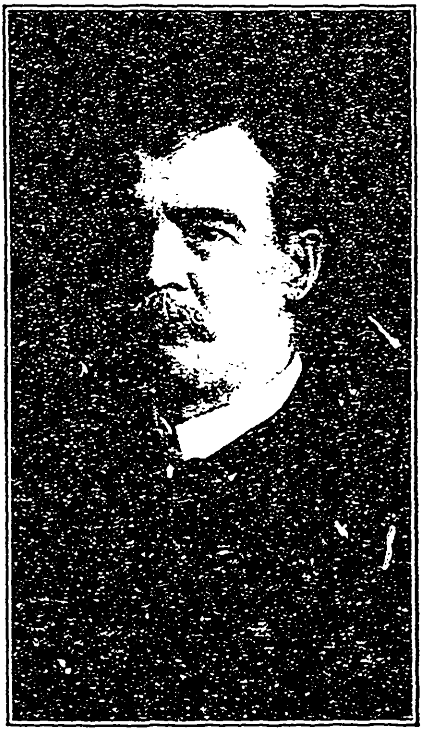

David Pearce Penhallow.

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A strong son of the resolute makers of New England, Dr. Penhallow possessed the tireless energy, the ceaseless industry, the love of enterprise, and the public spirit which made members of his family honored citizens in Portsmouth, N.H., for two hundred years. He was born on the opposite shore of the Piscataqua River, at Kittery Point, Me., on May 25th, 1854. Throughout twenty-seven years of loyal service to Canada, to Montreal, and to McGill University, he maintained his allegiance to his native land and cherished the traditions of his early home.

When only nineteen, Dr. Penhallow graduated from the Massachusetts State University, at Amherst. Later, he obtained the degree of B.Sc. from Boston University and that of D.Sc. from McGill University.

In 1876 he was appointed Professor of Botany and Chemistry in the Imperial College of Agriculture at Sapporo, Japan. There he remained until 1880, acting as President during the final year of his stay. Like other young Americans to whom Japan turned for a knowledge of western thought and methods, he learned to love the country and its people. After returning to

America, he kept in close touch with Japanese friends and pupils, some of whom became well-known scientists. Members of the Montreal Folklore Society, of which Dr. Penhallow was President for several years, will recall his symathetic presentation of charming Japanese proverbs and folk-tales and his interesting accounts of the Ainos, the remnant of an ancient Aryan race which has maintained its purity in Japan. After a few months at Harvard and two years at the Houghton Farm Experimental Station, Dr. Penhallow became Professor of Botany at McGill University, in 1883. His predecessors had been Dr. Holmes, whose collection of Canadian plants grew under Dr. Penhallow's care into the present large herbarium; Dr. Barnston, an able pupil of Balfour of Edinburgh; and Sir William Dawson, who was not only Principal of the University, but had been Professor of all the Natural Sciences. After Dr. Penhallow's arrival, practical courses were begun in the Redpath Museum. In 1890 the largest of the present laboratories was fitted up for ten students. So great a step forward did this seem that a detailed description of "The New Botanical Laboratory" was published in the *Canadian Record of Science*. Year by year, the courses were multiplied and made more comprehensive, until the amount of work done, in the shabby old rooms at the top of the Arts Building, bore comparison with that conducted in any good modern laboratory by a large staff of instructors.

Sir William Dawson's interest in fossil plants soon turned Dr. Penhallow's attention towards palæobotany. Papers published by the two collaborators were succeeded by a long series of notes, articles, and monographs prepared by Dr. Penhallow alone. In addition, he gave much time to the examination of fossils and the preparation of reports for the Geological Surveys of Canada and of the United States. General recognition as an authority, especially upon the Cretaceous and Tertiary floras of Canada, followed.

In determining the species of fossil plants, reliance must be placed largely upon the structure of the wood and comparisons with the stems of modern types must be instituted. Dr. Penhallow, therefore, spent several years in a study of the conifers. The results are embodied in a book entitled "North American Gymnosperms." The first part consists of a discussion of the minute anatomy of the stem and of the probable origin of the constituent elements. The second part is a manual by means of which a species may be determined through the microscopic examination of its wood. This useful work was to have been followed by a similar study of the Angiosperms, but only a paper upon the willows was completed.

