of which there are black bituminous shales, in the former case called the Marcellus, and in the latter the Genessee slate, either of them corresponding with the general condition of the Kettle Point shales; but between the Hamilton Group and the coal areas south-east of Lake Erie, on the one hand, and north-west of Lake St. Clair on the other, there occurs an important group of sandstones (called the Chemung and Portage Group): no trace of these sandstones any more than of the Carboniferous Group, has yet been met with in Western Canada.

Drift.

A great accumulation of drift was observed on the margin of the lake and on the banks of the rivers south of the Rivière au Sable (north,) consisting of clay, gravel, sand, and boulders. Allusion has already been made to their distribution on the coast, and from this they extend into the interior, and cover the greater part of the country between Lakes Erie and Huron. The clay in the cliffs overlooking the latter, was found to be very calcareous, containing sometimes so much as 30 per cent. of carbonate of lime, and constituting a rich marl, which would be of advantageous application, in an agricultural point of view, to the sandy portions of the district. The clay often contains numerous pebbles and boulders of limestone, quartz, granite and allied species derived from the ruins of rocks similar to those found in place in one part or other of the shore around the lake. Those of limestone were often discovered to hold fossils peculiar to the Corniferous formation, especially in the Township of Plympton, where they were numerous but usually water worn. The sands met with on the coast consisted of fine grains of white quartz; equally fine grains of mica, feldspar and limestone were distributed in smaller proportions,

* The substance is soft, dull, earthy, of a sulphur yellow, and in addition to possessing the exterior aspect, gives the blow pipe reactions of *Humboldtine* or oxalite of iron. It instantly blackens in the flame, without any sulphurous odour, and becomes magnetic, leaving, by the continuance of the heat, a bright red stain.

and a slightly ferruginous mixture gives it a pale yellow colour.

The strong calcareous quality of the clay which would give it value as a manure, renders it unfit for bricks or pottery. But clays suited for such purpose are found in abundance in some parts of the interior, such as in the vicinity of London and of Thorold, where it is supposed to overlie the calcareous clay.

Such brooks and rivulets as issued from marshes or swamps, often gave indications of iron ochre or bog iron ore by ferruginous incrustations on the banks or on the bottom, and in my excursion up the Grand River, numerous loose masses of bog iron ore were found strewed over the surface in the Township of Dumfries, near Galt, where, if it should be found in available quantity, it cannot fail to be of considerable importance to this thriving town, in which an extensive iron foundry is already established.

On Changes of the Sea-Level effected by existing Physical Causes during stated periods of time.

By Alfred Tylor, F. G. S.

Concluded from page 60.

Part II

Allusions have already been made to the difficulty of proving whether or not the sea-level had been *gradually* elevated, because the rise of the waters would conceal the evidence of their former height except just at the mouths of rivers, where deposits of fluviatile alluvium might raise the land from time to time and keep it above the waves. The recent strata formed at a few such localities have been described by the best observers, and while there are appearances in several cases which might be to some extent explained by the supposition of a gradual rise of the sea-level, yet no proof could be obtained without the concurrent testimony of a much greater number of instances than have yet been brought forward. Sufficient information, it appears, exists to show that the quantity of alluvium in the deltas of such rivers as the Mississippi, Ganges and Po, is so enormous, that the accumulation must have occupied a period of time during which it would not be possible to conceive the sea-level stationary.

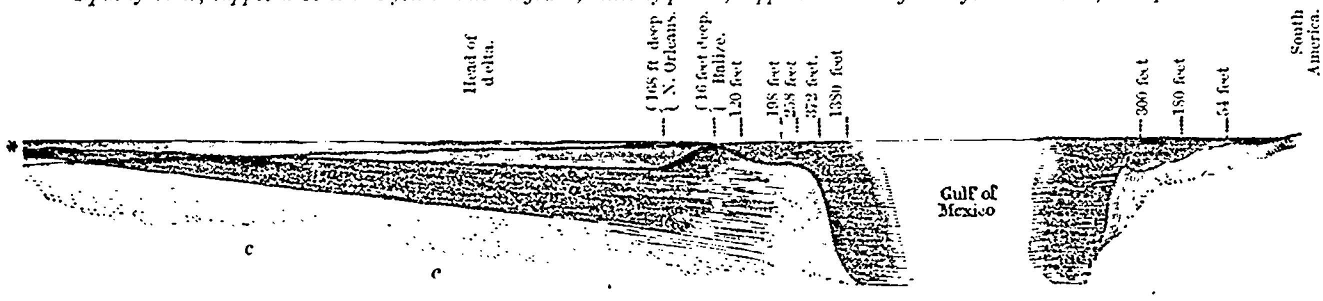
Little progress could be made in an inquiry of this kind without clear views of the operations of rivers. The recent reports of engineers upon this subject supply an important link in the chain of evidence, and enable us to understand the laws which govern the formation of alluvial plains along the lower parts of all river-courses.

The diagram (fig. 1) represents a section of 600 miles of North America, through the alluvial plains and delta of the Missisippi,* together with a section of the Gulf of Mexico from a point 100 miles east of the Balize to the continent of South America. The sea-bottom is marked from the soundings on the Admiralty Chart, and the depth of the Mississippi and its fluviatile deposit are inserted from statistics collected by Sir C. Lyell.†

* For a most valuable detailed description of the physical geography, &c of the Mississippi and Ohio valley, see Mr. C. Ellet's paper, Smithsonian Contributions, vol. ii, 1851.

† See note, page 26.

Fig. 1.—*Diagram showing depth of the Delta (supposed 600 feet); area 14,000 square miles; height of the river above the sea level 275 feet at *; depth of river, supposed 80 to 200 feet in this diagram; ditto of plains, supposed to average 264 feet. area, 16,000 square miles.*



* Junction with River Ohio

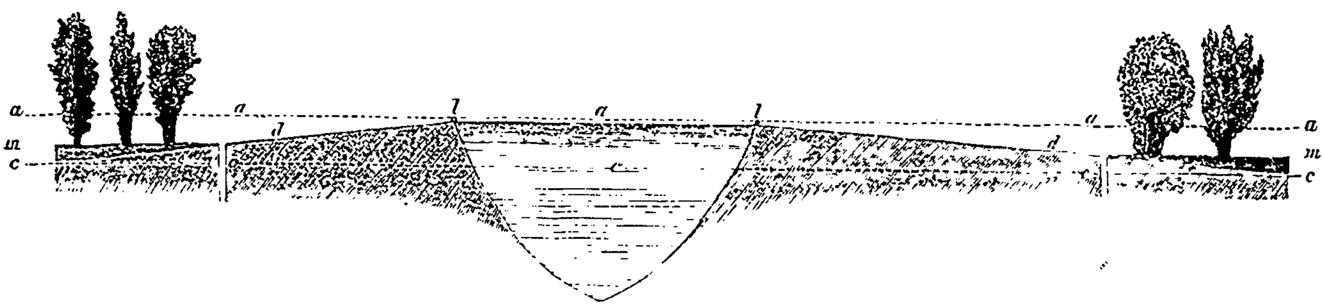
a, a Fluviatile strata of the plains of the Mississippi, the slope of these plains is determined by measurement to be about 1 foot in 10,000 towards the sea

c, Marine strata

Direct distances.—Junction with Ohio to Balize, 580 miles Head of Delta to Balize, 180 miles. New Orleans to Balize, 70 miles.

[Vertical scale 1 inch to 1000 feet. Horizontal scale 1 inch to 150 miles.]

Fig. 2.—*Transverse section of the Mississippi, where it is 1500 feet wide and 100 feet deep, running in the midst of an alluvial plain 50 miles wide.* [*This diagram shows the section of slow-flowing rivers in general.*] Vertical scale 100 feet to the inch.



a, a. The level of water in the river during flood, which is 25 feet above the level of the distant marshes, m, m.

c, c. The level of water in the dry season

b, b Artificial banks or levees, 4 feet high.

d, d The banks and plains

m, m Marshes supplied with water by filtration from the river at all seasons of the year

The whole body of water in the river must be in motion, so that even in flood time only a small per centage of the water and alluvium in the stream can escape over the banks

It will be seen that the level of the water in the Mississippi, near its junction with the Ohio, nearly 600 miles from the Gulf of Mexico, is 275 feet above that of the sea. The slope of the alluvial plains through which the river winds will therefore be less than 1 foot in 10,000.

The hills bordering the valley of the Mississippi are cut through in several places by the river, thereby exposing good sections of their component strata, consisting of alluvial deposits thought to be much more ancient than those we are about to consider.

An area of 16,000 square miles is occupied by the more modern alluvial formation between the head of the delta and the junction of the Ohio.* It is supposed to be, in the average, 264 feet deep, and is from 30 to 80 miles wide. The true delta extends over 14,000 square miles, occupying a frontage of 2¼ degrees on the coast-line of the Gulf of Mexico, and extends 180 miles inland. At its southern extremity its surface is hardly above the level of high tides, but it rises gradually as it passes inland, and at New Orleans is nearly 10 feet above the sea-level.

A boring near Lake Pontchartain, of 600 feet, failed to penetrate the modern alluvium; and wherever excavations are made, the remains of trees are frequently found, apparently in the places where they grew, but now far below the sea-level. Sir Charles Lyell computes its average depth at 528 feet, and consequently nearly the whole of this modern deposit is below the sea-level, yet is supposed not to contain marine remains. The fall of the Mississippi during a course of 600 miles is shown by fig. 1; the depth of the channel varies from 80 to 200 feet until it approaches the Balize, where it shallows to 16 feet. The rise of the tide at this point is only 2 feet. The depth of the alluvial deposit below the river-channel is also indicated, together with the surface of the more ancient formation upon which the Mississippi has formed this great alluvial deposit, the bottom of which is now more than 500 feet below the present sea-level.

Mr. Charles Ellet, Jun., in a Report to the American Secretary of War, January 29, 1851, communicates the information from which diagrams are constructed. (See page 57.)

The theory of Mr. C. Ellet is, that the velocity of the stratum of fresh water is communicated entirely to the underlying stratum, composed of salt water, partially to the next stratum 3, but not at all to stratum 4, which is stationary: stratum 5 is also marine, but it flows in an opposite direction to the rest, and restores the salt water which is carried away by the friction of the upper stratum, No. 1, against the surface of No. 2.

It is supposed that the rapid increase of deposit at the bar, arises from stratum No 5 carrying mud to that point, where its velocity is partially neutralized by impinging against stratum No. 1.

From the following particulars of the deltas of the Ganges and Po, it would appear that they are similarly situated to the Mississippi. "An Artesian well at Fort William near Calcutta, in the year 1835, displayed at a depth of 50 feet a deposit of peat with a red-coloured wood similar to that now living. At 120 feet clay and sand with pebbles were met with. At the depth of 350 feet a freshwater tortoise and part of the humerus of a ruminant were found. At 380 feet, clay with lacustrine shells was incumbent upon what appeared to be another dirt-bed or stratum of decayed wood At 400 feet they reached sand and shingle."*

In the delta of the Po, a well bored 400 feet failed to penetrate the modern alluvial deposits; very near the bottom it pierced beds of peat, similar to those now forming. The coarser particles of mud which have already passed the mouths of rivers may contribute to the marine or fluvio-marine deposits forming outside deltas; but this can only be to a limited extent, as the great bulk of the mud is far too fine to settle near the coast. Little material could be obtained from cliffs along the sea coasts, but we have information of marine currents specially bringing sand and mud from other parts of the sea-bottom to the neighborhood of deltas. (See Mr. Ellet's observations.)

For these reasons, if the further examination of the deltas of the Mississippi and other rivers should lead to the discovery of some recent marine or fluvio-marine strata, it may turn out that such deposits have been more rapidly accumulated than the purely fluviatile beds with which they may be associated. In estimating the age of deltas, allowance, however, ought to be made for such contingences, and also for their organic contents.

Let us now turn to fig. 2, which exhibits Sir Charles Lyell's transverse section of the channel and plains of the Mississippi, and at all points throughout a course of several hundred miles. The dotted lines are introduced to show the variation of the water-level in the wet and dry seasons: *b*, *b* represents the artificial levee; *d d*, the banks and plains; *m*, *m* the swamps of the Mississippi. "The banks† are higher than the bottom of the swamps, because when the river overflows, the coarser part of the sediment is deposited on the banks, where the speed of the current is first checked" (Lyell). The channel, however, is so wide and deep, that even if there were no artificial banks to prevent floods, the river would carry into the Gulf of Mexico the principal mass of the mud it had received with the water of its tributaries; for it is only for a short time in the year that the level of water in the river is above that of the adjoining plains. The swamps and the numerous lakes formed by deserted river-bends communicate at all times of the year with the main stream. In these places mud could be constantly deposited mingled with the remains of the vegetation which grows luxuriantly in the swamps The only supply of inorganic matter for rising the level of the vast plains through which the river winds for hundreds of miles, must be the mud deposited upon them during the periodical floods. These are very much prevented by the artificial levee; but when they do occur, their force is augmented by the water being artificially dammed up.

"I have seen, says an eye-witness, when the banks of the Mississippi burst, the water rush through at the rate of ten miles an hour, sucking in flat boats and carrying them over a watery waste into a dense swamp forest" (Lyell). It would appear that the Mississippi differs in size and proportion more than in other respects from our rivers. For instance, when floods occur upon our own alluvial plains, they are most conspicious at a distance from the stream which caused them, indicating that the parts of the plains nearest the banks are

* Lyell's Second Visit to the United States, 1849, vol. ii, pp. 146-152, 155, 169, 194, 195, 203, 213, &c.

* Lyell, *loc cit.* p. 218: and Principles, p. 267-270.

† There is a similar section of the Nile and its banks published in the fourth volume of the Quarterly Journal of the Geological Society, p. 311, but communicated by Lieut. Newbold in 1842.

higher than those at a distance from it, and therefore that fig 2 would also represent the *transverse section of slow rivers generally* The similarity of the physical features presented by the lower parts of all rivers was particularly remarked by Hutton.*

It has been observed by engineers,† that in all rivers in this country the large quantities of silt brought into them by winter freshets do not tend to choke the channels, but that, at that period of the year, former accumulations of deposit are actually removed by the force of the stream; and therefore, that although winter-freshets bring down silt with them, they carry into the sea a larger quantity than they have introduced into river channels.‡ If it were allowable to assume that the unequal supply of water at different seasons of the year produces effects in the channel of the Mississippi similar to those just described on our own streams, the following consequences might be deduced from the fact that winter freshets remove more detritus than they bring down. The diminution of the speed of the current of rivers assists the deposition of silt upon their beds, as much as its increased speed in the winter season favors its removal The summer deposit, however thin it may be, cannot occur without contracting the sizes of the channel.

Winter freshets following a sudden fall of rain would raise the water-level of rivers rapidly, and carry it above the banks before the augmented current has time to scour the river-channel and raise it to its former capacity. Accumulations of silt, small at any one place, must each raise the water a little above its proper level, and the point of overflow will be where the sum of the small elevations amounts to more than the height of the banks, above last year's level, but floods leave a deposit of silt, &c, upon the banks they pass over, which increases the capacity of the channel; and until new deposits has again reduced the area of the stream below its proper size, inundation will not occur.

As each flood raises only the part of the bank it flows over, it is easy to see that the point of overflow will be changed from time to time; and every part of the alluvial plains through which a river flows will be visited in turn by floods, provided there are no artificial banks These banks assist the scouring power of rivers in winter, because they retain more water in the river; but, on the other hand, silt that would have been carried over the banks is kept within the channel, and this may be the reason why the beds of all navigable rivers have become so much elevated during the historical period. The contraction of water-channels in summer, and their enlargement in winter, is thus directly traced to the unequal supply of rain at different periods of the year.

This being admitted, we have an explanation of the manner in which rivers may, by a succession of floods, build upon alluvial deposits along their courses, at the same time raising their beds in proportion to the height of their plains.

If river-channels were perfectly symmetrical in form, the identical sediment that had fallen in summer might be removed again in winter. It is, however, well known that river-channels are deep on one side and shallow on the other. The principal deposit therefore takes place on the shallow or quiet side, and the principal removal occurs from the deep side where the current runs more quickly.

This may explain why the traveller on the Mississippi sees for hundreds of miles a caving bank on one side and an advancing sandbar on the other (Lyell). When the action of the river is also unequal on its two banks in different places along its course, a channel consisting of curves instead of straight lines must be produced. When each curve, however, had assumed the complete horse-shoe form, the water, by travelling round the outer circumference of the bend, will have its effective speed reduced to that on the inner or shallow side The current would thus become more nearly equal in all parts of the channel, and necessarily the deposit likewise; and in winter it would have a nearly equal tendency to excavate the banks on both sides, which condition of equilibrium might last for some time.

Hutton, in 1795, has remarked, that there is evidence of denudation in every country where at any time of the year the streams carry off any particles of the superficial soil.* The Mississippi must derive it vast supplies of mud for thousands of such tributaries; for it could obtain them from no other source, unless we suppose it abstracts them from its own plains Certainly in many places soil is being removed from one part or other of its plains; but an equal quantity must be added to some other part, for the river could not make a permanent inroad into its plains without enlarging its channel This it does not do, or it would be able to carry off the winter-freshets without overflowing, and the present artificial bank would be unnecessary.

I have thus briefly referred to observations made by British engineers which may throw some light on the causes of periodical floods and changes of channel in rivers, and also upon the formation of alluvial plains along their course. These questions need not further be entered into, because the limited growth of alluvial plains and deltas may be best illustrated by tracing the alteration in the mean level of a large part of North America that would be consequent upon a denudation sufficiently extensive to furnish the alluvium said to exist in the valley of the Mississippi On the borders of the Gulf of Mexico at the present time marine strata are forming within a short distance of the fluviatile, and frequently alternate with them, because spaces of the sea-shore are enclosed by banks of river-mud and converted into lakes ordinarily communicating with the river, but sometimes with the sea after high tides.

