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A POPULAR EXPOSITION OF THE MINERALS AND GEOLOGY OF CANADA.

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(*Concluded from Vol. VIII. page 462.*)

GENERAL OUTLINE AND RECAPITULATORY SKETCH OF THE GEOLOGY OF CANADA.

1. *Canadian Rock Formations.*—The rock groups occurring within the limits of Canada, comprise representatives of the Azoic, Lower Palæozoic, and Post-Tertiary series. The Upper Palæozoic deposits (inclusive of the Coal Measures proper) together with the entire formations of the Mesozoic and Cainozoic Ages, are altogether unknown within the limits of the Province.

2. *Azoic Series.*—The rocks of this series, composed of Sedimentary matters deposited in ancient seas, apparently before the creation of organic types, and subsequently rendered more or less crystalline by metamorphic forces, are subdivided into two formations. The lower of these is named the Laurentian, and the higher, the Huronian Formation. The Laurentian strata consist principally of highly crystalline beds of micaceous and hornblendic gneiss; hornblende rock; crystalline limestone and dolomite; oxidized iron ores; quartzite; and anorthosites, or rocks composed chiefly of lime and soda feldspar. In

an economic point of view, the Laurentian Formation is essentially characterised by the vast beds of magnetic and specular iron ore that occur within it: full details of which are given in a preceding page. The formation is many thousands of feet in thickness, and it covers an area of 200,000 square miles—running from Labrador along the north shore of the St. Lawrence to the vicinity of Quebec, and throughout all the more northern and north-western portions of the Province, as shewn in the sketch-maps, figs. 154 and 243. By reference to the latter, it will be seen that in the district between Prescott and Kingston, a narrow belt of this formation crosses the St. Lawrence, and expands over a large extent of country, comprising the Adirondack region, in the State of New York. This belt forms a somewhat important feature in the geology of Western Canada. It will be alluded to again, in connection with this sketch, under the name of the "gneissoid belt of the Upper St. Lawrence." The Huronian Formation which constitutes the higher division of the Azoic series, consists chiefly of green and greyish slate-conglomerates and other partially altered strata, interstratified with greenstone masses, and traversed by numerous trap dykes. It contains also many quartz veins, holding copper pyrites and other copper ores in workable quantities. The total thickness of the formation is probably not much under 20,000 feet. Its strata are chiefly developed along the north shore of Lake Huron (No, 2, in fig. 243), and in places on Lake Superior.

3. *Laurentide Mountains. North and South Basins of Canada.*—A high water-shed or range of mountainous country, averaging a height of from one to two thousand feet above the sea, but rising in places to nearly four thousand feet, traverses the greater portion of the Laurentian area, and forms at one part of its course the "Laurentide Mountains." It divides the Province into two great basins or geological areas: known, respectively, as the North and South Basins.

4. *Great Northern Basin of Canada.*—The area occupied by this basin, lying to the north of the Laurentian water-shed, and sloping towards Hudson's Bay, as regards its geological characters, is still comparatively unexplored. The formations known to occur within its limits, comprise the Laurentian and the Upper Silurian series. The Huronian rocks are thought to occur also, in the form of Chloritic schists, in the valley of Lake Temiscaming, but no traces of Lower Silurian strata have anywhere been met with. Hence, it is suggested by Sir William Logan, that, the Laurentide mountainous

range formed, from Labrador to the Arctic Sea, the northern shore line of the ocean during the Lower Silurian period. The la. ! to the north, being thus above the level of the sea, would receive no deposition of Lower Silurian strata; but an after movement of depression must have ensued during the Upper Silurian epoch, bringing down this northern district beneath the sea, and so enabling the sediments of the latter period to be laid down upon its area.

5. *Great Southern Basin of Canada: Its subdivisions:*—The southern geological area of Canada, is in itself divisible into three smaller basins: (1) the Basin of the lakes; (2) The Basin of the St. Lawrence; and (3) The Eastern or Metamorphic Basin. The two first of these are separated from each other by the gneissoid belt of the Upper St. Lawrence alluded to above; whilst the third or Eastern Basin is separated from the St. Lawrence area by a remarkable dislocation, accompanied by physical and chemical changes of great moment. This dislocation is evidently connected with the elevation of the Appalachian mountain chain. As traced in Canada by Sir Wm. Logan, it runs from near the northern extremity of Lake Champlain in a general north-easterly direction to the St. Lawrence, which it crosses immediately above Quebec; and then turns to the east, traversing the northern part of the Island of Orleans and passing down the river into the Gulf, from whence it appears to re-enter the south shore a few miles above the mouth of the Magdalen River in Gaspé. The strata within the area circumscribed by this dislocation, are thrown up generally into highly inclined beds; and they exhibit, in other respects, many signs of the action of powerful disturbing forces. See under the head of the "Calciferous Formation," on a preceding page. In the more central portion of the area, also, they are much altered, or converted into crystalline schists, &c., and rendered met ferous by metamorphic agencies. The strata of the Lake and St. Lawrence Basins, on the other hand, betray few signs of these disturbing influences, except in the case of the upper copper-bearing series of Lake Superior, and in parts of Gaspé, as described fully in a preceding division of this Essay.

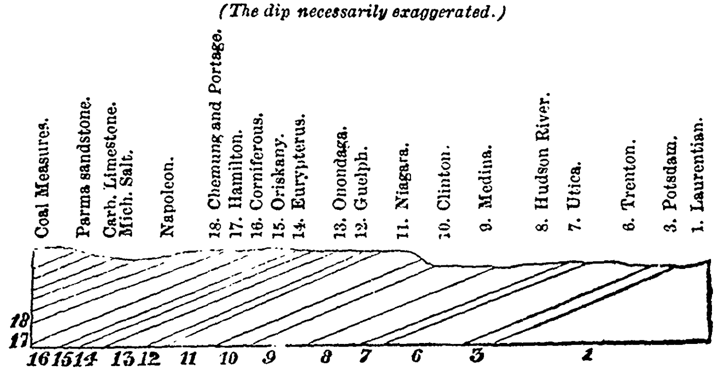
6. *The Lake Basin of Canada:*—Of this geological basin, properly speaking, only the north-eastern and northern portions actually occur within the boundaries of the Province. It includes all the area to the east or left of the Laurentian district marked 1—1 in the sketch-map fig. 243. Though affected here and there by slight local disturbances,

the strata within this area have a *general* westerly dip, extending as far as the central part of Michigan, in consequence of which, on proceeding from the gneissoid belt of the Upper St. Lawrence, just east of Kingston, towards the southern extremity of Lake Huron, the various formations (exclusive of the Calciferous and Chazy series?) from the Potsdam to the Hamilton beds, with those also of Kettle Point, are successively traversed. The dip of these strata, however, (except here and there, under local conditions) is exceedingly slight, rarely exceeding two or three degrees, and averaging in general less than half-a-degree, or about 30 or 40 feet in a mile. The annexed section will serve to convey a general idea of the sequence of these formations, as shewn on the map, between the gneissoid belt east of Kingston, and the coal strata of central Michigan. The thickness of intervening rock between the top of the Hamilton formation and the lowest of the Michigan coal seams, is about 840 or 850 feet.

Fig. 250.

SKETCH-SECTION OF FORMATIONS OF WESTERN PART OF CANADA AND EASTERN MICHIGAN.

(The dip necessarily exaggerated.)



At the extreme east of this basin, a little beyond Kingston, a narrow band of Potsdam sandstone rests on the western slope of the gneissoid or Laurentian rocks. This is followed to the west—the Calciferous and Chazy formations being apparently absent—by the strata of the Ontario group, comprising the Birds-eye, Black River, and higher limestones of the Trenton formation, the dark bituminous Utica schists, and the arenaceous shales, &c., of the Hudson River Series. The

Trenton formation is probably about 700 or 750 feet in thickness; the Utica shales, somewhat under 100 feet; and the Hudson River series, between 700 and 800 feet. These formations are developed chiefly along the shore of Lake Ontario, between Kingston and the central part of Nelson township, west of Toronto; and also on the shore of Georgian Bay, between Cape Crocker and a spot a little south of the outlet of the River Severn; as well as throughout all the intervening country: including within the Trenton area, Lake Simcoe, Balsam Lake, Rice Lake, and other bodies of water. Kingston, Belleville, Peterborough, Cobourg, Port Hope, Barrie and Collingwood, are situated over the Trenton district; Whitby and the country just west of Collingwood harbour, over the Utica *formation*; and Toronto, Oakville, Sydenham (Owen Sound,) and Meaford, over the Hudson River strata. These various formations, as explained fully under their respective descriptions on a former page, run also across the northern part of the Manitoulin Islands.

The Niagara or Anticosti group succeeds the Lower Silurian strata. The Medina Formation (Map: No. 9), at its base, sweeps round by Queenston, Hamilton, &c., below the great escarpment of that district, and continuing its course, first towards the north and then towards the north-west, comes out upon Georgian Bay near Cabot's Head, forms the extreme base of that promontory, and runs, it is supposed, in a narrow belt along the central part of the Manitoulin Isles. These Medina strata consist chiefly of red marls, shales, and sandstones, capped by a grey freestone, known as the "grey band." On Lake Ontario, they exceed 600 feet in thickness, but diminish considerably towards their north-western limits. The green and red shales of the Clinton division (No. 10,) with their interstratified limestone beds, appear above the grey band of the Medina formation proper; and are succeeded by the calcareous shales and limestones of the Niagara formation, holding *Pentamerus oblongus*, fig. 213, amongst their other fossils. The Niagara limestone (Map: No. 11) appears to represent in the Middle Silurian strata, the great Trenton limestone of the Lower series. Still higher in the scale, and farther to the west, follow successively the Guelph dolomites (No. 12), the gypsiferous and fossil-free strata of the Onondaga formation (No. 13), and the slightly developed Eurypterus beds of the Lower Helderberg group. These close the Silurian series, The country between the upper part of the Niagara River and the north-eastern shores of Lake Huron, is occupied by these Middle and Upper Silurian formations, but their strata are mostly concealed by Drift-deposits. The localities in which instructive exposures occur, have been mentioned under the separate descriptions of each formation, at the commencement of this Part of our Essay. The Clinton beds near the mouth of the Niagara River are only a few feet in thickness, but they increase towards the north-west, and attain, on the shores of Georgian Bay, a thickness of about 180 feet. The Niagara formation increases in the same direction, from about 240 or 250 feet, to probably about 400 feet. The Guelph formation at its thickest part is estimated by Sir Wm. Logan at 160 feet. The Onondaga formation averages from 200 to 300 feet.

Still further to the west, a thin band of sandstone, belonging to the Oriskany Formation (Map : No. 15), crops out above the Eurypterus beds in the townships of Bertie, Cayuga, &c. This forms the base of the Devonian series. It is succeeded by a large development of the cherty limestones of the Corniferous Formation, (No. 16), averaging collectively about 200 (?) feet in thickness, and supposed to be the source of the Petroleum supplies of that district. These are followed by the encrinal limestone bands and calcareous shales of the Hamilton (or Lambton) series (No. 17,) making up an additional thickness of from 200 to 300 feet. Finally, at Kettle Point, and in the townships of Warwick and Brooke, a few isolated patches of dark bituminous shales, containing calamites and fish-scales, conclude the Devonian series as developed in this part of Canada. These bituminous shales, are referred to the base of the Portage group (No. 18). The relations of the Hamilton or Lambton shales to the underlying Corniferous strata, and the chief points of interest belonging to the occurrence of petroleum in this region, have already been sufficiently discussed.

The Drift accumulations spread so generally over this western basin, consist of thick beds of clay, overlaid in most places by deposits of sand and gravel, with boulders of gneiss, syenite, limestone, and other rocks. The thickness of the entire mass varies greatly, but in places it exceeds 100 feet. In the upper Drift beds, or rather in those formed out of Drift and other materials by Post-glacial influences, numerous shells of existing fresh-water mollusks (*planorbis*, *cyclas*, &c.), occur at different heights above our present lake-waters ; whilst there seems to be an entire absence, in these beds, of marine or estuary types, such as occur in deposits of a similar age in the St. Lawrence basin. Hence the inference, that, at a comparatively recent geological period, our great lakes were united into one vast fresh-water sea, held back, on the east, by an elevation of the gneissoid belt of the Upper St. Lawrence or perhaps by a huge glacier-barrier extending in that direction, as explained on a former page.

7. *The St. Lawrence Basin:*—This Basin is separated from the Basin of the Lakes, just described, by the gneissoid band, which, passing southwards from the Lac des Chats on the Ottawa, crosses the St. Lawrence at the Thousand Isles, and forms the Adirondack region of New York. On the other hand, it is cut off from the Eastern or Metamorphic Basin (although, strictly considered, this forms an isolated central portion of its area) by the great dislocation alluded to under §5, above. This dislocation, accompanied both by a great upheaval and the manifestation of active metamorphic forces, runs from near the northern extremity of Lake Champlain to Quebec, and from thence along the north shore of the Island of Orleans, and down the river and gulf, as far as the coast of Gaspé, which it enters near the mouth of the Magdalen River. The area of the St. Lawrence Basin thus includes the peninsula between the gneissoid belt, the lower Ottawa, and the Upper St. Lawrence, together with a large extent of the south shore of the latter river, and all the north shore from the Ottawa to the Gulf, except a small portion (including the chief part of Quebec) lying within the above mentioned line of dislocation. It may be considered to include, also, the extreme eastern and southern parts of Gaspé; the Island of Anticosti, and the Mingan Islands. Towards the western part of this area, more especially in the peninsula just west of the junction of the Ottawa and St. Lawrence Rivers, the Potsdam and Calciferous formations (Map: Nos. 3 and 4) are well displayed, together with the Chazy and Trenton limestone beds (Nos. 5 and 6). The latter occur also largely on the eastern side of the Ottawa, as around Montreal, &c.; whilst the Utica and Hudson River formations extend more particularly along each bank of the St. Lawrence up to (and on the north, beyond) Quebec—apart from the small area, immediately around Quebec itself, cut off by the before-mentioned dislocation. At the Falls of Montmorenci, the Trenton, Utica, and Hudson River divisions occur in force; and the latter runs along the north side of the Island of Orleans. These formations occur also in the small outlying basin of Lake St. John on the Upper Saguenay. The Trenton limestones form likewise some isolated patches on the north shore of the Gulf, as at the Seven Islands, the Straits of Belle Isle, &c.; whilst the

Mingan Islands consist chiefly of the Chazy formation, the Trenton beds appearing at the south side of Large Island, one of the group. The northern shore of the Island of Anticosti is made up of Hudson River beds, the rest of the island consisting of Middle Silurian strata. In Gaspé, the Hudson River formation occurs on the north shore, between Cape Rosier and the River Marsouin. Eastward and southward the peninsula is chiefly composed of strata referred to the Devonian series, in which a thin seam of coal and numerous fossil plants are met with; whilst along the Bay of Chaleurs and the coast south of Gaspé Bay, the inclined Devonian beds are overlaid unconformably by a vast thickness (amounting to no less than 300 feet) of Carboniferous sandstones and conglomerates, the *Bonaventure Formation* of Sir William Logan. These strata, however, are quite destitute of coal.

Mountainous masses of eruptive traps and trachytes occur towards the more western extremity of the St. Lawrence Basin. These break through Lower Silurian strata, and were formed, probably, during the Upper Silurian or earlier part of the Devonian epoch. They are traversed in most cases by dykes of more recent origin—apparently erupted towards the close of the Devonian period, or perhaps at a still later date. The more important of these intrusive masses, comprise: Rigaud (in Vaudreuil Co.); Mount Royal or the Montreal mountain; Montarville or Boucherville (in Chambly Co.); Rougemont (in Rouville Co.); Belœil (in Verchères Co., near the Grand Trunk Railway); Monnoir or Mt. Johnson, south of Belœil; and Yamaska. Other masses of a similar character, as those of Brome and Shefford, lie just within the Eastern or Metamorphic Basin; but as these are evidently connected with the above series, the whole may be described together. The mountains of Montreal, Montarville, and Rougemont, are essentially augitic traps or dolerites. They present a dark color in most parts, and contain, in many places, distinct and comparatively large crystals of augite; Fig. 251. Small granular masses of olivine, with black grains of Magnetic Iron Ore and Ilmenite (minerals described in PART II.) are also commonly present, especially in the Montarville and Rougemont mountains. These trappean masses are penetrated by dykes of white or light-coloured compact trachyte (see PART III.), which contain minute crystals of iron pyrites, and generally effervesce in acids from the presence of intermixed carbonate of lime. The Rougemont mountain, is traversed also by granitic trachyte

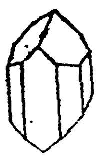


Fig. 251.

(PART III.) of a grayish colour, and partly micaceous. The mountains of Rigaud, Belœil, Monnoir, Yamaska, Shefford, and Brome, are essentially granitic trachytes, consisting of light-coloured potash-feldspar, with small grains of black hornblende, or scales of brown or black mica; and usually containing, in addition, some small crystals of yellow sphene (see PART II.) and grains of magnetic iron ore. Much valuable information on the composition of these picturesque and interesting mountains, is given by Professor Sterry Hunt, in the Geological Report for 1859. See also the *Canadian Journal,* Vol. V., p. 426, and the *Revised Report of the Geological Survey,* 1863.

The surface of the St. Lawrence Basin, like that of the Lake area, is also very generally covered by thick accumulations of the Drift and Post-glacial epochs: comprising clays, gravels, and boulders. But the fossil shells, found in the upper part of these, are all of a marine or estuary character. They are referrible to species which still exist in the Gulf of the St. Lawrence, or on the coast of Labrador. These shells occur, not only on comparatively low levels, but at considerable heights also, above the present surface of the sea. Some of the most noted localities comprise the neighbourhoods of Ottawa and Montreal; terraces on the Montreal Mountain: one, nearly 500 feet above the sea-level; Beauport near Quebec, about 120 feet above the sea; and various terraces on the Lower St. Lawrence, the Ste. Anne River, the Matanne, the Metis, &c., in the Gaspé peninsula, at heights varying from 40 or 50, to 245 feet above the present sea-level. It is evident, therefore, that at the commencement of the Post-glacial or present period, the entire or greater part of the St. Lawrence basin must have been deeply submerged beneath the sea.

8. *The Eastern or Metamorphic Basin of Canada:*—This basin, forming strictly, a portion of the St. Lawrence area, is separated from the latter by the great dislocation already described in §§ 5 and 7. It includes the site immediately under and around Quebec, the central and southern part of the Island of Orleans, the south shore of the St. Lawrence from a little west of Point Levis to near the Magdalen River, and all the intervening area to the south (including the greater part of the eastern townships, &c.) as far as the Province boundary. In the more northern part of this region, the strata, consisting of the Calciferous and Chazy formations (united into the Quebec group), are raised along the line of the before-mentioned dislocation into a position apparently above the horizon of the Trenton series. (See the remarks,

on this point, under the head of the Calciferous Formation, towards the commencement of the present Part of our Essay). They are also highly inclined, and consist chiefly of black and other coloured graptolitic shales, with associated beds of dolomite, limestone, &c. At a certain distance south of the St. Lawrence, and more especially in the counties of Bagot, Drummond, Shefford, Orford, Brome, Stanstead, Sherbrooke, Megantic, Beauce, &ç., these beds are much altered by metamorphic action: being changed into gneiss-rocks, talcose and chloritic schists, serpentines, variously coloured marbles, and other rocks of a similar metamorphic character; whilst their fossils become gradually obliterated. They are associated also in many of these localities, with vast irregular masses of copper and iron ores; and are traversed by veins containing galena, and here and there by auriferous quartz-veins. These metallic deposits, with the marbles, slates, and other economic substances of the region, are enumerated more fully under the Calciferous Formation, on a former page. The alluvial matters derived from the disintegration of the metamorphic rocks of this Eastern Basin, contain grains and occasionally small nodules of native gold—as explained at the same place, and also under the description of that metal in PART II. The Notre Dame and Shickshock Mountains, an extension of the Alleghanian chain, belong to the north-eastern part of this area. These mountains, which rise in places to a height of 4,000 feet above the sea, consist of metamorphic strata of the Quebec group, including vast beds of serpentine and intermixed chromic iron ore. The eruptive granites of the Megantic Mountains, and those which occur in Winslow, Hereford, Stanstead, Barton, Weedon, and other neighbouring townships, lie also within the limits of this metamorphic zone.

ON THE ANNUAL AND DIURNAL DISTRIBUTION OF THE DIFFERENT WINDS AT TORONTO.

BY G. T. KINGSTON, M.A.
DIRECTOR OF THE PROVINCIAL MAGNETIC OBSERVATORY, TORONTO.

The accompanying tables were derived from hourly records of the wind with Robinson's anemometer in the years 1853 to 1859 inclusive, during which period, with very few and short interruptions, the instrument was in continuous operation.

The monthly and hourly resultant directions and velocities include only the years 1854 to 1859, and were computed from the well known formulæ

$$\tan.\ \bar{\theta} = \frac{\Sigma(v \sin \theta)}{\Sigma(v \cos \theta)}; \qquad \bar{v} = \frac{\Sigma(v \cos \theta)}{n \cos \bar{\theta}}.$$

RESULTANT DIRECTIONS IN THE DIFFERENT MONTHS.

A comparison of the monthly resultant directions given in table I. shews that the general direction of the atmospheric current is considerably more from the westward in the winter than in the summer months, the monthly resultants oscillating about N. 43° W. from April to September inclusive, and about N. 72° W. during the remaining six months.

There is a much nearer approach to uniformity of direction in the different years for some months than for others; for instance, taking the angular difference between a monthly partial resultant in a particular year and the corresponding monthly resultant for the six years as a rough measure of the irregularity of the partial resultant, it is found that the averages of these differences are 7° for January and about 75° for June and July. The quarterly averages of the differences are for winter (commencing December 1st), 20°; for summer, 53°; for spring, 29°; and for autumn, 27°: their half-yearly averages being 46° from April to September inclusive, and 19° from October to March.

RESULTANT VELOCITIES AND MEAN VELOCITIES IN THE DIFFERENT MONTHS.

The resultant velocities and mean velocities have each their maximum in March and their minimum in July. The change from month to month is regular in both, with the exception of a small interruption of continuity in August, and another in December.

RESULTANT DIRECTIONS OF THE WIND IN THE DIFFERENT HOURS.

Confining our attention in the first instance to the annual resultants given in table II., we find that during the hour commencing noon the resultant wind is from N. 103° W., its extreme distance on the left of north. From this point, at which the wind is nearly steady during the three hours commencing at noon, it draws round regularly and continuously till it makes its nearest approach to the north (N. 38° W.) at 5 A.M., about which point it remains nearly steady from midnight to 7 A.M. It then rapidly recedes again to the westward.

The extreme recession of the resultant direction from the north takes place during the first three hours after noon in all months excepting in November, when it occurs between 11 A.M. and noon, and in December, when it is between 3 P.M. and 5 P.M. It occurs in May between 1 P.M. and 2 P.M., but in a contrary direction to that of all other months, being 108° to the *east* of north.

The hours of nearest approach to the north are not so well marked and are included within wider limits. For most months they were found between midnight and sunrise, but in May, June and November they occur in the early part of the night. The angular diurnal range in the direction of the resultant is 180° in July (its maximum) and 15° in November (its minimum). The quarterly averages of the diurnal ranges are 25° from December to February, 85° from March to May, 152° from June to August, and 65° from September to November; also the half yearly averages are 135° from April to September, and 29° from October to March.

MEAN RESULTANT VELOCITIES OF THE WIND IN THE DIFFERENT HOURS.

By table III. it is seen that the maximum resultant velocity for the whole year occurs during the hour commencing 1 P.M., and the minimum during the two hours between 4 A.M. and 6 A.M., the progression being continuous from the maximum to the minimum and to the maximum again, if the second place of decimals be disregarded.

The maximum takes place in one of the three hours commencing noon in every month but April and May, when it is found in the hours commencing at 9 P.M. in April and at 7 A.M. in May. The hours of minimum are not well marked in the separate months, and in July, August and September there is a double progression.

MEAN VELOCITIES OF THE WIND IN THE DIFFERENT HOURS.

On the average of the year, as shewn in table IV., the maximum velocity is from 1 P.M. to 2 P.M., and the minimum from 1 A.M. to 2 A.M. The maximum occurs in every month during one of the four hours commencing noon, and the minimum in most months within three hours of midnight, a prominent exception being in December, when the minimum is at 7 A.M.

MEAN VELOCITIES OF THE WIND IN DIFFERENT DIRCTIONS.

From table V. which includes only the winds at the six observation hours, we learn that the wind has a maximum mean velocity of 10.90 miles per hour when it blows from N.W., and a minimum mean velocity of 5.22 miles when it blows from S.E. There is an interruption to the continuity of the progression amounting to a second maximum at about E.N.E. and a second minimum at about N.N.E.

ANNUAL DISTRIBUTION OF THE DIFFERENT WINDS WITH RESPECT TO DURATION.

The results given in tables I. to IV. depend on the *velocities* as well as on the *durations* of the different winds; and as the average velocities in some directions are much greater than in others, these tables convey but indirect information as to the comparative prevalence of the different winds with respect to their duration. To supply this want tables VI. to IX. are given which were computed in the following manner.

From the monthly abstracts which give the direction of the wind during every hour of every day, tables for each month in the seven years 1853 to 1859 were formed, containing the number of times during like hours that the wind blew from each of the sixteen principal points, as well as the number of absolute calms in each group of like hours. By combining these tables the two following auxiliary tables were prepared.

Table (A) giving the absolute durations in hours of the different winds and of the calms for the several months, each month embracing the observations of seven years.

Table (B) The absolute durations of the different winds and of the calms for each of the twenty-four hours, each hour including all the winds recorded for that hour in the seven years.

Table VI. is derived from table (A) by expressing the absolute duration of each wind in each month and in the year, in terms of the monthly and annual mean durations for all winds. It is designed to give, for each month separately, and for the year collectively, a comparative view of the duration of the different winds.

It appears that winds from between S.S.W. and north have a more than average duration as compared with other winds taking the year round; but it is only those from N.N.W. whose duration exceeds the average in each separate month. Winds from E.N.E. and E. are above the average on the whole year as well as in each separate month but December, January, February, and August.

The north wind is above the average of all winds on the whole year, and is above the average in some months and below it in others, but without any perceptible annual period.

The duration of the south wind is below the average of all winds, taking the whole year collectively, as well as in each separate month but May, June, July and August.

The wind of maximum duration for the whole year collectively is N.N.W. and the wind of minimum duration S.E. with a second maximum at east and a second minimum at N.N.E.

The principal maximum is found at some point between W.S.W. and N.N.W. in seven months; but in April, May and June east winds are the most frequent, and in July and September the most frequent wind is from S.S.W.

The wind of least duration is from S.E., S.S.E. or south in seven months; but in May, July, August, and September,* the least frequent wind is from W.S.W., and in June it is from N.N.E.

