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THE FORESTS OF CANADA.[1]

BY ROBERT BELL.

The writer, who has had extensive opportunities during the last thirty years of becoming personally acquainted with the forests of the Dominion east of the Rocky Mountains, endeavoured to give an account of their extent, general characters, peculiarities, value, means of preservation, etc. Viewing the forests of the continent as a whole, only the northern portions come within the Dominion, a large part of which lies beyond the limit of trees of any kind. The central and eastern forest region of Canada and the United States presents the greatest variety of species. In the north,

[1] The above paper *in extenso* was contributed by the author to the Montreal meeting of the British Association for the Advancement of Science, in 1884, and was accidentally omitted from the volume of "Canadian Economics." Our abstract is somewhat fuller than that given by the authorized Report of the Association. We may mention that, at the late International Forestry Exhibition in Edinburgh, Dr. Bell was awarded a diploma for a large map showing the northern limits of some thirty species of timber trees.

a wide border of coniferous trees, which become smaller and more limited in number of species as we approach the verge of the forests, stretches across the continent; while toward the south deciduous forests prevail, but are interspersed with large areas of pines of various kinds. The sombre coniferous forests of the north are continuous over vast regions, which, from their high latitudes and the poverty of their soil, will never be cultivated to any great extent. This great coniferous belt has a crescentic form, curving southward from Labrador to the far Northwest, keeping Hudson Bay on its northern side. The distribution of our forests appears to be governed almost entirely by existing climatic conditions, although it may be modified to some extent by the geological character of different districts; and some of the peculiarities of their present distribution may be due to former conditions affecting their dispersion.

Beyond the northern limit of the forests on the mainland of the continent there is a large triangular area to the north-west and another to the north-east of Hudson Bay, called the Barren Grounds, which are destitute of trees solely on account of the severity of the climate, as the other conditions do not appear to differ from those of the adjacent wooded regions to the south. The treeless region of the Western States and the south-western part of the North-west Territories of Canada are called plains as distinguished from the prairies, which often are partially wooded. The latter occupy an immense space between the plains and the forest regions to the east and north-east. The plain and prairie conditions are also due to climate, and not, as some have supposed, to fires having swept away formerly existing forests. This is shown by the contours of the lines marking the western limits of the various kinds of trees which prevail in the east, as well as from the absence of water-courses, which would exist if sufficient rain had fallen in comparatively recent times to have maintained forest growth.

Although the Dominion embraces about half of the continent, only some ninety out of the 340 species of the forest trees of North America are found within her borders, including the Pacific slope. Yet the area under timber in

Canada is perhaps as great as that in the United States. It is, therefore, evident that the forests are less diversified in the north than in the south. This is in accordance with the general law of the greater richness of the flora of warm countries; but it may be due also in part to the fact that in the north we have greater uniformity of physical and climatic conditions over wide areas than in the south. For example, we have a similarity in these conditions from Newfoundland to Alaska, and hence throughout the great distance of 4,000 miles we find the same group of trees. Again in the great triangular area of the Northwest, between the United States boundary, the Rocky Mountains, and the Laurentian region, embracing over 600,000 square miles, very little difference could be observed in the climate, the soil, or the general level of the country, and hence the same group of trees—only about half a dozen in all—is found throughout this immense tract. In striking contrast with this is the fact that on the same farm lot in the south-western part of the Province of Ontario one may often count as many as fifty different kinds of trees. The richness in variety of the native trees of Ontario and the adjacent States is owing to the fertile soil and the favourable conditions as to summer temperature, constant moisture, and the absence of intense cold in the winter.

The writer exhibited a map showing the northern and western limits of the principal forest trees of the Dominion east of the Rocky Mountains. From this it appears that the range of species is not according to the mean annual temperature or precipitation, but rather to the absence of extremes of heat and cold, and of great dryness. For these reasons a number of the trees of the Province of Quebec and northern Ontario do not range west into Manitoba, although the annual means of temperature and precipitation are nearly the same in both. This map also shows in a striking manner that the northern limits of our various forest trees are by no means parallel to one another, although locally some groups may be nearly so for a certain distance. Some of them pursue extraordinary or eccentric courses, which are difficult to account for. The most remarkable of these is the white cedar, which in the central part of its trend reaches James Bay, but drops suddenly to the south at the Gulf of St. Lawrence in the east, and on reaching the longitude of the head of Lake Superior in the west. Yet the climate and other conditions appear to be the same for some distance both east and west of these lateral boundaries. An outlying colony of the white cedar is found at Cedar Lake near the north-western part of Lake Winnipeg. Colonies or outlying patches of other trees have been noted in different localities, such as of the basswood and sugar-maple at Lake St. John, north of Quebec, of the grey elm on Missinaibi River, near James Bay, and of the hemlock spruce at Thompson, near the west end of Lake Superior.

Rivers and lakes, by supplying heat and moisture and warding off summer frosts, often promote the growth of trees on their immediate banks which are not found elsewhere in the surrounding country. Instances of this may be seen along the North Saskatchewan, where the negundo, green ash, grey elm, white birch, alder, etc., thrive only on the river banks. In the cold regions, the white spruce grows to a much larger size on the shores and islands of rivers flowing north than elsewhere. It nas been found that exotic fruit trees and other introduced plants can be successfully cultivated around the shores of the larger lakes, especially on their southern sides, which will not grow at a short distance inland. On the other hand, the immediate proximity of the sea, with a lower summer temperature than the land, is unfavourable to the growth of timber in the north. The habits of some trees are much modified in different latitudes. Species which grow in warm dry soil in the north may be found in cold, heavy, or wet land in the south. The larch, balsam, white cedar, white pine, white birch, etc., are examples of this tendency. Some species extend far to the south of their general home along mountain ridges, while others seem to refuse to follow such lines. The existence of extensive swamps, the shelter of hills, or the elevations which they afford, are therefore to be regarded as among the minor conditions governing the distribution of trees.

The peculiarities in the outline of the northward limit of the white cedar and other species of trees, may throw some light on questions as to the direction from which they have migrated or been dispersed. In some cases which the author has studied, the trees appear to have reached the most northern limit possible. For example, in its most northern range, the first tender leaves and shoots of the black ash are blighted almost every year by the spring frosts; the trees are of small size or stunted in height, and only occasionally bear seed. Sir John Richardson mentions that, on the barren grounds, outlying patches of dying spruces were sometimes met with far out from the verge of the main forest, and that he saw no evidence of young trees springing up beyond the general line of trees; from which he infers that the latter is retreating southward. A similar condition is said to exist in Siberia.

In tracing the northern limits of several of the trees as laid down on the author's map, it would be observed that the northward variations from the general direction usually corresponded with depressions in the country, while the southward curves occurred where the elevations were greatest. The height-of-land dividing the waters of the St. Lawrence from those of Hudson Bay has a general parallelism with the northern limits of many of the species; but as the watershed is not marked by any great elevation or by a ridge, the circumstance referred to may be owing simply to the accident of its trend coinciding with the average course of the isothermal lines.

The author divides the trees of the Dominion east of the Rocky Mountains into four groups in regard to geographical distribution, namely: (1) A northern group, including the white and black spruces, larch, Banksian pine, balsam-fir, aspen, balsam-poplar, canoe birch, willows and alder,—these cover the vast territory from the northern edge of the forests down to about the line at which the white pine begins; (2) a central group of about forty species, occupying the belt of country from the white-pine line to that of the button-wood; (3) a southern group, embracing the button-wood, black walnut, the hickories, chestnut, tulip tree, prickly ash, sassafras, and flowering dog-wood, which are found only in a small area in the southern part of Ontario; (4) a western group, consisting of the ash-leaved maple, bur-oak, cotton-wood, and green ash, which are scattered sparingly over the prairie and partially-wooded regions west of Red River and Lake Winnipeg.

The finest timber of the second group within the limits of Canada is to be met with along the east side of Lake Huron in the counties of Lambton, Huron and Bruce, where the button-wood, elm, maple, yellow birch, cherry, bass-wood and hemlock attain a height of one hundred feet and upwards. Although the Ottawa valley has produced more white pine timber than any other region in the Dominion, the largest and finest trees grow on the sandy soils of the counties bordering the northern sides of Lake Erie and of the western part of Lake Ontario, where extensive and splendid pineries stood when these regions were first invaded by the white man. In the Northwest Territories, the largest trees are the elms along the rivers (which, however, do not extend far north) and the rough-barked poplars, which, even as far north as the Laird and the lower Mackenzie, have trunks five feet in diameter. Along Athabasca River the author had seen spruces which measured ten and twelve feet in girth.

The distribution of our forest trees affords us one of the most obvious tests of climate, and although it may not be more reliable than that of the smaller plants, it is more noticeable by the common observer. In the older provinces of Canada the settlers are often guided to a great extent in their selection of land by the kinds of trees it supports, a thrifty growth of beech and sugar-maple, for instance, being generally considered a good sign; but such tests must necessarily be only of local application. In the prairie region, timber may be entirely absent from the finest soil, while the least hardy trees of the west flourish in the stiff clay-banks or among the stones along the rivers on account of the moisture and heat derived from the water.

The map which has been referred to is useful in defining the extent of country over which each kind of timber was to be found. But in estimating the quantities which may be yet available for commercial purposes in the regions still untouched by man, various circumstances require to be considered, such as the favourable or unfavourable conditions of soil, etc., as well as the proportion which has been destroyed by fire, and other causes. The amount of timber which has been lost through forest fires in Canada is almost incredible, and can only be appreciated by those who have travelled much in our northern districts. The proportion of white and red pine which has been thus swept away in the Ottawa Valley and in the St. Maurice and Georgian Bay regions, is estimated by the lumbermen as many times greater than all that has been cut by the axe. Yet all this is insignificant in quantity compared with the pine, spruce, cedar, larch, balsam, etc., which has been destroyed by this means in the more northern latitudes all the way from the Gulf of St. Lawrence to Nelson River, and thence northwestward. It is true that the commercial value of this timber was not so great as that of the more southern pine regions which have also been partially ruined. The total quantities which have disappeared are almost incalculable, but even a rough estimate of the amount for each hundred or thousand square miles shows it to have been enormous, and of serious national consequence. The writer had traversed these great regions in many directions, and could testify to the widespread devastation which had taken place. Nearly every district was more or less burnt, the portions which had been overrun by fire usually exceeding those which remained green. These northern coniferous forests were more liable than others to be thus destroyed. In the summer weather, when their gummy tops and the mossy ground are alike dry, they burn with almost explosive rapidity. Small trees are thickly mingled with the larger ones, and they all stand so closely together that their compact branches touch each other, thus forming a sufficiently dense fuel to support a continuous sheet of flame on a grand scale. Before a high wind the fire sweeps on with a roaring noise, and at a rate which prevents the birds and beasts from escaping. Thus, in one day, the appearance which a large tract of country is to wear for a hundred years may be completely altered. After a time the burnt district becomes overgrown, first with shrubs and bushes, then with aspens and white birches, among which coniferous trees by-and-by appear; but finally at the end of a hundred and fifty years or more they regain possession of the burnt tract. This process of alternation of crops of timber appears to have been going on for centuries, but in modern times the fires must have been more numerous and frequent than formerly.

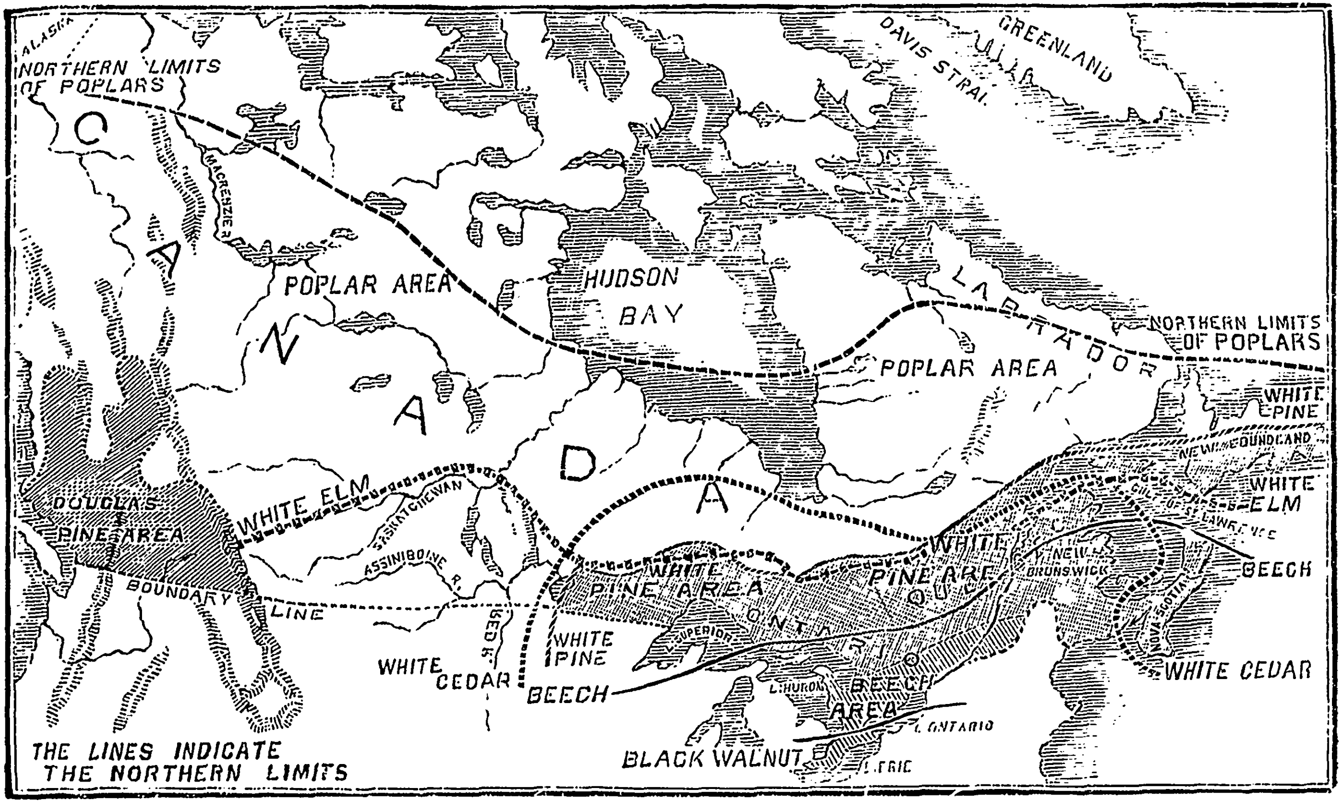
Along Moose River and the lower part of the Missinaibi, the original dark coniferous forest of these latitudes is replaced by the light green poplars and white birches, for more than a hundred miles, and this condition has existed since the memory of the oldest Indian of the district. Here and there may be seen a patch of large spruce—remnants of the original forest—and everywhere under the deciduous growth, the charred stumps of the old conifers may be found. On the east side of the southern part of Lake Winnipeg, and nearly all along Winnipeg River, the principal forests have been destroyed by fire, and replaced by aspen and white birch.

Forest fires are undoubtedly due occasionally to lightning, the author having once actually witnessed the origin of a fire in this way, and he had often been informed by the Indians that they had seen similar cases. But most of them are traceable to the carelessness of white men and demoralized Indians. In the partially inhabited regions, most of the forest fires originate by the settlers burning brush and log-heaps in clearing the land. It may be asked if we have no means of stopping this fearful destruction of the timber of the country. Laws on the subject do exist, but no adequate means appear to be provided for enforcing them. The author recommended a reform in this respect, before it be too late. Crown lands of real value for agriculture should be separated for the purpose of administration from those which are acknowledged to be useful only or principally for their timber, and settlement should be prohibited within the latter. Heretofore, the great consideration of Government was the peopling of the country, the timber being looked upon as of secondary importance, and it was willingly sacrified in the interests of the settler, who came to regard it as his natural enemy. The time has come when we must change all this. In the absence of forest guardians and proper regulations, lumbermen have often to submit to a species of blackmail from discharged employees and pretending settlers in order to keep them off their limits. Indians sometimes burn the forests off each other's hunting-grounds from motives of revenge, but as a rule the fires which they start are from carelessness or indifference. When cautioned in a friendly way, they are willing to exercise greater care, and the beneficial effects of this course are already manifest in the region between Lake Winnipeg and Hudson Bay, where the author had remonstrated with them on the subject. He suggests that the annuities which they receive from Government be withheld as a punishment for burning the woods, or that a bounty be paid each year that no fires occur. In this way the Indian chiefs and headmen may be made the most efficient and earnest forest guardians we could possibly have.