The present marine or fluvio-marine deposits must be composed of mud that has passed the mouth of the river, or washed up by the sea, while the freshwater strata must be entirely formed from sand and mud carried over the river banks, or deposited on the bottom of lakes supplied by the stream before it enters the Gulf of Mexico. An idea of the amount of denudation that has taken place in the interior of North America might be either obtained from the extent of the marine deposits formed of mud that had passed the mouth of the river, or from that of the purely fluviatile and contemporaneous deposits formed from mud which had never entered the Gulf of Mexico.

* Theory of the Earth, vol. ii, p. 205-211

† On this and the following points see First Report of the Tidal Harbors' commission, above referred to, which contains the opinions of our most celebrated engineers on the phenomena presented by Tidal and other rivers

‡ The author has not met with any explanation of the causes that produce changes in river-channels, although the constant alterations taking place in them have been repeatedly alluded to

* Our clearest streams run muddy in a flood. The great causes, therefore, for the degradation of mountains never stop as long as there is water to run; although, as the heights of mountains diminish, the progress of their diminution may be more and more retarded. *Op. cit.* vol ii, p. 250.

But it is also necessary to estimate what proportion of the total quantity of mud brought down by the river is carried completely out to sea, compared to what is left either upon the marine or fluviatile portion of the delta.

Sir Charles Lyell has remarked, that the alluvium now remaining in the valley of the Mississippi can only represent a fragment of what has passed into the Gulf of Mexico; and this can readily be believed when we reflect upon the depth and breadth of the channel, and upon the short period of the year that the stream would throw any large quantity of mud into the plains even if there were no artificial banks. We must also bear in mind that only the coarse mud could settle near the shore, for the finer particles could not deposit except in very deep water. For these reasons, even if the mud carried beyond the mouth of the river is only ten times the quantity left behind on the fluviatile portion of the delta and plains of the Mississippi, this amount of detritus could not be obtained without the mean level of one-fifth part of North America being reduced 100 feet by denudation affected by the action of rain, the atmosphere, and running water.* But Hutton (vol ii, p 401) remarks, in 1795, that wherever any stream carried off particles of soil in its waters at any period of the year, it might be said that denundation was taking place in that country; yet he particularly observed that the waste of land was very unequal, being much more rapid in the elevated than in the more level parts of any district. It is therefore possible that, during the reduction of the mean surface-level of the land drained by the Mississippi to the amount of 100 feet, some portions of the area might be lowered many times that amount, while other portions might suffer little, or be positively raised by the superposition of alluvial deposits. We are, however, informed by Sir Charles Lyell, that the Mississippi in one part of its course cuts through ancient fluviatile beds evidently antecedent to those recent deposits we have been considering. This formation is also stated to contain the remains of species of plants and animals now existing; so that evidence is to be obtained in this district of still greater denudations (by these results) than those of which we have spoken, and which would produce changes on the surface of the earth since the introduction of the present fauna and flora of extent enough almost to realize Hutton's vision of mountains wasted away by the action of rain, the atmosphere, and running-water, and carried along river-courses into the ocean. It is not necessary to take an extreme view of this subject to gain the object we have in view, which is to show that, during the time occupied by the formation of the Mississippi delta, the sea-level might be perceptibly raised† by the agency of physical causes now in operation.

The reasons for supposing that a rise of 3 inches in each period of 10,000 years might occur, have been already discussed, and it only remains to state that, at the present rate of denudation, it would require five such periods to produce the quantity of detritus said to exist in the valley of the Mississippi; while it would require fifty such periods to produce the requsite quantity of alluvium on the supposition that only one-tenth of the mud in *transitu* through the river was appropriated for the accumulation of its alluvial plains and deltas. Under these circumstances it appears a legitimate conclusion, that the level of the sea cannot be considered permanent for all practical purposes when it may be shown that it might be disturbed by the operation of present causes during the period occupied by the construction of a single geological formation. Elevations and subsidencies of the land or sea-bottom would also effect important changes in the height of the sea-level, sometimes counteracting and at others adding to the effects produced by the continuous operation of rivers, &c. The effects produced by these important causes would be an additional reason for not cosidering the sea-level permanent.

It is hardly necessary to add, that the continual waste of the earth's surface by the carrying of materials into the ocean by rivers and breakers particularly attracted the attention of Hutton. He considered* that this was counteracted by elevatory movements of the sea-bottom from time to time, but particularly mentions that it was not necessary to suppose that the dry land was equally extensive at all periods. Since the fluctuation in the sea-level would be directly consequent upon the destruction of land arising from the operation of rain, the atmosphere, and running water on its surface, such changes would be in harmony with the spirit of the Huttonian therory.

Part III.

The average thickness of the deposit formed on the sea-bottom by the solid materials brought on to it from all sources has been estimated in the preceding part of the paper at 3 inches in 10,000 years, producing an elevation of that amount in the sea-level in the same period. Some portion of the oceanic area may be supposed to receive no part of this supply, while other localities nearer the coast-line obtain a great deal more than the average. In the interval between these places, where the rate of deposit is extremely high, and those where it is extremely low, must lie on extensive tract of sea-bottom, where the accumulation of detritus does not much differ from the average rate, which we have supposed to be 3 inches in 10,000 years. Such localities may be more extensive near those parts of the ocean-bottom which receive no supplies of detritus whatever, but they must stretch up to the coast-line in many places. For instance, if it is supposed that a supply of 10 cubic feet of sand or mud is obtained from each foot of frontage of any coast-line, and distributed between high-water mark and 20 miles distant, it might raise the mean level of that portion of sea-bottom 1 foot in 10,000 years

Rivers opening on the shore might also bring down a still greater quantity of material; but although tides and currents are at work removing the sea-bed in one place and forming sedimentary strata in others from the old and new materials, there must everywhere be portions of every sea-bottom where the rate of deposit is intermediate between the highest and lowest, and may often not differ much from that of 3 inches in 10,000 years. These portions of the great oceanic area, wherever they may be situated, are particularly interesting, because on them the accumulation of sedimentary deposit is taking place without any change in the depth of water, and yet without necessitating the supposition of gradual subsidence

* The data for calculating the annual quantity of detritus carried over the river's banks, in relation with that carried down to the sea, are very imperfect. Further information on this subject is much needed

† This change of level may amount, under certain circumstances, to a great extent, but at the *lowest* calculation would be 15 feet.

* These remarks of Hutton are here introduced because he takes an entirely different view of this subject to that promulgated by Sir Charles Lyell, who considers that there has been always an excess of subsidence. (See principles, 1850, p. 543.)

of the sea-bottom.* Even where deposits are taking place much faster than the mean rate, the variation in the depth of water would be proportionately less than if the sea-level had been permanent.

The limited supply of detritus derived from cliffs, and the wide distribution of that from rivers, renders it difficult to imagine any very extensive tract of sea-bottom where the rate of deposit derived exclusively from new materials should many times exceed the average. Even on areas where extreme cases of denudation and deposition occurred (in periods when the sea-bottom was unaffected by movements, subsidence and elevation), there would be many parts where the condition of depth would remain unaltered, because on them the rise in the sea-level would compensate the addition to the sea-bottom. Also if, in periods that are past, the supplies of detritus from rivers and cliffs were many times greater than at present, they must have caused proportionately greater fluctuation of the sea-level, and therefore under such circumstances there would also be parts of the oceanic area receiving deposits at the same rate that the sea was rising. There would thus have been opportunities for the accumulation of sedimentary rocks without any change taking place in the depth of the water they were formed in, during the intervals when the sea-bottom was undisturbed by subsidences and elevations. For these reasons, in examining the section of a marine formation containing throughout the remains of the same species of Mollusca, it would require independent evidence to determine whether the equal depth of water indicated by the organic remains had been preserved during the formation of the deposit by means of changes of the level of the sea-bottom, or that of the sea itself, or of both conjointly.

Great caution must also be requisite in judging of the time occupied in the formation of the older rocks from their mineral character, as the following description of passing events will also apply to periods that are long gone by.

Mr. Austen relates in one of his papers, that "with a continued gale from the west large areas of the dredging-grounds on the French coast became at times completely covered up by beds of fine marly sand, such as occurs in the offing, and which becomes so hard that the dredge and sounding-lead make no impression upon it; with the return of the sea to its usual condition, a few tides suffice to remove these accumulations."†

Mr Deane, the submarine surveyor, also reported to the Institution of Civil Engineers, that the turn of the tide is felt as soon near the sea-bottom at a depth of 120 feet as it is at the surface: and he represents that the loose materials covering the Shambles Rocks are moved backwards and forwards with every tide

With these facts before us, what criterion can there be (even by estimating the sources of the detritus) for arriving at the minimum or maximum rate at which sands and marls become permanent additions to the sea-bed? For the materials may present all the appearances of hasty accumulation, and yet the interval of time between the deposit of two strata of sand now contiguous may have been occupied by countless temporary deposits, as quickly brought and as quickly removed by tide, and leaving no trace whatever of their existence. For the same reasons we cannot be certain that in the valley of the Mississippi we have an unbroken sequence of fluviatile strata, in which the accumulations of one century form the base for those of the next, from the bottom to the top of the series; because there, as in marine formations, the deposits of the one period may have entirely been removed in the next. It is therefore possible that many such movements may have occured and that the delta of the Mississippi may have occupied a longer period of time for its formation than could be computed from any data remaining. In the preceding part of the paper the conclusion was arrived at, without taking an extreme view of the rapidity with which the materials may have been collected for its deposition, that the work could not have been completed within a period for which the sea-level could be considered permanent.†

There must be, however, many rivers which are only able to afford very small supplies of mud to any alluvial formations, either from deriving their water from lakes or from countries with a very small rain-fall. During a period when the gradual elevation of the sea-level was not counteracted by the effects of more powerful causes, there would be conditions near the mouths of some rivers of this kind for the surface of their plains to be gradually elevated by the operation of winter floods at a rate somewhat similar to that of the sea-level. In this manner purely fluviatile deposits might be formed in the neighborhood of the ocean, occupying positions similar to that represented in the lower part of the longitudinal section of the Mississippi, without the necessity of supposing any subsidence of the land. In the upper portions of such rivers, the periodical floods, assisted by the accumulation of terrestrial remains in the adjoining plains, would add stratum after stratum during periods when the surface of the country was unaffected by subterranean movements. It is probable that the rate of deposit might be accelerated in periods of subsidence; but the manner in which rivers form plains along their course in all countries under ordinary conditions, when no subsidence or elevation is occurring, was traced by Hutton.

Even if, in ancient periods, the rate of denudation was greater than at present, and the supplies of detritus to rivers more extensive, the fluctuations of the sea-level and the elevation of beds and plains of rivers would have been proportionately greater. There would, therefore, still have existed some localities where the rate of the formation of alluvial plains near the sea kept pace with the elevation of the waters; so that, as at the present time, conditions would have existed for the accumulation of fluviatile strata containing terrestrial remains without any subsidence of the land. This is a subject, however, that must be further studied, more especially when its value is considered in relation to the great masses of fluviatile strata either of the Mississippi, the Ganges, the Nile, or the Po For the above reasons it would be difficult to determine, when examining sections of thick fluviatile strata, whether these accumulations of detrital matter had been formed during subsidence of the land, or during the gradual elevation of the level of rivers and seas, arising from the continual operation of ordinary physical causes.

* The effect of these causes on the general depth of the ocean would be of little importance in a geological point of view, except for *an extended period of time*, such as must have elapsed during the construction of a great serial group of strata.

† Quart. Journ. Geol. Soc, vol. vi p 79.

† It is hoped that in the course of a few years enough data will be forthcoming to determine more nearly the importance of this variation of level in a geological point of view.

Steam-Boiler Explosions—Mr. Fairbairn's Experiments—Proposed Associations for their Prevention.

The emphatic declaration of the jury, in a remonstrance appended to their verdict, at the recent inquest, held at Rochdale, on the bodies of the ten victims to the boiler explosion at Mr. G. WILLIAMSON's weaving sheds in the Bidgefield Mill, near that town, that they could not "separate without pressing on the consideration of the owners and users of steam-boilers throughout the kingdom the necessity there is that measures should be taken by them to ensure a thorough and frequent inspection of boilers, so as to prevent, as far as human foresight can, the recurrence of explosions," demands from us a special notice of the probable cause of that tragic occurrence. Peculiar interest is attached to the enquiry, from the fact that Mr. WILLIAM FAIRBAIRN, the justly celebrated engineer, at the solicitation of the coroner and jury, visited the scene of the accident, inspected the premises, and investigated the origin of the catastrophe. His report and evidence, therefore, furnish a valuable commentary on the proper regulations of steam-boilers, and may be considered a premonitory essay on the shameless ignorance and frightful recklessness which, we fear, are too often displayed in their management. He describes his finding the buildings, steam engine, boiler, and machinery, a heap of ruins; the boiler torn into eight or ten pieces; one portion of the cylindrical part flattened and embedded at a considerable depth in the rubbish; the two hemispherical ends burst asunder, and driven in opposite directions to a distance of 30 to 35 ft. from the original seating of the boiler. Other parts of the cylinder were projected over the buildings, and lodged in a field distant 90 yards from the point of projection; to one of which parts had been originally attached the 2-in. safety-valve, which was torn from the boiler by the force of the explosion, and carried along with its seating over a rising ground to a distance of nearly 250 yards. The other portion of the cylindrical part of the boiler was found on the opposite side in the bed of the river; and the hemispherical end of this part furthest from the furnace was rent in two, and thrown on each side to a distance from 30 to 35 ft. These two pieces had evidently come in contact with the chimney, razed it to the ground, and finally lodged themselves on the margin of the river, while the 3-in. safety-valve and pipe attached to that portion of the boiler imbedded in the river was broken from the flange; and with an extended range the 2-in. valve was projected over the river into a meadow at a distance of from 150 to 200 yards. Of the steam-engine not a vestige was to be seen, except the fly-wheel and a pump rod beside it, covered with bricks. The springing of a mine could not have been more destructive than this explosion; and we are thus enabled to judge of its terrific force.

The task of arriving at the extent of its violence was attended with many difficulties, arising from the want of an accurate knowledge of the state of the safety-valves, the density of the steam at the moment of rupture, and the ultimate strength of the boiler. Mr. FAIRBAIRN, accordingly, entered into a few comparisons, which he conceived would be useful to those entrusted with the management of boilers, and the employment of steam of increased density and great elastic power. Gunpowder is calculated to impel a body with a force 244 times greater than the pressure of the atmosphere, which, taken at 15 lbs., gives $244 \times 15 = 3660$ lbs. as the force upon a square inch of surface—being nearly 30 tons upon a piece of ordnance of 6 in. calibre. Bullets discharged with this force, augmented by the elastic power derived from the heat generated in firing gunpowder, will leave the muzzle of the gun at a velocity of 1700 ft. per second, or nearly 20 miles a minute; and although the effects of boilers bursting with high-pressure steam may not be equally appalling, they are, nevertheless, sufficiently so to be placed in the same category as engines of destruction, and ought to be treated in the same manner and with the same precaution.

Mr FAIRBAIRN found the boiler in question with hemispherical ends 18 ft. long, 5 ft diameter, and composed of plates supposed to be 5-16ths of an inch thick—a thickness equal to a pressure of 335 lbs. on the square inch; but one of the plates being under 5-16ths in thickness, and as the thinnest part is the measure of the strength of the boiler, he reduced its power to 300 lbs., which he considered the force at which it would burst. Taking 300 lbs. as the pressure on every square inch of the surface, and the superficies at 41,000 in., there was pent up in this comparatively small space the enormous force of $41{,}000 \times 300 = 12{,}300{,}000$ lbs., or 5491 tons of elastic force compressed in an iron case of little more than a quarter of an inch in thickness.

The relative volume of steam at the pressure of the atmosphere is 1700 times that of water. At higher temperatures, and increased density, the volume is reduced in a given ratio of its temperature and density; and it is impossible to increase the temperature without increasing the pressure. In boilers having an active fire burning under them, the engine standing, safety-valves fast, it matters not how, the temperature will rise, the pressure increase, and explosions ensue, unless relieved by starting the engine, or letting off the dangerous accumulation of temperature and pressure; for which purpose the valves must be looked to, the fires regulated, and the pressure kept down below the dangerous point of resistance. Steam-boilers, according to Mr. FAIRBAIRN, of every description should be constructed of sufficient strength to resist eight times the working pressure; and a boiler should not be worked unless provided with at least two, but he would prefer three, capacious safety-valves. Two of these valves should be nearly equal to double the area of the steam ports of the engine they are intended to drive, and the other about one-fourth of that area, as an indicator of the pressure. Nine-tenths of the boiler explosions which have occurred in that district have taken place when the engine was standing, or rather just after starting; and it has been generally found that the safety-valves were either of imperfect construction, or fastened down, or accidentally shut. The generated steam and accumulated pressure must, under these circumstances, have vent; and in case it cannot escape through the engine, or out through the safety-valves, it is sure to make way for itself—not through the usual outlets, but through the sides, ends, or bottom of the boiler. It has been asserted that explosive gas is generated in several cases where explosions occurred; but Mr. FAIRBAIRN utterly repudiated the notion, being satisfied from experience and long observation that gas had nothing to do with them—that they were governed by a fixed and determined physical law, and that law is neither more nor less than excessive pressure. In cases where boilers explode from want of water, and the plates become red-hot, then and then only does the spheroidical theory of BOUTIGNY come into operation, in which instances large globules of water, containing immense central heat, are formed, and bursting with great force and a loud report, might rupture the vessel in which they are contained. This could not, however, take place unless water is pumped into the boiler suddenly, and without reflection as to the results; and he was of opinion that accidents of this description seldom, if ever, occur. This lucid explanation of the theory will, we trust, prove a salutary precaution to proprietors not to confide such dangerous engines of destruction to ignorant and incompetent workmen, for whose acts and incapacity they are, according to the law as laid down in the House of Lords, referred to in our last week's Journal, most clearly responsible.