In table VII. the durations of the same wind in the different months are compared. As the months are of different lengths, instead of comparing the absolute durations, which for the longer months would be unduly great, this table is obtained by expressing the numbers of table VI. in terms of the annual arithmetic means for the several winds.

The change in duration from month to month exhibited by this table is very irregular, excepting in the case of the south wind, which decreases in duration continuously from its maximum in June to its minimum in December, the maximum being to the minimum nearly in the ratio of 8 to 1.

If N_3 be taken to denote the ratio which the duration of winds from the three points N.N.W., north and N.N.E. in the six winter months (October to March) bears to the duration of the winds from the same three points in the summer half year, and if N_7 be the corresponding ratio when the winds from north are associated with those from the three points on either side of it from W.N.W. to E.N.E., the ratios for the analogous combinations about the three other cardinal points being represented by S_3, S_7, E_3, E_7, W_3, W_7; it is found that

* In September, the duration of the wind from E.S.E. is the same as that from W.S.W.

$N_3 = 0.91$; $S_3 = 0.49$; $E_3 = 0.65$; $W_3 = 2.24$;
$N_7 = 1.01$; $S_7 = 0.91$; $E_7 = 0.70$; $W_7 = 1.39$;

Again, if the durations of the winds in the northern and in the western groups be compared with those of the groups diametrically opposite, and $\left(\frac{N}{S}\right)_3$ be employed to denote the ratio whose first term is the duration of the winds from the three points about north, the ratios between the other groups being expressed in an analogous manner, we have

	$\left(\frac{N}{S}\right)_3$	$\left(\frac{N}{S}\right)_7$	$\left(\frac{W}{E}\right)_3$	$\left(\frac{W}{E}\right)_7$
Winter	= 1.94;	= 1.36;	= 2.18;	= 2.25;
Summer	= 1.04;	= 1.22;	= 0.63;	= 1.13;
Year	= 1.34;	= 1.30;	= 1.25;	= 1.59;

DIURNAL DISTRIBUTION OF THE DIFFERENT WINDS WITH RESPECT TO DURATION.

The comparative durations, for each hour, of the sixteen winds and the calms are obtained by dividing the absolute duration of each wind in the hour by the average duration of all winds, including calms, in the same hour. The results are given in table VIII.

From this table the following facts may be gathered:

I. The durations of the winds from W.S.W. to N.N.W. inclusive, for each hour separately, as well as for all hours collectively, are above the average duration of all winds.

II. The durations of winds from E. to E.N.E., taking the twenty-four hours collectively, are above the average; and excepting from 2 A.M. to 3 A.M., one or other or both of these winds are above the average at all hours.

III. The durations of the north winds are above the average for the whole day collectively, and have a marked diurnal period, their durations being above the average duration of all winds from 9 P.M. to 9 A.M., and below the average from 9 P.M. to 9 A.M.

IV. The south winds have a duration less than the average of all winds, taking one hour with another, and they also have a diurnal period, their durations being above the average duration of all winds from 10 A.M. to 6 P.M., and below the average during the rest of the twenty-four hours.

V. The principal maximum occurs with the wind from S.S.W. from 11 A.M. to 4 P.M., namely, during a portion of the time when the duration of the south wind is above the average, and it occurs with the N.N.W. and north winds mostly at the hours when the duration of the north wind is above the average, a second maximum vibrating from east to E.N.E. during the whole of the day and night. From 9 A.M. to 11 A.M., and from 4 P.M. to 7 P.M., namely, when the north and the south winds respectively are near their averages as compared with other winds, and when the winds in the N.W. quadrant are more equally distributed among its several points, the easterly or second maximum surpasses in value the westerly or principal maximum.

The character of the diurnal periodicity of the different winds is more apparent in table IX., in which the duration of each wind at each hour is expressed in terms of the average duration of that wind in the twenty-four hours.

If the columns corresponding to the four cardinal points be examined, it is found that the west wind, during the night, is mostly above the twenty-four-hour average, and below that average during several hours of the day; but the range is small, the maximum being to the minimum in the ratio of 1.36 to 1.

The east wind from 8 A.M. to 9 P.M. is above the twenty-four-hour average for that wind, and is below the average from 9 P.M. to 8 A.M., its diurnal range, or the ratio of the maximum to the minimum, being 2.40 to 1. The north wind is above the average from 10 P.M. to 9 A.M., and below the average from 9 A.M. to 10 P.M., and has a range of 3.44 to 1. The south wind is above the average from 10 A.M. to 7 P.M., and below it from 7 P.M. to 10 A.M. Its range is 4.82 to 1.

Calms occur eight times as often between midnight and 1 A.M. as they do between 1 P.M. and 2 P.M. The hours of maximum and minimum frequency of calms are very nearly the same as those of minimum and maximum mean velocity, a correspondence which, as appears from table VII., does not hold in the case of the *annual* distribution of calms.

TABLE I.

Resultant Direction, Resultant Velocity, and Mean Velocity of the Wind, for each Month.

RESULTANT DIRECTION.

	January.	February	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Year.
1854	N 77° W	N 7° E	N 53° W	N 50° E	N 90° E	N 24° E	N 131° W	N 64° W	N 22° W	N 45° W	N 90° W	N 44° W	N 45° W
1855	N 73 W	N 40 W	N 88 W	N 36 W	N 1 W	N 69 W	N 161 W	N 63 W	N 20 E	N 82 W	N 66 W	N 92 W	N 64 W
1856	N 75 W	N 81 W	N 71 W	N 29 E	N 4 E	N 159 W	N 79 W	N 50 W	N 101 W	N 76 W	N 95 W	N 93 W	N 71 W
1857	N 70 W	N 102 W	N 63 W	N 60 W	N 23 W	N 49 W	N 112 E	N 77 W	N 68 W	N 19 W	N 119 W	N 89 W	N 74 W
1858	N 71 W	N 72 W	N 58 W	N 14 W	N 42 E	N 160 E	N 15 E	N 69 W	N 106 W	N 34 W	N 25 W	N 18 W	N 41 W
1859	N 99 W	N 54 W	N 64 W	N 38 W	N 72 E	N 77 W	N 56 W	N 36 W	N 44 W	N 68 W	N 81 W	N 53 W	N 61 W
1854 to 1859	N 77 W	N 67 W	N 70 W	N 23 W	N 20 E	N 73 W	N 66 W	N 58 W	N 61 W	N 62 W	N 85 W	N 70 W	N 62 W

RESULTANT VELOCITY.

	January.	February	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Year.
1854 to 1859	3.29	3.45	4.89	2.14	1.91	0.69	0.41	1.68	1.16	2.60	3.13	3.42	2.18

MEAN VELOCITY.

	January.	February	March.	April.	May.	June.	July.	August.	September	October.	November.	December.	Year.
1854 to 1859	8.56	8.87	9.86	8.50	7.37	5.91	5.44	6.24	5.96	6.81	9.15	9.75	7.70

TABLE II.

Monthly and Annual Resultant Direction of the Wind, for each hour of **Toronto** Astronomical Time, for the period 1854 to 1859 inclusive.

Hours commencing.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
0	N 84° W	N 83° W	N 83° W	N 111°W	N 107° E	N 158°W	N 180°W	N 142°W	N 146°W	N 86° W	N 91° W	N 73° W	N 103°W
1	N 86 W	N 82 W	N 84 W	N 110W	N 108 E	N 164W	N 175W	N 139W	N 142W	N 87 W	N 90 W	N 79 W	N 103W
2	N 87 W	N 81 W	N 83 W	N 97 W	N 80 E	N 168W	N 175W	N 123W	N 135W	N 84 W	N 90 W	N 81 W	N 101W
3	N 82 W	N 79 W	N 80 W	N 75 W	N 49 E	N 154W	N 176W	N 105W	N 120W	N 77 W	N 88 W	N 82 W	N 90 W
4	N 79 W	N 72 W	N 76 W	N 51 W	N 19 E	N 118W	N 153W	N 79 W	N 92 W	N 70 W	N 83 W	N 82 W	N 77 W
5	N 82 W	N 70 W	N 71 W	N 45 W	North	N 87 W	N 94 W	N 56 W	N 78 W	N 70 W	N 84 W	N 80 W	N 70 W
6	N 82 W	N 64 W	N 72 W	N 47 W	N 3 W	N 52 W	N 55 W	N 49 W	N 61 W	N 66 W	N 83 W	N 80 W	N 64 W
7	N 76 W	N 62 W	N 66 W	N 34 W	N 1 W	N 39 W	N 52 W	N 41 W	N 55 W	N 60 W	N 83 W	N 81 W	N 59 W
8	N 79 W	N 61 W	N 68 W	N 25 W	N 6 E	N 24 W	N 36 W	N 38 W	N 44 W	N 59 W	N 78 W	N 81 W	N 56 W
9	N 81 W	N 56 W	N 64 W	N 20 W	North	N 16 W	N 32 W	N 32 W	N 35 W	N 51 W	N 77 W	N 76 W	N 51 W
10	N 76 W	N 58 W	N 61 W	N 13 W	N 1 E	N 16 W	N 29 W	N 30 W	N 30 W	N 52 W	N 80 W	N 70 W	N 48 W
11	N 73 W	N 62 W	N 58 W	N 9 W	N 3 E	N 18 W	N 28 W	N 29 W	N 21 W	N 51 W	N 79 W	N 68 W	N 46 W
12	N 72 W	N 58 W	N 56 W	N 2 W	N 6 E	N 18 W	N 18 W	N 24 W	N 22 W	N 44 W	N 79 W	N 66 W	N 43 W
13	N 71 W	N 55 W	N 54 W	N 2 W	N 6 E	N 17 W	N 14 W	N 22 W	N 20 W	N 51 W	N 81 W	N 62 W	N 40 W
14	N 70 W	N 56 W	N 54 W	N 3 W	N 2 E	N 16 W	N 11 W	N 26 W	N 20 W	N 52 W	N 80 W	N 57 W	N 40 W
15	N 74 W	N 59 W	N 53 W	N 2 W	N 10 E	N 21 W	N 9 W	N 25 W	N 17 W	N 43 W	N 79 W	N 54 W	N 39 W
16	N 70 W	N 61 W	N 50 W	N 2 W	N 15 E	N 18 W	N 11 W	N 20 W	N 15 W	N 43 W	N 83 W	N 56 W	N 39 W
17	N 73 W	N 62 W	N 53 W	N 2 W	N 15 E	N 24 W	N 15 W	N 18 W	N 14 W	N 39 W	N 84 W	N 56 W	N 38 W
18	N 73 W	N 64 W	N 53 W	N 1 W	N 16 E	N 29 W	N 15 W	N 30 W	N 21 W	N 39 W	N 86 W	N 62 W	N 46 W
19	N 71 W	N 66 W	N 52 W	N 10 W	N 27 E	N 42W	N 14 W	N 38 W	N 36 W	N 45 W	N 82 W	N 56 W	N 42 W
20	N 68 W	N 65 W	N 53 W	N 9 W	N 29 E	N 67 W	N 19 W	N 55 W	N 49 W	N 50 W	N 83 W	N 59 W	N 48 W
21	N 69 W	N 68 W	N 62 W	N 12 W	N 36 E	N 126W	N 140W	N 74 W	N 78 W	N 58 W	N 87 W	N 59 W	N 63 W
22	N 75 W	N 72 W	N 72 W	N 40 W	N 61 E	N 145W	N 171 E	N 112W	N 121W	N 66 W	N 88 W	N 62 W	N 80 W
23	N 82 W	N 76 W	N 78 W	N 89 W	N 84 E	N 157W	N 173 E	N 138W	N 145W	N 79 W	N 92 W	N 67 W	N 96 W
Period of 24 hours.	N 77 W	N 67 W	N 70 W	N 23 W	N 20 E	N 73 W	N 66 W	N 58 W	N 61 W	N 62 W	N 85 W	N 70 W	N 62 W

TABLE III.

Monthly and Yearly Resultant Velocity of the Wind, for each hour of Toronto Astronomical Time, for the period 1854 to 1859 inclusive, the velocities being in miles per hour.

Hours.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Year.
0	4.71	4.34	5.97	1.17	1.49	2.35	2.97	2.67	2.35	3 54	4.40	4.30	2.61
1	4.69	4.17	6.14	1.50	1.17	2.46	2.90	2.92	2.10	3.29	4.75	4.46	2.71
2	4.45	3.94	6.26	1.68	0.98	2 34	2.73	2.73	2.05	3.34	4 15	4.24	2.70
3	3.92	3.98	6.26	1.92	1.03	1.70	1.97	2.29	1.75	3.21	4.07	3.94	2.56
4	3.48	3.76	6.27	1 99	1.37	1.42	1.16	1.98	1.70	3.39	3.77	3.89	2.60
5	3.02	2.94	5.99	2.45	1.89	0.96	0.75	2.50	1.43	2.55	3.10	3.75	2.48
6	3.10	3.13	5.48	2.08	2.29	0.86	0.69	2.50	1.38	2 47	2.83	3.82	2.44
7	3.05	3.29	5.10	2.47	2.27	1 14	0.69	2.21	1.47	2.47	2.59	3.92	2.38
8	3.02	3 28	4.93	2.84	2.04	1.19	0.80	2.30	1.58	2.45	2.53	4.00	2.35
9	2.55	3.12	5.15	3.38	1.95	1.50	1.05	2.37	1.60	2.34	2.44	3.98	2.38
10	[illegible]	2.92	4.60	3 17	2 02	1.66	1.46	2.24	1.92	2.15	2.53	3.88	2.36
11	2 8	2.80	4.39	2.79	2.28	1.58	1.64	2.93	1.82	2.00	2 38	3.80	2.28
12	2.77	2.92	4.24	3 01	2.21	1.68	1.81	2 08	1.69	1.92	2.61	3.53	.25
13	2.73	3.42	4.29	3.07	2.39	1.73	2.05	2.25	1.80	2.04	2.52	2.94	2.32
14	2 92	3.35	3.95	3.01	2.69	1.53	2.05	2.15	1.96	2.23	2.64	2.76	2.33
15	2.81	3.23	3.92	2.84	2.43	1.40	2.01	2.31	1.90	2.21	2.75	2.67	2.25
16	2.71	3 34	3.97	2.95	2.24	1.16	1.93	2.12	1.73	2.06	2.62	2.55	2.15
17	2.74	3.23	3.75	3 10	2.47	1.31	1 79	2.10	1 61	2.16	2.43	2.44	2.11
18	2.74	3.73	3 80	3.25	3.52	1.34	1.74	2.26	1.58	2.10	2.66	2 41	2.23
19	3.02	3.57	4.21	3.09	3.64	0.97	1.64	2.09	1.72	2.43	2.58	2.27	2.22
20	3.30	3.53	4.50	2.68	3.39	0.84	0 69	2.25	1.43	3.09	2.75	2.85	2.22
21	3.77	4.00	5.09	1.92	2.56	1.12	0.57	1.95	1.24	3.14	3.52	3 11	2.24
22	3.90	3.98	5.38	1.17	1.82	1.62	1·82	1 77	1.41	3.18	4.17	3.87	2.18
23	4.45	4.30	5.71	0.92	1.40	.08	2.48	2.49	2.01	3.33	4.43	3.93	·37
Period of 24 hours.	3.29	3.45	4 89	2.14	1.91	0.69	0.41	1.68	1.16	2.60	3.13	3.42	2.1[illegible]

TABLE IV.

Monthly and Yearly Mean Velocity of the Wind, for each hour of Toronto Astronomical Time, for the period 1854 to 1859 inclusive, the velocities being in miles per hour.

Hours.	Jan.	Feb.	March	April	May.	June.	July.	Aug.	Sept.	Oct	Nov.	Dec.	Year.
0	10.43	10.69	12.09	11.29	10.33	8.80	8.76	8.99	9.27	10.33	11.57	10.97	10.29
1	10.54	10.54	12.29	11.12	10.28	9.06	8.52	9.45	8.94	10.22	11.79	11.05	10 32
2	10.45	10.13	12.50	10.99	10.05	8.89	8.74	9.72	9.21	9.98	11.86	10.69	10.27
3	9.86	9 95	12.28	10.66	9.67	8.85	8.18	9.52	8.80	9 39	10.94	10.02	9.84
4	9.23	9.72	12.56	10.48	9.41	8 57	7.63	9.11	7.86	8.50	10.28	9.97	9.44
5	8.63	8.54	11.18	9.18	8.02	7.25	6.39	7.84	6.09	6.65	9.06	9.60	8.20
6	8.66	8.57	10.24	8.15	6.99	5.98	5 01	6.41	5.09	5.87	8.83	9.64	7.45
7	8.73	8.88	9.87	7.17	6.23	4 88	3.68	5.16	4.64	5.77	8.27	9.63	6.91
8	8.38	8.99	9.41	7.22	5.91	4.41	3.31	4.95	4.45	5.73	8.31	9.68	6.72
9	7.74	8.08	9.22	7.06	5.26	4.19	3.39	4.63	4.68	5.29	8.02	9.23	6.40
10	7 91	7.69	8.53	6.82	5.06	4.17	3.82	4 62	4.66	5.42	7.98	9.44	6.34
11	7.76	7.73	8.28	6 58	5.13	3.94	3 61	4.08	4.29	5.08	7.93	9.70	6.18
12	7.90	7.84	8.12	6.58	4.92	4 11	4.00	3.98	4.09	4.92	7.95	9.63	6.17
13	7 65	8.19	8.04	6.56	4.09	3.84	3.82	4.16	4.40	5.00	7.82	9.21	6.14
14	7.48	8.11	7.85	6.82	5.34	3.82	4.07	4.18	4.48	5.41	7.89	9 43	6.24
15	7.42	7.86	7.98	6.71	5.03	3.77	3.83	4.29	4.39	5.25	8.13	9.48	6.17
16	7.49	8.13	8.32	6.67	4.97	3.93	3.05	4.15	4.16	5 09	8.26	9.14	6.16
17	7.32	7.99	8.12	7.06	5.42	4.01	3.58	4.24	4.19	5.17	8.09	9.22	6.20
18	7.94	8.62	8.36	7.50	7.27	4.01	4.01	4.56	4.29	4.91	8.08	9.25	6.62
19	7 65	8.06	8 64	8.44	8.03	5.10	4.72	4.79	5.11	5.50	7.91	8.49	6.87
20	8.08	8.57	9.45	9.31	9.02	6.17	5.73	6.43	6.04	6.87	8.70	9.57	7.83
21	8.83	9.55	10.44	9.77	9.47	7.01	6.70	7.31	7.28	8.10	9.61	9.95	8.67
22	9.35	10.13	11.17	10.81	9.91	8.04	7.38	8.15	7.99	9.03	10.82	10.48	9.44
23	9 90	10.32	11.75	11.27	10.25	8 50	7.97	9.00	8.72	9.83	11.45	10.50	9.96
Period of 24 hours.	8.56	8.87	9.86	8.50	7.37	5.91	5.44	6.24	5.96	6.81	9.15	9.75	7.70

TABLE V.

Mean Velocity of the Wind, arranged according to its direction, for the period 1853 to 1859 inclusive.

Direction	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.
Velocity	7.31	6.03	6.92	8.77	8.40	6.05	5.22	5.73
Direction	**S.**	**S.S.W.**	**S.W.**	**W.S.W.**	**W.**	**W.N.W.**	**N.W.**	**N.N.W.**
Velocity	6.53	7.46	8.05	9.85	10.72	10.89	10.90	9.63

TABLE VI.

Ratios shewing the comparative duration of different winds, in the whole year as well as in each separate month, being the absolute durations of the different winds in the year or month, expressed in terms of the annual or monthly mean duration of all winds.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Year.
N.	1.15	1.24	0.68	1.29	1.31	0.91	1.06	1.20	1.20	0.99	0.75	1.29	1.09
N.N.E.	0.74	0.85	0.33	0.96	0.50	0.44	0.70	0.85	0.84	0.66	0.65	1.10	0.72
N.E.	0.96	0.78	0.34	0.84	0.71	0.66	0.59	0.65	0.78	0.85	0.68	1.02	0.73
E.N.E.	0.72	0.68	1.10	1.40	1.90	1.34	1.10	0.77	1.04	1.02	1.21	0.86	1.09
E.	0.75	0.96	1.01	1.71	2.08	1.85	1.40	1.10	1.14	1.12	1.47	0.72	1.28
E.S.E.	0.44	0.37	0.44	0.89	1.03	0.84	0.99	0.66	0.64	0.47	0.49	0.42	0.64
S.E.	0.23	0.20	0.46	0.48	0.56	0.51	0.72	0.75	0.69	0.22	0.43	0.22	0.46
S.S.E.	0.21	0.28	0.24	0.52	0.57	0.59	1.18	0.67	0.72	0.45	0.43	0.19	0.50
S.	0.25	0.37	0.47	0.75	1.08	1.40	1.39	1.15	0.96	0.91	0.42	0.18	0.78
S.S.W.	0.78	1.00	0.90	1.03	1.30	1.63	1.61	1.27	1.50	1.05	0.86	0.49	1.12
S.W.	1.58	1.18	1.39	0.73	0.70	1.35	0.72	0.83	0.98	1.01	1.50	1.42	1.12
W.S.W.	2.61	2.01	1.27	0.71	0.36	0.60	0.46	0.51	0.65	0.90	2.08	2.61	1.23
W.	1.78	2.08	1.81	0.93	0.49	0.90	0.53	0.92	0.78	1.35	1.78	1.98	1.28
W.N.W.	1.00	1.47	2.27	1.13	0.79	0.84	0.86	1.38	1.05	1.67	1.84	1.11	1.24
N.W.	1.18	1.19	2.05	1.12	0.97	1.20	1.00	1.49	1.12	1.37	1.01	1.08	1.23
N.N.W.	1.38	1.58	1.44	1.51	1.69	1.18	1.48	1.69	1.35	1.29	1.03	1.29	1.41
Calms.	1.23	0.83	0.80	1.00	0.96	0.76	1.22	1.11	1.56	1.67	0.89	1.02	1.09

TABLE VII.

Ratios shewing the comparative durations of each separate wind in the different months, being the numbers in Table VI. expressed in terms of the Annual Means.

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
N.	1.06	1.14	0.62	1.18	1.20	0.84	0.97	1.10	1.10	0.91	0.69	1.18
N.N.E.	1.03	1.18	0.46	1.34	0.70	0.61	0.98	1.18	1 17	0.92	0.90	1.53
N.E.	1.31	1.00	0.46	1 14	0.97	0.90	0.80	0.88	1.06	1.16	0 93	1.39
E N.E.	0.66	0.62	1.00	1.28	1.74	1.22	1.00	0.70	0.95	0.93	1.11	0.79
E.	0.59	0.75	0.79	1.34	1.63	1.45	1.09	0.86	0.89	0.88	1.15	0.56
E.S.E.	0.69	0.58	0.69	1.39	1.61	1.31	1.55	1.03	1.00	0.73	0.77	0.66
S.E.	0.50	0.44	1.00	1.05	1.24	1.12	1.58	1.65	1.51	0.48	0.94	0.48
S.S.E.	0.42	0.56	0.48	1.03	1.13	1.17	2.34	1.33	1.43	0.89	0.85	0.38
S.	0.32	0.48	0.60	0.97	1.38	1.82	1.78	1.49	1.23	1.18	0.54	0.23
S.S.W.	0.70	0.89	0.80	0.92	1.16	1.46	1.44	1.13	1.34	0.94	0.77	0.44
S.W.	1.42	1.06	1.25	0.65	0.63	1.21	0.64	0.74	0.88	0.91	1.34	1.27
W.S.W	2.12	1.63	1.03	0.58	0.29	0 49	0.37	0.41	0.53	0.73	1.69	2.12
W.	1.39	1.63	1.41	0.73	0.38	0.70	0.41	0.72	0 61	1.06	1.39	1.55
W.NW	0.81	1.19	1.83	0.91	0.64	0 68	0.69	1.11	0.85	1.31	1.08	0.90
N.W.	0.96	0.97	1.67	0.91	0.79	0.97	0.81	1.21	0.91	1.11	0.82	0.88
N.N W	0.98	1.12	1.02	1.07	1 20	0.84	1.05	1.20	0.96	0.91	0.73	0,92
Calms.	1.13	0.76	0.73	0.92	0.88	0.70	1.20	1.02	1 43	1.53	0.82	0.94

TABLE

Ratios shewing the comparative duration of different winds at each separate duration of all winds

Toronto Astronomical time.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S.S.E.	S.
0	0.61	0.83	0.43	0.86	1.61	1.02	0.78	0.96	1.65
1	0.55	0.28	0.44	0.98	1.54	1.04	0.80	0.99	1.65
2	0.50	0.29	0 43	0.86	1.78	1.05	0.70	0.94	1.62
3	0.54	0.28	0.39	0.96	1.76	1.12	0.69	0.96	1.31
4	0.61	0.31	0.45	1.01	1.84	1.00	0.71	0.81	1.16
5	0.74	0.34	0.53	1.14	1.72	0.86	0.54	0.75	1.00
6	0.70	0.40	0.59	1.30	1.58	0.67	0.46	0.66	0.97
7	0.83	0.44	0.68	1.32	1.38	0.71	0.38	0.51	0.71
8	0.94	0.53	0.66	1.24	1.30	0.51	0.46	0.39	0 54
9	1.08	0.68	0.73	1.22	1.18	0.46	0.33	0.41	0.44
10	1.27	0.80	0.77	1.22	1.04	0.43	0.37	0.35	0.40
11	1.46	0 88	0.85	1.00	1.05	0.41	0.38	0.31	0.39
12	1.59	0.97	0.86	1.08	0.88	0.41	0.31	0.25	0.37
13	1.54	1.14	0.98	1.01	0.79	0.35	0.31	0 25	0.39
14	1.62	1.26	1.02	0.98	0.84	0.35	0.27	0.23	0.37
15	1.72	1.24	0.97	1.01	0.82	0.34	0.27	0.21	0.42
16	1.66	1.18	0.98	1.12	0.76	0.33	0.21	0.27	0.35
17	1.62	1.18	1.03	1.16	0.77	0.34	0.19	0.33	0.37
18	1.54	1 17	1 07	1.13	0.86	0.33	0.24	0.29	0.39
19	1.46	1.07	1.02	1.18	1.07	0.35	0.27	0.24	0.41
20	1.19	0.86	0.92	1.34	1.36	0.54	0.35	0.27	0.44
21	0.96	0.64	0.84	1 18	1.55	0.75	0.46	0.37	0.66
22	0.79	0.53	0.53	1.04	1.57	0.93	0.70	0.62	1.12
23	0.62	0.43	0.44	0.96	1.52	1.06	0.80	0.78	1.52

VIII.

hour, being the absolute durations at the hour expressed in terms of the **Mean** at the same hour.