History, whether written upon the rocks or in forgotten volumes, was particularly attractive to Dr. Penhallow. His gleanings in the latter field are gathered in several articles. The most interesting and valuable comprise a complete "Review of Canadian Botany," from the time of the first settlement in New France until 1895.

Dr. Penhallow's power of administration was utilized not only within but without the University. The last years of his life were largely devoted to the organization of the new Marine Biological Station at St. Andrew's, New Brunswick. He was a trustee of the Marine Biological Laboratory, Wood's Holl, Mass.; Chairman of the American Biological Research Stations; Chairman, from 1902 to 1904, of the British Association's Committee on the Ethnological Survey of Canada; President of the Society of Plant Morphology and Physiology in 1899; Vice-President of the section of Botany at the meeting of the British Association in 1897; Fellow of the Royal Society of Canada and President of Section IV from 1896 to 1897; and President for several years of the Montreal Natural History Society. In addition, he was a member of many other organizations, including the Royal Microscopical Society of London, the Botani-

.cal Society of America, and the American Society of Naturalists.

From 1888 to 1890 he edited the *Canadian Record of Science;* from 1897 to 1907 he was associate editor of the *American Naturalist;* and from 1902 to 1907 he was editor of Palæobotany for the Botanisches Centralblatt.

With an exceptional interest in research, Dr. Penhallow combined the teacher's desire of extending to others the knowledge which he enjoyed, and of giving new views of life to people more limited by circumstance. A few of the manifestations of this spirit were: repeated attempts, in the face of strong opposition, to obtain Botanic Gardens for the free use of the general public; long-continued efforts to extend the work of the Natural History Society and to found a great museum for the use primarily of working-people; and the enthusiastic leadership of organizations like the dead Folklore Society, where such contributions as Beaugrand's "La Chasse Galerie" and Drummond's "Habitant" were enjoyed before being given to the public.

The limits set upon this sketch prevent further notice of Dr. Penhallow's many activities. An unexpected break in his laborious life came in December, 1909. A prolonged rest encouraged his friends to hope that another year would see him in his wonted place. But, when on his way to England with Mrs. Penhallow, his sudden death took place, on October 20th, 1910. The news of this peculiarly sad event called forth expressions of deep regret and heartfelt sympathy with his wife and his only son. Dr. Penhallow's name was known and honoured by the general public, his work was respected and his friendship valued by his colleagues and his pupils. But compartively few, until his life-work is adequately reviewed, will realize how varied were his interests, how wide his influence, and how valuable his work.

CARRIE M. DERICK.

McGill University, November 10th, 1914.

*FRESH-WATER ALGÆ OCCURRING IN THE VICINITY OF THE ISLAND OF MONTREAL.

By Clare Rothwell Miller, M.A., (Mrs. Hardolph Wasteneys).

INTRODUCTION.

In order to secure data in regard to the algal flora of Montreal Island, collections of material were made, during the autumn of 1911, from pools, ponds and streams in different localities and a number of aquaria containing the algæ were maintained in the Botanical Laboratory of McGill University, during the winter. Records were kept of the progress of the different cultures, the forms which had been collected were studied and classified, and a number of experiments were made with nutrient media.

The results of these observations are given in the following pages, with as full notes as possible in regard to the habits, associations and relative abundance of the forms described. The importance of such ecological data has been strongly emphasized by Fritsch[1] in his work upon the Algal Flora of the Tropics. The relation of certain of my results to the work of Benecke,[2] Danford,[3] Copeland,[4] and Fritsch and Rich[6] has been considered. Some observations of rhizoid formation in Spirogyra are given. A systematic list of the various species of the fresh-water algæ collected completes the account. The determination of the species in the systematic list has been based on standard taxonomic works and has been corroborated by Professor Derick, under whom the work has been done. I have been greatly aided in these studies by the advice and criticism of Professor Derick,

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*Read before the Natural History Society of Montreal, April 29th, 1912.

who suggested the problem, and my thanks are also due to Mr. Ardley of the Museum staff, who gave me very valuable assistance in collecting material.