Applying this theory to the facts of the present lamentable case, Mr. FAIRBAIRN came to the conclusion that such a boiler as that of Mr. WILLIAMSON's ought not to be worked with a pressure much above 40lbs. to the square foot, and certainly not exceeding 50lbs. It was difficult in this case, from the deficiency of the evidence, to ascertain the exact pressure; but, from the weights which had been placed upon the valves, it was necessarily excessive. In the course of his examination, Mr FAIRBAIRN further stated, that mercurial guages could not always be relied on, and were not in every instance correct indicators of pressure. He illustrated this by observing, that in the experiments, to which we subsequently refer, he had used two such guages, and found a difference of 10lbs. between the pressure they severally indicated, with which, being of course dissatisfied, he was obliged to get columns of mercury, so as to check them, and bring them to a standard.

In answer to a question whether he conceived that one of the two valves ought to be out of the control of the engineer—whether, in fact there should be an inside valve, or one weighted from the inside, Mr. FAIRBAIRN replied that he had been once favourable to the use of lock-up valves, because he thought that they could not be tampered with. He declared, however, that he since had reason to change his opinion, and he now believed that valves completely exposed were the safer, either having a dead weight on them, or with levers in front, so that any person could see them. He once had valves on the top of the boiler, so cased up with a hood over them, that although the steam could escape through something like a Venetian blind, not even a stick or a piece of wire could be put through to tamper with the fittings. There was a pulley lever through the stuffing-box, by which the engineers were able to lift the valve, and there was plenty of room for everything to work freely. On board the navy steamers, they use the lock-up valves; but it is the duty of the chief engineer to report daily as to the state of the valves, as regularly as the log of the vessel is kept. Mr. FAIRBAIRN was pressed to say whether he considered it an advantage to have a valve locked up, or weighted from the inside of the boiler; to which he replied, that it was a difficult question to deal with, but that he had already given his opinion.

Mr. FAIRBAIRN also submitted the following tabular results of some experiments which he had made in order to ascertain the force which steam acquires in a comparatively short period of time when the engine is at rest, and the usual outlets for escape are closed:—

Time in minutes.	Pressure in lbs	Temp Degrees.	Volume.
0	11·75	243 00	980
1	14·15	246·75	906
2	16·35	251 00	846
3	19·25	255 25	782
4	22·35	259 75	720
5	25.75	264·00	665
6	28·95	268 37	621
7	32·15	273·00	582
8	35·75	277 00	545
9	39·95	282·00	506
10	44 25	286·37	472
11	48·35	291·00	445
12	52 75	295·37	418
13	57 75	300·00	392
14	63 75	304 25	365
15	68 95	308 75	344
16	74 75	313 00	324
17	80 35	317·75	306
18	87 25	322·00	288
19	93 95	326·12	273
20	101 15	331 00	257
21	108 75	335 62	243
22	112 00	337·00	This experiment lost

These experiments were made with a boiler prepared for the purpose; and it will be seen that the steam which was starting 11-75lbs on the square inch, increased in density to nearly four times the pressure, and in 10 minutes more it was nearly nine times; that it continued to increase in an accelerated ratio, until in less than 20 minutes, had he been able to continue the pressure, it would have reached a point beyond all powers of resistance, when explosion must have been the result. —*Mining Journal.*

Longitude of Kingston.

To the Editor of the Canadian Journal.

SIR,—The Longitude of Kingston is sometimes stated to be 76° 40′. This, however, differs considerably from the truth, as might be expected from the comparatively rough and hasty manner in which the portions of the principal points in a newly settled country must, in general, be first determined. Eclipses of the sun, it is well known, afford one of the most accurate means of determining the longitude, independently of such means as telegraphic communication with an Observatory, the Longitude of which has been already ascertained. The Longitude of Kingston, as deduced from two Eclipses of the Sun, and one Transit of Mercury; the time being taken from a carefully regulated clock, the pendulum having a wooden rod, is as follows:—

	Longitude W.
By Eclipse of Sun	
April 25th, 1845	76° 32′ 45″.
May 26th, 1854	76° 32′ 59″.
By Transit of Mercury.	
May 8th, 1845	76° 31′ 45″.

Another Eclipse, May 6th, 1845, the time being taken from a carefully regulated watch, gave 76° 31′. The mean of these observations, 76° 32′ 7 25″ W., may, therefore, be considered as the Longitude of Kingston, very nearly. A lunar distance, worked out from observations with two instruments only, and which may be rejected except as an approximation, gave 76° 30′. The mean longitude, deduced from twelve observations of immersions, and emersions of Jupiter's satellites, a comparatively imperfect mode of its determination, gives 76° 31′ 17″.

Those who are familiar with such questions are aware that, until a regular Observatory for astronomical purposes be established, there must, even after very careful observations, be some uncertainty at least in the determination of the longitude. But the limit of error in the above mean of 76° 32′ 7·25″ W is, in all probability, not more than from a third to a half of a statute mile.

I do not know how far the Longitude and Latitude of Toronto may be considered as ascertained

I am, Sir, your very obedient servant.

JAMES WILLIAMSON

Expedition to Central Africa.

Further communications have been received from Dr. Barth, from Timbuktu, giving an account of his protracted sojourn at that dangerous place. The date of the present letters is two months more recent than that of the first letters despatched thence. They reach up to the 15th of December last. They contain the gratifying news that this indefatigble and courageous traveller had regained his full health and strength. He writes that he would have quitted Timbuktu long ago,—a place where his life was greatly exposed to the effects of an unfavourable climate, and much more so to the dangers arising from the hostile disposition towards Christians of the most fanatical Mahomedan population of Northern Africa,—were it not that he would have before him certain death, and share the fate of the unfortunate Major Laing, if he left Timbuktu without sufficient protection. The murder of that excellent officer was instigated by the Fullan (or Fellhas) of Hamd-Allahi,—a tribe living south-west from Timbuktu, the same faction that is much opposed to Dr. Barth. These Hamd Allah Fullan had received from their chief the most peremptory order to effect the capture of the traveller, and bring him to his head-quarters, whether dead or alive. For they had expressed their disbelief in the pretended character of Dr. Barth being an ambassador from Stamboul; and they had demanded all his papers, to ascertain whether they substantiated what the Sheikh el Bakay had caused the great man of the people to believe. Hitherto their hostility has availed nothing, owing to the protection of Sheikh el Bakay, and to the energetic bearing as well as the unceasing watchfulness of Dr. Barth himself. Unhappily the renowned Sheikh has no military power of any kind, his authority consisting solely of an extensive spiritual influence over a great portion of Western Sundan. Dr. Barth, therefore, and his own small retinue, are almost at all times well armed and ready to resist effectively any sudden attack. It is greatly to be regretted that Dr. Barth is not in possession of a letter from the "Sultan of Stamboul," inasmuch as he states most emphatically that he would then not be in the least molested by any of the Mohammedan inhabitants He hoped, however, to be able to depart from Timbuktu by the close of the year, and thus be freed from a situation which must at once be highly detrimental to mind and body.

While preparing the present letters Dr. Barth had the great joy to to receive Auab, the mighty chief of the Tingeregif, a Tuarick tribe inhabiting the regions east of Timbuktu along the Kowara, or Isa Balleo as it is more properly called there. That long-expected chief came, on the bidding of El Bakay, as the traveller's protector, with a welcome escort of 100 horseman, to see him safely through his dominions, on his way back to Sakatu. The news of Dr. Vogel having been despatched from Europe to join him, had also reached Timbuktu, and given him the utmost delight.

Dr. Barth had collected a great mass of information, and drawn up various maps; of both of which he sent a small but valuable portion on this occasion. There are no further news from the party under Dr. Vogel; but ample communications may be expected in the course of the present month. AUGUSTUS PETERMAN.

Mining Statistics—Coal, Copper, &c.

Coal may be justly considered the most important mineral product, and 265,198 persons were employed in Great Britain in 1851, either in extracting it from the earth, distributing it amongst the consumers, or manufacturing it into coke or gas. The owners of collieries are returned as 703 in number; agents and factors, 2342; coal miners or colliers, 150,722 men; 65,644 youths, or 216,366 in the aggregate; 10,507 persons are returned as coal merchants or dealers, and 11,691 as coal heavers or coal labourers. Besides this enumeration, 1752 men are returned as coke burners or dealers, and 113 as charcoal burners. The census also presents to us 19,860 men, and 3473 youths as stone quarriers; 2811 men as stone cutters; 6442 as slate quarriers; 5623 as limestone quarriers or burners; 1827 as marble masons; 23,374 men and 6586 youths as brickmakers; and 2338 as plate layers.

The copper miners are 18,468 [illegible] iz, 12,768 men, and 5700 youths; those engaged in the manufacture [illegible] opper are 2115, and the coppersmiths, 14,443—3918 females, namely, 1565 women, and 2353 girls, are returned under the class of copper miners, a number exceeding the females returned as coal miners, amounting only to 2649. Another subclass presents 12,912 tin miners,—8607 men, 4305 youths, besides 843 women, and 1295 girls. The lead miners are 16,680 men, 4937 youths, 400 women, and 513 girls. These are, of course, exclusive of the very extensive classes engaged in the manufacture and working of these several metallic products. Our limits will not permit us to pursue this enquiry, or present an enumeration of the vast variety of arts connected with metallic manufactures, particularly those of iron and steel. We have confined ourselves to the leading classes of our mining population, and the rapid improvement and commercial increase in England within the last half century demonstrates the great national advantages which the empire derives from their labours To ameliorate their lot, to improve their social condition, and to render their lives and persons comparatively secure in the perilous employments to which they are destined, have been objects to which we have long earnestly devoted our efforts. While it is the painful duty of this Journal to record, week after week, fatal casualties in our coal mines, attended with lamentable consequences, we feel for the infirmities of our nature, when we admit that the men who are the sufferers are, generally, also the authors of those calamities. To their reckless disregard to the most solemn admonitions, to their careless contempt for the most appalling examples, can, in almost every instance, be traced the causes of colliery explosions—a total disregard of human life, substituting the certainty of mischief in the naked candle for the almost unerring security of the safety-lamp. This deplorable want of prudence, this dificiency in due discipline, can only be fairly met by improved training and early cultivation. It is the imperative duty, therefore, as well as the decided interest of the colliery proprietors, amounting to so large a body in number as the census presents to us to introduce and encourage amongst the coal mining population—classes mutually dependent on each other—a system of education commensurate with their requirements —*Mining Journal.*

Report of the British Emigration Commissioners.

The annual report of the Emigration Commissioners has just been published. From this it appears that the total emigration of last year was 329,937, being 38,827 less than in 1852 There was a diminution of 26,480 to Australia, and 13,376 to the United States, the falling off being accounted for in the case of Australia by the greater excitement regarding the gold discoveries prevalent during the summer and autumn of 1852, and in that of the United States by the departure of a smaller number of Irish, the aggregate emigration of the latter people throughout the year being estimated at 199,392 against 224,997 in 1852. The remittances from their relatives in America were, however, larger than in any previous year, the amount sent through the various banks, apart from private channels, being £1,439,000. With respect to the Australian emigration, the total from the united kingdom to all the colonies was 61,401, or about one-fourth of that of the United States. Subjoined are the general figures:—

United States		230,885
Australia—		
New South Wales	10,673	
Victoria	40,469	
South Australia	6,883	
Western Australia	965	
Van Diemen's Land	991	
New Zealand	1,420	
		61,401
Canada, &c.		34,522
East Indies		928
Central and South America		833
West Indies		600
Cape of Good Hope		369
Western Africa		308
Mauritus		53
Hongkong		27
Falkland Islands		1
		329,937

According to a supplementary statement, it also appears that the emigration during the first three months of the present year has been 49,756 persons, against 60,867 in the corresponding period of 1853, and 59,523 in that of 1852. There has been a continued diminution in the departures to the United States, but in those to Australia, although there is a great falling off as compared with the first quarter of last year, there is a considerable increase as compared with the first quarter of 1852. Of the total, 49,756 emigrants, 26,128 were Irish, 12,420 English, 2,965 Scotch, and 8,233 foreign or unspecified. This proportion of Irish is much smaller than in 1852 or 1853.—*Evening Mail.*

An Iron Coffer Dam.

In a report of the proceedings of a semi annual meeting of the Cornwall Railway Company in England, embracing the report of Mr. Brunel, the Engineer, on the works of the Saltash Bridge, on a part of the line of unfinished railway between Truro and St. Austell, we find a description of a coffer-dam of a novel construction, sunk in a very deep part of the river, to facilitate the construction of a pier for the support of the centre of the bridge which forms a necessary part of the line. The dam in question is not only of a novel structure, but it is made to shut out water to a greater depth than any other work for a similar purpose that we have before seen any account of, viz., a pressure, under high tides, of 70 to 80 feet. It is so constructed as to act as the principle of the diving bell, in case the water should find its way into the inclosure. But it seems to have thus far served its purpose, without a resort to this apparatus. The structure is thus described:

"It consists of an iron cylinder, 37 feet in diameter and 85 in height, containing, within itself all the arrangements of air chambers, passages, &c., necessary for using it either as a large diving bell or simply as a coffer dam, as circumstances might require, and so constructed as to be afterwards divided into two parts vertically, and removed after the pier shall have been built within it. The whole, weighing upwards of three hundred tons, was safely launched and floated into place, where it was raised perpendicularly, and pitched upon its lower edge in the centre of the river. The river is at this point upwards of 50 feet deep at low water of neap tides, and except for a short space on the turn of the tide, there is a considerable current; under such circumstances, this cylinder, was pitched upon its lower edge accurately—that is, within three or four inches of the exact point required. Since then the work has been carried on at the bottom of the cylinder, as in a diving bell, against the pressure of water occasionally of 70 and 80 feet. The mud and other deposits, forming the bed of the river from 10 to 12 feet in thickness, have been removed, and cylinder is now resting on the rock, and preparations are making for excavating the rock into level beds for receiving the masonry."

The railway of which the branch now under construction, and nearly in readiness to receive the rails, forms a part, is an extension of the line of Great Western, the Bristol and Exeter, and the South Devon Railways, throughout a great part of the county of Cornwall to near the Land's End.—*Railway Times.*

Friendly Societies

Mr Finlaison, in the second part of his report upon friendly societies, furnishes very useful and elaborate tables showing the just rates of pecuniary contributions which should be paid in order to secure allowances in sickness, old age, and at death. This report has been prepared at the instance of the Treasury, and it contains so much valuable information that it ought to be carefully perused and studied by the members of every friendly society in the kingdom. For the ordinary purposes of his calculations Mr. Finlaison divides the population likely to avail themselves of these societies into those engaged in general labour, in light labour, and in heavy labour; but he observes that nine out of every ten established friendly societies are framed upon the principle of paying to the fund one uniform sum—every man alike, and that any advice for the adoption of a contrary method in the way of a graduated scale is generally received with impatience and treated with neglect. He observes that the half century of time which is comprised between the 16th and 66th years of age appears to be precisely the interval of life, during which man is destined to labour, and that on the general average the sickness for the first 25 years is 182 days, and for the ensuing 25 years 362 days, or about one week per annum in the first case and two weeks per annum in the second. The majority of clubs close their doors against new members at the age of 45, and many admit none above 40, but up to these ages, as we have before stated, all who are eligible contribute the same amount. Our able actuary, however, ascertains that between the ages of 15 and 65 a man employed in light labour undergoes but 467 days' sickness, while one employed in heavy labour is visited with 581 days' sickness; and hence he argues that where the former should pay for allowances in sickness during the working period £1 per annum, the latter ought to pay £1 4s. 10½d., or nearly 25 per cent. more. Practically therefore where the common rate of weekly contribution for allowances in sickness is 6d for the man engaged in light labour, his comrade engaged in heavy labour ought to pay one-fourth more, or 7½d. This being apparent, Mr. Finlaison recommends that societies should as much as possible limit the members to persons of one or other class of occupation, or, where that cannot be done, that the safe plan would be to adopt for all the rates derived from the experience of those employed in heavy labour, "because," he cautiously and characteristically observes, "those scales which are adopted to the greater risk will always comprehend the less." So much for sickness. The next portion of the report relates to mortality.

AVERAGE ILLNESS AMONG THE LABOURING CLASSES.—Upon this subject Mr Finlaison, in his second report upon Friendly Societies, affords some interesting information which is worthy of a careful perusal by the managers of those institutions. From the statistics furnished to him he calculates the average number of day's illness per annum suffered by the population at different ages. At the age of 45 he states that 99 out of the 100 benefit clubs close their doors to the admission of candidates, and we find that above that age the number of illnesses begin to increase. Between 15 and 16, the average number of days per annum with persons engaged in general labour is 6¼; between 16 and 26, 6¾; between 26 and 36, 7; between 41 and 46, 8¾; between 46 and 51, 10¼; between 51 and 56, 12¾; between 56 and 61, 16¼; between 61 and 66, 23¼; and between 66 and 71, 36 days. Mr. Finlaison adds, on an examination of the amount of sickness per annum recorded for the whole mass of the male members of Friendly Societies, from the age of 15 to that of 85, it may be premised that almost exactly five years' sickness is undergone by the man in the 70 years of time. But during the period of labour—that is, from the commencement of the 16th year of age to the close of the 66th—there are in this 51 years but 78 weeks, or exactly one year and a-half of sickness. Further, that in respect of this period of labour, the sickness, during what may almost be termed its second moiety—viz., from the age of 41 to that of 66—is almost exactly the double of that undergone in the previous moiety—from the age of 15 to that of 41 years. For the sickness during the first 26 years of manhood is exactly half-a-year, or 182½ days, while it is 362½ days, or almost exactly one whole year, during the next ensuing 25 years of maturity.

Process of whitening Pins and Needles made of Iron and Steel.

BY MM. VANTILLARD AND LEBLOND.

It well known that pins made of brass wire are deficient in strength and elasticity, and accordingly they have been replaced by pins made of iron or steel; but it is necessary to tin them over. This operation, however, cannot be performed equally well with iron as with brass; the pins have a rough, uneven surface, which renders them inconvenient to use, as they are liable to tear the cloth.

