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ON THE EARLY DISCOVERIES OF THE FRENCH IN NORTH AMERICA.

BY JOHN LANGTON, M. A.,

VICE CHANCELLOR OF THE UNIVERSITY OF TORONTO.

Read before the Canadian Institute, February 14th, 1857.

I do not design in the present paper to enter into any detail respecting the whole of the discoveries of the French in North America, but in presenting to the Institute a collection of tracings from old French maps, more peculiarly relating to Western Canada, I propose to offer some remarks in illustration of them.

A very exaggerated impression has gone abroad as to the extent and accuracy of the knowledge possessed by the French of the country which they occupied, and I have more than once seen it asserted in the public prints, that they knew more of the interior than we do even now, excepting in those parts which have been actually surveyed and laid out for settlement. It is not always easy to trace the origin of such popularly received opinions, which are repeated till they become accepted, without inquiry, as acknowledged facts; but, in the present instance, the impression seems to have arisen from a series of maps, possessed by the Library of Parliament, which have been copied from those which are preserved in the various archives in France. To speak of these maps, however, as surveys, as I have heard them described, is to do them by no means justice. They make no pretensions to any such accuracy. The great majority of them, except some plans of towns and particular localities in Lower Canada, are rough delineations of the country, either from the personal observation of the explorers,

or from the description of others, giving the estimated distances and directions of rivers, lakes, and portages, which the travellers followed, with here and there an observation for latitude, which, when they are given, I have often found to be a degree or more in error. Still, most of them are interesting, as amongst the earliest records of our country, and there is no doubt that, in some sections of the Province particularly, some of them do give details, which appear no where in our published maps, and are not to be found in the records of the Crown Lands Office. This arises in a great measure from that tendency to centralization, which has always characterized the French nation. If any trader or missionary had penetrated into an unknown region, a description of it was sure, sooner or later, to find its way to the Intendant, and by him was transmitted to the Government at home; whilst with us, if an individual hunter or lumberer has obtained a detailed knowledge of a particular locality, he does not feel in any way bound to report it to Mr. Cauchon, and he would still less think of transmitting it to Downing-street. I have seen private charts in considerable detail, of the country between the Ottawa and Lake Huron, where our published maps present nothing but a blank; and I myself, nearly twenty years ago, made a map, from my own knowledge and the descriptions of hunters and others, of several chains of lakes, forming the head waters of the River Trent, which are still only partially laid down with any correctness, partly by Mr. Murray, of the Geological Survey, and partly from some exploratory lines run last year by order of the Crown Lands Department. All such rough plans have the same distinguishing feature, that the distances are very much exaggerated, especially the portages; for, when you have a heavy pack or a canoe on your shoulders, a mile assumes very formidable proportions. The same thing is observable in these French maps. The latest discovery generally is unnaturally enlarged, and though the easy observation for latitude keeps the distances from north to south within reasonable bounds, those from east to west, where there is no such check, attain very exaggerated proportions.

But it is not for the geographical information to be obtained from them, so much as for their historical interest, that I propose introducing these maps to the Institute. It must, however, be confessed that there is a great drawback to their value in this point of view, in the fact that some of them bear no date, nor is there any record accompanying them of the source from which they were obtained; but many of them possess internal evidence of their origin, and of the period to which they relate; and I have selected for copying, those which are of the most general interest, especially for us Upper Canadians, which I

will illustrate by a short sketch of the progress of French discoveries on this continent.

Although Jacques Cartier entered the St. Lawrence in the first half of the sixteenth century, it was not till the beginning of the seventeenth that any sustained effort was made towards a permanent occupation of the country. A few trading visits were made from time to time; but at the period of Champlain's first voyage, in 1603, it is doubtful whether there was any establishment even at Tadousac, where parties regularly wintered, and certainly there was nothing beyond. He proceeded up the river as far as the Sault St. Louis, now the La Chine Rapids, and having crossed the portage to obtain a view of the country beyond, he returned to France, and devoted the following years to exploring the Atlantic coast of Maine, Nova Scotia, New Brunswick and Gaspé. It was not till the year 1608 that he returned to the St. Lawrence, and built the first house at Quebec.

Champlain at once entered into friendly relations with the Indians inhabiting the northern shore of the St. Lawrence. The Montagnets, from Quebec downwards, and higher up the Algoumequins, as he designates them, who were afterwards called Algonquins, together with allied tribes of various names, from the Ottawa country, appear all to have belonged to the great Chippewa family, which still extends over nearly a quarter of the continent. He also fell in with parties of the Ochateguins, or Hurons, as they are subsequently called, their own name for themselves being Yendats, or Wyandots, according to the English pronunciation. It was this tribe apparently that Cartier had found in occupation of the island of Montreal, but their settlements were now exclusively on the great lake which the French called by their name, and they only came down to the St. Lawrence for the purposes of trade. They belonged to the same race as the Iroquois, though at that time at deadly enmity with them. With the Iroquois themselves, called by the English the Five Nations, who occupied the south bank of Lake Ontario and the upper St. Lawrence, no cordiality ever existed, to the end of the French rule in Canada.

The very next spring after his arrival, with two or three companions, Champlain joined the Algonquins and Hurons in an expedition against the Iroquois, and having proceeded up the river Richelieu to the lake which still bears his name, he defeated them near where Ticonderoga now stands. During these earlier years Champlain himself seems generally to have returned to France for the winter, but some of his party remained behind at Quebec, or at another station on the island of St. Croix, and one of them accompanied a party of Algonquins to the upper Ottawa, in exchange for an Indian, whom Champlain took with

him to France. Hearing from this man, on his return in the spring of 1612, that by the route of the Ottawa he could reach the North Sea, where the English had in the meantime discovered Hudson's Bay, he proceeded up the Ottawa, giving a very clear description of the rapids and portages, and the confluence of the Rideau, Madawaska, and other streams, and reached as far as the great Alumette Island, which was the seat of the principal Algonquin Chief in those parts. Finding, however, that he had been deceived as to the probability of reaching the North Sea, and the Indians being unwilling to accompany him farther, he once more returned to France, and spent three years there in trying to induce some of the leading nobility to take his infant colony under their patronage.

This is the period of the first maps which I have seen. They bear date 1603, 1607, and 1609; but the most extensive is that published in 1613, with the first account of Champlain's voyages. It is not amongst those which I have copied. It gives his discoveries on the Atlantic coast, on the lower St. Lawrence, and the Ottawa, and indicates the existence of a large lake, from which the St. Lawrence flows.

Immediately upon his return in 1615, he joined, with about a dozen companions in another expedition against the Iroquois, the details of which are more particularly interesting to us, not only because it gave rise to the most important of the early discoveries, but because it was the first introduction of civilized man into what is now Upper Canada. Seeing that the Iroquois were seated on the south bank of the St. Lawrence, and their chief villages were amongst those lakes and rivers south of Lake Ontario which still bear the English names for the different tribes, he took a very curious road to reach them. It must, however, be remembered, that his Indian allies had to return home to collect their forces. He ascended the Ottawa beyond the limit of his first journey, till he branched off into the chain of small lakes, which led him to the Lake of the Epicerini, or Nebicerini, as later writers call them, an Algonquin tribe, who were long celebrated for their power as sorcerers, and whose name we still preserve in that of Lake Nipissing. Descending the river which flows out of that lake, he reached the great lake of the Attagouantans, or the fresh water sea of the Hurons, which he tells us is three hundred leagues from east to west, and fifty leagues wide. Turning to the east, and coasting along the northern shore, he crossed a bay at the end of the lake (Matchedash Bay) to a fine country which was the home of the Hurons. Proceeding from village to village, the names of several of which he gives, all of them evidently situated on Matchedash Bay, and between that and Lake Simcoe, he arrived at the chief place of the tribe, which he calls Cahiagué, situated apparently

somewhere in Oro or Orillia. After remaining there for a while to collect their forces, the party carry over land for three leagues to a small lake, which is connected by a narrow place with a large one twenty-six leagues round, and crossing the large lake, which, of course, is Lake Simcoe, they make a portage of ten leagues (really about half that distance) to another lake, below which is a fall, and from whence flows a river, which, after a course of sixty-four leagues, falls into the great lake of the Entouhonerons. Champlain describes this river, the course of which they followed, as running through beautiful lakes and a fine country, formerly thickly inhabited and cultivated, but at the time of his visit entirely deserted on account of the wars. This mention of extensive cultivation amongst the Indians is somewhat foreign to our notions, but it must be remembered, that though the Algonquin tribes were a wandering race of hunters, the Hurons and Five Nation Indians are always described as cultivating the soil, and living in permanent villages; and it is one of the hardships complained of by the missionaries, that they could rarely get any meat, but lived principally upon sagamité, with occasionally some fish. Champlain says that on their route they had five portages, some of which were four or five leagues long, whereas the only long carrying place between Balsam Lake and the Bay of Quinte is that from Mud Lake to Peterborough, about seven miles. This makes me suspect that they did not follow the course of the main river, but, being desirous of concealment, kept in the back country, and carrying over into the lakes of Belmont and Marmora, re-entered the Trent by Crow River. However this may be, they reach the Lake of the Entouhonerons, cross its eastern extremity, out of which the St. Lawrence flows, and after coasting along for some distance, leave their canoes, and make a four-days journey through the woods, crossing on their way a river, which comes from a large lake, (evidently Oneida Lake,) and so reach the village of the Iroquois, which was their destination. Being repulsed, however, and Champlain himself wounded, they retreat to their canoes, re-cross the lake, and ascend a river for twelve leagues, which, after a portage, brings them to a large lake ten or twelve leagues in extent. The description accords very well with Rice Lake, but it conveys the impression that it was not the same route by which they descended, which strengthens my conjecture as to their former course, for I know of no other large lake they could have reached in this manner, Longborough Lake lying too far out of their course. Here they remained hunting till the frost enabled them to return home over the ice. During the winter Champlain visited some tribes farther south, one of which, the Tobacco-growers, seem to have been located about Guelph; and he had intended pushing on in the

spring to a great lake he heard of above, beyond which, he was told, the buffaloes were to be found, whose skins he saw among the Hurons; but dissensions breaking out amongst his Indian allies, he returned to Quebec by the way he came, and for the rest of his life devoted himself to the care of the colony on the lower St. Lawrence.

The oldest map in this collection will illustrate the geographical knowledge obtained by Champlain's great expedition. It bears date, indeed, twenty years later, but it contains hardly anything but what is to be found in Champlain's account. It is almost identical with the map accompanying his second publication, and is, indeed, evidently copied from it, even to the rectangular islands on Hudson's Bay, and some marks, which mean nothing as they stand here, but in the published map refer to descriptions in the body of the work. Some additions were doubtless made to their knowledge in the interval between the great expedition and the date of the publication of Champlain's journal in 1632, for the Jesuits and Recollets had established missions amongst the Huron villages; but if we may judge from Sagard's journal, in 1622 and '23, the accessions would not be very great, for, interesting as it is in other respects, the geographical details are so meagre that you can only make out that he went and returned by Lake Nipissing. As to the additions between Champlain's publication and the date of the map, they only amount to six names, which I have underscored in red ink, and I have added, instead of the bare names in other parts, numbers in red ink referring to Champlain's descriptions, of which I append a copy. So unlike the reality is this map, that at first sight one would hardly make out what it is intended to represent. Lake Huron assumes a shape as dissimilar from the truth as can well be conceived. An imaginary lake appears to the north of Lake Huron, near Sault Ste. Marie, which, as it bears the same name, probably records a misunderstood description of Lake Michigan; and Lake Erie disappears altogether, being replaced by a simple river. The latter lake was however known, as one of the missionaries to the Hurons had penetrated as far the year before the date of the map, a trace of which is found in the addition of the name *Lac des Eriés;* but the configuration given by Champlain remains unaltered, and there is nothing but a river, on which it is said there is a great fall, at which quantities of fish are carried over and stunned.

The small accession of knowledge between 1614 and 1643 is of itself negative evidence of what we know from other sources, the pause in the course of discovery which took place after Champlain's expedition. Times, indeed, were approaching which were not favor-

able to discovery. In 1629 the English took Quebec, and held the colony for some years—no great feat of valour certainly, as there were no settlements except at Quebec and Tadousac, and a missionary station at Three Rivers; and in 1622, according to Charlevoix, there were only fifty souls at Quebec, including women and children. Almost immediately after Canada had been restored to France, the Iroquois wars commenced, which for many years confined the French to the lower St. Lawrence, and ended in the almost entire extermination of their Indian allies. The missionaries, it is true, adhered nobly to their converts, and in many instances perished with them; and when the remnants retired into the Far West and the Far North, they accompanied them, and so gained some acquaintance with more remote regions; but no discovery of importance is recorded. It was not till a temporary peace was made in 1669 that the adventurous spirit of the French settlers had room to display itself, and that they penetrated into the country occupied by the Iroquois.

The second map, in point of time, belongs to this period. It bears date 1670, and records the journey of two missionaries, Dolier and Galliné, who appear to have been the first, or amongst the first, who reached Lake Huron by the route of Lakes Ontario and Erie. I have found no other account of their travels, nor are their names mentioned by Charlevoix, any more than that of M. Perray, who appears to have made a portage from somewhere near Toronto to Lake Simcoe, unless he be the M. Perrot who, about the same time, was employed in negotiating with the western tribes. A letter of the Intendant, Talon, is referred to, which may probably be amongst our MS collection—detained at Quebec upon the somewhat far-fetched excuse, that it may be wanted to elucidate some knotty point connected with the Seignorial Tenure. The missionaries appear to have been very conscientious observers, distinguishing between what they have seen themselves and what they know only by report, and for gentlemen of their sacred calling, they take an unusual interest in all that pertains to the chase. There are two noticeable features about this map. The indefinite extension of Lake Erie westward, to be found in all the maps of this period, where Hennepin, nearly twenty years later, says no one had yet penetrated, for which this sufficient reason may be given, that no such extension exists in nature; and the singular delineation of Lake Huron, where the eastern shores are not very incorrectly given, nor the western shores of Lake Michigan, but there is an entire ignoring of the great peninsula of Michigan. This is the more sur-

prising, as they appear to have penetrated beyond the Straits of Mackinaw, and one can hardly account for their knowing nothing of the opposite shore.

From this period the progress of discovery was rapid. Perrot was very successful in his negotiations with the tribes round Lake Michigan, who, at a great gathering at Mackinaw, acknowledged the supremacy of France; and the new Governor, Count Frontenac, built the fort which long bore his name, where Kingston now stands. This was the first step which curbed the power of the Iroquois, and afforded any security to the French trade on Ontario. Other forts were soon after built at Niagara, Detroit, and on Lake Huron, which rendered French influence predominant over all the great Lakes. Important discoveries followed each other rapidly. Joliet and Marquette ascended the Outagami from Green Bay on Lake Michigan, and carrying across to the Wisconsin River, followed it down to the Mississippi, which they descended as far as the confluence of the Arkansas, when being satisfied that it flowed into the Gulf of Mexico, they returned by the way of Illinois River to the extremity of Lake Michigan. The latter route was soon after pursued by La Salle with larger means, the Mississippi was followed to its mouth, and a colony founded there.

I have copied Joliet's own map, and his letter to Frontenac giving a brief description of the newly discovered countries.* Father Marquette published a short account of their journey, with a very indifferent map, but this is the only record from Joliet himself, and he gives a pathetic relation of its conclusion; how after escaping all the dangers of a difficult and unknown navigation, amidst hostile Indians, his canoe was upset in sight of the house from which he started, two of his party, his journal and all his baggage were lost, and he brought home nothing but his life.† The inscription in red ink is apparently of a later date,

* Accurate tracings of this and the other maps referred to, in illustration of the paper, have been deposited by the author in the Library of the Canadian Institute.

† The following letter of Joliet to Frontenac, copied from the above map, is interesting as the sole memorial he has left of his expedition:—

Monseigneur le Comte de Frontenac, Conseiller du Roy en ses Conseils, Gouverneur et Lieutenant-general pour sa Majesté en Canada, Acadie, Isle de Terreneuve et autres pays de la France septentrionale.

Monseigneur,—C'est avec bien de la joye que j'ay le bonheur aujourd-hui de vous presente cette carte, qui vous ferra connoitre la situation des rivières et des lacs sur lesquels on navigue au travers du Canada ou Amerique septentionale, qui a plus de 1200 lieus de l'est à l'ouest. Cette grande rivière, qui porte le nom the Rivière Colbert, pour avoir esté decouverte ces derniers années 1673 and 167 4, par les premiers ordres que vous me donnates entrant dans votre gouvernement de la Nouvelle France, passe au-dela des Lacs Hurons et Illinois, entre la Floride et le Mexique, et pour se decharger dans la mer coupe le plus beau pays qui se puisse voir sur la Terre. Je n'ay rien veu de plus beau dans la France que la quantité de prairies que j'y ay admirés tous les jours, ny rien d'agréable comme la diversité des bocage et des forets, ou se ceuillent des prunes, des pommes, des grenades, des citrons, des meures,

although the account of the river by which you may go to California, may have been subsequently added by Joliet himself. But the lower inscription is clearly an error, for La Salle did not reach the Mississippi by the Ohio, as there stated, but by the Illinois.

La Salle's expedition is better known perhaps than any of the former ones, from Father Hennepin's journal. I find amongst the collection of maps many relating to the Mississippi, and also several to the North-western waters running into Lake Winnepeg; but I have confined myself more especially to Canada and shall not pursue the subject any further. I have added, however, two maps relating to this period. One, bearing the date 1688, is very rude, but it is interesting as shewing the principal settlements of the Iroquois south of Lake Ontario, which appears to have been the main object in view. The other has no date, but was evidently made a little earlier. It is clearly after 1678, as Fort Frontenac is set down, and it gives the portages by which Joliet reached, and returned from, the great River Colbert, as he calls it; but it cannot be of much later date, as it gives the Indian name of the Salmon River, at the south-east extremity of Lake Ontario, which after the sufferings of De LaBarre's expedition in 1683 was always called la Famine, and it makes no mention of Fort Niagara, which was built in 1685. It is a well executed map upon the whole, and interesting from the full detail which it gives of the habitats of the various Indian tribes. It is melancholy to look over it, and compare it with the earliest map in this collection, which is anterior to it by only about 40 years. The Iroquois wars had told their tale in the

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et plusieurs petits fruits qui ne sont point en Europe. Dans les champs on fait lever des cailles, dans les bois on voit voler les perroquets, dans les rivières on prend des poissons qui nous sont inconnus pour leur goust, figure et grosseur.

Les mines de fer, les pierres sanguines qui ne s'amassent jamais que parmy le cuivre rouge n'y sont pas rares; non plus que l'ardoise, le salpetre, les marbres, et moulanges et charbon de terre: pour le cuivre le plus grand morceau que j'ay veu estoit comme le poing, et tres purifié, il fut decouvert auprès des pierres sanguines qui sont beaucoup meilleurs que celles de France et en quantité. Tous les sauvages ont des canots de bois de 50 pieds le long; pour nourriture ils ne font pas d'etal de cerfs, ils tuent des bufles qui marchent par bandes de 30 et 50, meme j'en ay compté jusques à 400 sur le bord de la rivière, et les coqs d'inde y sont si communs qu'or n'en fait pas grand cas. Ils font des bleds d'inde la plus part trois fois l'année, et tous des melons d'eau pour se rafraichir pendant les chaleurs, qui n'y p mettent point de glaces et fort peu de neiges. On auroit veu la description de tout dans mon journal si le bonheur qui m'avait toujours accompagné dans ce voyage ne m'eut manqué un quart d'heure devant que d'arriver au lieu d'ou j'estois partv. J'avois évité tous les dangers des sauvages, j'avois passé 42 rapides et j'estois prest de debarquer avec toute la joye qu'on pouvoit avoir du succés d'une si longue et si difficile entreprise lorsque mon canot tourna hors des dangers, j'y perdis 2 hommes et ma cassette à la veue des premieres habitations françois que j'avois quittées il y avoit presque 2 ans, il ne me reste que la vie et la volonté pour l'employer à tout ce qui il vous plaira avec toute la joye possible.

Monseigneur,

Vostre très humble et très obeissant serviteur,

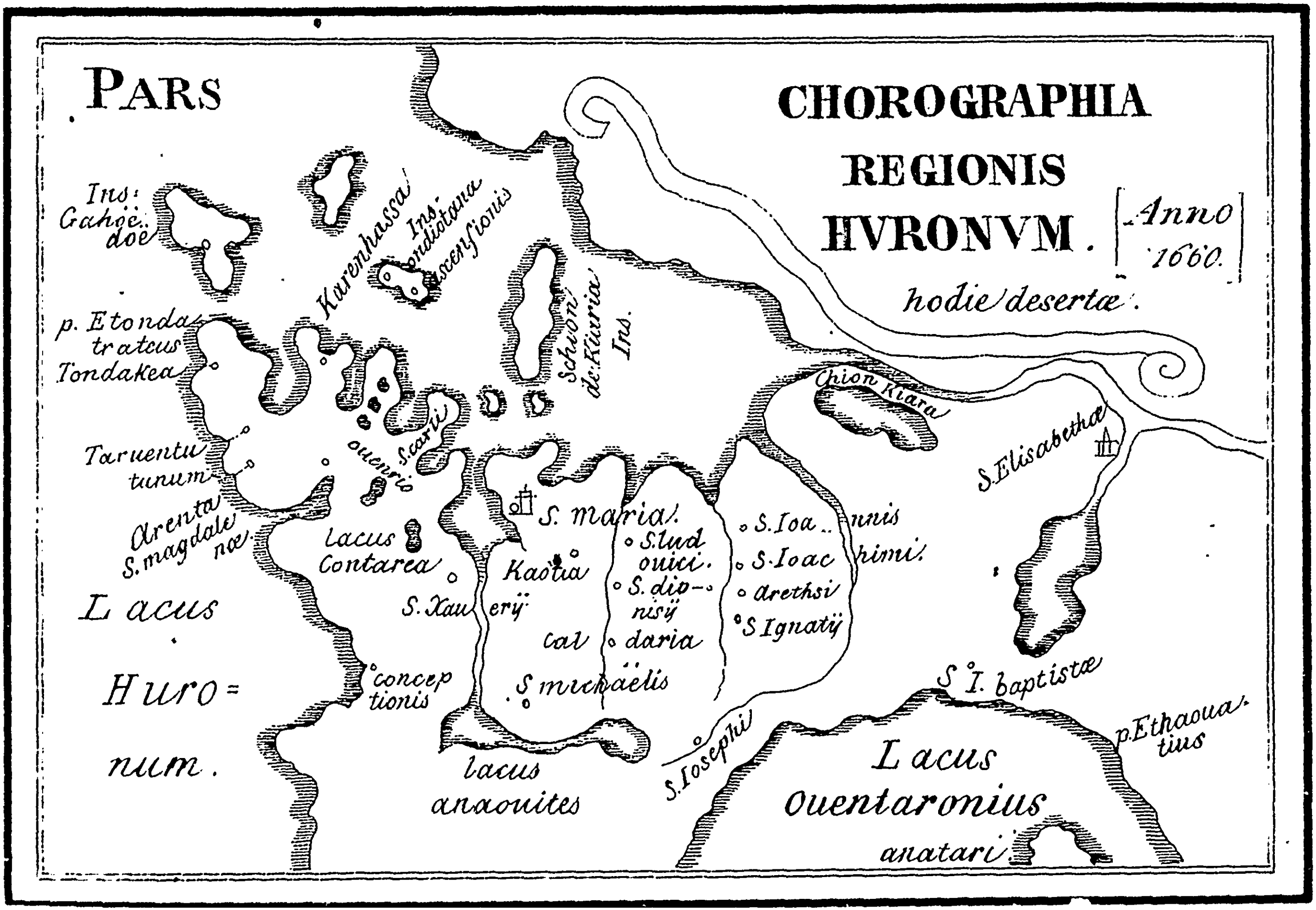
JOLIET.

mean time, and where Champlain indicates populous tribes we find here only Hurons, Eries, &c., "nation detruite."

The last map relating to Upper Canada is not copied from any old map, but represents Lake Ontario as it is, with the various names which are given in different maps and descriptions to localities on its shores, and I have added to it a somewhat enlarged copy of Creuxius' topography of the Huron villages near Lake Simcoe.* There is considerable confusion in these different names. One name which is variously written as Tejajagon, Teyogagon, Terraiagon, &c., is generally placed in the neighbourhood of Toronto, but Hennepin gives a similar name to a place 17 leagues above Kingston, and one of the maps to a place on Burlington Bay. Another place called Ganaraské is apparently Port Hope, but Lahontan gives that name to Burlington Bay also. As for the names given in Creuxius's map, bearing date 1660, either to places on our shore of Lake Ontario, or to the Huron villages round Lake Simcoe, I have hardly been able to identify one of them with any name which appears elsewhere. The carrying place to Lake Simcoe does not appear to have been at Toronto, but at some place considerably to the east of it, at the Rouge perhaps, and its name with various modifications of spelling, may be called Ganatchikiagon. As for the name Toronto, in the earlier maps it is always given to Lake Simcoe, and in the Huron language seems to have meant *much* or *multitude*, but Creuxius calls Lake Simcoe Lacus Ouentaronius. I do not find Toronto applied to its present locality till a map, which illustrates the campaign which ended in Braddocks defeat in 1755, when there appears to have been a French Fort here.

The remaining map belongs to Lower Canada exclusively, and to a portion of it which, being under lease to the Hudson's Bay Company at the munificent rent of £50 a year, is hardly at all known at present. It bears date 1735, and professes to be the first map that ever was made of that region, which was the Crown domain. It is compiled by a Jesuit living at Chicoutimi, and if it is not more accurate at a distance than it is within 30 or 40 miles from his own door, the great detail into which it enters cannot be much relied upon. It is, however, a curious map, with a very flowery dedication to the Dauphin,

*The accompanying map, engraved for the Journal from the original in Father Ducreux's *Historia Canadensis*, Paris 1664, represents the region around Lake Simcoe as laid down in 1660. Unfortunately the *narrows* which form the junction between Lake Simcoe and the little Lake Couchiching have been omitted, probably through the carelessness of the engraver, but in other respects the outlines are surprizingly accurate. The Indian names, however appear to be hopelessly corrupt and their Latin dress adds to the difficulty of identifying them. Lacus Ouentaronius may perhaps be read Ouen-tarontus in accordance with the name elsewhere assigned to Lake Simcoe.


PARS
CHOROGRAPHIA
REGIONIS
HVRONVM.
Anno 1660.
hodie desertæ.
Ins: Gahoë doë
Karenhassa
Ins. ondiotana
ascensionis
Schion de Kiaria Ins.
p. Etonda tratcus
Tondakea
Taruentu tunum
Arenta S. magdalenæ
ouenrio
S. carii
lacus Contarea
Lacus Huro=num.
Chion Kiara
S. Elisabethæ
S. maria
Kaotia
S. Xaueriy
S. Ludouici
S. dionisiy
S. Ioannis
S. Ioachimi
Arethsi
S Ignatiy
cal
daria
S. michaëlis
concep tionis
lacus anaouites
S. Iosephi
S. I. baptistæ
p. Ethaouatius
Lacus Ouentaronius
anatari

and a Latin inscription, which I submit as a puzzle to any members of the Institute, who are curious in such things.*

There are not so many details of the discoveries in this direction, and they are not of as interesting a character. Although Tadousac was so long the most important station in Canada, it was not till 1647 that the French reached Lake St. John. In 1663 they had penetrated as far as Hudson's Bay. Tadousac was the principal site of the Indian trade, long after Quebec had become the capital of the colony, and some of the oldest missionary settlements are or the Saguenay. In Champlain's time, the island of Montreal seems almost to have vied with it as a trading place for the Indians, who followed the route of the Ottawa, and Champlain himself built a house near where the Victoria Bridge crosses, though the trading rendezvous seems to have been at the back of the island, on the Riviere des Prairies. But the Iroquois wars must have rendered such a station too insecure, as no town or fort was built there till 1641, and the Indians even from Lake Huron used to ascend the streams, which fall into the Ottawa from the North, and after a portage, used to descend the St. Maurice to Three Rivers, or the Saguenay to Tadousac. Even as late as 1670, Charlevoix tells us that there were rarely less than 1200 Indians to be seen encamped at Tadousac during the trading season; but the ravages of the small-pox amongst the Northern tribes about that period, put an end to the trade of Tadousac and Three Rivers. Some nations were no more heard of. They were exterminated, amalgamated with other tribes, or carried their furs to the English fort on Hudson's Bay. Montreal, which was now rising into importance, became the chief seat of the trade, and Tadousac was deserted.

In tracing the history of these discoveries, one cannot but be struck with the extraordinary rapidity with which the French spread themselves over the continent, as compared with the progress of the English. The commencement of the colony may date from the foundation of Quebec by Champlain in 1608, one year after the permanent establishment of the English at Jamestown, and one year before the discovery of the Hudson River, and twelve years before the landing of the Pilgrim Fathers at Plymouth. The colonies therefore commenced nearly on equal terms, yet within 8 years the French had reached Lake Huron, whilst it was nearly a century before the English had extended to any considerable distance from the sea coast. The Iroquois wars now broke out, which for many years confined the French almost entirely to the Lower St. Lawrence, but no sooner were they brought to

* His in quam supersedimus in hoc 4ta editione ne doctiores veniant Romani et tollant nostram gentem propinante ad nauseam Baccho.

a close, or rather succeeded by a hollow truce, than the tide of discovery, which had been pent up, spread over the whole continent, and in a very few years extended to the North Sea, the Gulf of Mexico, and almost to the Rocky Mountains. Much of this difference must no doubt be ascribed to the facilities afforded by our immense chain of Lakes and Rivers, and to the character of the Indians with whom the French were brought into contact, for they never made any progress in the direction of the warlike Iroquois. Something may also be due to the missionary spirit of the Jesuits and Recollets, who penetrated in spite of dangers and privations to every tribe where there was a chance of propagating the faith, and something to the ambition of their home government, which prompted to the acquisition of new territory, whilst the British colonies were left very much to themselves. But much is still to be attributed to the national character of the settlers. The Englishman, grave and earnest, settled himself at once on his farm, and devoted any leisure he could spare to framing laws for the government of the society which surrounded him, and to enforcing them with the stringency of a man, who having strong convictions himself, is very intolerant of any body who deviates from his notion of right. He was essentially a member of a community, and rarely pushed beyond reach of his neighbours, until lack of space compelled the hive to give off a swarm. The Frenchman on the contrary, with characteristic impetuosity, leaving the cares of state to the Governor or Intendant, and questions of religion to his priest, plunged at once into the excitement and adventure which, in spite of its hardships, give such an irresistable charm to a half savage life. We find constant endeavours to check this tendency of the population to wander, and edicts which forbid the colonists, even on pain of death, to pursue their hunting excursions for more than a league beyond the settlements. But nature is stronger than laws, and the *coureurs des bois* were to be found everywhere, and often no doubt where no record of their adventures has been preserved. Only six years after Champlain's expedition, at the time when Quebec could only count fifty inhabitants, we find Sagard, whilst a missionary amongst the Hurons on Lake Simcoe, saying, that the only meat he had tasted for six months was given him by a party of French hunters. If the Celt has marked his progress on this continent by that dash and *elan* which characterizes him as a soldier, but cannot always resist long continued obstacles, the Anglo-Saxon has equally exhibited the invincible tenacity, which enables him to advance step by step in spite of difficulties, and keep what he gains.

One other remark has been suggested by these enquiries, viz., the extraordinary mutability of nations in the savage state, and the rapidity

with which one race supplants another over large areas. When Cartier arrived in the St. Lawrence he described large and permanent Indian villages at Stadacona and Hochelaga; but little more than half a century afterwards, when Champlain visited the same localities, he apparently found few Indians about Quebec, and none permanently settled at Montreal. There may have been some exaggeration in Cartier's account, but the main fact remains, and it may probably be accounted for by the increasing power of the Iroquois, which made those places dangerous abodes, and compelled the tribes, which formerly occupied them, to retreat into the interior. Again, the country north of Lake Ontario is described by Champlain as affording signs of having been formerly extensively cultivated and thickly inhabited, but in his day it was entirely deserted, and only used as a hunting ground by the neighbouring tribes. But the country of the Ottawa, and across to the Northern shore of Lake Huron, as also the Western Peninsula, is described as full of Hurons, and of Algonquin, Ottawa, Nipissing and other allied tribes. Amongst the Hurons alone, in the limited area between Matchedash Bay and Lake Simcoe, he reckons 18 walled villages, numbering 2,000 fighting men, and Sagard puts the whole population down at 30 or 40,000 souls.* Yet, within 30 years from that time this region was also a desert, and the remnants of the former inhabitants had retreated to the Northern Lakes, and as far west as the Sioux. The Hurons indeed were almost exterminated, and the paltry remnant which had not been either destroyed or incorporated with other tribes, were collected and brought down to Quebec, where their descendants still occupy the village of Lorette. All the tribes of the Western Peninsula, and the Eries on the South shore of that Lake, seem also to have been utterly exterminated, as well as the greater part of the Illinois, and other Western tribes, and the Iroquois were dominant over all Upper Canada, and all the northern part of New York and Ohio. All this occurred without the intervention of the white man, and there has been no disappearance of a savage race since from the diseases and vices which civilization brings in its train, which has surpassed, even if it has equalled in completeness and rapidity, the desolation which the conquering

* It would not appear that this estimate can have been very greatly exaggerated, from the account given of the missionary establishments. They numbered in their most flourishing period, about 1645, 42 missionaries besides their attendants. Of these two or three only remained at the principal station of Ste. Marie, at the mouth of the Wye, five other villages were called residences, where one or two missionaries remained permanently, and the rest moved from village to village often having as many as 10 under their charge. As several of these villages are mentioned as containing from 100 to 200 cabins, and 4 or 5 families residing in each, the whole population cannot have fallen far short of 30,000.

Iroquois spread around them. They too have now nearly vanished from the scene of their former power under other influences, and may soon, like the Eries and Hurons, be remembered only by a name; but when we find such extraordinary vicissitudes occurring during the brief space, of which we have any certain record, we cease to be so much surprized at the total disappearance of the Mound Builders and other prehistoric races.

SUPPOSED PREVALENCE OF ONE CRANIAL TYPE THROUGHOUT THE AMERICAN ABORIGINES.