S.S.W.	S.W.	W.S.W.	W.	W.N.W	N.W.	N.N.W.	CALMS.	Toronto Astronomical time.
1.82	1.16	1.05	1.23	1.14	1.10	1.00	0.25	0
1.87	1.16	1.12	1.19	1.12	1.14	0.96	0.22	1
1.91	1.04	1.16	1.23	1.08	1.04	1 08	0 27	2
1.83	1.11	1.12	1.23	1.08	1.05	1.22	0.36	3
1.57	1.21	1.09	1.22	1.06	1.12	1.27	0.55	4
1.48	1.30	1.11	1.13	1.20	1.04	1.28	0.86	5
1.24	1.34	1.20	1.13	1.13	1.29	1.35	0.99	6
1.11	1.37	1.28	1.10	1.31	1.21	1.55	1.11	7
0.87	1.36	1.34	1.29	1.25	1.22	1.66	1.46	8
0.77	1.06	1.35	1.29	1.31	1 31	1.69	1.68	9
0.68	1.00	1.34	1 46	1.28	1.24	1 67	1.67	10
0.74	0.94	1.38	1.40	1.22	1.30	1.66	1.63	11
0.68	0.95	1.34	1 34	1.26	1.29	1.59	1.82	12
0.65	0.90	1.40	1.30	1.22	1.35	1.61	1.80	13
0.74	0·90	1.38	1.24	1.35	1.44	1 52	1.49	14
0.68	0.95	1.26	1.23	1.38	1.35	1.62	1.52	15
0.67	0.99	1.22	1.28	1.48	1.28	1.65	1.56	16
0.65	0.92	1.22	1.33	1.38	1.33	1.70	1.47	17
0.69	1.05	1.14	1.22	1.38	1.31	1.60	1.60	18
0.75	1.08	1.22	1.34	1.32	1.25	1.48	1.49	19
0.96	1.25	1.26	1.42	1.24	1.25	1.48	0.96	20
1.28	1.29	1.26	1.40	1.28	1.31	1.12	0.64	21
1.55	1.22	1.21	1.29	1.20	1.24	1.06	0.41	22
1.69	1.17	1.05	1.26	1.12	1.14	1.06	0.39	23

TABLE

Ratios shewing the comparative duration of each separate wind in the different duration of the same

Toronto Astronomical time.	N.	N.N.E.	N.E.	E.N.E.	E.	E.S.E.	S.E.	S S.E.	S.
0	0.56	0.46	0.59	0.79	1.26	1.59	1.71	1.90	2.12
1	0.51	0.39	0.61	0.85	1.21	1.62	1.75	1.96	2.12
2	0.46	0.40	0.59	0.79	1.40	1.64	1.53	1.86	2.08
3	0.50	0.39	0.53	0.88	1.38	1.75	1.51	1.90	1.70
4	0.56	0.43	0.61	0.92	1.44	1.56	1.55	1.60	1.49
5	0.68	0.47	0.72	1.04	1.34	1.34	1.18	1.48	1.29
6	0.64	0.56	0.80	1.19	1.24	1.05	1.01	1.30	1.25
7	0.76	0.61	0.93	1.21	1.08	1.11	0.83	1.01	0.91
8	0.86	0.74	0.90	1.13	1.02	0.80	1.01	0.77	0.69
9	0.99	0.94	0.99	1.12	0.96	0.72	0.72	0.81	0.57
10	1.17	1.11	1.05	1.12	0.82	0.67	0.80	0.69	0.51
11	1.34	1.23	1.16	0.91	6.82	0.64	0.83	0.61	0.50
12	1.46	1.35	1.17	0.99	0.69	0.64	0.67	0.49	9.48
13	1.41	1.59	1.34	0.92	0.62	0.55	0.67	0.49	0.50
14	1.49	1.75	1.39	0.90	0.66	0.55	0.59	0.45	0.48
15	1.58	1.73	1.32	0.92	0.60	0.53	0.59	0.41	0.54
16	1.52	1.64	1.34	1.02	0.60	0.52	0.46	0.53	0.44
17	1.49	1.64	1.40	1.06	0.60	0.53	0.41	0.65	0.47
18	1.41	1.63	1.46	1.03	0.68	0.51	0.52	0.57	0.50
19	ʼ.34	1.49	1.39	1.08	0.84	0.55	0.59	0.47	0.53
20	1.09	1.20	1.25	1.23	1.07	0.84	0.77	0.53	0.57
21	0.88	0.89	1.14	1.08	1.22	1.17	1.01	0.73	0.85
22	0.73	0.74	0.72	0.95	1.23	1.45	1.53	1.23	0.44
23	0.57	0.60	0.61	0.88	1.19	1.66	1.75	1.54	1.96

IX.

hours, being the absolute durations at the hour expressed, in terms of the Mean wind for all hours.

S.S.W.	S.W.	W.S.W.	W.	W.N.W	N.W.	N.N.W.	CALMS.	Toronto Astronomical time.
1.62	1.04	0.85	0.97	0.92	0.89	0.71	0.23	0
1.67	1.04	0.91	0.94	0.90	0.93	0.68	0.20	1
1.70	0.93	0.95	0.97	0.87	0.85	0.77	0.25	2
1.63	1.00	0.91	0.97	0.87	0.85	0.87	0.33	3
1.40	1.09	0.89	0.96	0.85	0.91	0.90	0.50	4
1.32	1.17	0.90	0.89	0.97	0.85	0.91	0.79	5
1.11	1.20	0.98	0.89	0.91	1.04	0.96	0.90	6
0.99	1.23	1.04	0.87	1.06	0.98	1.10	1.02	7
0.78	1.22	1.09	1.02	1.01	0.99	1.18	1.34	8
0.69	0.95	1.10	1.02	1.05	1.06	1.20	1.54	9
0.61	0.90	1.09	1.18	1.03	1.01	1.19	1.53	10
0.66	0.84	1.12	1.06	0.98	1.06	1.18	1.49	11
0.61	0.85	1.09	1.03	1.01	1.04	1.13	1.67	12
0.58	0.81	1.14	0.98	0.98	1.09	1.14	1.65	13
0.66	0.81	1.12	0.97	1.09	1.17	1.08	1.36	14
0.61	0.85	1.03	0.97	1.11	1.09	1.15	1.39	15
0.60	0 89	0.99	1.01	1.19	1.04	1.17	1.43	16
0.58	0.83	0.99	1.05	1 11	1.08	1.20	1.35	17
0.62	0.94	0.93	0.96	1.11	1.06	1.13	1.47	18
0.67	0.97	0.99	1.06	1.07	1.01	1.05	1.37	19
0.86	1.12	1.03	1.12	1.00	1.01	0.99	0.88	20
1.14	1.16	1.03	1.10	1.03	1.06	0.80	0.59	21
1.38	1.10	0.98	1.02	0.97	1.01	0.75	0.38	22
1.51	1.05	0.85	1.00	0.90	0.93	0.75	0.36	23

A NEW PROOF OF THE EXISTENCE OF THE ROOTS OF EQUATIONS.

BY THE REV. GEORGE PAXTON YOUNG, M.A., TORONTO.

The equation of the m^{th} degree,

$$f(x) = x^m + a_1 x^{m-1} + \cdots\cdots\cdots + a_m = 0, \text{———} (1)$$

has a root. For, y and z being real variables,

$$f(y + \sqrt{-1}z) = P(\cos\lambda + \sqrt{-1}\sin\lambda);$$

where P and λ are real. When y and z receive the definite values y_1 and z_1, let P and λ become P_1 and λ_1 respectively; and let P_1^2 be the least possible value of P^2. Then $y_1 + \sqrt{-1}\,z_1$, or, as we may call it, x_1, is a root of the equation,

$$f(x) - P_1(\cos\lambda_1 + \sqrt{-1}\sin\lambda_1) = 0. \text{———} (2)$$

Let n be the greatest number of roots equal to x_1 which this equation has. Then $f(x) - P_1(\cos\lambda_1 + \sqrt{-1}\sin\lambda_1)$ is divisible by $(x - x_1)^n$ without remainder: which we may express by putting

$$f(x) - P_1(\cos\lambda_1 + \sqrt{-1}\sin\lambda_1) = (x - x_1)^n \{F(x)\}. \text{———} (3)$$

Take $x_2 = x_1 + k(\cos\phi + \sqrt{-1}\sin\phi) = x_1 + h$. Then

$$F(x_2) = F(x_1) + X_1 h + X_2 h^2 + \&c.;$$

where X_1, X_2, &c., are clear of h. In order to separate the real from the imaginary parts in the value of $F(x_2)$, put

$$F(x_1) = A(\cos\theta + \sqrt{-1}\sin\theta),\ X_1 = B(\cos\psi + \sqrt{-1}\sin\psi),$$

and so on. Since equation (3) is independent of the particular value of x, we may substitute x_2 for x in that equation. Then

$$\begin{aligned} f(x_2) &= P_1(\cos\lambda_1 + \sqrt{-1}\sin\lambda_1) + h^n\{F(x_1) + X_1 h + \&c.\} \\ &= P_1\cos\lambda_1 + k^n A\cos(n\phi + \theta) + \ldots\ldots \\ &\quad + \sqrt{-1}\{P_1\sin\lambda_1 + k^n A\sin(n\phi + \theta) + \&c\}. \end{aligned}$$

By putting $S=k^nA\cos(n\phi+\theta)+\&c$, and $T=k^nA\sin(n\phi+\theta)+\&c$, this becomes

$$f(x_2)=(P_1\cos\lambda_1+S)+\sqrt{-1}\,(P_1\sin\lambda_1+T);$$

which again if $P_2^2=(P_1\cos\lambda_1+S)^2+(P_1\sin\lambda_1+T)^2$, may be written

$$f(x_2)=P_2(\cos\beta+\sqrt{-1}\sin\beta).$$

Since P_2^2 is a particular value of P^2, and since the least value of P^2 is P_1^2, $P_2^2-P_1^2$ cannot be negative. But

$$P_2^2-P_1^2=2\,P_1(S\cos\lambda_1+T\sin\lambda_1)+S^2+T^2$$
$$=2\,k^nAP_1\cos(n\phi+\theta-\lambda_1)+\&c.\text{\_\_\_\_\_\_\_\_\_\_\_\_\_}(4)$$

We give only the first term in the expansion of $P_2^2-P_1^2$ according to the ascending powers of k. The other terms contain powers of k higher than the n^{th}. Now suppose if possible that P_1 is not zero. From the manner in which $F(x)$ was taken in equation (3), $F(x_1)$ is not zero; for if it were, $F(x)$ would be divisible by $x-x_1$, and therefore there would be more than n roots of equation (2) equal to x_1: which we supposed not to be the case. Hence A also, which is a factor of $F(x_1)$, is distinct from zero. Take then $n\phi$ such [θ and λ_1 being determined, the former from $F(x_1)$, and the latter from $f(x_1)$] that $\cos(n\phi+\theta-\lambda_1)$ may be distinct from zero, and have its sign opposite to that of AP_1. Then cause k, always remaining positive, to approach indefinitely near to zero; till the sign of the whole expression for $P_2^2-P_1^2$ in (4) is the same with that of its first term. The sign of that first term is necessarily negative. Therefore the sign of $P_2^2-P_1^2$ is ultimately negative: which, however, we have seen to be impossible. Therefore P_1 cannot but be zero. Hence $f(x_1)$ is zero; and x_1 is a root of equation (1).

PROCEEDINGS OF THE BRITISH ASSOCIATION.

For the following valuable extracts from the proceedings of the British Association for the Advancement of Science, we are indebted to the Reports of the London *Athenæum*. The Association met at Newcastle, under the Presidency of Sir Wm. Armstrong.

EXTRACTS FROM THE PRESIDENT'S ADDRESS.

The history of railways shows what grand results may have their origin in small beginnings. When coal was first conveyed in this neighbourhood from the pit to the shipping-place on the Tyne, the pack-horse, carrying a burden of 3 cwt., was the only mode of transport employed. As soon as roads suitable for wheeled carriages were formed, carts were introduced, and this first step in mechanical appliance to facilitate transport had the effect of increasing the load which the horse was enabled to convey from 3 cwt. to 17 cwt. The next improvement consisted in laying wooden bars or rails for the wheels of the carts to run upon, and this was followed b the substitution of the four-wheeled waggon for the two-wheeled cart. By this further application of mechanical principles the original horse load of 3 cwt. was augmented to 42 cwt. These were important results, and they were not obtained without the shipwreck of the fortunes of at least one adventurous man whose ideas were in advance of the times in which he lived. We read, in a record published in the year 1649, that "one Master Beaumont, a gentleman of great ingenuity and rare parts, adventured into the mines of Northumberland with his 30,000l., and brought with him many rare engines not then known in that shire, and waggons with one horse to carry down coal from the pits to the river, but within a few years he consumed all his money and rode home upon his light horse." The next step in the progress of railways was the attachment of slips of iron to the wooden rails. Then came the iron tramway, consisting of cast-iron bars of an angular section: in this arrangement the upright flange of the bar acted as a guide to keep the wheel on the track. The next advance was an important one, and consisted in transferring the guiding flange from the rail to the wheel; this improvement enabled cast-iron edge rails to be used. Finally, in 1820, after the lapse of about 200 years from the first employment of wooden bars, wrought-iron rails, rolled in long lengths, and of suitable section, were made in this neighbourhood, and eventually superseded all other forms of railway. Thus, the railway system, like all large inventions, has risen to its present importance by a series of steps; and so gradual has been its progress, that Europe finds itself committed to a gauge fortuitously determined by the distance between the wheels of the carts for which wooden rails were originally laid down.

Last of all came the locomotive engine, that crowning achievement of mechanical science, which enables us to convey a load of 200 tons at a cost of fuel scarcely exceeding that of the corn and hay which the original pack-horse consumed in conveying its load of 3 cwt. an equal distance.

* * * * * * * * *

In thus glancing at the history of railways, we may observe how promptly the inventive faculty of man supplies the device which the circumstances of the moment require. No sooner is a road formed fit for wheeled carriages to pass along, than the cart takes the place of the pack-saddle: no sooner is the wooden railway provided than the waggon is substituted for the cart: and no sooner is an iron railway formed, capable of carrying heavy loads, than the locomotive engine is found ready to commence its career. As in the vegetable kingdom fit conditions of soil and climate quickly cause the appearance of suitable plants, so in the intellectual world fitness of time and circumstance promptly calls forth appropriate devices. The seeds of invention exist, as it were, in the air, ready to germinate whenever suitable conditions arise, and no legislative interference is needed to insure their growth in proper season.

* * * * * * * * *

To persons who contend that all geological phenomena may be attributed to causes identical in nature and degree with those now in operation. the formation of coal must present peculiar difficulty. The rankness of vegetation which must have existed in the carboniferous era, and the uniformity of climate which appears to have prevailed almost from the Poles to the Equator, would seem to imply a higher temperature of the earth's crust, and an atmosphere more laden with humidity and carbonic acid than exist in our day. But whatever may have been the geological conditions affecting the origin of coal, we may regard the deposits of that mineral as vast magazines of power stored up at periods immeasurably distant for our use.

The principle of conservation of force, and the relationship now established between heat and motion, enable us to trace back the effects which we now derive from coal to equivalent agencies exercised at the periods of its formation. The philosophical mind of George Stephenson, unaided by theoretical knowledge, rightly saw that coal was the embodiment of power originally derived from the sun That small pencil of solar radiation which is arrested by our planet, and which constitutes less than the 2,000-millionth part of the total energy sent forth from the sun, must be regarded as the power which enabled the plants of the carboniferous period to wrest the carbon they required from the oxygen with which it was combined, and eventually to deposit it as the solid material of coal. In our day, the reunion of that carbon with oxygen restores the energy expended in the former process, and thus we are enabled to utilize the power originally derived from the luminous centre of our planetary system.

But the agency of the sun in originating coal does not stop at this point. In every period of geological history the waters of the ocean have been lifted by the action of the sun and precipitated in rain upon the earth. This has given rise to all those sedimentary actions by which mineral substances have been collected at particular localities, and there deposited in a stratified form with a protecting cover to preserve them for future use. The phase of the earth's existence suitable for the extensive formation of coal appears to have passed away for ever; but the quantity of that invaluable mineral which has been stored up throughout the globe for our benefit is sufficient (if used discreetly) to serve the purposes of the human race for many thousands of years. In fact, the entire quantity of coal may be considered as practically inexhaustible. Turning, however, to our own particular country, and contemplating the rate at which we are expending those seams of coal which yield the best quality of fuel, and can be worked at the least expense, we shall find much cause for anxiety. The greatness of England much depends upon the superiority of her coal in cheapness and quality over that of other nations; but we have already drawn from our choicest mines a far larger quantity of coal than has been raised in all other parts of the world put together, and the time is not remote when we shall have to encounter the disadvantages of increased cost of working and diminished value of produce.

Estimates have been made at various periods of the time which would be required to produce complete exhaustion of all the accessible coal in the British Islands. These estimates are extremely discordant; but the discrepancies arise not from any important disagreement as to the available quantity of coal, but from the enormous difference in the rate of consumption at the various dates when the estimates were made, and also from the different views which have been entertained as to the probable increase of consumption in future years. The quantity of coal yearly worked from British mines has been almost trebled during the last twenty years, and has probably increased tenfold since the commencement of the present century; but as this increase has taken place pending the introduction of steam navigation and railway transit, and under exceptional conditions of manufacturing development, it would be too much to assume that it will continue to advance with equal rapidity. The statistics collected by Mr. Hunt, of the Mining Records Office, show that at the end of 1861 the quantity of coal raised in the United Kingdom had reached the enormous total of 86 millions of tons, and that the average annual increase of the eight preceding years amounted to 2¾ millions of tons. Let us inquire, then, what will be the duration of our coal-fields if this more moderate rate of increase be maintained.

By combining the known thickness of the various workable seams of coal, and computing the area of the surface under which they lie, it is easy to arrive at an estimate of the total quantity comprised in our coal-bearing strata. Assuming 4,000 feet as the greatest depth at which it will ever be possible to carry on mining operations, and rejecting all seams of less than two feet in thickness, the entire quantity of available coal existing in these islands has been calculated to amount to about 80,000 millions of tons, which, at the present rate of consumption, would be exhausted in 930 years, but, with a continued yearly increase of 2¾ millions of tons, would only last 212 years. It is clear that long before complete exhaustion takes place, England will have ceased to be a coal producing country on an extensive scale. Other nations, and especially the United States of America, which possess coal-fields thirty-seven times more extensive than ours, will then be working more accessible beds at a smaller cost, and will be able to displace the English coal from every market. The question is, not how long our coal will endure before absolute exhaustion is effected, but how long will those particular coal-seams last which yield coal of a quality and at a price to enable this country to maintain her present supremacy in manufacturing industry. So far as this particular district is concerned, it is generally admitted that 200 years will be sufficient to exhaust the principal seams even at the present rate of working. If the production should continue to increase, as it is now doing, the duration of those seams will not reach half that period. How the case may stand in other coal-mining districts I have not the means of ascertaining; but as the best and most accessible coal will always be worked in preference to any other, I fear the same rapid exhaustion of our most valuable seams is everywhere taking place. Were we reaping the full advantage of all the coal we burnt, no objection could be made to the largeness of the quantity, but we are using it wastefully and extravagantly in all its applications. It is probable that fully one-fourth of the entire quantity of coal raised from our mines is used in the production of heat for motive power; but, much as we are in the habit of admiring the powers of the steam-engine, our present knowledge of the mechanical energy of heat shows that we realize in that engine only a small part of the thermic effect of the fuel. That a pound of coal should, in our best engines, produce an effect equal to raising a weight of a million pounds a foot high, is a result which bears the character of the marvellous, and seems to defy all further improvement. Yet the investigations of recent years have demonstrated the fact that the mechanical energy resident in a pound of coal, and liberated by its combustion, is capable of raising to the same height 10 times that weight. But although the power of our most economical steam-engines has reached, or perhaps somewhat exceeded, the limit of a million pounds raised a foot high per lb. of coal, yet, if we take the average effect obtained from steam-engines of the various constructions now in use, we shall not be justified in assuming it at more than one-third of that amount. It follows, therefore, that the average quantity of coal which we expend in realizing a given effect by means of the steam-engine is about 30 times greater than would be requisite with an absolutely perfect heat-engine.

The causes which render the application of heat so uneconomic in the steam-engine have been brought to light by the discovery of the dynamical theory of heat; and it now remains for mechanicians, guided by the light they have thus received, to devise improved practical methods of converting the heat of combustion into available power.

Engines in which the motive power is excited by the communication of heat to fluids already existing in the aëriform condition, as in those of Stirling, Ericsson and Siemens, promise to afford results greatly superior to those obtained from the steam-engine. They are all based upon the principle of employing fuel to generate sensible heat, to the exclusion of latent heat, which is only another name for heat which has taken the form of unprofitable motion amongst the particles of the fluid to which it is applied. They also embrace what is called the regenerative principle—a term which has, with reason, been objected to, as implying a restoration of expended heat. The so-called "regenerator" is a contrivance for arresting unutilized heat rejected by the engine, and causing it to operate in aid and consequent reduction of fuel.

It is a common observation that before coal is exhausted some other motive agent will be discovered to take its place, and electricity is generally cited as the coming power. Electricity, like heat, may be converted into motion, and both theory and practice have demonstrated that its mechanical application does not involve so much waste of power as takes place in a steam-engine; but whether we use heat or electricity as a motive power, we must equally depend upon chemical affinity as the source of supply. The act of uniting to form a chemical product liberates an energy which assumes the form of heat or electricity, from either of which states it is convertible into mechanical effect. In contemplating, therefore, the application of electricity as a motive po er, we must bear in mind that we shall still require to effect chemical combinations, and in so doing to consume materials. But where are we to find materials so economical for this purpose as the coal we derive from the earth and the oxygen we obtain from the air? The latter costs absolutely nothing; and every pound of coal, which in the act of combustion enters into chemical combination, renders more than two-and-a-half pounds of oxygen available for power. We cannot look to water as a practical source of oxygen, for there it exists in the combined state, requiring expenditure of chemical energy for its separation from hydrogen. It is in the atmosphere alone that it can be found in that free state in which we require it, and there does not appear to me to be the remotest chance, in an economic point of view, of being able to dispense with the oxygen of the air as a source either of thermo-dynamic or electro-dynamic effect. But to use this oxygen we must consume some oxidizable substance, and coal is the cheapest we can procure.

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I have hitherto spoken of coal only as a source of mechanical power, but it is also extensively used for the kindred purpose of relaxing those cohesive forces which resist our efforts to give new forms and conditions to solid substances. In these applications, which are generally of a metallurgical nature, the same wasteful expenditure of fuel is everywhere observable. In an ordinary furnace employed to fuse or soften any solid substance, it is the excess of the heat of combustion over that of the body heated which alone is rendered available for the purpose intended. The rest of the heat, which in many instances constitutes by far the greater proportion of the whole, is allowed to escape uselessly into the chimney. The combustion also in common furnaces is so imperfect, that clouds of powdered carbon, in the form of smoke, envelope our manufacturing towns, and gases, which ought to be completely oxygenized in the fire, pass into the air with two-thirds of their heating power undeveloped.

Some remedy for this state of things, we may hope, is at hand, in the gas regenerative furnaces recently introduced by Mr. Siemens. In these furnaces the rejected heat is arrested by a so-called "regenerator," as in Stirling's air-engine, and is communicated to the new fuel before it enters the furnace. The fuel, however, is not solid coal, but gas previously evolved from coal. A stream of this gas raised to a high temperature by the rejected heat of combustion is admitted into the furnace, and there meets a stream of atmospheric air also raised to a high temperature by the same agency. In the combination which then ensues, the heat evolved by the combustion is superadded to the heat previously acquired by the gases. Thus, in addition to the advantage of economy, a greater intensity of heat is attained than by the combustion of unheated fuel. In fact, as the heat evolved in the furnace, or so much of it as is not communicated to the bodies exposed to its action, continually returns to augment the effect of the new fuel, there appears to be no limit to the temperature attainable, except the powers of resistance in the materials of which the furnace is composed.

With regard to smoke, which is at once a waste and a nuisance, having myself taken part with Dr. Richardson and Mr. Longridge in a series of experiments made in this neighbourhood in the years 1857–58 for the purpose of testing the practicability of preventing smoke in the combustion of bituminous coal in steam engine boilers, I can state with perfect confidence that, so far as the raising of steam is concerned, the production of smoke is unnecessary and inexcusable. The experiments to which I refer proved beyond a doubt, that by an easy method of firing, combined with a due admission of air and a proper arrangement of fire-grate, not involving any complexity, the emission of smoke might be perfectly avoided, and that the prevention of the smoke increased the economic value of the fuel and the evaporative power of the boiler. As a rule, there is more smoke evolved from the fires of steam-engines than from any others, and it is in these fires that it may be most easily prevented. But in the furnaces used for most manufacturing operations the prevention of smoke is much more difficult, and will probably not be effected until a radical change is made in the system of applying fuel for such operations.

Not less wasteful and extravagant is our mode of employing coal for domestic purposes. It is computed that the consumption of coal in dwelling-houses amounts in this country to a ton per head per annum of the entire population; so that upwards of twenty-nine millions of tons are annually expended in Great Britain alone for domestic use. If any one will consider that one pound of coal applied to a well-constructed steam-engine boiler evaporates 10 lb., or one gallon of water, and if he will compare this effect with the insignificant quantity of water which can be boiled off in steam by a pound of coal consumed in an ordinary kitchen fire, he will be able to appreciate the enormous waste which takes place by the common method of burning coal for culinary purposes. The simplest arrangements to confine the heat and concentrate it upon the operation to be performed would suffice to obviate this reprehensible waste. So also in warming houses we consume in our open fires about five times as much coal as will produce the same heating effect when burnt in a close and properly constructed stove. Without sacrificing the luxury of a visible fire, it would be easy, by attending to the principles of radiation and convection, to render available the greater part of the heat which is now so improvidently discharged into the chimney. These are homely considerations—too much so, perhaps, for an assembly like this; but I trust that an abuse involving a useless expenditure exceeding in amount our income-tax, and capable of being rectified by attention to scientific principles, may not be deemed unworthy of the notice of some of those whom I have the honour of addressing.

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The increase of the earth's temperature as we descend below the surface is a subject which has been discussed at previous Meetings of the British Association. It possesses great scientific interest as affecting the computed thickness of the crust which covers the molten mass assumed to constitute the interior portions of the earth, and it is also of great practical importance as determining the depth at which it would be possible to pursue the working of coal and other minerals.