Fires are not so liable to run in forests of full-grown white and red pines, such as those of southern Ontario, which have suffered comparatively little from this cause, but have now been mostly cut down and utilized by the lumbermen. Hardwood forests are seldom burnt to any great extent, except where the soil is shallow and becomes parched in summer, as, for instance, on the flat limestone rocks of Grand Manitoulin Island and the Indian peninsula of Lake Huron, through much of which fires have run, burning the vegetable mould and killing the roots, thus causing the trees to fall over even before they have decayed. Hence the term "fire-falls" applied in such cases.

If we had educated and intelligent conservators of forests in Canada, appointed by the Government, their duties, in addition to preventing the destruction of the timber by fire and otherwise, might be directed to promoting the growth of existing timber, encouraging transplanting, the introduction of foreign trees which might grow in this country, the dissemination of information on practical forestry, etc., investigating the causes of diseases among trees, directing the attention of foreign purchasers to our woods and pointing out to our lumbermen possible new markets for timber products and for varieties of woods not now utilized. That disease does sometimes cause great havoc among our forests is illustrated by the recent fact that the spruces in New Brunswick, the principal timber tree of that province, died over extensive areas, a few years ago, and the disease has now spread into the Gaspé peninsula. It is supposed to be due to a fungus which attacks the roots, but it is not certain that the fungus itself may not be induced by the pre-existence of some other disease. In the Province of Quebec the larches or tamaracs, have sometimes died from unexplained causes in extensive tracts. As soon as coniferous trees have become scorched by fire or show signs of failing vitality, their trunks are attacked by boring beetles, and they must be immediately cut down and immersed in water if the timber is to be saved.

In regard to the future supplies of timber which may be available in Canada, the greater part of the white oak and rock elm has been already exported. The cherry, black walnut, red cedar, and hickory have likewise been practically exhausted. Red oak, basswood, white ash, white cedar, hemlock, butternut, hard maple, etc., as well as many inferior woods, are still to be found in sufficient quantity for home consumption. A considerable supply of yellow birch still exists, and in some regions it is yet almost untouched. Until recently there was an indistinct popular notion that the white pine, our great timber tree, extended thoughout a vast area in the northern parts of the Dominion, from which we might draw a supply for almost all time. The author's map showed, however, that its range was comparatively limited. The shaded portions of the accompanying little map will serve to give an idea of the extent of our pine lands, relatively to that of the whole Dominion. Even if we include the Douglas pine area of British Columbia, it will be seen to be small in comparison with the rest of Canada. And it must be observed that this shading represents the botanical and not the commercial distribution of the pine, and that the valuable timber has been already cut away or is very sparsely distributed through a large proportion of it. Although it was


NORTHERN LIMITS
OF POPLARS
GREENLAND
DAVIS STRAIT
HUDSON
BAY
LABRADOR
POPLAR AREA
POPLAR AREA
NORTHERN LIMITS
OF POPLARS
WHITE
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DOUGLAS
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BEECH
AREA
L. ONTARIO
L. ERIE
BLACK WALNUT
WHITE
PINE
WHITE
CEDAR
BEECH
THE LINES INDICATE
THE NORTHERN LIMITS

found over a very extensive district to the north-west of Lake Superior, it was very thinly scattered, of smaller size, and poorer quality than further south. Our principal reserves of white pine, as yet almost untouched, are to be found in the region around Lake Temiscaming, and thence westward to the eastern shore of Lake Superior. This tract lies partly to the north of the height-of-land. There is also more or less red pine in the district referred to. The newly constructed Canadian Pacific Railway between Lake Nipissing and Lake Superior has afforded a means of access to the centre of this great pine region, which could not so well be reached by any of the rivers. Lumbering operations have already begun near the railway west of Lake Nipissing, and unless the charges for transport prove too high, the probabilities are that hereafter a large amount of timber will be sent out of this district by rail. When the exportable white pine shall have become exhausted, as it must before many more years, we have still vast quantities of spruce and larch, which may even now be regarded as the principal timber available for this purpose in the future. But our stock of these woods is to be found mostly in the great country which drains into James Bay, whose numerous large rivers afford facilities for floating timber to the sea, and in the country thence westward to Lake Winnipeg. Fine white spruce is likwise found in some localities in the Northwest Territories between the prairie regions and the country of small timber to the north-east. The Banksian pine, which ranges all the way from New Brunswick to Mackenzie River, is often large enough for sawing into deals, and will afford large quantities of good railway ties.

If the vast northern forests can be preserved from fire in the future, our supply of small timber is practicably inexhaustible. When larger trees elsewhere shall have become scarce, much of it may some day be sawn into boards, scantling, joists, rafters, flooring, etc. Supplies of timber for railway-ties, telegraph-poles, mines, fencing, piling, small spars, cordwood, charcoal, paper-making, etc., may be drawn from these immense districts for all time, since the greater part of the regions referred to are not likely to be required for agricultural purposes, and by a proper system of cutting, a new growth will spring up to replace the timber removed, and in its turn become available to keep up the supply. The practically interminable extent of these forests will allow ample time for the smaller trees, which may be left on any ground cut over, to come to maturity before it is again called upon to furnish its quota. Some of the woods of the more southern districts of Canada, which have had little value hitherto, except for fuel, only require to be better known to be utilized for many purposes.

The people of Canada have heretofore been accustomed to such an abundance of wood, and to the idea that trees stood in the way of the progress of the country, that tree-planting has as yet made but little progress among us. A beginning has, however, been made in the last two years in the provinces of New Brunswick and Quebec, where "Arbor Days" have been proclaimed. In Ontario an Act was passed in 1883, and a fund set apart for the encouraging of tree-planting along highways. The time has arrived for more vigorous action by the general Government and the Local Legislatures looking to the improvement and preservation of the forests which still remain in Canada, and for the partial restoration of those which have been destroyed.

The Mound-Builders.

By Rev. William J. Smyth.

When the early settlers began to pioneer the unbroken forests of North America, they considered the various Indian tribes to be the true Aborigines of this continent. But long before the red man, even long before the growth of the present forests, there lived an ancient race, whose origin and fate are surrounded with impenetrable darkness. The remains of their habitations, temples and tombs, are the only voices that tell us of their existence. Over broad areas, in the most fertile valleys, and along the numerous tributaries of the great rivers of the central and western portions of the United States, are to be found these wonderful remains, of the existence and origin of which, even the oldest red man could give no history.

Following in the track of these ancient tumuli, which have been raised with some degree of order and sagacity, we are bound to believe that they were constructed by a very intelligent and somewhat civilized race, who during long periods enjoyed the blessings of peace, but like most nations of the earth, at times were plunged in the horrors of war. We cannot tell by what name these strange people were known during their existence. But archæologists, to keep themselves safe, have given them the name of "Mound-builders," from the nature of the structures left behind them.

Of this wonderful, semi-civilized, prehistoric race, we have no written testimony. Their mysterious enclosures, implements of war, and comparatively impregnable fortifications, together with a few strange tablets, are the only evidence of their character, civilization, and doom. No contemporary race, if such there existed on this continent, has left any record of them.

The mounds they have left are found in the western part of the State of New York, and extend, it is said, as far as Nebraska. And as they have lately been found in the North-west, they have thus a much more northern limit than was at first thought, while the southern limit is the Gulf of Mexico.

Having seen only a few mounds in Illinois, Indiana and Kentucky, I must confine my paper to those found in the State of Ohio, where, during a residence of seventeen months, I made the closest investigation my time and duties permitted. In Ohio, the number of mounds, including enclosures of different kinds, is estimated at about 13,000, though it requires the greatest care to distinguish between the mounds proper and those subsequently erected by the Indians. In some parts they are very close together, which is strong evidence that these regions were densely populated. In others, a solitary mound, with adjacent burial mounds, gives us the idea of a rural village or town.

Enclosures.—In the State of Ohio, alone, there have been found 1,500 enclosures. Some of these have walls ranging in height from three to thirty feet, enclosing areas of from ten to 400 acres. Those areas, enclosed by strong walls, erected in regions difficult of access, were undoubtedly intended as military enclosures; while those areas enclosed by slight walls, with no mounds to cover the openings, were intended as sacred enclosures. I shall leave the consideration of the sacred enclosures until I describe the temple, or sacrificial mounds, giving a brief outline of some of the famous fortifications built by those strange people.

Within convenient distance of the city of Xenia, on Little Miami River in Warren county, Ohio, can be seen at any time that famous enclosure known as "Fort Ancient." There can be no mistake as to the intention of this wonderful enclosure. It is situated on the east bank of the Miami on a most commanding position. On the east, two ravines originate, running on either side towards the river, leaving the great fortress on an elevation of 230 feet above the river. The whole is surrounded by a wall of five miles in length, but owing to the uneven course of the river, there are only enclosed one hundred acres. The wall has numerous openings, which, however, are well protected by inner walls, or mounds. These openings could be occupied by warriors while the interior would not be exposed to the enemy. Within the enclosure are disposed twenty-four reservoirs, which could be dexterously connected with springs, so that in time of siege, they would be comparatively independent. The strength of this fortress does not depend on the walls alone, which range in height from five to twenty feet, but upon its isolated position and steep sides. Near the fortification are two large mounds from which run two parallel walls for 1,350 feet, and then unite, enclosing another mound. We cannot tell what part these outer walls and mounds played in the defence of this fortification. But we know that all give evidence of an immense garrison occupied by an ancient and somewhat civilized race, whose numerous enemies, doubtless, forced such strong defence. In point of inaccessibility, engineering skill, and strength, this famous enclosure will compare not unfavorably with Edinburgh Castle, the stronghold of Quebec, or the impregnable Gibraltar.

Another stronghold of considerable importance may be seen at Fort Hill, in Highland county, on an elevation of 500 feet, and enclosing an area of forty acres. There is another near Piqua, on a hill 160 feet high; and another near the city of Dayton, on a hill 160 feet high, where a mound is enclosed, which like the ancient watch-towers of Scripture, can command a view of the whole surrounding country. Near Carlisle lies the site of another remarkable military enclosure, which overlooks the fertile valley, between the Twin and Miami Rivers. Two deep ravines fortify the north and south sides, while an almost perpendicular bluff fortifies the east. The wall which is partly of earth and partly of stone is 3,676 feet in length, and encloses a beautiful area of fifteen acres.

The settlers state that in early times there were two stone mounds and one stone circle, which contained such excellent building stone, that they removed them for building purposes. They had to cut a way and grade it, to remove the stones, which those rude architects of early prehistoric times found no difficulty in taking from a distant quarry to that high elevation. We must therefore agree that their knowledge of the mechanical powers was far superior to anything the Indian race has shown.

About the largest fortification in Ohio may be seen at Bournville. It encloses a magnificent area of fertility, on an elevation of 400 feet. The sides are remarkably steep, and are washed by small creeks, that empty into Paint Creek hard by. Within the fortification are several depressions, where water remains most of the year. The area, of itself, would be a beautiful farm, as it consists of 140 acres. The wall, which was about 2¼ miles in length, is very much in ruins, being chiefly built of stone. Some years ago the whole place was covered by the trees, and on the dilapidated stone wall, may still be seen immense trees, whose growth among the stones helped to displace them. The decayed wood beneath some of these trees indicates that successions of forests have flourished since these forts were abandoned by those who made them.

Graded Ways.—It is well known that, in most of these valleys, there are several terraces, from the river bottom or flats, up to the high lands in the distance. Near a place called Piketown there is a beautiful graded avenue. The third terrace is seventeen feet above the second and the second about fourteen feet from the river flat. These terraces form, when graded, this avenue, which has walls on either side in height twenty-two feet. These walls run for 1,010 feet to the third terrace, where they continue to run for 2,580 feet, terminating in a group of mounds one of which is thirty feet high. Some distance from these walls another wall runs 212 feet at right angles, and then turns parallel for 420 feet, when it curves inwardly for 240 feet.

Mounds.—I stated at the outset that the mounds in Ohio were very numerous. They are of various sizes, ranging from those which are only a few feet in height and a few yards at their base, to those which are about 90 feet in height, and covering some acres at their base. These mounds are mostly composed of earth, the material often differing greatly from the surrounding soil. When we consider the multitudes of these mounds, and the immense transportation of earth and stones required in their structure, it needs no stretch of imagination to conclude that the Mound-builders were a mighty race. Most of these mounds are located near large rivers or streams, and, consequently, in the valleys, although some few are to be found on high lands, and even on hills very suitable for military purposes. Sometimes they may be seen in clusters, indicating a great business centre and large population, while again only one may be found in a journey of fifty or one hundred miles.

During the last fifty years, these tumuli have been carefully examined, and, from their contents, shape and position, they are now classified as Temple or Sacrificial Mounds, Burial or Sepulchral Mounds, Symbolic Mounds, Signal Mounds and Indefinite Mounds. I shall briefly describe the characteristic of each class and give a few examples.

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Temple Mounds.—These mounds are not so numerous in Ohio as in some other States, yet they occur in sufficient numbers to deserve a small share of our attention. The city of Marietta has slowly encroached upon some interesting remains of a sacrificial character, which consist of two irregular squares containing 50 and 27 acres respectively. They are situated on a level plain 100 feet above the level of the Ohio and Muskingum Rivers. The smaller square has ten gateways, which are covered by mounds, while the larger square, being strictly a sacred enclosure, has no mounds to cover the 16 openings, but contains nevertheless four temple mounds of considerable interest. On the top of these mounds, doubtless there were erected capacious temples, as there are significant avenues of ascent. There may still be seen the remains of the ancient altar, where, without doubt, these people assembled for worship, and where, from the presence of human bones, we may conclude human beings were offered in sacrifice. In all the sacred enclosures, evidences of altars have been found, on which, doubtless, the sacrificial fires blazed for ages. Often are to be found successions of alternate layers of ashes and blue clay, indicating a desire for pure sacrifice.

In the neighborhood of Newark, Ohio, at the forks of Licking River, may be seen most elaborate enclosures, square, circular, and polygonal in their form, covering in all an extent of four square miles. Like the ancient temples of the Druids, most of the enclosures have their openings to the east, or rising sun, so that the first rays shall strike the altar where doubtless a priest, from the early hour of dawn, performed mysterious rites.

On the west, there is erected a mound, 170 feet long and 14 feet in height, which overlooks the whole works, and has been styled "the Observatory". To the east is a true circle 2,880 feet in circumference, the wall being 6 feet in height. To the north of this is an avenue leading from the circle to an octogon of fifty acres, in the wall of which are eight gateways, which, however, are covered by mounds five feet in height. From this strange eight-sided figure run three parallel walls. Those to the south are about two miles in length, and those running towards the east are each about one mile in length.

About a mile east, where the middle line of parallel walls terminates, is a square containing twenty acres, within and around the walls of which are disposed seven mounds. To the north-east of this is an elliptical work of large dimensions. On the south-east is a circle, in the centre of which is the form of a bird with wings expanded. The body is 155 feet, the length of each wing 110 feet, and the head of the bird is towards the opening. When this structure was opened, there was found an altar, proving that, in this circular place, this ancient people must have assembled for worship.