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Among the various grounds on which Columbus founded his belief in the existence of an undiscovered continent beyond the Atlantic, especial importance was attached to the fact that the bodies of two dead men had been cast ashore on the island of Flores, differing essentially in features and physical characteristics from any known race. When at length the great discoverer of this Western world had set his foot on the islands first visited by him, the peculiarities which marked the gentle and friendly race of Guanahanè were noted with curious minuteness; and their "tawny or copper-hue," their straight, coarse, black hair, strange features, and well-develloped forms, were all recorded as objects of interest, by the Spaniards. On their return the little caravel of Columbus was freighted not only with gold and other coveted products of the new world, but with nine of its natives, brought from the Islands of San Salvador and Hispaniola,—eight of whom survived to gaze on the strange civilization of ancient Spain, and to be themselves objects of scarcely less astonishment than if they had come from another planet. Six of these representatives of the western continent, who accompanied Columbus to Barcelona, where the Spanish Court then was, were baptised with the utmost state and ceremony, as the first fruits offered to heaven from the new found world. Ferdinand and the enthusiastic and susceptible Isabella, with the Prince Juan, stood sponsors for them at the font; and when, soon after, one of them, who had been retained

in the Prince's household, died, no doubt as to their common humanity marred the pious belief, that he was the first of his nation to enter heaven.

Such was the earliest knowledge acquired by the old world of the singular type of humanity generically designated as the Red Indian; and the attention which its peculiarities excited when thus displayed in their fresh novelty has not yet exhausted itself, after an interval of upwards of three centuries and a half. That certain special characteristics in complexion, hair, form and features, do pertain to the whole race of this continent is not to be disputed; and these prevalent characteristics were so generally noted, to the exclusion of all others, that Ulloa, and after him others of the Spanish explorers of the new world remarked: *He who has seen one tribe of Indians, has seen all.* In the sense in which this remark was first made, and by Spaniards, who knew only of Central America and the tropical region of the Southern continent, there was nothing in it to challange. But that which was originally the mere rude generalization of a traveller, has been adopted in our own day as a dogma of science; and the universality of certain homogeneous characteristics of the aboriginal tribes and nations of America, with the exception of the Esquimaux, is assumed as an established postulate for the strictest purposes of scientific induction, and has been repeatedly affirmed in the very words of the Spaniard.

Such authorities as Robertson the historian, and Malte Brun, may be classed along with the first Spanish observers, in the value to be attached to their sweeping generalizations. "The Esquimaux," says the former, "are manifestly a race of men distinct from all the nations of the American continent, in language, in disposition, and in habits of life. But among all the other inhabitants of America there is such a striking similitude in the form of their bodies, and the qualities of their minds, that, notwithstanding the diversities occasioned by the influence of climate, or unequal progress of improvement, we must pronounce them to be descended from one source."* Malte Brun, with more caution, simply affirms, as the result of a long course of physiological observations, that "the Americans, whatever their origin may be, constitute at the present day a race essentially different from the rest of mankind."† But greater importance is to to be attached to the precisely defined views of Humboldt, in so far as these are not—like those of so many other writers on this subject,

* Robertson's America, B. IV. In relation to languages, this difference between the Esquimaux and the Indians is no longer maintained.

† Malte Brun, Geog. Lib. XXV.

—a mere reproduction of the opinions of Morton. Humboldt remarks in the preface to his *Researches*: "the nations of America, except those which border the polar circle, form a single race, *characterized by the formation of the skull, the colour of the skin, the extreme thinness of the beard, and the straight glossy hair.*"

Very few and partial exceptions can be quoted to the general unanimity of American writers,—some of them justly regarded as authorities in ethnology,—in reference to this view of the nations of the whole American continent, north and south. With the solitary exception of the Esquimaux, they are affirmed to constitute one nearly homogeneous race, varying within very narrow limits from the prevailing type, and agreeing in so many essentially distinctive features, as to prove them a well defined variety, if not a distinct species of the Genus Homo. Prichard, Lawrence, Wiseman, Knox, Squier, Gliddon, Nott, and Meigs, might each be quoted in confirmation of this opinion, and especially of the prevailing uniformity of certain strongly marked cranial characteristics: but the fountain head of all such opinions and views is the justly distinguished author of the *Crania Americana*, Dr. Morton, of Philadelphia. His views underwent considerable modification on some points relating to the singular cranial conformation observable in certain skulls found in ancient American graves; especially in reference to the influence of artificial means in perpetuating changes of form essentially different from the normal type; but the tendencies of his matured opinions all went to confirm his original idea of universal approximation to one cranial type throughout the New World. In some of his latest recorded views he remarks, as the result of his examination of a greatly extended series of Peruvian crania:—"I, at first, found it difficult to conceive that the original rounded skull of the Indian could be changed into this fantastic form; and was led to suppose that the latter was an artificial elongation of a head remarkable for its length and narrowness. I even supposed that the long-headed Peruvians were a more ancient people than the Inca tribes, and distinguished from them by their cranial configuration. In this opinion I was mistaken. Abundant means of observation and comparison have since convinced me that *all these variously formed heads were originally of the same rounded shape.*"

Such are the latest views of Dr. Morton, as set forth in the posthumous paper on *The physical type of the American Indians*, contributed by him to the second volume of Dr. Schoolcraft's "History of the Indian Tribes," and edited for that work by his friend and fellow labourer, John S. Phillips. In that same final contribution to

his favourite science, Dr. Morton's matured views on the cranial type of the American continent—based on the additional evidence accumulated by him, in the interval of twelve years which elapsed between the publication of the *Crania Americana* and the death of its author,—are thus defined: "the Indian skull is of a decidedly rounded form. The occipital portion is flattened in the upward direction, and the transverse diameter, as measured between the parietal bones, is remarkably wide, and *often exceeds the longitudinal line.** The forehead is low and receding, and rarely arched as in the other races; a feature that is regarded by Humboldt, Lund, and other naturalists, as a characteristic of the American race, and serving to distinguish it from the Mongolian. The cheek-bones are high, but not much expanded; the maxillary region is salient and ponderous, with teeth of a corresponding size, and singularly free from decay. The orbits are large and squared, the nasal orifice wide, and the bones that protect it arched and expanded. The lower jaw is massive and wide between the condyles; but, notwithstanding the prominent position of the face, the teeth are for the most part vertical."† The views thus set forth by him who has been justly designated: "the founder of the American School of Ethnology,"‡ have been maintained and strengthened by his successors; and scarcely any point in relation to Ethnographic types is more generally accepted as a recognised postulate than the approximative homogeneous cranial characteristics of the whole American race. A distinction, indeed is made by Morton, and to some extent recognised by his successors, between the *barbarous*, or *American*, and the *civilized*, or *Toltecan* tribes of the continent; but the distinction, according to their own view, is arbitrary, and appears alike indefinite and unsatisfactory; unless an essential difference of race, corresponding to that which is held to separate the Esquimaux from the true *Autocthones* of America, is acknowledged to exist, whereas this is expressly denied. One of the three propositions with which Dr. Morton sums up the results borne out by the evidence advanced in his *Crania Americana* is: "That the American nations, excepting the polar tribes, are of one race and one species, but of two great families, which resemble each other in physical, but

* *In this statement Dr. Morton would seem to have had in view his theoretical type, rather* than the results of his own careful observations, unless he accepted as evidence the artificially abreviated and flattened skulls, and even of these his *Crania Americana* furnishes only one exceptional example, from a mound on the Alabama River, (pl. LIV.) "It is flattened on the occiput and os frontis in such manner as to give the whole head a sugar-loaf or conical form, *whence also its great lateral diameter, and its narrowness from back to front.*"

† Physical type of the American Indians. Schoolcraft's His., &c., II. p. 316.

‡ Types of Mankind. p. 87.

differ in intellectual character."* Any further difficulty, arising from physical differences, is sought to be overcome by the application of the hypothesis that "these races originated in *nations*, and not in a single pair; thus forming proximate but not identical species."† But it is not fairly grappled with by any of the writers of "the American School of Ethnology." The closest approximation to a recognition of the legitimate deduction from such contrasting cranial characteristics is made by Dr. Morton himself, where he remarks in reference to the larger cerebral capacity of the Indian in his savage state, than of the demi-civilized Peruvian or ancient Mexican: "Something may be attributed to a primitive difference of stock; but more, perhaps, to the contrasted activity of the two races." It is to be noted, moreover, that Dr. Morton distinctly recognises certain unmistakeable diversities of form into which the assumed American cranial type is subdivided. He thus remarks, in his *Crania Americana*, under the head: *General observations on the barbarous nations composing the American family*:—"After examining a great number of skulls, I find that the nations east of the Alleghany Mountains, together with the cognate tribes, have the head more elongated than any other Americans. This remark applies especially to the great Lenapé stock, the Iroquois, and the Cherokees. To the west of the Mississippi we again meet with the elongated head in the Mandans, Ricaras, Assinaboins and some other tribes." But to this, Dr. Morton superadds the further remark: "Yet even in these instances the *characteristic truncature of the occiput* is more or less obvious, while many nations east of the Rocky Mountains have the rounded head so characteristic of the race, as the Osages, Ottoes, Missouris, Dacotas, and numerous others. The same conformation is common in Florida; but some of these nations are evidently of the Toltecan family, as both their characteristics and traditions testify. The head of the Charibs, as well of the Antilles as of Terra Firma, are also naturally rounded; and we trace this character as far as we have had opportunity for examination through the nations east of the Andes, the Patagonians and the tribes of Chili. In fact, the flatness of the occipital portion of the cranium will probably be found to characterise a greater or less number of individuals in every existing tribe from Terra del Fuego to the Canadas. If their skulls be viewed from behind, we observe the occipital outline to be moderately curved outward, wide at the occipital protuberances, and full

* Crania Americana. p. 260.
† Types of Mankind. p. 276.
‡ Crania Americana. p. 65.

from those points to the opening of the ear. From the parietal protuberances there is a slightly curved slope to the vertex, producing a conical, or rather a wedge-shaped outline." These opinions are still more strongly advanced in Dr. Morton's most matured views, where he ascribes the same characteristics to the Fuegian, the Indian, the tribes to the west of the Rocky Mountains, and those which skirt the Esquimaux on the north. "All possess alike the long, lank, black hair, the brown or cinamon-coloured skin, the heavy brow, the dull and sleepy eye, the full and compressed lips, and the salient but dilated nose. The same conformity of organization is not less obvious in the osteological structure of these people, as seen in the square or rounded head, the flattened or vertical occiput, the large quadrangular orbits, and the low receding forehead;" and he goes on to reiterate the opinion that, in spite of any "mere exceptions to a general rule," the Indian of every variety "is an Indian still, and cannot be mistaken for a being of any other race." Still more, in the same final embodiment of his matured opininions, Dr. Morton affirms the American race to be *essentially separate and peculiar*, and with no obvious links, such as he could discern, between them and the people of the old world, but *a race distinct from all others.*

It is obvious that the tendency of Dr. Morton's views, as based on the results of his extended observations, was to regard the most marked distinctions in American crania, as mere variations within narrow limits, embraced by the common and peculiar type, which he recognised as characteristic of the whole continent, both north and south. In this opinion his successors have not only concurred, but they even attach less importance to the variations noted by his careful eye. Dr. Nott, for example, remarks on the peculiarities of the very remarkable brachycephalic skull taken from a mound in the Scioto valley, and figured the natural size in Messrs. Squier & Davis's *Ancient Monuments of the Mississippi Valley*:* "Identical characters pervade all the American race, ancient and modern, over the whole continent. We have compared many heads of living tribes, Cherokees, Choctaws, Mexicans, &c., as well as crania from mounds of all ages, and the same general organism characterizes each one."†

One more authority may be quoted to show that the conclusions thus early adopted by Dr. Morton, and maintained and confirmed by his subsequent writings, are still regarded as among the best established and most indisputable summaries deduced from well ascertained data of American Ethnology. Dr. J. Aitken Meigs, the edi-

* Smithsonian Contributions to Knowledge. vol. I. pl. 47.
† Types of Mankind. p. 291.

tor of Dr. Morton's "Catalogue of Skulls," subsequent to the transference of his greatly augmented collection to the Academy of Natural Sciences of Philadelphia, remarks, in his *Cranial Characteristics of the Races of Men:* "Through *Crania Americana*, it has long been known to the scientific world that a remarkable sameness of osteological character pervades all the American tribes from Hudson's Bay to Terra del Fuego. It is equally well known that the researches of Humboldt and Gallatin have demonstrated a conformity not less remarkable in the language and artistic tendencies of these numerous and widely scattered aborigines."*

Such, then, is the opinion honestly arrived at by Dr. Morton, as the result of extensive study and observation, accepted and confirmed by his successors, and now made the starting point from whence to advance to still more comprehensive and far-reaching conclusions. It is not necessary, therefore, to prove the universal recognition of this well known Ethnological postulate by further references to recent authorities; but there is one author, at once so distinguished among American men of science, and so peculiar from the point of view from whence he has regarded the entire question of American Ethnology, as to merit special attention. Professor Agassiz, in his *Sketch of the Natural Provinces of the Animal World, and their relation to the different Types of Man*, re-affirms the homogeneous characteristics and ethnic insulation of the American Indian on entirely novel and independent grounds. After defining the evidence on which the general opinion is based, that *the boundaries within which the different natural combinations of animals are circumscribed on the surface of the earth coincide with the natural range of distinct types of man*, he proceeds to show that America, including both its northern and southern continent, differs essentially from Europe and Asia, or Africa, in being characterised throughout by a much greater uniformity in all its natural productions, than anything which comparison enables us to trace in the old world. He then adds: "With these facts before us, we may expect that there should be no great diversity among the tribes of man inhabiting this continent; and indeed the most extensive investigation of their peculiarities, has led Dr. Morton to consider them as constituting but a single race, from the confines of the Esquimaux down to the southernmost extremity of the continent. But, at the same time, it should be remembered that, in accordance with the zoological character of the whole realm, this race is divided into an infinite

* Indigenous Races of Men, p, 332.

number of small tribes, presenting more or less difference one from another."

The latest views of Agassiz, as set forth in his contribution to the *Indigenous Races of the Earth*, present us with the same opinions, advanced with additional confirmation from other data. Passing from the general zoological analogies in the distribution of species, to the special one of the monkey, he *remarks on* the diversity of opinions among men of science as to the genus *Cebus*, which some Zoologists recognise as one species, others separate into two or three, while others again subdivide it into as many as ten :—"Here we have, with reference to one genus of monkeys, the same diversity of opinion as exists among Naturalists respecting the races of man. But in this case, the question assumes a peculiar interest, from the circumstance that the genus *Cebus* is exclusively American ; for that discloses the same indefinite limitation between its species which we observe also among the tribes of Indians, or the same tendency to splitting into minor groups, running really one into the other, notwithstanding some few marked differences,—in the same manner as Morton has shown that all the Indians constitute but one race, from one end of the continent to the other. . . . . In the Old World, notwithstanding the recurrence of similar phenomena, the range of variation of species seems less extensive, and the range of their geographical distribution more limited. In accordance with this general character of the animal kingdom, we find likewise that, among men, with the exception of the Arctic Esquimaux, there is only one single race of men extending over the whole range of North and South America, but dividing into innumerable tribes ; whilst, in the Old World there are a great many well-defined and easily distinguished races, which are circumscribed within comparatively much narrower boundaries." To this may be added Mr. Gliddon's summary of the views advanced by him, in carrying out the suggestive idea of Agassiz, in the *Monogenists and Polygenists* of the former :*—"We may now reconsider, some of the practical issues of this inquiry. It has been shown, 1st. That in America, humatile men and humatile monkeys occupy the same palæontological zones. 2nd. That whilst all such remains of man are exclusively of the American Indian type, the monkeys called *Hepale, Cebus, Callithrix*, &c., are equally 'terræ geniti' of this continent. . . . . Finally, that *permanence of type*, as well for humanity as for simiadæ, is firmly established in both genera, from the hour in which we are living

* Indigenous Races of Men, p. 522.

back to a vastly remote, if not incalculable era of unrecorded time."

Such being some of the very important and comprehensive deductions now based on the premises originally advanced by Dr. Morton, it becomes of some interest to the Ethnologist to ascertain if these premises are so surely established as to be beyond all question. That some of the assumed evidence of this all-pervading conformity has been adopted on insufficient data, is manifest from the premature generalizations in relation to the holophrastic or polysynthetic character affirmed to pertain to all the languages and dialects of America, and assumed to supply the place of that grammatical unity of structure in the Indo-European languages, the establishment of which has led to such important results.

The dialects of the numerous families of American tongues multiply with the labors of their investigators. Duponceau, writing in 1822, numbered them as one thousand two hundred and fourteen. Scarcely any trace of the roots of a common vocabulary help in the comparison of many of these diverse languages of the New World. Of some of the indigenous tongues even now spoken around the Rios and Colorado, and in more southern latitudes, the holophrastic attribute is rather assumed than known; and in more than one group, of which the Carib is an illustration, languages are found in nearly the lowest stages of undeveloped simplicity. Nevertheless, this holophrastic or polysynthetical mode of condensing a group of words into one abreviated term susceptible of further modification, and of inflexion, is well worthy of the interest it has excited. This distinguishing trait, or "plan of thought of the American languages," as Dr. Lieber has designated it, has yet to be applied as a philological test to many untried tongues and dialects of the new continents; but meanwhile some of the most comprehensive generalizations based on it seem to have been advanced in the inverse ratio of the linguistic knowledge of their advocates. Those most fitted to pronounce on the subject—as Duponceau, in his later writings, and Gallatin—most cautiously avoid general conclusions, such as the former was tempted to by earlier and less complete observations; and, as in many other inquiries, extended knowledge tends at present to complicate the question, instead of confirming the seductive theory of Duponceau, of a common philological character pervading the languages of America from Greenland to Cape Horn.

The extreme interest which attaches to the investigation of the distinguishing traits already recognized as pertaining to the languages

of the New World, cannot be over estimated, though it is not improbable that an exaggerated value has been assigned to the significance of their specialities. In more than one trait characteristics are recognized common both to Polynesian and African idioms; and further consideration suggests the probability that the special synthetic tendency pertains fully as much to an immature stage of development of these languages, as to any specific individualizing feature born of the New World's insulation. As, moreover, the opinion advanced by Gallatin, after mature investigation, of the correspondence of the Esquimaux language to those of the true Indians of America, in the same degree that these possess elements in common, is acknowledged to be correct: the assumed philological unity of the American Indians amounts to no more than a predominance of certain linguistic tendencies analogous to such as, in the Old World, embrace widely varied ethnic and geographic areas. "Physically," says Latham, "the Eskimaux is a Mongol and Asiatic; philologically he is American, at least in respect to the principles upon which his speech is constructed."*

The same manifestation of a predisposed tendency to shape the evidence to a foregone conclusion, or to assume as special whatever varies from the Normal type, may be traced in various other lines of argument; such as, for example, where, in proof of the essential ethnic difference between the Esquimaux and the true Indian of America, the traveller Herne is quoted as stating that "the Indian tribes who are their proximate neighbours on the South, once excused an unprovoked massacre of Esquimaux men, women and children, by asserting that they were a people of a different nature and origin from themselves." Such a line of argument would prove other tribes, besides the Esquimaux, to be of a different nature and origin. Similar evidence, indeed, might suffice to show that the Anglo-Saxons of the ancient Kingdom of Northumbria, so soon as they were separated by the political boundary line of the Sark or Tweed, became essentially different races; for assuredly no Indians and Esquimaux could manifest more deadly hatred to each other than that which intensifies the wild vigor of the old Border Minstrelsy.

But it is not necessary to go beyond the American pale for similar evidences. The Guanches, discovered by Columbus in 1492, attracted his attention by their gentle manners and inoffensive habits, and from them he learned of the Caribs, a fierce and warlike people

* Varieties of Man, p. 290.

of neighbouring islands and the mainland, of whom they lived in constant dread, and who subsequently became familiar to the Spaniards as a ferocious, crafty and revengeful race, delighting in cannibalism.

Moreover, the great Admiral failed not to note the marked distinction between the fair complexion of the Guanches and the reddish olive of the ferocious Caribs. Both Humboldt and Morton acknowledge the existence of considerable varieties in colour and complexion, from nearly white to a dark brown. The latter writer, indeed—guarding against possible deductions from such an admission, adverse to his favourite theory of a universally predominating conformity in all the essential characteristics of the American aborigines—adds: "These differences in complexion are extremely partial, forming mere exceptions to the primitive and national tint that characterises these people from Cape Horn to the Canadas. The cause of these anomalies is not readily explained; that it is not climate, is sufficiently obvious; and whether it arises from partial immigrations from other countries, remains yet to be decided."*

The stronghold, however, of the argument for the essential oneness of the whole tribes and nations of the American continents, is the supposed uniformity of physiological, and especially of physiognomical and cranial characteristics: an ethnical postulate which has not yet, so far as I am aware, been called in question.

On first visiting the American continent, and enjoying the opportunity of judging for myself of the physical characteristics of the aboriginal race of the forests, I did so under the full conviction of meeting with such a universal approximation to the assumed Normal type, as would fully bear out the deductions of previous observers, and especially of one so persevering in the accumulation of the requisite materials on which to base a legitimate result, as the author of the *Crania Americana*. I visited Philadelphia with a special view to examine the valuable collection of Crania formed by Dr. Morton, and looked with lively interest on some of the most striking illustrations which it affords, of the typical form assigned by him to the American race. Unfortunately, at that period, (September, 1853,) extensive alterations in progress on the buildings of the Academy, deprived me of the opportunity for such detailed observations as were requisite for drawing any just comparison between these data and the comprehensive deductions founded on them by their collector. When, therefore, I proceeded more recently to open some Indian graves in Canada, and to endeavour to procure crania from others on

* Crania Americana, p. 70.

ascertaining of their disturbance, it was solely with a view to possess myself of one or two specimens of the peculiar American type of cranium, which possessed a special interest to me from its approximation to the ancient brachy-cephalic skull, familiar to me, as found in one important class of early British barrows. It was accordingly, simply with a sense of disappointment that I found the results of repeated efforts, in different localities, supplied me with crania, which, though undoubtedly Indian, exhibited little or no trace of the rounded form, with short longitudinal diameter, so strikingly apparent in the ancient crania of Central America and the Mounds. Appreciating, as I did, the invaluable labours of Dr. Morton—which will be more fully prized, as the important science they tend to elucidate commands a wider attention and more careful study—it did not occur to me at first to question any of the results so frequently reiterted by him, and repeatedly confirmed by the concurrence of later writers. Slowly, however, the idea has forced itself upon me that, to whatever extent the affirmed typical form of the American cranium is found to prevail in other parts of the continent, the crania most frequently met with along the north shores of the great lakes, are deficient in some of its most essential elements.

In order to institute such a comparison as will satisfactorily test this question, it is necessary to define the essential requisites of the American type of cranium; for, neither Dr. Morton, nor his successors, have overlooked the fact of some deviation from the supposed normal type, not only occurring occasionally, but existing as a permanent characteristic of certain tribes, including those to which I have more particularly to refer. Dr. Morton, as has been already shown, recognized a more elongated head as pertaining to certain tribes, of which he names the Lenapé stock, the Iroquois, and the Cherokees, to the east of the Alleghany Mountains; and the Mandans, Ricaras, and Assinaboins, to the west. But such elongation he speaks of as a mere slight variation from the more perfect form of the normal skull; and he adds: "even in these instances the characteristic truncation of the occiput is more or less obvious."* So also Dr. Nott, after defining the typical characteristics of the American cranium, remarks: "Such are more universal in the Toltecan than the barbarous tribes. Among the Iroquois, for instance, the heads were often of a somewhat elongated form, but the Cherokees and Choctaws, who, of all barbarous tribes, display greater

* Crania Americana, p. 69.

aptitude for civilization, present the genuine type in a remarkable degree. My birth and long residence in Southern States have permitted the study of many of these living tribes, and they exhibit this conformation almost without exception. I have also scrutinized many Mexicans, besides Catawabas of South Carolina, and tribes on the Canada Lakes, and can bear witness that the living tribes everywhere confirm Morton's type."*

We cannot err in taking the very interesting cranium found by Dr. Davis and Mr. Squier in a mound in the Scioto Valley, Ohio, as an example of the true typical head; for it is produced as such by Dr. Nott, in the "Types of Mankind," and is described, in the words of Dr. Morton, in Dr. Meigs's *Catalogue of Human Crania, in the collection of the Academy of Natural Science of Philadelphia*, issued during the present year by order of the Academy, as: "an Aboriginal American; a very remarkable head. This is, perhaps, the most admirably-formed head of the American race hitherto discovered. It possesses the national characteristics in perfection, as seen in the elevated vertex, flattened occiput, great interparietal diameter, ponderous bony structure, salient nose, large jaws and broad face. It is the perfect type of Indian conformation, to which the skulls of all the tribes from Cape Horn to Canada more or less approximate." As shown by the front view of this skull it presents no trace of pyramidal conformation.

Of this skull the measurements which involve the most essential typical elements, and so furnish precise materials for comparison, are:—

Longitudinal diameter	6.5	inches.
Parietal "	6.	"
Vertical "	6.2	"
Intermastoid Arch	16.	"
Horizontal circumference	19.8	"

So that, in fact the cranium very closely corresponds in its measurements, in length, breadth, and height Still further it may be noted, on examining the full sized view of the skull, as given by Messrs. Squier and Davis (Pl. XLVII.) that the singular longitudinal abreviation of this skull is nearly all posteriorly. A line drawn through the meatus auditorius externus in profile, parallel to the elevated forehead, divides it into two unequal parts, of which the anterior and posterior parts are nearly in the ratio of two to one. To this type the Ancient Peruvian and Mexican crania unquestionably approximate. Of one of the former, from the Temple of the Sun,

* Types of Mankind, pp. 441.

Pl. XI.) Dr. Morton remarks: "A strikingly characteristic Peruvian head. As is common in this series of skulls, the parietal and longitudinal diameters are nearly the same," viz., longitudinal diameter 6-1, parietal diameter 6. So far, therefore, as such evidence goes it appears to justify the conclusion arrived at by Dr. Morton, that the people represented by the Mound skulls in his possession, "were one and the same with the American race, and probably of the Toltecan branch."*

The conformity affirmed to exist between the ancient Mexican and Peruvian skulls, and those of the modern barbarous tribes, may also be so far asserted as a partial approximation in relation to some of them, and appears to receive a fuller confirmation when carefully selected examples are referred to; as a sufficient number occur to indicate the occasional reappearance of some of the most striking typical peculiarities. Such reappearance of the extremest typical forms is not, however, peculiar to this continent. I possess measurements of a singular modern (female) skull in the collection of Dr. Struthers of Edinburgh, which reproduces in all its strongest features the ancient British brachy-cephalic head; and I have in view more than one living illustration of the same sort:—one, for example—a gentleman of education and intelligence—with such an elevation of the vertex, flattened occiput, and short longitudinal diameter, as, judging by the eye, would more nearly approach the measurement of the Scioto Mound Cranium, than that of any living Indian I have seen.

Of a similar nature is the correspondence pointed out by Dr. Nott† between the Scioto mound skull and that of a Cherokee Chief who died a prisoner near Mobile in 1837. In this example, in so far as can be judged from the comparison of both by drawings in profile without precise measurements, the points of agreement are indisputable, though even here amounting to no more than an approximation. The vertical occiput of the ancient skull—more markedly vertical in the original drawing than in the small copy,—is only partially represented in the other; the square form of the ancient profile in the coronal region, becomes conoid in the modern one; and the intersecting line drawn perpendicularly through the meatus shows a very partial reproduction in the modern example, of the remarkable preponderance of posterior cerebral development, which—if not produced by artificial means—is the most singular characteristic of the ancient head.

* Crania Americana, p. 229.
† Types of Mankind, p. 442.

But while acknowledging such approximation of the selected modern Cherokee cranium to the ancient type, neither the legitimate deductions following from this, nor from the other examples referred to by Dr. Nott, appear to bear out his conclusions, that not only that type "is found among tribes the most scattered, among the semi-civilized and the barbarous, among living as well as among extinct races;" but "that *no foreign race has intruded itself in their midst, even in the smallest appreciable degree.*" The examples of Cherokee heads referred to in the *Table of Anatomical Measurements* in the Crania Americana, in so far as they fairly represent the cranial characteristics of this tribe or nation, seem to indicate that the Mobile Chief is an exceptional case; and this is further borne out by the special example selected by Dr. Morton, and figured in his great work; "The head of a Cherokee warrior who was known in the army by the name of John Waring." The following are its most characteristic measurements, exhibiting such a wide divergence from the normal type, as illustrated in that of the Scioto Mound, as to substitute contrast for comparison:—

Longitudinal diameter	7.2
Parietal "	5.3
Vertical "	5.3
Intermastoid Arch	14.1
Horizontal circumference	19.1

In the typical head the longitudinal, parietal, and vertical diameters closely correspond; in this the excess of the longitudinal over the parietal and vertical diameters is such as is rarely exceeded in the modern Anglo-Saxon, or even the longer sub-celtic head. Yet, that such an excess in the longitudinal diameter did not present to the experienced eye of Dr. Morton any striking deviation from the form of the modern Indian head is proved by his noting of this very example: "Nor is there anything remarkable in the form of the skull."

Bearing in remembrance then, the partial nature of the approximation so far apparent between the ancient and modern American cranium; personal observation leads me to believe that such is to be found—with exceptional instances of closer affinities, and also with important divergencies from the typical Indian form and character, not exceptional, but pertaining to the whole nation,—among the still numerous examples of the Algonquin stock, as represented by the Chippeways. Of these I have examined, and compared by the eye, many at widely scattered locations: on Lake Simcoe and the Georgian Bay; at Mackinaw in Lake Huron, and at Sault St. Marie; at

Ontonagon, La Point, the Apostle Islands, and the St. Louis River, on Lake Superior; as well as such chance opportunities as occur in the neighbourhood of Niagara Falls, and on the streets of our Canadian towns and villages. Physiognomically they present the wide and prominent mouth, high cheek-bones, and broad face, so universally characteristic of the American Indian; but they by no means present in a remarkable degree the wide and massive lower jaw, which has been noted as of universal occurrence among the Red Indians. Still more noticeable is the absence of the aquiline nose, so characteristic generally of the true Indian in contradistinction to the Esquimaux. The eye may be fully depended on for physiognomical characteristics; it is of much less value in testing variations from any assumed cranial type, especially in reference to comparatively minute divergencies of measurement. Nevertheless, their heads appear to me, to be of short longitudinal diameter, as compared with those of other tribes in part displaced by them; but—in so far as may be judged from the observation of the living head covered with the thickly matted and long coarse hair of the Indian, —they are not remarkable for vertical elevation.

It is by no means an easy thing to obtain actual measurements of Indans' heads. I have found an Indian not only resist every attempt that could be ventured on, backed by arguments of the most practical kind; but on the solicitation being pressed too urgently, he trembled, and manifested the strongest signs of fear, not unaccompanied with anger, such as made a retreat prudent. In other cases where the Indian has been induced to submit his head to examination, his Squaw has interfered and vehemently protested against the dangerous operation. The chief object of dread seems to be lest thereby the secrets of the owner should be revealed to the manipulator; but this rather marks the more definite form of apprehension in the mind of the christianized Indian. With others it is simply a vague dread of power being thereby acquired over them; such as Mr. Paul Kane informs me frequently interfered to prevent his taking the portraits of the Indians of the North-west, unless by stealth.

The following table presents the results of an examination of six pure-breed Chippeways, at the Indian reserve on Lake Couchiching; with the addition of two others, the only examples of the same nation, given by Morton, in the *Crania Americana*. From these it will be seen that, while in the majority of them a certain approximation of the longitudinal to the parietal diameter is discernible, it is of a very partial nature, except in one instance (No. 5) where a manifest

correspondence to certain relative proportions of the Mound-builder type of head is apparent:

TABLE I.—CRANIAL MEASUREMENTS.—(CHIPPEWAYS.)

	Longitudinal Diameter	Parietal Diameter	Frontal Diameter	Intermostoid Arch.	Horizon'l Circumference.
1. Joseph Shilling.....	7.5	6.1	5.6	14.4	22.9
1. James Inglesol (Kobsequan).	7.4	6.0	5.0	14.8	22.3
3. Jac. Crane (Now-keise-gwab)	7.1	6.0	5.4	15.4	22.1
4. Peter Jacobs (Pah-tah-se-ga.)	7.3	5.8	5.4	15.0	22.6
5. Jacob Shilling.....	6.9	6.0	5.1	14.7	22.0
6. William Snake	7.1	6.0	5.5	15.1	22.0
7. Crania Americana, No. 683 .	7.3	5.8	4.8	15.1	20.9
8. Crania Americana, No. 684 .	7.2	5.5	4.3	14.8	20.2

Some of the measurements in the living head are necessarily affected by the hair, always coarse and abundant with the Indian. Others again, such as the vertical diameter cannot be taken; but the mastoid processes are sufficiently prominent to leave very little room for error in the measurement of the inter-mastoid arch; and this suffices to show the very exceptional approximation of the modern Chippeway head—in so far as it is illustrated by these examples,—to the ancient type, in the proportional elevation of the vertex. In the horizontal circumference some deduction must be made for the hair, to bring it to the true cranial measurement in all the six living examples.

I have selected the Chippeways for reference here, because—taking the above measurements, along with other observations,—they appear to indicate a nearer approach to some of the assumed characteristics of the American cranial type, in this widely spread branch of the Indian stock, than is observable in other Northern races, and especially than is apparent on an examination of skulls belonging, as I believe, to the original Huron occupants of the greater part of the country around Lakes Simcoe and Couchiching, where the Chippeways more especially referred to are now settled, including Upper Canada, when first explored.

But the divergent characteristics noticeable in these, and still more in the crania of older Canadian graves, are by no means confined to those named, as a few examples will suffice to show. Such a radical divergence from the assumed normal type as has been already noted in Dr. Morton's selected Cherokee cranium, is no less obvious in

that of the Miami,—the head of a celebrated chief, eloquent, of great bravery, and uncompromising hostility to the Whites: (*Crania Americana*, p. 182.)

Longitudinal Diameter	7.3
Parietal Diameter	5.5
Vertical Diameter	5.5
Inter-mastoid Arch	14.5
Horizontal Circumference	19.8

In the example of the Potawatomies, "A skull of a genuine Potowatomie, remarkable for its capacity behind the ears:" (Ibid p. 186.)