The deepest coal-mine in this district is the Monkwearmouth Colliery, which reaches a depth of 1,800 feet below the surface of the ground, and nearly as much below the level of the sea. The observed temperature of the strata at this depth agrees pretty closely with what has been ascertained in other localities, and shows that the increase takes place at the rate of 1° Fahr to about 60 feet of depth. Assuming the temperature of subterranean fusion to be 3,000°, and that the increase of heat at greater depths continues uniform (which, however, is by no means certain), the thickness of the film which separates us from the fiery ocean beneath will be about 34 miles—a thickness which may be fairly represented by the skin of a peach taken in relation to the body of the fruit which it covers. The depth of 4,000 feet, which has been assumed as the limit at which coal could be worked, would probably be attended by an increase of heat exceeding the powers of human endurance. In the Monkwearmouth Colliery, which is less than half that depth, the temperature of the air in the workings is about 84° Fahr. which is considered to be nearly as high as is consistent with the great bodily exertion necessary in the operation of mining. The computations, therefore, of the duration of coal would probably require a considerable reduction in consequence of too great a depth being assumed as practicable.

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In the course of the preceding observations I have had occasion to speak of the sun as the great source of motive power on our earth, and I must not omit to refer to recent discoveries connected with that most glorious body. Of all the results which science has produced within the last few years, none has been more unexpected than that by which we are enabled to test the materials of which the sun is made, and prove their identity, in part at least, with those of our planet. The spectrum experiments of Bunsen and Kirchhoff have not only shown all this, but they have also corroborated previous conjectures as to the luminous envelope of the sun. I have still to advert to Mr. Nasmyth's remarkable discovery, that the bright surface of the sun is composed of an aggregation of apparently solid forms, shaped like willow-leaves or some well known forms of Diatomaceæ, and interlacing one another in every direction. The forms are so regular in size and shape, as to have led to a suggestion from one of our profoundest philosophers of their being organisms, possibly even partaking of the nature of life, but at all events closely connected with the heating and vivifying influences of the sun. These mysterious objects, which, since Mr. Nasmyth discovered them, have been seen by other observers as well, are computed to be each not less than 1,000 miles in length and about 100 miles in breadth. The enormous chasms in the sun's photosphere, to which we apply the diminutive term "spots," exhibit the extremities of these leaf-like bodies pointing inwards, and fringing the sides of the cavern far down into the abyss. Sometimes they form a sort of rope or bridge across the chasm. and appear to adhere to one another by lateral attraction. I can imagine nothing more deserving of the scrutiny of observers than these extraordinary forms. The sympathy, also, which appears to exist between forces operating in the sun, and magnetic forces belonging to the earth merits a continuance of that close attention which it has already received from the British Association, and of labours such as General Sabine has with so much ability and effect devoted to the elucidation of the subject. I may here notice that most remarkable phenomenon which was seen by independent observers at two different places on the 1st of September, 1859. A sudden outburst of light, far exceeding the brightness of the sun's surface, was seen to take place, and sweep like a drifting cloud over a portion of the solar face. This was attended with magnetic disturbances of unusual intensity and with exhibitions of aurora of extraordinary brilliancy. The identical instant at which the effusion of light was observed was recorded by an abrupt and strongly marked deflection in the self-registering instruments at Kew. The phenomenon as seen was probably only part of what actually took place, for the magnetic storm in the midst of which it occurred commenced before and continued after the event. If conjecture be allowable in such a case, we may suppose that this remarkable event had some connexion with the means by which the sun's heat is renovated. It is a reasonable supposition that the sun was at that time in the act of receiving a more than usual accession of new energy; and the theory which assigns the maintenance of its power to cosmical matter plunging into it with that prodigious velocity which gravitation would impress upon it as it approached to actual contact with the solar orb, would afford an explanation of this sudden exhibition of intensified light in harmony with the knowledge we have now attained that arrested motion is represented by equivalent heat. Telescopic observations will probably add new facts to guide our judgment on this subject, and, taken in connexion with observations on terrestrial magnetism, may enlarge and correct our views respecting the nature of heat, light and electricity. Much as we have yet to learn respecting these agencies, we know sufficient to infer that they cannot be transmitted from the sun to the earth except by communication from particle to particle of intervening matter. Not that I speak of particles in the sense of the atomist. Whatever our views may be of the nature of particles, we must conceive them as centres invested with surrounding forces. We have no evidence, either from our senses or otherwise, of these centres being occupied by solid cores of indivisible incompressible matter essentially distinct from force. Dr. Young has shown that even in so dense a body as water, these nuclei, if they exist at all, must be so small in relation to the intervening spaces, that a hundred men distributed at equal distances over the whole surface of England would represent their relative magnitude and distance. What then must be these relative dimensions in highly rarefied matter? But why encumber our conceptions of material forces by this unnecessary imagining of a central molecule? If we retain the forces and reject the molecule, we shall still have every property we can recognize in matter by the use of our senses or by the aid of our reason. Viewed in this light, matter is not merely a thing subject to force, but is itself composed and constituted of force.

The dynamical theory of heat is probably the most important discovery of the present century. We now know that each Fahrenheit degree of temperature in 1 lb. of water is equivalent to a weight of 772lb. lifted 1 foot high, and that these amounts of heat and power are reciprocally convertible into one another. This theory of heat, with its numerical computation, is chiefly due to the labours of Mayer and Joule, though many other names, including those of Thomson and Rankine, are deservedly associated with its development. I speak of this discovery as one of the present age because it has been established in our time; but if we search back for earlier conceptions of the identity of heat and motion, we shall find (as we always do in such cases) that similar ideas have been held before, though in a clouded and undemonstrated form. In the writings of Lord Bacon we find it stated that heat is to be regarded as motion and nothing else. In dilating upon this subject, that extraordinary man shows that he had grasped the true theory of heat to the utmost extent that was compatible with the state of knowledge existing in his time. Even Aristotle seems to have entertained the idea that motion was to be considered as the foundation not only of heat, but of all manifestations of matter; and, for aught we know, still earlier thinkers may have held similar views.

The science of gunnery, to which I shall make but slight allusion on this occasion, is intimately connected with the dynamical theory of heat. When gunpowder is exploded in a cannon, the immediate effect of the affinities by which the materials of the powder are caused to enter into new combinations, is to liberate a force which first appears as heat, and then takes the form of mechanical power communicated in part to the shot and in part to the products of explosion which are also propelled from the gun. The mechanical force of the shot is reconverted into heat when the motion is arrested by striking an object, and this heat is divided between the shot and the object struck, in the proportion of the work done or damage inflicted upon each. These considerations recently led me, in conjunction with my friend Capt. Noble, to determine experimentally, by the heat elicited in the shot, the loss of effect due to its crushing when fired against iron plates. Joule's law, and the known velocity of the shot, enabled us to compute the number of dynamical units of heat representing the whole mechanical power of the projectile, and by ascertaining the number of units developed in it by impact, we arrived at the power which took effect upon the shot instead of the plate. These experiments showed an enormous absorption of power to be caused by the yielding nature of the materials of which projectiles are usually formed; but further experiments are required to complete the inquiry.

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Few sciences have more practical value than meteorology, and there are few of which we as yet know so little. Nothing would contribute more to the saving of life and property, and to augmenting the general wealth of the world, than the ability to foresee with certainty impending changes of the weather. At present our means of doing so are exceedingly imperfect, but, such as they are, they have been employed with considerable effect by Admiral FitzRoy in warning mariners of the probable approach of storms. We may hope that so good an object will be effected with more unvarying success when we attain a better knowledge of the causes by which wind and rain, heat and cold are determined. The balloon explorations conducted with so much intrepidity by Mr. Glaisher, under the auspices of the British Association, may perhaps in some degree assist in enlightening us upon these important subjects. We have learnt from Mr. Glaisher's observations that the decrease of temperature with elevation does not follow the law previously assumed of 1° in 300 feet, and that in fact it follows no definite law at all. Mr. Glaisher appears also to have ascertained the interesting fact that rain is only precipitated when cloud exists in a double layer. Rain-drops, he has found, diminish in size with elevation, merging into wet mist, and ultimately into dry fog. Mr. Glaisher met with snow for a mile in thickness below rain, which is at variance with our preconceived ideas. He has also rendered good service by testing the efficiency of various instruments at heights which cannot be visited without personal danger.

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The science of organic life has of late years been making great and rapid strides, and it is gratifying to observe that researches both in zoology and botany are characterized in the present day by great accuracy and elaboration. Investigations patiently conducted upon true inductive principles cannot fail eventually to elicit the hidden laws which govern the animated world. Neither is there any lack of bold speculation contemporaneously with this painstaking spirit of inquiry. The remarkable work of Mr. Darwin promulgating the doctrine of natural selection has produced a profound sensation. The novelty of this ingenious theory, the eminence of its author, and his masterly treatment of the subject have perhaps combined to excite more enthusiasm in its favour than is consistent with that dispassionate spirit which it is so necessary to preserve in the pursuit of truth. Mr. Darwin's views have not passed unchallenged, and the arguments both for and against have been urged with great vigour by the supporters and opponents of the theory. Where good reasons can be shown on both sides of a question, the truth is generally to be found between the two extremes. In the present instance we may without difficulty suppose it to have been part of the great scheme of creation that natural selection should be permitted to determine variations amounting even to specific differences where those differences were matters of degree ; but when natural selection is adduced as a cause adequate to explain the production of a new organ not provided for in original creation, the hypothesis must appear, to common apprehensions, to be pushed beyond the limits of reasonable conjecture. The Darwinian theory, when fully enunciated, founds the pedigree of living nature upon the most elementary form of vitalized matter. One step further would carry us back, without greater violence to probability, to inorganic rudiments, and then we should be called upon to recognize in ourselves, and in the exquisite elaborations of the animal and vegetable kingdoms, the ultimate results of mere material forces left free to follow their own unguided tendencies. Surely our minds would in that case be more oppressed with a sense of the miraculous than they now are in attributing the wondrous things around us to the creative hand of a Great Presiding Intelligence.

The evidences bearing upon the antiquity of man have been recently produced in a collected and most logically treated form by Sir Charles Lyell. It seems no longer possible to doubt that the human race has existed on the earth in a barbarian state for a period far exceeding the limit of historical record; but notwithstanding this great antiquity, the proofs still remain unaltered that man is the latest as well as the noblest work of God.

REPORT BY THE COMMITTEE APPOINTED TO INVESTIGATE SOME IMPROVEMENTS IN GUN-COTTON.

Since the invention of gun-cotton by Prof. Schonbein, the thoughts of many have been directed to its application to warlike purposes. Many trials and experiments have been made, especially by the French; but such serious difficulties presented themselves that the idea seemed abandoned in every country but one, Austria. From time to time accounts reached England of its partial adoption in the Austrian service, though no explanation was afforded of the mode in which the difficulties had been overcome, or the extent to which the attempts had been successful. The Committe, however, had been put in possession of the fullest information from two sources—Prof. Abel, chemist to the War Department, and Baron W. von Lenk, Major-General in the Austrian Artillery, the inventor of the system. Prof. Abel, by permission of the authorities, communicated to the Committee the information given by the Austrian Government to our Government, and also the results of his own elaborate experiments. General von Lenk, on the invitation of the Committee, by permission of the Austrian Government, paid a visit to this country, to give every information in his power on the subject, and brought over drawings and samples from the Imperial factory. The following is a summary of the more important points:—As to the chemical nature of the material, Von Lenk's gun-cotton differs from the gun-cotton generally made, in its complete conversion into a uniform chemical compound. It is well known to chemists that, when cotton is treated with mixtures of strong nitric and sulphuric acids, compounds may be obtained varying considerably in composition, though they all contain elements of the nitric acid and are all explosive. The most complete combination (or product of substitution) is that described by M. Hadon as $C_{36} H_{21} (9 NO_4) O_{30}$, which is identical with that termed by the Austrian chemists Trinitrocellulose, $C_{12} H_7 (3 NO_4) O_{10}$. This is of no use whatever for the making of collodion; but it is Von Lenks's gun-cotton, and he secures its production by several precautions, of which the most important are the cleansing and perfect desiccation of the cotton as a preliminary to its immersion in the acids,—the employment of the strongest acids attainable in commerce,—the steeping of the cotton in a fresh strong mixture of the acids after its first immersion and consequent imperfect conversion into gun-cotton,—the continuance of this steeping for forty-eight hours. Equally necessary is the thorough purification of the gun-cotton so produced from every trace of free acid. This is secured exclusively by its being washed in a stream of water for several weeks. These prolonged processes are absolutely necessary. It seems mainly from the want of these precautions that the French were not successful. From the evidence before the Committee it appears that this nitric compound, when thoroughly free from acid, is not liable to some of the objections which have been urged against that compound usually experimented upon as gun-cotton. It seems to have a marked advantage in stability over all other forms of gun-cotton that have been proposed. It has been kept unaltered for fifteen years; it does not become ignited till raised to a temperature of 136° C. (277° Fahr.); it is but slightly hygroscopic, and when exploded in a confined space, it is almost entirely free from ash. There is one part of the process not yet alluded to, and the value of which is more open to doubt—the treatment of the gun-cotton with a solution of silicate of potash commonly called water-glass. Prof. Abel and the Austrian chemists think lightly of it; but Von-Lenk considers that the amount of silica set free on the cotton by the carbonic acid of the atmosphere is really of service in retarding the combustion. He adds, that some of the gun-cotton made at the Imperial factory has not been silicated at all, and some imperfectly; but when the process has been thoroughly performed, he finds that the gun-cotton has increased permanently about 3 per cent. in weight. Much apprehension has been felt about the effect of the gases produced by the explosion of the gun-cotton upon those exposed to its action. It has been stated that both nitrous fumes and prussic acid are among these gases, and that the one would corrode the gun and the other poison the artilleryman. Now, though it is true that from some kinds of gun-cotton, or by some methods of decomposition, one or both of these gases may be produced, the results of the explosion of the Austrian gun-cotton without access of air are found by Karolys to contain neither of them, but to consist of nitrogen, carbonic acid, carbonic oxide, water, and a little hydrogen and light carburetted hydrogen. These are comparatively innocuous; and it is distinctly in evidence that, practically, the gun is less injured by repeated charges of gun-cotton than of gunpowder, and that the men in casemates suffer less from its fumes. It seems a disadvantage of this material as compared with gunpowder that it explodes at a temperature of 277° Fahr.; but against the greater liability to accidents from this cause may be set the almost impossibility of explosion during the process of manufacture, since the gun cotton is always immersed in liquid, except in the final drying.† Again, if it should be considered advisable at any time, it may be stored in water, and only dried in small quantities as required for use. The fact that gun-cotton is not injured by damp like gunpowder is, indeed, one of its recommendations, while a still more important chemical advantage which it possesses arises from its being perfectly resolved into gases on explosion; so that there is no smoke to obscure the sight of the soldier who is firing or to point out his position to the enemy, and no residuum left in the gun, to be got rid of before another charge can be introduced.

As regards the mechanical portion of this question, it appears that greater effects are produced by gases generated from gun cotton than by gases generated from gunpowder, and it was only after long and careful examination that the Committee were able to reconcile this fact with the low temperature at which the mechanical force is obtained. The great waste of force in gunpowder constitutes an important difference between it and gun-cotton, in which there is no waste. The waste in gunpowder is 68 per cent. of its own weight, and only 32 per cent. is useful. This 68 per cent is not only waste in itself, but it wastes the power of the remaining 32 per cent. It wastes it mechanically, by using up a large portion of the mechanical force of the useful gases. The waste of gunpowder issues from the gun with much higher velocity than the projectile; and if it be remembered that in 100 lb. of useful gunpowder this is 68 lb., it will appear that 32 lb. of useful gunpowder gas is wasted in impelling a 68-lb. shot composed of the refuse of gunpowder itself. There is yet another peculiar feature of gun-cotton. It can be exploded in any quantity instantaneously. This was once considered its great fault; but it was only a fault when we were ignorant of the means to make that velocity anything we pleased. *General von Lenk has discovered the means of giving gun-cotton any velocity of*

† In ten years' experience it is proved that this temperature is sufficiently high to insure safety of manipulation; 277° Fahr. is an artificial temperature, and artificial temperatures accidentally produced are generally high enough to ignite gunpowder. The greater liability to accident from this cause can, therefore, scarcely be admitted.

explosion that is required for merely the mechanical arrangements under which it is used. Gun-cotton in his hands has any speed of explosion, from 1 foot per second to 1 foot in $\frac{1}{1000}$ of a second, or to instantaneity. The instantaneous explosion of a large quantity of gun-cotton is made use of when it is required to produce destructive effects on the surrounding material. The slow combustion is made use of when it is required to produce manageable power, as in the case of gunnery. It is plain, therefore, that, if we can explode a large mass instantaneously, we get out of the gases so exploded the greatest possible power, because all the gas is generated before motion commences, and this is the condition of maximum effect. It is found that the condition necessary to produce instantaneous and complete explosion is the absolute perfection of closeness of the chamber containing the gun-cotton. The reason of it is, that the first ignited gases must penetrate the whole mass of the cotton, and this they do, and create complete ignition throughout, only under pressure. This presure need not be great. For example, a barrel of gun-cotton will produce little effect and very slow combustion when out of the barrel, but instantaneous and powerful explosion when shut up within it. On the other hand, if we desire gun-cotton to produce mechanical work, and not destruction of materials, we must provide for its slower combustion. It must be distributed and opened out mechanically, so as to occupy a larger space, and in this state it can be made to act even more slowly than gunpowder; and the exact limit for purposes of artillery General von Lenk has found by critical experiment. In general, it is found that the proportion of 11 lb. of gun-cotton, occupying 1 cubic foot of space, produces a greater force than gunpowder, of which from 50 to 60 lb. occupies the same space, and a force of the nature required for ordinary artillery. But each gun and each kind of projectile requires a certain density of cartridge. Practically, gun-cotton is most effective in guns when used as $\frac{1}{4}$ to $\frac{1}{3}$ weight of powder, and occupying a space of $1\frac{1}{10}$ of the length of the powder cartridge. The mechanical structure of the cartridge is of importance as affecting its ignition. The cartridge is formed of a mechanical arrangement of spun cords, and the distribution of these, the place and manner of ignition, the form and proportion of the cartridge, all affect the time of complete ignition. It is by the complete mastery he has gained over all these minute points that General von Lenk is enabled to give to the action of gun-cotton on the projectile any law of force he pleases. Its cost of production is considerably less than that of gunpowder, the price of quantities which will produce equal effects being compared. Gun-cotton is used for artillery in the form of a gun-cotton thread or spun yarn. In this simple form it will conduct combustion slowly in the open air, at a rate of not more than 1 foot per second. This thread is woven into a texture or circular web. These webs are made of various diameters, and it is out of these webs that common rifle cartridges are made, merely by cutting them into the proper lengths, and inclosing them in stiff cylinders of pasteboard, which form the cartridges. (In this shape its combustion in the open air takes place at a speed of 10 feet per second.) In these cylindrical webs it is also used to fill explosive shells, as it can be conveniently employed in this shape to pass in through the neck of the shell. Gun-cotton thread is spun into ropes in the usual way up to 2 inches diameter, hollow in the centre. This is the form used for blasting and mining purposes; it combines great density with speedy explosion. The gun-cotton yarn is used directly to form cartridges for large guns by being wound round a bobbin so as to form a spindle like that used in spinning-mills. The bobbin is a hollow tube of paper or wood, the object of the wooden rod is to secure in all cases the necessary length of chamber in the gun required for the most effective explosion. The gun-cotton circular web is inclosed in close tubes of india-rubber cloth to form a match line, in which form it is most convenient and travels with speed and certainty. In large quantities, for the explosion of mines, it is used in the form of rope, and in this form it is conveniently coiled in casks and stowed in boxes. As regards conveyance and storage of gun-cotton: it results from the foregoing facts, that 1 lb. of gun-cotton produces an effect exceeding 3 lb. of gunpowder in artillery. This is a material advantage whether it be carried by men, by horses, or in waggons. It may be placed in store, and preserved with great safety. The danger from explosion does not arise until it is confined. It may become damp and even perfectly wet without injury, and may be dried by mere exposure to the air. This is of great value in ships of war, and in case of danger from fire, the magazine may be submerged without injury. As regards its practical use in artillery, it is easy to gather from the foregoing general facts how gun-cotton keeps the gun clean and requires less windage, and therefore performs much better in continuous firing. In gunpowder there is 68 per cent. of refuse, or the matter of fouling. In gun-cotton there is no residuum, and therefore no fouling. Experiments made by the Austrian Committee proved that 100 rounds could be fired with gun-cotton, against 30 rounds of gunpowder. From the low temperature produced by gun-cotton the gun does not heat. Experiments showed that 100 rounds were fired with a 6-pounder in 36 minutes, and the gun was raised by gun-cotton to only 122° Fahrenheit, whilst 100 rounds with gunpowder took 100 minutes, and raised the temperature to such a degree that water was instantly evaporated. The firing with the gunpowder was, therefore, discontinued; but the rapid firing with the gun-cotton was continued up to 180 rounds without any inconvenience. The absence of fouling allows all the mechanism of a gun to have much more exactness than where allowance is made for fouling. The absence of smoke promotes rapid firing and exact aim. There are no poisonous gases, and the men suffer less inconvenience from firing in casemates, under hatches, or in closed chambers. The fact of smaller recoil from a gun charged with gun-cotton is established by direct experiment: its value is $\frac{2}{3}$ of the recoil from gun-powder, projectile effect being equal. To understand this may not be easy The waste of the solids of gunpowder accounts for one part of the saving, as in 100 lb. of gunpowder 68 lb. have to be projected in addition to the shot, and at a much higher speed. The remainder, General von Lenk attributes to the different law of combustion. But the fact is established. The comparative advantages of gun-cotton and gunpowder for producing high velocities, are shewn in the following experiment with a Krupp's cast-steel gun, 6-pounder. With ordinary charge 30 oz. of powder produced 1,338 feet per second. With charge of 13½ oz., gun-cotton produced 1,563 feet. The comparative advantages in shortness of gun are shown in the following experiments, 12-pounder:—

	Calibres.	Charge.	Velocity, feet per second.
Cotton, length,	10	15·9 oz.	1,426
Powder, "	13½	49 (normal powder charge.)	1,400
Cotton, "	9	17	1,402

—As to advantage in weight of gun, the fact of the recoil being less in the ratio of 2 : 3 enables a less weight of gun to be employed, as well as a shorter gun, without the disadvantage to practice arising from lightness of gun. As regards durance of gun, bronze and cast-iron guns have been fired 1,000 rounds without in the least affecting the endurance of the gun. As regards its practical application to destructive explosions of shells, it appears that from a difference in the law of expansion, arising probably from the pressure of water in intensely-heated steam, there is an extraordinary difference of result, namely, that the same shell is exploded by the same volume of gas into more than double the number of pieces. This is to be accounted for by the greater velocity of explosion when the gun-cotton is confined very closely in very small spaces. It is also a peculiarity that the stronger the shell the smaller the fragments into which it is broken. As regards mining uses, the fact that the action of gun-cotton is violent and rapid in exact proportion to the resistance it encounters, tells us the secret of its far higher efficiency in mining than gunpowder. The stronger the rock, the less gun-cotton, comparatively with powder, is necessary for the effect; so much so that while gun-cotton is stronger than powder as 3 to 1 in artillery, it is stronger in the proportion of 6 274 to 1 in a strong and solid rock, weight for weight. It is the hollow rope form which it is used for blasting. Its power of splitting up the material is regulated exactly as wished. As regards military and submarine explosion, it is a well-known fact, that a bag of gunpowder nailed on the gates of a city will blow them open. In this case gun-cotton would fail. A bag of gun-cotton exploded in the same way is powerless. If one ounce of gunpowder is exploded in scales, the balance is thrown down; with an equal force of gun-cotton nothing happens. To blow up the gate of a city a very few pounds of gun cotton, carried in the hand of a single man, will be sufficient, only he must know its nature. In a bag it is harmless; exploded in a box it will shatter the gates to atoms. Against the palisades of a fortification: a small square box containing 25 lb., merely flung down close to it will open a passage for troops; in actual experience on palisades a foot diameter and 8 feet high, piled in the gronnd, backed by a second row of 8 inches diameter, a box of 25 lb. cut a clean opening 9 feet wide. To this three times the weight of gunpowder produced no effect whatever, except to blacken the piles. Against bridges: a strong bridge of oak, 24 feet span, was shattered to atoms by a small box of 25 lb. laid on its centre; the bridge was not broken, it was shivered. As to its effect under water: in the case of two tiers of piles, in water 18 feet deep, 10 inches apart, with stones between them, a barrel of 100 lb. gun cotton, placed 3 feet from the face and 8 feet under water, made a clean sweep through a radius of 15 feet, and raised the water 200 feet. In Venice a barrel of 400 lb. placed near a sloop in 10 feet water, at 18 feet distance, threw it in atoms to a height of 400 feet. All experiments made by the Austrian Artillery Committee were conducted on a grand scale,—36 batteries, six and twelve pounders (gun cotton) having been constructed, and practised with that material.

The reports of the Austrian Commissioners are all based on trials with ordnance, from six pounders to forty-eight pounders, smooth bore and rifled cannon. The trails with small fire arms have been comparatively few, and not reported on. The trials for blasting and mining purposes were also made on a large scale by the Imperial Engineers' Committee, and several reports have been printed on the subject.