There is a place three miles north of Chillicothe, where an extensive enclosure—now called "Mound City"—contains 26 well formed and regularly disposed mounds, covering an area of 13 acres. Many of those mounds contained altars at their base, but have been subsequently converted into ordinary mounds. One mound, which is 90 feet in diameter at the base and 7½ feet in height, contained an altar, within the basin of which was found a layer of solid ashes three inches thick, in which were numerous pieces of pottery and shell-beads. On the top of the altar was a layer of sand, then gravel for two feet, then a thin layer of sand, then one foot of gravel.

Buried three feet below the apex of the mound, were found two well developed and highly preserved skeletons, which, however, were not those of Mound-builders, but rather of the Indians who were buried there long after the mounds were abandoned. One altar was covered by a layer of opaque mica, which must have been brought from a great distance. In the centre of the basin was found, besides numerous other relics, a large heap of burned human bones, which would indicate it an altar of human sacrifice. From other evidences, we may safely conclude that they were Sun or Fire-worshippers. As to the cause of these altars being afterwards changed into common mounds, it is difficult to determine. Many such mounds are found, which for a long time were used for purposes of sacrifice, and then covered over by many feet of earth. We may not wonder, however, at this, as even now many old churches are abandoned to the fate of being turned into dwelling houses or barns.

It may be, however, that after the decease of the priest who performed his sacred functions before the altar for many years, the people, to whom he had so long ministered, laid, or burned his remains on the altar which they so much revered, and then, like the ancient builders of the pyramids, erected a monument to departed worth, and during the strange ritual deposited beside the respected remains whatever implements or ornaments they could part with, in honor of the dead.

Burial Mounds.—As in modern days, a place of sepulture is usually selected some distance from the city or town, so the burial mounds may be expected without the enclosures. In our own time we find some cemeteries densely populated with graves, and others have but few. So it was in the days of the Mound-builders; for we find in some places groups of burial mounds, and in other places only a few may be found scattered over the plain.

Burial mounds are of various sizes, I presume, according to the dignity of the individual entombed. Sometimes one large mound is found to possess a skeleton, and some interesting relics, which indicate the position of the departed, while a group of smaller mounds is situated around it. The large one perhaps contained the skeleton of a leader, surrounded by a few of his intimate followers. Or perhaps it was that of a patriarch, surrounded by his numerous progeny, much as, in our own day, burial plots are set apart for families.

Grave Creek burial mound, which stands at the junction of Grave Creek, Virginia, with the Ohio, is one of the largest and most important burial mounds in America. It is 70 feet in height and at its base it is 1,000 feet in circumference. When this mound was opened, two vaults were found, one at the base contained two skeletons, one of them a female. The logs of which this vault was composed were all decayed, and the earth and stones lay upon the skeletons. In the upper vault there was a single skeleton very much decayed. Within these vaults and beside the illustrous dead, were found more than 3,000 shell-beads, ornaments of mica, copper bracelets, and other stone carvings. Around the lower vault were found ten much decayed skeletons, all in a sitting posture.

The skeletons in the vaults, doubtless, were the remains of royalty, or some distinguished chiefs, whose memory these devoted people desired to perpetuate, while the ten skeletons, which surrounded the vault, were perhaps some of their loyal subjects who were sacrificed according to the custom of some of the heathen nations both ancient and modern. Foster, desiring to draw a comparison or rather identify this mode of burial with those of the Greeks and other nations, directs our attention to Herodotus, Book IV, Chaps. 71 and 190. And for identifying the ceremonial with the funeral of Achilles, our attention is called to the Odyssey, Book XXIV, with the burial of Hector in the Iliad, Book XXIV.

Dr. Wilson identifies the burial of the living with the dead by giving an account of the burial of Black Bird, the great chief of the Omahas more than 60 years ago. He caught the smallpox at Washington, and dying on his way home, he gave instructions to his braves around him how he was to be buried. "His body was clothed with the gayest Indian robes, decorated with scalps and war eagle plumes, and he was carried to one of the loftiest bluffs on the Missouri. He was placed upon his favorite war horse, a beautiful white steed. His bow was placed in his hand. His shield, quiver, pipe, medicine-bag and tobacco-pouch hung by his side, for his comfort on his journey to the happy hunting grounds of the great Manitou. After a significant ceremonial, the Indians placed turf and sod about the legs of the horse; gradually the pile rose, until living horse and dead rider were buried together in this memorial mound, which may be seen from the banks of the Missouri."

But to come back to the mound, I now describe a sandstone disk, 1½ inch in diameter and ¾ inch thick, taken up from near the skeleton in the lower part of Grave Creek mound. According to Schoolcraft's analysis, communicated to the American Ethnological Society, "Of the 22 alphabetic characters, 4 correspond with the ancient Greek, 4 with the Etruscan, 5 with the old Northern runes, 6 with the ancient Gaelic, 7 with the old Erse, 10 with the Phœnician, 14 with the old British," and he also adds that equivalents may be found in the old Hebrew. It is, as some writers have described it, an exceedingly accommodating inscription. The following readings have been given:—

By M. Levy Bing: "What thou sayest, thou dost impose it, thou shinest in thy impetuous clan, and rapid chamois." By M. Maurice Schwab (1857): "The chief of emigration who reached these places, has fixed these statutes forever." By M. Oppert: "The grave of one who was assassinated here. May God, to revenge him, strike his murderer, cutting off the hand of his existence." We can only say of these readings what a Hebrew Rabbi said to an indolent student, who in reading a verse in the Psalms in the original, gave the translation of the next verse, "Gentlemen, that is a very free translation." Besides this, other readings have been given, all of which have the advantage that few can contradict them.

In the Scioto valley, where there are many very interesting remains of the Mound-builders, there are many burial mounds which have lately been opened. In many of these, the casts of unknown logs are still visible, showing that the dead were placed in a rude vault, which was afterwards covered by soil. One skeleton was found to have round the neck several hundred beads, made mostly of marine shells, others made of the tusks of animals and a few laminæ of mica. In the same mound from which this skeleton was taken, the vault gave strong evidence of its having been set on fire during the burial ceremony,—the large quantity of charcoal proving that it was suddenly quenched by the fresh soil heaped upon it.

If these Mound-builders were Sun-worshippers, as may safely be concluded from tablets and from rock markings, as well as from the fact of their sacred enclosures mostly looking towards the east, where the early rays would fall upon the altar, we may easily account for the fire having a share in the burial ceremony. Some have concluded that the blazing fire signified "life," and that the sudden quenching signified "death."

Let it not be thought, however, that there are no burying places but these few mounds. I believe the mounds of a burial character were only for persons of distinction, while in reality there are thousands of ancient cemeteries of vast extent, where multitudes have received common burial. The spring freshets yearly uncover many of these, exposing not only their bones, but many ornaments and implements that were used by this wonderful people, and which were deposited beside them when consigned to the silent tomb.

Symbolic Mounds.—There can be no mistake in affirming that the strange mounds, so prevalent in Wisconsin, and frequently found in other States, were the result of intention rather than accident. These are sometimes called "Effigy Mounds." In Wisconsin, even implements, as well as animals, are symbolized. The beaver, the tortoise, the elephant, the serpent, the alligator seem to be their favorite animals, whose images they have endeavored to perpetuate in mounds, of course on a large scale. In Adams county, Ohio, on a steep bluff, 150 feet above the level of Brush Creek, may be seen a huge serpent.

It is called the "Serpent Mound." The head of the serpent lies towards the point of the spur, and then like the serpent, its body winds gracefully back for 700 feet, the tail curved into a triple coil. From this and other evidences lately collected, we may assume that the serpent was among the sacred animals. Between the jaws of this serpent there is a stone mound, bearing marks of long use as an altar. The body, which is a mere winding wall, is, on an average, five feet in height, and thirty feet broad at the base near the centre. Doubtless this wall was much higher when first made, and owing to the rains of centuries it has become lower and broader.

Another mound, the shape and proportion of an alligator, may be seen in Licking county, Ohio, about one mile from Granville. This is also on a spur of land near the Licking River. Its length is 250 feet and height about four feet.

Its whole outline is strictly conformable to the alligator with which animal they must have been familiar along the Mississippi, where they could easily journey by boat. Rather than transport the animal from the south, they doubtless erected this representation of what they must have held sacred.

In the State of Wisconsin there is one symbolic mound more worthy of notice than any other. It is called "the Elephant Mound," from the fact that it bears the proportion and conformability of the Mastodon. This people must have known something of this animal which in early times roamed over this continent. I think we should not be going too far if we supposed that the Mound-builders lived contemporaneously with the last of these monsters of the Prehistoric forests.

Signal Mounds.—It seems quite in keeping with what we have already seen of the sagacity of this wonderful race, that they should erect stations of observation in various suitable regions, so that signals could be given to the multitudes who dwelt in the plain, when they were threatened by an approaching enemy. If a fire were lit on a much burnt mound at the ancient fort near Bournville, it could be seen over a large portion of the valleys, where numerous works are found. No doubt, this was a signal mound, where the appointed watchman, like the watchman of Scripture, could give the alarm of the coming foe, enabling the industrious people to reach the fortress in safety.

On a hill 600 feet high, near Chillicothe, Ohio, there is a mound, which in the days of the Mound-builders must have been a signal mound. A light on this can be seen for twenty miles either up or down the valley.

The great mound at Miamisburg, Ohio, which is 68 feet high and 852 feet in circumference at its base, served, no doubt, this important department of warfare, as a fire kindled on it could flash light into Butler county, near Elk Creek, where it would again be taken up by the watchman there, and light flashed in the direction of Xenia, and from one signal mound to another until it would reach the great works at Newark. Thus in the course of an hour the whole southern portion of the State of Ohio could be warned of danger and prepare for combat or shelter.

Such a system has been used by all nations, both civilized and savage. We need not wonder that the Mound-builders with such sagacity and forethought, should establish such a system of alarm by which the inhabitants could be apprised of invasion.

Indefinite Mounds.—Of this class there are many. Thousands of such indefinite mounds and squares and circles are to be seen scattered over the various States of the Union. Their structure, composition and contents, give us no clue by which they may be assigned a place. It is believed that many of the strange works that abound in Butler county, Ohio, and which cannot be classified, are among the incomplete works, that is, works left unfinished by the builders.

Implements.—The people of Ohio have appropriated the implements of the Mound-builders to a large extent. Almost every homestead in Ohio is ornamented with some of those ancient implements and relics, yet tons have been taken away to grace private and public museums in all parts of this country, and even the museums of Europe and Asia. Among the implements are to be found spear heads, arrow heads, rimmers, knives, axes, hatchets, hammers, chisels, pestles, mortars, pottery, pipes, sculpture, gorgets, tubes, and articles of bone and clothing. Fragments of coarse, but uniformly spun and woven cloth have been found, of course not in preservation, but charred and in folds. One piece, near Middletown, Ohio, was found connected with tassels or ornaments, and may be seen at the Smithsonian Institute at Washington. In Anderson township, Ohio, native gold has been found for the first time. Several small ornaments of copper have been found covered with thin sheets of gold. Earrings also, made of meteoric iron, have been found, and a serpent cut out of mica. Some terra-cotta figures also, which give us an idea of the way the hair was dressed in the days of the Mound-builders. I cannot here name all the implements and ornaments that have been discovered. Though most of them are of hard stone, yet many have been found made of copper.

MINING, ETC.—That these people were miners, is evident from the prevalence of various mineral fragments and implements. At Mound City, near Chillicothe, has been found galena, none of which can be found in Ohio. Obsidian also is found in the shape of instruments, which they must have transported from the Rocky Mountains. Ancient mining shafts are found in Minnesota, where the solid rock had been excavated to the depth of 60 feet. On Isle Royal there are pits 60 feet deep, worked through nine feet of solid rock, at the bottom of which is a rich vein of copper, and in the two miles of excavations in the same straight line have been found the mining implements in great numbers. Such advancement in mining, sagacity in warfare, industrial pursuits, and geometric skill, as their works display, prove their great superiority of race over the modern Indian. Their implements, some of them most elaborately made, their brick-making and various other ingenious works, enable us to place them high as an industrial people, while their sacred enclosures, and altars, and tablets, together with the numerous evidences of their being an agricultural nation, enable us to place them far above the modern Indian in the scale of civilization.

The people of the United States, though much to be commended because of their prudence and forethought in laying out their modern towns and cities along the various water courses, which serve as the different highways of commerce, have by no means shown a superior sagacity in that respect to the Mound-builders, whose great centres of population are now mostly occupied, or are encroached upon by the modern cities.

We may with safety assert that the population about Newark, and Xenia, and Mound City, was far above what it is now. The country about Dayton, Miamisburg, Oxford, Hamilton and Marietta was, undoubtedly, in the days of the Mound-builders moving with a greater mass of human beings than it can boast of to-day.

And if those peaceable and industrious inhabitants were as numerous as their remains indicate, what must have been the strength of those invading hordes who caused their downfall and perhaps wiped out forever every living representative of that ancient race, who could leave no more lasting memorial of their existence and struggles than those mysterious mounds which have given them their name.

Antiquity of the Mound-Builders.—Upon this point there are many theories, some regarding them as the earliest of the Indian tribes. Others give them a very great age and claim them to belong to preadamite man. By far the greater number of archæologists, however, place their existence at about 2,000 years ago.

In favor of the latter view we may call as evidence the present forest trees, which, though of great age, still flourish on some of the ancient remains. On one of the mounds at Marietta, Ohio, there stood a gigantic tree, which, when cut down displayed 800 rings of annual growth. In many other places, trees of the age of 750 years have been cut, and underneath them evidences of previous forests found. One tree 750 years old was found to have underneath it, on the walls of one of the forts in Ohio, the cast of another tree of equal size, which would carry us back at least 1,500 years since those trees began to grow on those deserted walls of that ancient fortification.

We have some data in the vegetable accumulations in the ancient mining shafts near Lake Superior, as well as in the vegetable and other matter deposited in the numerous pits and trenches found among the works. Though these evidences cannot give the exact time of their accumulation, yet they give it approximately by comparison with similar recent deposits.

There is another still stronger argument in favor of their antiquity, viz., the decayed condition of the skeletons. The skeletons of the oldest Indian tribes are comparatively sound while those of the Mound-builders are much decayed. If they are sound when brought out, they at once begin to disintegrate in the atmosphere, which is a sure sign of their antiquity. We know that some skeletons in Europe have lately been exhumed, which, though buried more than 1,000 years, are comparatively firm and well-preserved. We are, I think, bound to ascribe a greater antiquity to the Mound-builders' skeletons than to those found in the ancient burrows of Europe. Other considerations, such as stream encroachment, and river-terrace formation, might also be brought in as presumptive arguments in favor of their great antiquity.

ORIGIN OF THE MOUND-BUILDERS.—This is a question not easily answered. It brings me into no discredit before the educated world to acknowledge ignorance on this mysterious point. The study of Craniology and Philology, in connection with Ethnology, shall alone throw light on this subject. Dr. Wilson says, in his "Prehistoric Man" (p. 123), "The ethnical classification of this strange race is still an unsettled question," and he declares without fear of contradiction, "that especially concerning the Scioto Mound skull, the elevation and breadth of the frontal bone, differs essentially from the Indian, and that the cerebral development was more in accordance with the character of that singular people, who without architecture have perpetuated, in mere structures of earth, the evidences of geometric skill, a definite means of determining angles, a fixed standard of measurement, and the capacity as well as the practice of repeating geometrically constructed works of large and uniform dimensions."

Undoubtedly they were skilled in agriculture, from the remains of ancient garden-beds, which were cultivated in a methodical manner. The modern Indians give no such evidence of labor. For wherever they are found they love to roam in undisputed possession of the forest, and lead an indolent life. Of course I do not assign this as a valid reason for their not being identified with the Mound-builders. An ancient race may have a degenerate offspring.

Nor shall I attempt to find in the various inscriptions any clue to their Hebrew origin, or to identify that ancient people with the lost tribes, as some have dared to do. Foster inclines to regard them as emigrating from the tropics, rather than coming from the north.