Messrs. Vantillard and Leblond, wishing to avoid this defect, formed the idea of first covering the iron with a thin coating of copper or other metal having a greater affinity for tin than iron has; but in order that this result shall be satisfactorily attained, it is necessary to polish and pickle the pins before coppering them. The above named manufacturers have most ingeniously effected the polishing, the pickling, and the coppering, by one single operation. To treat for example, 2 kilogrammes (a little more than 4 lbs. 6½ oz.), 4 litres (about 7 pints of water, 300 grammes (10 ounces 9 drachms, avoirdupois, by weight) of oil of vitriol, 30 grammes (15 ounces 13 grains, avoirdupois) of white copperas, and 7 grammes (about 108 grains, avoirdupois) of sulphate of copper, are mixed together; this mixture is allowed to dissolve during twenty-four hours. The bath being thus prepared, it is to be introduced into a barrel of wood, made pitcher-like, and mounted upon an axis. Into this barrel, which has a capacity of about 35 pints, the pins are now to be put; it is then turned rapidly during half an hour, when the pins will be found to have received a pickling, a polishing, and a slight coppering. After the lapse of this time, 20 grammes (about 10 drachms 8 grains avoirdupois) of sulphate of copper in crystals (blue stone), are to be added, and the barrel again turned during 12 minutes, when a solid coppering will be effected with a finely-polished surface. This done, the liquid in the barrel is to be decanted off, and may be used repeatedly for the same purpose; the pins are washed in cold water, then put in a tray containing a hot solution of soap, and agitated for about two minutes. The soap ley is decanted off, and the pins put into a bag with some fine sawdust and shaken, by which means the coppered surface assumes a brilliant appearance. The pins thus prepared may be tinned in the ordinary way, but the operation can be effected much more rapidly than in the case of ordinary brass pins. The articles made in this way are far more beautiful and useful than those made in the ordinary way. This process is the more deserving of attention at present, quite independent of the superior quality of the pins, in consequence of the exceedingly high prices of brass wire.—*Bulletin de la Société d'Encouragement, March* 1853, *p.* 142

Twenty-fourth Meeting of the British Association for the Advancement of Science.

LIVERPOOL, SEPTEMBER 20.

THE PRESIDENT'S ADDRESS.

GENTLEMEN OF THE BRITISH ASSOCIATION,—When I first set myself to the task of preparing to address you on the present occasion, my impulse was to begin with an apology for appearing before you in so prominent a position—for assuming apparently a station in the world of science for which I had no pretensions. On second thoughts, however, it appeared better—more respectful in fact, having consented, though with unfeigned reluctance, to accept the office—to say no more on that head, but to discharge its duties as best I might. This, however, I must ask of you, not to expect from me what you have had from many of my predecessors, a luminous review of the state of Physical Science—a recital of its various recent triumphs—and suggestions for their further extension: that I should, in the words of the poet, though in a different sense,

"Allure to brighter worlds, and point the way."

Though I have been no indifferent spectator of that rapid and triumphant march of science, which, within the last fifty years, has been extending and enriching the old domains of knowledge, and planting, as it were, new colonies in hitherto unexplored and untrodden regions, yet I have been only a spectator—my avocations have been less with the properties of matter than with the busy concerns of men: and if I attempted now to assume, for the first time, the philosophic garb, I am afraid that the awkwardness of my gait would soon betray me. There are, however, some points of high and general interest, which, in a meeting like the present, cannot be entirely neglected, and in regard to which the kindness of friends has supplied me with some matter not unworthy of being submitted to your notice. How, for instance, in the land of Newton, and in the greatest seaport of the world, should I neglect astronomy? And here Professor Challis has been good enough to furnish me with a statement of its present condition and recent progress, which with your permission, I will lay before you:—

"*Notes on the Present State of Astronomy.*

"MEMORANDUM BY PROF. CHALLIS.

"Since the meeting of the British Association last year, four planets and four comets have been discovered. Three of the new planets were found at Mr. Bishop's Observatory, two by Mr. Hind, and one by Mr. Marth. This last was also discovered the following night at the Oxford Observatory—another of the many instances presented by astronomy of independent discoveries made nearly simultaneously. The fourth planet was found at the Observatory of Bilk, near Dusseldorf, by Mr. R. Luther, an astronomer distinguished by having already discovered two planets. Of the comets, one was discovered at Berlin, two at Gottingen, and the fourth was seen very generally with the naked eye at the end of last March. None of them have been identified with preceding comets. The large number of planets and comets discovered of late years, while it evinces the diligence of astronomers, has, at the same time, brought additional laborers into the field of astronomical science, and contributed materially to its extension. The demand for observations created by these discoveries has been met by renewed activity in existing observatories, and has led to the establishment, by public or private means, of new observatories. For instance, an observatory was founded in the course of last year by a private individual at Olmutz, in Moravia, and is now actively at work on this class of observations. Various such instances have occurred within a few years. In addition to the advantages just stated, the observations called for by the discovery of new bodies of the solar system, have drawn attention to the state of stellar astronomy, and been the means of improving this fundamental part of the science. The following are a few words on the existing state of stellar astronomy, so far as regards catalogues of stars. Subsequently to the formation of the older catalogues of bright stars, astronomers turned their attention to observations in zones, or otherwise of smaller stars, to the ninth magnitude inclusive. Lalande, Lacaille, Bessel, Argelander, and Lamont are the chief labourers in this class of observations. But these observations, unreduced and uncatalogued, are comparatively of little value. The British Association did great service to astronomers, by reducing into catalogues the observations of Lalande and Lacaille. A catalogue of part of Bessel's Zones has been published at St. Petersburg, and a catalogue of part of Argelander's at Vienna. Lamont's Zones have also been reduced in part by himself. The catalogue of 8377 stars, published by the British Association in 1845, is founded mainly on the older catalogues, but contains, also, stars to the seventh magnitude inclusive, observed once only by Lalande or Lacaille. The places of the stars in this catalogue are, consequently, not uniformly trustworthy; but as the authorities for the places are indicated, the astronomer is not misled by this circumstance. The above are the catalogues which are principally used in the observations of the small planets and of comets. This class of observations must generally be made by means of stars as fixed points of reference. The observer selects a star from a catalogue, either for the purpose of finding the moving body, or for comparing its position with that of the star; but, from the imperfection of the catalogue, it sometimes happens that no star is found in the place indicated by it, and in most cases, unless the star's place has been determined by repeated meridian observations, it is not sufficiently accurate for final reference of the position of the planet or comet. In catalogues reduced from zone observations the star's right ascension generally depends on a single transit across a single wire, and its declination on a single bisection. This being the case, astronomers have begun to feel the necessity of using the catalogue places of stars provisionally, in reducing their observations, and of obtaining afterwards accurate places by meridian observations. It will be seen by this statement that by the observations of the small planets and of comets, materials are gradually accumulating for the formation of a more accurate and more extensive catalogue of stars than any hitherto published. The British Association would add greatly to the benefits it has already conferred on astronomical science, by promoting the publication, when sufficient materials can be collected, of a general catalogue of all stars to the ninth magnitude inclusive, which have been repeatedly observed with meridian instruments. The modern sources at present available for such a work are the reduced and published observations of the Greenwich, Pulkowa, Edinburgh, Oxford, and Cambridge Observatories, and the recently completed catalogue of 12,000 stars observed and reduced by the indefatigable astronomer of Hamburgh, Mr. Charles Rumker, together with numerous incidental determinations of the places of comparison stars in the *Astronomische Nachrichten*. To complete the present account of the state of stellar astronomy, mention should be made of two volumes recently published by Mr Cooper, containing the approximate places arranged in order of right ascension of 30,186 elliptic stars from the ninth to the twelfth magnitude, of which only a very small number had been previously observed. The observations were made with the Markree Equatorial, and have been printed at the expense of her Majesty's Government. The determination of differences of longitude by galvanic signals is an astronomical matter of great practical importance. This method, employed first in America, was introduced into England by the Astronomer Royal, and has been applied to the determination in succession of the differences of longitude between the Greenwich Observatory and the observatories of Cambridge, Edinburgh, Brussels, and Paris. In the first and last instances results have been published which prove the perfect success and accuracy of the method. Mr. Airy, on recently announcing in the public papers the completion of the operation between the Greenwich and Paris Observatories, justly remarks that such an experiment could not have been made without the assistance afforded by commercial enterprise, and that commercial enterprise is in turn honored by the aid thus rendered to science. In the summer of last year, Professor Encke, following the example set in England, determined successfully by galvanic signals the difference of longitude between Berlin and Frankfort-on-the-Maine. Galvanism has also been applied to astronomical purposes in other ways. The method of observing transits by the intervention of a galvanic circuit, just put in practice in America, in which only sight and touch are employed, and counting is not required, is now in operation at the Greenwich Observatory. It is found to be attended with more labour than the old method; but as it is free from errors to which the other method is liable, it lays claim to general acceptance. At Greenwich, also, the galvanic circuit is most usefully employed in maintaining the movements of distant sympathetic clocks, and in dropping time-signal balls. A ball is dropped every day at Deal by a galvanic current from the Royal Observatory. Some anxiety was felt by astronomers respecting the continuation of that most indispensable publication, the *Astronomische Nachrichten*, after the decease of the editor, Mr. Petersen, in February last. This has been dispelled by a recent announcement that the King of Denmark has resolved to maintain the Altona Observatory in connection with that of the editorship of that work. The *Astronomical Journal*, an American publication of the same kind, undertaken by a young astronomer and mathematician, Mr. Gould, for the special information of his countrymen, has reached the end of Volume III. and will, it is hoped, be continued. Generally, it may be said of astronomy, at the present time, that it is prosecuted zealously and extensively, active observations being now more numerous than ever, and that the interests of the science are promoted as well by private enterprise as by the aid of Governments. J. CHALLIS."

"Cambridge Observatory, September 14, 1854."

You will have observed that Professor Challis speaks of the activity of private enterprise in the cause of astronomy; and can I in this place pass over the labours of a Lassells, or the enlightened public spirit of the corporation of this town, which, stimulated by your visit in the year 1837, has now for some years maintained an excellent and well-provided Observatory, under the able management of Mr. Hartnup, who has not only conferred great benefits on the navigation of the place by the regulation of its chronometers, but great honour upon the institution by the general services which he has rendered to meteorological, as well as astronomical science? Mr. Hartnup's improvements in the chronometer, by which the errors arising from variations are either corrected or estimated and allowed for, have been of the greatest value. In the words of a report of the Council of the Royal Astronomical Society—"It is found experimentally, that when a captain will apply the rate thus corrected for temperature, the performance of chronometers is much improved;" and in regard to the importance of the subject to the practical interests of navigation, I would take the liberty of quoting farther—"There are risks at sea, against which no foresight can provide: but loss from defective compasses or ill-regulated chronometers should be treated as a crime since common sense and common care will secure the efficacy of both these instruments. It is to be feared that life and property, to a large amount, are yearly sacrificed for a want of a little elementary knowledge, and a small amount of precaution on the part of our seamen, who neglect the safeguards furnished by modern science."

You may remember, that at the period of your last meeting, arrangements with Government were in progress for the construction of a reflecting telescope of four-feet aperture, which should bring to bear upon the Nebulæ and other starry phenomena of the southern hemisphere a far higher power than that to which they had been submitted by Sir John Herschel. You will regret to hear that, although the estimate was not objected to by the Government, it has not yet been submitted to Parliament. We must make some allowance for the preoccupations of war.

The labours of your Kew Committee are carried on with unabating assiduity and extending usefulness. You will, perhaps, forgive me for taking the liberty of urging upon you the importance of continuing to them an unabated, if not an enlarged support. By giving accuracy to the various implements of observation,—the thermometer, the barometer, and the standard weights and measures, they are doing a work of incalculable benefit to science in general, in this and in other countries. At this moment they have in their hands for verification and adjustment, 1,000 thermometers, and 50 barometers for the navy of the United States, as well as 500 thermometers and 60 barometers for our own Board of Trade, the instruments which are supplied in ordinary commerce being found to be subject to error to an extraordinary degree. At the suggestion of Sir John Herschel, they have also undertaken, by the photographic process, to secure a daily record of the appearance of the sun's disc, with a view of ascertaining, by a comparison of the spots upon its surface, their places, size, and forms whether any relation can be established between their variations and other phenomena. The Council of the Royal Society has supplied the funds, and the instrument is in course of completion. The same beautiful invention, which seems likely to promote the interests of Science in many branches, at least as much as those of Art, is employed under the able direction of the Committee, and of Mr. Welsh the curator, to record, by a self-acting process, something similar to that of the anemometer, the variations in the earth's magnetism. But I will not pretend to anticipate the results of the careful and extended study of this subject by our able associate, Col. Sabine, who has been kind enough to promise that we shall hear them from his own mouth in one of our evening meetings. Neither will I anticipate the report of my learned and distinguished predecessor in this chair, Mr. Hopkins, on a subject to which he called the attention of the Association at its last Meeting, and on which, in conjunction with Mr. Fairbairn and Mr. Joule, he has been engaged in a series of experiments. I allude to the effects of pressure, on the temperature of fusion,—a problem of great importance, as bearing on the internal condition of our planet.

A Report of a Committee of the Institute of France, consisting of MM. Lionville, Lamé and Élie de Beaumont, on the subject of a theory of Earthquakes, has been transmitted to me for the use of the Association. From a careful discussion of several thousands of these phenomena, which have been recorded between the years 1801 and 1850, and a comparison of the periods at which they occurred with the position of the moon in relation to the earth, the learned Professor M. Perrey, of Dijon, would infer that earthquakes may possibly be the result of an action of attraction exercised by that body on the supposed fluid centre of our globe, somewhat similar to that which she exercises on the waters of the ocean; and the Report of the Committee of the Institute is so far favourable that at their instance the Institute have granted funds to enable the learned Professor to continue his researches. You will recollect how often the attention of the Association has been drawn to this subject by the observations of Mr. Milne and of Mr. Mallet, which latter are still going on; and that the accumulating facts are still waiting for a theory to explain them.

On Geology.—I am sorry for the slightness of my acquaintance with so captivating as well as so practical a study. I have nothing to report, save that the increasing scarcity of ironstone and coal is driving the practical men to have greater respect for a science which enables them to form a very sound conjecture where such minerals are likely to be found, and to come to something like an absolute certainty as to where they are not. When the questions begin to be asked, "Is there a square mile in all the coal-fields of Britain unoccupied by the mines?"—"Of its 5,000 square miles of visible coal tract how much remains untouched?"—it is time, indeed, to listen to that science which has taught us so successfully, in the hands of a Murchison, a Phillips, and others, where further resources for the supply of this, the life of Britain, is to be found.

I need hardly tell you of the services which Meteorology may be expected to render to practical life, and perhaps there is no better instance of the value of the accumulation of facts, though in themselves apparently of small importance, and having apparently little connexion with each other.

What apparently can be less subject to rule and law, even to a proverb, than the changeful wind and the treacherous wave? Yet even here, observation and comparison have done some good work for science and for man, and are about to do more. You are all aware that the American Government have now for some years, at the instance and under the direction of Lieut. Maury, been collecting from the mercantile vessels of that nation observations of certain phenomena at sea, such as winds, tides, currents and temperature of the ocean; and that the results, digested into charts and books, have already been the means of adding speed and safety to their voyages in an extraordinary degree.

You are aware that application was made to our Government to cooperate in this great work of common benefit to every mercantile nation, and that the subject was brought before parliament by one of our Vice-Presidents, Lord Wrottesly, in a speech which he has since published, and which I would commend to every one's perusal who doubts of the importance of this branch of science to the interests of commerce and navigation. You are perhaps not aware that the Government has agreed to the proposal, and has created a special department for the purpose, in connexion with the Board of Trade, placing it under the management of perhaps the one man best fitted to carry it out with energy and success, my friend Capt. Fitzroy, one not less known on the banks of the Mersey by old associations, than on the general fields of maritime science. Conceiving that this was a subject of special interest to the place of our present Meeting, and that for such an object it was desirable as publicly and as widely as possible to solicit the co-operation of all who are connected with the commerce of the country, I have asked Capt. Fitzroy to communicate to me the present condition of the question: and he has kindly furnished me, not officially, with the following memoranda, which, with your permission, I will read:—

"*Memorandum I.*—The maritime commerce of nations having spread over the world to an unprecedented extent, and competition having arrived at such a point that the value of cargoes and the profits of enterprise depend more than ever on the length and nature of voyages, it has become a question of the greatest importance to determine the best tracks for ships to follow, in order to make the quickest as well as the safest passages. The employment of steamers in such numbers,—the general endeavour to keep as near the *direct* line between two places (the arc of a great circle) as the intervening land, currents, and winds will allow—and the improvements in navigation, now so prevalent, have caused a demand for more precise and readily available information respecting all frequented parts of the oceans. Not only is greater accuracy of detail required, but much more concentration and arrangement of very valuable, though now scattered, information. Besides which, instrumental errors have vitiated too many results, and have prevented the greater portion of the meteorological observations hitherto made at sea from being considered better than approximations. 'It is one of the chief points of a seaman's duty,' said the well known Basil Hall, 'to know where to find a fair wind, and where to fall in with a favourable current:' but, with the means at present accessible, the knowledge of such matters can only be acquired by years of toil and actual experience, excepting only in the greater thoroughfares of the oceans, which are well known. Wind and Current Charts have been published of late years, chiefly based on the great work of the United States Government, at the suggestion of, and superintended by, Lieut. Maury: and by studying such charts and directions, navigators have been enabled to shorten their passages materially. In many cases as much as one-fourth, in some one-third of the distance or time previously employed. Much had been collected and written about the winds and currents by Rennell, Capper, Reid, Redfield, Thom, Piddington, and others: but general attention was not attracted to the subject, however important to a maritime country, till the publication of Lieut. Maury's admirable observations Encouraged by the practical results obtained, and induced by the just arguments of that officer, the principal maritime powers sent duly qualified persons to assist at a conference held at Brussels last year on the subject of Meteorology at sea. The report of that Conference was laid before Parliament, and the first direct result of it was a vote of money for the purchase of instruments and the discussion of observations. All the valuable meteorological data which have been collected at the Admiralty, and all that can be obtained elsewhere, will be tabulated and discussed in this new department of the Board of Trade, in addition to the continually accruing and more exact data to be furnished in future. A very large number of ships, chiefly American, are now engaged in observations: stimulated by the advice, and aided by the documents so liberally furnished by the United States Government, at the instance of Lieut. Maury, whose labours have been incessant. Not only does that Government offer directions and charts gratis to American ships, but also to those of our nation, in accordance with certain easy and just conditions. In this country the Government, through the Board of Trade, will supply a certain number of ships which are going on distant voyages with 'abstract logs' (or meteorological registers), and instruments gratis, in order to assist effectively in carrying out this important national undertaking. In the preface to a late edition of Johnston's 'Wind and Current Charts,' published last June at Edinburgh, Dr. Buist says,—'It has been shown that Lieut. Maury's charts and sailing directions have shortened the voyages of American ships by about *a third*. If the voyages of those to and from India were shortened by no more than *a tenth*, it would secure a saving in freightage alone, of £250,000 annually. Estimating the freights of vessels trading from Europe with distant ports at £20,000,000 a year,—a saving of a tenth would be about £2,000,000; and every day that is lost in bringing the arrangements for the accomplishment of this into operation occasions a sacrifice to the shipping interest of about £6,000, without taking any account of the war navies of the world.' It is obvious that, by making a passage in less time, there is not only a saving of expense to the merchant, the ship-owner, and the insurer, but a great diminution of the risk from fatal maladies,—as, instead of losing time, if not lives, in unhealthy localities, heavy rains, or calms with oppressive heat, a ship properly navigated may be speeding on her way under favourable circumstances. There is no reason of any insuperable nature why every part of the sea should not be known as well as the land, if not indeed better than the land, generally speaking, because more accessible and less varied in character. Changes in the atmosphere, over the ocean as well as on the land, are so intimately connected with electrical agency (of course including magnetism), that all seamen are interested in such matters,—and the facts which they register become valuable to philosophers. Meteorological information collected at the Board of Trade will be discussed with the two-fold object in view—of aiding navigators, or making navigation easier, as well as more certain,—and amassing a collection of accurate and well-digested observations for the future use of men of science.