Sir W. Armstrong said it was impossible to listen to the report which had been read without being very much impressed with the great promise there was of gun-cotton becoming a substitute for gunpowder; but at the same time there were certain peculiar anomalies about it which he certainly should like to have cleared up, and until they were, they could not feel that perfect confidence in the results that they wished to do. In the first place, with regard to the heat evolved, they were told that, with such a quantity of gun cotton as would produce a given quantity of gas, a certain initial velocity was imparted to the projectile, and that the heating effect upon the gun was much less than when a similar velocity was produced by an equivalent quantity of gunpowder. The absence of heat in the gun implied an absence of heat in the gas. Where was the projectile force to come from, if there was no heat in the gas? He could not, for his part, conceive how it was possible of explanation. The next point that occurred to him was with regard to the recoil. It was stated that the recoil was very much less. That was ascribed to the absence of solid inert matter in the charge, which, in gun-cotton, was next to nothing. If the recoil was only two-thirds that of gunpowder, it would require, in order to account for that difference, a much larger quantity of solid matter than there really was in the case of gunpowder. The report stated that the use of gun-cotton enabled them to reduce the length of the gun. It was quite certain, however, that with a short gun they could not get an equal initial velocity as with a long gun. If the initial velocity were increased there was more danger of bursting the gun than with gunpowder. Because if they got any velocity, or an equal velocity with the shorter gun, it must be concluded that it was done by virtue of a greater initial pressure and an earlier action upon the shot. That necessarily implied a greater strain upon the gun at the first explosion, and that would necessitate the employment of stronger guns. He should have expected a smaller velocity by a shorter gun, for the action of the gas was necessarily shorter than in a longer gun. The heat question, however, was to him the greatest puzzle of all. How they could have the propelling power without heat in the gas, and if they heated the gas, how they escaped heating the gun, he could not understand.—Prof. Pole said he was quite unable to give any explanation of the difference of recoil. If the shot left the gun with the same velocity as when fired with gunpowder, it was natural to suppose that there must be the same quantity of recoil.—Mr. Siemens having briefly spoken on the dynamical question involved in the matter, suggested that the greater heat imparted to the gun in the case of gunpowder might be owing to the greater amount of solid matter, which taking up the great heat of the gases under a pressure of some 400 atmospheres imparted a portion of the same by radiation to the side of the gun, while in the case of gun cotton gases only were produced, which could only impart heat to the gun by the slower process of conduction, and left a larger margin of heat to be developed in force by expansion.—Admiral Sir

E. Belcher thought that the reason the gun was not heated by an explosion of gun-cotton might be because the gases had not time to heat the gun owing to the rapidity of the explosion, which was slower in the case of gunpowder; or that it might arise from the greater amount of fouling in the case of gunpowder.—Capt. Maury said this Report was something more than interesting, because it was so exceedingly suggestive; and it appeared to him that it afforded them an element of security by giving the preponderance on the side of defence. Ever since steam had been applied to purposes of naval warfare it had been considered a matter of very great doubt by many professional men how far ordinary steamers and men-of-war, where forts were to be passed at the mouth of a river, were capable of sustaining the fire of such forts and passing up the river. And to show that there was ample time for them to do so, they had only to recollect the fact of steamers having fought forts for several hours. In the Crimea and at Charleston the steamers had remained under fire for several hours—a much longer time than was necessary to enable them to pass the forts and go higher up the river into a place of safety where they could do damage to the enemy. Iron clads had rendered this much more easy than it had previously been. If then their principal defences failed them at the mouth of the river in this way, the question was whether they should not have recourse to mining for the destruction of the invading vessels? He himself had been engaged upon the subject. He found this difficulty in employing gunpowder, that in order to be sure of destroying the vessel as she passed in a given line by means of gunpowder, the magazines must be in actual contact, or very nearly in actual contact with the side of the vessel; otherwise the probability was that the vessel would not be destroyed. Last week they had the intelligence of a vessel having had a mine exploded under her on the James River. That magazine contained several thousands of pounds of powder. The vessel did not know that the mine was there; but the mine did not destroy the vessel. It merely threw up a column of water which washed some of the men overboard. His own conclusion was that to make sure of destroying a vessel after she had passed the forts, they must mine the channel in such a manner that the vessel must come in contact with one or other of the mines. It was found that wooden vessels to contain the powder would not do. They would not confine the powder long enough to produce a sufficient force. It was necessary to make them of stout boiler iron. It would not do to leave the magazines on the top of the water, and it would not do to put them at the bottom, for then there would be a cushion of water between the bottom of the ship to be destroyed and the magazine, which would protect the vessel. In short they had to anchor them beneath the surface with short buoy-ropes, at a depth proportioned to the kind of vessel expected to come up. But when they made the magazine of boiler-iron they had to have buoys to float it so large that they were always in danger of being carried away by the vessels crossing the line of magazine. The plan was to place those magazines in a ring in such a position that the vessel in passing would have to come in contact with at least one and probably two of them. It was necessary to place those magazines of powder so that when you saw the vessel in that range you had only to bring the two poles of the galvanic battery together and make the explosion. There was, as already stated, a difficulty in using gunpowder. But since gun-cotton had the remarkable effect of destroying a vessel—he did not know her strength—at a distance of 18 feet, and that not vertically, but laterally, the question arose whether they might not fortify and protect those channel ways by placing a ring of gun cotton magazines along the bottom; but, at any rate, if that was not necessary, they could float them at any depth, and out of reach of the vessels generally using the channel. That appeared to him to be one of the most important uses of gun cotton, and it was one which would give safety to cities which were some distance from the mouths of navigable rivers. He trusted that in the event of the Committee continuing their labours, they would address their attention to this important point.—Admiral Sir E. BELCHER stated that the explosion of powder under water was once done under one of his own vessels to clear away ice. He placed it upon the ground, thinking that its explosion would blow the ice clear of her bows without touching the vessel. There was, however, sufficient water to form a cushion, and when the explosion took place it only produced a great wave upon which the vessel rose Prof. POLE said what they wanted was something to show the varying pressure of the gases in the gun; in fact, an indicator diagram.—Mr. J. SCOTT RUSSELL set himself to clear away the many difficulties which attended this very difficult subject. How was it that in gunpowder and in gun-cotton where there were equal quantities of gas put in, the gas in the case of gunpowder was raised to an enormously high temperature, and came out at an enormously high pressure, showing that they had gas enormously expanded by heat; whereas in the case of gun cotton the gas came out quite cool, so that you might put your hand upon it, and the gun itself was quite cool? He (Mr. Russell) had a theory Steam was a gas, and steam expanded just by the same laws as other gases did. A great deal of the gas of gun-cotton happened to be steam. Let them conceive 100 lb. of gun-cotton shut up in a chamber that just held it. They had got there all the gases that had been spoken of, but they had also got 25 lb. of solid water—about one-third of a cubic foot of water—in that chamber. What did they do with it? They put fuel, they put fire to it. They heated the whole remaining pounds of patent fuel. If, then, they considered the gun-cotton gun as the steam-gun, they got rid of two difficulties. They would have, first, the enormous elasticity of steam; and secondly, they would get the coolness of it. They all knew that if they put their hand to expanded high pressure steam, it had swallowed up all the heat and came out quite cool. He believed that the gun cott n gun was neither more nor less than Perkins's old steam gun with only this difference, that you bottled up the fuel and water, and let them fight it out with each other. They did their work and came out quite cool. He hoped, however, that it was understood that he did not dogmatize. He put all he had said with a note of interrogation upon it. Prof. TYNDALL said he thought that a note of interrogation ought to be put to what Mr. Russel had said.

The subject is considered of so much importance that the British Association, though it has re-appointed the Joint-Committe to continue its inquiries, has passed a resolution to urge on the Government the appointment of a Commission by means of which a more complete investigation, and such as the subject unquestionably deserves, may be made than the means at the disposal of the Association will admit of.

A communication from the Astronomer Royal, 'On Boiler Explosions,' was read by Mr. P. Le Neve Foster. The author stated that, in considering the cause of the extensive mischief done by the bursting of a high-pressure boiler, it is evident that the small quantity of steam contained in the steam chamber has very little to do with it. That steam may immediately produce the ruptnre, but as soon as the rupture is made, and some steam escapes, and the pressure on the water is diminished, a portion of the water is immediately converted into steam at a slightly lower temperature and lower pressure, and this, in the same way, is followed by other steam at still lower temperature and pressure, and so on till the temperature is reduced to 212° Fahr. and the pressure to 0. Then there remains in the boiler a portion of water at the boiling point, the other portion having gone off in the shape of steam of continually diminishing pressure. From this it is evident that the destructive energy of the steam, when a certain pressure is shown by the steam gauge, is proportional to the quantity of water in the boiler. By the assistance of Prof. Miller, of Cambridge, Messrs. Ransome, of Ipswich, and George Biddell, Esq., the author has been able to obtain a result which he believes to be worthy of confidence. He first stated, as the immediate result of Mr. Biddell's experiments, that when there were in the boiler of a small locomotive 22 cubic feet of water, at the pressure of 60 lb. per square inch, and the fire was raked out, and the steam was allowed gently to escape, with perfect security against priming, the quantity of water which passed off before the pressure was reduced to 0 was $2\frac{3}{4}$ cubic feet, or $\frac{1}{8}$ of the whole. In regard to the use made of Prof. Miller's theory, Prof. Miller had succeeded in obtaining a numerical expression for the pressure of steam at twelve different measures of the volume occupied by water and steam, which expression the author has succeeded in integrating accurately, and had thus obtained an accurate numerical expression for the destructive energy of steam. In regard to the use of General Didion's experiments, these experiments gave the velocity of the ball, in cannon of different sizes, produced by different charges of powder. The author found, by trial with the formula $\frac{Wv^2}{2g \times \text{weight of powder}}$, which of these experiments exhibits the greatest energy per kilogramme of powder, and had adopted it in the comparison. The result is as follows:—the destructive energy of one cubic foot of water, at 60 lb. pressure per square inch is equal to the destructive energy of two English pounds of gunpowder in General Didion's cannon experiments; Gen. Didion's experiments were made as the author understood with smooth bored cannon. It cannot be doubted that much energy is lost in the windage; some also from the circumstance that the propelling power ceases at the muzzle of the gun, before all the energy is expended; and some from the coolness of the metal. If we suppose that from all causes one-half of the energy is lost, then we have this simple result: the gauge-pressure being 60 lb. per square inch, 1 cubic foot of water is as destructive as 1 lb. of gunpowder. In one of Mr. Biddell's experiments, the steam-valve was opened rather suddenly, and the steam escaped instantly with a report like that of a very heavy piece of ordnance. This is not to be wondered at; it appears from the comparison above that the effect was the same as that of firing a cannon whose charge is 44 lb. of powder.

'On Spectral Analysis,' by Prof. Plucker.—It is generally admitted now, that every gaseous body rendered luminous by heat or electricity sends out a peculiar light, which, if examined by the prism, gives a well-defined and characteristic spectrum. By such a spectrum, by any one of its brilliant lines, whose position has been measured, you may recognize the examined gas. This way of proceeding constitutes what is called spectral analysis, to which we owe, until this day, the discovery of three new elementary bodies. In order to give to spectral analysis a true and certain basis, you want the spectrum of each elementary substance. Most recently, some eminent philosophers, in examining such spectra, met with unexpected difficulties, and doubts arose in their minds against the new doctrine. These doubts are unfounded. The fact is, that the molecular constitution of gases is much more complicated than it has been generally admitted till now. The spectra, therefore, always indicating the molecular constitution of gases, ought to be more complicated also than it was thought at first. By these considerations, a new importance a rather physical one, is given to spectral analysis. You may recognize by the spectrum of a gas, not only the chemical nature of the gas, but you may also obtain indications of its more intimate molecular structure—quite a new branch of science. Allow me now to select out of the results already obtained two instances only. Let me try to give what I may call the history of the spectra of two elementary bodies—of sulphur and nitrogen. In order to analyse by the prism the beautiful light produced by the electric current, if it pass through a rarefied gas, I gave to the tube in which the gas is included such a form that its middle part was capillary. Thus I got within this part of the tube a brilliant film of light, extremely fitted to be examined by the prism. The date of my first paper on this subject is the 12th of March. 1858. After having provided myself with apparatus more suited to my purposes, I asked, about a year ago, my friend, Prof. Hittorf, of Münster, to join me in taking up my former researches. The very first results we obtained in operating on gases of a greater density opened to us an immense field of new investigation. We found that the very same elementary substance may have two, even three, absolutely different spectra, which only depend on temperature. In our experiments we made use of Ruhmkorff's induction coil, whose discharge was sent through our spectral tubes. In order to increase at other times the heating power of the discharge, we made use of a Leyden jar. Now, let us suppose a spectral tube, most highly exhausted by Geissler's mercury pump, contains a very small quantity of sulphur. The discharge of the coil will not pass through the tube if it do not meet with ponderable matter, either taken from the surface of the glass, or, if the discharge be very strong, by the chemical decomposition of the glass. In heating slowly the tube by means of a lamp, in order to transform a part of the sulphur into vapour, all accidental spectrum, if there be one, will disappear, and you will get a pure and beautiful spectrum of sulphur. I supposed the Leyden jar not to have been interposed. If you now interpose it, the spectrum just spoken of will suddenly be replaced by a quite different one. We were generally led to distinguish two quite different classes of spectra. Spectra of the first class consist in a certain number of bands, variously shadowed by dark transversal lines. Spectra of the second class consist in a great number of most brilliant lines on a dark ground. Accordingly, sulphur has one spectrum of the first class and another one of the second class. You may as often as you like obtain each of these two spectra. In operating on a spectral tube, containing nitrogen at a tension of about 50 millimètres, you will, without the Leyden jar, get a most beautiful spectrum of the first class. After interposing the jar, a splendid spectrum of the second class will be seen. But here the case is more complicated yet. The above mentioned spectrum of the first class is not a simple one, but it is produced by the superposition of two spectra of the same class. Ignited nitrogen at the lowest temperature has a most beautiful colour of gold. When its temperature rises, its colour suddenly changes into blue. In the first case, the corresponding spectrum is formed by the less refracted bands extended towards the violet part; in the second case, it is formed by the more refracted band of the painting extending towards the red. Nitrogen, therefore, has two spectra of the first class and one spectrum of the second class. The final conclusion, therefore, is that sulphur has two, nitrogen three, different allotropic states. It may appear very strange that a gaseous body may have different allotropic states—*i. e.*, different state of molecular equilibrium. It may not appear, perhaps, more strange that a substance, hitherto supposed to be an elementary one, may really be decomposed at an extremely high temperature. From spectral analysis there cannot be taken any objection that sulphur and nitrogen may be decomposed. Chloride of zinc (or cadmium), for instance, exhibits two different spectra. If heated like sulphur and then ignited by the discharge of Ruhmkorff's coil, you will get a beautiful spectrum either of chlorine or of the metal, if either the Leyden jar be not interposed or be interposed. There is, in this case, a dissociation of the elements of the composed body in the highest temperature, and re-composition again at the lower temperature. You may consider the dissociation as an allotropic state, and, therefore, I may make use of this term as long as the decomposition be not proved by the separated elements.

'On the Star Chromatoscope,' by Mr. A. CLAUDET.—The scintillation and change of colours observed in looking at the stars are so rapid that it is very difficult to judge of the separate lengths of their duration. If we could increase on the retina the length of the sensations they produce we should have the better means of examining them. This can be done by taking advantage of the power by which the retina can retain the sensation of light during a fraction of time which has been found to be one-third of a second—a phenomenon which is exemplified by the curious experiment of a piece of incandescent charcoal revolving round a centre, and forming a continual circle of light. It is obvious that if the incandescent charcoal during its revolution was evolving successively various rays, we could measure the length and duration of every ray by the angle each would subtend during its course. This is precisely what can be done with the light of the star. It can indeed be made to revolve like the incandescent charcoal, and form a complete circle on the retina. When we look at a star with a telescope we see it on a definite part of the field of the glass; but if with one hand we slightly move the telescope the image of the star changes its position, and during that motion, on account of the persistence of sensation on the retina, instead of appearing like a spot, it assumes the shape of a continued line. Now if, instead of moving the telescope in a straight line, we endeavour to move it in a circular direction, the star appears like a circle, but very irregular, on account of the unsteadiness of the movement communicated by the hand. Such is the principle of the instrument employed by the author to communicate the perfect circular motion which it is impossible to impart by the hand. The instrument consists of a conical tube placed horizontally on a stand, and revolving on its own axis by means of wheels inside this tube a telescope or an opera glass is placed, by which, by means of two opposite screws, the end of the object-glass can be placed in an excentric position in various degrees according to the effect desired, while the eye-glass remains in the centre of the small end of the tube. Now, if we understand that when the machine makes the tube to revolve upon its axis, the telescope inside revolves in an excentric direction, during the revolution the star seen through it must appear like a circle. This circle exhibits on its periphery the various rays emitted by the star, all following each other in spaces corresponding with their duration, showing also blank spaces between two contiguous rays which must correspond with the black lines of the spectrum. The instrument, in fact, is a kind of spectroscope, by which we can analyze the light of any star, study the cause of the scintillation, and compare its intensity in various climates or seasons and at different altitudes.

The Abbé Moigno exhibited and described M. Soleil's Tenebroscope, for illustrating the invisibility of light. It is well known to scientific men, although the general public do not sufficiently appreciate the fact, that light in itself is invisible unless the eye be so placed as to receive the rays as they approach it, or unless some object be placed in its course, from whose surface the light may be reflected to the eye, which will generally thus give notice of the presence of that object. Thus, if the strong beam of sunlight be admitted into a darkened chamber through a small opening and received on some blackened surface placed against the opposite wall, the entire chamber will remain in perfect darkness, and all the objects in it invisible, except in as far as small motes floating in the air mark the course of the sunbeam by reflecting portions of its light. Upon projecting a fluid or small dust across the course of the beam its presence also becomes perceptible. The instrument exhibited consisted of a tube with an opening at one end to be looked into, the other end closed, the inside well blackened, and a wide opening across the tube to admit strong light to pass only across. On looking in all is perfectly dark, but a small trigger raises at pleasure a small ivory ball into the course of the rays, and its presence instantly reveals the existence of the crossing beam by reflecting a portion of its light.

'On the System of Forecasting the Weather pursued in Holland,' by Dr. Buys Ballot.—The author said:—" I shall not abuse your indulgence, which I earnestly implore. I shall very shortly explain (1.) what are the rules about foretelling weather in Holland, given before a similar system was introduced in England; (2.) how they behaved themselves; and (3.) what is to be done now: and I will very abundantly answer to any question or remark if they be made, for in that case I am justified in trespassing on your time.—(1.) Under our plan, where observations are taken in Holland, there are four principal places: Helder indicated by H, Groningen indicated by G, Flushing indicated by V, and Maestricht indicated by M, on the indications of which I base my forecasts, and in the first place on the barometer readings. For every day of the year and for every hour of the day I have very carefully determined the height of the barometer in the place of observation at that height above the sea, where it is suspended. This is a cardinal point not sufficiently observed in England, and not at all in France. The difference of an observed pressure from that calculated on I call the departure of the pressure—positive when the pressure is greater, negative when it is less. Those departures, besides the observations of the other instruments, are communicated from post to post. The rule is now very simple. If the departures are greater (more positive) in the southern places than in the northern, greater at M. or V. than at G. or H., the wind will have a W. in its name; when the departures are greater in the northern places the wind will have an E. in its name. More accurately, you may say, the wind will be nearly at right angles with the direction of the greatest difference of pressures. When you place yourself in the direction of the wind (or in the direction of the electric current) you will have at your left the least atmospheric pressure (or the north pole of the magnet). When the difference of pressure of the southern places above the northern is not above four millimètres there will be no wind of a force above 30 lb. on the square mètre. Moreover, he greatest amount of rain will fall when the departures are negative; and at the places where the departures are most negative there also the force of the wind will be generally stronger. Moreover, there will be no thunder if the barometric pressure is not less than two millimètres above the average height, and when at the same time the difference of the departures of temperature is considerable. Those rules, and especially the first two, were laid down by me, in 1857, in the *Comptes Rendus*, and on the 1st of June, 1860, the first telegraphic warning by order of the Department of the Interior was given in Holland. It was unfortunate that these telegraphic warnings were not introduced four days sooner, for in that case the first communication would have been a first warning against the fearful storm of May 28, 1860, called the Finster-storm. All of you know how amply Admiral Fitz Roy has arranged the telegraph warnings all over England. —2. Those rules used in Holland have behaved themselves very well, as is laid down in the translation of a paper of Mr. Klein, captain of a merchant ship, whereto I have added my observations and signals compared with the signals of Admiral Fitz Roy in table A, p. 25. My own paper dates from June 1, 1860, and is extracted by Mr. Klein as you may see, but I preferred that the less complete and precise paper of a practical man be translated, because I thought that the seamen would put more reliance on it. From the tables added to that translation it appears that I have warned from my four stations, just as Admiral Fitz Roy has done from his twenty. It must, however, be recorded that besides those four stations, there are also some stations—Paris, Havre, Brest—in France, and some in England—Hartlepool, Yarmouth, Portsmouth, Plymouth—that send me their observations. Generally they arrive too late, and therefore they throw but very little light on the forecasting, principally while the barometers are not so well known. So much for the strength, now for the direction. The direction is in the first twenty-four hours after the observations three times of the four such as indicated, and the second 24 hours and the third 24 hours still two times of the three such as indicated (see table B, p. 29), and moreover no storm has occurred in those six years when not before the difference of the southern departures above the northern has been four millimètres.—To come to the third point. 3rd. What is to be done? The normal heights of the barometric pressure, or better, of the barometers, which are read, must be conscientiously taken, the observation must be made at more points once a day, and mutually communicated, and at days when there are greatly different departures, that is to say, of three millimètres, or when there is change of inclination, there must be sent a message at noon or in the evening of the same day. In all cases, not only the pressure in the morning, but likewise that at night should be given. A critical indication is, when the previous day the northern stations had greater departures, and the following day the southern had greater departures, even when the difference in the latter case was small. There is caution to be had when the difference of the departures is 4 millimètres. But I may not trespass on your time and kindness in expressing wishes only, it may be sufficient to have communicated the general rule.

'On Aluminium,' by Mr. I. L. Bell.—The author said—"The progress of the manufacture of this, so far as the arts are concerned, new metal has scarcely been such as to require much to be added to the researches bestowed upon the process by the distinguished chemist, M. St. Cairi Deville, of Paris. Upon the introduction of its manufacture at Washington, three years and a half ago, the source of the alumina was the ordinary ammonia alum of commerce, a nearly pure sulphate of alumina and ammonia. Exposure to heat drove off the water, sulphuric acid and ammonia, leaving the alumina. This was converted into the donble chloride of aluminium and sodium by the process described by the French chemist and practised in France, and the double chloride subsequently decomposed by fusion with sodium. Faint, however, as the traces might be of impurity in the alum itself, they, to a great extent, if not entirely, being of a fixed character when exposed to heat, were to be found in the alumina, from which, by the action of the chlorine on the heated mass, a large proportion, if not all, found their way into the sublimed double chloride, and once there, it is unnecessary to say that under the influence of the sodium, any silica, iron, or phosphorus found their way into the aluminium sought to be obtained. Now, it happens that the presence of these impurities in a degree so small as almost to be infinitesimal, interferes so largely with the colour as well as with the malleability of the aluminium that the use of any substance containing them is of a fatal character. Nor is this all, for the nature of that compound which hitherto has constituted the most important application to this metal—I mean aluminium-bronze—is so completely changed by using aluminium containing the impurities referred to, that it ceases to possess any of those properties which render it valuable. As an example of the amount of interference exercised by very minute quantities of foreign matters, it is, perhaps, worthy of notice that very few varieties of copper have been found susceptible of being employed for the manufacture of aluminium-bronze; and hitherto we have not at Washington, nor have they in France, been able to establish in what the difference consists between copper fit for the production of aluminium-bronze, and that which is utterly unsuitable for the purpose. These considerations have led us, both here and in France, to adopt the use of another raw material for the production of aluminium, which either does not contain the impurities referred to as so prejudicial, or contains them in such a form as to admit of their easy separation. This material is Bauxite, so called from the name of the locality where it is found in France. The Bauxite is ground and mixed with the ordinary alkali of commerce, heated in a furnace. The metal is so extensively used in the arts as to keep the only work in England, namely, that at Washington, pretty actively employed. As a substance for works of art, when whitened by means of hydrofluoric and phosphoric acid, it appears well adapted, as it runs into the most complicated patterns, and has the advantage of preserving its colour, from the absence of all tendency to unite with sulphur or become affected by sulphuretted hydrogen. A large amount of the increased activity in the manufacture referred to is due to the exceeding beauty of its compound with copper, which is so like gold as scarcely to be distinguishable from that metal, with the additional valuable property of being nearly as hard as iron."

'On the Syndactylous Condition of the Hand in Man and the Anthropoid Apes,' by Mr. C. C. Blake.—The author said, "I call the attention of the Section to a curious abnormity which is presented by the integument of a specimen of old male gorilla which was brought from the Gaboon by Mr. W. Winwood Reade, and presented by that gentleman to the Museum of the Anthropological Society of London. The specimens of gorilla which have been the subjects of the elaborate and complete Memoirs which have appeared from the pens of MM. Duvernoy and Isidore Geoffroy St. Hilaire, in the Archives of the Paris Museum (vols. viii. and x.) and by Prof. Owen in various parts of the Zoological *Transactions*, have, with other authors, all coincided in the statement of a fact, true as regards the specimens with which they were acquainted, which probably represent the majority of specimens of gorilla which have been examined in Europe. This statement, reduced to a general proposition, was that the integument of the skin of the fingers was more or less connected across the first digital phalanx in such a manner that the first joints were firmly connected together by skin, sometimes as far as the distal extremity of the first phalanx, sometimes merely to the middle of the phalanx. In no specimen of gorilla, of the description of which I am yet cognizant, are the digits of the anterior extremity free to the same extent as in man, in which the distal extremities of the metacarpals mark the termination of the amount of syndactylity of the hand. In the specimen of gorilla to which allusion is made in this short note, the digits of the fingers present a different condition of connection from the typical specimens described by zoologists. The second (index), third (medius), and fourth (annulus) digits are free beyond the distal end of the metacarpals as in the human subject; the fifth digit (minimus) is also in a less degree attached to the annulus than in the specimens of gorilla contained in various public museums. We have thus a specimen of gorilla in which the digits of the hand are almost as free as in the hand of the lower races of mankind. Careful examination by a lens of the integument before the preparation of the specimen by Mr. Leadbeater, who first called my attention to this abnormity, demonstrates the fact that the epidermis covers the cutis on the inner sides of the interdigital spaces of the first phalanges of this specimen. The consistency of this epidermis merely differs in degree from that of the homologous structure in the foot and other parts of the body. It would be interesting to compare such a curious abnormity of the integument with the similar abnormities which exist in the human species. The human fingers are most frequently connected together by syndactyli, and remain during life in that state of arrested development (as regards the integument) which is typified by the permanent stage of the development of the gorilla. On the other hand, I have never yet met, either in the chimpanzee or orang-utan, with a similar case of freedom of digits to that here described. We must, however, recollect that the number of specimens of chimpanzee and orang-utan, which have been accurately described anatomically, form a very small per-centage. How many individuals of gorilla may exist, in which there may be a similar 'accidental' variety, must remain for a long time unknown to us. Syndactylity is often congenital. A case has recently come before my observation of a married female, in which the *medius* and *annulus* of both hands are firmly connected together by integument. A similar condition prevails in one of her children; another has deformity on the right hand; while the youngest preserves the digits in their normal condition. The speculation whether a like rule or its converse may or may not prevail in the ape,—whether it might not through generations during which the congenital defect of the gorilla, or absence of the characteristic syndactylity, might be transmitted, operate towards the production of a more preh-ensile form of hand, must, however, be postponed until a vaster series of specimens shall be examined by anthropologists or zoologists."

'On the Physical and Mental Character of the Negro,' by Dr. J. Hunt.