This would involve us in investigating the antiquity of the Mexican and Peruvian ruins, where vast works of high architecture and more advanced civilization were found than among the Mound-builders. There is little difficulty in concluding that the Aztecs, who occupied Mexico during the Spanish invasion under Cortez, were the conquerors of several races that preceded them. Among these conquered races, no doubt, were the Toltecs, who were afterwards found in such great numbers, and in an amazing state of advanced civilization. The crania of the Mound-builders and the Toltecs correspond. Now, whether they migrated to the north from the tropics, or journeyed south from the north, I cannot say. I should incline to the latter theory. Industry is sure to advance. The rude mounds of the United States are far surpassed by those immense pyramids in Mexico and Peru, surpassing the Egyptian in size. And those fine architectural palaces and temples, whose history we cannot fully know, far eclipse anything in the northern part of America.

Whoever they were and wherever they came from, they were doubtless driven southward by the invading tribes of the north. They nobly fought their way, contesting every foot, until superior numbers took them by force. Thus these quiet and inoffensive creatures were finally expelled from their home which doubtless their fathers had occupied through centuries. If any escaped they, no doubt, found an asylum southward, where there were other tribes equally civilized, and, forming an union with them or conquered by them, they began a higher and better civilization as seen in Mexico and Peru.

Geology and Geologists in New Brunswick.

By L. W. Bailey.

In a recently issued Bulletin (No. XI.) of the Museum of Comparative Zoology, relating to the Azoic System and its proposed subdivisions, the authors (Messrs. J. D. Whitney and M. E. Wadsworth) review the progress of geological investigation in New Brunswick and my connection there-with in a way which, in justice to myself and my colleague, Mr. G. F. Matthew, seems to call for some explanation. In the review referred to, it is the avowed object of the author or authors to show, by numerous citations, as well as by tabular representation, that great diversity of opinion has existed as to the age of the older rock-formations of this Province, that these opinions have had no reliable basis of observed facts, are a mass of confusion, and by consequence worthless.

To the first of the above statements I have no special objection to offer, but desire to emphasize the fact that the review in question embraces a period of over twenty years, and the work of not less than five different observers, engaged at different times and places, often independently, and in a region of the most varied and complicated character. During that period changes of the greatest importance have occurred alike in geological methods, in geological nomenclature, and in general geological theories; while, as regards more particularly regions of metamorphic rocks, these have everywhere been the subject of continued and keen controversy. Such diversities of opinion and the discussions to which they give rise are inseparable, as I believe, from investigations of this kind, and not only have occurred, but must occur in the study of all regions of disturbed and highly altered rocks. The comparative review of such studies over many different parts of the continent (and, I might add, of Europe also,) shows that the investigations in New Brunswick are in no way exceptional in this particular.

But I have now to add that the actual changes of opinion complained of have really been much less than the citations of Dr. Wadsworth and his colleague would seem to indicate. Thus, since the time of the first determination of the real age of the St. John City slates as Primordial, neither Mr. Matthew nor myself have ever held or expressed any other opinion than that the great bulk of gneissic, calcareous, siliceous, and felsitic rocks which underlie them (and which we compared with the generally accepted Laurentian and Huronian systems) were pre-Silurian, and that their sequence was that given in our first accounts of the region. Owing however to the successive study of adjoining districts and the often very different relations exhibited at these several points (members which were apparently conformable at one point ceasing to be so at another, while portions largely developed at some points failed to appear altogether at others), different views have at various times been held as to where the lines of separation between successive formations were to be drawn. Thus, while the base of the Primordial was at first believed to be marked by certain white sandstones or quartzites, while the underlying purple sandstones and conglomerates were thought to be more intimately connected with the Huronian, reason was afterwards found for regarding the real base of the Primordial as being *beneath* these coarser beds; thus accounting for the apparently contradictory statements, first, that no sandstones or even grits were contained in this formation, and later, that it included at its base heavy conglomerates filled with the debris of the underlying Huronian. As these conglomerates are at some points wholly wanting, the different views expressed above become readily intelligible. So again, while at St. John there is an apparent conformity and great similarity among all the rocks, notwithstanding that they are now known to contain in different parts fossils of widely different ages, a few miles away from the city that conformity fails altogether, and hence so long as the conditions of the formations at that city alone were known, the views of their relations might well be different from what later and more extended observations showed to be the more correct ones.

The conformity or unconformity of the Primordial to the Huronian (Coldbrook group) dwelt upon at length by the authors of the "Azoic System" will be apparent or not just according to what we regard as being Primordial. If the conglomerates and associated beds beneath the fossil-bearing strata be regarded as Huronian, the two series, so far at least as these beds are concerned, will be conformable; if included with the Primordial (as later investigations fully prove to be the case), then the want of conformity of the latter to the pre-Silurian is marked and general. I may here add that the observations on which these conclusions were based were far from being made in a day or even in a single season, but involved an amount of difficult exploration, in a region but little settled, which only those who have worked in such localities can fairly appreciate.

One point more. The authors of the "Azoic System" take exception to the work of Mr. Matthew and myself for introducing structural complications, such as faults, folds, and overturns, merely for the purpose of satisfying certain theoretical conceptions, and assert that these are entirely the work of the imagination. In the face of the fact that the authors referred to have probably no personal acquaintance with the district described, it is quite as fair to reply that *their* opinion in the matter has no solid foundation to rest upon. If the occurrence of a reversed succession is any proof of a reversed or folded position of the beds in which it is exhibited, then the evidences of such folds and reversals, as detailed in the reports, are certainly ample. As to faults, the country, as in most regions of highly disturbed rocks, is full of them, and where their existence explains relations which are otherwise inexplicable, I am at a loss to understand why they should be ignored. It is true that an error into which we had fallen as regards one of the groups described (the Bloomsberry group), from a want of knowledge of its relations to other formations beyond the district examined, was corrected by Dr. Hunt; but that in the main facts, as to the age and succession of the several groups and their structural relations, we were subject to the "dictum" of that gentleman, is quite incorrect. So far is this from being the case that the views of that succession as ascertained by us prior to Dr. Hunt's first visit to this region, have been steadily maintained by us and by the Canadian Survey, and I believe are generally accepted.

Want of space prevents my noticing a number of misconceptions and some mis-statements by the authors of the "Azoic System." A comparison of the recently issued maps of this region with those in existence twenty years ago, when our labors began, will sufficiently show how far a real progress has been made.

Studies in the Comparative Physiology of the Heart.[1]

By T. Wesley Mills.

RHYTHM AND INNERVATION OF HEART OF SEA TURTLE.

This investigation was undertaken partly as a continuation of previous work on the sea turtle, a short account of which had already been published in the *Journal of Physiology*, but chiefly as a continuation of my work on Chelonian heart physiology in general. A paper of mine, on the terrapin's heart, has recently appeared in Vol. VI, Nos. 4 and 5, of the journal referred to; but the whole of my work on the Chelonians is intended to furnish a systematic comparison from a physiological point of view of several of the genera and species of the Chelonians. It is thought that no such systematic comparison has ever before been attempted for physiology, though it is constantly being done in morphology.

The investigation on the terrapin was carried on in the Biological Laboratory at Baltimore; those on the sea turtle, alligator and fish, at the Marine Laboratory at Beaufort, N. C. Only a very brief account of this work is furnished here, the papers *in extenso* having been sent for publication in the *Journal of Physiology* of Cambridge, England, in which also due acknowledgement is made of my indebtedness to the authorities and teachers of the Johns Hopkins University for facilitating these investigations.

In all of them the direct method of observation has been used and the heart has been experimented upon mostly *in situ*. For electric stimulation, a Du Bois induction coil, fed by one Daniell's cell has been used, except in the case of one set of experiments on the alligator, in which a Bunsen's cell was substituted.

In order to insure the specimens of the sea turtle being in the best possible condition, those not used at once

[1] Contributed by Prof. Mills, of McGill University, Montreal, to *John Hopkins University Circulars.*

on being caught were kept on the sea shore in a "turtle pen," so arranged as to admit of free ingress and egress of water. They were also fed on crabs, their natural diet. In all, 20 specimens were employed, belonging to three species *Chelonia caretta* (Loggerhead), *Chelonia imbricata* (Hawksbill), *Chelonia midas* (Green Turtle). By way of comparison, experiments have also been made on a limited number of specimens of the land tortoise (*pyxis*).

The Sympathetic System of Nerves in the Marine Turtle.—It is very remarkable that *Chelonia midas* in its cervical and thoracic sympathetic should very closely resemble the terrapin, but differ widely from *C. caretta* and *imbricata*. In the latter, the sympathetic in the neck runs widely apart from the vagus and almost equals it in size. Its superior and middle cervical ganglia are ill-defined cordiform swellings, while the lower cervical and the first thoracic ganglia are fused together to form the ganglion cardiacum basale. The latter is very large and gives off upward many strong branches to the brachial plexus, and downward to the lungs, etc., and probably to the heart.

From the middle cervical ganglia a strong branch passes to the heart along the vagus. This is a cardiac accelerator. The corresponding branch in the terrapin is much less defined and often wholly wanting.

Chelonia midas differs greatly from *C. caretta* and *imbricata*, resembling very closely in its sympathetic system the terrapin. The sympathetic in the neck is very much smaller than the vagus, its ganglia well marked and it is often more or less united with (though easily separable from) the vagus. But a great difference is observed in the absence of fusion of the lower cervical and the first thoracic ganglia. These ganglia are in the terrapin often connected by an annulus Vieussenii.

Sympathetic Cardiac Accelerators.—Stimulation of the branch from the middle cervical ganglion referred to above leads in the sea turtle with greater constancy than in the terrapin to acceleration of the rate, and especially augmentation of the force, of the beat of the heart. Also stimulation of the ganglion cardiacum basale or the main chain between it and the first associated metamere below, leads to acceleration and augmentation. The same laws apply to this as to vagus acceleration.

The Results of the Stimulation of the Vagus.—The vagus when stimulated may arrest the auricle and ventricle in the manner described for the alligator. In no Chelonian thus far examined is the heart arrested by the vagus through the reduction of the force of the beat to zero, as in the frog. As in the terrapin, unilateral vagus effects are comparatively common; i.e., a strength of current sufficing to arrest one auricle, for example, when the corresponding vagus is stimulated, has much less effect on its fellow.

Comparative Effect of each Vagus.—A large number of experiments have given results very closely resembling those obtained for the terrapin, i.e., in the great majority of instances the right vagus has greater power, especially in maintaining the heart in stand-still or continued stimulation, than the left; but in both terrapin and sea turtle this difference appears to be less than in the land tortoise. This difference in the vagi seems to extend to other families of cold-blooded animals, and is to be explained not by a difference in the number of inhibitory fibres in each vagus, nor by inequality in the distribution of them, but by the fact that the right pulsatile venous area (right sinus and veins), to which the right vagus is mostly distributed, is the chief or dominating part in the driving machinery of the heart, for arrest of the heart is practically dependent on arrest of the sinus. In one case, in the sea turtle, prolonged alternate stimulation of the vagi gave perfect cardiac inhibition for more than six hours. This is the longest case of heart stand-still of this kind yet recorded for any animal.

Structure of the Chelonian Heart.—Between the sinus and the conspicuous auricle there is a part of the heart somewhat different in appearance, structure, and physiological qualities from either the sinus or auricle proper. A similar structure is found in some fishes. Especially have my experiments shown that the capacity for independent rhythm in this part is greater than in the so-called "bulged" part (Gaskell) of the auricles. I have, therefore, thought it well to name this part "sinus extension," and consider it a separate part of the heart. It is in reality more allied functionally to the sinus than to the auricle proper.

Very frequently in the Chelonians and especially in the marine turtles, stimulation of the vagus with a weak current suffices to arrest the auricles proper; in that case the contraction wave of the sinus is conducted along the sinus extension to the ventricle. The same occurs in the alligator and the fish.

The Law of Inverse Proportion.—My work on the various genera of Chelonians and the alligator has shown conclusively that, whether the vagus or the sympathetic cause the cardiac acceleration and augmentation, one law invariably applies, viz., that the increase in the rate and force of the heart-beat, after stimulation of the vagus or accelerating sympathetic, is always inversely as the rate and force at the time of stimulation, i. e., the slower and weaker the heart, the greater the increase. The vagus seems to be the most constant and powerful cardiac augmentor known to us.

Faradisation of the Heart directly has given for the sea turtle results analagous to those obtained in other Chelonians and the fish, but in the sea turtle there seems to be less effect, especially as regards dilation around the area stimulated.

The fact that arrest of the sinus by direct stimulation is not possible when the heart nutrition has much suffered (and especially, therefore, its nerves), and that the dilating effects are like those produced by vagus stimulation, etc., favors the view that the results of faradisation are not due to direct stimulation of the heart muscle but accomplished mediately through its nerves. The light-colored areas, which, I have pointed out, are seen in all cases at the exact points of contact of the electrodes, are due to direct effects of the muscle (contraction).

Spontaneous Rhythm.—The order in which spontaneous rhythm most readily arises and is best maintained is: sinus, sinus extension, auricle, ventricle. A large number of experiments on the ventricle, especially, of the sea-turtle, show that in the latter, as in all other Chelonians thus far examined, the ventricle has in most cases a certain capacity for independent rhythm, but that apart from all forms of stimulation, this rhythm is never very marked, though it may last for hours. This seems to be greater in the land tortoises than in other Chelonians.

The ventricle of the sea turtle is characterized by great sensitiveness as compared with that of other Chelonians, hence its spontaneous rhythm may be greatly increased by slight stimulation. Results, like those of Gaskell, obtained by suspending the heart, attaching recording levers and feeding it through its own system of vessels, without regard to the normal blood pressure therein, must not be considered as those of pure spontaneous rhythm, for such methods furnish stimulation. In my experiments, the heart was kept surrounded with nutriment and covered so as to provide a "moist chamber," but it remained *in situ.* The ventricle was separated by ligature in most cases, by section in a very few.

Is there a Depressor Nerve in the Chelonions ?—Blood pressure experiments on the terrapin and the sea turtle have shown that no nerve, with the characters of a physiological depressor, exists in this family. Certain fine nerves in the neck of the sea turtle have, on stimulation, given results of a peculiar and puzzling kind. They have been inconstant in action, sometimes giving rise to acceleration, sometimes to retardation of the cardiac rhythm, or to both—now one, and now the other.

Stimulation of the Cerebral End of one Vagus, the medulla and other vagus being intact in all the Chelonians I have examined, has usually produced cardiac arrest. In the sea turtle, in one case, this was followed by decided after-acceleration, but the different genera of Chelonians and even different species and individuals show variation in this respect, as also in the degree to which the heart can be reflexly inhibited ; the terrapin and *C. Midas* resembling each other most and giving the best marked results. In fact this research has confirmed the truth of the law, that with anatomical resemblances are usually associated physiological ones.

Evolution of Function.—The experiments on the sea turtle have shown that where the cardiac nutrition suffers considerably, the left auricle may even be quiescent when the right is still beating well; also that the ventricle dies in a certain segmental order, the last part to get rigid being on its right side. Thus for some time before death an earlier condition (from a developmental point of view) is established, viz., reduction to sinus, one auricle, and a simplified ventricle. It is thus seen that the order of death for the different parts of the heart indicates its history, the oldest parts have greatest vitality. Further, the greater size and importance of the right (part of the) sinus, of the right auricle, etc., have also a relation to the order of acquisition. In the only fishes having a left auricle, the Dipnoï, this part is very small and insignificant as compared with the right.

Anomalous Results.—Stimulation of the liver in certain cases in the sea turtle, when reflex inhibition was being studied, has given results analagous to those obtained in the alligator, and especially in the fish, i.e., the effect has not been pure inhibition, but preliminary acceleration with or without after-retardation. The subject is of great interest, though very puzzling in the present state of knowledge. It is further considered in the account of the investigation on the alligator.

(To be continued.)

Aboriginal Trade of the Canadian Northwest.

By Charles N. Bell.