"*Memorandum II.*—As soon as the estimate for meteorological expenses had passed, steps were taken to organise a new branch department at the Board of Trade. On the 1st of August, Captain Fitzroy was appointed to execute the duties of this new office, referring to Dr. Lyon Playfair, of the department of science and art, and to Admiral Beechey, of the marine department, for such assistance as they could render. As soon as registers and instruments are ready, and an office prepared, Captain Fitzroy will be assisted by four or five persons, whose duties he will superintend. It is expected that several ships will be supplied with 'abstract logs' (meteorological registers) and instruments in October, and that the office will be in full work next November. The Admiralty have ordered all the records in the Hydrographical Office to be placed at the disposal of the Board of Trade for a sufficient time. All other documents to which Government has access will be similarly available; and the archives of the India House may likewise be searched. There will be no want of materials, though not such as would have been obtained by using better instruments on a systematic plan. Captain Fitzroy ventures to think that the documents hitherto published by Lieutenant Maury present too much detail to the seaman's eye; that they have not been adequately condensed; and therefore are not, practically; so useful as is generally supposed. His Instructions, or Sailing Directions (the real condensed results of his elaborate and indefatigable researches), have effected the actual benefits obtained by mariners. Reflecting on this evil, which increasing information would not tend to diminish, Captain Fitzroy proposes to collect all data, reduced and meaned (or averaged) in a number of conveniently arranged tabular books, from which, at a subsequent period, diagrams, charts, and 'meteorological dictionaries,' or records, will be compiled, so that, by turning to the latitude and longitude, all information about that locality may be obtained at once, and distinctly."

I cannot doubt that the spirited merchants and shipowners of England will not be slow to follow the example of their brethren in the United States, and will lend their heartiest assistance to a work so useful. Great facilities will be afforded them in the way of instruments of tested accuracy; and the increasing number of scientific seamen, which is resulting from the local institutions of education, and the system of examination of masters and mates for certificates, will furnish them with observers in every part of the ocean, fit to be intrusted with such instruments and skilful in their use. Let not the practical man think lightly of such matters when he is reminded of the great services of the barometer in forewarning of the coming storm, that the ascertained temperature of the sea which his ship is traversing, will inform her master whether he is engaged in one current or another, and announce to him the approach of the dangerous iceberg, when it is not discoverable by any other means.

I will now, with your permission, proceed to the consideration of some other departments of our work, such as geography, ethnography, and statistics, which are more connected with my own pursuits, which, affected as they are by the character of man, the uncertainties of his will, and the accidents of his physical and moral nature, and thus being less the subjects of direct and pure experiment, seem at first sight to be hardly reducible to those fixed laws which it is the object of science to investigate and ascertain. For these reasons, indeed, among others, these branches of study formed at first no part of the scheme of the British Association, and there was some doubt about their subsequent admission.

Nevertheless, I rejoice that they were so admitted. The apprehension that they must introduce the spirit of party into our proceedings has been most honourably disappointed; and as one, who, in the capacity of a member of the Legislature, has to act from time to time on the subject of some of their inquiries, I cannot but express my gratitude for the assistance which they have afforded, both by informing and forming the public mind on many important questions: and above all, for the lesson they have taught on the importance of testing every theory by a patient collection and impartial discussion of the facts; in a word, for having imported the spirit of science into what, in the largest sense of the word, may be called politics, instead of importing the spirit of politics, in its narrower sense, into science.

What is more important than to rescue questions of this nature, such as Finance and Political economy, for instance, in some degree at least, from the domain of party contention? And how can we better contribute to that desirable result, than by discussing the carefully collected facts in a scientific spirit on an arena within which no party spirit is excited, no party allegiance is acknowledged, no party victory has to be lost or won, and when men are at liberty to convince or be convinced without risking a charge of treachery or a change of ministry as the consequence? But, in fact, these studies could not fairly have been excluded from our peripatetic university of science.

Who shall separate Political altogether from the influences of Physical Geography, or Ethnology from Physiology, or the destinies of man upon this globe from the study of his physical nature? By its employment of the doctrine of probabilities, one branch of statistics is brought into immediate contact with the higher mathematics, and the actuary is thus enabled to extract certainty in the gross out of uncertainty in the detail, and to provide man with the means of securing himself against some of the worst contingencies to which his life and property are exposed. In fact, statistics themselves are the introduction of the principle of induction into the investigation of the affairs of human life,—an operation which requires the exercise of at least the same philosophical qualities as other sciences. It is not enough in any case merely to collect facts and reduce them into a tabular form. They must be analyzed as well as compared; the accompanying circumstances must be studied (which is more difficult in moral than in material investigations), that we may be sure that we are (that is to say, in reality calling the same things by the same names) treating of the same facts under the same circumstances; and all disturbing influences must be carefully eliminated before any such pure experiment can be got at as can fairly be considered to have established a satisfactory conclusion. In some cases this is easier than in others. In regard to the probabilities of life or health, for instance, there are, at least, no passions or prejudices, no private interests at work, to interfere with the faithful accumulation of the facts, and if they be numerous enough, it might be supposed that their number would be a sufficient protection against the effect of any partial disturbances. But even here, caution, and special, as well as extensive knowledge, are required. There are disturbing influences even here,—habits of life, nature of employment, immigration or emmigration, ignorance or mis-statement of age, local epidemics, &c., which leave sources of error, in even the most extended investigations. Still results are attained, errors are more and more carefully watched against, and allowed for, or excluded, and more and more of certainty is gradually introduced. And here I should not omit to notice the valuable services of the Society of Actuaries, not long ago established, and who are represented in our statistical section. They discuss all questions to which the science of probability can be applied; and that circle is constantly extending—assurance in all its branches, annuities, reversionary interests, the laws of population, mortality, and sickness; they publish transactions; and what is of the greatest importance in this, as indeed in any branch of inductive science, they hold an extensive correspondence with foreign countries. In fact, they are doing for the contingencies of human life, and for materials apparently as uncertain, something like what meteorology is doing for the winds and waves.

What shall I say to the statistics of crime, of education, of pauperism, of charity, at once and reciprocally the effect and the cause of that increasing attention to the condition of the people, which so favorably distinguishes the present age? Who can look at the mere surface of society, transparently betraying the abysses which yawn beneath, and not desire to know something of their secrets, to throw in the moral drag, and to bring to the light of day some of the phenomena, the monstrous forms of misery and vice which it holds within its dark recesses? and who can look at these things, no longer matter of conjecture, but [illegible]rtained, classed, and tabled, without having the desire awaken[illegible] strengthened to do something towards remedying the evils thu[illegible] vealed, and without feeling himself guided and assisted towards a remedy? Yet here, more than in other cases, should a man suspect himself; here should he guard himself against hasty conclusions, drawn from the first appearance of the results, for here are disturbing influences most busily at work, not only from without, but from within—not only in the nature of the facts themselves, but in the feelings, passions, prejudices, habits, and moral constitution of the observer.

Still, the tabling of the facts is of infinite importance. If they disturb, as they are sure to do, some feeling, some prejudice, some theory, conviction, it will be felt, that anyhow the facts have to be accounted for; further investigation will follow; and if it appear that no correction is required, the truth will be established, and the hostile theory will, sooner or later, give way and disappear. In these things it is, of course, more than usually important that the facts to be selected for collection should be such as are, in their own nature, and under the circumstances, likely to be ascertained correctly, and that the business of collection should be in the hands of those who have no bias to do it otherwise that fairly, no interest in the result: and this was, I believe, kept studiously in view by those who had the management of our great statistical work, the recent Census of our own country, which we are still studying, but, whether they were successful or not, in this respect, has already become matter of discussion.

The work itself is, doubtless, one of the greatest monuments that has ever been presented to a nation as a record of its own constituent elements and condition; compiled and commented on with singular industry, judgment, acuteness, and impartiality,—the Domesday-book of the *people* of England, as the great volume of the Conqueror was of its *surface*.

Nor can I, while speaking of statistics, avoid referring to the Statistical Congress which took place at Brussels, about this time last year; which had mainly for its object to produce uniformity among different nations in the selection of the facts which they should record, and in the manner of recording them, without which, indeed, no satisfactory comparisons can be established, no results can safely be deduced. To bring about such an uniformity absolutely is, I am afraid, hopeless, inasmuch as the grounds of difference are, in many cases, so deeply imbedded in the laws, the institutions, and the habits of the different countries, that no hammer of the statist is likely to remove them.

To understand, however, the points of difference, even if they are not removed, is, in itself, one great step towards the object. It at least prevents false conclusions, if it does not fully provide the means of establishing the true ones. It gets rid of sources of error, even if it fail of giving the full means of ascertaining truth. Take, for instance, the case of criminal statistics. We wish to ascertain the comparative prevalence of different crimes, either at different times or in different countries. For this purpose must we not know under what heads the jurists and statists of the times or countries to be compared array the various offences which are recorded; with what amounts of penalty they were visited; and with what rigour, from time to time, the penalties were enforced?

That which is called manslaughter in one country, and assassination in another, is called murder in a third. That which in one country is punished with death, in another is visited by imprisonment. The bankruptcy which in one country is a crime, in another is a civil offence. The juvenile offences which in one country are punished by imprisonment, and swell the criminal calendar, in another are treated, as they should in many cases be, only as a subject of compassion and correction,—take no place in the criminal calendar at all.

Indeed, it is one of the difficulties which beset a large proportion of these investigations, whether into morals, health, education, or legislation, and which must always distinguish them from those which deal either with matter or defined abstractions, that, in using the same terms, we are often uncertain whether we mean the same things; whether, in fact, when we are using the same denominations the same weights and measures are really employed. Such conferences, however, as those of Brussels tend much to limit the extent of error.

Among the objects which may best occupy the attention of the Statistical Section, at the present moment, will be the discussion of a decimal coinage, and the statistics of agricultural produce. It is important in regard to both, that by previous sifting and discussion not only the best conclusions should be arrived at, but the subject should be so familiarized to general apprehension as to secure the widest co-operation. In regard to a change in the coinage, the interests and feelings of the lower classes must be especially consulted; and, with this view, without expressing any ultimate opinion, I would recommend to those who are considering the question, the perusal of a pamphlet, full of important matter, by the late Mr. Laurie, the work of the la[illegible] hours of a man of eminent knowledge and virtue, which he had hoped to be able to communicate in person, as a paper, to the present Meeting. With regard to the statistics of agriculture, the main object is to procure such knowledge of the facts as shall guide the operations of the consumer and the merchant. I would suggest that they should be taken and published at two periods of the year, once in the spring, recording the extent of soil devoted to each kind of grain,—a fact easily ascertained; the second time as soon as the harvest is concluded,—announcing the amount of the crop, as ascertained on several specimen fields under different circumstances of soil and climate, and applying it in due proportion as a multiple to the acreage already published. A really accurate census of the harvest is, I believe, impracticable, at least within the period which would alone make it valuable for present use; and the approximation which I have suggested would, I conceive, be adequate to the purpose.

In regard to Geography and Ethnography, there are few sections, I believe, which have more general interest, and none, I imagine, which would be more attractive here,—where every new discovery is connected with the material interests of the place, a new source of raw material, or a new destination for finished work; and where every new communication, established and reported, is another channel for the extension of that commerce, which, bursting from the channels of the Mersey, permeates and percolates every creek and cranny of the known world.

The great navigations which are opening up the heart of the South American continent, by the Paraguay, the Amazons, and the Orinoco; that are traversing and uniting the colonies of Victoria and South Australia by the river Murray; the projected exploration of North Australia, which, I am sorry to say, is as yet only a project, and may require some of the fostering warmth of the Association to bring it into actual existence; the wonderful discoveries in South Africa, by Livingston and Anderson—(I am happy to say that Mr. Anderson is here to tell his own story),—and the explorations of central Africa, by Barth and Vogel; the pictures given us by Capt. Erskine and others of the condition of the islanders of the South Pacific, passing in every stage of transition from the lowest barbarism to a fitness for the highest European and Christian culture; these, and a hundred other topics, awaken an ever new interest in the mind of the philosopher and statesman, in the feelings of the Christian and the lover of his kind. What new fields for science! What new opportunities for wealth and power! What new openings for good! How important that those who issue from this great emporium of modern commerce—this more than Tyre of modern times—should know how to turn them to advantage! Surely your periodical visits here, with their kindling, stimulating—I was going to say infectious—influences are no mean instrument for such a purpose.

It cannot be for nothing that the heroes of every branch of science are assembled from many countries within these walls, and are brought into personal contact with the most enterprising and public-spirited of our merchants; that, in the language of my distinguished predecessor in this chair, slightly adapted, "the counting-house is thus brought into juxtaposition with the laboratory and the study." Commerce will more than ever be auxiliary to science—and science more than ever the helpmate of commerce—and a still further impulse will be given to those beneficial influences, which, in spite of some painful, though necessary interruption, occasioned by our present state of war, a good Providence is so visibly extending over the whole habitable globe.

It is happily becoming every year less and less necessary to press these things on public notice. In an age of gas and steam—of steam-engines and steamboats—of railroads, and telegraphs, and photographs—the importance of science is no longer questioned. It is a truism—a commonplace. We are far from the foundation days of the Royal Society,—when, in spite of the example of the monarch, their proceedings were the ridicule of the Court; and even the immortal Butler thought the labours of a Wallis, a Sydenham, a Harvey, a Hooke, or a Newton, fit subjects for his wit.

It is still, however, worth inquiring whether sufficient facilities for education in science exist or are in progress in our country; and whether Government and other important bodies provide sufficient encouragement and reward for its prosecution.