As far as algal literature is concerned, Canada appears to be an unknown land. No references occur even in the latest works to the distribution of any of the forms in Canada, and Mr. Collins in the preface to "The Green Algæ of North America"[7] laments that apparently no data are to be had on the subject. With the exception of a list of forms recorded by Mr. A. B. Klugh from the Bruce Peninsula, in the *Ottawa Naturalist*[3] for September, 1911, I believe this is the first attempt at a systematic study of any Canadian fresh water algæ.

Occurrence and Distribution of Fresh-water Algæ.

No moist situation is without some type of alga. While quiet lakes, pools and ponds form the most congenial home for the larger forms, algæ are also to be found in great abundance in water-falls, and all sorts of swift-running streams, and, indeed, there is no tree-trunk, wet rock, water trough, damp wall or decaying fence-post but forms the habitat of some member of the group.

In quiet pools the large filamentous forms frequently occur, attached as epiphytes to rocks or to other aquatic plants, and stream up towards the surface in great felt-like masses. Some forms are found floating on the surface of ponds and lakes as conspicuous slimy green masses; while others occur, especially on rocks over which water is constantly dripping, in thin gelatinous films, exhibiting a variety of color. These are usually forms belonging to the Cyanophyceæ, or blue-green algæ, and are some of the most beautiful and interesting of all the species.

Some algæ have acquired a symbyotic relationship with other plants and even with animals. Examples are a species of Anabæna which lives symbiotically with the Hepatic, *Blasia,* and a Nostoc which is similarly connected with *Anthoceros.* Both of these forms occur on the Island of Montreal. Then, there are several species of Chlorella which are associated symbiotically with Hydra viridis.

Many of the most beautiful Algæ are very small and grow in gelatinous films on the leaves and stems of submerged plants. Other minute forms, together with an abundance of Peridinieæ and Copepoda, abound in the surface waters of lakes and rivers, and constitute a great part of the fresh-water plankton which forms the food of most of the smaller aquatic animals, which, in turn, serve as the food of the lake and river fishes.

Algæ exist under very diverse conditions of temperature. Many forms survive freezing. Filaments of Spirogyra and Vaucheria, which I have melted out of the ice, appear to suffer in no way from the low temperature. Species of the Cyanophyceæ and Bacillariaceæ are found in the Arctic regions and on mountain tops, forming the principal parts of the snow-flora and passing their entire existence on snow or ice. Other members of the same groups flourish in the waters of hot springs, where the temperature reaches 85°C.

The comparative richness of any district in fresh-water algæ depends largely on its physical and geological features. West, in his "British Fresh-water Algæ,"[9] states that a mountainous region may be expected to show more forms than a flat district. The latter will contain the larger filamentous algæ, and an abundance of unicellular forms. On the other hand, a mountainous region will show forms belonging chiefly to the Cyanophyceæ and Conjugatæ, especially numerous species of Mougeotia and Desmids. Moreover, he says, "If the mountains consist of the older Palæozoic rocks or the Pre-Cambrian rocks, there is a surprising numerical increase not merely of species but also of individuals, and in comparison a mountainous region of carboniferous limestone or other formations is distinctly poor." Accordingly, it will be of interest to notice briefly the chief physical features of the Island of Montreal where the material for this study has been collected.

The Island of Montreal contains about two hundred and six square miles and is a rough isosceles triangle in shape. The long side is bounded by the Lake of Two Mountains and the Rivière des Prairies, and the other two sides by Lake St. Louis and the St. Lawrence River, respectively.

The island itself is a part of a great palæozoic plain, which extends up the Laurentian plateau on the north, southward into the United States, and from the Notre Dame Mountains in Quebec to Lake Huron on the west. The plain is flat, and the average elevation in the vicinity of Montreal is about a hundred feet above the sea level. The whole area is covered with drift and forms excellent farming lands. On the Island, the continuity of the plain is broken by Mount Royal, an igneous mass rising behind the city and occupying an area of about one and a half miles. This is the most westerly of a line of old volcanoes and laccolites, known as the Monteregian Hills. About the base of Mount Royal, the strata of the lower Silurian are represented by the Trenton Group, which covers the greater part of the island,—with Calciferous limestone at the western extremity, Chazy at Point Claire and at Cartierville, and Utica Shale along the river front at Verdun and Bout de l'Ile.