This paper brought up Mr Craft, a negro of nearly pure black skin, in defence of his race. Mr. Craft said, that as Africans were very dark, and the inhabitants of Northern Europe very fair, and as, moreover, the nations of Southern Europe were much darker than those of Northern Europe, it was perfectly fair to suppose that climate had a tendency to bleach as well as to blacken The thickness of the skulls of the negroes had been wisely arranged by Providence to defend their brains from the tropical climate in which they lived If God had not given them thick skulls their brains would probably have become very much like those of many scientific gentlemen of the present day. The woolly hair was not considered by Africans as a mark of inferiority, though some of them shaved it off, but it also answered the purpose of defending the head from the sun. With regard to his not being a true African, his grandmother and grandfather were both of pure negro blood. His grandfather was a chief of the West Coast; but, through the treachery of some white men, who doubtless thought themselves greatly his superiors, he was kidnapped and taken to America, where he (Mr. Craft) was born. He had recently been to Africa on a visit to the King of Dahomey. He found there considerable diversities even among the Africans themselves. Those of Sierra Leone had prominent, almost Jewish features. Their heels were quite as short, generally, as those of any other race, and upon the whole they were well formed. Persons who had any knowledge of Africans knew that, when they enjoyed advantages, they were capable of making good use of them. He might refer to the instance of the little girl brought to this country by Capt. Forbes. This child was presented to the Queen, who had her carefully educated. When she grew up, she mingled in good society, and interested every one by her proficiency in music; and recently she had been married to a commercial gentleman of colour at Lagos. Another case was mentioned by Mr. Chambers in one of his works; and another case was that of Mr. Crowther, who was well known to many gentlemen in this country. One word with reference to the ancient Britons. When Julius Cæsar came to this country, he said of the natives that they were such stupid people that they were not fit to make slaves of in Rome. It had taken a long time to make Englishmen what they now were, and therefore it was not wonderful if the negroes made slow progress in intellectual development. It was, however, proved, that they made very rapid progress when placed in advantageous circumstances. As to the negro not being erect, the same thing might be said of agricultural labourers in this country. He pointed to Hayti as furnishing an instance of independence of character and intellectual power on the part of the negro; and contended that in America the degraded position which he was forced to occupy gave him no chance of proving what he really was capable of doing. He was sorry that learned and scientific men should waste their time in discussing a subject that could prove of no benefit to mankind. He spoke with great deference to their opinions; but, for his own part, he firmly agreed with Cowper, that

Fleecy locks and black complexion
Cannot alter nature's claim;
Skins may differ, but affection
Dwells in white and black the same.

'Military Budgets of English and French Armies for 1863–4, statistically compared,' by Col. Sykes.—He showed by a series of elaborate returns that the total effective English army was 147,118; that of the French, 355,187. The cost per head of the effective and non-effective English, numbering 147,118 men, was 94*l.* 1*s.* 1½*d.*, while that of the French effective and non-effective forces of 400,000 was 43*l.* 9*s.* 4*d.* per head. The cost of the British manufacturing department was 6*l.* 10*s.* per head, against 2*l.* 15*s.* 10*d.*; military stores (British) per head, 5*l.* 14*s.*, French, 3*l.* 0*s.* 2*d.*; purchase of small arms (British), 14*s.* 4½*d*, against 5*s.* 8*d.*; British military education, 1*l.* 3*s.* 5*d.*, French, 7*s.* 1*d*; administration of the British army (Secretary of State and Commander-in-Chief's Department), 1*l.* 8*s.* 11*d.*, French, 6*s.* 11½*d.*; Government staff (British) per individual 304*l.* 5*s.*, French, 390*l.*; clothing (British), 4*l.* 0*s.* 2*d*, against 1*l.* 19*s.* 11*d.* Col. Sykes gave further details, showing the great difference in the amount of estimates required for the support of the British and French armies. He (Col. Sykes) expressed his opinion that economy would be secured in a much greater degree if the Government, instead of manufacturing themselves the *matériel* required for use in the army and navy, would intrust it to contractors. He had been hoping that the contrast between the expenditure on the French army and that on our own could have been satisfactorily explained, and that the French army was only one-half of our own. The details could not be gainsaid. Then, again, when a certain total sum was granted, there was the greatest possible vigilance exercised to insure that the sums appropriated to various purposes were actually spent in the department to which they were originally intended to be applied, or that they were clearly accounted or if not required. He had received a communication from a friend of his own of high position and fully acquainted with military matters, who, after making inquiries in the proper quarters, was of opinion that the administration of French military affairs was in a very healthy state indeed, and had exercised a most beneficial influence on the political condition of the country. No Englishman would for a moment begrudge the proper means of securing the respectability, the gentlemanly bearing, the self respect of the common soldier even, but Englishmen did wish that, whatever public money was given for that purpose, should be devoted in the most economical manner to the purposes for which it was given. It was what the people of England had a right to expect; and his object in calling attention to those comparisons was that all those things might be looked into, and that, in future, there would be less cause for the army and navy to absorb nearly one-half of the taxes of the country.

RESEARCHES ON THE MOON.—BY PROF. PHILLIPS.

The author having on previous occasions presented his views as to the methods and objects of research in the moon, was desirous now to state a few results, and exhibit a few drawings, the fruit of recent examinations of the moon by means of a new equatorial by Cooke, with an object-glass of 6 inches. In sketching ring mountains, such as Theophilus and Posidonius, the author has been greatly interested by the changes of aspect which even a small alteration in the angles of elevation and azimuth respectively produce in the shadows and lights. Taking an example from Cyrillus, with its rocky interior, and fixing attention on the nearly central mountain, it always appears in the morning light to have two principal unperforated masses. By a slight change in the direction of the light, the division of these masses is deeply shaded on the north or deeply shaded on the south, and the figure of the masses, *i. e.*, the limit of light and shade, seems altered. A slight change in the angle of elevation of the incident light makes more remarkable differences. On Posidonius, which is a low, nearly level plateau, within moderately raised borders, the mid-morning light shows with beautiful distinctness the shield-like disc of the mountain, with narrow broken walls, and in the interior, broad, easy undulation one large and several smaller craters. In earlier morning more craters appear and the interior ridges gather to form a broken terrace subordinate to the principal ridge. This circumstance of an interior broken terrace, under the high main ring of mountain, is very frequent, but it is often concealed by the shadow of the great ridge in early morning shadows. To see it emerge into half-lights, and finally to distinct digitations and variously directed ridges, as the light falls at increasing angles, is a very beautiful sight. But it is chiefly to the variations in the central masses of lunar mountains and their physical bearings that the author wishes to direct attention. Many smaller mountains are simply like cups set in saucers, while others contain only one central or several dispersed cups. In Plato is a nearly central very small cup, bright, and giving a distinct shadow on the grey ground, as seen by Mr. Lockyer, Mr. Birt, and Prof. Phillips himself. But in the centre of many of the larger mountains, as Copernicus, Gassendi and Theophilus, is a large mass of broken rocky country, 5,000 or 6,000 feet high, with buttresses passing off into collateral ridges, or an undulated surface of low ridges and hollows. The most remarkable object of this kind which the author has yet observed with attention is in Theophilus, of which mountain two drawings are given, in which the author places equal confidence, except that the latter drawing may have the advantage of more experience. The central mass is seen under powers of 200—400 (the best performance is from 200 to 300), and appears as a large conical mass of rocks about fifteen miles in diameter, and divided by deep chasms radiating from the centre. The rock-masses between these deep clefts are bright and shining, the clefts widen towards the centre, the eastern side is more diversified than the western, and like the southern side has long excurrent buttresses. *As the light grows on the mountain, point after point of the mass on the* eastern side comes out of the shade, and the whole figure resembles an uplifted mass which broke with radiating cracks in the act of elevation. Excepting in steepness, this resembles the theoretical Mont d'Or of De Beaumont; and as there is no mark of cups or craters in this mass of broken ground the author is disposed to regard its origin as really due to the displacement of a solidified part of the moon's crust. He might be justified by Prof. Secchi's drawing of Copernicus, in inquiring if the low excurrent buttresses may indicate issues of lava on the southern and western sides? On the whole, the author is confirmed in the opinion he has elsewhere expressed, that on the moon's face are features more strongly marked than on our own globe, which, rightly studied, may lead to a knowledge of volcanic action under grander and simpler conditions than have prevailed on the earth during the period of subaërial volcanoes. The author also exhibited a drawing of Aristarchus, showing some undescribed features in the aspect of that, the highest part of the moon's surface.

'On some Phenomena produced by the refractive power of the Eye,' by Mr. A. Claudet.—This paper was to explain several effects of the refraction through the eye, one of which is, that objects situated a little behind us, are seen as if they were on a straight line from right to left. Another, that the pictures of external objects which are represented on the retina, are included in an angle much larger than one-half of the sphere at the centre of which the observer is placed; from this point of view a single glance encompasses a vast and splendid panorama extending to an angle of 200°. This is the result of the common law of refraction. All the rays of light passing through the cornea, to the chrystalline lens are more and more refracted in proportion to the angle at which they strike the spherical surface of the cornea. Consequently, the only objects which are seen in their true position are those entering the eye in the direction of the optic axis. By this refraction the rays which enter the eye at an angle of 90°, are bent at 10°, and appear to come from an angle of 80°. This phenomenon produces a very curious illusion. When we are lighted by the sun, the moon, or any other light, if we endeavour to place ourselves in a line with the light and the shadow of our body, we are surprised to find that the light and the shadow seem not to be connected at all, and that, instead of being in a line, they appear bent to an angle of 160° instead of 180°, so that we see both the light and the shadow a little before us, where they are not expected to be. The eye refracts the line formed by the ray of light, and the shadow and the effect is like that of the stick, one half of which being immersed in water, appears crooked or bent into an angle at the point of immersion. This enlargement of the field of vision to an angle of 200°, is one of those innumerable and wonderful resources of nature by which the beauty of the effect is increased. Our attention is called to the various parts of the panorama which appear in any way a desirable point of observation, and we are warned of any danger from objects coming to us in the most oblique direction. These advantages are particularly felt in our crowded towns, where we are obliged to be constantly on the look out for all that is passing around us.

On the Cultivation of Cinchona in India," by Mr. C. R. Markham.

Dr. Thompson said it was those only who knew how rapidly the supply of quinine from Chili and South America was being exhausted that could know how inestimable was the work which the paper described. The experiments which had been made had shown, not only that the plant might be grown in other countries, but that the bark of the young tree yielded a much larger proportion of quinine than that of the old. The good which would result from carrying the cultivation of the plant into new fields was immense; for while the application of quinine was extending, many of the hospitals had had to restrict its use on account of the expense; and the result of the recent discoveries would be that physicians, when prescribing bark alone, would give the preference to young bark.

On the Reason why the Stomach is not Digested by its own Secretion during Life, by Dr. Pavy.—How is it (he observed) that the stomach, composed as it is of digestible materials, escapes being digested itself, whilst digestion is being carried on in its interior? The question here raised must be admitted to be one of the utmost interest and importance to us all, because it touches upon the means by which we escape after every meal we consume from the occurrence of an event which would inevitably prove fatal to life. Hunter noticed that the stomach was susceptible of being attacked by the digestive liquid after death, and accounted for its power of resisting destruction during life by reference to the 'living principle.' The stomach, he says, which at one instant, that is, while possessed of the living principle, was capable of resisting the digestive powers which it contained, the next moment, namely, when deprived of the living principle, is itself capable of being digested. In illustration, he further says, "if it were possible for a man's hand to be introduced into the stomach of a living animal, and kept there for some considerable time, it would be found that the dissolvent powers of the stomach could have no effect upon it; but if the same hand were separated from the body and introduced into the same stomach, we should then find that the stomach would immediately act upon it" This statement, however, fails to stand the test of actual experience. Bernard, of Paris, ingeniously contrived to introduce the hind legs of a living frog through a fistulous opening in the interior of a digesting stomach, and found that they underwent digestion, notwithstanding that the life of the animal was maintained. My own experience enables me to testify to the accuracy of this result; and further, I have found that the tip of a living rabbit's ear has similarly yielded to the influence of the digestive menstruum. The "living principle" must, therefore, be discarded, as insufficient to account for the state of security under which the living stomach exists. To replace the refuted influence of the "living principle," it has been suggested that it is the epithelial lining which gives to the stomach the immunity from destruction it enjoys during life. The stomach, it has been said, is lined with an epithelial layer, and this, with the mucus secreted, acts as a kind of varnish in protecting the deeper parts. Whilst digestion is proceeding, the epithelium and mucus are constantly being dissolved, like the food contained in the stomach; but a fresh supply being as constantly produced, the organ is thereby maintained intact. Death taking place, and the epithelial layer being no longer produced, the gastric juice, after acting upon and dissolving it, reaches the deeper coats, and then, continuing to exert its influence, may ultimately, the temperature being maintained sufficiently favourable for the purpose, occasion a perforation of the organ. This view, however, like Hunter's "living principle," fails to stand when submitted to the test of experiment; for I have found that a considerable sized patch of mucous membrane may be removed, and food will afterwards be digested without the slightest sign of attack being made upon the deeper coats of the organ. Indeed, it might almost be assumed upon reflection, that something more constant—that some condition presenting less exposure to the chance of being influenced by external circumstances than that supplied by the existence of an epithelial layer, would be required to account for that unfailing security from *ante mortem* solution which the stomach appears to enjoy. From the articles swallowed, abrasion of the mucous membrance may be presumed to have been not unfrequently produced, and ulceration is not of so uncommon an occurrence; yet perforation has not been observed as the necessary result. The problem, therefore, as to why the stomach is not susceptible of attack during life as it is after death, still remains open for solution; and the view that I have to offer refers the immunity observed to the circulation within the walls of the organ of an alkaline current of blood. It will not be disputed that the presence of acidity is one of the necessary circumstances for the accomplishment of gastric digestion. Now, alkalinity is a constant character of the blood, and, as during life, the walls of the stomach are everywhere permeated by a current of this alkaline blood, we have here an opposing influence, the effect of which would be to destroy, by neutralizing its acidity, the solvent properties of the digestive fluid tending to penetrate and act upon the texture of the organ. The blood being stagnant after death, the opposing influence is lost that is offered by the circulating current. Should life happen to be cut short at a period of digestion, there is only the neutralizing power of the blood actually contained in the vessels of the stomach, to impede the progress of attack upon the organ itself; and the consequence is, that digestion of its parietes proceeds. as long as the temperature remains favourable for the process, and the solvent power of the digestive liquid is unexhausted. There is, therefore, no want of harmony between the effect that occurs after death and the explanation that refers the protection afforded during life to the neutralizing influence of the circulation. In support of this view I have found, experimentally, that by arresting the flow of blood through the stomach during life, the organ is placed in the same condition as it is after death: having lost its protecting influence, digestion of its texture now proceeds. It will be naturally required of me to reconcile the view advanced, with the effect that is noticed when the living frog's legs and rabbit's ears were introduced through a fistulous opening into the digesting stomach. If the circulation, through its neutralizing power, protect the stomach, why should it not have afforded equal protection to the tissues of the living animals introduced through a fistulous opening into the organ? According to the proposition offered, the result is involved in a question of degree of power between two opposing influences. And because through degree of vascularity the neutralizing power of the circulation is sufficient to hold in check the solvent action of the gastric juice in the case of the walls of the stomach, it does not follow that it should similarly be sufficient to do so in the case of the frog's legs and rabbit's ears. With the frog it may be fairly taken that the amount of blood possessed by the animal would be totally inadequate to furnish the required means of resistance to the influence of the acidity of a dog's gastric juice. With the rabbit's ears the vascularity is so much less than that of the walls of the stomach that there is nothing incomprehensible in the fact of the one yielding to, and the other resisting the attack. In support of the position that has been taken, it can be shown by experiment that even with the stomach itself, by increasing the acidity of its contents beyond a certain point, its circulation is no longer adequate to enable it to resist digestion.

ENTOMOLOGICAL SOCIETY OF CANADA.

The ordinary monthly meeting of the society was held in the Council-room of the Canadian Institute, on Tuesday, the 8th December, at three o'clock, p.m Nearly all the members from Toronto and the vicinity were present.

In the absence of Prof Croft and Mr. Saunders, Dr. Morris was called to the chair, and Mr. Hubbert appointed secretary, *pro. tem.* The minutes of the previous meeting were read and confirmed.

Communications were received from

Professor Hincks, expressing regret at his inability to attend, in consequence of indisposition;

F. Grant, Esq , and R. V. Rogers, Esq., on business connected with the society.

The following gentlemen were proposed as suitable persons to become members of this society:

The Rev. H. P. Hope, Toronto.
Rice Lewis, Esq., "
James Wright, Esq , Vienna.

The following donations were acknowledged, and the thanks of the society voted to the donors:

From Prof. Croft—
A cabinet of seven drawers.

To the Library:

From the Smithsonian Institution—
Monographs of the Diptera of North America. By H. Laen. Part I.

From the author, W. Saunders, Esq , London, C. W.—
(1) Monograph of the Arctiadæ of Canada. 20 copies.
(2) Description of two new species of Arctia.
(3) "On some hitherto undescribed Lepidopterous larvæ."

From A. L. Packard, Jun , Esq , Cambridge, Mass., through Principal Dawson—
Photographs of the following undescribed Bombyces: Crambuda pallida, Callimorpha vesta, Callochlora chlorata, Cyrtosia albopunctata ♂ and ♀, Entortricallis testacea, Cyrtosia geminata, Cilodasys cinereafrons, Laphodonta ferruginea, Gluphisia trilineata ♂ and ♀, Platycorura furcilla, Cilodasys biguttata, and Edapleuza bilineata.

From James Hubbert, Esq., B.A.—
Popular Entomology. By Maria E. Catlow.
British Butterflies. By W. S. Coleman.

To the Cabinet:

From Prof. Croft—
48 Specimens, including 27 species of Chinese Lepidoptera.
164 " " 61 " Coleoptera.

From B. R. Morris, Esq., B.A., M.D.—

47 Specimens, including 16 species of Coleoptera.

From J. H. Sangster, Esq., M.A.—

23	Specimens,	including	17	species of	Coleoptera.
6	"	"	5	"	Lepidoptera.
11	"	"	10	"	Diptera.
10	"	"	10	"	Hymenoptera.
5	"	"	4	"	Neuroptera.
4	"	"	4	"	Orthoptera.

From B. Billings, Esq., Ottawa—

236	Specimens,	including	132	species of	Coleoptera.
21	"	"	19	"	Lepidoptera.
6	"	"	5	"	Diptera.
7	"	"	5	"	Orthoptera.
3	"	"	2	"	Strepsiptera.
3	"	"	3	"	Hemiptera.

From James Hubbert, Esq., B.A.—

251	Specimens,	including	176	species of	Coleoptera.
63	"	"	25	"	Lepidoptera.
49	"	"	40	"	Diptera.
38	"	"	27	"	Hymenoptera.
12	"	"	10	"	Orthoptera.
12	"	"	8	"	Neuroptera.
15	"	"	10	"	Hemiptera.

From Thomas Reynolds, Esq., Montreal—

13	Specimens,	including	8	species of	Coleoptera.
154	"	"	53	"	Lepidoptera.
1	"	"	1	"	Diptera.
9	"	"	6	"	Hymenoptera.
2	"	"	1	"	Hemiptera.

From Wm. Saunders, Esq., London—

345	Specimens,	including	121	species of	Coleoptera.
111	"	"	37	"	Lepidoptera.
1	"	"	1	"	Diptera.
8	"	"	5	"	Neuroptera.
4	"	"	1	"	Strepsiptera.

A communication was read from Mr. Saunders, regarding the practicability of publishing a catalogue of the known Canadian species of each order of insects. After considerable discussion as to the best form, &c.,—

It was moved and seconded,—That the society take immediate steps to prepare and publish catalogues of the Coleoptera and Lepidoptera, to be followed by similar catalogues of the other orders as soon as possible; and that Mr. Saunders, Prof. Croft, and Mr. Billings, be a committee on Coleoptera; and Prof. Hincks, Mr. Saunders, and Dr. Morris, on Lepidoptera.—Carried.

The committee are very anxious to secure the co-operation of all persons having either named collections or lists of species. Any informat which would aid in bringing out full and accurate catalogues, should be communicated without delay to Mr. Saunders or Prof. Hincks.

Moved and seconded,—That a supply of entomological pins and sheet cork, for lining cabinets, be kept on hand, to be furnished to members at the lowest cost prices.—Carried

It is intended ultimately to keep all the apparatus required in capturing and preserving insects.

Moved and seconded,—That the Rev. Charles Bethune, B.A., be requested to use influence to advance the interests of this society among Naturalists in Great Britain.—Carried.

A verbal communication was made by Dr. Morris, on insects captured in the vicinity of Orillia, during the summer of 1863. Among the interesting specimens exhibited by Dr. Morris, were several examples of *Colias edusa*, so seldom met with in Canada,—only two or three individuals having been taken as yet. Dr. Morris remarked that this insect seems to differ from the *C. edusa* of British Naturalists, in its habits of flight, &c., which seems to indicate either a distinct species or very wide variations.

Both sexes of *Terias lesa*, also very rare in Canada, had been captured.

A species of *Anhenodes*, taken by Mr. F. Grant, of Orillia, was also exhibited. The general appearance of the insect closely resembled that of *A. septentrionis*, of which it is probably a variety. The form of the rostrum is so peculiar, as to lead Dr. Morris to think that possibly there may be two species with us.

The following papers were presented by Mr. Hubbert :

(1) Notes on insects captured near Kingston. 1863.

(2) What the insects do in January.

The meeting then adjourned

CANADIAN INSTITUTE.

ANNUAL REPORT OF THE COUNCIL FOR THE YEAR 1863.

The Council of the Canadian Institute have the honour to present the following Report of the Proceedings of the Society for the past year:

I.—Membership.

The present state of the membership is as follows:

Members at commencement of Session—December, 1862	447	
New Members elected during Session 1862–63	18	
By the Council during the recess of 1863	3	
		468
Deduct—Deaths	3	
Withdrawn	16	
Left the Province	3	
Non-payment	1	
		23
Total—30th November, 1863		445

Composed of—Honorary Members	4
Life Members	32
Corresponding Members	6
Junior Members	3
Ordinary Members	400
Total	445

The Council have to deplore the loss, during the past year, of Sir John Beverley Robinson, Bart. The active interest which he evinced in the prosperity of the Institute, and the valuable services which he rendered to it, will long be held in grateful recollection. Death has also removed Mr. Justice Connor and John Hutchinson, Esq., who, although they did not take part in the proceedings of the Society, yet lent their aid in promoting its welfare.

II.—Communications.

The following list of papers, read at the ordinary meetings held during the session, will be found to contain many valuable communications, and some of general interest:

13th December, 1862.

Rev. Prof. Hincks, F.L.S., &c., "On certain Vegetable Monstrosities considered in reference to the question of the reality and permanence of Species amongst organized beings."

P. Freeland, Esq., exhibited and described Smith and Beck's New Universal Microscope.

20th December, 1862.

Prof. H. Y. Hind, M.A., F.G.S., &c., "On Vegetable Parchment, its uses and preparations."

10th January, 1863.

The Rev. J. McCaul, LL.D., read the "Annual Address."

17th January, 1863.

Prof. D. Wilson, LL.D., "On the Characteristics of the Flint Implements of the Drift as compared with those of a later Stone Period."

John Martin, Esq., LL.D., "On some General Properties of Curves."

24th January, 1863.

A. E. Williamson, Esq., "A proposed Classification of the Genus Helix."

Professor J. B. Cherriman, M.A., (1) "Remarks on Comets." (2) "On Poinsot's memoir on Rotation."

31st January, 1863.

No papers.—Death of the late Chief Justice Robinson.

7th February, 1863.

Prof. G. T. Kingston, M.A., "Meteorological Report of 1862."

James Hubbert, Esq., "On the Fungi"

B. R. Morris, M.D., "On the Natural Checks to the Destruction of our Crops by Insects."

14th February, 1863.

Prof. G. T. Kingston, M.A., "On the Disturbance of Magnetical Declination at Toronto, during the years 1855–1862, inclusive."

Prof. D. Wilson, LL.D., "Relative to a new kind of Cannon which was described to him on his recent visit to Washington."

21st February, 1863.

U. Ogden, Esq., M.D., "On Chloroform and its effects."

T. J. Cottle, Esq., "On a new Species of Astacus,"

28th February, 1863.

Sandford Fleming, Esq., C.E., "On the present condition of the Enniskillen Oil Wells."

The Rev. Prof. Hincks, F.L.S., &c., "On the position and relations of certain families of Birds."

W. Saunders, Esq., "Catalogue of Plants found near London, C. W.,"

7th March, 1863.

Prof. D. Wilson, LL.D., "Notes of a recent Visit to the Mortonian Collection of the Academy of Natural Sciences of Philadelphia."

14th March, 1863.

Professor Hind, M.A., F.G.S., "On the Masquapees."

28th March, 1863.

P. Freeland Esq., "On the Measurement of Microscopic Objects."

The President, the Rev. J. McCaul, LL.D., "On the determination of Ancient Roman dates"

J. Bovell, Esq., M.D., "On Growth and Repair."

11th April, 1863.

Prof. E. J. Chapman, Ph.D., "On a Specimen of Carbonaceous matter from Lake Superior, with remarks on the Origin of the Petroleum, as applied more particularly to the Oil District of Western Canada, and some new views on the general formation of Coal."

18th April, 1863.

Rev. H. Scadding, D.D., "On Phonetic Anomalies observed in some modern forms of ancient proper names."

Rev. Prof. G. P. Young, M.A., "Formulæ for the cosines and sines of multiple arcs."

W. Saunders, Esq, "On Canadian Arctiadæ."

25th April, 1863.

Sandford Fleming Esq., C.E, "Notes on projected Canadian Canals to connect the Upper Lakes with the St. Lawrence."

The increase in the number of original papers and of contributors is a gratifying feature of the year. The number of our active members is still, however, too limited, and further cooperation is earnestly invited.

III.—Report of Editing Committee of the Journal.

"Your Committee have little to report on this occasion, beyond stating the fact of the completion of the Eighth Volume of the *Journal*, and expressing the hope that its usefulness has not been deteriorated below its predecessors. The general plan of the publication has in no respect been changed, although a larger number than usual of original communications has this year entered into it, and it is thus acquiring more and more the character which the Institute designed it to bear, namely, a record of the proceedings of the Society. No less than *twenty-six* such communications have been given, all of them bearing more or less closely on scientific or literary progress in connection with the Province. In addition to these, several translations of important articles from foreign sources, not otherwise accessible to the English readers, have been furnished, as well as Reviews on subjects of prominent interest, which may fairly claim for the most part to be considered as essays on those subjects of independent value. The Committee desire to express their obligations to Mrs. M. M. Kingsford and S. Kingsford, Esq., for valuable aid in this department. It was deemed advisable to curtail the space allotted to miscellaneous intelligence, or extracts from other journals, in order not to increase the cost of the *Journal* beyond its usual limit. In view of the reduction of the Government Grant to the Institute, of the withdrawal of the order for the supply of copies of the *Journal* to the Parliamentary Library Committee, and of the necessity that has otherwise arisen for economy in the affairs of the Institute, it is proposed to reduce the issue of the *Journal* to 500 copies, which will be sufficient for present need, and will leave a margin for future wants. The cost of publication of the *Journal* has amounted to $1348.

"All which is respectfully submitted.

"J. B. CHERRIMAN, *General Editor.*"

The Council have much satisfaction in noticing that the *Journal* continues its high reputation as a Scientific and Literary Periodical.

IV.—REPORT OF TREASURER.