Now, in regard to the former, there can be no doubt that, until a very late period, the assistances to scientific education furnished in this country, either by educational institutions or the State, were very slight, and totally unworthy of the object or the nation. Look at the lower schools: until very lately nothing but reading and writing, and hardly that, was ever offered to the labouring classes. Look at the grammar schools: they were limited to the acquisition of a small modicum of Greek and Latin, often not even of arithmetic. The middle classes of society, those who did not send their children to the Universities, had no opportunity of acquiring any, the slightest, knowledge of science, whether practical or abstract, from the untested, ill-respected teachers in private commercial schools, or from the casual visit of an itinerant lecturer with his travelling apparatus. But what did the Universities? My own University, Oxford, to which I acknowledge in other respects the highest obligations, did little for physical science. True, that the study of Mathematics, as an exercise and training of the understanding, received its honours there, though the genius of the place has never yet been favourable to the pursuit. True, that until comparatively a recent period, the honours of the sister University were exclusively, or nearly so, confined to the same science; and that the school of Newton has seldom been without names not unworthy of such a founder. But even there the Mathematics were still too exclusively regarded as a mere training of the understanding, and not as an instrument for the discovery of further truth; and the fair tree of science, planted within the academic courts, though healthy and vigorous, was somewhat barren of fresh fruit. Such as it had been in the time of Newton, such, in a great degree, for a century and a half, at least, it remained. But to other than mathematical science, I believe I may say at either University encouragement there was little or none. If now and then a professor was to be found whose title promised something of the kind, on approaching him you would find that his existence was little more than nominal; that his courses were not frequented, even if they were offered,—or if at all only by those who were considered rather as the idle men; because success in them was not only no advantage in the University career, but, by the time which they abstracted from the rewarded studies, was a positive loss and obstruction in the way of the honours and emoluments of the place. So that it might fairly be said, that if any advance was made in such sciences, at least in the Universities of England, it was rather in spite of than by reason of the system pursued in those otherwise useful, noble and magnificent institutions. In Scotland, indeed, the extended study of medicine, connected as it is with so many other branches of science, together with the less amount of artificial forcing into other studies, led naturally to the pursuit of physical science, and a Black and a Gregory, a Leslie, and a Playfair had no rival contemporary names at Oxford and Cambridge. The names of a Whewell and a Herschel, an Airy, a Challis, and a Sedgwick, of a Powell and a Daubeny, and a Buckland,—alas that he is only a name now—would forbid the assertion in regard to more recent times. But what, meanwhile, was the State doing? That State which, with its limited population and territory, depends not upon the number of its people, but upon the individual value of each man,—not upon the number of its acres, but upon their skilful cultivation,—not even upon the resources of its surface, however well developed, but upon the mines which lurk beneath it,—not even upon its mines but upon all the various and varying manufactures, which these mines give extraordinary facilities for carrying on; not even on these manufactures, but on the extended commerce and navigation, which are necessary to provide the materials to draw them forth from the remotest corners of the earth, and to send them back with speed, safety and economy, in another form and combination, often to the very spots from which they were derived;—in a word dependent for the full development of its agriculture, its mining industry, its manufactures and its commerce, upon the widest extension and the fullest cultivation of Chemistry, of Natural History, of Mineralogy, of Geology, of Astronomy, of Meteorology and Mechanics. What did the State do for these things? Why, absolutely nothing. There was for a time a Board of Longitude, which instead of enlarging and improving, it abolished; a Board of Agriculture, which it dropped; a School of Naval Architecture, which, at the bidding of a narrow economy, and at the instance of practical men, it abolished when the fruits were ripening; a School of Naval Instruction, at Portsmouth, which it dropped. Here and there still survives a grant from the bounty of an individual monarch, grudgingly adopted by the State,—of £40 for a Professor of Natural Philosophy at Aberdeen, or 50 guineas for a similar Professor at St. Andrews, or £150 to one at Glasgow, or £30 to one at Edinburgh, and more recently, grants of £100 a year each to four or five Professors in each of the old Universities of England. This is, as far as I can discover, all that the magnificent State of Britian did, until recently, for that Science on which her wealth,—and if her wealth, her power,—and if her power her very existence,—is dependent. True, one advantage we have enjoyed.

which is indeed worth all the organized instruction in the world which despotism could offer,—"although no science fairly worth the seven," —we have enjoyed security for life and property; the free exercise of thought and action; religion, which does not chain the energies of mind and character, but stimulates and exercises, while it regulates and directs them; and though last, not least, a country to be proud of, and to be fond of, and which every one desires to bequeath to his posterity better, more beautiful, and stronger, than he found it. And it is by reason of this indirect influence on national character, that, in spite of the more than want of encouragement of science of which our Government has been guilty, England has yet to boast of an array of men of science, of workers and discoverers, if not always of teachers, such as she need not be ashamed to show by the side of any other country, whatever stimulants or encouragements its Government may have supplied.

But because so much has been done by the spontaneous vigor of the people's character and of their political and religious institutions, without special assistance or encouragement, does it follow that still more would not be done with those aids? Such, happily, is not the opinion of the present day—not the opinion of the legislature—not that of the Universities themselves. We do not believe that such difficulties are an advantage even to the vigour of the plant, still less to its extended propagation, and accordingly, individuals, colleges, and, I hope, Governments, are now heartily and honestly engaged in repairing the defect of centuries, and not only in promoting the general development of intellect, but especially in directing it to the fields of science. And, happily, the facilities for the purpose already at hand are enormous. The Chancellor of the Exchequer need not apprehend excessive demands upon his treasury to meet the case; though, if they were necessary, I believe he is too sensible a man to withhold them; but such demands are not required. The encouragements and assistances already given by the State to the education of the people, in various shapes, the superior class of trained and examined teachers, who are spreading over the land, and whose training has in no small degree been in physical science, the books provided for early education by our societies and by individual enterprise having the same character; the every-day more and more acknowledged connexion between agriculture and science, showing itself in such papers as enrich the pages of the Journal of the Royal Agricultural Society; the establishment of the department of science, with its school of mines, under the Board of Trade; the improvement which is to be expected, under the action of the charity commissioners, in the system of our old grammar schools; the spontaneous action of our old Universities, not superseded, but facilitated and stimulated by parliamentary interposition. These and such like changes, which are taking place, partly within the bosom of society itself, and partly by the action of Government, will shortly provide such means of scientific education, although not systematised with the exactness of continental organisation, as will, after our rough English fashion, adequately provide for all our wants in that respect, and give us no cause to lament over any considerable deficiencies in practical result.

But will there be encouragements to make use of these facilities? Are there rewards in prospect, whether of direct emolument or social consideration, which will induce men "to wear out nights, and live laborious days," in a service which has hitherto, in the world's eye at least, appeared often to be ill requited? Now, the real stimulant to science has at all times been the delights of the pursuit itself, and the consciousness of the great services rendered to humanity by every conquest within the domain of truth; but still these questions may fairly demand an answer. To the questions of pecuniary rewards I will presently advert, they have certainly been miserably inadequate; but in regard to social consideration, I think there has existed some misunderstanding. It has been often asserted, and made the subject of lamentation or complaint, that men of science do not enjoy in this free country, the consideration which they do in some countries less favored otherwise in their institutions than ourselves. Now, if by this it is intended to express, that men of science are not made Knights of the Garter or Peers of Parliament—that they are not often met with in the haunts of wealth and fashion—that they are not called into the councils of their Sovereign, or sent to represent her in foreign Courts, I admit the fact; but, then, I doubt whether these are the natural or fitting objects of ambition to the scientific man; and if it is intended by the assertion that they are not, as a class of individuals, appreciated by their fellow-citizens for their genius and honored for their services, I cannot so fully admit the fact. I would ask any of those whose presence adorns this meeting, do they not find that their names are a passport into any society, the proudest of the land? Whose doors, that are worth entering, are not open to them? There are certain advantages, superficially considered, which will always belong to mere wealth or power; but are they such as the lover of science can bring himself to envy or desire? Wherever he is known, he is honoured—witness in themselves the meetings of this great Association, and of other kindred bodies, who visit, from time to time, different quarters of our land: where is their presence not hailed, not struggled for? Where is it not the endeavour of rank and wealth on every such occasion to do honour to itself by showing honour generally and personally to those who, by their successful pursuit of science, have done honour to our own or foreign lands? If, indeed, there be anything yet wanting in this respect, either in our people or our Government, the progress of education in science, to which I have before alluded, will soon supply it when the various classes of our population, in their schools, their mechanics' institutes, and, not least, in their colleges, are themselves less ignorant of science, when they have learnt to appreciate its value by personal acquaintance with its truths, there is no fear that those at whose feet they have sat—whose names are familiar to them in association with so valuable an acquisition—will not receive all due honour and regard. Whether, or to what extent, the result will be a greater association of science with political position, and how far such association would be advantageous to either politics or science is another question. The experience of foreign countries on this head can hardly be held to be quite satisfactory. I am not sure that their men of science have been very successful politicians, or that science itself has profited by the union. Public life, more than science, is a jealous mistress, and does not well tolerate a known devotion to any other pursuit. It has besides a science of its own, essential to it, especially in a free country,—the knowledge of men; and this is not always the special gift of men of science, who deal less with men than with things and thoughts, and I am not sure that the qualities which fit a man for success in the one pursuit, are peculiarly advantageous to him in the other. This, however, is certain,—that those who administer the affairs of this country ought at least (I do not think as yet they do) to know enough of science to appreciate its value, and to be acquainted with its wants and with its bearings upon the interests of society; but such knowledge, I cannot doubt, will soon become the common apanage of all well-educated men, and when it is so, as I said before, whatever, either in the position of science, or of men of science, is still wanting, will soon be supplied.

To accelerate, however, this process, I would gladly see a more direct communication established between the organs of power and scientific bodies. Something in this respect has already been done by the Parliamentary Committee of this Association, and the results have been already seen in the increased attention of Parliament and Government to scientific objects. Still, however, in regard to science, I must admit that there is one great deficiency. For often may it be said of science, as it was said satirically of virtue by the poet, *laudatur et alget,*—It is praised and starves. The man of science may not desire to live luxuriously; he may not, nor ought he, desire to rival his neighbours in the follies of equipage and ostentation, which are often indeed, rather imposed by the customs of society than an advantage or even a gratification to the parties themselves; but he must live, and for the sake of science itself he ought to be able to live, free from those anxious cares for the present, and the future, or from the calls of a profession, which often beset and burden his laborious career. Why was our Dalton compelled to waste the powers of such an intellect on private teaching? As a teacher, a physician, or a clergyman, or more rarely as a partner in a profitable patent, such a man may earn a competence, and give to science the hours which can be spared from his other avocations, and it is indeed astonishing what results have been the produce of these blessings of a laborious life,—these leisure hours, if so they may be called, of men who are engaged in arduous duties of another kind. But this ought not to be; and it will not long be, I am confident. It must give way before the extended cultivation of science itself. The means of occupation in connexion with our schools and our colleges, and our examinations, will increase; and I cannot but hope that a grateful country will insist upon her benefactors in science receiving a more liberal share of her bounty than has hitherto been allotted them. If I recollect right, out of the £1,200 which are annually appropriated in pensions to the successful cultivators of science, literature and art, a poor pension of £50 is all that last year fell to the lot of science, and in former years the disproportion has often been little less remarkable. I do not grudge their share to Literature and Art; but I confess I cannot but consider that the labours of

Science are at least of equal value to a nation's welfare; that they have at least an equal claim upon her gratitude, and I am sure that they stand in no less need of encouragement and support.

Nor have I any fear that the study of Science should ever become too exclusive, that is, should make us too material, that it should overgrow and smother those more ethical, more elevating influences which are supposed to grow from the pursuit of Literature and Art.

In the first place, the demands of Science upon the patient and laborious exercise of thought are too heavy, too severe, to make it likely that it should ever become the favorite study of the many. In Art and Literature, the mind of the student is often comparatively passive, in a state of almost passive enjoyment of the banquet prepared for him by others; in those of Science the student must work hard for his intellectual fare. He cannot throw up his oars,

> And let his little bark, attendant sail,
> Pursue the triumph and partake the gale,

but he must tug at the oar himself, and take his full share in the labour by which his progress is to be made.

Nor, indeed, when I read the works of a Whewell, and a Herschel, and a Brewster, a Hugh Miller, or a Sedgwick, and a hundred others the glory of our days, can I see any reason for apprehending that the study of Science deprives the mind of imagination, the style of grace and beauty, or the character of its moral and religious tone, its elevation and refinement.

And, now, ladies and gentlemen, I have done. Once more assuming for a moment the character of a representative of this great town, I welcome you, the British Association, a second time to Liverpool. It is right that you and Liverpool should have frequent meetings, and should cultivate an intimate acquaintance. There is no place which can do more for science if she pleases; none has opportunities so extensive of becoming, by her ships and commercial agencies, by her enterprising spirit and connexion with every soil and climate, the missionary of science,—perhaps I should rather say, the importer of the raw material of facts and observations,—the exporter of the manufactured results arising from their scientific discussion. There is no town which owes more to science. Without science can her vessels stir without danger out of sight of land, or walk the waters independent of wind or tide? Without science would they have docks to shelter them, railroads to bring their produce to their docks, telegraphs to announce their movements, manufactures to freight them to distant lands? I do not believe that Liverpool is insensible to her obligations. This magnificent reception is one evidence of the feeling,—but a still better is to be found in her liberal support to such institutions as the Public Libraries and Museums, as her Collegiate Institution, and above all, to her magnificent Observatory.

Again I welcome the British Association for the Advancement of Science to the walls of Liverpool, fully assured as I am of the great benefits, direct and indirect, which their presence will confer upon the town, and of the deep sense which, I know the inhabitants entertain of the honour conferred upon them by this repeated visit.

Fate of Sir John Franklin.

DR. RAE'S LETTER TO SIR GEORGE SIMPSON.

York Factory, 4th August, 1854.

MY DEAR SIR GEORGE,—Your several letters, public and private, of dates 15th June, and 1st December, 1853, and 13th and 16th June, 1854, were handed me on the 28th ultimo, on my reaching Churchill, and I rejoiced to learn that your health had benefited so much by your visit to the north.

Let me now allude to the Expedition affairs. I arrived here on the 31st ult. with my small party, in excellent health, but I am sorry to say without having effected our object. At the same time, information has been obtained and articles purchased from the natives, which places the fate of a portion, if not all of the then survivors of Sir John Franklin's miserable party beyond a doubt—a fate the most deplorable—Death from starvation, after having had recourse to cannibalism as a means of prolonging life.

I reached my old quarters at Repulse Bay, on the 15th August, and preparations were immediately commenced for wintering. On the 1st September I explained to the men our position, the stock of provisions we had on hand, (not more than 3 months rations), and the prospects we had of getting more, &c., &c., pointing out all the danger and difficulty of our position. All readily volunteered to remain, and our exertions to collect food and fuel went on with unabated energy. By the end of September, 109 deer, 4 musk ox, 53 brace of Ptarmigan, and one seal had been shot, and the nets produced 190 salmon.

Of the larger animals above enumerated, 19 deer and the musk ox were shot by myself, 21 deer by Mistegan, (the deer hunter), 14 by one of the men, 9 by Ouligbuck and 16 by the other four men. The migration of the deer terminated about the middle of October, and 25 animals were added to our stock.

On the 28th of October, the snow being sufficiently hard for building, we were happy to exchange our cold tents for the more comfortable shelter of the snowhouses. The winter was very severe, but the temperature in our snow-huts was never so low as in my winter quarters of 1846-7. Up to the 12th January we had nets set under the ice in the lakes, the nets were taken up on that date as they produced nothing.

On the 31st of March my spring journey commenced, but in consequence of gales of winds, deep and soft snow, and foggy weather, we made but very little progress. We did not enter Pelly Bay until the 17th. At this place we met with Esquimaux, one of whom, on being asked if he ever saw white people, replied in the negative, but said that a large party, (at least 40 persons) had perished from want of food, some 10 or 12 days' journey to the westward. The substance of the information, obtained at various times and from various sources, was as follows:—

In the spring, four winters past, (spring, 1850) a party of white men, amounting to about forty, were seen travelling southward over the ice, and dragging a boat with them, by some Esquimaux who were killing seals on the north shore of King William's Land, which is a large island named Kei-ik-tak, by the Esquimaux. None of the party could speak the native language intelligibly, but, by signs the natives were made to understand that their ships or ship had been crushed by ice, and that the "whites" were now going to where they expected to find deer to shoot. From the appearance of the men, all of whom, except one officer, (chief), looked thin, they were then supposed to be getting short of provisions, and they purchased a small seal from the natives.

At a later date, the same season, but previous to the disruption of the ice, the bodies of about thirty white persons were discovered on the continent, and five on an island near it, about a long days' journey, (say 35 or 40 miles) to the N. W. of a large stream, which can be no other than Back's Great Fish River, (named by the Esquimaux, Out-koo-hi-ca-lik), as its description, and that of the low shore in the neighbourhood of Point Ogle and Montreal Island agree exactly with that of Sir George Back. Some of the bodies had been buried, (probably those of the first victims of famine), some were in a tent or tents, others under a boat that had been turned over to form a shelter, and several lay scattered about in different directions. Of those found on an island one was supposed to be an officer, as he had a telescope strapped over his shoulder and his double-barrelled gun lay underneath him.

From the mutilated state of many of the corpses, and the contents of the kettles, it is evident that our miserable countrymen had been driven to the last resource—cannibalism—as a means of prolonging life.

There appears to have been an abundant stock of ammunition, as the powder was emptied in a heap on the ground by the natives, out of the kegs or cases containing it, and a quantity of ball and shot was found below high water mark, having been left on the ice close to the beach. There must have been a number of watches, telescopes, compasses, guns, (several double-barrelled) &c., all of which appear to have been broken up, as I saw pieces of these different articles with the Esquimaux, and together with some silver spoons and forks, purchased as many as I could obtain. A list of the most important of these I inclose, with a rough pen-and-ink-sketch of the events, and initials on the forks and spoons. The articles themselves shall be handed over to the Secretary of the Hon. Hudson's Bay Company on my arrival in London.

None of the Esquimaux with whom I conversed had seen the "whites," nor had they ever been at the place where the dead were found, but had their information from those who had been there, and those who had seen the party when alive.

From the head of Pelly Bay,—which is a bay spite of Sir H. Beaufort's opinion to the contrary.—I crossed 60 miles of land in a westerly direction, traced the west shore from Castor and Pollux River to Cape Porter of Sir James Ross, and I could have got within 30 or 40 miles of Bellot Strait, but I thought it useless proceeding further as I could not complete the whole.

Never in my former Arctic journeys had I met with such an accumulation of obstacles. Fogs, storms, rough ice, and deep snow we had to fight against. On one occasion we were 4½ days unable to get a glimpse of the sun, or even to make out his position in the heavens. This, on a level coast, where the compass was of little or no use, was perplexing in the extreme.

The weather was much finer on our return journey than when outwards bound, and our loads being lighter, our days marches were nearly double the distance, and we arrived at Repulse Bay on the 26th May, without accident, except in one instance, in which one of the party lost a toe from a frost bite.

The commencement of spring was very fine, but June and July were colder. We were unable to get out of the bay until the 6th of August.

Our progress along the coast as far as Cape Fullerton, was much impeded by ice; but on getting to the southward of the cape we had clear water, and saw no ice afterwards.

The conduct of the men, I am happy to say, was, generally speaking, good: and we had not a single case of sickness all the time of our absence.

Being anixous to send this to Red River by the first boats, I write in haste and briefly, but shall have the pleasure of sending a more detailed account by some future opportunity.

With the utmost respect,
I have the honour to be,
Your very obedient servant.

JOHN RAE.

LIST ENCLOSED IN DR. RAE'S LETTER.

CRESTS.