Longitudinal Diameter	7.8
Parietal Diameter	5.7
Vertical Diameter	5.3
Intermastoid Arch	16.0
Horizontal Circumference	22.1

In that of the Blackfeet, the largest of two brought to Philadelphia by Catline, and noted by Dr. Morton for its great breadth between the parietal bones. It is also very markedly pyramidal. Nevertheless, here also the longitudinal diameter is nearly two inches in excess both of the parietal and vertical diameters: (Ibid, 202.)

Longitudinal Diameter	7.1
Parietal Diameter	5.4
Vertical Diameter	5.1
Inter-mastoid Arch	13.8
Horizontal Circumference	19.9

So also Dr. Morton says of the Menominees: "I have received a series of Menominee skulls, embracing eight specimens. They are something larger than the average of Indian crania; and although for the most part they present *a rather oval shape*, they are all marked by a gently flattened occiput." (Ibid. 179.) A reference to the Catalogue of the Morton Collection at Philadelphia discloses the important fact that of those marked by the shorter longitudinal diameter, Nos. 35, 44, and 563, are females.

Again of the Delawares he remarks: "The few Delaware skulls in my possession are more elongated than is usual in the American tribes; they are also narrower in proportion in the parietal diameter and less flattened on the occiput."

Such are some indications of data—derived from a source altogether unexceptionable in the present argument,—which seem to render it impossible to uphold the views so repeatedly affirmed, of the physiog-

nomical, physiological, and above all, the cranial unity characterizing the whole ancient and modern aborigines of the New World.

I omit, meanwhile, any reference to the characteristics ascribed by Dr. Morton to the Iroquois and Hurons or Wyandots: those tribes to whom, with the greatest probability, may be assigned the crania specially examined by me, found along the shores of Lake Ontario, the north shore of Lake Erie, and on Lake Huron. When Champlain effected permanent settlements on the Lower St. Lawrence in 1608, he found the north shores of the river occupied, below Quebec, by the Montagnets or Montagnards, and above it by the Ottawas, and other branches of the Algonquin stock. The country to the westward, constituting the great Canadian Peninsula lying between Georgian Bay; the Lakes Huron, Erie, and Ontario, was chiefly, if not entirely, in the possession of the Hurons; while the Iroquois—to whom the latter were most nearly allied in social and physical characteristics, though at deadl enmity with them,—occupied the south bank of the St. Lawrence, and had their chief villages scattered among the clustering lakes, and the rivers, on the southern shore of Lake Ontario, which they continued to occupy and cultivate till driven out or exterminated in the revolutionary wars. The Iroquois and the Huron tribes were alike distinguished from many others, and especially from the neighbouring hunter tribes of the Algonquin nations, by considerable attention to cultivation, and by living permanently in large settled villages. But the Iroquois Wars effectually arrested the progress of agriculture, and at length eradicated or drove out the Hurons from their country between Georgian Bay and Lake Ontario, where they were replaced by rude Algonquin tribes formerly lying to the north of them.

The Hurons then, and, in very modern years, the Algonquins, but more especially the former, are the occupants of the country immediately to the north of Lakes Erie and Ontario, whose remains are to be looked for in the Indian graves of this district. Of them Latham remarks: "The Iroquois and Algonkins exhibit in the most typical form the characteristics of the North American Indians, as exhibited in the earliest descriptions, and are the two families upon which the current notions respecting the physiognomy, habits, and moral and intellectual powers of the so-called Red Race are chiefly founded."* In many respects, however, they presented a striking contrast. The Algonquin stock, represented by the modern Chippeways, is only known to us as embracing rude and savage hunter tribes; and both

* Varieties of Mankind. p. 333.

physically and intellectually the Chippeways were inferior to the Iroquois and Hurons. The latter displayed a manifest aptitude for civilization. In war they repeatedly effected and maintained extensive and powerful combinations. Their agricultural operations gave proof of a systematic and continuous cultivation of the soil. Corn especially was grown to a great extent. Tobacco also was so extentensively cultivated by one of the tribes of Upper Canada as to lead to its designation by the French Jesuit Missionaries of the seventeenth century as the *Petunians*, or Tobacco Growers. Moreover, their knowledge and practice of agriculture appears to have originated independently of all European influence; and but for their fatal involvement in the struggle between the Colonists and the representatives of the mother country, there seemed a reasonable prospect of such an Iroquois civilization being developed in the western districts of the State of New York, as might have enabled these representatives of the ancient owners of the soil to share in the gradual advancement of European arts and progress instead of being trodden under heel in the march of civilization.*

Of Indian skulls dug up within the district once pertaining to the Huron or Wyandot branch of the Iroquois stock, I had observed and cursorily examined a considerable number before my attention was especially drawn to the peculiar characteristics now under consideration, owing to my repeated rejection of those which turned up, as failing to furnish specimens of the assigned typical American head. Since then I have carefully examined and measured twenty-nine Indian skulls, with the following results:

1. Only three exhibit such an agreement with the American type, as judged by the eye, to justify their classification as true brachycephalic crania. One of these (No. 11,) a very remarkable and massive skull, was turned up at Barrie, on Lake Simcoe, with, it is said, upwards of two hundred others. It differs from all the other Indian crania in exhibiting the vertical occiput so very strikingly, that, when laid resting on it, it stands more firmly than in any other position. Of the Scioto Valley cranium, Dr. Morton remarks, in reference to the occiput, "Similar forms are common in the Peruvian tombs, and have the occiput, as in this instance, so flattened and vertical, as to

* La Hontan estimated the Iroquois, when first known to Europeans, at 70,000. At the present time they number about 7,000, including those in Canada; and they still exhibit traces of the superiority which once pertained to them in comparison with other Indian tribes. The very name of a Mohawk still fills with dread the lodges of the Chippeways; and the Algonquin Indians settled on the Canadian reserves on Lake Couchiching and Rice Lake, have been known repeatedly to desert their villages and camp out in the woods, or on an island, from the mere rumor of a Mohawk having been seen in the vicinity.

give the idea of artificial compression; yet this is only an exaggeration of the natural form, caused by the pressure of the cradle-board in common use among the American nation." I think it extremely probable that further investigation will tend to the conclusion that the vertical or flattened occiput, instead of being a typical characteristic, pertains entirely to the class of artificial modifications of the natural cranium familiar to the American Ethnologist alike in the disclosures of ancient graves, and in the customs of widely separated living tribes. In this I am further confirmed by the remark of Dr. Morton, in reference to the Peruvian crania: "These heads are remarkable, not only for their smallness, but also for their irregularity, for in the whole series in my possession, there is but one that can be called symmetrical. This irregularity chiefly consists in the greater projection of the occiput to one side than the other, showing in some instances a surprising degree of deformity. As this condition is as often observed on one side as the other, it is not to be attributed to the intentional application of mechanical force; on the contrary, it is to a certain degree common to the whole American tribes, and is sometimes, no doubt, increased by the manner in which the child is placed in the cradle."* To this Dr. Morton subsequently added the further remark, in describing an unsymmetrical Mexican skull: "I had almost omitted the remark, that this irregularity of form is common in, and *peculiar to American crania*."† The latter remark, however, is too wide a generalization. I have repeatedly noted the like unsymmetrical characteristics in the Brachycepalic crania of the Scottish Barrows, and it has occurred to my mind, on more than one occasion, whether such may not furnish an indication of some partial compression, dependent, it may be, on the mode of nurture in infancy, having tended, in their case also, if not to produce, to exaggerate the short longitudinal diameter, which constitutes one of their most remarkable characteristics. In the case of the Barrie skull, there can be little doubt that the flattened occiput is the result of artificial compression, of a much more decided nature than that of the cradle-board of the papoose.

It is not undeserving of notice here, that the example selected by Cuvier, among his "crania pertaining to the four principal types of the human species," to illustrate the American race, exhibits a strikingly marked prolongation of the occiput. It is described as: "*Crâne trouvé dans une caverne, près du Village de Maïpuré près des*

* Crania Americana, p. 115.
† Types of Mankind, p. 444.

bords de l'Orénoque ; rapporté par M. de Humboldt ;"* and so far suffices to indicate in how far the opinion already quoted from Humboldt's *Researches* coincides with his own independent observations.

2. In addition to what has been above remarked in reference to the probable artificial origin of the supposed typical form of occiput, assigned by Dr. Morton to the whole American race; I am struck, in the majority of the examples examined, with the total absence of any approximation to the flattened occiput. Fifteen of the crania referred to exhibit a more or less decided posterior projection of the occiput, twelve of these being markedly so, and seven of them presenting such a prolongation of it, as constituted one of the most striking features in one class of ancient Scottish crania, which chiefly led to the suggestion of the term Kumbecephale,† as a distinctive term for them.

3. The tendency to the pyramidal form, occasioned by the angular junction of the parietal bones, is apparent in the majority of the skulls examined. I have noted its occurrence more or less prominently in fourteen crania, of which five exhibit a strongly marked pyramidal form, extending to the frontal bone. In some, however, it is only slightly indicated, while in several it is totally wanting.

4. I am further struck with the frequency of the very partial projection, and in some examples the total absence of the supercilliary ridge, a characteristic which I am not aware has been noted before. In seven of the skulls carefully noted by me, this is particularly manifest, and along with their pyramidal vertex and predominant longitudinal diameter, suggest affinities hitherto overlooked, with the Esquimaux form of skull.

5. I would also note that, whereas Dr. Morton states, as the result of his experience, that the most distant points of the parietal bones are, for the most part, the protuberances, I have only found such to be the case in two out of twenty-nine Canadian skulls. The widest parietal measurement is generally a little above the squamous suture.

6. The occurrence may also be noted in several of these crania, of wormian bones of such regularity of form and position, as to constitute indications at least, seemingly confirmatory of the supposed tendency to the development of an *interparietal* or *superoccipital* bone, first pointed out by Dr. Bellamy. This, which is a permanent cranial characteristic in some of the mammalia, is regarded

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* *Cuvier: Le Régne Animal. Races Humaines, planches* 1 *et* 2. *pl.* 8. *fig.* 2.

† Prehistoric Annals of Scotland, p. 109.

by Dr. Tschudi as an osteological feature peculiar to the Peruvians, and is, he affirms, traceable in all the skulls of that race.

* TABLE II.—CRANIAL MEASUREMENTS.—WESTERN CANADA, (HURONS.)

		1. Long. Diam.	2. Parie. Diam.	3. Front. Diam.	4. Verti. Diam.	5. Inter-Mast. Arch.	6. Inter-Mast. Line.	7. Occip front. Arch.	8. Do from Oc. prot. to root of nose.	9. Horiz. circumf'rence.
1	Orillia	7.5	5.7	4.5	5.6	15.6	4.2½	15.	13.	21.1
2	do	7.4	5.5	4.4	5.4	14.7	4.5	.....	12.	20.6
3	Oakridges	7.6	5.5	4.7	6.	15.7	4.6	15.	13.7	21.2
4	do (Female)	6.8	4.8	4.2	5.	13.6	4.	13 2	11.3	18.9
5	Windsor	6.6	5.3	4.2	5.5	14.5	4.2	13.5	12.2	19.
6	Peterborough	7.7	5.5	4.9	5.3	15.4	4.6	15.	13.6	21.1
7	Windsor	7.	5.7	4.7	5.7	15.2	4.3	14.5	12.9	20.1
8	do	7.	5.7	4.5	5.7	16.1	4.	14.4	12.4	20.1
9	do	7.4	6.1	4.9	5.7	.....	4.5	15.5	13.4	21.4
10	Penetanguishene	7.8	5.6	4.6	5.9	15.5	4.5	15.6	13.5	21.3
11	Barrie	6.6	6.4	5 2	5.3	16.	4.6	14.4	12.1	20.7
12	Burlington Bay	7.	5.2½	4.4	5.3	14.	4.	13.6	11.9	19.5
13	do do	7.6	5.6	4.4	5.4	15.2	4.2	14.9	12.9	20.9
14	Burwick	7.2	5.1	4.4	5.6	14.3	4.3	14.7	12.4	21.
15	Tecumseth	7.3	5.6	4.4	5 5	14.5	4.9	14.4	12.5	20.2½
16	do (Female)	7.2	5.2	3.9	5.	14.1	3.6	14.2½	12.9	19.7
17	do	7.9	6.	4.6	5.7	16.	3.4	16.1	14.2½	22.
18	do (Female)	7.6	5.2½	4.3	5.6	14.	4.1	14.2½	12.6	20.2
19	do (Female)	7.5	5.2	4.1	5.1	13.4	4.2	14.8	13.	20.5
20	do	7.4	5.6	4.6	5.5	15.	4.4	15.	13.6	20.9
21	do	7.6	5.4	4.2	5.7	15.1	4.4	15.3	14.	20.9
22	Owen Sound	7.	5.5	4 2	5.	13.8	4	14.	12.2	19.8
23	do	7.3	5.3	4.2½	5.2½	14.4	4.2	14.2½	12.4	20.4
24	do	7.2	5.4	3.8	5.2½	14.5	3.9	14.2	12.	19.9
25	do	7.7	5.4	4.7	5.6	14.6	4.2	15.	13.	21.4
26	Oro	7.4	5.4	.....	4.2½	15.2½	4.	14.9	12.4	20.4
27	Owen Sound	7.5	5.9	5.1	5.5	15.	4.2½	15.6	13.3	21.8
28	do	7.6	5.5	4.5	5.4	14.6	4.5	14.9	13.1	21.3
29	Oro	7.5	5.6	4.4	5.5	15.5	4.3	15.2	13.	21.4

The table of measurements of skulls procured from Indian cemeteries to the north of Lakes Erie and Ontario, (Table II.) supplies some, at least, of the elements essential to the formation of a sound judgment on the question under consideration. It embraces twenty-nine examples. To these I have added, in another table, (Table III.) the corresponding measurements of the skull of the celebrated Mohawk Chief, Joseph Brant, (Tayendanaga,) from a cast taken on the opening of his grave, at the interment of his son, John Brant, in 1852. I have also further added, from the *Crania Americana*, the Iroquois and Huron examples given there, which, it will be seen, agree in the main with the results of my own independent observations; while a comparison of the two tables will be satisfactory to those who may, not unnaturally, hesitate to adopt conclusions, based

* Table II.—Of the crania referred to in this Table, Nos. 1 to 9 and No. 29, are in my own possession. Nos. 10, 11, in the Museum of the Canadian Institute. Nos. 12, 13, Museum of Toronto University. No. 14, Museum of Knox's College, Toronto. Nos. 15 to 21, in the collection of Dr. Hodder, Toronto. Nos. 22 to 25, Museum of Trinity College, Toronto. No. 26, in the possession of Rev. John Gray, Orillia. Nos. 27, 28, in the collection of Professor Bovell, M.D., of Trinity College, Toronto.

on the amount of evidence produced, adverse to opinions re-affirmed under such various forms by so high an authority as Dr. Morton, and adopted and made the basis of such comprehensive inductions by his successors.

TABLE III.—CRANIAL MEASUREMENTS.—SIX NATIONS.

	1. Long. Diam.	2. Parie. Diam.	3. Front Diam	4. Verti. Diam.	5. Inter-Mast. Arch.	6. Inter-Mast. Line.	7. Occip. front. Arch.	8. Do from Oc.prot. to root of nose.	9. Horiz. circumf rence.
Mohawk: Brant	7.8	6.	5.	.....	15.6?	.....	.....	13?	22.
Oneida, Morton, No. 33	7.5	5.6	4.1	5.8	14.4	4.3	14.9	.....	20.8
Cayuga, do No. 417	7.8	5.1	4.2	5.4	14.2	4.5	15.5	.....	20.8
Huron, do (Fem.) No. 607	6.7	5.6	4.1	5.2	14.5	3.9	14.	.....	19.2
Huron, do No. 15	7.2	5.3	4.3	5.5	15.	4.4	14.2	.....	19.8
Iroquois, do No. 16	7.5	5.5	4.5	5.7	15.2	4.5	15.1	.....	20.8
Iroquois, do A.N.S	7.1	5 4	4.2	5.3	14.3	4.	14.1	.....	20.

The intimate relations in language, manners, and the traditions of a common descent, between those Northern and Southern branches of the Iroquois stock, render these two tables, in so far as they present concurrent results, applicable as a common test of the supposed homogeneous cranial characteristics of the aboriginal American, in relation to the area of the great Lakes. Twenty-nine skulls, such as the first table supplies, or thirty-six as the result of both, may, perhaps, appear to be too small a number on which to base conclusions adverse to those promulgated by an observer so distinguished and so persevering as Dr. Morton, and accepted by writers no less worthy of esteem and deference. Still more may these data seem inadequate, when it is remembered that Dr. Morton's original observations and measurements embraced upwards of three hundred American skulls. But—in addition to the fact that the measurements now supplied, are only the more carefully noted data which have tended to confirm conclusions suggested by previous examinations, in a less detailed manner, of a larger number of examples—an investigation of the materials which supplied the elements of earlier inductions, will show that only in the case of the ancient "Toltecan" tribes did Dr. Morton examine nearly so many examples; while, in relation to what he designated the "Barbarous Race," to which the Northern tribes belong, even in Dr. Meigs' greatly enlarged catalogue of the Morton Collection, as augmented since his death, the Seminole crania present the greatest number belonging to one tribe, and these only amount to sixteen.

In contrast to the form of head of the true American race, Dr. Morton appends to his *Crania Americana* drawings and measurements

of four Esquimaux skulls, familiar to me, if I mistake not, in the collection of the Edinburgh Phrenological Society. In commenting on the views and measurements of these, he remarks: "The great and uniform differences between these heads and those of the American Indians will be obvious to every one accustomed to make comparisons of this kind, and serve as corroborative evidence of the opinion that the Esquimaux are the only people possessing Asiatic characteristics on the American continent." In some respects this is undoubtedly true; the prognathous form of the superior maxilla, and the very small development of the nasal bones, especially contrast with well known characteristics of the American aborigines. But having had some little familiarity in making comparisons of this kind, it appears to me, notwithstanding these distinctive points, that an impartial observer might be quite as likely to assign even some of the examples of Iroquois and other northern tribes figured in the *Crania Americana*, to an Esquimaux, as to a Peruvian, Mexican, or Mound-Builder type. Compare, for example, the vertical and occipital diagrams, furnished by Dr. Morton, of the Esquimaux crania (p. 248) with those of the Iroquois and Hurons (pp. 192-194). Both are elongated, pyramidal, and with a tendency towards a conoid rather than a flattened or vertical occipital form; and when placed alongside of the most markedly typical Mexican or Peruvian heads, the one differs little less widely from these than the other. The elements of contrast between the Hurons and Esquimaux are mainly traceable in the bones of the face: physiognomical, but not cerebral.

Taking once more their cranial measurements as a means of comparison; these, when placed alongside each other, equally bear out the conclusions already affirmed. For comparison, I select, in addition to the Scioto Valley Mound-Builder, the following, as those pointed out by Dr. Morton's own descriptions as among the most characteristic he has figured: Plate XI. Peruvian from the Temple of the Sun: "a strikingly characteristic Peruvian Head." Plate XI, C. "Here again the parietal and longitudinal diameter are nearly equal. The posterior and lateral swell of this cranium are very remarkable, and the vertex has the characteristic prominence." Of the Mexican skulls Dr. Morton remarks, of Plate XVII: "with a better forehead than is usual, this skull presents all the prominent characteristics of the American race,—the prominent face, elevated vertex, vertical occiput, and the great swell from the temporal bones upward;" and of Plate XVIII: "a remarkably well characterised Toltecan head, from an ancient tomb near the city of Mexico."

TABLE IV.—COMPARATIVE CRANIAL MEASUREMENTS.

	Longitud Diameter	Parietal Diameter	Frontal Diameter	Vertical Diameter	Int. Mastoid Arch	I. M. Line.	Occipito-frontal Arch.	Horizon Circumf.
Scioto Mound.....	6.5	6.	4.5	6.2	16.	4.5	13.8	19.8
Peruvian.....	6.1	6.	4.7	5.5	16.	4.5	14.1	19.5
Peruvian.....	6.	5.9	4.4	5.	15.5	4.	13.2	19.
Mexican.....	6.8	5.5	4.6	6.	15.6	4.4	14.6	19.9
Toltecan	6.4	5.7	4.5	5.4	14.6	4.5	13.5	20.2
Iroquois.....	7.5	5.5	4.5	5.7	15.2	4.5	15.1	20.8
Cayuga	7.8	5.1	4.2	5.4	14.2	4.5	15 5	20.8
Oneida.....	7.5	5.6	4.1	5.8	14.4	4.3	14.9	20.8
Huron	7.2	5.3	4.3	5.5	15.	4.4	14.2	19.8
Esquimaux	7.5	5.4	4.6	5.4	14.3	4.1	15.2	20.4
„	7.3	5.5	4.4	5.3	14.1	4.3	14.4	20.3
„	7.5	5.1	4.3	5.5	14.8	3.9	15.5	20.3
„	6.7	5.	4.4	5.	13.6	4.	13.9	18.9

If the data which this table supplies furnish any fair illustration of the cranial measurements of the different nations selected, it is scarcely possible to avoid the conclusion, that—in so far as this test is to be relied on,—if a line of separation is to be drawn, it cannot be introduced, as heretofore, to cut off the Esquimaux from all others, but must rather group the Iroquois with them, on the one side, while the Toltecans and the Mound-builders stand as the representatives of a diverse class, on the other. These examples I refer to in preference to those derived from other sources, or presented in the previous table as the result of my own observations, as they are necessarily unbiassed. They are the specimens of the very races referred to, selected or brought by chance under the observation of Dr. Morton, and included as the characteristic or sole examples in his great work. But the same conclusions are borne out by the examples obtained within the Canadian frontiers; and they seem to me to lead inevitably to this conclusion: that if crania measuring in some cases, two inches in excess in the longitudinal over the parietal and vertical diameters, and in others nearly approximating to such relative measurements,—without further reference here to variations in occipital conformation,—if such crania may be affirmed, without challenge, to be of the same type as others where the longitudinal, parietal, and vertical diameters vary only by small fractional differences, then the distinction between the *brachycephalic* and the *dolichocephalic* type of head is, for all purposes of science, at an end, and the labours of Blumenbach, Retzius, Nilsson, and all who have trod in their footsteps have been wasted in pursuit of an idle

fancy. If differences of cranial conformation of so strongly defined a character, as are thus shown to exist between various ancient and modern people of America, amount to no more than variations within the normal range of a common type, then all the important distinctions between the crania of ancient European barrows, and those of living races amount to little; and the more delicate details, such as those, for example, which have been supposed to distinguish the Celtic from the Germanic cranium; the ancient Roman from the Etruscan or Greek; the Sclave from the Magyar or Turk; or the Gothic Spaniard from the Basque or Morisco, must be utterly valueless.

For the purpose of testing the assumed predominance of one uniform cranial type throughout the whole American area south of the Arctic circle, by a comparison of measurements of ancient and modern skulls: with those of the exceptional Arctic American, the Esquimaux measurements given by Dr. Morton, have been placed alongside of the others derived from the *Crania Americana*, in table IV. Through the obliging courtesy of Dr. J. Aitken Meigs, however, I am enabled to present the following table, embracing measurements of fourteen Esquimaux skulls, with one exception, in the collection of the Academy of Natural Sciences of Philadelphia, to which they have been added since Dr. Morton's death. Seven of these, Nos. 200, 674,—679, were procured at Godhavn, Disco Island, on the coast of Greenland, by Dr. B. Vreeland, U.S.N. Five of them, Nos. 1558,—1562, were obtained from different localities and ancient graves or cairns, by the lamented Arctic voyager, Dr. E. K. Kane. No. 1563, from the Danish Settlement at Upernavick, was presented to the Academy by Dr. S. W. Mitchell; and the remaining example (A.) is added from a private source. The measurements in this table differ in some respects from the previous ones. The fractions are here sixteenths, instead of tenths. The parietal diameter in the previous tables indicates the extreme breath of the skull between the parietal bones; in this it is invariably taken between the parietal protuberances. In lieu of the mastoid processes, the meati are here selected as yielding measurements of more unvarying uniformity and precision; though they have the disadvantage of being less applicable to comparisons with the living head. Bearing these variations in view, the following table presents additional means for instituting comparisons between the Indian and Esquimaux cranium; and also supplies some valuable data for testing the characteristics of the Esquimaux skull. This Dr. Meigs describes as "large, long, nar-

row, pyramidal; greatest breadth near the base; sagittal suture prominent and keel like, in consequence of the junction of the parietal and two halves of the frontal bones; proportion between length of head and height of face as 7 to 5 . . . . forehead flat and receding; occiput full and salient; face broad and lozenge-shaped, the greatest breadth being just below the orbits; malar bones broad, high, and prominent, zygomatic arches massive and widely separated: nasal bones flat, narrow, and united at an obtuse angle, sometimes lying in the same place as the naso-maxillary processes."* The remarks of Mr. J. Barnard Davis on the last named peculiarities, are worthy of note. In the Esquimaux of the eastern shores of Baffin's Bay, he observes, the nasal bones are scarcely broader, though frequently longer than in some Chinese skulls, where they are so narrow as to be reduced to two short linear bones. "In those of the opposite, or American shores of Baffin's Bay they are very different, presenting a length, breadth, and angle of position, almost equal to those of European races, having aquiline noses." † This slight yet striking anatomical difference seems to supply a link of considerable value as indicative of a trait of physiognomical character in the more southern Esquimaux, tending,—if confirmed by further observation,—like other physical characteristics already noticed, to modify the abrupt transition assumed heretofore as clearly defining the line of separation between the contrasting Arctic and Red Indian races of the New World.

TABLE V.—CRANIAL MEASUREMENTS.—ESQUIMAUX.

A. N. S. Philadelphia.	Longitudinal diam.	Frontal diam.	Parietal Diam.	Vertical diam.	Intermeatoid Arch.	Intmeatoid Line	Occip'to frontal Arch.	Horiz. Periphery.
No. 200	7.12	4. 5	4. 6	5.12	12.10	4.3	15.12	21. 6
" 674	6.15	4. 2	4.12	5. 3	12.	4.5	14. 4	19. 6
" 675	7. 2	4.	4.10	5. 9	12.12	4.5	14.10	.....
" 676	7. 8	4. 6	4.13	5. 7	13.	4.2	14.14	21.
" 677	7. 8	4. 6	4. 6	5.10	12.10	4.7	14.14	20.12
" 678	6.14	3.12	4. 1	5. 4	11.12	4.5	13.10	19.
" 679	7. 6	4. 4	4.14	5.10	12 4	4.3	14.12	20. 8
" 1558	7.11	4. 6	4. 7	5.10	12.10	4.8	15. 2	21. 6
" 1559	7. 3	4. 4	4. 8	5. 8	12. 4	4.5	14. 4	20. 4
" 1560	7. 1	3.13	4.13	5. 4	11.12	4.6	14. 4	19. 6
" 1561	7. 1	4. 3	4.12	5. 1	12.	4.	14.	19.12
" 1562	7. 1	4.	4.12	5. 4	12. 4	4.4	14. 2	19.10
" 1563	7.	4. 5	5. 4	5. 8	12.14	4.5	14.10	20. 6
A	7. 4	4. 4	5.	5. 4	12. 6	4.1	14.12	20.

In the above table the great length and narrowness of the Esquimaux skull is abundantly apparent, with no very remarkable elevation of the crown. A comparison, however, with the corresponding

* Catalogue of Human Crania, A.N.S., 1857, p. 50. † Crania Britannica, p. 30.

measurements in Table II.—keeping in remembrance the difference in the values of the fractions,—will bear out the analogies already indicated, and add new proof that the supposed uniformity traceable throughout this continent, is no more than might fairly be looked for among nations placed to so great an extent under the operation of similar conditions of social life, and affected by so many corresponding extraneous influences.

If external circumstances or the progress of civilization, exercise any influence on physical form, a greater diversity of conformation is to be looked for in Europe than among the Indians of America, where—as in Africa—nearly the same habits and modes of life have characterised the whole "Barbarous Race," throughout the centuries during which Europe has had any knowledge of them. But, making full allowance for such external influences, it seems to me—after thus reviewing the evidence on which the assumed unity of the American race is founded,—little less extravagant to affirm of Europe than of America, that the crania every where and at all periods have conformed, or even approximated, to one type.

As an hypothesis, based on evidence accumulated in the *Crania Americana*, the supposed homogeneity of the whole American aborigines was perhaps a justifiable one. But the evidence was totally insufficient for any such absolute and dogmatic induction as it has been made the basis of. With the exception of the Ancient Peruvians, the comprehensive generalizations relative to the Southern American continent strangely contrast with the narrow basis of the premises. With a greater amount of evidence in reference to the Northern continent, the conclusions still go far beyond anything established by absolute proof; and the subsequent labors of Morton himself, and still more, of some of his successors, seem to have been conducted on the principle of applying practically, and in all possible bearings, an established and indisputable scientific truth, instead of testing by further evidence a novel and ingenious hypothesis.

Dr. Latham, after commenting on the manifest distinctions which separate the Esquimaux of the Atlantic from the tribes of the American aborigines lying to the south and west of them, as elements of contrast which have not failed to receive full justice, adds: "It is not so with the Eskimos of Russian America, and the parts that look upon the Pacific. These are so far from being separated by any broad and trenchant line of demarcation from the proper Indians or the so-called Red Race, that they pass gradually into it; and that in respect to their habits, manner, and appearance, equally. So far is this

the case that he would be a bold man who should venture in speaking of the southern tribes of Russian America, to say: *here the Eskimo area ends, and here a different area begins.*"* The difference thus pointed out may be accounted for, to a considerable extent, by the diverse geographical conformation of the continent, on its eastern and western sides, which admit in the latter of such frequent and intimate intercourse as is not unlikely to lead to an intermixture of blood, and a blending of the races, however primarily distinct and diverse. The evidence presented here, however, refers to tribes having no such intercourse with the Esquimaux, and distinguished from them by many important characteristics, in manners, social habits, and external physiognomy. Nevertheless if these conclusions, deduced from an examination of Canadian crania, are borne out by the premises and confirmed by further investigation, this much at least may be affirmed: that a marked difference distinguishes the Northern tribes, now or formerly occupying the Canadian area, in their cranial conformation, from that which pertains to the aborigines of Central America and the southern valley of the Mississippi; and that in so far as the Northern differ from the Southern tribes, they approximate more or less, in the points of divergence, to the characteristics of the Esquimaux:—that intermediate ethnic link between the Old and the New World, acknowledged by nearly all recent ethnologists to be physically a Mongol and Asiatic, if philologically an American.

ON ATOMIC CONSTITUTION AND CRYSTALLINE FORM AS CLASSIFICATION CHARACTERS IN MINERALOGY.†

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The difficulties that beset the framing of a satisfactory classification in Mineralogy are altogether unknown in other departments of Natural Science. These difficulties originate essentially in the compound nature of minerals, or, in other words, in the apparent absence of corelation between the chemical and physical characters of these bodies. So long as we are forced to admit the existence of dimorphous substances—so long as chemistry remains unable to distinguish or

* Varieties of Man, p. 291.

† Abridged from a paper read before the Montreal Meeting of the American Association for the Advancement of Science.

individualize these—so long must the physical nature of the mineral embodiment claim to be considered, and to be considered prominently, in the classification. The time is now altogether departed when calcite and iron-spar, for example, were held to be less nearly related than calcite and arragonite.

But if this truth be now almost universally admitted, there seems to be a strong tendency in its application to make all characters subservient to two: atomic constitution on the one hand, and crystalline form on the other; and to force these into correlation, by the assumption of various arbitrary and scarcely consistent principles. I do not, of course, intend to deny the high value of these characters, considered generally; but I feel warranted in asserting that, by their arbitrary employment, to the exclusion of other considerations, many really unphilosophical groupings are so concealed under an apparently philosophical garb, as seriously to retard the proper progress of the science.

That mere agreement of crystalline form—even in minute angular measurements, planes of composition, &c.—is really in many instances of no greater value as a classification-character than similarity of hardness or lustre, is necessarily forced upon us, to cite but a single case, by the crystalline identity of borax with augite. That the identity in question may be explained, perhaps, not only here but in other cases, by reference to atomic volume, does not in any way invalidate our argument. Borax and augite, alike in crystalline form, are, when viewed as minerals, when considered in their entire relations, altogether dissimilar. Hence, if two minerals happen to exhibit the same forms and combinations, with corresponding angles, &c., they are not solely on that account to be placed in the same classification group, because, as shewn in the example just referred to, in all their other relations—their essential mineral relations—they may stand most widely apart.