Statement of the Canadian Institute General Account, for the Year 1862–63, *from* 1*st December*, 1862, *to* 30*th November*, 1863:

DR.		£	s.	d.
Cash—Balance last year		389	13	1
" Received from members		163	10	0
" " for Journals		49	11	10½
" " for Interest and Rent		91	10	8
" " due by Members		455	16	3
" " due for old Journal	£28 11 8			
" " due for new Journal	55 1 3	83	12	6
" Parliamentary Grant (not received)		187	10	0
		£1421	4	4½

CR.	*Cash paid on account of Journal.*	£	s.	d.
Cash paid on account of Journal in the year 1862	£53 18 1			
" " " " 1863	197 7 0½	251	5	1½
" " for Library and Museum		61	9	9
" " on account of sundries		222	1	8
" " due on account of Journal for the year 1863		62	0	0
" " due on account of Sundries		38	8	4
" " due on account of Library		8	0	0
Estimated Balance		777	19	6
		£1421	4	4½

The Treasurer in account with the Canadian Institute, for the Year 1862–63, *from* 1*st December*, 1862, *to* 30*th November*, 1863:

DR.	£	s.	d.
Cash—Balance last year	389	13	1
" Interest received on Securities	64	16	8
" Received from Members	163	10	0
" " on account of Journal	49	11	10½
" " for Rent	26	14	0
" Securities paid	150	0	0
" " "	75	0	0
" " "	500	0	0
" Securities held	775	0	0
	£2194	5	7½

Cr.	*Cash paid on account of Journal.*					
Cash paid for Journal for the year 1852	£53	18	1	251	5	1½
" " " 1863	197	7	0½			
" paid on account of Library and Museum				61	9	9
" paid on account of Sundries				222	1	8
" paid for Lot and Conveyance				662	10	0
Securities				775	0	0
Balance in Bank				221	19	1
				£2194	5	7½

Statement of the Building Fund.

Balance from last year	2140	1	9
Received Interest on Loans	64	16	8
" Rent	26	14	0
Subscriptions (uncollected)	534	15	0
	£2766	7	5
Cash paid for Lot and Conveyance	662	10	0
Balance	2103	17	5
	£2766	7	5

D. Crawford, *Treasurer.*

V.—Report of Auditors.

Toronto, 12th December, 1863.

Compared the vouchers with the cash-book. Balance due by Treasurer, £221 19s. 1d. [Two hundred and twenty-one pounds nineteen shillings and one penny.]

Sam. Spreull, } *Auditors.*
G. H. Wilson, }

VI.—Report of Librarian.

The additions to the Library of the Institute during the year 1863, have not been very numerous. They consist principally of the Reports and Transactions received from the Scientific Societies of Europe and the United States.

In addition to its own publications, the Smithsonian Institution has transmitted valuable reports from the Royal Dublin Society, and from several German and Scandinavian Scientific Associations.

From the Hon. J. M. Broadhead, of Washington, have been received eight official reports on Statistics, &c. Through Professor Hincks, fourteen volumes (in parts) of the Linnean Society's Journal have been presented.

The fourth volume of Agassiz's Contributions to the Natural History of the United States,—the gift of the late Sir John Beverley Robinson,—has arrived, rendering the work, so far as published, complete.

The Scientific Reports comprise thirty-four bound volumes, forty-five unbound volumes, and about sixty-seven pamphlets.

Ten sheets (all published) of a very valuable Ethnological Map of Finmark have been transmitted by the Smithsonian Institution. A Chart of Lake Ontario has been presented by Mr. Chewett Mr Bohn has sent—through Messrs. Rollo and Adam—the three latest additions to his interesting series of Libraries. A copy of the Statutes of Canada for 1863, has been received from the Record Office, Quebec.—These works, amounting in all to a little over one hundred and fifty, constitute the donations of the year.

The additions to the Library by purchase during the same period have been comparatively few. In view of the proposed commencement of a building by the Institute, economy in this, as in every other direction, seemed desirable. The volumes purchased amount to only eighteen. These include four volumes in continuation of series in course of publication, viz., three volumes of Bacon's Works, the third volume of Carlyle's Life of Frederick II., the third volume of Smiles' Lives of the Engineers, and the second volume of May's Constitutional History of England.

Detailed lists of all books, pamphlets, and maps received, are appended below.

About seventy volumes belonging to the Library are out on loan: many of them since 1861; some ten of them since 1858. Members when applied to by circular on the subject of these loans, do not in every instance respond. It seems desirable that there should be a return of all borrowed books at least once a year.

In regard to ordering books, it is important that in every instance the title of the work should be entered first in the order-book of the Institute: there is otherwise a danger of duplicates arriving to the address of the Institute. It is also important that every volume should be entered in the Librarian's Catalogue before passing into the hands of members.

The present Library is becoming somewhat over-crowded; but some space has been gained by placing two rows on one shelf, where the size of the volumes admitted of that arrangement.

H Scadding,
Librarian Canadian Institute.

Toronto, Dec. 5th, 1863.

VII—Report of Building Committee.

In the spring of the year, the Society purchased an eligible lot of land as a site for a building, in which the business of the Institute might be satisfactorily conducted, and designs were submitted and approved. The following report states the causes which prevented the Building Committee from carrying out the intention of the Society. The plans, which have been adopted, provide ample and convenient accommodation, and the Council trust that the funds of the Institute may soon be sufficient to warrant the commencement either of the projected building or of one on a smaller scale.

REPORT.

"The Building Committee report that the tenders which they received for the building, so far exceed the expectation of the Council and the means at the disposal of the Institute, that they have deemed it necessary to bring the whole subject again under the consideration of the Council.

"The amount of the lowest tender sent in for the carpenters' and masons department, was $9,924.00; and the only reductions which the architect suggested, amounted to $1,319.00,—leaving $8,605.00 as the cost of the building. But to this must be added the necessary expenditure on light, heating, and fencing, which would be about $1,200; so that the minimum cost may be assumed at about $10,000,—being so far in excess of available funds that the Committee did not feel warranted in undertaking the building.

"JOHN MCCAUL, *Chairman*."

VIII.—MEDICAL SECTION.

During the past year, a section for the cultivation of Medical Science was formed. Its meetings have been regularly held, and much valuable information has been communicated in the papers which have been read, and in the discussions which have arisen.

REPORT.

Since the organization of this section, on the 1st of April last, six regular meetings have been held, at which the following papers were read by the respective authors, viz:

1. "On the treatment of Asthma by Acetic Acid" .. ... Dr. C. B. Hall.
2. "On Hybridity" .... Dr. Barrett.
3. "On Food" .... Dr. Thorburn.
4. "On Hip Joint disease"...... .... Dr Clarke.
5. "On the law of the continuous development of Cells".. Dr. O'Dea.
6. "On the Yellow Spot of Sœmmering".... .... Dr. Barrett.

UZZIEL OGDEN, *Chairman*.

Toronto, December 12th, 1863.

IX.—THE ENTOMOLOGICAL SOCIETY OF CANADA.

This Society, which holds its meetings in the rooms of the Institute, was also formed during the past year, for the encouragement of the study of the important branch of Natural History, from which it derives its name. Its progress is a satisfactory earnest of its future success.

REPORT.

The following are a few of the points of interest connected with our Entomological Society.—The first meeting was held on Thursday, the 16th of April. As the summer vacation has occupied most of the intervening time only two other meetings have yet been held. The Society numbers thirty-six members, all of whom are actual working Entomologists. Eight papers have been read; and several valuable contributions to the Library have been received. The donations to the Reference Cabinet, which is the property of the Institute, comprise-

235	Species of	Coleoptera.
76	"	Lepidoptera.
43	"	Diptera.
35	"	Hymenoptera.
8	"	Orthoptera.
8	"	Neuroptera.
18	"	Hemiptera.
2	"	Strepsiptera.

Duplicates of many of these have been received, swelling the whole number received to 1480 specimens. Most of these duplicates will be used for effecting exchanges, and thus will ultimately go to increase the collection in the reference cabinet.

JAMES HUBBERT,
Curator.

The Council, in conclusion, desire to express their regret, that the Institute was deprived, during the latter part of the year, of the valuable assistance of their Recording Secretary, Patrick Freeland, Esq. Serious illness compelled him to resign the office, which he had so efficiently occupied. The Council sincerely trust that restored health may permit him again to take part in the Society's proceedings. The duties of the vacant office were kindly undertaken by the Corresponding Secretary, Dr. Morris.

JOHN McCAUL,
President.

APPENDIX.

DONATIONS OF BOOKS, MAPS, &c., SINCE LAST ANNUAL REPORT.

Those marked thus * are not bound.

From the Vermont State Library, Montpelier, Vermont, U. S. VOLS.

The Geology of Vermont, &c. Vols. 1 and 2. By Ed. Hitchcock, LL D.; Ed. Hitchcock, Jr., M.D.; Albert D. Hager, A.M.; and C. H. Hitchcock, A.M. 2

From the Hon. J. M. Brodhead, Washington.

Patent Office Reports. Agriculture. 1861 1

Preliminary Report, Eighth Census, 1860, United States. By Joseph C. G. Kennedy, Superintendent 1

Annual Report of the Board of Regents of the Smithsonian Institution, for the year 1861 1

Results of Meteorological Observations made under the direction of the United States Patent Office and the Smithsonian Institution, from the year 1854 to 1859, inclusive. A Report of the Commissioner of Patents, 1st Session, 36th Congress. Vol. 1. Washington, 1861 1

Fourth Meteorological Report of Prof. J. P. Espey. Washington, 1854.... 1

	VOLS
Report on the Art of War in Europe, in 1854, 1855, and 1856. By Major Richard Delafield, Corps of Engineers. Washington, 1860	1
Military Commission to Europe, 1855 and 1856. Report of Major Alfred Mordecai, Ordnance Department. Washington, 1860	1
The Commercial Relations of the United States with Foreign Nations, for the year ending September 30th, 1861. Washington, 1862	1

From the National Association for the Promotion of Social Science, per the Hon. G. W. Allan, M.L.C.

Transactions of the National Association for the Promotion of Social Science, 1860 and 1861	2

From the Hon. Sir J. B. Robinson, Bart.

Contributions to the Natural History of the United States. By Louis Agassiz. Vol. 4	1

Presented by the Author.

Britanno-Roman Inscriptions. By the Rev. John McCaul, LL.D., Pres. Univ. College, Toronto..	1

From the Government of India.

Magnetical and Meteorological Observations made at Bombay in 1860	1

From the respective Societies.

Transactions of the Royal Irish Academy. Vol. 24.—Part II. Science	1*
Proceedings of the Literary and Philosophical Society of Liverpool, 51st Session. 1861-62. No. 16	1*
Transactions of the Royal Society of Edinburgh. 1857-58. Vol. 22. Part I.	1*
" " " " 1558-59. Vol. 23. Part I.	1*

From the University of Norway.

Recherches sur la Syphilis Appuyées de Tableaux de Statistique Tirés des Archives des Hôpiteaux de Christiania. Par W. Boeck, &c. 1862....	1*
Ten Maps..	10
Die Culturpflanzen Norwegens Beobachet Von Dr. F. C. Schubeler. 1862..	1*
Geologiske Undersogelser i Bergens omegn af Th. Hiortdahl og M. Irgens. 1862	1*
Beskrivelse over Lophogaster Typicus, &c., af Dr. Michael Sars	1*
Forhandlinger Videnskabs—Selskabet i Christiania. Aar, 1861	1*
Meteorologische Beobachtungen Aufgezeichnet auf Christiania's Observatorium. Lieferung I. and II	1*
Generalberetning fra Gustad Sindssygeasyl for Aaret 1861	1*
Beretning om Bodsfaengflets Virksomhed i Aaret, 1859..................	1*

From Smithsonian Institution—supposed from Society.

Verhandlungen der k. k. Zoolog.-botanischen Gesellschaft in Wien Jahrgang, 1861	1*
Nachtrage zu Maly's Enumeratio plantarum phanerogamicarum imperii Austriaci Universi. Von August Neibreich. Wein, 1861	1*
Bericht über die Thätigkeit der St. Gallischen naturwissenschaftlichen Gessellschaft Währerd des Vereinsjahres. 1861-62. (Redaktor. Prof. Dr Wartman) St. Gallen, 1862	1*

From the Royal Dublin Society, per Smithsonian Institution,	VOLS
Journal of the Royal Dublin Society—January and April, 1861	1*
" " " July and October "	1*
" " " January, 1862	1*
" " " April "	1*
From the State of Wisconsin, U. S., per Smithsonian Institution.	
The Geology of Wisconsin. Vol. 1. Hall and Whitney, 1862............	1
From the United States Patent Office, Washington	
Patent Office Reports, 1860. Vol. 1. Mechanics	1
" " " Vol. 2. "	1
" " 1861. Agriculture	1
From Dr. Oldham, Superintendent of the Geological Survey, India.	
Memoirs of the Geological Survey of India. Vol. 4, Part 1..............	1*
Annual Report of do. do. do. for 1861–62	1*
Memoirs of the Geological Survey of India—Palæontologia Indica—2. 1. The Fossil Flora—Rajmahal Hills	1*
Do. do. do 2. 2.	1*
From the Office of Routine and Record.	
The Statutes of Canada, for 1863	1*
From W. C. Chewett & Co., Toronto.	
Chart of Lake Ontario	1
From H. G. Bohn, Esq., London.	
The Historical Works of Giraldus Cambrensis Revised. By Thos. Wright. 1863	1
Demosthenes' Miscellaneous Orations, with Index...........	1
Lownde's Bibliographer's Manual. Vol. 4, Part 2	1
From Vienna, through the Smithsonian Inst .ution.	
Mittheilungen der Kaiserlich—Königlichen Geographischen Gesellschaft,	
I. Jahrgang, 1857. Heft 1..	1*
I. do. " " 2..	1*
II. do. 1858. " 1..	1*
II. do. " " 2..	1*
II. do. " " 3..	1*
III. do 1859. " 1..	1*
III. do. " " 2..	1*
III. do. " " 3..	1*
IV. do. 1862	1*
From Leonard Scott & Co., New York.	
Reviews—Westminster, Edinburgh, London, North British, and Quarterly; and Blackwood, monthly. Each one set	1
From B. Quaritch, London.	
Catalogue Raisonneé of Rare and Valuable Books, 1863......	12

DONATIONS OF PAMPHLETS, SHEETS, &c.

From J. Hall, Albany, New York.	VOLS
Fifteenth Annual Report of the Regents of the University of the State of New York, on the condition of the State Cabinet of Natural History and the Historical and Antiquarian Collection annexed thereto. Apl. 12th, 1862	5
Contributions to Palæontology. By James Hall	5
Notice of some New Species of Fossils from a locality of the Niagara Groupe, in Indiana, with a list of Identified Species from the same place. By J. Hall	1
From Harvard College, U. S.	
Report of the Committee of the Overseers of Harvard College, appointed to visit the Library, for the year 1862, &c.	1
From J. W. Dawson, LL D., F.G.S., &c. (the author.)	
On the Flora of the Devonian Period, in North Eastern America	1
Air Breathers of the Coal Period, Nova Scotia	1
From Samuel Spreull, Esq., Toronto.	
On Ribs and Transverse Processes, with special relation to the theory of the Vertebrate Skeleton. By J. Cleland, M.D	1
On the relations of the Vomer, Ethnoid, and Intermaxmillary Bones. By J. Cleland, M.D	1
From the Linnæan Society, London, per Rev. W. Hincks.	PARTS
Botany—Vol 1. Nos. 1—4	4*
" 2. 5—8	4*
" 3. 9—12	4*
" 4. 13—16	4*
" 5. 17—20	4*
" 6. 21—24	4*
" 7. 25, 26	2*
Supplement to Botany. Nos. 1 and 2. Vol. 1	2*
" " Vol. 4	1*
" " " 5	1*
Second Supplement to Botany. Vol. 5	1*
Zoology—Vol. 1. Nos. 1—4	4*
" 2. 5—8	4*
" 3 9—12	4*
" 4. 13—16	4*
" 5. 17* 17—20	5*
" 6. 21—24	4*
" 7. 25, 26	2*
The President's Address, and List of Members of Linnæan Society, for 1862	2*
From Prof. Kingston, Magnetic Observatory, Toronto.	VOLS.
Abstract of Magnetical Observations made at the Magnetic Observatory, Toronto, C. W., 1856—1862, inclusive, and parts of 1853—1855	1

From the Society. per Dr. D. Wilson. PAMPHLETS

Annals of the Botanical Society of Canada, Vol. 1, Part I., from 7th Dec., 1860, to 8th March, 1861.. 1

From S. Fleming, Esq.

Memorial of the People of Red River 1

From McGill College, Montreal.

Faculty of Medicine, 1863–1864.. 1

From T. C. Keefer, Esq.

Descriptive Catalogues, Exhibition ; London, 1862.

- Jamaica 1
- Trinidad.. 1
- Venezuela 1
- New South Wales 1
- Victoria, Australia 1
- Norway (Vegetable Productions)....... 1
- Russian Section 1
- Zollverein, Mining &c.......................... 1
- Belgium.. 1
- Paris Artistical Bronze.... 1

From E. A. Meredith, Esq., Quebec.

Report of the Board of Inspectors of Asylums, Prisons, &c., 1862 1

From T. C. Wallbridge, M. P. P.

Third Military District Rifle Association of Upper Canada Rifle Match on Barriefield Common, Pittsburgh Sept., 1863.......................... 1

Lectures on Canada. By the late Mr. Charles Bass...................... 1

Letter to the Right Hon. C. B Adderly, M. P., on the relations of England with her colonies. By Hon. Joseph Howe, Premier of Nova Scotia..... 1

Annuaire de L'Université-Laval Pour L'Année Academique, 1863, 1864 1

Copies of all Reports of any Officers of the Public Works, 9th Sept., 1863.

District Town of Kamouraska, Change of.............................. 1

Bill for protection of growing timber 1

Return for Copies of Correspondence and Papers relative to certain Bonds of Grand Trunk Railway Co... 1

Act, the City of Montreal to aid the G. T. R............................ 1

Act connected with the Peterborough and Port Hope Railway 1

Act, Stanstead Railway 1

Report of the Library of Parliament 1

The Post Office contract. Montreal Ocean Steamship Company............ 1

From the Trustees of the New York State Library, Albany.

45th Annual Report of the Trustees of the New York State Library, April 7, 1863.. 2

16th Annual Report of the Trustees of the New York State Cabinet of Natural History, &c., April 15, 1863................................ 10

76th Annual Report of the Regents of the University of the State of New York, March 4, 1863 6

In Exchange for Journal, 1863. PAMPHLETS

The Journal of the Society of Arts, 1863.................................. 1
The Journal of Education, Upper Canada (Duplicate)..................... 1
The Journal of the Franklin Institute, Philadelphia, 1863 1
The Artizan, 1863, London... 1
Silliman's American Journal. 1863 1
Canadian Naturalist and Geologist, 1863 1
Transactions of the Royal Scottish Society of Arts. Vol VI., Part I 1
Proceedings of the Academy of Natural Sciences, Philadelphia, 1863....... 1
Historical Recollections of the Essex Institute, 1863 1

Annales des Mines, &c., France.

Tome II. 4 Livraison de 1862, 6 Series.. 1
" 5 " " " 1
" 6 " " " 1
III 1 " " 1863 " 1
" 2 " " " 1
Proceedings of the Boston Natural History Society 1
The Canadian Agriculturist, Upper Canada, 1863 1
Journal of the Board of Arts and Manufactures, 1863....................... 1
The Journal of the Royal Dnblin Society
No. 20 and 21, January and April, 1861..................................... 1
No. 22 and 23, July and October, 1861.. 1
No. 24, January 1862 1
No. 25, April, 1862 1
No. 26, 27 and 28, July, 1862, to January, 1863............................. 1
Transactions of the Royal Society of Edinburgh for the Session 1857–58 and 1858-59. Vol. 22, Part 1.. 1
Transactions of the Royal Society of Edinburgh for the Session 1861–62. Vol 23, Part.... ....
Transactions of the Academy of Sciences, St. Louis. Vol. II., No. 1 1
Transactions of the Royal Irish Academy. Vol. 24, Part 2. Science...... 1
Proceedings of the American Geographical and Statistical Society, New York, 1862–63. No. 1, Vol. 1; No 2, Vol. 1; and Session 1862–63.... 3
Transactions of the Literary and Historical Society of Quebec. New Series. Vol. 1, Part 1 1
The Anthropological Review. No. 1, May, 1863. 1
The British American Magazine, 1863.. 1

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The Works of Bacon. Vol. 5, 6 and 7.. 3
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Kingslake's Crimea. Vol. 1	
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BOOKS BINDING FROM PERIODICALS.

Athenæum, January to June, 1863	1
" July to Dec., 1862	1
Illustrated London News, July—Dec., 1862	1
" " January—July, 1863	1
Mining Journal, 1862	1
Builder, 1862	1
Civil Engineer and Architects' Journal, 1862	1
The Art Journal, 1862	1
Chemical News, 1862	1
Blackwood, January—June, 1858	1
" July—Dec., 1858	1
" July—Dec., 1862	1
" January—June, 1863	1
Reviews, Westminster, 1862	1
" North British, 1862	1
" North American, 1862	2
" do 1863	1
" Natural History, 1862	1
" Edinburgh, 1862	1
Journal, Board of Arts and Manufactures, 1862	1
" Franklin Institute, July—Dec., 1862	1
London, Dublin, and Edinburgh Philosophical Magazine, July—Dec., 1862	1
Quarterly Journal of Microscopical Science, 1862	1
Edinburgh New Philosophical Journal, July—October, 1862	1
" " " January—April, 1863	1
Journal of Education, Upper Canada, 1861 and 1862	1
Proceedings of the Academy of Natural Sciences of Philadelphia, 1862	1
Historical Collections of the Essex Institute, 1862	1
Journal of the Society of Arts, 1861	1
Canadian Naturalist and Geologist. Vol. 7, 1862	1

		VOLS
Canadian Agriculturist, 1860 and 1862	....	2
Canadian Journal, 1862	....	2
Silliman's Journal, July—Dec., 1862	....	1
	Total	36

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"	C.	328	4 " 25 "
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"	E.	305	9 " 8 "
"	F.	307	6 " 6 "
"	G.	30[illegible]	10 " 130 Law Reports.
"	H.	136	71 " 107
"	I.	199	26 " 23
Lent Members,		56	- - 28
Office,		13	12 in parts.
Table,		42	
Binding,		36	
		2610	1[illegible]
		179	
Total Volumes,		2789 Bound and unbound.	
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DONATIONS TO THE MUSEUM.

From S. Fleming, Esq., C. E.

Large Salmon Trout from Lake Huron.

From Thomas Devine, Esq., per S. Fleming, Esq.

A Number of Electrotype (thirteen) casts of Fossils.

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—OCTOBER, 1863.