No. 1—Head of (apparently) a Walrus or Sea-horse, with dragon's wings.
No. 2—A Griffin, with wings and forked tongue and tail.
No. 3—A Griffin's head with wings.
No. 4—A Dove with olive branch in its bill, surronded by a scroll, with the motto, *Spero meliora.*
No. 5—A Fish's Head, with (apparently) coral branches on either side.

List of Articles purchased from the Esquimaux, said to have been found to the West, or rather N. W. of Back's River, at the place where the party of men starved to death in Spring, 1850.

1	silver table fork,				Crest No.	2
3	do.	do.	do.		" "	1
1	do.	do.	spoon,		" "	3
1	do.	do. motto *Spero meliora*			" "	4
1	do.	do.	fork,	do.	" "	5
1	do.	dessert	do.		" "	5
1	do. table spoon,		do.		" "	5
1	do. tea	do.	do.		" "	5
1	do. table fork, with intitials "H.D.S.G."					
1	do.	do.	do.	"A. McD."		
1	do.	do.	do.	"G.A.M."		
1	do.	do.	do.	"J.F."		
1	do.	do.	do.	"J.F.B." or "J.S.B."		
1	small silver plate (engraved) "Sir John Franklin, K.C.B."					

A Star with motto, "Nec Aspera Terrent" on one side, and on the reverse "G. R. MDCCCXV."

Also, a number of other things of minor importance, as they have no particular marks by which they could be recognised, but which along with those above named, shall be handed over to the Secretary of the Hon. Hudson's Bay Company.

JOHN RAE, C. F.

Repulse Bay, July, 1854.

Commercial Enterprise and Scientific Investigation.

Professor Airy, the astronomer Royal, has recently published a letter in which the power and capabilities of private companies are strikingly contrasted with the efforts of government in scientific investigations and great commercial projects. Among other interesting illustrations he gives an account of former and recent attempts to determine the difference of longitude between the observatories of Paris and Greenwich. As the details have already been published there is no need to repeat them. It may be sufficient to observe that the determination of the difference of the longtitude between two places is a process which has, up to the present time, demanded the exercise of the most profound mathematical knowledge, great mechanical aptitude, and very extensive pecuniary resources. It was supposed to be matter more peculiarly the business of Governments than of private individuals, and Governments have undertaken it in full consciousness of their superior capabilities. The national authorities of England and France took the matter in hand in the year 1787, and endeavoured to attain their object by the expensive means of an accurate survey in both countries. The result of their labors so little satisfied scientific men that, in the words of Professor Airy, "it was thought desirable to take the earliest opportunity of verifying the result by an operation of a different kind."

In 1825, the Governments of the two nations again made an attempt in the same direction. Sir. John Herschel and Captain Sabine, assisted by other scientific persons, were appointed by the English Government; and a body of distinguished engineer officers undertook the duty in France. In spite of these apparently efficient preparations, the costly experiment failed. Other attempts have been made, but with similar results.

At length the submarine telegraph was established, and the astronomical authorities on both sides of the Channel applied to the company for assistance in establishing a connection by galvanic telegraph between the Observatories of Greenwich and Paris. The permission was granted, the company behaving in a most liberal manner. Several thousand observations were made, and the success has been complete. It may be sufficient to show the superiority of the method afforded by the use of the electric telegraph; Prof. Airy states that one single observation made by the telegraph gives a more accurate result than can be deduced from the whole mass of observations in the attempt made in 1825 to determine the difference of longitude by signals. "The former determination is now," says the Professor, "shown to be erroneous by almost a second of time (a large quantity in astronomy), and this correction is nearly certain to its hundredth part. For this gain of accuracy, this veritable advance of science, we are indebted in the first instance to the power of commercial association." Professor Airy may well congratulate the world on the growing tendency towards a closer union between commerce and science. Here is a most important scientific result achieved by the means of the resources of a company which never proposed to itself any such end. The Electric Telegraph Company was a purely commercial speculation. There was no intention certainly of employing it to determine the difference of longitude. Nevertheless, while carrying on international intercourse, it solves a philosophical problem which has baffled mighty states as a mere matter of by-law. It makes no display. It trumpets forth no grand preparations. The operations of the astronomers caused no interruption of its wonderful activity. It throws off the solution of a great astronomical difficulty as carelessly as if nothing wonderful were to be achieved, and receives the thanks of the scientific men as a matter of course. If any one would wish to have a convincing proof that the future destinies of the world will depend, not on individual wills, but in the united agencies of the multitudes, he may have it, as the *Mining Journal* says, in Professor Airy's letter.

The Canadian Steam Navigation Company's New Iron Screw-Propeller Steam-Vessel "Canadian."

Built by Messrs. William Denny and Brothers, iron ship-builders, Dumbarton; machinery by Messrs. Tulloch and Denny, engineers, Dumbarton; 1854.

Dimensions.	Ft.	Tenths.
Length on Deck	277	2
Breadth at two-fifths of middle depth	35	0
Depth of hold amidships	80	0

Tonnage.	Tons.
Hull	1764 59-100
Engine-room and shaft space	719 40-100
Register	1045 19-100

Fitted with a pair of direct-acting engines of 300-horse (nominal) power; diameter of cylinders, 62 inches; length of stroke, 3 feet 6 inches. Screw-propeller, diameter, 16 feet; length on axis, 5 feet 8 inches: pitch, 25 feet; two blades. Two tubular boilers, fired at both ends, having two funnels. Length of boilers, 18 feet 10 inches; breadth, 9 feet 9 inches; depth, 11 feet 3 inches. Twelve furnaces, six in each boiler, three at each end; length, 6 feet 6 inches; breadth, 2 feet 7 inches; 732 tubes, or 366 in each boiler, or 183 at each end; diameter 3¼ inches; length, 6 feet 6 inches. Funnels, diameter, 4 ft. 10 inches, and 48 feet long; intended steam pressure, 14 lbs. Frames of hull, 6 × 3 × ⅜ and ½ inches, spaced 12 inches apart; 19 strakes of plates, tapering from 1 to 7-16ths of an inch in thickness; eight bulkheads.

For the Liverpool, Quebec, and Montreal line.

DESCRIPTION.

A shield figure-head; no galleries; elliptical sterned and clinch-built vessel; three masts; barque rigged; standing bowsprit; three decks (flush); clipper-bow.—*Artisan.*

CANADIAN INSTITUTE ESTABLISHED 1849

INCORPORATED BY ROYAL CHARTER.

The attention of members of the Institute is requested to the subjoined extracts from the Regulations and By-Laws:—

1. The sessions of the Institute shall commence annually on the first Saturday in December; and ordinary meetings shall be held on every succeeding Saturday (omitting the Christmas holidays), until the first Saturday in April; but it shall be in the power of the Council to protract the sessions if it should seem necessary. The chair may be taken when five members are present.

2. The chair shall be taken by the officer or member entitled to the same; and the business of the evening commence at eight o'clock precisely, and be conducted in the order prescribed in the by-laws.

3. Every member shall have the privilege of introducing two visitors to be present at the public business of the Institute by ticket of admission, on which the name and address of each visitor must be written.

4. The annual general meeting of the Institute shall be held on the third Saturday in December, at seven o'clock in the evening, to receive and deliberate on the report of the Council on the state of the Institute, and to elect the officers and members of the Council for the ensuing year.

5. The Council may, at any time, call a special general meeting of the Institute for a specific purpose, giving to city members six days' notice; and they are at all times bound to do so, on the written requisition of five members, which shall specify the nature of the business to be transacted.

6. Those members of the Institute residing at a distance from the city, shall have the power of forming themselves into Branch Societies, for the purpose of holding meetings, and discussing scientific and other subjects; and are to be governed by the regulations of the Institute, and such other By-laws hereafter to be enacted by them and approved by the Council.

BY-LAWS.

I. At the ordinary meetings of the Institute, every Saturday evening, the following order of business shall be attended to, as closely as circumstances will admit:—

1. The Minutes of the previous meeting to be read and confirmed, and signed by the Chairman; and no entry shall be considered valid until this be complete.
2. New members present to be introduced to the meeting.
3. Names of candidates for admission to be announced.
4. Business arising out of the Minutes to be entered on.
5. Communications received since the last meeting to be announced, and read if required.
6. Donations received and acknowledged.
7. Communications from the Council to be brought forward.
8. Candidates to be balloted for. A ballot shall be taken for the entire body of candidates proposed for admission; if one or more black balls appear, the ballot shall be taken for each individually, and any candidate shall be rejected against whom appear a number of black balls equal to one-fourth of the number of members voting.
9. Papers on the lists to be read.

II. Notices of questions to be brought forward for discussion, must be given at least one week before the same shall be brought forward; and it shall be competent for the Council, or for any member to propose a subject for discussion.

III. A circular letter may be sent to all the country members, at the commencement of each session, with a list of questions that are appointed for discussion at the ordinary meetings of the Institute, requesting communications from the members on them, or on any other subject connected with the objects of the Institute.

IV. A similar letter may also be transmitted about the middle of the session, with the addition of any new questions that may have been brought forward and accepted; and at the end of the session, a list of questions shall also be sent to all the members, in order to collect information during the recess. Each letter shall contain a list of the written communications that have been made to the Institute.

Notices of Books.

Geological Survey of Canada—Report of Progress for the year 1852-53. Printed by order of the Legislative Assembly.

The large amount of space occupied by the reports of the proceedings of the British Association for the Advancement of Science, prevents us from giving an abstract of Messrs. Logan, Murray, and Hunt's valuable reports on the Geological Survey of Canada for the year 1852-53. The December number of this Journal will contain copious extracts from these important documents.

The Principal Forms of the Skeleton and of the Teeth. By Professor R. Owen, F.R.S., &c. Philadelphia: Blanchard and Lea, 1854, oc, pp. 329.

The Principles of Animal and Vegetable Physiology; a Popular Treatise on the Functions and Phenomena of Organic Life. To which is prefixed a General View of the Great Departments of Human Knowledge. By J. Stevenson Bushnan, M.D. Philadelphia: Blanchard and Lea, 1854, oc, pp. 233.

For the reason given above, a detailed notice of these works is deferred until the next issue of this Journal.

Extraction of Metals by the Battery.—Bunsen has been investigating the circumstances most favorable to the separation of metals from their compounds. These are the density of the current, and the greater or less concentration of the liquid to be decomposed. The greatest effect is obtained with the most dense current and the most concentrated solutions. Density denotes the concentration of electric action upon a single point, analogous to the concentration of heat and light in the focus of a concave mirror. Thus, we connect a charcoal crucible with the positive pole of the battery, and place in it a small capsule of glazed porcelain containing the liquid to be decomposed. The space between the capsule and crucible is then filled with hydrochloric acid, and the liquid in the small capsule is put in communication with the battery by means of a thin platinum wire, which must be exactly in the centre. The current is then established between a large surface, the charcoal crucible, and a fine platinum wire in which it is concentrated, and the current becomes capable of overcoming affinities which have resisted powerful batteries. The whole apparatus is then set in a large porcelain crucible, and kept warm in the sand-bath. Chrome and manganese are thus readily separated from the solution of their chlorides, provided the negative pole is small and the solution very concentrated. In this state the chrome is quite pure; it presents the appearance of iron, but is less affected by moist air. Heated in the air, it is converted into sesqui-oxide. It resists nitric acid even when boiling, but is acted on by hydrochloric and dilute sulphuric acids, forming proto salts. Its density coincides with the density calculated from the atomic volume. Bunsen obtained sheets of chromium of more than 50 square millimetres surface; they were brittle, and showed a perfect polish on the side which had been in contact with the platinum. Manganese was obtained in the same manner in very little plates of more than 100 square millimetres surface, which oxdised in damp air almost as rapidly as potassium. To reduce barium and calcium, a denser current was required. Concentrated solutions of the chlorides are acidulated with hydrochloric acid, and poured boiling into the glazed porcelain capsule. Amalgamated platinum wire in connection with the battery is then introduced, upon which calcium is deposited in a grey layer, easily detached, and containing a little mercury. If water or moist air be present, this amalgam is rapidly oxdised with evolution of hydrogen; when heated it burns with brilliancy. Barium is more easily extracted. The chloride is powdered and made into a paste with water acidulated with hydrochloric acid, heated to 200° Fah. in the water-bath, and the current established. The amalagam of barium thus obtained is silvery white, and very crystalline. In contact with moist air, it is converted into hydrate of baryta. If heated in a current of hydrogen upon a charcoal support, the mercury is carried off, and a residue of porous barium appears, containing brilliant metallic particles.

Consumption of Coal in the United States.—The Consumption of coal does not increase so rapidly as was supposed. In 1852 the increase was less than 13 per cent., and left a surplus in the market. In 1853 the increased supply was less than 9 per cent. from all sources. To this, of course, is to be attributed the high price of coal during the latter part of the year, but taking the average over 12 per cent. it will reach it. We see no good reason to believe that this average per centage in the demand is likely to be exceeded in the present year, which would require an increase in the supply of about 623,009 tons in 1854, from all sources, to keep the market healthy. The increased supply can easily be furnished by the different regions, provided dealers and customers will come forward and take coal early in the spring. The following is a summary of operations in Schuylkill county:—

Total number of collieries...113	Number of operators.. 82
Red ash collieries 58	Employed at collieries 9792
White ash collieries.......... 55	Miner's houses out of towns 2756

Whole capital invested in these collieries $3,162,000
By individual operators, about 2,600,000
Thickest vein worked at Heckshersville .... 80 ft.
Smallest .... 2 ft.

All the coal lands now worked in Schuylkill county are owned by six corporations, and about 60 individuals. About 25 of the owners reside in Schuylkill county, and the balance abroad. The coal rent will average 30 c. a ton. The product of 1853 in Schuylkill county was 2,551,603 tons. This would give an income of $765,480 to the landholders in the shape of rents for the year.—*Pottsville Mining Journal.*

On the Permanent Expansion of Cast Iron by successive Heatings.—In the Memoirs of the Industrial Society of Hanover for last year, there are some interesting remarks on this question. The remarkable phenomenon that cast-iron presents on being heated, of not returning back to its original volume, but of continually showing an increase of the volume, and of permanently acquiring an enlarged volume by successive heatings and coolings, had been first observed by Rinsep, in 1829. That chemist found that a cast-iron retort, whose capacity was exactly measured by the quantity of mercury which it could contain, held at first, 9·13 cubic inches; after the first heating and cooling, 9·61 inches; and after three heatings, up to the melting point of silver, 10·16 cubic inches, The cubical expansion ought, therefore, to be 11·28 per cent., which gives 3.76 per cent. nearly of linear expansion.

At subsequent periods different phenomena were observed, more or less confirmatory of this law. The cast-iron bars of grates, where powerful fires were made, were frequently observed to elongate, so as to become jammed tight in their frames; and when these obstructed all further enlargements, the bars become curved or twisted. Mr. Brix, in his work on the calorific power of the fuels of Prussia, has detailed a few experiments on this subject. By the aid of several measurements, he has shown that the entire permanent elongation increases after each successive heating, but that the amount produced by each heating diminishes the more frequently the bar is heated, until it finally becomes insensible. Thus, a furnace bar 3½ feet long, after being three days exposed to a moderate fire, had already acquired a permanent elongation of 3-16ths of an inch, or ·446 per cent.; at the end of seventeen days, 1·042 per cent.; and after thirty days, 2 per cent., but had not yet reached its maximum. Another bar of the same kind, after a long service, had a permanent elongation of 3 per cent.

If it be remembered that bars while exposed to the fire undergo another temporary elongation, we must agree with M. Brix, that an allowance should be made in a bar which has not as yet been used, amounting to 1 per cent. of its length, for this cause of elongation. The bars must, of coerse, be sufficiently long to stand between their supports when cool; but it seems that hitherto sufficient room has not been given for this permanent expansion in laying down new bars.

Robinson's Patent for the Novel Application of the Slags or Refuse Matters obtained during the Manufacture of Metals.—Dr. George Robinson, of Newcastle-on-Tyne, has taken out a patent for the formation of sheets or plates from the slags produced in the various processes of manufacturing and refining iron and other metals. He proposes to convert the molten slag into sheets by pouring it upon an iron or other table previously heated, and then rolling or pressing it to any requisite thickness, according to the purpose for which it is intended to be used. The plates thus formed are afterwards to be annealed, by being allowed to cool gradually in any suitable furnace. While in a plastic state, the sheets may be ornamented by means of suitable elevations and depressions on the rollers by which they are formed. When cold the thin sheets of slag may be used for roofing instead of slates, the thicker plates for flooring, and those having patterns on their surface for covering walls. The Newcastle papers, in alluding to the invention, state that in that district alone there are materials for a very extensive manufacture, and in the other great seats of metallurgic operations the supply of suitable slags is practically unlimited.

The Precious Metals in England.—At a time when the extraction of gold in England occupies so much attention, the following account of the presence of silver in England may prove interesting. An immense silver mine was worked in the vicinity of Aberystwith, in the reign of Elizabeth, by which a Company of Germans enriched themselves; after whom Sir Hugh Middleton accumulated £2,000 a month out of one silver mine at Bwlch-yr-Eskir, by which produce he was enabled to defray the expense of bringing the New River to London. After him, Mr. Bushell, a servant of Sir Francis Bacon, gained from the same mine such immense profits, as to be able to present Charles I., with a regiment of horse, and to provide clothes for his whole army. Besides this he advanced, as a loan to his Majesty, no less a sum than £40,000, equal to at least four times the amount of the present currency, and he also raised a regiment amongst his miners at his own charge.