Atomic constitution, on the other hand—even if we shut our eyes to the fact of its arbitrary and unsettled character—is of no greater value. Minerals may be assumed to possess, wholly or in part, the same atomic constitution, and yet be utterly opposed in habitus, in conditions of occurrence, in all in fact that constitutes their mineral embodiment. Subdivisions, consequently, founded on this principle, become most artificial. Iron pyrites, for example, is commonly considered to be represented by the formula FeS^2, whilst in magnetic pyrites and in copper pyrites we have, as one of the constituents, the compound Fe^2S^3. A sesqui-sulphide (Sb^2S^3 or As^2S^3) is also present (according to the received opinion) in the red silvers, zinkenite, &c.; but who will for a moment maintain that copper pyrites (to say nothing of magnetic pyrites) is not more closely related, in every

essential respect as a mineral, to iron pyrites, than to these latter substances. It is utterly impossible not to admit this. Nevertheless, if we blindly follow the chemical view, we are actually forced to maintain the contrary. In the well-known *Krystallo-chemische System* of Gustav Rose, for example—a system held up by many as a perfect model—magnetic and copper pyrites are not only widely separated from iron pyrites, but they are placed in the same general division with the red silvers, zinkenite, jamesonite, &c. And, in like manner, the carbonates and titaniates, the silicates and sulphates, &c., stand together, from the assumed constitution of their respective acids. Arrangements of this kind may be to a certain extent convenient, but who will venture to call them anything more. Natural classifications akin to those of the botanist and zoologist, most assuredly they are not. Although opposed to my earlier belief, I now feel confident that a satisfactory classification of minerals will never be accomplished until the mineralogist cease altogether the attempt to force his groupings into corelation with the present views of Chemistry. Let it not be forgotten, that Mineralogy has in more than one instance, when in seeming opposition to Chemistry, led the chemist to the adoption of new principles by which the harmony of the two sciences has been maintained; and hence it may be legitimately inferred that, if the mineralogist proceed fearlessly to classify the objects of his study without regard to the restrictions which Chemistry would set before him, further means of agreement will be found to reconcile any differences that may spring up from this independent method of procedure. At present, Chemistry is to the mineralogist, in many respects, a tyrant the most absolute, compelling him by its exactions to groupings in which natural analogies have not the slightest voice. If two compounds have the same representative formulæ, or if amongst binary compounds of oxygen or sulphur, for example, the basic elements happen to be isomorphous or otherwise related in the simple state, they must be placed in the same group, no matter how loudly their physical characters and general conditions of occurrence may exclaim against it. In this manner, in a mineral classification beyond comparison the most philosophical in its general features yet arrived at, we have the unavoidable union of carbonic acid gas with sassolin (hydrated boracic acid) and quartz: the three occurring together, as binary oxygen compounds, the respective bases of which (carbon, boron, silicon,) happen in the simple state to be of a kindred nature. In the system of Gustav Rose again, arsenic acid and iron-glance are placed in the same group, simply because the two are sesqui-oxygen compounds; a collocation permissible, perhaps, in the case of sesqui-

oxide of iron and arsenic acid as laboratory or chemical products, but certainly without value as regards the occurrence of iron-glance and arsenic acid in their conditions as minerals—in relation to which the following leading truth cannot be too strongly insisted on, viz.: that *chemical compounds and minerals are two and distinct;* frequently, at least, if not always so. In the vast majority of cases, the products obtained by the chemist from a given mineral are not in the same condition as that in which they existed prior to their separation, and hence are not, when properly considered, the same bodies. Allowing, first of all, that bodies in combination preserve their atomic constitution unchanged, does it necessarily follow that they preserve their actual physical conditions, or what we may call their normal state of occurrence? Carbonic acid, water, &c., if present as such in solid bodies, must evidently be present in some physical condition altogether unknown to us. Amongst simple bodies also, oxygen, chlorine, &c., may be said to follow a similar law; and hence we are not justified in reasoning upon the nature of compound bodies from the nature of their constituents when uncombined. But it may also be fairly inferred, that compound bodies in combination do not always retain the atomic constitution which they are assumed to possess in the simple state; and if so, the formulæ by which we are accustomed to represent these combinations may be absolutely false, and thus worse than valueless, because leading to groupings of an artificial and arbitrary character. When we place cinnabar in the same group with galena, or, on account of the hexagonal crystallization, in a sub-group with millerite and arsenical nickel (kupfer nickel), for example, we know that by the test of the botanist and zoologist our collocation must be pronounced a faulty one; but we defend it on the plea that these minerals are each and all simple binary combinations of a metal with sulphur or with arsenic, exhibiting the general formula RS or RAs. But then the question arises—can we be quite sure of this? And so ultimately we find ourselves obliged to confess that, after all, our knowledge is limited to the fact (if fact it really be,) of the existence in these minerals of equal atoms of base and electro-negative element. This, however, does not necessarily exact for cinnabar the formula HgS. The real formula may be Hg^2S+HS^2. It is true that this latter compound HgS^2 has not yet been obtained in the laboratory, but analagous compounds of silver and copper (metals considered by Kühn and other chemists to be closely related to mercury,) exist, and whilst various recognized bodies still remain unisolated, the existence of the compound in question cannot be considered entirely hypothetical. At the same time I would not be understood to deny that HgS

may not be the true formula of cinnabar, because, even if such be the case, the peculiar character of the mineral may be accounted for by the not improbable assumption, that the mercury is present in some allotropic condition, essentially different from the normal state of mercury as known to us in its isolated aspect.

In the much-studied division of the silicates, we have a further proof of the really indefinite nature of our present formulæ, and consequently of the uncertain value of the groups founded on this consideration. For example: Al^2O^3 replaces SiO^3 in certain augites and hornblendes. Also, most probably, in staurolite, sillimanite, &c., and perhaps to a certain extent in some spinels and sapphires. On the other hand it is now universally allowed, that in the generality of silicates the formulæ are often greatly simplified by placing the Al^2O^3 among the monatomic bases, FeO, MgO, CaO, &c.,—a fact brought out very prominently by Professor Dana in the last edition of his *System of Mineralogy*, and in other publications. Hence, if Al^2O^3 sometimes replace SiO^3, and sometimes replace the bases RO, there is no reason why SiO^3 should not also replace the latter in certain proportions. This granted, our present formulæ may be modified to almost any extent, and sub-groups thus obtained to suit all cases.

From these and other analogous considerations—such as will readily suggest themselves to all who have made the investigation of minerals their study—I think we may fairly admit that crystalline form and atomic composition are not alone sufficient for the foundation of a truly philosophic and satisfactory classification. Important as we may allow these characters to be, they are not all-important. The general aspect of the mineral, as indicating allotropic relations, its conditions of occurrence, and other characters, must also be allowed a certain value in the elaboration of at least our secondary groups.

ON THE DIVISION OF THE AZOIC ROCKS OF CANADA INTO HURONIAN AND LAURENTIAN.

BY SIR WILLIAM E. LOGAN, F. R. S.,
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Read before the American Association for the advancement of Science, at Montreal, August 13th, 1857.

The Subsilurian Azoic rocks of Canada occupy an area of nearly a quarter of a million of square miles. Independent of their stratifica-

tion, the parallelism that can be shewn to exist between their lithological character, and that of metamorphic rocks of a later age, leaves no doubt on my mind that they are a series of very ancient sedimentary deposits in an altered condition. The further they are investigated the greater is the evidence that they must be of very great thickness, and the more strongly is the conviction forced upon me, that they are capable of division into stratigraphical groups, the superposition of which will be ultimately demonstrated, while the volume each will be found to possess, and the importance of the economic materials by which some of them are characterized, will render it proper and convenient that they should be recognised by distinct names, and represented by different colors on the geological map.

So early as the year 1845, as will be found by reference to my report on the Ottawa district, presented to the Canadian Government the subsequent year, a division was drawn between that portion which consists of gneiss and its subordinate masses, and that portion consisting of gneiss interstratified with important bands of crystalline limestone. I was then disposed to place the lime-bearing series above the uncalcareous, and although no reason has since been found to contradict this arrangement, nothing has been discovered especially to confirm it; and the complication which subsequent experience has shewn to exist in the folds of the whole,—apparent dips being from frequent overtures of little value,—would induce me to suspend any very positive assertion in respect to their relative superposition, until more extended examination has furnished better evidence.

In the same report is mentioned, among the Azoic rocks, a formation occurring on Lake Temiscamang, and consisting of Siliceous slates and slate conglomerates, overlaid by pale sea-green or slightly greenish-white sandstone, with quartzose conglomerates. The slate conglomerates are described as holding pebbles, sometimes a foot in diameter, derived from the subjacent gneiss, the boulders displaying red feldspar, translucent quartz, green hornblende, and black mica, arranged in parallel layers, which present directions according with the attitude in which the boulders were accidentally enclosed. From this it is evident that the slate conglomerate was not deposited until the subjacent formation had been converted into gneiss, and very probably greatly disturbed; for while the dip of the gneiss, up to the immediate vicinity of the slate conglomerate, was usually at high angles, that of the latter did not exceed nine degrees, and the sandstone above it was nearly horizontal.

In the report transmitted to the Canadian Government, in 1848, on the north shore of Lake Huron, similar rocks are described as consti-

tuting the group which is rendered of such economic importance, from its association with copper lodes. The group consists of the same silicious slates and slate conglomerates, holding pebbles of syenite instead of gneiss; similar sandstones sometimes shewing ripple-mark, some of the sandstones pale sea-green; and similar quartzose conglomerates, in which blood-red jasper pebbles become largely mingled with those of white quartz, and in great mountain masses predominate over them. But the series is here much intersected and interstratified with greenstone trap, which was not observed on Lake Temiscamang.

These rocks were traced along the north shore of Lake Huron, from the vicinity of Sault Ste. Marie, for 120 miles, and Mr. Murray ascertained that their limit on the Lake Shore occurred near Shebahahnahning, where they were succeeded by the underlying gneiss.

The position in which the group was met with, on Lake Temiscamang, is 130 miles to the north-east of Shebahahnahning, and last year Mr. Murray, in exploring the White-Fish river, was enabled to trace the out crop of the group, characterized by its slates, sandstones, conglomerates, greenstones, and copper lodes, for sixty-five miles from Shebahahnahning to the junction of the Maskinongé and Sturgeon rivers tributary to Lake Nipissing. The general bearing of the out-crop is N.E., and an equal additional distance, in the same direction, would strike the exposure on Lake Temiscamang. In the portion which Mr. Murray examined last year, the dip appears to be about N.W., often at a high angle, while that of the subjacent gneiss is more generally S.E.; sometimes at a low angle, and in some places nearly horizontal.

To the eastward of this out-crop, Canada has an area of 200,000 square miles. This has yet been *but imperfectly* examined, but in so far as investigation has proceeded, no similar series of rocks has been met with in it; and it may safely be asserted that none exists between the basset edge of the Lower Silurian and the group from Shebahahnahning to the Mingan Islands, a distance of more than 1,000 miles, and probably still farther to Labrador.

The group on Lake Huron, we have computed to be about 10,000 feet thick; and from its volume, its distinct lithological character, its clearly marked date posterior to the gneiss, and its economic importance as a copper-bearing formation, it appears to me to require a distinct appellation, and a separate color on the map. Indeed, the investigation of Canadian Geology could not be conveniently carried on without it. We have, in consequence, given to the series the title of Huronian.

A distinctive name being given to this portion of the Azoic rocks, renders it necessary to apply one to the remaining portion. The only local one that would be appropriate in Canada is that derived from the Laurentide range of mountains, which are composed of it, from Lake Huron to Labrador. We have therefore designated it as the Laurentian series.

These local names are, of course, only provisional, devised for the purpose of avoiding periphrastic or descriptive titles, the use of which had been found inconvenient, and they can be changed when more important developments, proved to be the equivalents of the series, are met with elsewhere.

REVIEWS.

Essay on the Insects and Diseases injurious to the Wheat Crops. By H. Y. Hind, Esq., M.A., Professor of Chemistry at Trinity College, Toronto; to which was awarded by the Bureau of Agriculture and Statistics, the first prize. Toronto: Printed by John Lovell, 1857.

This essay,—the product of a competition for prizes recently offered by the Canadian Minister of Agriculture,—is quite as good as could have been expected, considering the circumstances under which it was produced. It is a compilation, and it could not well have been anything else; but it shows knowledge of the subject, industry, and judgment. If our farmers and country gentlemen take the trouble to examine it, they will doubtless derive much benefit from it. Some of them may, perhaps, say that it is too scientific for them and may fancy it better suited to the incipient entomologist than to the practical man; but the truth is, if any better means than we possess (which are but very imperfect) for controlling the ravages of insect pests are to be discovered, it must be through a knowledge of their nature and mode of life. Practical men have need of a certain amount of scientific knowledge, and Professor Hind gives the assistance many of them require in a clear, simple, intelligible style, without much superfluous matter. The practical suggestions are generally sound and useful, and as the reasons for them are explained, every one is enabled to form his own judgment.

The essay is not of mere temporary interest; it is a useful digest on a highly important subject, of what is to be found in various volumes, and in detached essays and observations scattered through periodicals; such as Harris' Insects injurious to vegetation, Fitch's

Essay, Kirby and Spence's Manual, &c. We are not aware that the author has availed himself of the valuable original work of Kollar, on injurious insects, which is in reality the chief source from whence the writers on this subject have derived much of their more valuable information.

Whilst the author has entitled himself to much credit for his diligence and research, we think the Minister of Agriculture may be satisfied with the working of his scheme, and may congratulate himself on having obtained for a very moderate copyright what cannot but be beneficial to the country. But where are the other prize essays? We expected to have seen all published in one volume; or at least a volume for Western Canada containing the two English essays, and one for Eastern Canada, containing the French prize essay, with a translation of Mr. Hind's. It would even, perhaps, not be lost labour to cull something for public use from the other essays, some of which the judges have named as containing valuable matter; and which even where they have the least pretension to literary merit, knowledge, or research, would doubtless, in some instances, convey a fact or opinion, which, communicated by a practical man and from patriotic motives, is not unworthy of being recorded. There may be obstacles to what we suggest, in the Bureau not claiming a right to use essays to which no prize has been awarded, in the cost of printing, and in a reasonable apprehension that increase in the quantity of matter diminishes the probability of its being made use of. But it is a pity not to secure all the benefit attainable from the labours of those who sent in their observations, some of them probably without expectation of reward, but with a desire to do what they could for the public service. It is hardly necessary to quote from Mr. Hind's essay, which will be in the hands of all who are interested in its subject. We congratulate him on the honorable distinction he has attained, and recognize with pleasure the merit of his work.

W. H.

Crania Britannica.—Delineations and descriptions of the skulls of the early inhabitants of the British Islands, together with notices of their other remains. By Joseph Barnard Davis, M.R.C.S.E., and John Thurnam, M.D. Decades I and II. London, Taylor and Francis.

In the introduction to this national work, the joint product of the zealous labours of Mr. J. Barnard Davis and Dr. Thurnam, Mr.

Davis plainly sets forth their aim, as a further effort in the same direction as "the two first permanent and beautiful superstructures" of the science of comparative cranioscopy, reared by Morton on the earlier foundations of Blumenbach. In all directions the enthusiastic students of British History are aiming to extend our vision further and more clearly into the past. Dr. Todd, Algernon Herbert, Graves, and a host of other zealous Celtic scholars, are restoring to us the most ancient native Literature of the British Isles. Kemble and Thorpe, following in the wake of Sharon Turner, with greater advantages and profounder scholarship, have thrown fresh light on the Anglo-Saxon era; Palgrave continues those labors which promise to complete the links requisite to unite in complete coherence Norman and Saxon England; and Latham, Petrie, Wright, Ackerman, Roach Smith, and other Archæologists and Philologists, extend their researches in various directions, and add new and diverse contributions to the same end. It is well, therefore, that such zealous co-adjutors as the authors of the *Crania Britannica* should be welcomed, in undertaking to add to all these one more resurrection from the ancient past, and to treat with adequate minuteness and accuracy of detail, another department of the theme which our great English Ethnologist, Pritchard, dealt with in so masterly a style.

The design aimed at in this new contribution to British Ethnology is, "to apply the study of the minuter diversities in the form of the skull to the discrimination and elucidation of the various ancient races who have dwelt in the British Islands, the forerunners, at least, if not the progenitors, of a people who may be safely assumed to occupy a place in future history, inferior to none who have preceded them. The investigation of the facts connected with these races is involved in obscurity from their remoteness in time; the want of information to be derived from the scanty notices of ancient writers, whether the consequence of imperfect knowledge, or inaccurate observation, or their use of ill-understood general terms; and especially from the fanciful speculations of learned theorists." To supply some of the desiderata thus deplored, an examination of the personal remains of the ancient people is accordingly resorted to. Their memorials of ancient arts, domestic habits, military skill, and sepulchral rites, have each and all been made to contribute their quota. Now, it is proposed to ascertain the ancient lineaments and physical characteristics of the people themselves, by means of the still enduring osseous remains of those who "swayed the rod of empire," while yet the cradle-land of Anglo-Saxondom was the seat of Celtic

and the arena of the Briton's untold history; or when the Saxon colonist was entering amid the Druid oak-glades of England, a stranger, like his hard descendant who pioneers the way amid the primeval forests of our far-west. Morton, in his *Crania Americana*, dealt with the ethnic craniology of a very wide and nearly virgin area. From the northern Arctic circle, to where the Terra del Fuego reaches towards Antarctic snows, the American Ethnologist sought to gather his materials, and from the data thus accumulated, conclusions applicable to the two continents of the new world have been deduced. Compared with such a wide field of investigation, the little island-home of the Saxons may well seem narrow ground for exploration. But to the Ethnologist it is not so. There, amid the rudest traces of primeval arts, he seeks, and probably not in vain, for the remains of primitive European Allophyliæ. There it is not improbable that both Phœnician and early Greek navigators have left behind them evidences of their presence, such as he alone can discriminate. There unquestionably was the home of the ante-christian Celt, and of the Picts, the Scots, the Belgæ, and other races of disputed origin. There, too, the Roman not only abode for upwards of three centuries, and left enduring memorials of his presence, but his sculptured tablets still attest the introductior by him of legionary colonists, not only from Gaul, Germany, Spain, and Italy, but from Asia Minor and Africa. Colonists from almost every people who had been subdued by the Roman arms were planted among the subject Britons, and these not in indiscriminate collocation, but each nationality with its own station assigned to it, where votive inscriptions and sepulchral tablets still guide the curious explorer to classify the remains he exhumes. There, too, in that same historic soil, lie the remains of the old Scandinavian Viking, Dane and Norseman, buried with the pomp of Pagan sepulture, that still tells of his northern birth-land.

As an example of the accuracy of the data thus open to investigation: amid the beautifully executed plates of life-sized crania of ancient Britons, Caledonians and Saxons, appear also more than one of the Roman conquerors. One of these was procured from a sculptured stone sarcophagus, on the outskirts of the ancient Roman Eburacum, or English York, around which lay numerous urns, paterœ, a terra-cotta lamp, and other remains of the foreign arts of the Roman Colonist. The partially mutilated Sarcophagus, belonging to the second, or at latest, the third century of our era, and is an invaluable adjunct, alike for the purposes of the Antiqua-

ry and the Ethnologist, from its bearing an inscription, which reads :—

MEI . . . . AL. THEODORI
ANI . . OMENT. VIXIT. ANN
XXXIV. M. VI. EMI. THEO
DO : : A. MATER. E. C

Imperfect as the memorial now reaches us, there is no doubt of its general tenor. It is the dedication by the Roman Matron Theodora, to the memory of her son, Theodorianus, who died at the age of thirty-four, in that remote outpost of the empire, far from Nomentum, his Latian or Sabine home. The skull of Theodorianus is a fine example of the old Roman cranium. Dr. Thurnam remarks of it:—"It is unusually capacious, and its dimensions are much above the average in almost every direction." The deductions from this single skull well illustrate how far such materials may contribute to the recovery of minute and accurate knowledge in the hands of a cautious and experienced observer. The fine aquiline profile is still discernible, slightly marred by a partial prognathic character in the jaws and position of the teeth. The uneroded crowns of the latter suffice to show the nature of the diet, and the civilized habits of the old Roman, in contrast to those of the native Britons of his age. *Still* further the condition of the sutures, and of the internal surface of the skull, suggest the habits of the soldier, who had not passed through the ordeal of war without sharing freely in its dangers.

"There is conclusive evidence in this noble cranium of Theodorianus," says Mr. Davis, "—the like of which we by no means anticipate meeting with in the further course of our labours,—that he was a fine Roman, of tall stature, over whose premature decease a tender mother might naturally grieve with a deep sorrow. His native country was near the imperial city itself, his family, without doubt, of consequence, and his residence in Britain possibly connected with the command of the legion which garrisoned Eburacum for so many years."

In dealing with the sepulchres of the old Briton or Saxon, the Ethnologist cannot, as with the Roman, quote the inscription which records the name and age, the birth place, and the race of the owner. But other and scarcely less intelligent records supply its place. In the *Crania Britannica* there are accordingly introduced, along with the beautifully executed cranial illustrations, other plates, besides wood cuts, which show unmistakeably the very diverse character of the sepulchral disclosures which establish the evidence of

ownership in the old burial mounds and cists of the British Isles. Here are engraved the primitive cinerary urns and domestic pottery from the ancient British Barrows of Staffordshire and Derbyshire, and the rude stone cist of Juniper Green, near Edinburgh. The flint implement of Ballidon Moor Barrow, tells of the rudest barbarism of Britain's primeval night; while at the same time such sepulchral architecture as the Gloucestershire chambered and galleried tumulus of Uley, the Derbyshire cist and megalithic mound of Parsley Hay Low, or the cist and superincumbent urn-chamber of Ballidon Moor, reveal the mode of thought of an era, analogous in its constructive ideas to that which gave birth to the pyramids and catacombs of the Nile valley. Another era succeeded, of the arts of which, the bronze dagger of End Low Barrow, Derbyshire, and the horse furniture, glass beads, and personal ornaments of the Yorkshire Barrows, furnish striking illustration; and then we come to the Iron umbos and spearheads, and the ponderous sword, of the Saxon Graves of Salisbury and Gloucester, the situla and cinerary urns of Linton Heath, Cambridgeshire, and with these the curiously ornamented glass vase, the fibulæ, and the toilet implements of Saxon times. Between the first and last of these, the era of Theodorianus intervenes, with the sculptured and inscribed Sarcophagi, the classic pottery and other intruded foreign arts of Roman Yorkshire; and, later than all, the Dane and Norseman tell, by Runic inscriptions and sepulchral hoards of the implements and the weapons of Northern Europe, how another, and yet another wave of colonization, mingled the diverse races of Europe with the elder colonists of the British Isles.

Such is the rich field of Ethnological research which Dr. Thurnam and Mr. Davis have undertaken to explore and to illustrate, with the added feature of accurate and critical descriptions and drawings of the osteological remains. The work is to be published in six "Decades," of which two only have appeared, embracing as yet incompleted chapters, and partially apportioned illustrations to some of the completed descriptions. Some of the most important questions that have recently attracted the attention of British Ethnologists and Archæologists, are expressly reserved for discussion at the close, and even of those which may be assumed to be completed, such as the interesting and suggestive one from the pen of Mr. Davis, on "Distortions of the Skull," it is to be anticipated that further illustrations may incidentally occur during the progress of the work. It would obviously, therefore, be premature to anticipate the final de-

ductions of the authors, or to discuss the comprehensive questions which the work illustrates, from imperfect and unclassified materials. Meanwhile we may record our conviction, that for beauty of typography, and artistic skill and minute accuracy of illustration, we can scarcely conceive the work surpassed. When completed it will form a mine of information to be worked by many a succeeding laborer, and must be considered as an indispensable addition to every public and scientific library.

D. W.

SCIENTIFIC AND LITERARY NOTES.

CHEMISTRY.

FLUORINE.

Nicklès is of opinion that the usual test for fluorine is not so reliable as has been supposed. Sulphuric acid, however carefully purified, often contains traces of hydrofluoric acid, and also from the fact that the vapours of any acid, or even of water at a rather elevated temperature, are capable of acting upon glass so as to produce an engraving similar to that obtained by hydrofluoric acid, additional grounds for doubt exist. He recommends the substitution of plates of rock crystal for those of glass, that substance being acted on only by hydrofluoric acid.

ALUMINA.

Gaudin has obtained hard, brilliant and clear crystals of alumina by introducing into a crucible, luted with lamp-black, equal parts of common alum and bisulphate of potassa, previously calcined and reduced to powder. The crucible is submitted to the violent heat of a blast furnace for a quarter of an hour. On breaking the crucible we find, in the hollow of the luting, a concretion bristling with brilliant points. The alumina is separated by dilute nitromuriatic acid.

TANTALUM.

Rose has obtained a niturct of tantalum, and has described the processes for obtaining tantalic acid, perfectly pure, by fusion with the bisulphate of potassa or ammonia. The acid dissolves in the latter salt, forming a clear syrup, which remains clear for years; the solution takes place at a temperature below a dull red heat, and may be effected in a glass flask. Tantalic acid, obtained by the decomposition of the perchloride, or by the action of sulphurous acid on a solution of the tantalate of soda, differs from that obtained by fusion, inasmuch as it exhibits incandescence when heated, which the other does not. From this and other circumstances Rose concludes that there are two modifications of tantalic acid, the one convertible into the other by heat. He has also examined the various salts which it forms with potassa.

TANNIN.

By acting upon some organic compounds with boiling alkaline solutions, in an atmosphere of hydrogen, Rochleder has succeeded in decomposing several, and

producing grape sugar. Tannin, when thus treated, readily gives oxalic acid, and a yellowish amorphous substance, like gum arabic, having the same composition as cane sugar but none of its reducing power. No trace of sugar is formed during this reaction.

STRYCHNINE.

Prollius proposes a method for separating strychnine, which promises to be of considerable value in toxicological investigations. The substance is digested with alcohol and a little tartaric acid, gently evaporated to a small bulk, and filtered to separate the fat. (If evaporated to dryness the fat might be separated by ether, which does not dissolve salts of the alkaloids.) To the filtrate ammonia is added, then a small quantity of chloroform, and the whole strongly agitated. The chloroform, which settles to the bottom, is drawn off and washed, mixed with three times its bulk of alcohol, and allowed to evaporate. Fine crystals of strychnine are thus obtained in a state of absolute purity.

H. C.

MATHEMATICS AND NATURAL PHILOSOPHY.

THE RELATIONS OF GOLD TO LIGHT.

At a meeting of the Royal Institution, in June last, Professor Faraday read a communication on the relation of gold to light. In this he furnished additional views and observations of great interest, in continuation of a former paper on the same subject, read by him last year, and printed in the *Proceedings* of the Royal Institution (Vol. II. p. 310.) The general relations of *gold leaf* to light are described in the former communication. The following is a summary of the additional remarks which complete the report of Professor Faraday's observations on the subject up to this time:—Since the printing of the former paper pure gold leaf has been obtained, through the kindness of Mr. Smirke, and the former observations verified. This was the more important in regard to the effect of heat in taking away the green colour of the transmitted light, and destroying to a large extent the power of reflection. The temperature of boiling oil, if continued long enough, is sufficient for this effect; but a higher temperature (far short of fusion) produces it more rapidly. Whether it is the result of a mere breaking up by retraction of a corrugated film, or an allotropic change, is uncertain. Pressure restores the green colour, but it also has the like effect upon films obtained by other processes than beating. Corresponding results are produced with other metals. As before stated, *films* of gold may be obtained on a weak solution of the metal, by bringing an atmosphere containing vapours of phosphorous into contact with it. They are produced also when small particles of phosphorous are placed floating on such a solution; and then, as a film differing in thickness is formed, the concentric rings due to Newton's thin plates are produced. These films transmit light of various colours. When heated they become amethystine or ruby, and then when pressed become green, just as heated gold leaf. This effect of pressure is characteristic of metallic gold, whether it is in leaf, or film, or dust. Gold wire, separated into very fine particles by the electric *deflagration*, produces a deposit on glass, which, being examined, either chemically or physi-

cally, proves to be pure metallic gold. This deposit transmits various coloured rays; some parts are grey, others green, or amethystine, or even a bright ruby. In order to remove any possibility of a compound of gold, as an oxide, being present, the deflagrations were made upon topaz, mica, and rock crystal, as well as glass, and also in atmospheres of carbonic acid and of hydrogen. Still the results were the same, and ruby gold appeared in one case as much as in another. Being heated, all parts of the deposit became of an amethystine or ruby colour; and by pressure these parts could be changed so as to transmit the green ray. The production of *fluids*, consisting of very finely divided particles of gold diffused through water, was spoken of before. These fluids may be of various colours, by transmitted light, from ruby to blue; the effects being produced only by diffused particles of metallic gold. If a drop of solution of phosphorous in bisulphide of carbon be put into a bottle containing a quart or more of very weak solution of gold, and the whole be agitated, the change is brought about sooner than by the process formerly described; or if a solution of phosphorous in ether be employed, very quickly indeed; so that a few hours' standing completes the action. All the preparations have the same qualities as those before described. The differently coloured fluids may have the coloured particles partially removed by filtration; and so long as the particles are kept by the filter from aggregation, they preserve their ruby or other colour unchanged, even though salt be present. If fine isinglass be soaked in water, then warmed to melt it, and one of these rich fluids be added, with agitation, a ruby jelly fluid will be obtained, which, when sufficiently concentrated and cold, supplies a tremulous jelly; and this, when dried, yields a *hard ruby gelatine*, which being soaked in water becomes tremulous again, and by heat and more water yields a ruby fluid. The dry hard ruby jelly is perfectly analagous to the well known ruby glass, though often finer in colour, and both owe the colour to particles of metallic gold. Animal membranes may in like manner have ruby particles diffused through them, and then are perfectly analagous in their action on light to the gold ruby glass, and from the same cause. When a leaf of beaten gold is held obliquely across a ray of common light, it *polarizes* a portion of it, and the light transmitted is polarized in the same direction as that transmitted by a bundle of thin plates of glass; the effect is produced by the heated leaf as well as by the green leaf, and does not appear to be due to any condition brought on by the heating, or to internal structure. When a polarized ray is employed, and the inclined leaf held across it, the ray is affected, and a part passes the analyzer, provided the gold film is inclined in a plane forming an angle of 45° with the plane of polarization. Like effects are produced by the films of gold produced from solution and phosphorous, and also by the deposited dust of gold due to the electric discharge. The same effects are produced by the other deflagrated metals so long as the dusty films are in the metallic state. As these finer preparations could be held in place only on glass or some such substance, and as glass itself had an effect, it was necessary to find a medium in which the power of the glass was nothing; and this was obtained in the bisulphide of carbon. Here the effect of gold upon a ray of light which was unaffected by the glass supporting it, was rendered manifest, not only to a single observer, but also to a large audience. The object of these investigations was to ascertain the varied powers of a substance acting upon light, when its particles were extremely divided, to the exclusion of every other change of constitution. It was hoped that some of the very important differences in the action upon the rays might in

this way be referred to the relation in size or in number of the vibrations of the light and the particles of the body, and also to the distance of the latter from each other, and as many of the effects are novel in this point of view, it may be anticipated that they will prove of service to the physical philosopher.

THE SUPPOSED DECENNIAL INEQUALITY IN THE LUNAR-DIURNAL MAGNETIC VARIATION.

In 1854 General Sabine stated to the British Association that he had at that time found no trace, in the magnetic variations depending on the moon, of the ten-years period which is so distinctly marked in those depending on the sun, and in 1856, after an elaborate discussion of the Toronto observations, he stated this conclusion to be decisively confirmed. M. Kreil having, however, indicated an opinion that the observations at Milan and Prague rather favored the supposition that the same decennial period which exists in the solar variation affects also the lunar magnetic influence, General Sabine, with the unwearying zeal which distinguishes him, has submitted to analysis the eight years observations at Hobarton, and finds therein confirmation of the conclusions he had arrived at from the Toronto observations, namely, that no such decennial period as Mr. Kreil supposed is to be traced in the magnetic influence of the moon, while such a period is indubitably shewn in that of the sun, whether examined by means of the "disturbances," or of the "mean" solar variation. With regard to the former General Sabine remarks that, "when the disturbances, occurring at Hobarton during eight years, are broken into four distinct and equal portions, each of two years duration, each such portion manifests the same periodical law of diurnal variation, almost identical in the principal features of direction and turning hours, and differing only in the *magnitude of the* variation in different years, in which difference it conforms strictly to the decennial period, as indicated elsewhere, having a minimum in 1843-44, and a maximum five years later. This law may be accounted a general one, since it has been found to prevail at stations so widely distant from each other as Toronto, St. Helena, and Hobarton." The same result follows when the mean diurnal solar variation, the larger disturbances being excluded, is examined, both for the eight years 1841-8, when the observations were made hourly, and also when the six succeeding years are included, during which two-hourly observations were taken. By treating in the same way the lunar-diurnal variations, General Sabine shows that the differences in these "show no conformity to the inequality manifested in those of the solar-diurnal variations." With this weight of evidence, we may fairly conclude that the ten years' period has no existence for the moon, and thank General Sabine for the settlement of this vexed question.

ON THE COMPOSITION OF COLOURS.

Professor Challis, in the Phil. Mag., November, 1856, has attempted to give an explanation of this difficult matter, on the principles of the undulatory theory. Taking for his guide the analogy of sound, and a hint thrown out by Sir J. Herschel in his well-known treatise, Professor Challis proceeds to compound two simple undulations of different wave-lengths. As a musical note is produced by a regular succession of similar vibrations, while a mere noise is produced by irregular impulses, so he conceives a simple colour to consist of vibrations, whose type composes only one wave length and amplitude, while a mixed colour, of whiteness, is produced by the coëxistence of different types; melody thus corresponding to pure colour, harmony to mixed colour, and unmusical noise to white

light. By throwing the compounded velocity of two colours (taking the usual cycloidal type) into a peculiar analytical form, he shows that the resulting vibration will consist partly of a colour whose wave-length is a harmonic mean between those of the original, and partly of irregularities, which may cause the sensation of whiteness, and dilute the colour, and may sometimes be powerful enough to overcome the sensation of colour altogether. This, however, requires that the maximum velocities in each vibration shall not be very different from each other, and Professor Challis ingeniously employs this to account for the fact that the mixing of coloured substances produces different results from the mixing of the prismatic colours which to all appearance are identical with the former. The method gives a good explanation of complementary colours, and of several other well-known facts in colour-compounds, as given by Newton, Helmholtz, Maxwell, and others. It also leads to the abandonment of the doctrine (always looked on with suspicion) of three primitive colours. There is one point Professor Challis does not notice, which is this: in the composition of two musical notes, whether, by the superposition of vibrations on the vibrating body (as in a string, giving out two notes at the same time), or by their union on entering the ear, each note is still heard separately, and the sensation of harmony is altogether different from the perception of its components; in colour, however, the union of the two may destroy this perception of the components, and give rise to a single sensation only. Now, if we take the same precise analytical forms of vibration in the two cases, it does not appear manifest how this distinction may be made visible in the analytical result. The whole subject is, however, a very difficult one, and, whether altogether sound or not, this idea of Professor Challis is well worth carrying out.

PROFESSOR W. THOMSON'S BAKERIAN LECTURE (R. S., FEB. 28, 1856.)

This lecture communicates some most valuable discoveries and experiments made by the author in electro-thermotics. (1.) An electric current in an unequally heated conductor, if its nominal direction be from hot to cold through the metal, causes a cooling effect in iron and a heating effect in copper. Brass has the same property as copper, and platinum as iron, with respect to this electric conversion of heat. (2.) In thermo-electric inversion between metals, a mode of experimenting is described by which inversions, when they exist, may readily be detected, and the temperature of neutrality determined with precision. Various substances have in this way been subjected to trial by the author. (3.) The effects of mechanical strain, and of magnetisation, on the thermo-electric qualities of metal, are investigated. In a mass of iron under longitudinal stress, the thermo-electric quality *across* lines of traction differs from that *along* lines of traction as bars of bismuth differ from bars of antimony. Unstrained iron has intermediate thermo-electric quality between those of the two critical directions under distorting stress. The effect of permanent lateral compression is the same as that of permanent longitudinal extension, or of hardening by wire-drawing, upon the thermo-electric quality of a wire placed lengthwise in an electric circuit in iron, being a deviation from the [*un?*] constrained metal towards bismuth, and in the other metals (copper, tin, brass, platinum, cadmium and lead [?]), a deviation towards antimony; also that in copper and iron, it is the reverse of the effect experienced by the same metal while under the stress that caused the strain. Generally, it is inferred, that in iron hardened by compression in one direction,

the thermo-electric qualities in this direction differ from those in lines perpendicular to it as antimony differs from bismuth; that the reverse statement applies to iron hardened by traction in one direction; and that in each case the thermo-electric quality of soft iron is intermediate to the two differing states.