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

Day.	Barom. at temp. of 32°.				Temp. of the Air.				Excess of mean above Normal.	Tens. of Vapour.				Humidity of Air.				Direction of Wind.			Result't. Direction.	Velocity of Wind.					Rain in inches.	Snow in inches.
	6 A.M.	2 P.M.	10 P.M.	Mean.	6 A.M.	2 P.M.	10 P.M.	ME'N		6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.	M'N	6 A.M.	2 P.M.	10 P.M.		6 A.M.	2 P.M.	10 P.M.	Re-sul't.	ME'N		
1	29.681	29.620	29.509	29.5988	53.3°	63.4°	60.9°	59.53°	+ 9.12°	.377	.404	.450	.413	.92	.69	.85	.82	N E b E	E	E N E	S 75° E	5.8	9.5	1.2	5.08	6.61	0.160	...
2	.436	.441	.537	.4753	50.1	61.2	49.7	53.52	+ 5.58	.464	.443	.267	.382	.93	83	.75	.84	S	S b E	N W b W	S 66 W	12.4	7.2	5.5	3.47	5.58	0.020	...
3	.577	.478	.372	.4393	40.7	58.0	49.7	50.58	+ 1.05	.231	.394	.298	.322	.91	.82	.83	.86	N W b W	S S E	S E	S 2 E	1.8	6.0	4.2	2.04	3.60	0.018	...
4	.371	.465	—	—	50.4	52.2	—	—	—	.299	.232	—	—	.81	.59	—	—	S W b W	S W b S	S W b W	S 46 W	7.0	20.0	9.5	11.80	11.86	0.012	...
5	.493	.564	.659	.5790	43.9	49.0	47.2	47.10	— 1.52	.226	.270	.300	.270	.79	.79	.92	.83	S W b W	W S W	W	S 70 W	10.8	12.8	7.2	7.36	7.48	0.007	...
6	.685	.693	.720	.7060	44.3	47.9	43.2	45.18	— 3.03	.248	.230	.244	.243	.86	.69	.87	.81	W b S	S S W	Calm.	S 37 W	1.8	9.0	0.0	4.02	4.10	Inp.	...
7	.717	.637	.539	.6220	42.8	45.0	49.0	45.95	— 1.90	.240	.278	.337	.284	.87	.93	.97	.91	Calm.	N E	Calm.	N 40 E	0.0	8.0	0.0	2.88	4.00	0.207	...
8	.498	.486	.562	.5187	45.4	51.5	42.8	45.07	— 1.48	.272	.256	.232	.255	.90	.68	.84	.82	N W	W N W	N W b W	N 66 W	6.8	11.0	0.5	4.74	4.81	0.005	...
9	.578	.613	.746	.6535	42.1	47.7	45.7	45.25	— 1.82	.232	.261	.268	.251	.86	.78	.87	.83	N W b W	N N E	N	N 6 E	3.0	1.8	7.5	3.60	3.85	0.043	...
10	.858	.872	.926	.8902	39.2	47.9	38.8	42.22	— 4.45	.190	.192	.186	.198	.79	.57	.79	.74	N	N E b N	N b W	N 7 W	7.0	8.0	6.6	7.70	7.86	...	...
11	.956	.913	—	—	38.8	46.1	—	—	—	.213	.263	—	—	.90	.84	—	—	N	N W	N W b N	N 20 W	5.2	10.5	2.5	4.37	4.63		...
12	.808	.742	.752	.7638	30.9	47.5	37.5	39.02	— 6.95	.141	.198	.182	.174	.81	.60	.83	.73	N b E	S b W	N	N	5.2	7.5	5.0	2.45	4.48	...	...
13	.774	.755	.727	.7508	34.2	49.3	40.7	41.80	— 3.77	.168	.231	.196	.201	.85	.65	.77	.76	N N E	E N E	N N E	N 50 E	7.0	8.2	5.5	4.08	4.87	...	...
14	.656	.615	.615	.6343	43.2	56.9	47.9	49.20	+ 3.93	.254	.351	.311	.303	.91	.76	.93	.87	N	S S W	N b E	N 39 E	0.5	2.2	3.0	0.05	1.05	Inp.	...
15	.641	.610	.563	.6063	44.3	62.7	52.2	53.18	+ 8.33	.268	.379	.337	.321	.92	.66	.86	.79	N N E	E S E	N E b N	N 53 E	0.5	0.2	3.0	2.74	3.20	Inp	...
16	.523	.406	.339	.4130	53.6	59.8	58.0	57.25	+12.72	.384	.458	.452	.431	.93	.89	.94	.92	N E	N E b E	N E b E	N 58 E	5.2	6.4	7.0	6.81	6.85	0 305	..
17	.276	.332	.383	.3337	57.6	61.2	57.6	58.73	+14.50	.458	.486	.446	462	.96	.90	.94	.93	E N E	S b W	E S E	S 67 E	6.2	6.2	6.0	3.38	4.84	0.180	...
18	.310	.327	—	—	57.2	57.6	—	—	—	.451	.421	—	—	.96	.88	—	—	E S E	S b W	W b N	S 30 W	2.2	9.5	5.5	7.46	8.06	...	...
19	.537	.540	.507	.5605	49.0	52.2	40.7	46.82	+ 3.03	.317	.284	.204	.263	.91	.73	.80	.81	S S W	S b W	Calm.	S 17 W	5.6	6.5	0.0	3.22	4.79	...	...
20	.599	.499	.459	.5263	42.1	58.7	53.3	51.73	+ 8.17	.249	.285	.301	.282	.93	.57	.74	.74	E N E	S b E	S b W	S 34 W	3.8	11 0	1.5	5.11	8.68	...	...
21	.715	.804	.938	.8343	41.4	51.8	40.7	44 80	+ 1.55	.214	.150	.188	.183	.81	.38	.73	.63	W S W	W b N	W b N	N 81 W	7.2	12.0	3.2	8.20	8.78	...	...
22	30.009	30.014	.980	.9948	34.5	45.0	40.3	40.07	— 2.90	.166	.204	.166	.184	.83	.67	.66	.74	N W	S S E	N E b N	N 43 E	4.5	2.5	5.8	3.45	4.84	0.205	...
23	29.755	29.619	.677	.6800	39.6	41.4	38.1	39.52	— 3.23	.237	.221	.213	.222	.97	.85	.93	.92	N E b E	N W b W	N W b W	N 40 W	5.2	8.2	0.5	3.43	5.07	0.390	...
24	.840	.968	30.084	.9896	34.5	39.2	33.4	35.78	— 6.72	.181	.155	.149	.161	.90	.64	.78	.77	N W b N	N	N N E	N 4 E	4.0	11.0	2.8	6.07	6.33	...	...
25	30.162	30.102	—	—	33.1	37.1	—	—	—	.167	.146	—	—	.88	.67	—	—	N E b N	E S E	N E b N	N 48 E	8.0	3.5	3.0	4.23	4.95	...	...
26	30.197	30.145	30.098	30.1412	32.7	40.7	36.0	36.40	— 5.58	.165	.187	.162	.169	.88	.73	.76	.78	N	E	N E b N	N 55 E	4.0	5.0	3.4	3.10	4.35	...	...
27	30.121	30.085	30.056	30.0857	36.3	41.7	36.3	38.07	— 3.72	.193	.166	.151	.167	.90	.62	.71	.73	N E b N	E S E	N	N 64 E	4.0	9.5	3.8	3.64	4.85	...	...
28	30.042	30.032	29.998	30.0240	34.2	40.7	37.4	37.37	— 4.12	.160	.146	.162	.151	.81	.56	.72	.68	N b E	S E b E	E S E	S 73 E	4.5	8.0	8.0	5.82	6.52	...	...
29	29.953	29.821	.723	.8265	34.9	45.4	47.1	42.95	+ 1.68	.161	.198	.278	.216	.79	.65	.86	.77	E S E	E b S	S b E	S 37 E	2.5	9.5	13.8	8.00	9.94	...	...
30	.690	.520	.330	.4610	46.4	48.2	48.6	48.28	+ 7.33	.178	.307	.332	.316	.88	.91	.97	.93	S b E	S b E	E b S	S 8 E	13.0	9.0	7.0	8.41	9.88	0.970	...
31	.323	.697	.944	.6962	50.0	45.4	35.3	42.30	+ 1.65	.335	.119	.164	.189	.93	.39	.80	.69	S S W	W b S	W S W	S 76 W	24.5	23.2	5.8	13.72	14.07	...	...
M	29.700	29.6888	29.6968	29.6972	42.60	50.35	44.73	45.95	+ 0.91	.252	.260	.258	.260	.88	.70	83	.80	....	....	....	....	5.78	8.48	4.46	....	6.16	2.522	....

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR OCTOBER, 1863.

Highest Barometer . . . . . . 30.218 at 10 a.m. on 25th. } Monthly range=
Lowest Barometer . . . . 29.272 at midnight on 30th. } 0.946 inches.

Self-registering Ther.:
- Maximum temperature . . . . 66°4 on p.m. of 1st } Monthly range=
- Minimum temperature . . . . 30°5 on a.m. of 26th } 35°9
- Mean maximum temperature . . 52°79 } Mean daily range=12°25
- Mean minimum temperature . . 40°54 }
- Greatest daily range . . . . . . 23°8 from a. m. to p. m. of 20th.
- Least daily range . . . . 6°1 from a. m. to p. m. of 2nd.

Warmest day . . . 1st...Mean Temperature . . . 59°53 } Difference=23°75.
Coldest day . . . . 24th...Mean Temperature . . . 35°78 }
Maximum { Solar . . . . 83°0 on p.m of 1st } Monthly range=
Radiation { Terrestrial . . . . 23°0 on a. m. of 25th } 60°.0

Aurora observed on 3 nights, viz., 8th, 10th, and 12th. Possible to see Aurora on 13 nights; impossible on 18 nights.

Raining on 16 days; depth, 2.522 inches; duration of fall, 65.9 hours.

Mean of cloudiness=0.61; above average, 0.03. Most cloudy hour observed, 6 a.m; mean=0.74; least cloudy hour observed, 4 p.m.; mean=0.59.

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

North.	South.	East.	West.
1407.04	1523.32	1258.50	[illegible]98.35

Resultant direction, S. 71° W.; Resultant Velocity, 0.48 miles per hour.
Mean velocity 6.16 miles per hour.
Maximum velocity 29.4 miles, from 11 a.m. to noon on 31st.
Most windy day 31st—Mean velocity 14.07 miles per hour. } Difference 13.02.
Least windy day 14th—Mean velocity 1.05 miles per hour. }
Most windy hour, noon to 1 p.m.—Mean velocity, 8.87 miles per hour. } Difference
Least windy hour, 10 to 11 p.m.—Mean velocity, 4.51 miles per hour. } 4.36 miles.

3rd. Hoar frost and thin ice at 6 a.m.; sheet lightning 8.30 to 10 p.m. and midnight. —6th. Particles of hail falling at 2 p.m.—7th. Fog at 10 p.m. and midnight.—8th. Auroral light and streamers in N. N. E. and N. W. at 10 p.m. and midnight.—10th. Bright auroral light and some fine streamers in N. at 9 p.m.—12th. Hoar frost and thin ice 6 a.m.; auroral light, arches and streamers, 9 p.m. to midnight.—13th. Sharp hoar frost 6 a.m.—14th. Fog and heavy dew 8 p.m. to midnight.—15th. Fog and heavy dew 6 a.m.; sheet lightning 7.30 p.m. —16th. Distinct solar halo 3 to 4 pm.—17th. Fog at 6 a.m.—22nd. Hoar frost 6 a.m.—24th, 25th, and 26th. Thin ice at 6 a.m.—26th. Faint lunar halo during the evening; particles of hail at 4.30 p.m.—29th. Solar halo 2 p.m.; lunar halo at midnight.

Heavy dew recorded on 4 mornings during this month.

October, 1863, was comparatively mild, windy and cloudy. The depth of rain recorded was above the average; but as there was no appreciable depth of snow, the total amount of moisture fell below the average.

COMPARATIVE TABLE FOR OCTOBER.

YEAR.	TEMPERATURE. Mean.	Excess above Average, (45°5).	Maximum observed.	Minimum observed.	Range.	RAIN. No. of days.	Inches.	SNOW. No. of days.	Inches.	WIND. Resultant. Direction.	Velocity.	Mean Force or Velocity
1840	44.4	— 1.1	68.5	23.9	44.6	13	1.860	3	...	...	...	...
1841	41.6	— 3.9	58.3	20.3	38.0	6	1.360	2	...	...	...	0.41 lbs
1842	45.1	— 0.4	68.5	30.0	38.5	8	5.175	0	...	...	...	0.35 "
1843	41.8	— 3.7	65.7	24.5	41.2	12	3.790	4	2.5	...	...	0.54 "
1844	43.3	— 2.2	69.6	17.8	51.8	7	Imp.	4	12.0	...	...	0.43 "
1845	46.4	+ 0.9	62.7	20.0	42.7	11	1.760	1	Inp.	...	...	0.26 "
1846	44.6	— 0.9	69.7	20.7	49.0	14	4.180	2	Inp.	...	...	0.44 "
1847	44.0	— 1.5	65.0	20.3	44.7	13	4.390	2	Inp.	...	...	0.19 "
1848	46.3	+ 0.8	62.2	26.4	35.8	11	1.550	0	0.0	N 54 W	1.24	4.60 ms
1849	45.3	— 0.2	59.2	25.5	33.7	13	5.065	1	Inp.	N 12 W	1.27	7.76 "
1850	45.4	— 0.1	66.6	24.8	41.8	10	2.085	0	0.0	N 60 W	1.10	5.30 "
1851	47.4	+ 1.9	66.1	25.0	41.1	10	1.680	2	0.3	S 72 W	1.06	4.39 "
1852	48.0	+ 2.5	70.7	29.8	40.9	12	5.280	0	0.0	N 5 E	1.19	4.47 "
1853	44.4	— 1.1	64.7	25.5	39.2	10	0.875	2	Inp.	S 88 W	1.74	4.77 "
1854	49.5	+ 4.0	74.2	29.8	44.4	15	1.495	3	Inp.	N 45 W	1.52	4.57 "
1855	45.4	— 0.1	64.3	28.0	36.3	14	2.485	5	0.8	N 82 W	4.91	9.88 "
1856	45.3	— 0.2	70.1	23.3	46.8	10	0.875	2	0.1	N 76 W	2.15	6.07 "
1857	45.4	— 0.1	63.5	27.7	35.8	10	1.040	2	0.2	N 19 W	2.93	6.24 "
1858	48.8	+ 3.3	76.3	34.2	42.1	17	1.797	1	Inp.	N 34 W	0.36	5.96 "
1859	43.0	— 2.5	68.4	22.3	46.1	11	0.940	4	Inp.	N 68 W	5.04	8.12 "
1860	47.3	+ 1.8	63.7	28.4	35.3	15	1.618	1	Inp.	N 9 W	2.00	6.93 "
1861	48.7	+ 3.2	64.5	30.2	34.3	15	1.993	1	Inp.	N 61 W	1.06	5.96 "
1862	48.7	+ 3.2	76.0	27.0	49.0	19	2.684	2	0.5	N 78 W	2.89	6.53 "
1863	45.9	+ 0.4	63.4	30.9	32.5	16	2.522	0	0.0	S 71 W	0.48	6.16 "
Results to 1861.	45.52	...	66.48	25.38	41.10	11.7	2.485	1.9	0.84	N 56 W	1.67	5.86
Exc. for 1863.	+0.43	...	— 3.08	+ 5.52	— 8.60	+ 4.3	+ 0.037	— 1.9	— 0.84	...	...	+ 0.30

MONTHLY METEOROLOGICAL REGISTER, AT THE PROVINCIAL MAGNETICAL OBSERVATORY, TORONTO, CANADA WEST,—NOVEMBER, 186[illegible].

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

Day	Barom. at temp. of 32°. 6 A.M.	2 P.M.	10 P.M.	MEAN.	Temp. of the Air. 6 A.M.	2 P.M.	10 P.M.	ME'N	Excess of mean above Normal.	Tens. of Vapour. 6 A.M.	2 P.M.	10 P.M.	M'N	Humidity of Air. 6 A.M.	2 P.M.	10 P.M.	M'N	Direction of Wind. 6 A.M.	2 P.M.	10 P.M.	Resultant Direction.	Velocity of Wind. 6 A.M.	2 P.M.	10 P.M.	Resul't.	ME'N	Rain in Inches.	Snow in Inches.
					°	°	°	°	°												°							
1	30.030	30.074	—	—	32.4	39.6	—	—	—	.169	.168	—	—	.91	.99	—	—	W	N N W	E b N	N 81 E	0.5	2.5	2.0	3.28	4.77	...	...
2	29.920	29.674	29.491	29.6935	33.8	44.3	47.1	43.28	+ 3.02	.186	.203	.209	.231	.79	.69	.92	.81	E b S	E b S	S E b E	S 57 E	15.5	12.2	1.2	3.08	8.98	0.647	...
3	.588	.667	.788	.7012	45.0	45.0	35.6	41.57	+ 1.57	.204	.185	.159	.183	.67	.62	.76	.69	W	W b N	W	W	20.0	16.0	3.2	10.32	10.37	...	...
4	.858	.782	.577	.7205	32.7	50.0	46.4	43.23	+ 3.47	.135	.232	.221	.204	.73	.63	.70	.72	W S W	S b W	E N E	S 19 E	4.0	9.0	6.0	3.66	6.58	0.355	...
5	.182	.237	.374	.2735	46.8	57.6	45.0	50.15	+10.67	.295	.310	.230	.281	.92	.64	.80	.77	E	W	W b S	S 85 W	4.0	24.5	1.2	10.69	12.12	...	...
6	.334	.461	.558	.4627	43.5	42.1	33.4	39.43	+ 0.27	.223	.194	.171	.194	.78	.72	.89	.79	W S W	W N W	W b S	N 76 W	1.2	26.5	5.2	9.59	9.85	0.180	...
7	.460	.337	.452	.4253	37.8	40.3	37.8	38.50	— 0.50	.208	.236	.217	.220	.91	.95	.96	.94	W N W	N E b E	N b E	N 9 E	5.0	4.4	1.6	2.27	4.46	0.250	...
8	.614	.708	—	—	34.9	35.6	—	—	—	.186	.177	—	—	.92	.85	—	—	W N W	N W b N	N	N 24 W	8.0	11.2	2.5	7.69	7.82	...	Inp.
9	.793	.791	.875	.8333	26.6	34.5	29.8	30.60	— 7.80	.126	.122	.125	.126	.87	.60	.75	.74	N b W	N W b N	N b E	N 28 W	2.5	7.0	3.2	6.66	7.00	...	..
10	.938	.893	.764	.8535	25.2	33.8	30.6	30.17	— 7.92	.122	.115	.138	.129	.90	.58	.80	.77	N W b N	W b N	S W	S 79 W	12.4	9.2	11.3	8.03	9.88	...	Inp.
11	.535	.320	.302	.4128	36.3	46.4	43.9	42.03	+ 4.25	.176	.249	.190	.204	.92	.79	.66	.76	S W	W S W	S W b W	S 53 W	10.8	18.0	11.2	11.45	11.69	..	...
12	.309	.453	.476	.4535	40.3	50.0	38.9	42.57	+ 5.07	.219	.283	.203	.230	.87	.78	.86	.84	W b S	S W b S	Calm.	S 40 W	1.2	5.0	0.0	1.18	1.25	...	...
13	.478	.504	.568	.5212	37.1	41.7	38.9	39.40	+ 2.22	.200	.222	.203	.213	.90	.84	.86	.88	N N E	E N E	E b N	N 76 E	1.8	8.8	10.5	9.32	9.46	0.095	...
14	.472	.303	.340	.3716	37.4	45.0	47.9	43.87	+ 6.97	.196	.269	.311	.265	.87	.90	.93	.91	E	N E b E	Calm.	N 74 E	12.4	11.2	0.0	4.94	6.33	0.242	...
15	.426	.373	—	—	43.9	48.2	—	—	—	.273	.307	—	—	.95	.91	—	—	Calm.	N E b N	N N E	N 15 E	0.0	7.8	10.0	5.72	6.05	0.405	...
16	.496	.561	.623	.5663	45.0	43.2	41.7	43.25	+ 7.05	.298	.262	.255	.271	.99	.94	.96	.96	N E b N	S	Calm.	N 82 E	0.5	3.8	0.0	1.23	1.81	0.070	...
17	.578	.464	.301	.4377	39.4	47.5	44.6	44.18	+ 8.39	.241	.216	.235	.233	.98	.65	.80	.81	N	N N W	N W	N 52 W	0.8	11.4	19.8	12.91	13.43	...	...
18	.248	.227	.249	.2423	43.5	46.8	41.7	43.53	+ 8.05	.214	.217	.218	.218	.75	.67	.82	.76	W	W S W	S W b W	S 57 W	20.5	10.2	1.5	5.80	5.97	..	...
19	.353	.322	.296	.3248	41.0	50.8	50.0	46.97	+11.88	.237	.273	.295	.267	.92	.73	.81	.82	S W b S	S S W	S S W	S 45 W	1.4	15.0	6.8	8.03	9.52	Inp.	...
20	.303	.481	.650	.5198	41.0	43.9	33.1	39.22	+ 4.45	.192	.208	.153	.189	.75	.72	.81	.78	W b N	W b S	W S W	S 76 W	19.0	14.0	1.3	7.31	7.39	...	...
21	.634	.474	.499	.5110	28.7	39.9	33.8	34.68	+ 0.30	.138	.190	.182	.173	.87	.77	.93	.85	Calm.	E N E	W b S	S 47 W	0.0	5.0	3.5	1.90	3.69	...	...
22	.768	.916	—	—	32.7	37.8	—	—	—	.150	.114	—	—	.80	.50	—	—	S W b W	W	Calm	S 82 W	8.0	16.0	0.0	6.36	6.58	...	...
23	30.162	30.144	.937	30.0597	30.9	38.5	37.8	35.43	+ 1.77	.120	.163	.157	.147	.69	.70	.69	.71	N W	E	E	N 74 E	0.2	5.0	7.0	5.55	5.78	0.230	...
24	29.682	29.268	.202	29.3760	35.6	41.0	42.8	39.68	+ 6.42	.202	.246	.169	.206	.97	.95	.61	.84	E N E	E b S	W b S	S 67 W	11.0	10.0	21.4	5.30	14.72	0.532	...
25	.486	.516	.628	.5593	34.5	36.3	29.8	33.37	+ 0.40	.148	.125	.125	.129	.74	.59	.75	.68	W b N	W	W b S	N 87 W	10.8	7.0	3.0	7.58	7.91	...	Inp.
26	.688	.742	.753	.7297	29.1	38.5	35.6	34.22	+ 1.65	.141	.140	.149	.145	.87	.60	.72	.74	W S W	S W b W	W S W	S 56 W	2.8	10.3	5.2	6.01	6.06	...	...
27	.770	.650	.544	.6435	30.9	45.0	37.4	38.02	+ 6.73	.149	.221	.196	.201	.86	.74	.87	.84	W S W	S b W	Calm.	S 17 W	1.0	7.0	0.0	3.83	4.03	0.510	...
28	.378	.210	.411	.3148	41.4	42.8	30.2	37.35	+ 5.47	.250	.232	.136	.203	.95	.84	.80	.87	S b W	Calm.	N W b W	N 62 W	8.0	0.0	18.5	11.26	13.35	0.140	Inp.
29	.595	.640	—	—	24.1	26.2	—	—	—	.100	.124	—	—	.77	.87	—	—	W N W	W	N E	N 41 W	11.2	4.0	0.2	4.32	5.37	...	0.1
30	.751	.773	.898	.8202	21.5	25.7	23.0	22.72	— 8.37	.082	.099	.106	.093	.71	.70	.86	.76	W	W b S	W S W	S 73 W	14.5	25.0	8.0	13.53	13.65	...	Inp.
	29.5933	29.5308	29.5458	29.5537	36.42	42.82	38.27	39.13	+ 2.98	.188	.208	.194	.198	.84	.73	.81	.80	......	......	......	......	6.97	10.57	5.51	......	7.86	3.656	0.1

REMARKS ON TORONTO METEOROLOGICAL REGISTER FOR NOVEMBER, 1863,

NOTE.—The monthly means do not include Sunday observations. The daily means, excepting those that relate to the wind, are derived from six observations daily, namely at 6 A.M., 8 A.M., 2, 4 and 10 P.M., and midnight. The means and resultants for the wind are from hourly observations.

Highest Barometer............................30.181 at 8 a.m. on 23rd } Monthly range =
Lowest Barometer ....29.096 at 7 p. m. on 24th } 1.085 inches.

Self-registering Thermom.
- Maximum Temperature .... 67°0 on p.m. of 5th } Monthly range=
- Minimum Temperature .... 17°8 on a.m. of 30th } 49°2
- Mean maximum Temperature .... 44°82 } Mean daily range=
- Mean minimum Temperature .... 33°34 } 11°49
- Greatest daily range ......23°0 from a.m. to p.m. of 5th.
- Least daily range............ 3°3 from a.m. to p.m. of 16th.

Warmest day .... 5th... Mean temperature......... 50°15 } Difference = 27°43.
Coldest day .... 30th... Mean temperature......... 22°72 }
Maximum { Solar.. 79°0 on p.m. of 5th } Monthly range =
Radiation. { Terrestrial.. 7°4 on a.m. of 30th } 71°6
Aurora observed on 1 night, viz.,—on 1st.
Possible to see Aurora on 10 nights; impossible on 20 nights.
Snowing on 6 days, depth 0.1 inches; duration of fall, 10.9 hours.
Raining on 13 days, depth 3.656 inches; duration of fall 93.8 hours.
Mean of cloudiness = 0.71; below average 0.03.
Most cloudy hour observed, 4 p.m; mean = 0.78; least cloudy hour observed, 6 a.m.; mean, = 0.65.

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

North.	South.	East.	West.
1359.76	1274.06	991.83	3502.44

Resultant direction N. 88° W.; Resultant velocity 3.50 miles per hour.
Mean velocity ....7.86 miles per hour.
Maximum velocity .... 33.0 miles, from noon to 1 p.m. on 5th.
Most windy day ....24th............Mean velocity, 14.72 miles per hour. } Difference=
Least windy day ...12th.............Mean velocity, 1.25 ditto. } 13.47 miles.
Most windy hour .... 1 to 2 p.m...............Mean velocity, 11.07 ditto. } Difference=
Least windy hour ...8 p.m. to 9 p.m..........Mean velocity 5.83 ditto. } 5.24 miles.

1st. Faint auroral light at 9 p.m.—5th. Fog at 6 a.m.; very mild day; wind in warm gusts.—6th. Showers of rain and hail during the forenoon.—8th. Particles of snow 3 to 6 p.m., and from 8 to 9.30 p.m.—9th. Brilliant Meteor in N at 7.40 p.m.—10th. Particles of Snow 0.30 to 2 p.m.—11th. Faint Solar Halo at 2 p.m.—13th. Fog at 6 a.m.; Solar Halo at 1 p.m.—19th. Fog at 6 and 8 a.m.—21st. Fog at 8 a.m.—23rd. Spray rising from Niagara Falls distinctly visible.—24th. Dense fog 2 to 6 p.m., Wind in violent squalls at night.—25th. Particles of Snow during forenoon; Lunar Corona at midnight.—27th. Faint Solar Halo at noon.

November, 1863, was comparatively mild, wet, windy, and clear.

COMPARATIVE TABLE FOR NOVEMBER.

YEAR.	TEMPERATURE.					RAIN.		SNOW.		WIND.		
	Mean.	Excess above aver'ge (36.7)	Max. ob-served.	Min. ob-served.	Range.	No. of days.	Inches	No. of days.	Inches	Resultant. Direction.	Resultant. V'y.	Mean Force or Velocity.
	°	°	°	°	°							
1840	35.9	— 0.8	54.4	20.5	33.9	5	1.220	8	...	...	...	....
1841	35.0	— 1.7	63.2	7.6	55.6	8	2.450	5	...	...	...	0.91lbs.
1842	33.3	— 3.4	50.6	7.6	43.0	9	5.310	10	...	...	...	1.22
1843	33.5	— 3.2	51.2	14.4	36.8	10	4.765	7	1.2	...	...	0.59
1844	34.9	— 1.8	49.8	12.0	37.8	8	Imp.	4	8.0	...	...	0.48
1845	36.8	+ 0.1	58.8	7.6	51.2	7	1.105	4	5 0	...	...	0.53
1846	41.3	+ 4.6	55.5	18.2	37.3	12	5.805	2	0.4	...	...	0.64
1847	38.6	+ 1.9	48.2	7.8	50.4	14	3.155	3	Inp.	...	...	0.36
1848	34.5	— 2.2	49.3	16.5	32.8	9	2.020	3	1.4	N 81° W	1.81	4.81mls.
1849	42.6	+ 5.9	56.7	28.4	28.3	10	2.815	2	1.0	N 39° W	1.55	4.78
1850	38.8	+ 2.1	62.3	18.1	44.2	7	2.955	1	Inp	N 42° W	1.43	5.27
1851	32.9	— 3.8	50.1	16.5	33.6	5	3.885	6	6.7	N 50° W	1.25	4.70
1852	36.0	— 0.7	50.4	18.7	31.7	7	1.775	3	2.0	N 59° W	1.53	6.50
1853	38.7	+ 2.0	54.1	14.4	39.7	15	2.425	6	2.7	N 9° W	0.55	5 52
1854	36.8	+ 0.1	54.9	15.1	39.8	13	1.115	4	1.3	W	3.44	7 54
1855	38.6	+ 1.9	54.1	18.7	35.4	8	4.590	6	3.0	N 66° W	3.18	10.81
1856	37.4	+ 0.7	56.4	22.8	33.6	10	1.375	9	9.5	S 85° W	2.95	8.75
1857	33.5	— 3.2	57.8	—2.3	60.1	14	3.235	9	6.9	S 61° W	5.45	9.25
1858	34.2	— 2.5	52.0	20.5	31.5	12	3.879	13	4.0	N 25° W	3.14	8.87
1859	38.9	+ 2.2	61.0	24.1	36.9	12	5.193	9	0.6	N 81° W	3.39	9.65
1860	37.9	+ 1.2	62.7	14.0	48.7	12	2.569	8	1.9	S 89° W	4.95	11.02
1861	37.1	+ 0.4	51.5	25 1	26.4	14	4.291	8	3.2	N 46° W	1.94	7.44
1862	35.6	— 1.1	58.0	17.2	40.8	11	2.205	11	5 3	N 46° W	3.00	6.60
1863	39.1	+ 2.4	57.6	19.4	38.2	13	3.656	6	0.1	N 88° W	3.50	7.86
Results to 1861.	36.69	...	55.23	15.74	39.49	10.0	3.140	5.9	3.10	N 76° W	2.29	7.49
Exc. for 1863.	+ 2.44	...	+ 2.37	+ 3.66	— 1.29	+ 3.0	+ 0.516	+ 0.1	— 3.00	....	......	+ 0.37