Rosin Oil for lubricating Machinery.—Payen and Buran recommend the oil obtained by the distillation of common rosin with from 5 to 10 per cent of quicklime, as a good material for greasing machinery. As it is generally slightly acid, even when distilled with lime, it is recommended to add from 2 to 5 per cent. of lime or magnesia to the cold oil, which unites with the free acid, and gives the whole mass the consistence of butter.—*Polytechnisches Centralblatt, No. 12, 1853.*

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

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

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.	Mean Temp. + or — of the Average	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.
					°	°	°	°	°													
1	29·797	29·757	29.681	29·732	62·8	61·7	64·4	63·97	+ 0·93	0·503	0·490	0·546	0·526	·90	.91	·93	·91	N N E	S S E	N E	3·43	1·330
2	·671	·612	.587	.621	64·8	81·0	68·2	71·40	+ 8·67	·561	·756	·595	·641	94	64	89	81	Calm	Calm	Calm	1·37	0·595
3	·703	·709	—	—	70·2	85·3	—	—	—	·673	·756	—	—	94	64	—	—	NWbN	S S W	—	2·58	...
4	·717	·657	.647	.661	66·0	80·2	68·4	71·83	+ 9·70	·542	·718	·560	·611	87	71	84	80	N E b N	E S E	Calm	2 62	...
5	·605	·533	.530	.550	64·5	93·1	73·9	77·95	+16·12	·568	·743	·671	·676	96	49	82	75	Calm	S S W	Calm	1·47	0·020
6	·533	·463	.576	.525	71·1	89·0	71·2	77·63	+16·20	·660	·668	·658	·666	80	51	89	73	W S W	SW b W	W	5·38	0·250
7	·677	·690	.771	.714	56·9	77·4	53·1	63·48	+ 2·33	·416	·477	·350	·437	91	49	88	77	Calm	W b N	Calm	5·72	...
8	·716	·618	.512	.607	50·0	69·5	57·8	60·17	— 0·57	·328	·409	·431	·407	92	58	92	81	N b W	N	N b E	4·60	1·705
9	·471	·494	.529	.503	55·5	59·7	57·7	57·95	— 2·40	·395	·439	·406	·416	92	87	87	88	N N E	N N E	N b E	5·34	0·030
10	·582	·589	—	—	53·1	65·7	—	—	—	·263	·321	—	—	66	52	—	—	N E b N	N E	—	5·86	...
11	·677	·600	.501	.582	46·2	69·5	63·0	60·42	+ 0·77	.278	·420	·538	·415	90	60	96	81	N	E b S	S E b E	3·68	...
12	·451	·555	.713	.592	61·1	77·0	58·5	64·68	+ 5·45	·490	·586	·350	·441	93	65	73	74	Calm	NW b W	N N W	8·60	...
13	·877	·873	.800	.848	48·3	68·4	55·3	56·57	— 2·28	·251	·412	·347	·336	75	60	84	74	N N E	E	E	5·60	0·395
14	·698	·578	.612	.623	55·6	64·5	63·2	61·25	+ 2·92	·405	·534	·542	·493	93	90	96	93	N b E	N b E	Calm	1·53	0·140
15	·737	·813	.931	.836	59·2	62·2	45·1	54·93	— 2·98	·403	·290	·249	·312	82	53	83	74	N b W	N b W	Calm	7·24	...
16	·994	·961	30.001	.983	42·7	65·8	50·0	53·85	— 3·67	·235	·345	·260	·295	87	56	73	72	Calm	NW b N	N	3·02	...
17	30·086	·993	—	—	45·5	60·8	—	—	—	·227	·318	—	—	75	61	—	—	N N E	Calm	—	1·38	...
18	29·778	·618	29.539	.632	50·5	69·6	65·0	63·37	+ 6·75	.254	·561	·549	·485	70	80	92	83	Calm	S	SW b W	3·81	0·165
19	·445	·332	.323	.366	64·6	77·3	60·7	66·92	+10·80	·558	·468	·453	·488	94	51	87	78	SW b W	W	NW b N	10·89	0·245
20	·594	·731	.872	.751	50·6	55·5	42·4	48·52	— 7·08	·253	·217	·201	·219	69	50	75	66	NW b N	N b W	N N W	9·52	...
21	·950	·906	.940	.938	41·3	59·9	51·7	50·77	— 4·35	·214	·235	·355	·257	83	45	94	72	N b E	S b W	W	5·47	0·005
22	30·099	30·112	30.028	30.081	35·3	61·5	52·2	51·98	— 2·65	·183	·372	·320	·292	86	70	83	76	N W	S	S W	3·44	...
23	29·956	29·812	29.734	29.825	40 9	70·7	56·5	56·78	+ 2·57	·214	·427	·387	·357	97	59	86	79	Calm	S b W	Calm	4·03	...
24	·680	·581	—	—	52·8	71·6	—	—	—	·323	·485	—	—	82	65	—	—	W b N	S S E	—	1·73	0·080
25	·429	·438	.503	.464	57·6	70·2	61·4	63·55	+10·32	·417	·620	·470	·509	90	87	88	89	Calm	S b E	Calm	1·63	0·050
26	·596	·559	.553	.568	53·3	74·5	59·6	62·85	+10·12	·354	·613	·447	·484	88	74	89	86	Calm	S b E	Calm	1·39	...
27	·558	·459	.626	.547	59·3	79·0	57·6	65·08	+12·87	·448	·674	·444	·531	91	70	96	87	Calm	S W b S	NW b N	6·04	0·365
28	·693	·683	.727	.700	48·3	70·1	56·0	59·03	+ 7·20	·287	·321	·367	·346	86	46	84	73	NW b N	S b W	N b E	4·51	...
29	·966	30·047	30.092	30.048	38·1	60·6	42·2	50·70	— 0·62	·263	·309	·238	·272	80	60	90	76	N N E	E S E	N b E	4·40	...
30	30·098	29·973	29.781	29.923	41·6	60·9	52·0	51·47	+ 0·65	·202	·232	·351	.269	78	41	92	73	N N E	S E	Calm	2·86	Inap.
																		Miles.	Miles.	Miles.		
M	29·722	29·688	29.697	29·7008	53·73	70·34	57·98	61·04	+ 3·55	0·373	0·475	0·426	0·430	87	63	87	79	4·41	7·78	3·93	4·31	5·375

Highest Barometer...... 30·142, at 9·30 a.m. on 22d } Monthly range:
Lowest Barometer....... 29·302, at 4 p.m. on 19th } 0·840 inches.

Highest registered temperature 93°·6, at p.m. on 5th } Monthly range:
Lowest registered temperature 35°·8, at a.m. on 22d } 57°·8.

Mean Maximum Thermometer............. 72°·59 } Mean daily range:
Mean Minimum Thermometer............. 49°·09 } 23°·50.

Greatest daily range.........35°·9, from p.m. of 6th to a.m. of 7th.

Warmest day....... 5th. Mean temperature...... 77°·95 } Difference,
Coldest day......... 20th. Mean temperature...... 48°·52 } 29°·43.

Greatest intensity of Solar Radiation, 104°·8 on 6th, p.m. } Range,
Lowest point of Terrestrial Radiation, 29°·8 on 22d, a.m. } 75°·0.

Aurora observed on 6 nights: viz. 10th, 15th, 17th, 21st, 26th, & 27th.

Possible to see Aurora on 22 nights.

Impossible to see Aurora 8 nights.

Raining on 14 days. Raining 49·8 hours: depth, 5·375 inches.

Thunder Storms occurred on the 1st, 2d, 3d, 6th, 14th, and 27th.

Sheet Lightning, not accompanied by thunder or rain, observed on the 18th, and 19th.

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

North.	West.	South.	East.
1579·54	1051·45	632·80	657·49

Mean direction of the Wind, N 18° W.

Mean velocity of the Wind, 4·31 miles per hour.

Maximum velocity, 25·5 miles per hour, from 11·30 to 12·30 p. m. on 19th.

Most windy day, the 19th; mean velocity, 10·89 miles per hour.

Least windy day, the 2d; mean velocity, 1·37 " "

During the violent thunder storm on the 6th, the velocity of the wind from 4h. 00m. to 4. 25m. p.m., was at the rate of 32·4 miles per hour.

A beautiful, very perfect, and well defined Auroral Arch or Band extending across the Zenith from West towards East, from 8·15 to 9·30 p.m., on the 26th.

Hoar Frost was observed on the mornings of the 21st, 22d, and 30th. That on the 21st was the earliest noticed at the Observatory this season.

The Registered Maximum on the 5th (93°·6) is the highest temperature yet recorded at this Observatory in September.

Comparative Table for September.

Year.	Temperature. Mean.	Dif. f'm Avr'ge.	Max. obs'vd.	Min. obs'vd.	Range.	Rain. D's.	Inch.	Wind. Mean Vel'y.	
	°	°	°	°	°				
1840...	54·0	—4·0	70·2	29·4	40·8	4	1·380	...	
1841...	61·3	+3·3	79·9	37·5	42·4	9	3·340	0·26	lb.
1842...	55·7	—2·3	83·5	28·3	55·2	12	6·160	0·45	lb.
1843...	59·1	+1·1	87·8	33·1	51·7	10	9·760	0·57	lb.
1844...	58·6	+0·6	81·5	29·6	51·9	4	Impt.	0·26	lb.
1845...	56·0	—2·0	78·8	35·3	43·5	16	6·245	0·34	lb.
1846...	63·6	+5·6	84·0	39·0	45·0	11	4·595	0·33	lb.
1847...	55·6	—2·4	74·8	38·1	36·7	15	6·665	0·33	lb.
1848...	54·2	—3·8	80·9	29·5	51·4	11	3·115	5·81	Miles.
1849...	58·2	+0·2	80·6	33·5	47·1	9	1·180	4·23	Miles.
1850...	56·5	—1 5	76·0	31·7	44·3	11	1·735	4·78	Miles.
1851...	60·0	+2·0	86·3	33·4	52·9	9	2·665	5·45	Miles.
1852...	57·5	—0·5	81·8	36·1	45·7	10	3·630	4·60	Miles.
1853...	58·8	+0·8	85·4	36·1	49·3	12	5·140	4·30	Miles.
1854...	61·0	+3·0	93·1	36·3	56·8	14	5·375	4·31	Miles.
								4·78	
M'n.	58·01		81·64	33·79	47·85				

Monthly Meteorological Register, St. Martin, Isle Jesus, Canada East.—September, 1851.

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. 6 A.M.	Barom. 2 P.M.	Barom. 10 P.M.	Temp. of the Air. 6 A.M.	Temp. 2 P.M.	Temp. 10 P.M.	Tension of Vapor. 6 A.M.	Tension 2 P.M.	Tension 10. P.M.	Humidity of Air. 6 A.M.	Humidity 2 P.M.	Humidity 10 P.M.	Direction of Wind. 6 A.M.	Wind 2 P.M.	Wind 10 P.M.	Velocity in Miles per Hour. 6 A.M.	Velocity 2 P.M.	Velocity 10 P.M.	Rain in Inch.	Weather, &c. A cloudy sky is represented by 10; A cloudless sky by 0. 6 A.M.	Weather 2 P.M.	Weather 19 P.M.
1	30.167	30.121	30.057	50.6	65.8	59.7	·316	.419	.452	·81	·72	·89	E N E	N E b E	E b N	2.30	10.19	0.15	...	Cum. Str. 2.	Str. 10.	Cum. Str. 10.
2	29.971	29.927	29.887	63.	61.1	63.1	516	565	567	89	96	98	N E b E	S S W	S S W	6.00	0.60	2.15	0.610	Rain.	Slight Rain.	Str. 10.
3	.880	.820	.961	66.0	83.0	66.0	615	600	516	96	54	80	W	N W b W	N	Inap.	3.81	6.25	...	Str. 10.	Clear.	Cir. 2. [L'ng.
4	30.017	30.010	.931	53.0	80.1	61.6	361	681	322	87	68	59	E b N	N E b E	N E b E	1.62	8.73	1.41	...	Cum. Str. 4.	Cir. Str. 4.	Str. 10. Th. &
5	29.933	29.842	.947	64.0	87.6	73.0	401	851	692	67	68	86	E b N	S W b S	N E	2.53	0.86	0.37	0.903	Str. 9.	Str. 2.	Do. 4. Dis. Th.
6	.801	.787	.765	65.6	91.0	70.0	615	739	692	96	53	95	E N E	W b S	W	0.61	0.87	7.50	1.036	Fog.	Clear. Dis. Th.	Do. 10.
7	.815	.962	30.053	65.3	70.4	52.4	497	597	283	80	82	70	N E b N	N E b N	N	6.31	10.50	2.96	...	Str. 4.	Cum. Str. 2.	Clear.
8	30.028	.981	29.898	47.0	60.0	51.4	291	411	400	86	81	93	N E b E	N E b E	N E	Calm	Inap.	Calm	0.200	Cir. Cum. Str. 8.	Rain.	Cum. Str. 10.
9	29.821	.797	.887	51.4	72.1	51.1	361	473	304	93	61	70	E N E	N b E	N N W	0.19	2.40	0.27	...	Cum. Str. 4.	Cir. 2.	Clear.
10	30.010	30.023	30.018	45.0	61.8	41.7	218	286	217	69	53	79	E N E	E N E	E N E	15.87	6.59	3.05	...	Clear.	Clear.	Do. Aur. Bor.
11	30.010	30.023	29.876	33.2	68.8	59.8	187	358	402	90	52	79	E N E	S W b S	S W b S	Calm	Inap.	0.25	...	Do.	Do.	Cum. Str. 4.
12	29.750	29.760	.968	56.2	76.7	57.1	432	597	281	91	67	69	S W b S	W b S	N	0.59	2.75	7.97	0.136	Str. 10.	Cum. Str. 4.	Clear, Aur. Bo.
13	30.286	30.261	30.262	46.2	67.2	41.2	303	328	211	93	49	79	E N E	N E b E	E N E	3.75	1.25	0.85	...	Clear.	Clear.	Do. do. do.
14	30.151	30.032	29.913	42.5	59.0	53.8	263	452	386	90	89	93	E N E	S S W	S	Calm	1.13	11.25	0.800	Do.	Rain at noon.	Rain.
15	29.926	29.999	30.105	55.5	63.4	48.0	391	326	212	88	56	69	N E b N	N W	N N W	Inap.	Calm	6.75	0.200	Cir. Str. 8.	Clear.	Clear, F't. Aur.
16	30.205	30.139	30.219	42.1	58.1	41.1	208	274	217	73	55	79	N W	N W	N W	1.25	11.90	13.31	...	Clear.	Cir. C. Str. 4.	Do. [Bor.
17	30.376	30.277	30.259	44.1	66.2	49.1	261	317	233	85	49	61	N W b W	W b N	W b N	3.00	3.73	3.19	...	Do.	Clear.	Do. Aur. Bor.
18	30.192	30.000	29.861	44.0	69.4	63.2	291	511	488	91	76	81	W b S	W b S	S W	Calm	Calm	1.76	...	Cir. Str. 9.	Cum. Str. 4.	Rain at 8.40.
19	29.636	29.624	.526	61.4	76.0	62.0	565	568	472	91	61	81	W	N W b W	W	Calm	11.75	5.28	0.330	Str. 10.	Do. 8.	Str. 2. Lig. R'n
20	.682	.912	30.098	47.7	64.2	39.2	313	425	196	93	71	76	N b W	N b W	N b W	11.30	12.17	9.78	1.453	Rain.	Do. 8.	C'r. A.B. [11.30
21	30:268	30.237	30.300	36.6	56.6	44.0	178	287	231	86	62	76	N b W	W N W	W	Calm	0.50	2.77	...	Clear.	Clear.	Do. do. do.
22	30.291	30.273	30.210	38.1	63.6	46.7	236	366	306	91	63	91	W N W	W N W	W	Calm	Calm	5.75	...	Do.	Cum. Str. 4.	Do.
23	30.277	30.144	30·030	41.0	71.0	60.6	253	481	383	92	61	71	W	W N W	W N W	2.01	11.12	10.01	...	Do.	Do. 2.	Cir. Str. 4.
24	29.951	29 881	29.869	56.8	76.2	56.3	408	541	385	89	61	84	W N W	W N W	S E	6.93	4.06	2.50	...	Cum. Cir. Str. 4	Clear.	Clear.
25	.742	.729	.834	48.0	61.7	62.0	331	565	528	96	91	91	S E b E	W b N	W b N	1.14	0.72	3.03	0.266	Fog, Rn'd 10.25.	Cum. Str. 8.	Cum. Str. 5.
26	.852	.812	.865	59.1	74.2	62.5	501	588	528	99	70	91	W	W	W	Calm	5.27	1.06	...	Cir. Str. 4.	Do. 2.	Clear. Aur. Bor
27	.825	.701	.765	58.6	82.2	66.8	500	628	605	98	58	91	W S W	W	N W	0.31	6.02	7.65	0.233	Clear.	Clear.	Str. 2. Th. Sh.
28	.952	.958	30.063	53.1	62.1	49.8	337	315	290	81	56	80	N	N	N N W	4.28	2.63	4.33	...	Do.	Do.	Cir. Str. 1 [6pm.
29	30.288	30.274	30.373	42.9	51.1	41.2	225	326	186	79	76	78	N E b N	N E b N	N E b E	3.75	1.12	3.75	...	Do.	Do.	Clear.
30	30.300	30.211	30.171	29.2	61.0	45.4	161	362	235	89	69	74	N b W	N b W	S W	0.44	Calm	0.31	...	Do.	Do.	Cir. Cum. 4.

Barometer	Highest, the 29th day	30·373
	Lowest, the 19th day	29·526
	Monthly Mean	30·001
	" Range	·847
Thermometer.	Highest, the 5th day	93°·4
	Lowest, the 30th day	29°·2
	Monthly Mean	58°·01
	" Range	64°·2
	Mean Humidity	·781
Greatest Intensity of the Sun's Rays		118°·9

Amount of Evaporation. 3·41 inches.
Rain fell on 11 days, amounting to 6·167 inches, and was accompanied by thunder and lightning on 4 days. Raining 15 hours, 16 minutes.
Most prevalent Wind, W. Least prevalent Wind, S.
Most Windy Day, the 20th day; mean miles per hour, 11·08.
Least Windy Day, the 8th day; mean miles per hour, Inap.
Aurora Borealis visible on 8 nights. Might have been seen on 10 nights.
First frost on the 11th day.
Snow fell at Quebec on the 22nd day.
Electrical Apparatus out of order.