Articles of beaten native copper such as knives, chisels, awls, scrapers, bracelets, etc., have been taken from mounds situated on the banks of Rainy River. The metal in all probability was mined at Lake Superior; perhaps at Isle Royal, which is opposite the eastern terminus of a canoe route leading from Rainy River. On this island many mines, first worked by a prehistoric people, have been discovered during the past few years.

Sea shells of the genera *Natica* and *Marginella* (?) have been found in the mounds in close proximity to articles of copper. This fact gives us a clue to the direction of the line of trade and the articles which were exchanged by the Mound-builders of the north and south.

By ascending any of the several small streams which flow from the south into Rainy River, communication is had without difficulty with the Mississippi, along the banks of which, Mound-builders' remains may be counted in thousands. Articles made from the Lake Superior copper are found in many of the mounds to the far south, and when we find southern sea shells in the northern mounds, it may be taken for granted that one was exchanged for the other.

Gold, silver, mica, asbestos, lead, pyrites, etc., appear in the rocks of Lake of the Woods, close at hand to the mounds on Rainy River, but none of these minerals, so far as reported, have been taken from the tumuli. This is rather peculiar in the matter of the mica, as it is frequently found in the mounds of the Central States, generally in the form of thin sheets covering the interments, though often cut into shapes intended for use as ornaments.

So far as known, few manufactured articles of copper or pieces of the raw metal have been taken from the mounds on Red River in Manitoba, in striking contrast to the rich yields of the Rainy River tumuli. So little exploration has been done in the Manitoba mounds, that it is not possible to state with any degree of certainty that copper implements or ornaments will not yet be found in them; but, if we judge from the data to hand, there must have been a difference in the stock in trade, available for exchange with southern tribes, possessed by the Mound-builders living on Red and Rainy Rivers. The mound systems of these two rivers merge into one about the head of the Mississippi, and it seems impossible that the residents of the two districts were not in communication with each other.

The presence of pipes for smoking in some N. Mississippi mounds, makes it apparent that tobacco was an article of exchange, for though the Indians of the present day use various substitutes for tobacco, in the form of bark and leaves, there would be an eager demand for the tobacco of the south, the existence of which must have been known to this northern people through their intercourse with tribes to the south.

Fur was plentiful in the northern country, and would be traded with the people living in the south, who, though inhabiting districts possessing a milder climate, were glad to have the light fine furs for protection at certain seasons.

Mounds on Red River in Manitoba have been found to contain ornaments cut from shells of the *Busycon perversum*, which necessarily were transported fully 1,500 miles from the waters in which they are produced, to be made an object of barter.

Red River valley was, at a not very remote date, the feeding ground for countless thousands of bison, and their remains have been found by me in the mounds and amongst the kitchen middens of their old camp site in the immediate vicinity. The dried flesh of the bison was likely stored up for winter use, and became an article for exchange with the people of the wooded country and the copper miners.

At St. Andrew's, Manitoba, a limestone ridge topped with drift-gravel and boulders from the Laurentian formation to the east or north-east, crosses Red River. Near a group of mounds at this point I discovered an ancient camp site, and from the bank of the river took quantities of flint chips, partially worked and finely finished arrow-heads, scrapers, etc. The drift on the ridge supplied the raw material, and this place was evidently a resort where flint implements were manufactured to supply the wants of the residents of less favored localities.

From the quantities of broken pots found in the river bank and the fact that the clay and decomposed granite, entering into the composition of the earthenware, is to be had in abundance in the vicinity, it seems altogether likely that pottery was also made at this camp site and became an article of trade. I have examined an earthenware pot taken from a mound situated within the city limits of St. Paul, Minnesota, which, as regards size, composition, construction, and style of marking, is identical with specimens of the fragments taken from the Manitoba camp site, and with a complete cup from a mound situated at the International Boundary Line. Though 500 miles apart, these two localities are practically connected by a continuous line of mounds, and it is not improbable that pottery made on Red River was passed from hand to hand until it reached a distance of 500 miles from the workshop.

No article of European manufacture has been taken from the Manitoba mounds, not even from about the remains of the intrusive burials, so that there is every likelihood that the work of the builders in that country had ceased long before Kelsey, de La Vérendrye, and later European adventurers made their appearance in the Northwest and revolutionized trade.

Variation of Water in Trees and Shrubs.

By D. P. Penhallow.

The amount of water which highly lignified plants contain, particularly as influenced by season and condition of growth, obviously bears a more or less important relation to physiological processes incident to growth, and most conspicuously to those which embrace the movement of sap. Studies relating to the mechanical movement of sap in early spring, at once suggest the question as to how far this is correlated to greater hydration of the tissues at the time when this movement is strongest. It was with a view to exhibiting this relation more clearly, that determinations of moisture in a large number of woods, representing growth of one and also of two years, collected at different seasons, were made by me in 1874.[1] The range of seasons was not as complete as could have been desired, and no attempt was made to formulate a general law applicable to this question. With a view to extension of data in this direction, I undertook additional determinations in 1882. The final determinations were made in most cases by Mr. W. E. Stone, then acting as assistant. It is the object of the present paper to combine all the results thus obtained, together with such other facts

[1] W. S. Clark: Agriculture of Massachusetts, p. 289.

as have come to hand, and to see how far they indicate a general law.

Theoretical considerations lead us to infer that if there is any variation at all, the hydration of the structure must be greatest during the period of active growth, and least during the period of rest. How far this is supported by the facts, will appear in the following.

HYDRATION OF DEAD WOOD.

Incidentally to the main question, specimens of dead wood, devoid of the bark, and representing an age of four to six or eight years, were collected and the moisture determined. While the branches were dead, none of them were in advanced stages of decay, so that the contained water could not be regarded as that of active decomposition, but simply that which would be readily retained in the lifeless, air-dried substance as exposed on the tree. The results obtained from fifteen species of trees showed an extreme variation of 6.4 per cent., the range being from 12.9 per cent. to 19.0 per cent. of water. The mean hydration obtained from these determinations, was 15.1 per cent. The results appear in the following table:—

HYDRATION OF DEAD WOODS.

Determined at 100° C.

SPECIES.	PER CENT. WATER.
Acer saccharinum	18.8
Amelanchier canadensis	19.0
Betula alba	15.1
" excelsa	15.9
" lenta	13.7
Carpinus americana	13.8
Castanea vesca	14.0
Cydonia vulgaris	12.9
Cornus sericea	13.6
Pinus strobus	11.9
Pirus malus	12.9
Prunus serotina	17.4
Quercus alba	15.5
Tsuga canadensis	18.6
Ulmus americana	13.5
MEAN.	15.1

HYDRATION OF WOOD FROM LIVING TREES.

The specimens, upon which the principal facts of this paper are based, were collected as sections of living trees, representing on the one hand, branches of two years growth, and on the other, branches from two to four years old. For the obvious reason that the bark could not be properly separated from the wood with any degree of uniformity, it was left on in every case, so that in all the determinations here given, the results show the combined percentage of water in wood and bark. Obviously, this gives a result which differs materially from that which would be obtained if bark and wood were considered separately. Also, while care was taken not to collect specimens in which the dead bark was strongly developed, thus securing as great uniformity as possible, the very fact that the bark was present, as well as the certainty of its being variable in structural character and thus also in hydration, as collected even from the same species at different seasons, rendered variations in the results unavoidable. This will doubtless appear upon examining individual cases, but the error from this source is reduced in the aggregate, so that the mean results, in view of all the precautions taken, may doubtless be accepted as correct.

From an examination of the results that follow, it will appear that, comparing the younger with the older wood, the percentage of water is sometimes greater in one, sometimes greater in the other, apparently conforming to structural peculiarities of the species. The mean results, however, show clearly what we might infer upon theoretical grounds, viz., that in the youngest growth, as also in the sap wood, the percentage of water is higher by two per cent. than in the older growth where the heart-wood is in relative excess. This is found to hold true in the mean results, not only for each season, but also for all seasons; in the former case, however, this difference shows a variation of from 0.8 per cent. to 3.3 per cent. of water.

Species.	English Name.	February. 1st Year	February. 2nd Year	March. 1st Year	March. 2nd Year	April. 1st Year	April. 2nd Year	September. 1st Year	September. 2nd Year	December. 1st Year	December. 2nd Year
MAGNOLIACEÆ.											
Liriodendron tulipifera, L.	Tulip tree	......	55.8	52.7	54.9	......	......	......	......	......	59.30
TILIACEÆ.											
Tilia americana, L.	Bass wood	55.1	53.9	......	55.6	......	......	48.6	55.9	53.20	58.1
RUTACEÆ.											
Ailanthus glandulosus, *Desf*	Tree of heaven	48.6	46.0	......	......	......	......	......	......	......	......
ANACARDIACEÆ.											
Rhus glabra, *L.*	Smooth sumach	......	......	45.6	41.1	......	......	......	......	41.2	36.4
" typhina, *L.*	Staghorn sumach	......	......	51.3	33.3	......	......	......	......	......	......
VITACEÆ.											
Vitis cordifolia, *Michx.*	Frost grape	42.1	41.7	48.3	48.0	......	......	......	......	48.8	48.7
Ampelopsis quinquifolia, *Michx.*	Virginia creeper	......	......	59.2	60.7	......	......	......	......	76.4	62.4
ILICINEÆ,											
Ilex verticellata, *Gray*	Black alder	......	......	46.2	46.4	......	......	......	......	48.0	49.4
CELASTRACEÆ.											
Celastrus scandens, *L.*	Bitter sweet	......	......	47 7	49.4	......	......	......	......	52.3	52.4
RHAMNACEÆ.											
Ceanothus americanus, *L.*	New Jersey tea	......	......	17.3	37.6	......	......	......	......	19.5	41.4
SAPINDACEÆ.											
Acer saccharinum, *Wang*	Rock maple	46.5	47.1	47.5	42.9	......	......	48.1	44.0	42.6	42.7
" rubrum, L	Soft maple	44.9	44.7	50.8	45.4	......	48.7	......	......	53.0	55.1
Æsculus hippocastanum, *L*	Horse chestnut	49.1	46.1	......	......	......	......	......	......	......	......
" flava, *Ait*	Sweet buckeye	......	......	......	......	......	......	64.9	65.4	......	......

LEGUMINOSÆ.											
Gleditschia triacanthos, *L.*	Honey locust	34.9	......	......	......	......	......	......	......	......	......
Robinia pseudacacia, *L.*	Locust	......	......	44.0	38.3	......	......	......	......	51.3	......
ROSACEÆ.											
Amygdalus persica, *L*	Peach	46.1	40.4	50.9	49.4	56.0	43.7	......	......	55.3	42.0
Prunus domestica, *L.*	Plum	......		48.1	41.2	......	......	......	......	53.9	46.2
" serotina, *Ehrhart*	Black cherry	......	......	52.7	50.8	......	......	50.6	50 3	47.3	46.0
" cerasus, *L.*	Cherry	......	......	49.9	......	......	......	......	......	50.6	47.7
Cydonia vulgaris, *L.*	Quince	45.5	39.6	......	......	......	......	56.3	52.6	......	......
Pirus communis, *L*	Pear	49.9	47.7	49.7	48.1	55.4	54.0	54.0	51.5	53.7	50.0
" malus, *L.*	Apple	49.5	44.8	45.7	41.5	49.0	46.4	56.2	54.5	48.3	51.9
Amelanchier canadensis, *Torr & Gr.*	Shad bush	44.3	38.0	......	44.6	......	......	......	......	47.4	45.1
Cratœgus tomentosa, *L*	Thorn	......	......	43.1	40.4	......	......	......	......	55.9	43.4
HAMAMELACEÆ.											
Hamamelis virginica, *L*	Witch hazel	41.7	41.1	48.2	54.2	......	......	......	......	48.7	51.3
CORNACEÆ.											
Cornus florida, *L.*	Flower'g dogwood	......	......	55.1	43.2	......	......	......	......	53.6	52.8
" sericea, *L.*	Silky dogwood	......	......	50.6	49.2	......	......	55.4	......	51.2	......
Nyssa multiflora, *Wang*	Tupelo	50.9	49.0	48.0	49.3	......	......	51.1	50.9	50.8	58.7
CAPRIFOLIACEÆ.											
Sambucus canadensis, *L.*	Elder	......	......	58.2	48.2	......	......	......	......	56.3	55.1
" pubens, *Michx*	Red-berried elder	54.5	55.7	......	......	......	......	......	......	......	......
Viburnum opulus, *L.*	Cranberry tree	44.7	47.7	......	......	......	......	......	......	......	......
RUBIACEÆ.											
Cephalanthus occidentalis, *L.*	Button bush	......	......	54.1	42.8	......	......	......	......	42.8	......
ERICACEÆ.											
Andromeda ligustrina, *Muhl.*	......	......	......	46.7	45.9	......	......	......	......	38.0	59.0
Kalmia latifolia, *L*	Calico bush	......	42.5	50.7	44.4	......	......	......	......	49.4	42.3
Azalea nudiflora, *L.*	Azalea	......	......	41.3	43.8	......	......	......	......	45.8	49.9

Species.	English Name.	February.		March.		April.		September.		December.	
		1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year	1st Year	2nd Year
OLEACEÆ.											
Fraxinus americana, *L.*	White ash	32.0	29.6	38.3	34.4	......	......	......	......	35.2	29.5
THYMELEACEÆ.											
Dirca palustris, *L.*	Leatherwood	51.8	......	......	......	......	......	......	......	......	......
LAURACEÆ.											
Sassafras officinalis, *Nees*	Sassafras	34.9	33.9	40.7	38.1	......	......	......	......	......	41.4
SOLANACEÆ.											
Lycium barbarum, *L.*	Matrimony	......	......	......	......	......	......	......	......	65.4	58.0
URTICACEÆ.											
Ulmus fulva, *Michx*	Red elm	......	......	52.1	44.0	......	......	......	......	51.5	36.3
" americana, *L.*	White elm	41.4	39.8	45.6	36.8	......	......	57.1	52.3	43.0	43.9
Morus alba, *L.*	White mulberry	52.1	43.0								
" rubra, *L.*	Red mulberry	......	......	47.0	42.8	......	......	......	......	56.2	40.9
PLATANACEÆ.											
Platanus occidentalis, *L.*	Plane tree	44.5	51.6	50.2	52.1	52.5	53.8	......	......	48.2	50.6
JUGLANDACEÆ.											
Juglans nigra, *L.*	Black walnut	45.5	46.1	50.2	56.1	......	......	......	......	50.6	53.8
" cinerea, *L.*	Butternut	......	......	50.5	52.2	......	......	54.2	54.1	49.5	50.4
Carya alba, *Nutt.*	Hickory	......	......	39.2	40.2	......	......	45.7	45.1	38.4	37.8
" porcina, *Nutt.*	Pig nut	......	......	40.8	38.0	......	......	......	......	38.1	35.4
" amara, *Nutt.*	Bitter nut	33.3	31.2	......	......	......	......	......	......	......	......