The upper part of the Palæozoic and the whole of the Mesozoic and Tertiary are unrepresented, but the Pleistocene has left its record in a drift of Leda clay and Saxicava sand and in a series of terraces between Mount Royal and the harbor, marking the gradual retreat of the Pleistocene Sea.

Collection of Algæ.

Throughout the month of October I collected material for study and classification from a variety of situations and from as widely separated parts of the island as possible, including:—

(1) The shore of the St. Lawrence at Verdun.

(2) The quarries at Amherst Park.

(3) The ponds and streams on Mount Royal.

(4) The Back River and brooklets emptying into it at Sault au Recollet.

(5) The shores of the St. Lawrence at Rivière des Prairies at Bout de l'Ile.

(1) VERDUN:

Here, just opposite Nun's Island, the river is very shallow near the shore and abounds with small islands among which it runs slowly, forming a low, swampy tract of land. Reeds, rushes and sand-bar willows (Salix longifolia, Mühl) line the water edge, and a great variety of water weeds, such as Nymphaæ, Utricularia, Elodea and Myriophyllum, grow partly submerged in the shallow water. Entangled with these and also floating freely in the water, I found a great number of species of Zygnema and Spirogyra, also a very little Oscillatoria, some Nostoc, Pediastrum and quantities of Desmids. Some Diatoms were secured attached to filaments of Cladophora, which was found in abundance growing fastened to stones. A pool inside of the old river dyke contained an enormous amount of Lemna; and, in March, Chætophora was found growing in a thin film on the sides of the aquaria in which some of this Lemna had been placed. Leaves of Nymphæa, tufts of Elodea canadensis and other water weeds were collected and washed, to secure forms attached to them. When this locality was visited, on the 30th of September, the water was quite warm and abounded in animal life. I noted that, although there were many species of algæ present, there were comparatively few individuals. Ulothrix occurred in tufts, unmingled with other forms, but Spirogyra and Zygnema were always associated with each other. No

Spirogyra but only one Zygnema was found in a fruiting condition.

(2) Amherst Park:

This is a section of land at the north-east of the mountain, which is now beginning to be built up. There is a thin layer of sandy soil over the surface of the Trenton limestone, which is well developed here. This has been and is still being extensively quarried. Many abandoned workings exist, which have nearly all become filled with water, forming ponds of some size and great depth. The limestone is cut at intervals by dykes from the fourth period of Mount Royal's activity, and these, not having the commereial value of the limestone, have been left intact and serve to divide some of the quarries into ponds.

In two of the largest quarries, *Anabena inequalis,* (Kütz) Born. & Flah., was found covering the whole surface like a thin creamy-yellow film. Associated with this was a very little Oscillatorio. Very few water weeds were to be seen in any of these artificial ponds, save here and there a few tufts of Elodea, probably because the sides were too steep and sheer to afford any convenient place for it to take root. It was noticeable that each quarry invariably had a dominant form. The shallower pools contained the filamentous forms, some presenting a very beautiful appearance because of the long graceful strands of filaments which streamed up from the bottom. These pools were supplied with water both by drainage from the surrounding plain and from tiny springs.

This was by far the richest region discovered, both in the number of species and also in the quantity of individuals. More than twenty of these ponds, large and small, were visited upon several occasions and a great deal of material was collected. The ponds which contained the most refuse—these abandoned quarries are evidently largely used as dumping grounds for rubbish—i.e. those which contained the most nitrogenous material, were very much the richest in algæ. One pool in particular, which contained a great quantity of garbage, tin cans, old boots, etc., was evidently an ideal location for the Scenodesmaceæ. All the weeds in the pool and all the marginal plants which hung into it were coated with a thick gelatinous film composed of Desmids and Protococcaceæ.

As far as the sources of the flora of these quarry holes are concerned, there is little possibility of the dissemination of spores by water currents, as the various excavations are unconnected, and there is but one small stream in the whole region. On the other hand, dissemination may occasionally take place by currents of air bearing spores for short distances. Probably the chief means of transportation are insects, birds and other animals. Frogs, in going from one pond to another, would readily convey spores or even filaments of algæ attached to their bodies, and it has been observed by Mr. C. H. Thompson[11] in a study of the "Dissemination of Lemna," that Belostoma americana, commonly found flying about electric globes on the street, carries Lemna attached to its body. This insect stays in the water all day and flies about at night, possibly distributing algæ which grow in the same habitats as Lemna.