Again, in soft iron under magnetic force, and in that permanently magnetised after the removal of the magnetising force, directions along the lines of magnetisation deviate thermo-electrically towards antimony, while those perpendicularly across the lines of magnetisation deviate towards bismuth, from the unmagnetised metal. Thus if a riband of iron, magnetised at an angle of 45° to its length, be heated along one edge while the other is kept cool, when the two ends, kept at the same temperature are put in communication with the electrodes of a galvanometer, a powerful current is indicated, in such a direction that, if pursued along a rectangular zigzag from edge to edge through the band, the course is always from *across* to *along* the lines of magnetisation through the *hot* edge, and from *along* to *across* the same lines through the *cold* edge. (4.) Various experiments were made to detect the effects of certain influences on the electric conductivities of metals. For instance, longitudinal magnetisation diminishes the conducting quality of iron wire, and its electric conductivity is greater across than along lines of magnetisation; also, by magnetisation across the lines of electric current, iron gains in conducting power, whence it is inferred that there is a certain direction, oblique to the lines of magnetisation, along which the conductivity of magnetised iron would remain the same on a cessation of the magnetising force.

ON THE TEMPERATURE AT TORONTO.

In the Phil. Mag., Nov., 1856, Mr. S. M. Drach points out that General Sabine's formula (Phil. Trans., 1852) can be put approximately into the simple form—

$44°.23 - 21°.81 \sin a - 1°.06 \cos 2a - 0°.80 \cos 3a + 0°.22 \cos 4a - 0°.88 \sin 5a$

where a is the angle reckoned at 30° a month from October 24th, which is the epoch of mean annual temperature. Hence he suggests that the meteorological year should be taken from October to September inclusive.

A NEW SPHYGMOSCOPE.—BY DR. S. SCOTT ALISON, (PROC. L.S.)

This instrument, designed for the purpose of indicating the movements of the heart and blood-vessels, consists of "a small chamber containing spirits of wine or other liquid, provided with a thin india-rubber wall where it is to be applied to the chest. This chamber communicates with a bent graduated tube which rises to some height above the level of the chamber; liquid is supplied to the instrument till it spreads in the tube a little above the level of the chamber. The pressure of this liquid, acting on the elastic wall, causes it to protrude, and the protruding part is very sensible to external impulse, yielding to the slightest touch, and, being pushed inwards or returning outwards, causes a rise or fall of the liquid in the tube, the amount and duration of which can be estimated with much delicacy. By means of this instrument, Dr. Alison has detected two great laws not hitherto known, namely, 'that the beat of the heart *alternates* with the pulse of the wrist,' and, 'that the pulse of arteries beyond the chest takes place in all parts at the same instant, and without any appreciable interval.'"

PHOTOGRAPHY.

The attention of Photographers has been mainly directed of late to the perfecting of some dry process by which the necessity of immediately using the wet

collodion film may be obviated. Many modifications of Shadbolt's original honey-process have been proposed, and the use of various substances, such as glycerine metagelatine, golden-syrup, oxymel, has been recommended, all adopting for their basis the principle of washing off the free nitrate of silver after the plate has been excited, and then covering it with the preservative syrup which keeps it moist and prevents the small excess of free nitrate left on the collodio-iodide from drying and crystallising. Another plan, claimed by several originators, is remarkable, consisting in leaving the excited plates in distilled water, when, if protected from the light, they will retain their sensitiveness for weeks unimpaired. The most promising however seems to be Taupenot's Albumen process (described in Can. Journ., Vol. I., N.S., pp. 195) of which the following is the latest simplification, as practised by Mr. H. P. Robinson. The Nitrate-Bath consists of: Nitrate of Silver, 35 grs., Glacial Acetic Acid, 1 min., Distilled Water, 1 oz. Having coated the plate with collodion, and excited as usual, let it be immersed for about one minute in distilled water, then washed for two or three minutes under a tap, allowed to drip for a minute, and then have poured over it some iodised albumen which need only remain for a few seconds on it. This iodised albumen is made as follows: Albumen, 1 oz.; Distilled Water, 2 drachms; Ammonia, 8 minims; Iodide of Ammonia, 5 grs.; Bromide of Ammonia, 1 gr.; dissolve the iodide and bromide in the water, and then add the ammonia to the albumen, beat the whole into a froth, and, when again liquified, strain through calico. The plates may now be put away to dry; they are perfectly insensitive to light, and will keep for any length of time. When wanted for use, dip them again into the nitrate-bath for one minute, and wash precisely as before. They are now ready for the camera, and may be kept (in darkness of course) for weeks without losing sensitiveness. Develope with pyro-gallic acid, adding free nitrate, if necessary, (this is a long process), and fix with hyposulphite of soda.

Mr. Hardwich has brought out another edition of his excellent treatise on Photographic chemistry: he now recommends the use of fused nitrate of silver instead of the crystallised. Mr. Scott Archer, the inventor of the Collodion process has died, leaving a widow and family in distressed circumstances. A committee of the Photographic Society has been formed to raise a subscription for them and to urge their claims on government for pecuniary aid. Mr. Crookes and Mr. Grubb have succeeded in procuring photographic images of the moon—the former with the Liverpool Equatorial obtaining good negatives in four seconds. No practical benefit seems likely to result from this mode of operation, as the minute image thus formed loses its distinctness on being magnified. Is Bromine of any use in Photography? It seems conceded that in the paper-processes Bromine is useful in gaining intensity; but in collodion there does not appear to be the same result. For some time it was imagined that the Bromide was peculiarly sensitive to the green rays of the spectrum, and was on this account advantageously employed when vegetation and foliage were to be photographed; but Mr. Crookes has shown that the only part of the spectrum where it enjoys any advantage over the Iodide is the unimportant and narrow strip between Fraunhofer's *b* and *G*, so that its fancied superiority vanishes compared with the injury it inflicts on the film. Mr. Shadbolt has confirmed by a remarkable experiment the inference of M. Claudet, that the yellow rays not only destroy the actinic effect of the blue, but actually reverse it. Mr. Shadbolt says: "I coated and excited a glass plate in the usual way, and exposed it to the light. I then took a piece of stained

yellow glass and covered with it one half of this plate. I then exposed the whole to the direct rays of the sun for ten minutes, and afterwards placed the same plate in the camera in order to attempt to take a picture upon it. In developing, the part I had covered with yellow glass after previously exposing the whole to the light, produced a picture, (though not a very good one), and the part left uncovered, produced, as might have been expected, a perfect mass of blackness; hence I conclude that the yellow glass undid the work that had previously been done by the ordinary light."

Photographers seem now to be pretty generally convinced that positive paper prints, if toned by hyposulphite of soda, will fade when exposed to moisture. Mr. Shadbolt publishes a process in which sulphide of silver (a permanent compound) is substituted for the ordinary sulphuret. The paper is salted on a bath of gelatine, 1 gr.; Chloride of Ammonium, 10 grs; Water, 1 oz. After exposure, it is washed with water, then with liq. amm. fort. diluted with four or five times its bulk of water; again washed with plain water, and then toned with a solution of hydrosulphite of ammonia; a final washing and drying completes the picture. The tone is said to be an agreeable brownish black, which acquires a yellowish tinge by time.

THE GREENWICH OBSERVATORY.

In the report of the Astronomer Royal to the Board of Visitors, the following curious fact is mentioned: "There is a well-marked annual periodical change in the position of the Transit Circle, the southerly movement of the eastern pivot having its minimum value in September, and its maximum in March, the extreme range being about 14 seconds; and there is a similar change, but of smaller amount, in the position of the Collimator. I cannot conjecture any cause for these changes, except in the motion of the ground. There is a very frequent change of still smaller amount in the Azimuth of the Transit Circle, accompanied by a nearly equal change in the apparent Azimuth of the Collimator, so that from day to day the Transit Circle and Collimator preserve their relative position unaltered; these I conceive to be the effects of accident in observation of the circumpolar stars, arising either from fault of the observer, or from irregularities either in the level or in the collimation; at the same time, viewing the great accuracy of the observations of circumpolar stars, and the extreme simplicity of the pivot-supports and of the instrument frame, I cannot conjecture how such irregularities can arise." During the past winter, Mr. Airy received intimation from Prof. Hansteen that the dip, as determined at Greenwich, appeared to have become greater than was consistent with the changes of dip going on in the North of Europe. A similar discordance was found to exist between Greenwich and Kew. This led Mr. Airy to examine the observatory instrument, and it was found so imperfect in its mechanical construction, that when the needle was lifted up from its agate bearings, its upper point almost always struck the brass circle. These defects have been amended, and the apparent dip is diminished by nearly the quantity which Prof. Hansteen conjectured. Mr. Airy regrets that this irregularity unfortunately causes the dip-observations at Greenwich for several years past to possess very little value.

COLONIAL MAGNETIC OBSERVATORIES.—BY MAJOR. GEN. SABINE. (PROC. R. S.)

The magnetic investigations designed to be carried into execution by the Colonial Observatories recommended by the Royal Society, embraced a much wider

scope than had been contemplated by any previous institutions, or than had been provided for by the arrangements or instrumental means of any then existing establishment, whether national or private. Not, as previously, limited to observations of a single element (the declination)—or combining at the most one only of the components of the magnetic force,—the instructions of the Royal Society, and the instrumental means prepared under its direction, provided for the examination, in every branch of detail, of each of the three elements which, taken in combination, represent, not partially, but completely, the whole of the magnetic affections experienced at the surface of the globe, classed under the several heads of absolute values, secular changes, and variations either periodical or occasional, —and proceeding from causes either internal or external. To meet the requirements of inductive reasoning, it was needful the results to be obtained should comprehend all particulars under these several heads, attainable by an experimental inquiry limited duration. That no uncertainty might exist as to the objects to which, in so novel an undertaking, attention was to be directed, the Report of the Committee of Physics, approved and adopted by the President and Council of the Royal Society, stated in a very few sentences, remarkable alike for their comprehensiveness and conciseness, the desiderata of magnetical science. It may be convenient to reproduce these, when desiring to show the degree in which the Observatories have fulfilled their contemplated purposes.—"The observations will naturally refer themselves to two chief branches, into which the science of terrestrial magnetism in its present state may be divided. The first comprehends the actual distribution of the magnetic influence over the globe, at the present epoch, in its mean or average state, when the effects of temporary fluctuations are either neglected or eliminated by extending the observations over sufficient time to neutralise their effects. The other comprises the history of all that is not permanent in the phenomena, whether it appear in the form of momentary, daily, monthly, or annual change and restoration; or in progressive changes not compensated by counter-changes, but going on continually accumulating in one direction, so as in the course of many years to alter the mean amount of the quantities observed."

With reference to the first of these two branches, viz., the actual distribution of the magnetic influence over the globe at the present epoch, the Report goes on to state:—"The three elements, viz., the horizontal direction, the dip, and the intensity of the magnetic force, require to be precisely ascertained, before the magnetic state of any given station on the globe can be said to be fully determined .....and as all these elements are at each point now ascertained to be in a constant state of fluctuation, and affected by transient and irregular changes, the investigation of the laws, extent, and mutual relations of these changes is now become essential to the successful prosecution of magnetic discovery."

With reference to the second branch, viz., the secular and periodical variations, it is observed that—"The *progressive* and *periodical* being mixed up with the *transitory* changes, it is impossible to separate them so as to obtain a correct knowledge and analysis of the former, without taking express account of and eliminating the latter;" and with reference to the secular changes in particular, it is remarked—"These cannot be concluded from comparatively short series of observations without giving to those observations extreme nicety, so as to determine with perfect precision the mean state of the elements at the two extremes of the

period embraced; which, as already observed, presupposes a knowledge of the *casual* deviations."

It is clear from these extracts that in the discussion of the observations, the first point, in the order of time, ought necessarily to be an investigation into "the laws, extent, and mutual relations of the *transient* and," (as they were called at the time the Report was written,) "*irregular* changes," as a preliminary step to the elimination of their influence on the observations, from which a correct knowledge and analysis of the progressive and periodical changes were to be obtained. It will be proper to show therefore, in the first place, what the Observatories have accomplished in regard to the so-called casual or transitory variations.

Casual Variations.—All that was known regarding these phenomena at the period when the Report of the Committee of Physics was written, was, that there occurred occasionally, and, as it was supposed, irregularly, disturbances in the horizontal direction of the needle, which were known to prevail, with an accord which it was impossible to ascribe to accident, *simultaneously* over considerable spaces of the earth's surface, and were believed to be in some unknown manner connected, either as cause or effect, with the appearances of the aurora borealis. The chief feature by which the presence of a disturbance of this class could be recognised at any instant of observation,—or by which its existence might be subsequently inferred independently of concert or comparison with other Observatories,—appeared to be, the deflection of the needle from its usual or normal position to an amount much exceeding what might reasonably be attributed to irregularities in the ordinary periodical fluctuations. The observations which had been made on the disturbances anterior to the institution of the Colonial Observatories had been chiefly confined to the declination. A few of the German Observatories had recently begun to note the disturbances of the horizontal force; but as yet no conclusions whatsoever had been obtained as to their laws: in the words of the Committee's Report, the disturbances "apparently observe no law." By the instructions cited above, the field of research was enlarged, being made to comprehend the disturbance-phenomena of the *three* elements; and the importance of their examination was urged, not alone as a means of eliminating their influence on the periodic and progressive changes, but also on the independent ground, that "the theory of the transitory changes might prove itself one of the most interesting and important points to which the attention of magnetic inquirers can be turned, as they are no doubt intimately connected with the general causes of terrestrial magnetism, and will probably lead us to a much more perfect knowledge of those causes than we now possess."

The feature which has been referred to as furnishing the principal if not the only certain characteristic of a disturbance of this class, viz., the *magnitude* of the departure from the usual or normal state at the instant of observation, has, in the discussion of the observations, been made available for the investigation of their laws: it has afforded the means of recognizing and separating from the entire mass of hourly observations, taken during several years, a sufficient body of observations to furnish the necessary data for investigating at three points of the earth's surface—one in the temperate zone of the northern hemisphere, a second in the temperate zone of the southern hemisphere, and a third in the tropics—the laws or conditions regulating or determining the occurrence of the magnetic disturbances. The method by which this separation has been effected has been explained on several recent occasions, and will be found fully described in the Phil-

Trans. for 1856, Art. XV. By a process of this description, the disturbances of principal magnitude in each of the three elements, the Declination, Inclination and Total Force, have been separated from the other observations, at the three Observatories of Toronto, Hobarton, and St. Helena, and submitted to an analysis of which the full particulars will be found in the preliminary portions of the volumes which record the observations. By the adoption of a uniform magnitude as constituting a disturbance throughout the whole period comprised by the analysis, the amount of disturbance in the several years, months, and hours, is rendered intercomparable. The result of this investigation (which could not be otherwise than a very laborious operation, since the observations at a single one of these stations, Toronto, considerably exceeded 100,000 in number, each of which had to be passed through several distinct processes,) has made known to us that the phenomena of this class, which may in future with propriety and advantage receive the appellation of "*occasional*," are, in their mean or average effects, subject to periodical laws of a very systematic character; placing them, as a first step towards an acquaintance with their physical causes, in immediate connexion with the sun as their primary exciting cause. They have—1, a *diurnal* variation which follows the order of the solar hours, and manifests therefore its relation to the sun's position as affected by the earth's rotation on its axis; 2, an *annual* variation, connecting itself with the sun's position in regard to the ecliptic; and 3, a third variation, which seems to refer still more distinctly to the *direct* action of the sun, since, both in period and in epochs of maximum and minimum, it coincides with the remarkable solar period of about *ten*, or perhaps more nearly *eleven*, of our years, the existence of which period has been recently made known to us by the phenomena of the solar spots; but which, as far as we yet know, is wholly unconnected with any thermic or physical variation of any description (except magnetic) at the surface of the earth, and equally so with any other cosmical phenomena with which we are acquainted. The discovery of a connexion of this remarkable description, giving apparently to magnetism a much higher position in the scale of distinct natural forces than was previously assigned to it, may justly be claimed on the part of the Colonial Observatories, as the result of the system of observation enjoined (and so patiently and carefully maintained), and of the investigation for which it has supplied the data; since it was by means of the disturbance-variations so determined, that the coincidence between the phenomena of the solar spots and the magnitude and frequency of magnetic disturbances was first perceived and announced (Phil. Trans. 1852, Art. VIII.)

The extent and mutual relation of the disturbance-variations of the three elements, even at a single station, supply a variety of points of approximation and of difference, which are well suited to elucidate the physical causes of these remarkable phenomena; but valuable as such aids may be when *obtained for a* single station, their value is greatly augmented when we are enabled to compare and combine the analogous phenomena, as they present themselves at different points of the earth's surface. To give but a single example:—there are certain variations produced by the mean effects of the disturbances which attain their maximum at Toronto during the hours of the night; the corresponding variations attain their maximum, at Hobarton, also during the hours of the night, but with a small systematic difference as to the precise hour, and with this distinguishing peculiarity, that the deflection at Hobarton is of the opposite pole of the needle (or of the same pole in the opposite direction,) to the Toronto disturbance; whilst

at a third station, St. Helena, which is a tropical one, the hours of principal disturbance are those not of the night, but of the day. A very superficial examination is sufficient to show that for the generalization of the facts,—a generalization which is indispensable for their correct apprehension and employment in the formation of a theory,—the stations at which the phenomena are to be known must be increased. Those which were chosen for a first experiment were well selected to prove the importance of the investigation, and thus to lead to its extension. It is only at the Colonial Observatories that the disturbance-variations have hitherto been made out; and taking experience as our guide, we have before us the evidence of the means by which the inquiry may be further successfully prosecuted.

Periodical Variations.—The anticipation expressed in the Report of the Committee of Physics, that for the purpose of obtaining a correct knowledge of the *regular periodical variations*, it would be found necessary to eliminate the "casual perturbations," has been fully confirmed. Had the latter been strictly "casual" (or accidental, in a sense contradistinguished from and opposed to periodical), a sufficiently extended continuance of observation might have occasioned their mutual compensation; but now that we have learned that the mean effects which they produce are governed by periodical laws, and that these laws and those of the regular periodical variations are dissimilar in their epochs, it is manifest that in their joint and undivided effects we have two variations, due to different causes and having distinct laws, superimposed upon each other; *to know the one correctly we must necessarily therefore eliminate the other.* A striking illustration of the importance of such elimination is furnished by the solar-diurnal variation of the total force. It will readily be imagined that the question must be an important one, whether a variation, which is supposed to derive its origin from the sun, be a single or a double progression; whether it have two maxima and two minima in the twenty-four hours, or but one maximum and one minimum in that period. When no separation is made of the disturbances, the progression appears to be a double one, having two minima, one occurring in the day and the other in the night. With the removal of the disturbed observations the night minimum disappears, and we learn that the regular solar-diurnal variation of the total force has but one notable inflection in the twenty-four hours, viz., that which takes place during the hours when the sun is above the horizon. The night minimum is in fact the mean effect of the occasional disturbances. It is probable that the nocturnal inflection of the solar-diurnal variation of the Declination may be ascribed to the same cause, namely to the superposition of two distinct variations.

A careful analysis of the solar-diurnal variations of the Declination at the Colonial Observatories has brought to light the existence at all these stations, of *an annual inequality* in the direction of the needle concurrent with changes in the sun's declination, having its maxima (in opposite directions) when the sun is in or near the opposite solstices, and disappearing at or near the epochs of the equinoxes. An intercomparison of the results of the analysis at these stations has shewn, that this inequality has the remarkable characteristic of having notably the same direction and amount in the southern as in the northern hemisphere, and in the tropical as in the temperate zones. An ingenious explanation of the phenomena has been suggested by Dr. Langberg of Christiana (Proceedings of the Royal Society, vol. vii., p. 434); but whether this explanation be or be not the correct one, the theoretical importance of the facts cannot be doubted, inasmuch as they appear to be wholly irreconcileable with the hypothesis which would attribute the

magnetic variations to thermic causation. We may ascribe to the general and almost exclusive prevalence of the thermic hypothesis, and to its influence on magnetic reasonings, that the well-known erroneous opinion was so confidently promulgated by a deservedly high magnetic authority, that a line *must* exist surrounding the globe, in which the needle would be found to have *no diurnal variation*. We have now, on the contrary, reason to be assured, by the facts of the annual inequality thus discovered, that there is no such line; but that everywhere in the regions of its supposed existence a diurnal variation subsists, having opposite characteristics in opposite parts of the year as influenced by the sun's position on either side of the equator, and disappearing only at the epochs when the sun passes from south to north or from north to south Declination.

Lunar Variation.—But if thermic relations have failed to supply a connecting link between the sun and those magnetic variations which are, without doubt, referable to the *sun* as their primary cause, the failure of that hypothesis is made still more obvious by the existence of variations governed by the *moon's* position relatively to the place of observation. We are indebted to M. Kreil, now holding the same position in Austria that I have filled in England, for the first suggestion of the existence of a lunar-diurnal variation of one of the elements, viz., of the Declination, founded on observations at Milan and Prague; and in the Phil. Trans. for 1856, Art. XXII., will be found an exposition of the facts of the moon's diurnal influence on each of the three magnetic elements at Toronto, viz., on the Declination, Inclination and Total Force. In the case of this investigation, notwithstanding the smallness of the values concerned, the instrumental means supplied to the Colonial Observatories have been found competent to determine, with an approximation sufficient for present theoretical purposes, the character and amount *for each element* of the regular daily effect of the moon on the terrestrial magnetic phenomena, the existence of which does not appear to have been even suspected at the time when the Report of the Committee of Physics was drawn up. The *discovery* of the moon's influence on any of the magnetic elements is due, as already stated, to M. Kreil; but Toronto is the first, and as yet the only, station, at which the numerical values at every lunar hour of the lunar-diurnal variations of the three elements have been published. Corresponding statements to that which has been given for Toronto, will be found for St. Helena and Hobarton, in the volumes of those observatories, which are now in preparation. All the results at the three stations present the same *general* characters. The lunar influence does not appear to participate in the decennial inequality which is found in all the solar variations (Phil. Trans. 1857, Art. I.). The lunar-diurnal variation of each of the elements is a double progression in the twenty-four hours, having epochs of maximum and minimum symmetrically disposed. In *character*, therefore, it differs from what might be expected to take place if the moon were possessed of inherent magnetism, *i. e.* if she were a maguet, as it is usually termed, *per se*; and accords with the phenomena which might be expected to follow if she were magnetic only by induction from the earth. On the other hand, it is believed that the *amount* of the variation, as observed at each of these stations, very far exceeds what can be imagined to proceed from the earth's inductive action reflected from the moon. In this theoretical difficulty we are naturally thrown back to seek a more extensive knowledge of the phenomena than we have yet obtained, and to the generalization which will follow, when sufficient materials for it have been procured. In subordinate particulars, a difference, which is apparently systematic

is perceived to exist in regard to the hours which constitute the epochs of maxima and minima at the three stations, as well as in regard to the amounts of the respective variations; these differences are no doubt intimately connected with the causes of the phenomena, and are likely to lead to their elucidation.

The domain of periodical variations has thus been considerably enlarged since the Report of the Committee of Physics was drawn up; and must henceforth be understood to comprise, in addition to the variations "whose amount is a function of the hour-angle of the sun, and of his longitude" (or of his declination) (Report, p. 10),—1stly, those variations of the three elements whose amount is a function of the hour-angle of the moon; 2ndly, those variations which were classed in the Committee's Report as "irregular," or "apparently observing no law," but which are now known to be governed by laws depending on the sun's declination, and hour-angle; and 3rdly, those variations, both "irregular" and "occasional," which have their epochs and amounts dependent apparently on a solar period of not yet perfectly ascertained duration, manifesting itself also by periodical changes in the frequency and amount of the solar spots.

Absolute Values and Secular Changes.—But interesting and valuable as is the acquisition of a fuller and more precise knowledge of the comparatively small magnetic variations produced at the surface of the earth by the action or influence of external bodies, even greater importance seems to attach,—when *terrestrial* magnetism is in question,—to the purposes of that distinct branch of the duties of a magnetic observatory, which consists in the determination of the absolute values and secular changes of the three magnetic elements. By the *absolute values* we seek to acquire a knowledge of the actual present order and distribution of the terrestrial magnetic influence at the surface of the earth, and to provide the materials by which the constancy, or otherwise, of the earth's magnetic charge may hereafter be examined; and by determinations of the present direction and amount of the *secular changes*, we seek to become acquainted with the laws, and ultimately with the causes, of that most mysterious change, by which the magnetic condition of the globe at one epoch passes progressively and systematically into that of another. It is specially by determinations of this class, obtained with the necessary precision in different parts of the globe, that, in the words of the Committee's Report, "the patient inductive inquirer must seek to ascend to the general laws of the earth's magnetism." At the time when the Report of the Committee of Physics was written, doubts were reasonably entertained, whether the limited time, during which the Colonial Observatories were likely to be maintained in action, would be sufficient for the determination of the secular changes; and it was therefore very properly argued, that these changes cannot be concluded from comparatively short series of observations without giving to the observations *extreme nicety*, so as to determine with perfect precision the mean state of the elements at the two extremes of the period embraced. It is with much satisfaction, and with a well-deserved recognition of the pains which have been bestowed by the successive directors of the Toronto Observatory, and their assistants, on this branch of their duties, that I am able to refer to the determinations of the absolute values and secular changes of the three elements contained in the third volume of the Toronto observations, in evidence that the instrumental means which were devised, and the methods which have been adopted, have proved, under all the disadvantages of a first essay, sufficient to determine these data with a precision which is greatly in advance of preceding experience, and, as far as may be

judged, equal to the present requirements of theoretical investigation. This is the more deserving of notice, because Toronto is a station where the casual and periodical variations, which it was apprehended would seriously interfere with the determination of absolute values, are unusually large. We may derive, therefore, from the results thus obtained, the greatest encouragement to persevere in a line of research which is no longer one of doubtful experiment, and to give it that further extension which the interests of science require.

Amongst the results which have recompensed the labours of the Colonial Observatories in this branch of their inquiries, perhaps there is none of more importance in respect to the general theory of terrestrial magnetism, than the conclusion which has been established by means of the observations of the Declination at St. Helena, that the current annual amount of secular change takes place by *equal aliquot portions in every month, and even in every fortnight of the year.* The magnitude of the annual change of the Declination at St. Helena, 8′ (or more precisely 7′·93 in each of the eight years in which the observations were maintained), and the comparative tranquillity of the tropical regions in regard to magnetic disturbances, were circumstances which rendered St. Helena a particularly eligible locality for an investigation of this nature. The result has been, to remove secular change altogether from the category of atmospheric or thermic relations, with which, in the absence of a correct knowledge of the facts, it has frequently been erroneously associated; and to show conclusively that it is a phenomenon of far more systematic order and regularity than has been generally apprehended (Proceedings of the Royal Society, vol. vii. pp. 67–75).

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

One of the most brilliant and successful meetings which have signalized the progress of the British Association in the accomplishment of its important aims, opened at Dublin on the 26th of August. Twenty-two years have elapsed since last the Association graced the halls of the Irish Capital: and great as are the changes every where noticeable in such a lapse of time, a more momentous epoch has not occurred in the history of Ireland. To whatever city the Association returns after such an interval, the survivors who bore a part in its deliberations and discussions, must recall many former valued coadjutors now no more; while also the hopeful and cheering element is not wanting. The eager boy who then gratified his vague longings by a stolen peep into the sections, is now seen entering as a scientific cadet, and doing duty on the local committee, or honored with a special and recognized rank as a secretary of his favourite section; while again the youthful sectional secretary of former years, now steps down into the arena, acknowledged as an equal among the veterans of science.

After the usual preliminary business, including the reading of the Report of the Council to the General Committee, and the presentation of the reports of the Kew Observatory, the Parliamentary Committee, and the General Treasurer; the members and friends of the association assembled in the Rotunda, where Professor Daubeny resigned the chair to his successor, the Rev. Humphrey Lloyd, D. D.

After some interesting reminiscences of a personal and local nature, with which the President opened his Address, he thus proceeded in accordance with the well

approved practice of presidents of the British Association, to give an epitome of some of the most remarkable recent additions to science:

"To commence, then, with *Astronomy*:—The career of planetary discovery, which began in the first years of the present century, and was resumed in 1845, has since continued with unabated ardour. But since 1846 not a single year has passed without some one or more additions to the number of the planetoids; and in one year alone (1852), no fewer than *eight* such bodies were discovered. The last year has furnished its quota of *five*, and in the present *three* more have been found, one by Mr. Pogson, of Oxford, and the other two by M. Goldschmidt, of Paris. The known number of these bodies is now forty-five. Their total mass, however, is very small. The diameter of the largest is less than forty miles, while that of the smallest (Atalanta) is little more than four. These discoveries have been facilitated by star-maps and star-catalogues, the formation of which they have on the other hand stimulated. Two very extensive works of this kind are now in progress—the Star Catalogue of M. Chacornac, made at the Observatory of Marseilles, in course of publication by the French Government; and that of Mr. Cooper, made at his observatory at Markree, in Ireland, which is now being published by the help of the Parliamentary Grant of the Royal Society. It is a remarkable result of the latter labour, that no fewer than seventy-seven stars, previously catalogued are now missing. This, no doubt, is to be ascribed in part to the errors of former observations; but it seems reasonable to suppose that, to some extent at least, it is the result of changes actually in progress in the Sidereal System. The sudden appearance of a new fixed star in the heavens, its subsequent change of lustre, and its final disappearance, are phenomena which have at all times attracted the attention of astronomers. About twenty such have been observed. Arago has given the history of the most remarkable, and discussed the various hypotheses which have been offered for their explanation. Of these, the most plausible is that which attributes the phenomenon to unequal brightness of the faces of the star which are presented successively to the earth by the star's rotation round its axis. On this hypothesis the appearance should be *periodic*. M. Goldschmidt has recently given support to this explanation, by rendering it probable that the new star of 1609 is the same whose appearance was recorded in the years 393, 798, and 1203. Its period, in such case, is 405¼ years. The greater part of the celestial phenomena are comprised in the movements of the heavenly bodies and the configurations depending on them; and they are for the most part reducible to the same law of gravity which governs the planetary motions.

"But there are appearances which indicate the operation of other forces, and which, therefore, demand the attention of the physicist—although, from their nature, they must probably long remain subjects of speculation. Of these, the spiriform nebulæ, discovered by Lord Rosse, have been already referred to from this chair, as indicating changes in the more distant regions of the universe, to which there is nothing entirely analogous in our own system. These appearances are accounted for, by an able anonymous writer, by the action of gravitating forces combined with the effects of a resisting medium—the resistance being supposed to bear a sensible proportion to the gravitating action.

"The constitution of the central body of our own system presents a nearer and more interesting subject of speculation. Towards the close of the last century many hypotheses were advanced regarding the nature and constitution of the sun,

all of which agreed in considering it to be an opaque body, surrounded at some distance by a luminous envelope. But the only certain fact which has been added to science in this department is the proof given by Arago that the light of the sun emanated (not from an incandescent solid, but) from a gaseous atmosphere, the light of incandescent solid bodies being *polarized by refraction*, while the light of the sun, and that emitted by gaseous bodies, is *unpolarized*. According to the observations of Schwabe, which have been continued without intermission for more than thirty years, the magnitude of the solar surface obscured by spots increases and decreases *periodically*, the length of the period being 11 years and 40 days. This remarkable fact, and the relation which it appears to bear to certain phenomena of terrestrial magnetism, have attracted fresh interest to the study of the solar surface; and, upon the suggestion of Sir John Herschel, a photoheliographic apparatus has lately been established at Kew, for the purpose of depicting the actual macular state of the sun's surface from time to time. It is well known that Sir William Herschel accounted for the solar spots by currents of an elastic fluid ascending from the body of the sun, and penetrating the exterior luminous envelope. A somewhat different speculation of the same kind has been recently advanced by Mosotti, who has endeavoured to connect the phenomena of the solar spots with those of the *red protuberances* which appear to issue from the body of the sun in a total eclipse, and which so much interested astronomers in the remarkable eclipse of 1842.

"Next to the sun, our own satellite has always claimed the attention of astronomers, while the comparative smallness of its distance inspired the hope that some knowledge of its physical structure could be attained with the large instrumental means now available. Accordingly, at the meeting of the Association held at Belfast in 1852, it was proposed that the Earl of Rosse, Dr. Robinson, and Prof. Phillips, be requested to draw up a Report on the physical character of the moon's surface, as compared with that of the earth. That the attention of those eminent observers has been directed to the subject, may be inferred from the communication lately made by Prof. Phillips to the Royal Society on the mountain Gassendi, and the surrounding region. But I am not aware that the subject is yet ripe for a Report. I need not remind you that the moon possesses neither sea nor atmosphere of appreciable extent. Still, as a negative, in such case, is relative only to the capabilities of the instruments employed, the search for the indications of a lunar atmosphere has been renewed with every fresh augmentation of telescopic power. Of such indications, the most delicate, perhaps, are those afforded by the occultation of a planet by the moon. The occultation of Jupiter, which took place on the 2nd of January last, was observed with this reference, and is said to have exhibited no *hesitation*, or change of form or brightness, such as would be produced by the refraction or absorption of an atmosphere. As respects the sea, the mode of examination long since suggested by Sir David Brewster is probably the most effective. If water existed on the moon's surface, the sun's light reflected from it should be completely polarized at a certain elongation of the moon from the sun. No traces of such light have been observed; but I am not aware that the observations have been repeated recently with any of the larger telescopes. It is now well understood that the path of astronomical discovery is obstructed much more by the earth's atmosphere than by the limitation of telescopic powers. Impressed with this conviction, the Association has, for some time past, urged upon Her Majesty's Government the scientific importance of establishing a large reflector at

some elevated station in the Southern Hemisphere. In the mean time, and to gain (as it were) a sample of the results which might be expected from a more systematic search, Prof. Piazzi Smyth undertook, last summer, the task of transporting a large collection of instruments—meteorological and magnetical, as well as astronomical—to a high point on the Peak of Teneriffe. His stations were two in number, at the altitudes above the sea of 8,840 and 10,700 feet respectively; and the astronomical advantages gained, may be inferred from the fact, that the heat radiated from the moon, which has been so often sought for in vain in a lower region, was distinctly perceptible, even at the lower of the two stations.