Cupuliferæ.											
Quercus alba, *L.*	White oak	38.0	35.2	40.6	38 7	41.2	36.7	43.1	39.5	45.0	41.9
" bicolor, *Willd.*	Swamp oak	......	......	45.0	......	......	......	......	......	46.9	......
" coccinea, *var. tinctoria, Wang*	Scarlet oak	......	......	42.5	38.0	......	......	......	......	44.9	39.3
" ilicifolia, *Wang*	Scrub oak	......	......	40.6	39.4	......	......	......	......	42.2	38.4
" palustris, *DuRoi*	Pin oak	......	......	43.2	39.8	......	......	......	......	44.8	39.9
" prinus, *L.*	Chestnut oak	......	......	42.4	37.9	......	......	......	......	42.4	......
" rubra, *L.*	Red oak	......	34.3	42.6	38.6	......	......	......	......	41.7	39.9
Castanea vesca, *L.*	Chestnut	......	......	47.4	45.6	......	......	......	......	45.1	44.5
Fagus ferruginea, *Ait*	Beech	44.2	44.7	45.4	45.7	......	......	......	......	45.2	45.8
" sylvatica, *var.* purpurea	Purple beech	......	......	43.8	43.3	......	......	......	......	43.7	43.5
Corylus americana, *Walt*	Hazel	......	......	49.8	48.6	......	......	......	......	50.9	52.8
Ostrya virginica, *Willd*	Lever wood	57.6	38.6	43.0	36.5	......	......	......	......	44.4	44.5
Carpinus americana, *Michx*	Iron wood	38.7	39.4	45.6	42.8	......	......	51.7	48.7	44.5	43.9
Myricaceæ.											
Comptonia asplenifolia, *Ait*	Sweet fern	40.6	40.0	......	......	......	......	......	......	......	......
Betulaceæ.											
Betula lenta, *L.*	Cherry birch	......	......	44.9	38.9	......	......	......	......	44.7	41.5
" lutea, *Michx*	Yellow birch	42.4	43.6	......	38.2	......	......	49.7	49.4	44.4	42.5
" alba, *var.* populifolia, *Spach*	White birch	46 2	42.0	41.1	37.7	......	......	53.9	48.5	45.0	39.1
Alnus viridis, *D.C.*	Green alder	......	......	47.9	43.2	......	......	......	......	48.9	55.0
" incana, *Willd*	Speckled alder	50.4	51.5	......	......	......	......	......	......	......	......
Salicaceæ.											
Salix alba, *var.* vitellina, *L.*	White willow	49.9	51.7	55.5	55.5	......	......	53.1	49.7	55.4	55.5
Populus tremuloides, *Michx*	Aspen	49.8	50.9	47.9	52.5	......	......	53.3	51.0	52.8	51.5
Coniferæ.											
Larix europea, *L.*	Larch	40.9	47.8	......	......	......	......	......	......	......	......
Juniperus virginiana, *L.*	Red cedar	......	......	57.6	45.9	......	......	......	......	56.2	45.1
Tsuga canadensis, *Carriere*	Hemlock	48.7	49.6	46.8	49.9	......	......	......	......	44.1	45.6
Pinus rigida, *Miller*	Pitch pine	......	......	54.2	54.3	......	......	......	......	53.8	57.6
" strobus, *L.*	White pine	......	......	58.8	52.1	56.3	55.5	62.9	58.3	63.1	51.6

If we next inquire into the relation which seasons bear to the contained water, we shall observe that the percentage continually rises from the midwinter period until spring, and that it again falls from the close of summer to the midwinter period. The extreme variations as exhibited in our figures, show, between February and September, a difference of 8.4 p. c. for the youngest growth, and 7.1 p. c. for that which is older.

MEAN HYDRATION OF WOODS.

MONTHS.	Per Cent. Water.		No. for Average.	
	1st Year.	2nd Year.	1st Year.	2nd Year.
February	44.7	43.9	37.0	38.0
March	47.2	44.8	59.0	60.0
April	51.7	48.4	6.0	7.0
September	53.1	51.0	19.0	18.0
December	48.3	47.2	61.0	58.0
MEAN	49.0	47.1	36.4	36.2

Our figures also indicate that the maximum hydration of the tissues must occur either in September, or at some period intermediate to this month and April. By graphic representation of these results, it will become possible to determine with approximate accuracy the true period at which this maximum is reached. The figures show that, from February to April, the rate of percentage increase is much more rapid than the rate of percentage decrease from September to December. A curve which will show this, should also show the period of maximum percentage. By reference to the chart, it will be seen that the curves for both young and old wood run nearly parallel, but that they tend to approach at their greatest depression, and to separate more widely at their greatest elevation. It is also seen that, from midwinter to spring, the curve rises rapidly and reaches its greatest elevation about May 18th for the youngest wood, while that for the older wood attains its maximum a few days later, or about the 22nd. From this time on, the curve descends at a more gradual rate until December, when it suddenly drops to its minimum depression, which evidently occurs in January.

PERIODS OF CESSATION OF GROWTH.

As, upon theoretical grounds, the tissues contain most water when the growth is most active, data which will enable us to fix accurately the limiting periods for the season's growth, will have an important bearing upon this question. Mr. W. E. Stone, [1] accepting the completion of terminal buds as marking completion of the longitudinal growth for the entire year, has obtained the following data, as establishing periods limiting growth in trees for the latitude of West Point, New York, 41° 23′ N.:—

JUNE 1ST.

Acer saccharinum. *Wang.*
" rubrum. *L.*
Amelanchier canadensis. *Torr & Gr.*
Carya alba. *Nutt.*
Fagus ferruginea. *Ait.*
Fraxinus americana. *L.*
Hamamelis virginica. *L.*
Kalmia latifolia. *L.*
Populus tremuloides. *Michx.*
Quercus alba. *L.*
" bicolor. *Willd.*
" coccinea. *Wang.*
" prinus. *L.*
Sambucus pubens. *Michx.*
Tilia americana. *L.*
Ulmus americana. *L.*
" fulva. *Michx.*

JUNE 15TH.

Betula lenta. *L.*
Carpinus americana. *Michx.*
Castanea vesca. *L.*
Juglans nigra. *L.*
Lindera benzoin. *Meissner.*
Morus rubra. *L.*
Ostrya virginica. *Willd.*
Prunus cerasus. *L.*

[1] Bull. Torrey Bot. Club., xii. 8, 83.

JULY 19TH.

Andromeda ligustrina. *Muhl.*
Alnus incana. *Willd.*
Nyssa multiflora. *Wang.*
Staphylea trifolia. *L.*

INDETERMINATE PERIOD.

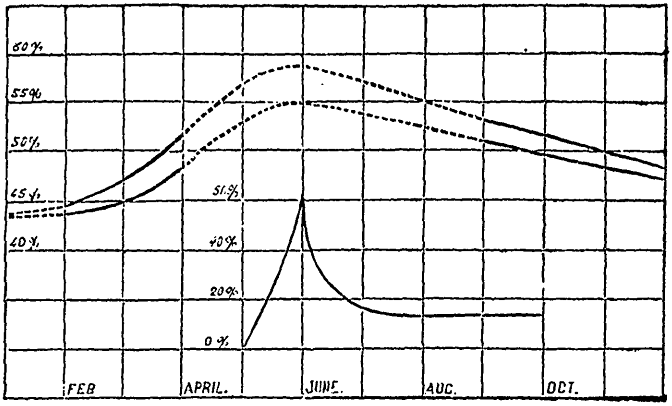
Ampelopsis quinquifolia. *Michx.*
Celastrus scandens. *L.*
Rhus. *Sp.*
Vitis. *Sp.*

This, therefore, gives us the following percentage quantities, showing cessation of growth at different periods :—

May 1st, commencement of growth.			
June 1st, cessation of growth	in	51.5	p. c.
June 15th, "	"	24.2	"
July 19th, "	"	12.1	"
Indeterminate period	"	12.1	"

Growth in length having ceased at these periods, the energy of the plant then becomes directed to the lignification of tissues and the deposition of reserve material for growth the following year. These changes, however, involve of necessity, a continual decrease in the contained water. The data above, also, show that the majority of plants complete their longitudinal growth within the first six weeks of the growing season ; that most of these complete their growth in from three to four weeks ; and that, as the season advances, the number of plants still growing rapidly diminishes until the middle of July, after which there are left but few, those being plants like the grape, which continue to grow to the very end of the season.

A graphic representation of these changes will enable us to institute a comparison with the relations of seasons to hydration of the structure. The lower figure of the chart is the curve expressing this decrease of growth with advancing season. A comparison of both curves will show most conspicuously, that that period, during which growth for the season is most rapid, is coincident with the period of maximum hydration of the tissues.



It is evident from the facts stated, that the amount of water contained in trees can have no direct relation to their bleeding when punctured. Indeed, it is a well-known fact that the bleeding of trees, such as enables us to collect maple sugar, is a purely physical process, wholly dependent upon the effect of external temperature in producing variable internal tension, hence in no sense connected with physiological processes; that this bleeding may occur at any time during the rest period, provided the conditions of temperature are favorable; hence, that it is most pronounced when there is the least water in the tissues: that during the seasons of most active growth, when the plant contains most water, no bleeding occurs.

CONCLUSIONS.

From the foregoing facts, we are justified in the conclusions which follow:—

(1.) The hydration of woody plants is not constant for all seasons, and depends upon conditions of growth.

(2.) The hydration reaches its maximum during the latter part of May or early June, and its minimum during the month of January.

(3.) *Hydration is greatest in the sap wood; least in the heart wood.*

(4.) *Greatest hydration is directly correlated to most active growth of the plant,—lignification, and storage of starch and other products, being correlated to diminishing hydration.*

These conclusions are to be understood as applying only to latitudes lying between New York and Boston. For other latitudes, certain modifications might be necessary.

A Natural System in Mineralogy.

By T. Sterry Hunt.

In farther illustration of the system set forth by the writer in his memoir on "A Natural System of Mineralogy," which appears in the third volume of the Transactions of the Royal Society of Canada, and of which a partial analysis has already appeared in the Record (Vol. I. pp. 129, 244), we make the following extracts:—

The same mineral types, which serve to divide each of the suborders of natural silicates into well-defined tribes, reappear in the non-silicated oxyds, and serve for their classification. Reserving for another occasion the details of classification of this great order of Oxydates, we may note that while the Oxyadamentoid tribe embraces such species as periclasite, chrysoberyl, the spinels, magnetite, corundum, diaspore, hematite, quartz, rutile, cassiterite, etc., the Oxyspathoids include cuprite, zincite, crednerite, pyrolusite, tridymite and senarmontite, and the Hydroxyspathoids, gibbsite, gothite, and manganite. Among the Oxyphylloids are brucite, pyrochroite, massicot, minium, melaconite, hydrotalcite and pyraurite, while the Oxycolloids or Opaloids embrace bauxite, limonite, opal, urangummite and eliasite.

The metals proper, *together with the bodies of the sulphur and the arsenic series, and the various binary and ternary compound of all these, make up the great natural order* of Metallates, *which includes two suborders. Of these* the first or *Metallometallates*, distinguished by opacity and metallic lustre, is divided into six tribes, which are: 1. Metalloids,—native metals and metal-like elements; 2. Galenoids,—argentite, galenite, stannite, chalcopyrite, pyrrhotite, alabandite, etc.; 4. Smaltoids,—smaltite, niccolite, breithauptite, with other arsenids, antimonids, etc.; 5. Arsenopyritoids,—including arsenopyrite, cobaltite, etc.; 6. Bournonoids,—enargite, bournonite, zinkenite, etc. The various selenids and tellurids form subtribes distinct from the sulphurous or Thiogalenoids. In the second suborder are included those species more or less resinous or adamantine in lustre, generally red in color or in streak, and often transparent or translucent, whence the distinctive name of *Spathometallates*. In this suborder we distinguish at least two tribes: 1. Sphaleroids, corresponding to galenoids, and including cinnabar, realgar, christophite, marmatite, sphalerite, greenockite and hauerite; 2. Proust ids, corresponding to bournonoids, and embracing proustite and other red silver ores, tetrahedrite, livingstonite, dufrenoysite, binnite, etc. It is worthy of notice that while sulphid of mercury, in the forms of metacinnabar and cinnabar, appears in both suborders of the Metallates, the sulphid of antimony is also represented among the Spathometallates by the red and generally uncrystalline kermes. The various forms of sulphur and of phosphorus, together with vitreous selenium, will constitute a third tribe of the second suborder of Metallates. The Spathometallates, as seen in their typical forms, sphalerite, wurtzite, greenockite, cinnabar, proustite, etc., serve, through the sulphoxydates, kermesite and voltzite, and through sulphosilicates like helvite and danalite, to connect the order of Metallates with spathoid Oxydates and Silicates.

In these various tribes the relations of hardness to condensation are not less apparent than in Silicates and Oxydates. Dividing the simplest atomic formula of the complex Metallates by the number of atoms, we get, as the most convenient term for comparison, the mean weight of the elemental unit from which to deduce the volume V. We thus find for the pyritoids, pyrite and marcasite, values for V of 4·0 and 4·2; for linnæite, 4·4; for pyrrhotite and chalcopyrite, 5·0 and 5·3; and for alabandite, 5·4. The smaltoids, niccolite and smaltite, give 4·4 and 5·1; the arsenopyritoids, cobaltite and gersdorffite, from 4·3 to 4·6; the thiogalenoids, for chalcocite, 7·0, for stibnite, 7·4, for galenite, 7·9, and for argentite, 8·5. Of the sphaleroids, hauerite gives 5·8; sphalerite, 6·0, and other species, 7·0–7·4. The contrasts between the last two tribes and the preceding three, alike in their hardness, and in their condensation, as shown in the different values of *V*, are apparent; and these are not less marked, when the hard and dense arsenopyritoids are compared with the chemically analogous, but softer, bournonoids and proustoids. Of the former of these, enargite gives for *V*, 6·9, and bournonite, zinkenite and jamesonite, 7·7–7·8; while of the proustoids, miargyrite, proustite, pyrargyrite and polybasite give from 8·0 to 9.0, and dufrenoysite, and tetrahedrite, from 7·2 to 8·3. By reason of the variations in the recorded specific gravities of most of the species compared, the values here given for *V* must be regarded as but approximations to be corrected with the help of more exact determinations.

The native compounds of the haloid elements may be included under the order HALOIDATE, with the four suborders of *Fluorid*, *Chlorid*, *Bromid* and *Iodid*. Titanates, niobates, tantalates, tungstates, molybdates, chromates, vanadates, antimonates, arsenates, phosphates, nitrates, sulphates, borates, carbonates and oxalates constitute as many distinct orders. Of these the soluble chlorids, sulphates, borates, carbonates, etc., belonging to the salinoid type, form tribes under their respective orders, as Chlorosalinoid, Sulphatosalinoid, Borosalinoid and Carbosalinoid. The native combustible carbons and hydrocarbonaceous bodies are included in a single order, which, from the fire-making property of these may be aptly designated as the order of PYRICAUSTATES. This is divided into two suborders: 1. *Carbates*, including the phylloid, graphite, and the adamantoid, diamond, representing two tribes; and 2. *Carbhydrates*, which may be conveniently grouped in the four tribes, Naphthoid, Asphaltoid, Resinoid and Anthracoid.

Of these orders, Metallates, Haloidates and Pyricaustates will each constitute a Class,—all the remaining orders being included in another Class. These four classes, with their orders and suborders, may be tabulated as follows:—

Classes.	Orders and Suborders.
I.	1. Metallates: *a.* Metallometallates; *b.* Spathometallates.
II.	2. Oxydates.—3. Silicates: *a.* Protosilicates; *b.* Protopersilicates; *c.* Persilicates.—4. Titanates. — 5. Niobates. — 6. Tantalates. — 7. Tungstates.—8. Molybdates.—9. Chromates. 10. Vanadates.—11. Antimonates.—12. Arsenates.—13. Phosphates.—14. Nitrates.—15. Sulphates.—16. Borates.—17. Carbonates.—18. Oxalates.
III.	19. Haloidates: *a.* Fluorids; *b.* Chlorids; *c.* Bromids; *d.* Iodids.
IV.	20. Pyricaustates: *a.* Carbates; *b.* Carbhydrates.

Physical Characteristics of the Ainos.

By D. P. Penhallow.

The great timidity of the Ainos, coupled with an instinctive delicacy with reference to all matters of a personal nature, offers a great obstacle to the acquisition of exact knowledge concerning their physical development. That these feelings are not easy to overcome and often raise an insuperable barrier, has been the experience of nearly if not quite all those who have undertaken a study of them. Many important measurements are thus wanting, but the following determinations may be of some value as contributing to a more exact knowledge of their leading characteristics.

The Ainos, occupying Yezo and the Kuriles, are usually spoken of as the "Hairy Kuriles" in allusion to one of their more prominent characteristics. They constitute that group usually designated as "Yezoines" or "Kurilians," to distinguish them from those of markedly different aspect, occupying the Russian territory of Saghalien, Kamschatka and the lower Amoor district in Siberia.