(3) Mount Royal:

The ponds and streams on the Mountain were by no means such favourable situations for algæ as the abandoned quarries at Amherst Park. But the fact that the summer of 1911 had been very long and very hot was, no doubt, partly the cause of this apparent scarcity; most of the small streams being dried up and the ponds low. A large artificial pond in the Roman Catholic cemetery, at the back of Mount Royal, was found to contain a very large quantity of Microspora entangled with Myriophyllum. A small streamlet of water which flowed down a steep bank into this pond was filled with almost a pure mass of Ulothrix. On the brick flags of the floor of the conservatory, I noticed a thin blackish green scum which proved to be a mixture of Calothrix, Tolypothrix, Scenodesmus and Lyngbya. The metal horse-trough on the driveway contained Ulothrix, some filaments of Spirogyra and Zygnema, and a good many Palmellaceæ.

(4) Back River:

The Rivière des Prairies, which is also known as Back River, is very shallow in some places, especially at Sault au Recollet. Here, along the edge of the water, Elodea was very plentiful. Entangled with this was a great deal of Hydrodictyon, Spirogyra and Zygnema. Later on, in the winter, Mougeotia developed in the aquaria in which these collections were placed. Cladophora also occurred here, showing its preference for running water. A small brook emptying into the river contained an enormous amount of Spirogyra, Vaucheria, Œdogonium and Zygnema growing together attached to stones on the bottom. The Spirogyra was very luxuriant and dark green in color.

(5) Bout de l'Ile:

This is the extreme eastern end of the island, where the Rivière des Prairies and the St. Lawrence join. Both rivers are very deep at this point and flow swiftly, consequently algal growth is scanty. Along the edge of the Rivière des Prairies, Stigeoclonium was abundant on the Leda clay, which always appears to be a favourable substratum for it. All along the edge of the St. Lawrence great mats of Vaucheria and Microspora were found having evidently been brought down by the current and caught in tufts of Elodea. Nearly all were covered by a thin layer of ice, for by this time it was the end of October. The Elodea appeared to have been killed by the low tempeprature, but the algæ were unhurt. Quantities of Spirogyra and Œdogonium were found in the swamp near the street-car tracks. Cladophora, as usual, occurred along the edges of the river, this alga showing a preference for well-aerated waters. In general there was a constant association of Elodea and filamentous forms.

PRESERVATION OF ALGÆ.

While the majority of algæ can be cultivated, or at least kept alive in fresh water under suitable conditions of light and temperature, some forms disintegrate and disappear within a short time after being brought into the laboratory. In order to secure those which might otherwise have disappeared before they could be identified, I preserved a sample of the freshly gathered contents of each aquarium. For this purpose I used a two per cent. solution of potassium acetate, containing just enough acetate of copper to make it faintly blue. This solution which is much more satisfactory than formalin as a preservative for algæ, gave the most excellent results with nearly every form. Vaucheria was slightly plasmolysed by it. This may be avoided by a method suggested by Mr J. H. Nieuland[12]. The plant should be killed rapidly with three or four per cent. formalin, which must be quickly and completely removed by repeatedly washing the plant in water, after which it should be put into glycerine to which a little thymol has been added. Thus it will retain its color perfectly.

Anabæna was also very difficult to preserve in this solution, the filaments rapidly becoming disorganized and breaking down. This was probably due to the copper having been too strong. As Moore[13] has shown in his experiments with copper as an algicide and disinfectant of water supplies, one part of copper to ten million parts of water is sufficient to destroy Anabæna in ponds and in reservoirs, while Oscillatoria requires one part of copper in every five million parts of water, and forms like Eudorina and Pandorina require one part of copper in every one hundred thousand parts of water.

The chief advantage of the potassium-copper-acetate solution, which serves at once as a killing, fixing and preserving solution, is the way in which it preserves the delicate shades of the green algæ. Material preserved in this way may be mounted satisfactorily in glycerine-jelly. I found the solution remarkably successful for Desmids and the various species of Spirogyra.