"The researches relative to the *Figure of the Earth* and the *Tides* are intimately connected with Astronomy, and next claim our attention. The results of the Ordnance Survey of Britain, so far as they relate to the earth's figure and mean density, have been lately laid before the Royal Society by Col. James, the Superintendent of the Survey. The ellipticity deduced is $\frac{1}{299 \cdot 33}$. The mean specific gravity of the earth, as obtained from the attraction of Arthur's Seat, near Edinburgh, is 5·316; a result which accords satisfactorily with the mean of the results obtained by the torsion balance. Of the accuracy of this important work, it is sufficient to observe, that when the length of each of the measured bases (in Salisbury Plain and on the shores of Lough Foyle) was computed from the other, through the whole series of intermediate triangles, the difference from the measured length was only 5 inches in a length of from 5 to 7 miles.

"Our knowledge of the laws of the *Tides* has received an important accession in the results of the tidal observations made around the Irish coasts in 1851, under the direction of the Royal Irish Academy. The discussion of these observations was undertaken by Prof. Haughton, and that portion of it which relates to the diurnal tides has been already completed and published. The most important result of this discussion is the separation of the effects of the sun and moon in the diurnal tide—a problem which was proposed by the Academy as one of the objects to be attained by the contemplated observations, and which has been now for the first time accomplished. From the comparison of these effects Prof. Haughton has drawn some remarkable conclusions relative to the mean depth of the sea in the Atlantic. In the dynamical theory of the tides, the ratio of the solar to the lunar effect depends not only on the masses, distances, and periodic times of the two luminaries, but also on the depth of the sea; and this, accordingly, may be computed when the other quantities are known. In this manner Prof. Haughton has deduced from the solar and lunar co-efficients of the diurnal tide, a mean depth of 5·12 miles—a result which accords in a remarkable manner with that inferred from the ratio of the semi-diurnal co-efficients, as obtained by Laplace from the Brest observations. The subject, however, is far from being exhausted. The depth of the sea, deduced from the solar and lunar *tidal intervals*, and from *the age* of the lunar diurnal tide, is somewhat more than double of the foregoing; and the consistency of the individual results is such as to indicate that their wide difference from the former is not attributable to errors of observation. Prof. Haughton throws out the conjecture that the depth, deduced from the tidal *intervals* and *ages*, corresponds to a different part of the ocean from that inferred from the *heights*.

"The phenomena of *terrestrial magnetism* present many close analogies with those of the tides; and their study has been, in a peculiar manner, connected with the labours of this Association. To this body, and by the hands of its present general secretary, were presented those reports on the distribution of the

terrestrial magnetic force which re-awakened the attention of the scientific world to the subject. It was in the Committee rooms of this Association that the first step was taken towards that great magnetic organization which has borne so much fruit. It was here that the philosophical sagacity of Herschel guided its earlier career; and it was here again that the cultivators of the science assembled, from every part of Europe, to deliberate about its future progress. It was natural, therefore, that the results obtained from such beginnings should form a prominent topic in the addresses which have been annually delivered from this chair; and the same circumstances will plead my excuse if I now revert to some of them which have been already touched upon by my predecessors. It has been long known that the elements of the earth's magnetic force were subject to certain regular and recurring changes, whose periods were, respectively, a *day* and a *year*, and which, therefore, were referred to the sun as their source. To these periodical changes Dr. Lamont of Munich, added another of *ten years:* the diurnal range of the magnetic declination having been found to pass from a maximum to a minimum and back again, in about that time. But besides these slow and regular changes, there are others of a different class, which recur at *irregular* intervals, and which are characterized by a large deviation of the magnetic elements from their normal state, and generally also by rapid fluctuation and change. These phenomena, called by Humboldt 'magnetic storms,' have been observed to occur *simultaneously* in the most distant parts of the earth, and thus to indicate a cause operating upon the entire globe. But, casual as they seem, these effects are found to be subject to laws of their own. Prof. Kreil was the first to discover that, at a given place, they recurred more frequently at certain hours of the day than at others; and that, consequently, in their mean effects, they were subject to periodical laws, depending upon the *hour* at each station. The laws of this periodicity have been ably worked out by General Sabine in his discussion of the results of the British Colonial Observatories; and he has added the important facts, that the same phenomena observe also the two other periods already noticed,—namely, the *annual* and the *decennial* periods. He has further arrived at the very remarkable result, that the decennial magnetic period coincides, both in its duration and in its epochs of maxima and minima, with the decennial period observed by Schwabe in the solar spots; from which it is to be inferred that the sun exercises a magnetic influence upon the earth dependent on the condition of its luminous envelope. We are thus in the presence of two facts, which appear at first sight opposed—namely the absolute simultaneity of magnetic disturbances at all parts of the earth, and their predominance at certain local hours at each place. General Sabine accounts for this apparent discrepancy by the circumstance, that the hours of maximum disturbance are different for the different elements; so that there may be an abnormal condition of the magnetic force, operating at the same instant over the whole globe, but manifesting itself at one place chiefly in one element, and at another place in another. I would venture to suggest, as a subject of inquiry, whether the phenomena which have been hitherto grouped together as 'occasional' effects may not possibly include two distinct classes of changes, obeying separate laws; one of them being strictly periodic, and constituting a part of the regular diurnal change; while the other is strictly abnormal, and simultaneous at all parts of the globe. If this be so, it would follow that we are not justified in separating the larger changes from the rest, merely on the ground of their magnitude, and that a different analysis of the phenomenon is required. The effects hitherto con-

sidered are all referable to the sun as their cause. Prof. Kreil discovered, however, that another body of our system—namely, our own satellite—exerted an effect upon the magnetic needle, and that the magnetic declination underwent a small and very regular variation, whose amount was dependent on the lunar hour angle, and whose period was therefore a lunar day. This singular result was subsequently confirmed by Mr. Broun in the discussion of the Makerstown Observations; and its laws have since been fully traced, for all the magnetic elements, by General Sabine, in the discussion of the results obtained at the Colonial Magnetic Observatories.

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"The most important step which has been recently taken in this country to advance the science of *Meteorology* has been the formation of a department connected with the Board of Trade, for the collection and discussion of meteorological observations made *at sea*. The practical results of a similar undertaking in the United States are now well known. The charts and sailing directions published by Lieut. Maury have enabled navigators to shorten their passages, in many cases by one-fourth of the time, and in some even to a greater extent. The commercial importance of such a result could not fail to attract general attention; and accordingly, when the United States Government invited other maritime nations to co-operate in the undertaking, the invitation was cordially accepted. A conference was held at Brussels in 1853, at which meteorologists deputed by those powers attended; and a Report was made, recommending the course to be pursued in a general system of marine meteorological observations. This Report was laid before the British Parliament soon after, and a sum of money was voted for the necessary expenditure. The British Association undertook to supply verified instruments by means of its Observatory at Kew; and the Royal Society, in consultation with the most eminent meteorologists of Europe and America, addressed an able Report to the Board of Trade, in which the objects to be attended to, so as to render the system of observation most available for science, were clearly set forth. With this co-operation on the part of the two leading scientific societies, the establishment was soon organized. It was placed under the direction of a distinguished naval officer, Admiral FitzRoy; and in the beginning of 1855 it was in operation. Agents were established at the principal ports for the supply of instruments, books, and instructions; and there are now more than 200 British ships so furnished, whose officers have undertaken to make and record the required observations, and to transmit them from time to time to the Department. The observations are tabulated, by collecting together, in separate books those of each month, corresponding to geographical spaces bounded by meridians and parallels 10 degrees apart. At the present time, 700 months of logs have been received from nearly 100 merchant ships, and are in process of tabulation. Holland is taking similar steps; and the Meteorological Institute of that country, under the direction of Mr. Buys Ballot, has already published three volumes of nautical information, obtained from Dutch vessels in the Atlantic and Indian Oceans. For the purposes of meteorological science, this system cannot be considered as complete until observations *on land* are included. Most of the greater atmospheric changes are due to the distribution of land and water, and to the different effects of the sun's rays on each Observation alone can furnish the data from which the effects of these agencies may be calculated; and we can therefore probably make no great advance in the knowledge of the meteorology of the globe, without a concurrent investigation of

its two leading departments. Land observations exist in great numbers. In Prussia, in Russia, in Austria, and in Belgium, such observations are organized under Government direction, or at least with Government support. In other parts of Europe, as in Britain, the labour is left to individuals or scientific Societies. What is needed is to give *unity* to these isolated labours—to connect them with one another, and with the results obtained at sea; and the first step to this seems to be to give them, in each country, that permanence and uniformity of system which can only be insured in measures adopted by the State.

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"The most important of the recent additions to the theory of *Light* have been those made by M. Jamin. It has been long known that metals differed from transparent bodies, in their action on light, in this, that plane-polarized light reflected from their surfaces became *elliptically polarized;* and the phenomenon is explained on the principles of the wave theory, by the assumption that the vibration of the ether undergoes a *change of phase* at the instant of reflexion, the amount of which is dependent on its direction and on the angle of incidence. This supposed distinction, however, was soon found not to be absolute. Mr. Airy showed that *diamond* reflected light in a manner similar to metals; and Mr. Dale and Prof. Powell extended the property to all bodies having a high refractive power. But it was not until lately that M. Jamin proved that there is *no distinction* in this respect between transparent and metallic bodies; that all bodies transform plane-polarized into elliptically-polarized light, and impress a change of phase at the moment of reflexion. Prof. Haughton has followed up the researches of M. Jamin, and established the existence of *circularly polarized* light by reflexion from transparent surfaces. The theoretical investigations connected with this subject afford a remarkable illustration of one of those impediments to the progress of natural philosophy which Bacon has put in the foremost place among his examples of the *Idola*—I mean the tendency of the human mind to suppose a greater simplicity and uniformity in nature than exists there. The phenomena of polarization compel us to admit that the sensible luminous vibrations are *transversal*, or in the plane of the wave itself; and it was naturally supposed by Fresnel, and after him by McCullagh and Neumann, either that no *normal* vibrations were propagated, or that, if they were, they had no relation to the phenomena of light. We now learn that it is by them that the *phase* is modified in the act of reflection; and that, consequently, no dynamical theory which neglects them, or sets them aside, can be complete. Attention has been lately recalled to a fundamental position of the wave-theory of light, respecting which opposite assumptions have been made. The vibrations of a polarized ray are all parallel to a fixed direction in the plane of the wave; but that direction may be either *parallel or perpendicular* to the plane of polarization. In the original theory of Fresnel, the latter was assumed to be the fact; and in this assumption Fresnel has been followed by Cauc' In the modified theories of McCullagh and Neumann, on the other hand, the v[illegible]ations are supposed to be parallel to the plane of polarization. This opposition of the two theories was compensated, as respects the results, by other differences in their hypothetical principles; and both of them led to conclusions which observation has verified. There seemed, therefore, to be no means left to the theorist to decide between these conflicting hypotheses until Prof. Stokes recently, in applying the dynamical theory of light to other classes of phenomena, found one in which the effects should differ on the two assumptions. When light

is transmitted through a fine grating, it is turned aside, or *diffracted*, according to laws which the wave theory has explained. Now, Prof. Stokes has shown that, when the incident light is *polarized*, the *plane of vibration* of the diffracted ray must differ from that of the incident, the two planes being connected by a very simple relation. It only remained, therefore, for observation to determine whether the *planes of polarization* of the incident and refracted rays were similarly related, or not. The experiment was undertaken by Prof. Stokes himself, and he has inferred from it that the original hypothesis of Fresnel is the true one. But, as an opposite result has been obtained by M. Holzmann, on repeating the experiment, the question must be regarded as still undetermined. The difference in the experimental results is ascribed by Prof. Stokes to the difference in the nature of the gratings employed by himself and by the German experimentalist, the substance of the diffracting body being supposed to exert an effect upon the polarization of the light, which is diffracted by it under a great obliquity. I learn from Prof. Stokes that he proposes to resume the experimental inquiry, and to test this supposition by employing gratings of various substances. If the conjecture should prove to be well founded, it will greatly complicate the dynamical theory of light. In the mean time the hypothesis is one of importance in itself, and deserves to be verified or disproved by independent means.

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"In the whole range of experimental science there is no fact more familiar, or longer known, than the development of *Heat* by friction. The most ignorant savage is acquainted with it,—it was probably known to the first generation of mankind. Yet, familiar as it is, the science of which it is the germ dates back but a very few years. It was known from the time of Black, that heat disappeared in producing certain changes of state in bodies, and reappeared when the order of those changes was reversed; and that the amount of heat, thus converted, had a given relation to the effect produced. In one of these changes—namely, evaporation, a definite mechanical force is developed, which is again absorbed when the vapour is restored by pressure to the liquid state. It was, therefore, not unnatural to conjecture, that in all cases in which heat is developed by mechanical action, or *vice versa*, a definite relation would be found to subsist between the amount of the action and that of the heat developed or absorbed. This conjecture was put to the test of experiment by Mayer and Joule, in 1842, and was verified by the result. It was found that *heat* and *mechanical power* were *mutually convertible;* and that the relation between them was *definite*, 772 *foot-pounds* of motive power being equivalent to a *unit of heat*—that is, to the amount of heat requisite to raise a pound of water through one degree of Fahrenheit. The science of Thermodynamics, based upon this fact, and upon a few other obvious facts or self-evident principles, has grown up in the hands of Clausius, Thomson, and Rankine, into large proportions, and is each day making fresh conquests in the region of the unknown. Thus far the science of heat is made to rest wholly upon the facts of experiment, and is independent of any hypothesis respecting the molecular constitution of bodies. The dynamical theory of heat, however, has materially aided in establishing true physical conceptions of the *nature of heat*. The old hypothesis, of caloric, as a separate substance, was indeed rendered improbable by the experiments of Rumford and Davy, and by the reasonings of Young; but it continued to hold its ground, and is interwoven into the *language* of science. It is now clearly shown to be self-contradictory; and to lead to the result that the amount of heat

in the universe may be indefinitely augmented. On the other hand, the identification of radiant heat with light, and the establishment of the wave-theory, left little doubt that heat consisted in a *vibratory movement* either of the molecules of bodies or of the ether within them. Still, the relation of heat to bodies and the phenomena of conduction, indicate a mechanism of a more complicated kind than that of light, and leave ample room for further speculation. The only mechanical hypothesis (so far as I am aware) which is consistent with the present state of our knowledge of the phenomena of heat, is the theory of *molecular vortices* of Mr. Rankine. In this theory all bodies are supposed to consist of *atoms*, composed of *nuclei* surrounded with *elastic atmospheres*. The radiation of light and heat is ascribed to the transmission of oscillations of the nuclei; while *thermometric heat* is supposed to consist in circulating currents or *vortices*, amongst the particles of their atmospheres, whereby they tend to recede from the nuclei, and to occupy a greater space. From this hypothesis Mr. Rankine has deduced all the laws of thermo-dynamics, by the application of known mechanical principles. He has also, from the same principles, deduced relations (which have been confirmed by experiment) between the pressure, density and absolute temperature of elastic fluids, and between the pressure and temperature of ebullition of fluids. The dynamical theory of heat enables us to frame some conjectures to account for the continuance of its supply, and even to speculate as to its source. The heat of the sun is dissipated and lost by radiation, and must be progressively diminished, unless its thermal energy be supplied. According to the measurements of M. Pouillet, the quantity of heat given out by the sun in a year is equal to that which would be produced by the combustion of a stratum of coal seventeen miles in thickness; and if the sun's capacity for heat be assumed equal to that of water, and the heat be supposed to be drawn uniformly from its entire mass, its temperature would thereby undergo a diminution of 2°.4 Fahr. annually. On the other hand, there is a vast store of force in our system capable of conversion into heat. If, as is indicated by the small density of the sun, and by other circumstances, that body has not yet reached the condition of incompressibility, we have, in the future approximation of its parts, a fund of heat probably quite large enough to supply the wants of the human family to the end of its sojourn here. It has been calculated that an amount of condensation, which would diminish the diameter of the sun by only the ten-thousandth part, would suffice to restore the heat emitted in 2,000 years. Again, on our own earth, *vis viva* is destroyed by friction in the ebb and flow of every tide, and must therefore reappear *as heat*. The amount of this must be considerable, and should not be overlooked in any estimation of the physical changes of our globe. According to the computation of Bessel, 25,000 cubic miles of water flow in every six hours from one quarter of the earth to another. The store of mechanical force is thus diminished and the temperature of our globe augmented by every tide. We do not possess the data which would enable us to calculate the magnitude of these effects. All that we know with certainty is, that the *resultant effect* of all the thermal agencies to which the earth is exposed has undergone no perceptible change within the historic period. We owe this fine deduction to Arago. In order that the *date palm* should ripen its fruit, the mean temperature of the place must exceed 70° Fahr: and, on the other hand, the *vine* cannot be cultivated successfully when the temperature is 72° or upwards. Hence, the mean temperature of any place at which these two plants flourished and bore fruit must lie between these narrow

limits, *i. e.* could not differ from 71° Fahr. by more than a single degree. Now, from the Bible we learn that both plants were *simultaneously* cultivated in the central valleys of Palestine in the time of Moses; and its then temperature is thus definitively determined. It is the same at the present time; so that the mean temperature of this portion of the globe has not sensibly altered in the course of thirty-three centuries.

"The future of physical science seems to lie in the path upon which three of our ablest British physicists have so boldly entered, and in which they have already made such large advances. I may, therefore, be permitted briefly to touch upon the successive steps in this lofty generalization, and to indicate the goal to which they tend. It has been long known that many of the forces of nature are related. Thus, heat is produced by *mechanical action*, when that is applied in bringing the atoms of bodies nearer by compression, or when it is expended in friction. Heat is developed by *electricity*, when the free passage of the latter is impeded. It is produced whenever *light is absorbed*; and it is generated by *chemical action*. A like interchangeability probably exists among all the other forces of nature, although in many the relations have not been so long perceived. Thus, the development of electricity from chemical action dates from the observations of Galvani; and the production of magnetism by electricity from the discovery of Oersted. The next great step was to perceive that the relation of the physical forces was *mutual;* and that of any two, compared together, either may stand to the other in the relation of *cause*. With respect to heat and mechanical force, this has been long known. When a body is *compressed* by mechanical force, it gives out *heat;* and, on the other hand, when it is *heated*, it dilates, and evolves *power*. The knowledge of the action of electricity in dissolving the bonds of chemical union followed closely upon that of the inverse phenomenon; and the discovery of *electro-magnetism* by Oersted was soon followed by that of *magneto-electricity* by Faraday. With reason, therefore, it occurred to many minds that the relations of any two of the forces of nature were *mutual*—that that which is the *cause*, in one mode of interaction, may become the *effect*, when the order of the phenomena is changed;—and that, therefore, in the words of Mr. Grove, one of the able expounders of these views, while they are "correlative," or reciprocally dependent, "neither, taken abstractedly, can be said to be the essential cause of the other." But a further step remained to be taken. If these forces were not only related, but mutually related, was it not probable that the relation was also a *definite* one? Thus, when heat is developed by mechanical action, ought we not to expect a certain definite proportion to subsist between the interacting forces, so that if one were doubled or trebled in amount, the other should undergo a proportionate change? This anticipation, it has been already stated, has been realized by Mayer and Joule. The discovery of the mechanical equivalent of heat has been rapidly followed by that of other forces; and we now know not only that electricity, magnetism, and chemical action, in given quantities, will produce each a *definite amount of mechanical work*, but we know further—chiefly through the labours of Joule—what that relation is, or, in other words, *the mechanical equivalent of each force*. The first step in this important career of discovery—though long unperceived in its relation to the rest—was, undoubtedly, Faraday's great discovery of the definite chemical effect of the voltaic current. The last will probably be to reduce all these phenomena to *modes of motion*, and to apply to them the known principles of dynamics, in such a way as not only to express

the laws of each kind of movement, as it is in itself, but also the connexion and dependence of the different classes of the phenomena.

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"The science of *Geology* appears, of late years, to have entered upon a new phase of its development,—one characterized by a stricter reference of its speculative views to the principles of those sciences with which it is connected, and upon which it ought to be based. We have an example of this in the able Memoirs of Mr. Hopkins, on what may be called *Dynamical Geology*, including the changes which have taken place in the earth's crust by the operation of internal forces. Another instance of application of sound physical principles to this science is found in the explanations which have been recently offered of the phenomena of *slaty cleavage*. A report on this interesting subject was presented to the Association by Prof. Phillips at its last meeting, and will be found in the volume just published. These sounder views originate, I believe, with himself and with Mr. Sharpe; but they have been enlarged and confirmed by Mr. Sorby, Dr. Tyndall, and Prof. Haughton. We have another interesting proof of the readiness of geologists of the present day to submit their views to the test of exact observation, in the measurements undertaken by Mr. Horner for the purpose of approximating to the age of sedimentary deposits. Of the geological changes still in operation, none is more remarkable than the formation of deltas at the mouths of great rivers, and of alluvial land by their overflow. Of changes of the latter kind, perhaps the most remarkable is the great alluvial deposit formed in the valley of the Nile by the annual inundations of that river; and here it fortunately happens that history comes to the aid of the geologist. These sedimentary deposits have accumulated round the bases of monuments of *known age;* and we are, therefore, at once furnished with a *chronometric scale* by which the rate of their formation may be measured. The first of the series of measurements undertaken by Mr. Horner was made with the co-operation of the Egyptian Government, around the obelisk of Heliopolis, a monument built, according to Lepsius, 2300 years B. C. A more extensive series of researches has been since undertaken in the district of Memphis; but Mr. Horner has not yet, I believe, published the results. The problems now to be solved in *Palæontology* are clearly defined in the enunciation of the problem recently proposed by the French Academy of Sciences as one of its prize questions, viz.: 'to study the laws of distribution of organic beings in the different sedimentary rocks, according to the order of their superposition; to discuss the question of their appearance or disappearance, whether simultaneous or successive; and to determine the nature of the relations which subsist between the existing organic kingdom and its anterior states.' The prize was obtained by Prof. Broun, of Heidelberg; and his memoir, of which I have only seen an outline, appears to be characterized by views at once sound and comprehensive. The leading result seems to be, that the genera and species of plants and animals, which geology proves to have existed successively on our globe, were *created in succession*, in adaptation to the existing state of their abode, and *not transmuted* or *modified*, as the theory of Lamarck supposes, by the physical influences which surrounded them."

Having embraced in his address a review of some of the most remarkable evidences of recent progress in science, Dr. Lloyd devoted the concluding portion of his speech to the administrative measures of the Association, in so far as these have a direct bearing on the advancement of its highest objects. The steps already

taken for the preparation of a catalogue of papers occurring in the Transactions of the Scientific Societies and in Scientific Journals, were noted by him, and commended to the attention of the General Committee. The still more important subject of guiding the influence of the British Government and of Parliament, for improving the position of British Science, and advancing the just interests and claims of its students, next occupied his attention. The establishment of a Scientific Board for the control and expenditure of the public funds devoted to science; and the provision of a central National Building in the British Metropolis, for the meetings and other requirements of the principal Scientific Societies, were specially noted by the President, as objects now aimed at, and towards the accomplishment of which Her Majesty's Government have evinced a gratifying readiness to render every aid consistent with the other claims, which war and rebellion have recently made so preeminent.

Finally, Dr. Lloyd congratulated the Association on the extension of their field of labours, by the enlargement of the scope of the statistical section so as to embrace economic science in all its relations; and concluded in these words: "I am conscious that the sketch of the recent progress of the Physical Sciences, which I have endeavoured to present, is but a meagre and imperfect summary of what has been accomplished; but it is enough, at all events, to prove that science is not on the decline, and that its cultivators have not been negligent in their high calling. I now beg in the name of the local members of this body, to welcome you warmly to this city; and I pray that your labours here may redound to the glory of God, and to the welfare and happiness of your fellow-men."

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

Among the features of the American Scientific Congress, in the Capitol at Albany, last year, which were felt alike by Americans and Strangers as giving a novel interest to that meeting, was the Canadian deputation sent to invite the representatives of the Science of the United States to step beyond their political bounds, and accept the hospitality of Montreal. Other, and older claims were at the same time advanced. Baltimore was especially urgent, and refused to hear of delay; but a spirit of liberal cosmopolitanism prevailed, and the invitation was accepted, which has this year enabled us to witness the honored veterans of American Science welcomed with no stinted cordiality to the chief city of the Canadas, the commercial metropolis of British America. The duties which thereby devolved on the citizens of Montreal, and on the Province at large, were neither few nor trivial; and to most of these duties past experience could lend us little aid. Nevertheless, what hearty earnestness and cordial good-will could accomplish was done; and though the occasion may not have passed off without some of those little jealousies and slights to which all such large and miscellaneous congresses are everywhere liable, we have reason to believe that the general impression remaining on the minds of those who took a part in the meeting, is one of unalloyed pleasure; while the conviction has been frankly expressed by those longest and most intimately conversant with the proceedings of the American Association, that the success of the meeting was as gratifying to the assembled representatives of American Science, as it was creditable to the citizens of Montreal.

The opening meeting was graced by proceedings of a cordial and hearty geniality, well suited to the occasion. His Excellency, Sir William Eyre, the Administrator of the Government, occupied the right hand of the chair. The lamented death of the President elect, Professor Bailey, devolved the inaugural duties on the Vice-President, Professor Caswell; and his graceful urbanity, ready tact, and conciliatory equanimity, were felt not only on this occasion, but throughout the meeting, to contribute not a little to the uninterrupted harmony which constituted one of the chief elements of its success. Professor Hall, of Albany, the retiring President, having introduced Professor Caswell, resigned the chair to him; and the new President thereupon proceeded to address the members of the Association, congratulating them on the large attendance, and the happy circumstances under which they there met. "It augurs well for the interests of Science," he observed, "that so many have come here to place their choicest contributions on her altar, and to welcome to her fellowship the humblest laborer in her cause. I think also, that it is a matter of congratulation that we have met beyond the limits of the United States. However it may have been in former times, it is not now the case that:—

> "Lands intersected by a narrow frith
> Abhor each other; or mountains interposed
> Make enemies of nations."

It is one of the felicities of our time, that in the onward march of Science, little account is taken of the boundaries that separate states and kingdoms. The discoverer of a new law or principle in nature, of a new process in the arts, or a new instrument of research, is speedily heralded over land and ocean; is welcomed as the benefactor of his race; and is immediately put into communication with the whole civilized world. We have *before us a practical* illustration of the amenities of science. We of the United States are here convened on British soil, little thinking that we have passed the boundary of the protection of American law, or that amidst the generous hospitality of this enterprising commercial capital of a noble Province of Great Britain, we are aliens to the *British constitution*. We have left the American eagle, but we feel in no danger of being harmed by the British lion. I have said that we are aliens to the British constitution; but that must be taken in the narrowest and most technical sense, for I am proud to say, on deliberate conviction, that nothing is alien to the British constitution that looks to the perfection of knowledge, to the furtherance of the arts or the amelioration of the condition of humanity. And, further, the proudest achievements of British arms,—and they have been proud enough for the highest desires of ambition or of glory,—have been less glorious than that generous patronage of science, that success in the arts, and those efforts to improve the condition of our race, which have placed Old England in the van of the nations; and at no period of her long history has that patronage been more wisely directed, or those noble efforts more earnestly persevered in, than under the reign of the present *illustrious* sovereign, whose virtues are alike the ornament of her sex and her crown."

Addresses of welcome were then delivered by His Excellency, the Administrator of the Government, on behalf of the Province; by Sir William Logan, for the Local Committee and the citizens of Montreal; and by Dr. Dawson, the Principal of McGill College, as President of the Natural History Society.

To those who are familiar with the recognised sectional divisions which so largely contribute alike to the interest and the efficiency of the British Association, the

desire manifested by the American men of Science to maintain as nearly as possible an undivided action throughout, is only less surprising than their transference to a daily General Meeting, so many questions of detail which we have been accustomed to see disposed of by a Committee. In the British Association there are now seven sections in full and efficient operation; while the American Association,—divided till last year only into a Natural History and a Physical Science Section, required that the Ethnologists, when craving at this meeting a separate one for themselves, should produce ten papers ready for reading before they could even be allowed to organise themselves into a dependent sub-section. Nevertheless it was apparent that materials were not wanting for a much more extensive organization of sections and classification of subjects; as indeed became abundantly manifest when chemistry, statistics, and political economy, all claimed to be received by the Ethnological sub-section, as orphan sciences elsewhere unprovided for. Nothing, we believe, would be found more calculated to increase at once the popular interest and the practical efficiency of the Association, than its subdivision into more numerous sections for daily work. It would indeed of necessity diminish the crowd of miscellaneous auditors. But to compel the Chemist to submit his papers to an impatient auditory of Geologists, or the Political Economist or Statistician to intrude himself on unwilling Ethnologists, is to impede the work of all, and to drive the intruding sciences to seek a heartier recognition on some other arena. Some of the characteristics which specially distinguish the organization and procedure of the American Association, are undoubtedly traceable to the circumstances in which it originated. Formed at first solely as an Association of American Geologists, the other sciences have been admitted into favour chiefly in so far as they had a bearing on the favorite study; and hence its Natural History has been to a great extent palæontological; its Chemistry has been mineralogical or atmospheric; and Physics with Mathematics have alone heretofore secured an independent footing.

The address of the retiring President, Professor Hall, was devoted exclusively to the elucidation of his views on some novel but highly interesting questions in his own favorite science of Geology. In this he presented at great length, and with much ability, very comprehensive generalizations relative to the rise of continents, the direction and influence of currents of deposition, and the causes in operation in the formation of mountain chains. This address was originally delivered at a Conversazione given to the members of the Association by the Natural History Society of Montreal in the Bonsecours Hall. But, notwithstanding the chivalrous promptness with which the American asserts the rights and the intellectual equality of woman, it was felt by the more enthusiastic devotees of science that the gay assembly of ladies which graced the entertainment supplied an audience who might not perchance enter with all their enthusiasm into the abstruse geological questions they were challenged to discuss. Some slight dissatisfaction was accordingly expressed by a few of the more eager militant geologists who, while longing to break a lance in the lists, were too much bent on the combat *à l'outrance*, to look with favor on bright eyes and fair faces crowding the arena. The difficulty was at length solved by Professor Hall being invited to re-deliver his address before the general meeting on a subsequent day. Its length, however, precluded the desired discussion even then; and we regret the impossibility of embracing any adequate epitome of its comprehensive generalizations within the limits at our command.

SECTION OF GEOLOGY AND NATURAL HISTORY.

ON THE VARIETIES AND MODE OF PRESERVATION OF THE FOSSILS KNOWN AS STERNBERGIÆ—BY J. W. DAWSON, LL.D., PRINCIPAL OF M'GILL COLLEGE, MONTREAL.

The fossils which have been named Sternbergiæ and sometimes Artisiæ, are usually mere casts in clay or sand, having a transversely wrinkled surface, and sometimes an external coaly coating and traces of internal coaly partitions. They are found in the coal formation rocks of most countries, and very abundantly in those of Nova Scotia. Until the recent discoveries of Corda and Williamson, they were objects of curious and varied conjecture to geologists and botanists, and were supposed to indicate some very extraordinary and anomalous vegetable structure. They are now known to be casts of the piths or internal medullary cavities of trees, and the genera to which some of them belong have been pointed out. In the present paper I propose to offer some further contributions toward their history, and the geological inferences deducible from it.

In a paper communicated to the Geological Society of London, in 1846, I stated my belief that those specimens of Sternbergiæ which occur with only thin smooth coatings of coal, belonged to rush-like endogens; while those to which fragments of fossil wood were attached, presented structures resembling those of conifers. Additional specimens affording well-preserved coniferous tissue, in connection with others in a less perfect state of preservation, have enabled me more fully to comprehend the homologies of this curious structure, and the manner in which specimens of it have been preserved independently of the wood.

My most perfect specimen is one from the coal field of Pictou, cylindrical but somewhat flattened. The diaphragms or transverse partitions appear to have been continuous, though now somewhat broken. They are rather less than one-tenth of an inch apart, and are more regular than is usual in these fossils. The outer surface of the pith, except where covered by the remains of the wood, is marked by strong wrinkles, corresponding to the diaphragms. The little transverse ridges are in part coated with a smooth tissue similar to that of the diaphragms, and nearly the same thickness. In its general aspect, the specimen perfectly resembles many of the ordinary marked Sternbergiæ.

On microscopic examination the partitions are found to consist of condensed pith, which, from the compression of the cells, must have been of a firm bark-like texture in the recent plant. The wood attached to the surface is distinctly coniferous, with two and three rows of discs on the cell walls. It is not distinguishable from that of Witham, or from the specimens figured by Professor Williamson. The wood and transverse partitions are perfectly silicified, and of a dark brown colour. The partitions are coated with small colourless crystals of quartz and little iron pyrites, and the remaining spaces are filled with crystalline laminæ of sulphate of barytes.

Unfortunately this fine specimen does not possess enough of its woody tissue to show the dimensions or age of the trunk or branch which contained this enormous pith. It proves, however, that the pith itself has not been merely dried and cracked transversely by the elongation of the stem, as appears to be the case in the Butternut, (*Juglans Cinerea*,) and some other modern trees; but that it has been condensed into a firm epidermis-like coating and partitions, apparently less destructible than the woody tissue which invested them. In this specimen the

process of condensation has been carried much farther than in that described by Professor Williamson, in which a portion of the unaltered pith remained between the Sternbergia-cast and the wood. It thus more fully explains the possibility of the preservation of such hollow chambered piths, after the disappearance of the wood. It also shows that the coaly coating investing such detached pith casts is not the medullary sheath, properly so called, but the outer part of the condensed pith itself.