Among those who have attempted to study the Ainos, there appears to be a greater diversity of opinion with regard to their hirsuteness, than any other subject concerning them. This has arisen too often from superficial observation; again from second-hand evidence, and yet again from the expression of an unrestrained enthusiasm. "Covered with hair like animals," is the unqualified description which has more than once been applied to this people; while Mr. Griffis as boldly asserts to the contrary, that they are "Not more hairy as to their bodies than many Japanese or other peoples who eschew pantaloons and shirts," and that the term "*Hairy Kuriles* or *Ainos*, is rather the pet phrase of some closet writers than the expression of a fact."[1] It would appear, however, that Mr. Griffis did not have a sufficient number of typical Ainos, upon the examination of whom he could base a reliable opinion, since his studies were confined to the few who were sent to Tokio for education. From my own personal acquaintance with these same men, it was evident that a study of them could lead to no other conclusion than that reached by Mr. Griffis, but unfortunately they were few in number and not types.

Wood[2] remarks that "Esau himself could not have been more hairy than are these Ainos." Again, Mr. B. S. Lyman,[3] for several years geologist to the Kaitakushi, and thus possessing unusual opportunities for the study of these people, says "It was surprising to see how many of them were wholly or partially bald, and though they are reckoned by the Japanese as so very hairy, how many were, naturally, comparatively free from hairs on their faces and bodies." Miss Bird[4] correctly observes that "There is frequently a heavy growth of stiff hair on the chest and limbs." Prof. Wm. Wheeler employed a guide during one of his surveys, of whom he afterwards said to me, "The hair on his back and over the entire chest was long and matted, and reminded me strongly of the fur coating of an animal."

[1] Bull. Amer. Geog. Soc., 1878, No. 2.
[2] Trans. Eth. Soc., New Ser., iv. 34, etc.
[3] Rept. Horace, Capron., p. 390.
[4] Unbeaten Tracks, ii. 10.

My own experience, extending over four years of intimate acquaintance with these people, hundreds of whom were brought under observation, shows that while all these views express a measure of truth, they do not accurately represent the true facts. With reference to the baldness spoken of by Mr. Lyman, it should be pointed out that, while it is a very common occurrence, it is by no means a true physical characteristic, since it arises, in large part at least, from the great prevalence of scalp diseases among the children and youth.

As to the hairiness of the body and limbs, one remarks the most extreme variations. During one of my own expeditions, eighteen Ainos were employed as boatmen. Of these, twelve were exceedingly hairy, more so than I had ever before observed man to be. Of the others, three, formerly students at Tokio, and studied by Mr. Griffis, were quite smooth, and one had a very fair skin. It has repeatedly been brought to my notice that the Yezoines are not more hairy than Europeans, while in many more cases I have observed the exact reverse to be conspicuously true. The conclusion appears justifiable that, the Yezoine in general, is to be regarded as possessing a more than ordinarily hairy body, enough so at least, to make him deserving of the epithet of "Hairy Kurile."

A stranger gains his first impression of the great hairiness of these people from their exceedingly bushy hair and beards. The latter are a general feature of the men, their absence being rather exceptional; but their very bushy growth is doubtless due as much to the fact that the men never shave and seem rarely even to clip their beards, as to any natural excess of growth.

The hair of the head is straight, black and rather coarse. It is never brushed, but is allowed to fall naturally, usually to the base of the neck, being trimmed uniformly to this length all round. There is also a frequent tendency in the hair to stand straight out from the head. The effect of all this upon the stranger is to impress him at once with the uncouth aspect and great hairiness of the people.

We shall see, however, that the Saghalien Ainos present a striking departure from the rule of hairiness which essentially characterizes the Yezoine; and this would, therefore, rather appear, not as a race characteristic, but as a feature due to the peculiar and widely different conditions of life, dress and exposure to which these people have been subjected.

In stature, the Ainos are much below the average height of Europeans, but their bodies are generally well formed and robust, shoulders square, chests full, and limbs muscular. Accustomed to a forest life, and depending for sustenance upon the product of the chase and fishing, the men are early accustomed to considerable hardship and are soon capable of much endurance. This renders them invaluable as boatmen and as porters, in which latter capacity they will carry very heavy loads over long distances for days at a time. In my journal of an expedition into the interior, I find the following note with reference to this: "During the whole of our tramp of eighteen miles, the three men carried loads on their backs weighing from fifty to one hundred and twenty pounds, and that too through places where it was enough for me to carry myself and gun; yet they never seemed exhausted, but walked with a firm, strong step to the last."

The following determinations will show some of the leading features of the Aino physique:—

IJIRI AINO.—

Shoulders square; breadth 17.25 inches.
Chest well formed, full.
Height 5 feet 4.25 inches.
Forehead well formed; breadth 5.5 inches; height 4 inches.
Eyebrows well developed and prominent.

FACE (exclusive of forehead):

Facial angle 67°.
Height 5.25 inches.
Breadth 6.0 inches.
Cheek-bones high.
Eyes brown and dull.
Chin well formed, medium.

MATAIJI AINO.—

Shoulders rather square; breadth 16.2 inches.
Chest medium.
Height 5 feet 3.75 inches.
Forehead rather contracted and narrow in front; breadth 4.4 inches; height 4 inches.

FACE (exclusive of forehead):

Facial angle 74.30°.
Breadth 5.33 inches.
Height 5.5 inches.
Chin medium and well formed.
Cheek-bones rather prominent.
Eyebrows large and overhanging.
Eyes medium, dark brown and dull.

ENNOEKI AINO.—

Shoulders sloping; breadth 16.75 inches.
Chest medium.
Height 5 feet 2.75 inches.
Forehead broad in front; breadth 5 inches; height 4 inches.

FACE (exclusive of forehead):

Facial angle 73°.
Height 5.5 inches.
Breadth 5.5 inches.
Eyebrows poorly developed and flat.
Chin well formed and small.
Eyes large, dark-brown and rather bright.
Cheek-bones prominent.

UTTEGURU AINO.—

Shoulders square and well formed; breadth 17 inches.
Chest well developed.
Height 5 feet 5.25 inches.
Forehead narrow towards the front; height 4 inches, breadth 5.33 inches.

FACE (exclusive of forehead):

Facial angle 73°.
Breadth 5.33 inches.
Height 4.6 inches.
Chin small and rather retreating.
Cheek-bones prominent.
Eyebrows rather flat and poorly developed.
Eyes rather large, brown and dull.

NURIAN AINO (Woman).—

Shoulders well formed; breadth 15.5 inches.
Height 4 feet 7.62 inches.
Forehead rather well formed; breadth 5.17 inches, height 3.67 inches.
Chin well developed.
Cheek-bones very prominent.
Eyebrows well formed, medium.
Facial angle 74.30°.

So many valuable data have been obtained by Mr. B. S. Lyman, that it seems desirable to introduce them here in his own words:—

"The average weight of the Ainos with their light clothing was 141 pounds, varying from 108 pounds—the boy—to 183 pounds—the ferryman. In general, their hair was thick, with a tendency to stand out all over the head. The forehead varied from low to high, commonly of middling height; it was always round. Their brows were always overhanging; their eyes commonly of middling size and always black; their cheekbones were rather high; their nose commonly with a very low bridge and with broad nostrils, was often turned up, but sometimes straight. Their mouth, lips and chin commonly hidden by the beard, seemed to be of middling character, the mouth not very small, the lips, as compared with Europeans, not unusually thick and the chin not very large, perhaps even rather small: Of those who had special compensation and were therefore bound to submit to anything, we took a number of other dimensions. Their average age was twenty-six, height 5.46 feet, and weight 161 pounds. Their heads measured on the average from front to back 0.68 feet; from side to side 0.55 feet, and from chin to crown or rather vertical height 0.77 foot; from chin to mouth 0.10 foot. The facial angle was taken very imperfectly but seemed to be about 65 degrees. The upper arm measured on the average 1.08 foot long; the forearm 0.83 foot; the hand from the wrist bone 0.66 foot; in all from shoulder to finger tips 2.57 feet, a rather unusual length, I believe, for Europeans of their height. The average length of the leg down from the hip bone—taken by mistake instead of the joint—was 3.10 feet or probably the true length of the leg 2.70 feet, of which 1.14 was thigh and 1.56 feet, measured, foot and leg below the knee. The foot averaged 0.85 foot long by 0.37 foot wide, and the heel was always short. The shoulders averaged 1.46 feet in breadth, the neck 0.20 foot in length, the body from shoulders to hip bone 1.60 feet, or to the hip joint probably 2.00 feet. But their muscles were the most striking feature from their enormous size. The men seemed one mass of hard muscle, and in feeling for the hip bone I could not perceive it, even when they pointed out to me its place. Around the chest they measured on the average 2.99 feet; around the upper arm 1.04 feet; forearm, 0.97 foot; wrist, 0.56 foot; thigh, 1.76 feet; calf, 1.26 feet; ankle, 0.86 foot. A few other measurements were also taken, but probably less important ones."

The following detailed list is also from the same source :—

NAME.	AGE.	WEIGHT. POUNDS.	HEIGHT. FEET.
Chabo	36	135	4.80
Atashite	35	147	5.38
Taegato	35	136	5.28
Chilkamakura	33	133	5.07
Shinangura	33	150	5.49
Kusarengara	32	155	5.46
Ikuyange	27	142	5.53
Yoshimatsu	26	150	5.40
Shussa no Aino	25	184	5.74
Shokubashite	23	150	5.40
Huriranku	25	135	5.37
Patekuwengum	28	150	5.35
Idatsiba	28	137	5.22
Naoba	28	133	5.20
Jasnutoku	25	150	5.34
Pashikura	22	145	5.28
Yukyashito	21	133	5.22
Krotokura	16	142	5.29
Okonokara	40	142	5.22
Youde	34	128	5.06
Tetta	28	155	5.37
Nisago	26	128	5..33
Kinshuka	26	132	5.18
Fugari	25	137	5.11
Taro	23	132	5.05
Itakichari	13	108	5.16

From the facts thus obtained, we may fairly summarize the physical characteristics of the Ainos as follows.—

The forehead is usually high, though narrow; eyebrows heavy and overhanging; nose somewhat inclined to flatness, though but little more so than in Europeans; mouth wide, but well formed; chin well formed and medium size; eyes straight, brown and dull; cheekbones inclined to be prominent; facial angle high, the mean of our measurements giving an angle of 72°; the body is compact, well built and muscular; much more than ordinarily hairy; skin of light color, comparable to that of Europeans.

With regard to the ages given, it may be stated that the Ainos have no definite method of reckoning age, and it is exceedingly difficult to determine how old a man really is. The same standards according to which we would estimate age among our own people, will by no means apply here, and one is as likely to guess too much as too little. Thus most of the ages given are only approximations. In a few instances they seemed to be known with some degree of accuracy.

From the heights given it would appear that Davis' conclusion, based upon measurements of skeletons, "That the Ainos average not far from 5 feet 2 inches in height,"[1] is not very far from the actual truth, though it possibly falls a little below.

The Ainos from Saghalien and other Russian territory, are in some respects quite different from the Yezoines. In stature and general proportion of both men and women, there is no essential difference. Their hair is also worn long, but, unlike that of the Yezoines, it is not cut so squarely; it is also not so bushy, but falls more gracefully around the head and neck, while the ends frequently have a strong tendency to curl, and in both men and women it is usually neatly brushed and parted, much care frequently being displayed in this respect. Doubtless this, as many other striking departures from a more savage appearance, as common to their southern relations, is to be traced to the

[1] Man. Anthrop. Soc., iii. 366, etc.

influence of more intimate contact with civilizing influences. Whatever the cause, however, the result is a total disappearance of that extreme uncouthness which so impresses the stranger when first brought in contact with a Yezoine. The latter, however, are capable of the same change, as is amply proved by those Ainos of the Ishikari tribe, who spent some time at the Tokio schools. In their case, the removal of accumulated dirt and unkempt beard and hair, did much to reveal, in a fair skin and intelligent face, the natural good qualities they possessed.

One peculiarity which at once distinguishes the Saghalien Aino from the Yezoine, is the greater absence of beards, nor do they appear to have so hairy bodies generally. I have frequently seen Saghalien Ainos divested of their clothing, and their bodies were in no case more hairy than those of Europeans, and it seems highly probable that the great difference in hairiness, between these people and the Yezoines, is to be ascribed to their different conditions of life; the Saghalien usually being provided with plenty of warm clothing, furs, etc., while the Yezoine makes little or no change between his summer and winter clothing.

The skin is quite light and may very properly be compared with that of the Caucasian, the hue of which it very closely resembles. The foreheads are high but narrow, in some cases conspicuously so. The carriage of the men is active, and their general bearing and facial expression denote an intelligence much superior to that of the Yezoines; in fact, if we are to measure their mental ability by their achievements, then the Saghaliens must certainly be accounted the superior, for since their residence in Yezo they have applied themselves with success to various pursuits, including silk-weaving, boot-making, tanning, harness-making and several other industries in which the Yezo Aino does not or cannot engage. One or two have also become petty officials in the agricultural bureau, showing that they have capacities capable of improvement and expansion.

As one first encounters the Aino, their general appearance is by no means calculated to produce a favorable impression, but rather as Wood remarks[1] "The uncouthness and wildness of their aspect is calculated at first to strike a stranger with dismay or repugnance." Upon closer examination, however, the forbidding exterior is largely lost sight of in view of their quiet demeanor and gentle though rude politeness which is so constantly manifested. In respect to external features, the Saghaliens produce a really favorable impression which is in very marked contrast to the feelings developed by contact with a Yezoine. It is hardly to be doubted, however, that this arises largely from the fact that the former are usually cleanly in appearance, while the bodies of the latter look as if water had never come in contact with them.

The opinion is sometimes expressed that the Japanese are an offshoot of the Ainos, but a critical examination of the pure types would not permit such a belief to be entertained. There is an undoubted mixture of Japanese and Ainos, as invariably occurs along the border line of contact between two distinct people, and this half-breed type is as easily recognized in those parts of northern Japan where it chiefly occurs, as it is in our own Northwest. The Japanese, however, are unquestionably Mongoloid, while the facts here stated not only show the Ainos to be physically distinct, but the accounts given by our best authorities all agree in the great resemblance which they bear to Europeans,—the prevailing view being that they are distinctly Aryan.

METEOROLOGICAL OBSERVATIONS FOR 1885.

BY C. H. MCLEOD.

The table on a succeeding page is a summary of the meteorological observations made in 1885 at the McGill College Observatory, Montreal. The observatory is situated at the height of 187 feet above the level of the sea. Latitude N. 45° 30′ 17″. Longitude 4^h 54^m $18^s.55$, W.