The examination of this specimen having convinced me that the structure of Sternbergiæ implies something more than the transverse cracking observed in Juglandaceæ, I proceeded to compare it with other piths, and especially with that of Cecropia Peltata, a West Indian tree, of the natural family Artocarpaceæ. This recent stem is two inches in diameter. Its medullary cylinder is three-quarters of an inch in diameter, and is lined throughout by a coating of dense whitish pith tissue, one-twentieth of an inch in thickness. This condensed pith is of a firm corky texture, and forms a sort of internal bark lining the medullary cavity. Within this the stem is hollow, but is crossed by arched partitions, convex upward. These partitions are of the same white corky tissue with the pith lining the cavity; and on their surfaces, as well as on that of the latter, are small patches of brownish large-celled pith, being the remains of that which has disappeared from the intervening spaces.

Inferring from these appearances that this plant contains two distinct kinds of pith tissue, differing in duration and probably in function, I obtained, for comparison, specimens of living plants of this and allied families. In some of these, and especially in a "Ficus Imperialis," from Jamaica, I found the same structure; and in the young branches, before the central part of the pith was broken up, it was evident that the tissue was of two distinct kinds—one forming the outer coating and transverse partitions opposite the insertions of the leaves, and retaining its vitality for several years at least; the other occupying the intervening spaces or internodes, of looser texture, speedily drying up, and ultimately disappearing.

Another variety of the Sternbergia-like pith structure appears in a rapidly growing exogenous tree with opposite leaves, cultivated here, and I believe a species of Paullinia. In this trunk there are thick nodal partitions, and the intervening spaces are hollow and lined with firm corky pith, with its superficial portion condensed into a sort of epidermis, and marked with transverse wrinkles; a cast of which would resemble those Sternbergiæ which have merely wrinkles without diaphragms.

The trunks above noticed are of rapid growth, and have large leaves; and it is probable that the more permanent pith tissue of the medullary lining and partitions serve to equalize the distribution of the juices of the stem, which might otherwise be endangered by the tearing of the ordinary pith in the rapid elongation of the internodes. A similar structure has evidently existed in the coal formation conifers of the genus Dadoxylon, and possibly they also were of rapid growth, and furnished with very large or abundant leaves.

Applying the facts above stated to the different varieties or species of sternbergia, we must in the first place connect with these fossils such plants as the Pinites Medullaris of Witham. All are distinctly coniferous, and the differences that appear may be due merely to age, or more or less rapid growth.

Other specimens of sternbergia want the internal partitions, which may, however, have been removed by decay; and these often retain very imperfect traces,

or none, of the investing wood. In the case of those which retain any portion of the wood sufficient to render probable their coniferous character, the surface-markings are similar in character to those of my Pictou specimen, but often vary greatly in their dimensions, some having fine transverse wrinkles, others having these wide and coarse. Of those specimens which retain no wood, but only a thin coaly investment representing the outer pith, many cannot be distinguished by their superficial markings from those that are known to be coniferous, and they occasionally afford evidence that we must not attach too much importance to the character of their markings.

The state of preservation of the sternbergia casts in reference to the woody matter which surrounded them, presents, in a geological point of view, many interesting features. Frequently, only fragments of the wood remain, in such a condition as to evidence an advanced state of decay; while the bark-like medul, lary lining remains. In other specimens the coaly coating investing the cast sends forth flat expansions on either side, as if the sternbergia had been the mid-rib of a long thick leaf. This appearance, at one time very perplexing to me, I suppose to result from the entire removal of the wood by decay, and the flattening of the bark, so that a perfectly flattened specimen may be all that remains of a coniferous branch nearly two inches in diameter. A still greater amount of decay of woody tissue is evidenced by those sternbergia casts which are thinly coated with structureless coal. These must, in many cases, represent trunks and branches which have lost their bark and wood by decay; while the tough, cork like, chambered pith drifted away to be imbedded in a separate state. This might readily happen with the pith of Cecropia; and perhaps that of these coniferous trees may have been more durable; while the wood, *like the sap wood of many* modern pines, may have been susceptible of rapid decay, and liable, when exposed to alternate moisture and dryness, to break up into those rectangular blocks, which are seen in the decaying trunks of modern conifers, and are so abundantly scattered over the surfaces of coal and its associated beds in the form of mineral charcoal.

Some specimens of sternbergia appear to show that they have existed in the interior of trunks of considerable size. The best instance of this that I have found is one from the South Joggins, which appears to show the remains of a tree a foot in diameter, now flattened and converted into coal, but retaining a distinct cast of a wrinkled sternbergia pith.

Are we to infer from these facts that the wood of the trees of the genus Dadoxylon was necessarily of a lax and perishable texture? Its structure, and the occurrence of the heart wood of huge trunks of similar character in a perfectly mineralized condition, would lead to a different conclusion; and I suspect that we should rather regard the mode of occurrence of sternbergia as cautioning against the too general inference from the state of preservation of trees of the coal formation that their tissues were very destructible, and that the beds of coal must consist of such perishable materials. The coniferous character of the sternbergiæ, in connection with their state of preservation, seem to strengthen a conclusion at which I have been arriving from microscopic and field examinations of the coal and carbonaceous shales, that the thickest beds of coal, at least in Eastern America, consist in great part of the flattened bark of coniferous, sigillaroid and lepidodendroid trees, the wood of which has perished by slow decay, or appears only in the state of fragments and films of mineral charcoal. This is a view, however, on

which I do not now wish to insist, until I have further opportunities of confirming it by observation.

The most abundant locality of sternbergia with which I am acquainted, occurs in the neighbourhood of the town of Picton, immediately below the bed of erect calamites described in the Journal of the Geological Society. The fossils are found in interrupted beds of very coarse sandstone, with calcareous concretions, imbedded in a thick reddish brown sandstone. These gray patches are full of well preserved calamites, which have either grown upon them, or have been drifted in clumps with their roots entire. The appearances suggest the idea of patches of gray sand rising from a bottom of red mud, with clumps of growing calamites which arrested quantities of drift plants, consisting principally of sternbergia and fragments of much decayed wood and bark, now in a state of coaly matter too much penetrated by iron pyrites to show its structure distinctly. We thus probably have the fresh growing calamites, entombed along with the debris of the old decaying conifers of some neighbouring shore; furnishing an illustration of the truth that the most ephemeral and perishable forms may be fossilized and preserved, contemporaneously with the decay of the most durable tissues. The rush of a single summer may be preserved with its minutest striæ unharmed, when the giant pine of centuries has crumbled into mould. It is so now, and it was so equally in the carboniferous period.

ON FLEXURE OF STRATA IN THE BROAD-TOP COAL FIELD, PENNSYLVANIA.

BY J. P. LESLIE.

In introducing the subject, Mr. Leslie stated that it had only recently come under his notice, and required more consideration for the full elucidation of all the truths which the phenomena he had to refer to tended to illustrate. Meanwhile it was of importance to call the attention of scientific geologists to such a remarkable example of flexure of strata as he had now to describe. Accordingly, availing himself of an opportunity so favorable, he had prepared a diagram of the appearance which these flexures presented, and although not so able to illustrate the aspect in question as he desired to have been, the subject represented a single fact to which he wished meanwhile to draw the attention of the Association. The diagram represented a section of the only coal bed in the broad-top region worked to any extent. He had obtained the section by studying that bed in eight or ten entries. The principal facts of the case, and patent to observation, were these: The bed itself is seven or eight feet thick, nine feet at its thickest portions, and seldom becomes less than five feet. In working this bed the greatest difficulties have been met with, in the shape of these flexures. Such details are rarely witnessed elsewhere in any consecutive series. Single instances have been found in innumerable places, but here they occur in consecutive series, presenting a curious difficulty to the practical miner. The form which these flexures present amid their involutions, may be described as running up in an angular position, and becoming steeper and steeper, until they finally appear to "run out." But on examination, it is found that the top shale turns upon itself, and becomes the bottom of the flexure, with a perfectly even surface, and without any fracture. In this case, the miner is at a loss to discover where to go, and there exists no trace of the coal upwards through the rock. The appearance which these present, Mr. Leslie stated, is beautifully illustrated by a specimen which Sir William Logan has in his cabinet, derived from a Canadian locality, where it may be usefully

studied by any person desirous of examining the subject. In the construction of these flexures, side-pressure is the only thing that can be thought of. A slow steady irresistible pressure seems to have been brought to bear upon the rock, alternately hard and soft, so that when brought around upon each other the soft ones have been obliged to yield to the hard ones. The bed of coal alluded to is within 100 feet of the top of the old conglomerate. Above the top shales there is a mass of fine-grained sand-stone. But the effect as exhibited in these flexures could not have been so great, but for the fact that immediately below there is a bed of fine white clay, thirty or forty feet thick. How much of these flexures are the result of the forcing forward of this fine clay is one of the practical questions to which future observations must be directed.

The seams below the one now referred to have never been opened, and accordingly have not been studied, so that it is impossible to say whether these flexures correspond with those underneath. This is unfortunate meanwhile, because one of the questions which the practical geologist is most anxious to have solved, is how far this pressure carries itself forward in vertical lines. But as the progress of mining operations will tend to effect the desired exposure of the lower strata, geologists may be glad to have their attention directed to the subject thus early.

SUBSIDENCE OF THE LAND ON THE NEW JERSEY COAST.—BY PROFESSOR G. H. COOK, OF RUTGER'S COLLEGE.

In the course of some geological examinations near the coast of Southern New Jersey, the author's attention had been called to various facts indicating a change in the relative level of the land and water at some recent period. An attentive examination of these led him to the conclusion that a gradual subsidence of the land is now in progress throughout the whole length of New Jersey and of Long Island; and from information derived from others, he was induced to think that this subsidence might extend along a considerable portion of the Atlantic coast of the United States. The occurrence of timber in the marshes and water, below tide-level, is common along their whole Atlantic shore. Almost every one familiar with shore-life had observed the remains of logs, stumps, and roots, in such places, although they had been looked upon generally as the remains of trees torn from their original place of growth by torrents, or by the necessary moving of the shores, and deposited in the places where they were found, by the ordinary action of the water. But close examination made it evident that they grew upon the spots where they are found. The stumps remain upright—their roots are still fast in the firm loamy ground which underlies the marsh, and their bark and small roots remain attached to them. The localities in which they are most abundant are such as are least liable to be affected by the violent action of the water, or of storms. Thus they are by far the most abundant on the low and gently sloping shores of Long Island, New Jersey, and all the States farther South which are protected from the violent action of the surf by a line of sand beaches, at the same time that the numerous inlets allow free access to the tides. In these protected situations hundreds and even thousands of acres can be found in which the bottom of the marshes and bays is as thickly set with the stumps of trees as is the ground of any living forest. His own observations were chiefly made upon the southern part of New Jersey, following the shores of Delaware Bay from its head down to Cape May, and the Atlantic shore from Cape May north to Great Egg Harbor,

and thence eastward at several points along the south shore of Long Island. In the ditches in the marshes, above Salem, great numbers of the stumps and trunks of trees are met with at all depths, down to the solid ground. At Elsinboro' Point, a little farther down on the Delaware Bay shore, the cutting away of the marsh by the water has left great numbers of stumps exposed, where they can be seen at every low tide still firmly rooted in the hard ground. They are also common in all the marshes of Cumberland County, and great numbers of them can be seen in the marshes on Main River, at Dorchester and below. In Cape May County they are seen everywhere in the marshes and the creeks, on the Delaware Bay; on the inside of Seven Mile Beach, on the sea side; and below Luckahoe, on Great Egg Harbour. In the marsh on the Raritan, above South Amboy, hundreds of them were dug out in cutting a canal across a bend in South River. The marshes on Staten Island also contain buried timber; and on Long Island, at Hempstead, and still further east, the same fact is of constant occurrence. At several places in Southern New Jersey an enormous quantity of white cedar timber is found buried in the salt marshes—sound and fit for use, and a considerable business is carried on in mining this timber and splitting it into shingles for market. At Dennisville there is a large tract of marsh underlaid by cedar swamp, earth and timber. By probing the marsh with an iron rod, the workmen find where the solid timber lies, and then removing the surface sods and roots, they manage to work in the mud and water with long one-handed saws and cut off the logs, which then rise and float, as the timber is not water-logged at all, but retains its buoyancy, and the removal of that nearest the surface releases that which is below and it rises in turn, so that a new supply is constantly coming up to the workmen. In this way a single piece of swamp which is below tide-level has been worked for fifty years past, and still gives profitable returns.

Other facts tend to the same conclusions. The owner of an extensive tract of land, between Maurice River and West Creek, informed the author that within the last fifty years he had lost 1,000 acres of timber by the tides running higher on the upland than they formerly did. On West Creek he was shown portions of upland on which good crops of wheat had been raised, within thirty years, which are now liable to be overrun by the tides. The same farm has, within the last fifty years, lost fifty acres—part wood and part cultivated land—in the same way, and taking into account all the evidence noted by himself, or set forth by others who had directed their attention to the subject, he could find no other theory which would embrace all the facts, than that of a slow and continued subsidence of the ground.

In regard to the rate at which this subsidence was going on, Professor Cook quoted the result of several examinations—three of a subsidence of three feet in 150 years, one of two feet in 100 years, two of one foot in fifty years,—and one of four inches and one of eight inches in two years. From these facts he conceived he might, with some degree of probability, set the average subsidence in the district where the observations were made, at two feet in a century, and he believed that this would also apply to all the observations yet made on the New England coasts.

ON PARTHENOGENESIS OF ANIMALS AND PLANTS—BY B. SEEMANN, F.L.S.

One of the most paradoxical questions, recently brought under the notice of men of science, is that known as the Parthenogenesis of Animals and Plants.

The belief in a Parthenogenesis or *Lucina sine concubitu* is by no means of recent growth, but has arrested the attention of mankind since the earliest ages. In diving into the writings of the Classics, and studying the mythology of the Greeks, it will be found more than once indicated; and in searching the pages of ancient naturalists of a subsequent period, the subject frequently meets our eye; but the observations upon which such statements were founded, are of no value for the purpose of modern science.

It is different with the publications that in more recent times have been forced upon our attention, and which, having been made with all the caution, circumspection and accuracy demanded by modern criticism, have in the opinion of many eminent naturalists, completely established the fact, that there exist occasionally individual females of both animals and plants, which, in a state of virginity are able to propogate their respective species. We have no modern observations proving the existence of a *Lucina sine concubitu* in any of the higher animals,—at least I am not aware of any,—but few are inclined to doubt that Professor Von Siebold's works, "On Parthenogenesis in Moths and Bees," have set this question at rest as regards Insects. It is well known that Professor Richard Owen, applied the term Parthenogenesis, some years ago, to the non-sexual reproduction observable in the genus Aphis, but that process being merely one of gemmation, a budding process, equivalent to what we see in the sprouting of a plant, it is now generally rejected, and Siebold and others always understand by Parthenogenesis the *Lucina sine concubitu* of ancient Naturalists, and therefore lay great stress upon the distinction of true Parthenogenesis and alternation of generation. Siebold, by carefully investigating the observations on Parthenogenesis in Insects, made by former naturalists, arrived at the conclusion that these observers were not sufficiently guarded against possible deceptions, and that entomologists had better reject them as inconclusive. He then shows that a true Parthenogenesis does undoubtedly exist in Psyche Helix, Solenobia clathrella, and lichenella, in Bombyx Mori, and Apis mellifica, (the Honey-bee,) but is of opinion that it occurs among insects in a much greater degree than we are at present able to prove. He places in this category the observations of Leon Dufour, that he never was able to obtain a male Diplolepis gallæ tinctariæ, and alludes to the statement of Hartig, who examined 9,000 to 10,000 individuals of Cynips divisa. and about 4,000 of Cynips folii, without ever finding among them a single male. The peculiar kind of reproduction observable in the lower Crustaceæ, which some have attempted to explain as alternation of generation or gemmation, may prove on closer investigation to be a true Parthenogenesis. Amongst the Molluscs there are also certain phenomena, which may possibly be explained as phases of a true Parthenogenesis. These allusions sufficiently show that the catalogue of reproduction in animals by means of Parthenogenesis, may be expected to receive considerable additions; whilst the doctrine hitherto generally received, that the developement of the ovum could take place solely under the direct influence of the male principle, has received a shock from which it is not likely to recover.

In the vegetable kingdom, authentic proofs of the existence of a Parthenogenesis are much more abundant than they are in the animal. Spallanzani, seems to have been the first who, towards the close of the last century, pointed out that the female hemp did produce ripe seeds without the aid of pollen; but his statement, though confirmed by the experiments of Bernhardi, met with so much opposition that it could not obtain the acknowledgment due to it; and it is only

the recent observations of Naudin in Paris, which, by confirming it still more, have at last vindicated for it the character of an accurate and strictly correct observation. Nor is it to be wondered at, that a fact, opposed to so many theories looked upon as true laws of nature, should have been received with the greatest distrust, and been, ex-cathedra, absolutely denied. That subjective deception should somewhere have taken place was a thought that readily suggested itself, as a plausible excuse for disbelieving so astounding a fact. How easy for polygamous flowers to be hidden among the female ones! (as Mr. Masters has shown them to exist occasionally in the dioicious hop plant.) How easy for pollen to be wafted to the stigmas! These and others were the objections of the unbelievers in the new discovery. To this must be added that the experiments of Koelreuter on hybrids, placed the sexuality of plants on a firmer footing than it formerly enjoyed, and that the concession that a dioicious plant could, under certain circumstances, develope its ovula without the aid of pollen, was looked upon as an absolute negation of sexuality.

The polemic on this subject was continued for many a year, but for the want of new observations began also to slacken, when on the 18th June, 1839, Mr. John Smith, Curator of the Royal Botanic Gardens at Kew, announced before the Linnean Society of London that there existed in the Royal Gardens a female specimen of a Euphorbiaceous plant, Cælebogyne ilicifolia, from New Holland, which annually produced ripe seeds without the aid of pollen. Robert Brown Lindley, the two Hookers, myself and others, subjected the Cælebogyne to strict and repeated examinations, but the result invariably was a confirmation of the case as stated by Smith. The Parthenogenesis of this plant was therefore generally accepted by the public of England; but on the Continent of Europe it was rejected,—as the observations of Treseinus on Datisca cannabina, of Lecogon Spinacia oleracea of Tenore, on Pistacia narbonensis, (confirmed by Bocconi on this and other species of Pistacia,) and of Ramisch on Mercurialis annua had already been. All these observations were regarded as mere delusions, of which science ought to be purged as speedily and completely as possibly; a fact which can take us the less by surprise when we reflect that the doctrine so ably and long maintained by the Horkelian school that the pollen contains the true origin of the embryo and that the ovulum is merely matrix—has only very recently become untenable through the experiments and observations of Hofmeister, Radlkofer and others.

It had been mentioned by Wenderoth and others that the monœcious Ricinus communis, the Castor Oil plant, produced ripe seed without the aid of pollen; but the direct observations of Naudin show that such is not the case, and that so far from exhibiting any tendency towards Parthenogenesis, all the female flowers fell off the moment the male ones were removed; a similar effect was produced on Esbalium elaterium, another monœcious plant, all the female flowers of which faded after the male ones of the same specimen were taken off: observations which justify us in considering as doubtful the existence of a Parthenogensis in monœcious plants, but which have established it in *nine* dioicious ones belonging to seven different natural orders.

The existence of a Parthenogenesis in animals and plants throws more light upon the history of the embryo than the most able and valued physiological researches could possibly do. It shows more clearly than the most lucid explanation, that the origin of the embryo has not to be looked for in the pollen of plants, or the semen

of animals, but in the ovula and ova themselves. And it is in this hin,t science recognizes the real practical utility of this great question. That the Parthenogenesis occupies an important office in the economy of nature we can already perceive, but how it comes to pass that the ova and ovula are developed without the aid of the male principle, and what means are employed to make a sexual reproduction, under such anomalous circumstances, possible, constitute one of those riddles, the solution of which is reserved for future investigation.

QUESTIONS CONNECTED WITH THE SALTNESS OF THE SEA.*—BY PROFESSOR CHAPMAN, OF UNIVERSITY COLLEGE, TORONTO.

It is a current opinion that, owing to the surface of the sea becoming salter and consequently heavier by evaporation, a downward motion of the surface water necessarily takes place; and hence Lieutenant Maury's hypothesis that the sea is salt in order to produce circulation. Some time ago I suggested another object in explanation of the saltness of the sea, viz.: that the sea is salt in order to regulate evaporation. The greater the amount of salt, the slower the evaporation of the water,—and the reverse; so that, if by any easily conceivable cause, or combination of circumstances, the normal degree of saltness become either increased or diminished—a kind of self-regulating force is set up to resist the continuation of the abnormal action, until time restore the balance. Even leaving out of consideration the equalizing effects produced by the accession of fresh water to the surface of the sea by rain and rivers, it seemed to me that the principle of diffusion was in itself sufficient to prevent the sinking of the water thus affected by evaporation; or, at least, to prevent the sinking of this water to any extent. But how to prove the point. The fact that the saltness of the open sea is substantially the same at considerable depths and at the surface, says nothing; as it would necessarily follow, that for every heavy particle of water that sunk, a lighter particle would rise up to supply its place; and hence the composition of the water would be kept uniform, without the principle of diffusion being in any way required to explain the phenomenon. After some consideration I adopted the following method, as one sufficiently trustworthy to afford an answer to the question under review:—I procured a leaden pipe one inch in diameter, and bent into the form of the letter U; each upright being about thirty-nine inches in height, and the connecting piece at the bottom rather more than twelve inches long. This I filled up to about an inch on each side with a solution of common salt in rain water (the salt being present to the amount of 3.786 per cent.,) and then I carefully closed one end, leaving the other end open, but protected from dust by a cone of silver-paper fixed on a bent wire, and so arranged as not to prevent evaporation. The per centage of salt (3.786) was carefully ascertained, and the apparatus left in an unoccupied room, the window and door of which were kept almost constantly open, in order to promote the evaporation of the solution as much as

* It is of course to be understood, that the term "Saltness of the sea," as here applied, has reference solely to the presence of a comparatively large amount of chloride of sodium in the water: to that principle, in fact, which constitutes the essential difference between the waters of the sea and those of lakes and rivers. The other saline substances present in variable proportions in sea-water, are present also, more or less, in bodies of fresh-water: and as they necessarily subserve the same general purposes in each case, their consideration does not legitimately belong to the present inquiry.

possible. After the lapse of about three months, (April 18 to July 14,) portions were taken from each end of the tube, and from the connecting piece below, (a small orifice being made in this;) and the amount of salt in each portion was accurately determined. Now, if the principle of diffusion had not been brought into play, it is evident that the solution in the open limb of the tube ought to have been stronger than that in the closed limb, although, by the circulating process, the amount of salt at the top and bottom of the former might have been alike; and, again, it will be equally evident that if the principle of diffusion were brought into play, the supposed sinking of the surface solution, as the result of evaporation, must be altogether imaginary. Six separate determinations, two from each of the three portions of the tube, shewed a per centage of salt essentially the same. The following table exhibits the results obtained:

		Solution.	Am. of Salt.	Per ct'ge of salt.
1	A. From the top of the open limb.	302.261..	11.59...	3.830
	B. From the bottom of the same.....	300.24...	11.51...	3.835
	C. From the top of the closed limb.....	288.60...	11.055..	3.831
2	A. From the top of the open limb.....	264.83...	10.16...	3.837
	B. From the bottom of the same.....	290.10...	11.12...	3.833
	C. From the top of the closed limb.....	306.66...	11.75...	3.832

These experiments justify us, I think, in assuming that owing to diffusion, the surface waters of the sea do not become heavier than the lower strata simply by losing water by evaporation. It is quite true, that under the influence of evaporation a lowering of temperature may take place, and that an upward and downward circulation, to a certain extent, may in this manner be produced*; but the same reasoning will apply, and with equal force, to bodies of fresh water. In conclusion, therefore, I feel justified in expressing my sustained belief, that the theory which I have proposed to account for the saltness of the sea, is worthy of acceptance; this theory being that the sea is salt, essentially if not principally, in order to regulate evaporation.

Note.—Through the courtesy of various members of the American Association for the Advancement of Science, we have been favoured with abstracts of their papers, authenticated and revised reports, or, in some cases, with the loan of the original papers as submitted to the meeting in the different sections. We shall accordingly continue our report of the Montreal meeting in the next number, and endeavour to furnish a succinct embodiment of some of the most important contributions to science, presented at the first American Scientific Congress held within our Canadian frontier.

The January number of the Journal will also contain such a selection as our limited space will allow, from the numerous and valuable communications laid before the various sections during the recent meeting of the British Association for the Advancement of Science, at Dublin.

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* It should be stated that no intermixture could have taken place in the closed limb of the apparatus described above by ascending currents produced by unequal temperature, as the temperature of the lower portion of the closed tube was kept purposely lower (or at least prevented from becoming higher) than the upper portion by means of a damp rag permanently attached to it.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST—AUGUST, 1857.

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°.				Temp. of the Air.				Mean Temp. +or− of the Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Resultant Direction.	Velocity of Wind.					Rain in Inches.	Snow in Inches.
	6 A.M.	2 P.M.	10 P.M.	MEAN	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M	10 P.M	M'N	6 A.M	2 P.M	10 P.M	M'N	6 A.M.	2 P.M.	10 P. M.		6 A.M	2 P.M	10PM	Result't	ME'N		
					°	°	°	°													°						
1	29.488	29.466	29.508	29.4872	57.7	74.3	63.0	65.60	— 1.37	.412	.518	.399	.437	.88	.63	.71	.72	W N W	W b N	N W	N 76 W	3.0	12.0	6.8	4.84	5.62	.....	...
2	.546	.554	—	—	57.7	74.7	—	—		.371	.508	—	—	.79	.61	—	—	W b S	S b W	N W	S 86 W	1.5	8.8	2.0	3.31	4.74	.....	...
3	.642	.625	.601	.6212	57.5	76.1	66.2	68.20	+ 1.35	.395	.528	.509	.483	.86	.60	.81	.73	N W	S	E b N	S 57 W	2.4	6.0	4.8	2.27	4.35	.....	...
4	.553	.507	.527	.5317	61.8	74.6	67.1	68.60	+ 1.80	.475	.617	.540	.555	.89	.74	.84	.82	N E	S b W	N b W	N 14 W	4.5	5.1	9.6	5.19	6.70	0.020	...
5	.573	.575	.627	.5933	60.6	75.2	62.1	66.85	+ 0.03	.420	.376	.396	.395	.81	.44	.73	.64	N b W	N N W	N N W	N 15 W	9.5	10.8	7.0	4.02	7.82	.....	...
6	.701	.716	.747	.7248	60 3	74.8	62.3	66.58	— 0.18	.383	.550	.477	.468	.75	.66	.87	.74	W N W	S	E	N 63 E	1.8	0.2	2.8	1.95	2.87	.....	...
7	.761	.761	.733	.7560	62.1	78.7	66.2	69.80	+ 3.12	.430	.513	.563	.519	.78	.54	.94	.75	N N E	S E b S	Calm.	S 64 E	3.0	5.5	0.0	2.51	2.85	.....	...
8	.728	.706	.760	.7340	67.5	82.2	68.6	73.68	+ 7.02	.580	.642	.458	.530	.89	.60	.67	.67	Calm.	S b W	N N W	N 25 W	0.0	6.4	10.5	5.04	7.94	Inap	...
9	.821	.746	—	—	64.8	73.1	—	—		.394	.550	—	—	.66	.69	—	—	N E b N	S S E	E b S	N 83 E	6.2	5.6	2.2	3.99	4.97	.....	...
10	.466	.343	303	.3617	62.9	71.9	64.4	67.43	+ 0.92	.442	.565	.440	.511	.78	.74	75	.77	N N E	S W b S	N W b N	S 83 W	5.0	13.5	6.5	2.33	5.37	.....	...
11	368	.444	.525	.4568	62.4	74.2	60.3	65.30	— 1.13	.482	.366	.260	.367	.88	.44	.52	.61	N W b W	W N W	N N W	N 35 W	6.0	9.8	2.0	6.60	7.17	.....	...
12	.650	.580	.523	.5745	56.3	64.0	67.3	63.25	— 3.08	.328	.540	.609	.512	.74	.93	.93	.89	N	E b N	E N E	N 61 E	4.0	8.5	5.2	2.44	5.20	0.890	...
13	.497	.434	.465	.4620	70.6	85.3	74.0	76.38	+10.15	.631	.744	.678	.698	.87	.63	.84	.30	S W	W S W	S W b S	S 42 W	7.0	18.0	6.4	9.30	9.57	.....	...
14	.480	.419	.404	.4317	72.3	78.1	64.0	70.17	+ 3.93	.669	.755	.434	.601	.87	.81	.75	.82	S W	S W b S	W N W	N 73 W	4.2	12.4	5.5	4.45	6.89	0.840	...
15	.584	.592	.685	.6280	55.9	70.7	59.2	62.78	— 3.37	.372	.489	.334	.402	.85	.67	.67	.71	N W b W	S b W	N N W	N 44 W	6 0	7.9	10.4	4.81	7.58	.....	...
16	.802	.781	—	—	57.4	66.0	—	—		.333	.319	—	—	.73	.52	—	—	N	E b N	N E b E	N 70 E	5.0	8.5	6.4	7.66	8.11	1.110	...
17	.535	.604	.671	.6070	57.4	60.3	61.0	59.43	— 6.53	.407	.445	.491	.445	.88	.87	.94	.90	N E	E N E	N b W	N 22 E	16.5	4.0	3.0	5.78	6.23	0.275	...
18	.635	.677	.669	.6783	57.8	66.0	58.4	61.92	— 3.92	.387	.406	.385	.392	.82	.65	.81	.73	N	S E b S	S S E	S 46 E	5.5	9.0	1.0	2.41	4.42	0.240	...
19	.645	.610	.681	.6453	56.6	68.9	57.2	61.63	— 4.13	.416	.534	.378	.454	.92	.78	.83	.84	N N E	S S W	W b N	N 76 W	1.5	8.5	4.0	6.05	7.07	0.055	...
20	.738	.743	.772	.7533	55.1	70.0	65.7	62.97	— 2.58	.350	.284	.461	.347	.82	.40	.74	.64	N W b W	W N W	N N W	N 41 W	3.4	11.2	5.2	7.52	7.87	.....	...
21	.826	.761	.648	.7313	51.9	68.2	60.6	61.18	—4.25	333	.397	.461	.406	.87	.59	.88	.77	N N W	S E b E	E S E	S 46 E	4.0	5.0	8.5	5.51	7.24	0.125	...
22	479	.293	.237	.3270	62.4	68.6	61.9	63.95	— 1.40	.453	.516	.459	.476	.82	.76	.85	.82	S E	S b W	S W b S	S 5 W	13.0	14.5	5.4	8.82	10.05	0.145	...
23	.244	.226	—	—	58.3	60.6	—	—		.397	.443	—	—	.83	.85	—	—	S W	S W b S	N W	N 75 W	6.2	8.0	16.0	10.63	12.92	0.150	...
24	.607	.701	.769	7013	50.1	64.4	56.6	57.93	— 7.02	.306	.369	.375	.353	.86	.63	.84	.76	W N W	S S W	S W	S 67 W	5.8	0.8	4 7	4.33	5.67	.....	...
25	.836	.819	.821	.8292	53.4	71.6	61.7	63.35	— 1.58	.306	.527	.423	.448	.91	.71	.78	.79	W S W	S b W	S W	S 25 W	3.0	13.0	2.8	5.74	5.87	.....	...
26	.847	.778	.696	.7675	53.5	73.6	62 4	64.33	— 0.20	.372	.401	.447	.436	.93	.50	.82	.76	Calm.	S E	N E b E	E	0 0	4.0	2.5	2.96	3.52	.....	...
27	.622	.436	.179	.3915	63.1	70.7	65.7	67.52	+ 3.20	.491	.622	.583	.568	.87	.85	.95	.87	N E b E	E b S	S	S 23 E	3.2	3.4	13.0	3.84	4.73	0.915	...
28	.193	.286	383	.2938	61.7	70.6	59.5	65.62	+ 1.48	.490	.555	.449	.492	.91	.77	.90	.81	S W b S	S b W	S W b W	S 63 W	3.0	7.4	3.2	5.34	6.27	0.500	...
29	.424	.477	.601	.5092	56.6	66.4	55.9	60.18	— 3.63	.411	.415	.354	.396	.92	.65	.81	.78	S W	N W b N	N W b N	N 36 W	0.5	7.5	5.0	8.25	8.48	.....	...
30	.673	.677	—	—	50.7	66.9	—	—		.322	.484	—	—	.88	.75	—	—	N W	S W b S	W b S	S 67 W	2.7	7.5	3.5	4.27	4.83	.....	...
31	.784	.794	.813	8032	57.0	71.5	60.3	63.55	+ 0.23	.400	.472	.458	.454	.88	.64	.89	.80	W S W	S W	Calm.	S 42 W	1.0	8.2	0.0	4.17	4.30	.....	...
M	29.6043	29.5826	29.5938	29.5943	59.40	71.96	62.75	65.31	— 0.45	.431	.506	.455	.467	.86	.66	.81	.77					4.46	8.39	5.35	.....	6.36	5.265	...

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR AUGUST, 1857.

Highest Barometer . . . . . 29.860 at 8 a.m. on 25th } Monthly range=
Lowest Barometer . . . . . 29.155 at midnt on 27th } 0.705 inches.

Self-registering Ther.
- Maximum temperature . . . . 88°2 on p. m. of 13th } Monthly range=
- Minimum temperature . . . . 46.0 on a. m. of 24th } 42°2
- Mean maximum temperature . . 74°45 } Mean daily range = 19°50
- Mean minimum temperature . . 54°95 }
- Greatest daily range . . . . . 28°0 from 14th p. m. to 15th a. m.
- Least daily range . . . . . 6.7 from p. m. of 17th to a. m. of 18th.

Warmest day . . 13th ... Mean Temperature . . . 76°38 } Difference=18°45.
Coldest day . . . 24th ... Mean Temperature . . . 57.93 }

Maximum. { Solar . . . . . 101°5 on p. m. of 13th } Monthly range=
Radiation. { Terrestrial . . . . . 34.0 on a. m. of 24th } 67°5

Aurora observed on 1 night, viz.: 26th at 9.30 p.m, (faint); possible to see Aurora on 23 nights; impossible to see Aurora on 9 nights.

Raining on 13 days; depth, 5.265 inches; duration of fall, 67.3 hours.

Mean of cloudiness=0.47; most cloudy hour observed, 6 a. m., mean=0.55: least cloudy hour observed, 10 p. m.; mean=0.35.