The year 1885 had an average temperature of 2°.6 below

[1] Trans. Eth. Soc., New Ser., iv. 34, etc.

the normal and was the coldest year since 1875. The deviation in temperature for the year is almost entirely due to the very low temperatures of the months of February and March, which, as will be seen on inspection of the table, made the very marked departure of over 10° below the mean. August and September were also considerably below the average. The year may be described as having a very cold winter, a cold summer, and a spring and autumn of average temperature. The greatest heat 87°.1 was on July 17th, the greatest on the records of the past eleven years is 93°.9. The lowest temperature, 21°.3 below zero, was on Jan. 22nd, while the lowest on the records is 26°.0. The greatest range of the thermometer on one day was 35°.9 on April 23rd, and the least range 3°.0 on Nov. 6th. The mean temperature of the warmest day, July 30th, was 75°.5 and that of the coldest day 15°.0 below zero. The highest barometer reading was 30.747 on Jan. 23rd, and the lowest 29.104 on Jan. 12th. The extremes of barometric pressure which have been recorded here in eleven years are 30.999 and 28.766. The average weight of vapour in the air was slightly less than the lowest in eleven years, the lowest value being 0.234 for 1883. The driest state of the air was on May 29th, when the relative humidity was 21. The greatest mileage of wind in one hour was 46 on January 17th, when the velocity in gusts was at the rate of 64 miles per hour. The total mileage of the horizontal component of the wind during the year was 93,279, and the resultant mileage 46,290 in the direction S. 67°.6 W. The rainfall is slightly in excess of the average, and the snowfall very decidedly so, being 55 inches above the normal and the greatest, by 17 inches, for any one year on the records. The rainfall in October, of which 4.06 inches fell during 28 hours, is the greatest recorded here during any one month in the past eleven years. Although the amount of precipitation measured in depth was above the average the number of days on which rain or snow fell was considerably below the average. The year is thus marked as one of heavy falls of both rain and snow. The amount of clouded sky has been slightly less than usual, while there has been

Month.	Thermometer. Mean.	¶ Deviat'n from 11 year means.	Max.	Min.	Mean daily range.	* Barometer. Mean.	Max.	Min.	Mean daily range.	†Mean pressure of vapour.	‡Mean relative humidity.
January	12.13	+0.32	48.0	—21.3	16.7	30.0043	30.747	29.101	.358	.0753	79.2
February	5.88	—10.42	34.0	—16.3	15.6	29.9415	30.451	29.111	.249	.0534	83.7
March	13.25	—10.45	39.8	—14.4	15.8	29.9809	30.466	29.339	.270	.0720	76.6
April	37.68	—1.76	76.9	10.7	16.0	29.9930	30.542	29.347	.232	.1634	69.2
May	55.43	+1 29	81.0	25.2	19 7	29.9532	30.254	29.529	.148	.2623	58.4
June	62.13	—2.29	85.4	38.0	18.0	29.8896	30.178	29.355	.169	.3768	66.6
July	69 23	+0.30	87.1	49.5	16.4	29.8735	30.150	29.565	.143	.5282	73.5
August	62.98	—4.72	82.6	44.5	16.7	29 9128	30.185	29.4[illegible]	.163	.4383	74.0
September	55.36	—3.67	74.3	38.2	16.7	29.9700	30.311	29.426	.175	.3325	74.6
October	44.08	1.87	68.3	22.6	12.7	30.0068	30.396	29.468	.178	.2348	76.8
November	32.82	+0.08	51.0	11.6	8.1	29.9161	30.380	29.506	.176	.1580	84.1
December	19.38	+0.45	44.6	— 3.4	14.7	29.9579	30.717	29.165	.318	.0983	82.6
Means 1885	39.20	—2.65	....	....	15.6	29.9500	.....	.....	.215	.2328	74.9
Means 11 years, ending 1885.	41.85	......	....	.....	...	29.9728	.....	.....	....	.2509	74.3

Month.	Mean Dew point.	Wind. Resultant direction.	Mean velocity in miles per hour	Sky clouded per cent.	Bright sunshine per cent.	Inches of Rain.	No. of days on which rain fell.	Inches of Snow.	No. of days on which snow fell	Inches of rain and snow melted.	Number of days on which rain *and* snow fell.	Number of days on which rain or snow fell.
January	6.7	S. 75° W.	14.50	63	23 5	1.11	5	21.5	18	3.24	3	20
February	1.7	S. 78° W.	13.36	49	49.9	0.50	1	43.5	13	4.79	1	13
March	7 0	S. 65° W.	12.70	56	53.2	0.36	3	29.1	15	2.98	3	15
April	27.8	S. 78° W.	12.58	49	55.5	1.16	10	29.8	9	4.05	5	14
May	39.6	S. 18° W.	8.76	54	63.1	1.66	10	0.0	0	1.66	0	10
June	50.2	S. 55° W.	11.08	57	49.2	3.61	15	0.0	0	3.61	0	15
July	59.9	S. 66° W.	7.43	52	64.1	2.85	9	0.0	0	2.85	0	9
August	54.0	S. 64° W.	8.83	62	55.4	2.46	14	0.0	0	2.46	0	14
September	46.9	S. 64° W.	9.05	45	64.4	4.16	12	0.0	0	4.16	0	12
October	36.8	S. 62° W.	8.51	66	34.6	7.17	15	2.8	1	7.49	1	15
November	28.0	N. 72° W.	9.20	77	16.7	2.27	12	14.4	9	3.70	3	18
December	14.9	S. 73° W.	11.52	74	26.3	1.38	8	36.5	18	5.07	4	22
Means 1885	31.1	S. 67°.6 W.	10.63	58.7	46.3	....	..	....	..	....	.	..
Totals 1885	....	....	....	...	....	28.69	114	177.6	83	46.06	20	177
Means 11 years, ending 1885.	....	....	11.00	60.8	§46.8	27.40	134	122.1	85	39.56	16	203

* Barometer readings reduced to 32° Fah., and to sea level.

† Inches of mercury.

‡ Relative saturation being 100.

§ For 4 years only.

¶ "+" indicates that the temperature has been *higher*; "—" that it has been *lower* than the average for eleven years, inclusive of 1885. The monthly means are derived from readings taken every 4th hour, beginning with 3h. 0m., Eastern Standard time.

an average amount of bright sunshine. Auroras were observed on 17 nights, but may have occurred oftener. There was hoar-frost on 15 days, fogs on 19 days, lunar halos on 9 nights, thunderstorms on 13 days, and lightning without thunder on 3 days.

The sleighing of the winter closed on April 17th. The first snow of the autumn fell on October 30th. The first sleighing of the winter was on Nov. 25th. Upper river navigation opened on May 5th, and the river was open to ocean ships on May 6th.

Miscellaneous Notes.

Natural History Society of Toronto.—This Society has amalgamated with the Canadian Institute of this city, of which association it forms the Biological Section. We have received their programme for the Winter Session which was as follows:—Jan. 18th, Medicinal Plants, by Mr. Hollingworth; Fauna Canadensis, by Mr. Brodie. Feb. 1st, The Acadian Owl, by Mr. Melville; Flora of Ontario compared with that of England, by Mr. Moore. Feb. 15th, Buds, by Mr. Noble; Destruction of Wild Animals, by Mr. Williams. March 1st, Chlorophyll, by Mr. Pearce; Blood, by Mr. Pursey. March 15th, Entomological Reports, by Mr. Armstrong; Fauna Canadensis, by Mr. Brodie.

Natural History Society of New Brunswick.—At the regular January meeting a preliminary paper on the "Algæ of the Bay of Fundy" was read by G. U. Hay. It contained an enumeration and description of the principal species of marine plants found on the northern shore of the Bay of Fundy from collections made at St. John and Frye's Island, Charlotte County, in the summer of 1886. The causes of the paucity of our marine flora were alluded to—chiefly, the erosive action of the tides, the influence of Arctic currents, etc. The economic plants. such as *Chondrus crispus, Porphyra vulgaris, Rhodymenia palmata* and the Fuci, were described with their uses and characteristics.

The Annual Meeting of this Society was held on Jan. 26th, at which Dr. Botsford, the President, read his annual address on "Some Thoughts on Social Science." Dr. Botsford was re-elected President. The following officers for the current year were elected: *Vice-Presidents*, G. F. Matthew, M. A., Edwin Fisher; *Corresponding Secretary*, G. U. Hay; *Treasurer*, Alf. Seely; *Recording Secretary*, W. J. Wilson; *Treasurer*, Alf. Morrisey.

At the February meeting, a paper on the "Occurrence of Arctic Plants" in New Brunswick from the pen of Rev. Prof. Fowler, of Queen's University, Kingston, was read. Quite a large proportion of the Arctic plants are found in New Brunswick and the paper from Prof. Fowler was accompanied by a list showing their distribution and occurrence.

Movement of Tendrils.—D. P. Penhallow contributes an important paper to the *American Journal of Science* (xxxi. 46, 100 and 178,) on the movement of tendrils in *Cucurbita maxima* and *pepo*, incidentally dealing with other phenomena of growth in these plants. The results obtained are based upon observations covering a period of ten years, the original and principal facts having been obtained in 1875 by a series of experiments which involved almost continuous observation through night and day, for a period of one week. He fully discusses the relation which meteorological conditions bear to growth, and confirms previous observations concerning the stimulating influence of combined heat and moisture, but the retarding effect of the former, when acting alone. The daily periodicity in growth, dependent upon alternation of day and night, is shown to be quite marked, the influence of conditions during the day being found to be greater in promoting the general growth than the retarding influence of sunlight, so that the general extension of parts during the day exceeds that for the same number of hours of night as 44.4 to 34.3, a result which confirms that previously obtained by Rauwenhoff. The most important facts, however, are those relating to the mechanism of movement. This is found to depend primarily upon the presence of three active bands of parenchyma tissue, which traverse the tendril throughout its entire length, and by their more rapid rate of growth produce, through unequal tension of the various tissues, all the phenomena of torsion and circumnutation usually noticed. These bands, which the author calls *Vibrogen*, in allusion to their peculiar relation to movement, are found, one on the upper side of the tendril arm, and one on each side, somewhat above the horizon of the major and transverse axis of the section. Their direct connection with the circumnutation is most ingeniously obtained from the figures described by the circumnutating tip of the tendril. Each figure is shown to exhibit changes of direction in movement, which are exactly reversed or follow an intermediate course, accordingly as any one band is directly succeeded by greater activity of its opposite or the remaining two bands; the direction thus taken being the direct expression of more vigorous growth in one band, or representing the resultant of activity in two bands at the same time. He next shows that the total latitudes of movement are one-half the total departures, thus bringing out in a more conclusive manner the precise relation of vibrogen to motion.

The final conclusions, with reference to the cause of motion, are as follows:—(1) Movements of the tendril and petiole are due to unequal growth, as producing uuequal tension of tissues. (2) The unequal growth is chiefly defined in the vibrogen tissue, which may therefore be regarded as the seat of movement. (3) The band of unequal growth does not arise at successive points of the circumference. (4) The vibrogen tissue consists of three longitudinal bands, each of which becomes more active in turn, without regular order. (5) The collenchyma tissue is that which is chiefly concerned in variations of tension under mechanical stimuli. (6) Bending or coiling under the influence of irritation results from release of tension, or (free coiling) from inequality of tension through maturity of tissues. (7) Transmission of impulses is effected through continuity of protoplasm in the active tissues.

Dr. C. J. E. Morren.—On February 28th Dr. Morren died at the age of 53 years. He was Professor of Botany in the University of Liége, Director of the Botanical Institute of the same city, and Secretary of the Belgian Horticultural Society. In all of these positions he rendered important services to Botany and Horticulture.

Prof. Edward Tuckerman, LL.D.—Dr. Tuckerman died at Amherst, Mass., on March 15th, at the age of 69 years. Although not actively engaged in teaching, he filled the chair of Botany at Amherst College from 1858 to the time of his death. He will be chiefly remembered for his studies of Lichens, having been recognized as one of the leading lichenologists of the day, and the highest authority on this continent.

Feeding Insects with "Comma" Bacillus.—Dr. R. L. Maddox, in a paper before the Royal Microscopical Society, details the results of further experiments in feeding insects with the comma bacillus. His observations were chiefly made upon the common blow-fly (*Musca vomitoria*), and included a very large number of microscopical determinations, special cultures of the comma bacillus being used for the purpose of feeding. The results of all his investigations lead him to believe that the comma bacillus from cultures can pass through the digestive tubes of some insects in a living state, and through this fact, such insects are likely to become an important means of distributing disease, especially to animals, birds and fishes which feed upon them. This, therefore, is in accord with the quoted views of Dr. Grassi, "That insects, especially flies, may be considered as veritable authors of epidemics and agents in infectious maladies."—*Journal Royal Mic. Soc.*, 2nd S., V. 602 and 941.

PROCEEDINGS OF THE NATURAL HISTORY SOCIETY.

The *Third Monthly Meeting* of the Session took place on Monday evening, January 18th, 1886, Sir Wm. Dawson being in the chair. The minutes of the previous meeting were read, also those of the council meetings of December 22nd, 1885, and January 12th, 1886.

Dr. W. H. Hingston presented the Society with a copy of his work on "the Climate of Canada."

Mr. T. D. Watson, through Dr. T. Sterry Hunt, presented the Society with a specimen of Walking Stick, *Spectrum femoranthum* (Say), and a dipterous insect, *Pyrgota undata* (Weidman).

Dr. Harrington reported that the list of the Course of Sommerville Lectures had been completed as follows, viz. :—

February 4th, "Antiseptics and Disinfectants." By Alfred H. Mason, F.C.S., F.S.Sc.

February 11th, "The Chalk Formation." By Rev. W. J. Smyth, M. A., Ph. D.

February 18th, "The Source of Igneous Rocks." By Thos. Macfarlane, F.R.S.C.

February 25th, "The Chemistry of Bread and other Farinaceous Foods." By Dr. Casey A. Wood, C.M.

March 4th, "Cotton and Cotton Manufactures." By William Hobbs.

March 11th, "Breathing and Ventilation." By Dr. J. B. McConnell.

March 18th, "The History of a Modern Volcano." By Sir William Dawson, LL.D., F.R.S.

Prof. Penhallow reported that, having been in Quebec a few days ago, the question of a renewal of the annual grant was referred to, in the presence of some of the members of the Cabinet, when the assurance was given that the proposed petition to be presented to the Government, on the eve of the next session of the Provincial Parliament, would receive favorable consideration.

The President named the following Committee to prepare the necessary petition and press upon the Ministry the urgent claims of the Society for a renewal of the grant, viz., John S. Shearer, Major Latour, P. S. Ross and the Corresponding and Recording Secretaries.

Dr. J. Baker Edwards gave notice of motion to change the date of the Annual Meeting from the 18th day of May to the last Monday in May of each year.

The following candidates were duly elected:—Wm. Drysdale, C. N. Bell, F.A.G.S., Dr. T. Wesley Mills and Captain John Lawrence; while Mr. R. R. Stevenson, Rev. Dr. Wm. J. Smyth, and Dr. Thomas Roddick were proposed as Ordinary members. The Hon. Thomas White was proposed as a Corresponding member.

Prof. Penhallow then read a paper on "the Hydration of Wood Tissues in Trees and Shrubs," and Dr. J. Baker Edwards followed with one on "the Danger of Poisoning from the Commercial Uses of Arsenic."

Prof. Penhallow also read a paper on "Physical Characteristics of the Ainos," which elicited some discussion.

A suitable vote of thanks was passed to both gentlemen for their respective papers.

Mr. Edward Murphy exhibited some microscopic specimens of arsenic in connection with Dr. Edwards' paper.

The *Fourth Monthly Meeting* of the Session was held on Monday evening, February 22nd, 1886, the President Sir Wm. Dawson occupying the chair. The minutes of the previous meeting, with that of the last meeting of council, were read and approved.

Mr. Charles Robb presented several volumes of rare works to the Society, which were accepted with thanks and an acknowledgement was ordered to appear in the RECORD OF SCIENCE.

Mr. Wm. G. Oswald, of Hill Farm, presented the Society with a curiosity of vegetation in the form of a natural budding or grafting by the interlacing of Beech root branches, for which a vote of thanks was passed to the donor.

It was moved by Edward Murphy and seconded by J. H. Joseph, "that in accordance with notice of motion by Dr. J. Baker Edwards, the date of the Annual Meeting be changed from the 18th day of May to the last Monday in May of each year." The same motion also embodied the following resolution, viz., "that the Bye-laws as revised be and are hereby adopted." Carried.

Dr. Harrington then proceeded with a very interesting description of Canadian minerals, and displayed a fine selection of specimens from the collection of the late Mr. Miller, of Ottawa, recently purchased by Mr. John H. R. Molson for McGill College.

Sir Wm. Dawson, Charles Robb, C. E., and Mr. Thomas Macfarlane followed with some remarks on the different forms of crystals found in Norway and Canada.

Sir Wm. Dawson next read extracts from a letter by Professor Bailey, referring to recent criticisms on the Geologists of New Brunswick.