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

North.	South.	East.	West.
1712.96	1465.83	914.04	2007.33

Resultant direction of the wind, N 77° W; Resultant Velocity, 1.51 miles per hour.

Mean velocity of the wind 6.36 miles per hour.
Maximum velocity . . . 26.6 miles per hour, from 5 to 6 p. m. of 23rd.

Most windy day . . . . . 23rd—Mean velocity, 12.92 miles per hour.
Least windy day . . . . . 7th—Mean velocity, 2.85 do

Most windy hour 4 to 5 p.m.—Mean velocity, 9·23 do } Difference
Least windy hour 4 to 5 a. m.—Mean velocity, 4.34 do } 4.89 miles.

Thunderstorms occurred on the 12th from 8.30 to 11.30 p.m.—14th from 2.10 to 3.30 p.m.—22nd from 3 to 7 p.m.—27th 6 to 7.15 p.m.—and on 28th from 5.30 p.m. continuing with a few intermissions.

Distant Thunder heard on the 1st at 3 p.m. and Sheet Lightning observed on the 10th from 8.30 p.m.

Heavy Dew recorded on the mornings of the 2nd 4th 10th 16th 20th 21st and 30th.

Rainbows observed on the 23rd at 5.30 p.m. (imperfect) and on the 28th at 6.30 p.m., double, and very perfectly defined.

Meteors numerous on the nights of the 10th 11th and 13th—a very brilliant meteor observed on the 31st at 11.10 p.m. in the South, passing from W. to E.

Slight hoar Frost reported to have been observed on the morning of the 24th.

Rain—The rain that fell this month was nearly twice the average. Its depth was never exceeded but in 1841 when the depth recorded was 6.170 inches.

Wind—The resultant direction for August from 1848 to 1857 inclusive was N62°W and the resultant velocity 0.68 miles per hour.

COMPARATIVE TABLE FOR AUGUST.

YEAR.	TEMPERATURE. Mean.	Difference from Average.	Maximum observed.	Minimum observed.	Range.	RAIN. No. of days.	RAIN. Inches.	SNOW. No. of days.	SNOW. Inches.	WIND. Resultant Direction.	WIND. Resultant Velocity.	WIND. Mean Velocity
	°	°	°	°	°							
1840	64.7	— 1.3	80.1	47.4	32.7	12	2.605	...	...	—	—	—
1841	64.4	— 1.6	83.5	48.7	36.8	9	6.170	...	...	—	—	0.19 lbs
1842	65.7	— 0.3	80.7	45.3	35.4	6	2.500	...	...	—	—	0.30 "
1843	66.4	+ 0.4	85.5	44.4	41.1	4	4.850	...	...	—	—	0.12 "
1844	64.3	— 1.7	82.5	44.3	38.2	17	imp.	...	...	—	—	0.16 "
1845	67.9	+ 1.9	82.5	44.4	38.1	9	1.725	...	...	—	—	0.19 "
1846	68.4	+ 2.4	86.3	50.4	35.9	9	1.770	...	...	—	—	0.17 "
1847	65.1	— 0.9	83.1	44.9	38.2	10	2.140	...	...	—	—	0.19 "
1848	69.2	+ 3.2	87.5	49.3	38.2	8	0.855	...	...	S 21 E	0.98	4.55mls
1849	66.3	+ 0.3	79.5	51.4	28.1	10	4.970	...	...	N 71 W	0.60	3.76 "
1850	66.8	+ 0.8	84.2	43.0	41.2	13	4.355	...	...	N 15 E	0.35	4.46 "
1851	63.6	— 2.4	79.8	43.6	36.2	10	1.360	...	...	N 63 W	0.40	4.62 "
1852	65.9	— 0.1	81.2	46.7	34.5	9	2.695	...	...	N 70 E	0.56	3.80 "
1853	68.6	+ 2.6	91.6	47.6	44 0	11	2.575	...	...	S 29 E	0.87	4.23 "
1854	68.0	+ 2.0	96.1	47.0	51.1	5	0.455	...	...	N 62 W	1.74	4.74 "
1855	64.1	— 1.9	82.1	44.0	37.2	7	1.455	...	...	N 63 W	1.04	3.97 "
1856	63.6	— 2.4	81.3	44.0	37.3	12	1.680	...	...	N 50 W	2.88	7.03 "
1857	65.3	— 0.7	85.3	50.1	35.2	13	5.265	...	...	N 77 W	1.51	6.36 "
Mean	66.02	...	84.15	46.41	37.74	9.7	2.807	...	...	—	—	5.00

MONTHLY METEOROLOGICAL REGISTER AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—SEPTEMBER, 1857.

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°.				Temp. of the Air.				Mean Temp. + or − of the Average	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Result. Direction.	Direction of Wind.				Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M	2 P.M	10PM	ME'N		6 A.M	2 P.M	10 P.M.	M'N	6 A.M	2 P.M.	10 P.M.	M'N	6 A. M.	2 P. M.	10 P.M.		6 AM.	2 PM.	10 P.M.	Result.	ME'N		
					°	°	°	°	°																			
1	29.911	29.979	29.907	29.9185	54.5	75.8	61.4	63.30	+ 2.27	.378	.569	.488	.488	.91	.66	.91	.81	Calm.	s w b s	Calm.	s 34 w	0.0	3.0	0.0	2.16	2.16	...	...
2	.917	.905	.920	.9145	58.8	74.3	65.0	66.67	+ 3.03	449	589	529	527	92	72	88	83	s w b s	s s E	E	s 85 E	3.5	3.2	3.2	1.32	2.71	...	...
3	.962	.935	.926	.9395	66.8	74.1	66.2	67.43	+ 5.00	478	525	477	496	91	64	76	77	N b E	E	E b N	N 71 E	1.0	6.0	4.0	2.26	3.19	...	...
4	.931	.866	.795	.8523	61.7	76.1	65.5	67.83	+ 5.70	467	610	486	528	87	70	85	80	Calm.	s s w	Calm.	s 15 E	0.0	1.0	0.0	0.50	0.58	...	...
5	.741	.606	.730	.7012	60.6	74.9	60.3	65.25	+ 3.42	413	611	417	513	80	73	81	33	Calm.	s w	N b W	N 74 W	0.0	8.4	12.0	3.68	5.97	1.213	...
6	.910	.919	—	—	50.7	65.3	—	—	—	312	225	—	—	86	37	—	—	N	W N W	N N W	N 31 W	0.8	4.4	4.5	3.41	5.01	...	...
7	30.043	30.068	30.027	30.0423	50.7	59.6	49.6	54.75	— 6.40	285	250	266	265	79	50	77	64	N b W	S E b s	Calm.	S 62 E	4.0	5.0	0.0	2.54	3.55	...	...
8	30.017	29.920	29.854	29.9178	45.4	66.8	54.1	57.30	— 3.43	262	332	362	341	88	52	88	75	S S E	S S W		S 22 W	1.2	3.6	0.0	1.51	1.54	...	...
9	29.849	.753	.677	.7520	51.6	71.1	58.2	61.18	+ 0.83	318	484	460	423	84	65	93	80	Calm.	s w b s	Calm.	S 30 W	0.0	2.2	0.0	1.03	1.03	...	...
10	.638	.550	.565	.5842	56.3	78.0	67.8	68.60	+ 8.55	403	621	585	558	91	67	89	82	Calm.	S W	Calm.	S 45 W	0.0	14.0	0.0	5.55	5.59	...	...
11	.661	.580	.662	.6160	65.4	81.4	64.8	70.92	+11.27	554	744	518	601	91	71	87	81	Calm.	S W	E N E	S 80 E	0.0	11.8	12.0	1.38	7.69	0.002	...
12	.683	.628	.583	.6278	61.1	66.0	61.7	63.45	+ 4.22	456	518	518	499	87	84	96	88	E N E	E N E	Calm.	N 83 E	6.0	3.8	0.0	2.63	2.72	...	...
13	.576	.542	—	—	60.6	74.0	—	—	—	483	577	—	—	94	71	—	—	Calm.	E b S	E N E	S 88 E	0.0	5.5	0.3	1.74	1.99	...	...
14	.525	.418	.576	.5215	65.3	74.9	62.4	67.42	+ 9.08	566	677	392	559	93	81	72	84	Calm.	S b E	N W	N 56 W	0.0	4.0	10.4	5.14	6.60	0.135	...
15	.681	.745	.834	.7590	54.5	67.6	55.2	59.63	+ 1.72	350	301	325	329	84	45	76	68	N W b W	N W b N	N N W	N 35 W	10.5	12.4	3.5	9.87	10.23	...	...
16	.847	.781	.622	.7387	50.5	60.3	60.4	57.75	+ 0.23	302	333	391	361	84	65	78	78	N b W	S E b E	S E b S	S 56 E	3.0	2.0	5.0	3.91	4.67	0.225	...
17	.381	.248	.495	.3822	59.9	71.8	58.8	63.80	+ 6.80	469	664	422	512	93	88	87	88	S E	W S W	N W b W	N 50 W	3.3	12.0	3.5	6.52	8.04	0.215	...
18	.645	.748	.803	.7445	52.1	56.3	49.0	52.15	— 4.47	293	260	255	275	77	59	74	72	N b W	N E	N b E	N 20 E	18.0	6.0	5.6	7.24	8.70	...	...
19	.764	.642	.499	.6230	46.5	51.4	49.8	48.27	— 7.85	266	281	309	273	85	75	88	82	N E	E N E	N N W	N 36 E	11.5	13.2	10.1	9.38	10.70	0.430	...
20	.567	.657	—	—	46.5	56.6	—	—	—	257	375	—	—	82	83	—	—	N b W	N W	N W b N	N 27 W	4.5	7.2	5.0	6.48	6.67	...	...
21	.806	.768	.686	.7478	41.5	57.6	56.3	52.87	— 2.25	218	255	316	277	84	55	71	70	N b W	S E	E S E	S 45 E	4.5	5.4	11.0	4.48	5.37	...	...
22	.525	.410	.442	.4455	54.6	58.1	44.3	52.45	— 2.18	327	367	247	307	78	77	86	79	S E b S	S W	N W b W	N 87 W	7.0	6.8	13.2	4.99	6.67	0.210	...
23	.494	.457	.496	.4850	41.1	51.9	50.3	48.63	— 5.58	218	286	260	248	85	75	72	73	W b N	N W b W	S W b W	S 74 W	2.4	6.6	5.1	7.13	7.27	0.015	...
24	.875	.568	.617	.5945	46.2	66.1	56.3	56.25	+ 2.50	279	434	387	375	90	70	87	84	W S W	S	S W b S	S 20 W	4.5	10.2	2.2	5.42	5.62	...	...
25	.674	.612	.654	.6490	52.3	68.8	59.3	61.52	+ 8.28	334	497	395	411	87	73	86	77	Calm.	S b W	S S W	S 29 W	0.0	14.0	2.5	5.08	6 56	...	...
26	.772	.836	.797	.8055	54.8	65.0	51.6	57.50	+ 4.77	332	422	343	361	79	71	91	79	N W	S b W	S b W	S 15 W	5.0	3.8	1.8	1.32	3.27	...	...
27	.754	.611	—	—	49.8	72.6	—	—	—	333	536	—	—	94	69	—	—	S b E	S S W	N W b W	S 45 W	3.0	13.0	7.2	5.85	7.52	0.100	...
28	.545	.534	.725	.6107	56.3	55.2	45.3	52.63	+ 0.80	387	328	219	309	87	77	73	78	S W	W b N	N W b N	N 78 W	3.8	19.2	9.6	12.37	13.11	0.085	...
29	.778	.821	.816	.7960	39.3	47.6	37.1	41.32	—10.00	207	145	177	178	87	44	86	71	W N W	N N W	Calm.	N 37 W	6.1	17.8	0.0	6.86	7.09	...	...
30	.756	.719	.757	.7432	39.5	52.5	38.4	43.73	— 7.08	180	199	192	195	75	51	83	71	W b S	W N W	Calm.	N 73 W	0.4	16.5	0.0	4.57	4.69	0.010	...
M	29.7331	29.6960	29.7102	29.7120	53.13	65.51	55.70	58.64	+ 1.15	.353	.435	.375	.393	.86	.67	.83	.78					3.47	8.07	4.49		5.55	2.640	

TOA.—II.

Highest Barometer..... 30.076 at 8 a. m., on 7th } Monthly range=
Lowest Barometer ..... 29.248 at 2 p. m., on 17th } 0.828

Self-registing Thermom.

Maximum Temperature.....82°.0 on p. m., of 11th } Monthly range=
Minimum Temperature.....34°.1 at midt. of 29th } 47.°9

Mean maximum Temperature ..... 67°48 } Mean daily range=
Mean minimum Temperature ..... 48°14 } 19.34

Greatest daily range .....28°5 from p. m. of 5th to a. m. of 6th.

Least daily range..... ..... 7°0 from p. m. of 12th to a. m. of 13th.

Warmest day..... 11th ... Mean temperature..... 70°92 } Difference = 29°60.
Coldest day..... 29th ... Mean temperature..... 41.32 }

Maximum } Solar..... 98°0 on p. m. of 4th, } Monthly range=
Radiation. } Terrestrial..... 23°5 on a. m. of 29th. } 74°5

*Aurora observed on 6 nights, viz., 3rd, 10th, 14th, 23rd, 25th and 29th.
Possible to see Aurora on 21 nights; impossible on 9 nights.

Raining on 11 days,—depth 2.640 inches; duration of fall 31.9 hours.

Mean of cloudiness = 0.43.
Most cloudy hour observed, 2 p. m., mean = 0.49; least cloudy hour observed, 10 p. m., mean, =0.30.

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

North.	South	East.	West.
1536.94	1111	721.52	1797.17

Resultant direction N. 68° W.; esultant Velocity 1.61 miles per hour.
Mean velocity..... 5.55 miles per hour.
Maximum velocity ..... 23.1 miles from 11 a. m. to noon on the 28th.
Most windy day..... 28th...Mean velocity 13.11 miles per hour.
Least windy day ..... 4th...Mean velocity 0.58 ditto.
Most windy hour ... 3 to 4 p. m.....Mean velocity 9.27 ditto. } Difference
Least windy hour ... 6 to 7 a. m.....Mean velocity 3.47 ditto. } 5.80 miles.

Corona round the Moon on 1st at midnight, 3rd at midnight, 4th at 10 p.m., 5th from 10 p.m. and 7th from 10 p.m.

Halo round the Moon on 9th at midnight, and round the Sun on 21st, from 9.30 to 1 p.m.

Dense Fog on 5th at 6 a.m., 12th from 4.40 p.m., and on 13th at 6 a.m.

Heavy Dew very frequent, having been recorded on 15 days during the month

Hoar Frost on 21st, at 5.40 a.m., and on 30th at 1 a.m.

Hail Shower on 28th at 0.10 p.m., and on 30th at 2 p.m.

Rainbow on 28th, at 2.20 p.m., very perfect.

Thunderstorm on 5th from 1.40 to 4 p.m., and on 11th at 5.30 p.m.

Sheet Lightning on 13th from 6.50 p.m., 25th from 7 to 9 p.m., and on 27th during the evening.

Wind.—The resultant direction of the wind for September, from 1848 to 1857 inclusive, was N. 54° W., and the resultant velocity 0.93 miles per hour.

Rain.—The depth of rain was 1.693 inches less than the average of 17 years.

COMPARATIVE TABLE FOR SEPTEMBER.

Year.	Temperature. Mn.	Diff. from Aver.	Max. ob'd.	Min. ob'd.	Range.	Rain. No. of days.	Rain. Inch's.	Snow. No. of days.	Snow. Inch's.	Wind. Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
	°	°	°	°	°							
1840	54.0	—4.1	70.2	29.4	40.8	4	1.380	...	...	...	...	.....
1841	61.3	+3.2	79.9	37.5	42.4	9	3.310	...	...	...	...	0.26 lbs.
1842	55.7	—2.4	83.5	28.3	55.2	12	6.160	...	...	...	...	0.45
1843	59.1	+1.0	87.8	33.1	54.7	10	9.760	...	...	...	...	0.57
1844	58.6	+0.5	81.5	29.6	51.9	4	.....	...	...	...	...	0.26
1845	56.0	—2.1	78.8	35.3	43.5	16	6.245	...	...	...	...	0.34
1846	63.6	+5.5	84.0	39.0	45.0	11	4.595	...	...	...	...	0.33
1847	55.6	—2.5	74.8	38.1	36.7	15	6.665	...	...	...	...	0.33
1848	54.2	—3.9	80.9	29.5	51.4	11	3.115	...	...	N 71° W	2.38	5.81 mls.
1849	58.2	+0.1	80.6	33.5	47.1	9	1.480	...	...	N 75° W	0.69	4.25
1850	56.5	—1.6	76.0	31.7	44.3	11	1.735	...	...	S 63° W	1.02	4.78
1851	60.0	+1.9	86.3	33.4	52.9	9	2.665	...	...	N 14° E	1.03	5.45
1852	57.5	—0.6	81.8	36.1	45.7	10	3.630	...	...	N 77° W	0.53	4.60
1853	58.8	+0.7	85.4	36.1	49.3	12	5.140	...	...	N 5° E	1.05	4.30
1854	61.0	+2.9	93.1	36.3	56.8	14	5.375	...	...	N 23° W	1.42	4.31
1855	59.5	+1.4	81.7	36.1	45.6	12	6.585	...	...	N 20° E	1.29	7.61
1856	57.1	—1.0	77.3	37.4	39.9	13	4.150	...	...	S 79° W	1.98	6.53
1857	58.6	+0.5	81.4	34.1	47.3	11	2.640	...	...	N 68° W	1.61	5.55
M	58.07	...	81.39	34.14	47.25	10.7	4.333	...	...	...	...	5.32miles.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—AUGUST, 1857.

(NINE MILES WEST OF MONTREAL.)

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

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

Day.	Barom. corrected and reduced to 32° Fahr. 6 A.M.	2 P.M.	10 P.M.	Temp. of the Air. 6 A. M.	2 P. M.	10 P. M.	Tension of Vapor. 6 A.M.	2 P.M.	10 P.M.	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Velocity in miles per hour. 6 A.M.	2 P.M.	10 P.M.	Mean direction of Wind.	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0. 6 A.M.	2 P.M.	10 P.M.
1	29.569	29.533	29.655	62.7	66.6	60.6	.528	.516	.511	.93	.80	.93	S W	W S W	S W B S	7.22	2.96	1.11	...	0.540	...	Cir. Str. 10.	Ni. 10.	C. St. 2. Thund.
2	.614	.620	.798	60.0	76.7	65.6	.512	.692	.586	.96	.78	.93	S W B S	S W B S	S W B S	0.12	0.18	0.40	...	Inapp	...	Do. 7.	C. C. Str. 6.	C. C. Str. 2.
3	.734	.700	.898	62.2	81.0	68.8	.528	.739	.634	.93	.71	.90	S E	S B y E	S E B E	0.12	0.18	0.40	...	...	...	Clear.	C. St. 4.	C. St. 3.
4	.754	.712	.678	66.1	87.7	70.6	.574	.814	.541	.89	.65	.74	S S W	S S W	N N W	0.00	0.35	0.30	...	...	...	Do.	Do. 2.	Do. 10.
5	.643	.700	.726	63.2	87.9	62.5	.461	.801	.499	.29	.62	.89	N B E	N B E	N W B W	6.57	3.06	4.65	...	...	...	C. Str. 10.	Do. 2.	Clear.
6	.812	.835	.949	59.6	86.0	59.0	.478	.648	.452	.90	.53	.89	E N E	E by N	S E	3.16	2.08	0.10	...	...	...	Clear.	Clear.	Do.
7	.967	.915	.999	56.5	88.1	68.0	.488	.692	.582	.89	.53	.85	S S W	S W	S B E	0.48	0.43	0.10	...	...	...	Do.	Do.	C. Str. 2.
8	.848	.749	.891	61.4	83.0	64.0	.565	.715	.476	.93	.64	.79	S B W	W S W	W N W	6.66	7.21	8.77	...	...	...	C. Str. 10.	C. St. 9.	Clear.
9	.980	.970	.846	55.6	72.5	58.0	.552	.498	.437	.79	.64	.89	W	N E	S S W	9.75	4.27	0.21	...	...	...	Clear.	Clear.	Str. 2.
10	.685	.552	.491	58.0	79.2	64.2	.462	.659	.565	.90	.67	.63	S S E	S by E	S W B S	0.00	1.90	1.16	...	Inapp	...	C. C. Str. 6.	C. C. St. 8.	C. S. 10. D. Thun.
11	.857	.468	.596	62.6	70.3	62.0	.528	.511	.499	.93	.74	.89	W	N W	N B W	1.30	6.31	3.93	...	0.274	...	Cir. Str. 10.	C. Str. 4.	Do. 6. Dis. Thun.
12	.696	.700	.724	48.1	78.0	64.0	.334	.607	.501	.93	.64	.84	W B S	S S W	S E	0.36	0.40	2.60	...	...	...	Clear.	Clear.	Do. 2.
13	.676	.512	.446	63.0	70.0	63.0	.546	.659	.546	.94	.89	.94	S S E	N E	N E	3.71	1.40	1.42	...	1.079	...	Ni. 10.	C. St. 9.	Do. 10.
14	.417	.524	.551	67.0	84.0	67.3	.626	.854	.593	.93	74	.89	W by S	N N W	W N W	1.05	5.50	9.65	...	...	...	C. Str. 10.	Do. 6.	Clear.
15	.641	.714	.830	65.0	76.0	58.0	.529	.659	.437	.85	.74	.89	N B W	W	N W B W	0.21	5.63	8.27	...	...	...	Do. 6.	Clear.	Do.
16	.858	.778	30.005	55.0	76.0	57.2	.372	.559	.376	.84	.74	.76	W B N	W B S	W	0.40	9.52	5.93	...	...	...	Clear.	St. 2.	C. St. 8.
17	.811	.746	29.688	48.7	68.0	49.6	.366	.552	.326	.92	.81	.88	N	N E by E	W B N	0.20	3.17	4.12	...	...	...	C. C. Str. 6.	Clear.	Cirr. Str. 4.
18	.813	.741	.764	47.0	72.0	54.7	.313	.578	.373	.92	.74	.87	N E by E	N E	N E	0.00	0.09	0.86	...	...	...	Do. 4.	C. C. Str. 8.	Clear.
19	.801	.714	.817	47.0	74.1	57.1	.313	.648	.378	.93	.78	.84	S	S	S B E	1.32	1.15	1.25	...	...	...	C. Str. 2.	C. St. 10.	Ni. 10.
20	.806	.672	.856	67.4	73.0	58.9	.447	.692	.478	.94	.86	.92	N E	S W	S W	2.11	0.37	1.40	...	1.200	...	Ni. 10.	Do. 6.	C. St. 2.
21	.917	.915	.954	61.0	76.6	60.6	.520	.597	.441	.96	.67	.84	S W B S	S E	S B E	0.13	0.17	0.80	...	...	...	C. Str. 8.	C. C. St. 4.	Clear.
22	.817	.720	.666	55.6	72 1	61.0	418	.578	.483	.93	.74	.89	S S E	S B E	S E	0.28	5.91	9.51	...	Inapp	...	C. Str. 10.	C. St. 6.	C. Str. 10.
23	.517	.358	.404	57.4	71.6	61.0	.447	.681	.512	.93	.89	.96	E S E	S B E	S S W	8.61	8.25	0.22	...	0.473	...	Cirr. 4.	Do. 4.	Clear.
24	.527	.511	.783	53.2	63.5	51.1	.311	.546	.337	.87	.93	.87	W	W B N	S W B W	7.78	10.53	9.43	...	Inapp	...	C. Str. 6.	C. C. St. 6.	Do.
25	.928	.868	.992	55.0	78.9	65.0	.396	.670	.555	.89	.71	.89	W B S	S W	S W	0.05	3.27	3.70	...	...	...	Clear.	Clear.	Do.
26	.925	.900	.883	37.0	79.7	65.5	.449	.692	.555	.94	.71	.89	S S W	S S W	S S W	1.63	4.52	5.06	...	...	...	Do.	Do.	Do. Aur. Boreal.
27	.880	.786	.614	64.0	86.0	70.1	365	.910	.628	.93	.73	.86	S S E	S S E	S B E	0.02	0.63	9.30	...	...	...	Do.	C. C. St. 2.	C. St. 10.
28	.377	.344	.485	65.0	79.9	68.0	.589	.692	.613	.93	.71	.89	S B y E	S W	S S W	22.25	7.10	8.00	...	1.025	...	C. Str. 10.	C. Str. 10.	Do. 4.
29	.504	.521	.624	66.0	68.0	60.0	.514	.590	.467	.89	.86	.89	S W B S	W	N W	2.18	7.63	4.65	...	Inapp	...	Do. 4.	Do. 8.	C. C. Str. 8.
30	.681	.679	.746	48.2	66.6	60.7	.302	.440	.417	.86	.68	.89	W B N	W by S	W S W	6.96	9.81	7.07	...	...	...	Do. 10.	Clear.	C. Str. 4.
31	.817	.883	30.052	60.1	73.6	50.6	.441	.568	.349	.84	.71	.92	W B N	S S E	S E	11.75	3.70	1.81	...	...	...	Do. 8.	C. St. 4.	Clear.

MONTHLY METEOROLOGICAL REGISTER, ST. MARTIN, ISLE JESUS, CANADA EAST—SEPTEMBER, 1857.

(NINE MILES WEST OF MONTREAL.)

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

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

Day.	Barom. corrected and reduced to 32°			Temp. of the Air.			Tension of Vapor.			Humidity of Air.			Direction of Wind.			Velocity in miles per hour.			Mean direction of Wind.	Rain in Inches.	Snow in Inches.	WEATHER, &c. A cloudy sky is represented by 10; A cloudless sky by 0.		
	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.	6 A.M.	2 P.M.	10 P.M.				6 A. M.	2 P. M.	10 P. M.
1	30.061	30.019	30.090	46.9	85.7	68.2	.282	.763	.582	.86	.65	.86	S W	S W	S W	0.20	5.61	3.06	...	...	...	Clear.	Clear.	Clear.
2	.049	29.974	.093	62.0	88.4	70.0	.471	.801	.628	.84	.62	.86	S W	S S W	S b W	1.46	1.72	0.30	...	...	...	Do.	Do.	Cir. Str. 2.
3	.099	30.076	.083	60.7	88.6	62.5	.511	.801	.540	.93	.62	.92	S b W	S b W	S b W	0.46	0.17	6.35	...	...	...	Fog.	Clear.	Clr. Au. Bor.
4	.081	.076	.003	63.5	91.4	68.2	.516	.814	.646	.89	.59	.93	S b W	S S E	S S E	0.15	0.05	0.00	...	...	...	Clear.	Do.	Cirr. 2.
5	29.861	29.701	29.691	69.8	81.2	65.7	.668	.704	.605	.92	.68	.93	S	S W	W N W	0.00	G 16	10.11	...	1.001	...	Do.	C. Str. 9.	C. Str. 8. T. S.
6	29.987	.935	30.031	51.2	63.3	46.6	.315	.307	.282	.81	.53	.86	N W	N W	N W	10.15	17.77	8.30	...	...	...	Str. 1.	Do. 2.	Clear.
7	30.160	30.135	.179	48.4	66.3	48.0	.281	.449	.302	.80	.68	.86	N W	S W	S	1.26	0.63	0.73	...	...	...	Clear, 1st Fr.	Str. 1.	Do.
8	.158	.035	29.959	54.0	69.1	60.9	.304	.437	.456	.89	.62	.84	W	W S W	S W	0.15	4.99	5.33	...	...	...	C. Str. 8.	Cirr. C. 4.	C. Str. 9. Thun
9	29.961	29.883	.905	58.2	69.0	62.4	.462	.570	.472	.92	.81	.84	W b S	N W	E S E	4.00	1.20	0.21	...	0.140	...	Do. 6.	C. Str. 10.	Clear. Light'g.
10	.837	.671	.598	60.4	81.6	73.0	.494	.739	.692	.91	.71	.86	E N E	W b S	W S W	0.26	15.22	3.96	...	0.133	...	Do. 10.	Clear.	Do. Au. Bo.
11	.451	.806	.925	70.0	58.0	54.6	.628	.437	.400	.86	.89	.92	W b S	N E b E	E b N	5.00	10.12	0.96	...	0.104	...	Do. 3.	Nimb. 10.	C. Str. 8.
12	.912	.814	.766	48.0	58.7	52.0	.302	.387	.349	.86	.79	.87	N E by E	N E	N E	6.78	8.12	12.05	...	Inp.	...	Do. 9.	C. Str. 8.	Do. 10.
13	.764	.609	.745	48.1	84.8	69.0	.281	.854	.634	.80	.75	.90	S E b E	S S W	S E b E	1.62	0.12	0.82	...	...	...	Clear.	Clear.	C. C. Str. 4.
14	.747	.712	.604	65.7	77.9	66.1	.586	.787	.605	.92	.86	.92	S S E	S S E	S S E	0.10	1.21	4.08	...	0.330	...	C. Str. 8.	C. Str. 2.	C. Str. 8. Ltg.
15	.680	.722	.900	59.5	67.5	52.9	.452	.480	.373	.89	.72	.92	W	W N W	N W b W	12.42	16.50	2.00	...	...	...	Do. 6.	Do. 2.	Clear.
16	.952	.885	.946	46.2	67.9	53.0	.282	.563	.361	.86	.85	.87	N	S b W	W S W	10.96	1.61	2.67	...	...	...	Clear.	Do. 4.	C. C. Str. 4.
17	.599	.453	.531	41.5	56.7	52.7	.235	.432	.386	.85	.94	.93	N W	W S W	W S W	0.22	0.10	0.35	...	0.140	...	Do.	Nimb. 10.	C. Str. 9.
18	.635	.975	.981	45.4	35.5	33.1	.253	.203	.187	.80	.91	.90	S b E	N W	N W	0.92	18.77	3.77	...	...	...	C. Str. 10.	Clear.	Clear.
19	.968	.908	.892	34.2	58.1	42.0	.170	.367	.243	.79	.75	.85	E	E S E	E	6.57	0.47	0.08	...	...	...	Clear.	C. C. Str. 8.	Do.
20	.694	.715	.901	44.0	50.9	41.7	.241	.326	.263	.79	.87	.92	E	N	S W b W	1.97	6.15	1.70	...	0.210	...	Nimb. 10.	Nimb. 10.	Do.
21	.980	.970	.999	37.7	57.8	42.9	.218	.422	.263	.91	.89	.92	S S E	E b N	E b S	0.00	0.50	0.07	...	...	...	Clear,	C. Str. 2.	Clear.
22	.847	.704	.581	44.7	50.5	49.2	.261	.349	.336	.85	.90	.93	S b E	S b E	S by E	0.86	2.27	10.32	...	0.720	...	C. Str. 7.	Nimb. 10.	Rain.
23	.500	.494	.604	40.2	51.4	44.9	.227	.253	.261	.85	.66	.85	W b N	W b N	W S W	15.87	19.48	9.42	...	0.170	...	Clear.	C. Str. 2.	Clear. Au. Bo.
24	.686	.712	.810	44.1	67.3	56.6	.282	.534	.432	.92	.81	.91	S W	W b S	S W	7.80	8.26	4.33	...	...	...	Do.	Do. 2.	Do.
25	.852	.819	.835	48.0	80.5	59.0	.291	.751	.452	.84	.75	.89	S	W S W	S b W	0.98	5.89	1.22	...	...	...	Do.	Clear.	Do. Au. Bor.
26	.861	.992	.954	57.1	72.5	54.1	.422	.450	.349	.89	.58	.81	S W	W	W S W	1.52	6.90	3.71	...	...	...	Do.	Do.	Do.
27	.897	.762	.718	51.2	73.6	63.2	.361	.692	.516	.92	.78	.89	S b W	W b S	S b W	0.35	3.82	7.00	...	...	...	Do.	Do.	Do. Light'g.
28	.574	.580	.583	57.0	51.7	48.0	.447	.315	.324	.94	.81	.92	S W b S	W	S W	4.22	1.62	10.47	...	1.053	...	C. Str. 10.	Rain, Thun.	C. Str. 9.
29	.754	.759	.852	39.0	47.0	36.0	.214	.271	.192	.84	.80	.83	W N W	W b N	W	19.32	15.67	11.32	...	...	...	Clear.	C. Str. 6.	C. Lt. Snow.
30	.868	.840	.857	34.0	52.0	38.2	.186	.274	.226	.87	.70	.90	W N W	S W	S W b S	1.90	4.80	2.71	...	0.170	...	Do.	C. Str. 8.	C. Str. 6. A.B.

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

Barometer	Highest the 31st day	30.052
	Lowest the 28th day	29.344
	Monthly Mean	29.723
	Monthly Range	0.708
Thermometer	Highest the 7th day	90°4
	Lowest the 25th day	45°.2
	Monthly Mean	65°07
	Monthly Range	45°2
Greatest Intensity of the Sun's Rays		120°0
Lowest Point of Terrestrial Radiation		41°.4
Mean of Humidity		.848
Amount of Evaporation		2.84 inches

Rain fell on 11 days, amounting to 4.580 inches; it was raining 43 hours and 10 minutes and was accompanied by thunder on 3 days.

Most prevalent wind, S. W. Least prevalent wind, E. by N.

Most windy day, the 28th day; mean miles per hour, 12.45.

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

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

Ozone was in large quantity.

Aurora Borealis visible on 1 night.

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

Barometer	Highest, the 7th day	30.179
	Lowest, the 11th	29.451
	Monthly Mean	29.842
	Monthly Range	0.728
Thermometer	Highest, the 4th day	91°.4
	Lowest, the 19th day	30°.4
	Monthly Mean	57°47
	Monthly Range	61°0
Greatest intensity of the Sun's Rays		121°.2
Lowest point of Terrestial Radiation		29°.8
Mean of Humidity		.823
Amount of Evaporation		2.48 inches.

Rain fell on 11 days amounting to 4.171 inches; and was accompanied by thunder on three days, it was raining 45 hours 4 minutes.

A few flakes of snow fell on the 29th day, being the first this season.

The most prevalent wind was the W S W.

The least prevalent wind N.

The most windy day the 29th; mean miles per hour 15.43.

Least windy day the 21st; mean miles per hour 0.19.

The electrical state of the Atmosphere has indicated rather high intensity.

Ozone was in moderate quantity.

The Aurora Borealis visible on 5 nights.

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