As well as securing forms for later identification, the sample from each aquarium served as a valuable check or control in studying the persistence or disappearance of various forms, the normal habit, the periodicity, and the appearance and development of those, whose spores only had been gathered.

Algæ under Artificial Environment.

On the field trips a number of small collecting bottles were carried and each sample of algæ secured from pool, pond or wet bank was placed by itself in one. If several samples were taken from the same large pond, they were all put into separate bottles. On being brought into the laboratory, the contents of each was placed in a separate aquarium which was then filled up with water. Stones and tufts of water-weed with algæ attached were collected and treated in the same way. By the end of October some sixty-five aquaria, ranging in size from one to ten liters, were set up, the majority having a capacity of about three liters. In every case the water used was the ordinary tap-water. The reports of various botanists who have cultivated algæ in water and in nutrient solutions show that the results of tap-water cultures have been distinctly variable. The variation naturally depends largely on the chemical qualities of the water. The good results from cultures in Montreal water were marked. It was learned from the City Analyst[14] that in connection with the filtration plant the Montreal Water-works regularly placed a definite quantity of hypochlorite of lime in the water supply as a disinfectant. Less than one part of the bleach to a million parts of water were used. While this amount destroys the deleterious bacteria, it was proved to have no ill effects upon higher organisms.

The following analysis obtained from the Chemical Department of McGill University, in addition, shows that the water contained the nutrient salts necessary for normal growth:

Total solids	11.13	parts per 100,000
Temporary hardness	7.39	
Permanent hardness	none	
Organic and volatile matter	1.92	
Free NH_3	0.0026	
Albuminoid NH_3	0.0154	
Nitrogen as nitrate	0.65	
Nitrogen as nitrite	none	
Oxygen as used in KNO_4 test	0.45	
Chlorine	0.6	
Silica	0.24	
Lime	2.5	
Magnesia	3.2	
Iron oxide and alumina	0.76	

In the Botanical Laboratories, where these experiments with algæ under artificial conditions were conducted, the windows facing the north were used during the early part of the winter for the aquaria. Towards spring, when experiments were made with nutritive solutions, parallel cultures were placed in both north and south windows, but no difference in effect could be observed. Toward the latter part of March, when the sunlight was much stronger than it had been during the winter, it was noticed that in such aquaria as had a coating of Oscillatoria, Stigeoclonium, Chætophora or Ulothrix about the sides, growth was much more successful than in those where the filaments were exposed to the direct sunlight.

The beneficial effect of a comparatively low temperature was also apparent. The most favourable range was from 5° to 15° C. Under this temperature, Spirogyra, Vaucheria and Cladophora lived most successfully, whereas they appeared less healthy and were shorter-lived when the temperature of the culture was raised above 20°C. Mougeotia, Ulothrix, Stigeoclonium and the Desmids seem to require a slightly higher temperature than other forms, usually appearing in aquaria where the temperature had been raised. Oscillatoria also showed in a marked degre the effect of a higher temperature, the blue-green tufts of this form always appearing in a culture within a day or two after the temperature had been allowed to rise to 25° or 30°C.

In the case of the filamentous forms like Cladophora and Vaucheria, the lower temperature probably proved favourable to growth because of the increased amount of oxygen and carbon dioxide, which would be dissolved in the water at the lower temperature. The same consideration would also apply to the Spirogyras, though as a rule they can grow in less aerated water than Vaucheria and Cladophora, probably because they possess thinner cell walls and numerous chloroplasts which permit an easy diffusion of gases.[1]

Mougeotia, Ulothrix, Stigeoclonium, Oscillatoria and the Desmids, on the other hand, were probably collected in the form of spores, and an increase of temperature, in the cultures in which they happened to be, induced germination.

It was found impossible to keep Anabæna alive in the laboratory for more than a week or two after collection. Generally, after a few days, the filaments had begun to disintegrate. Zygnema was also difficult to cultivate. Although in some of the aquaria it continued to live for a couple of months, it had disappeared from the majority after about a month. But both Anabæna and Zygnema began to appear in some of the aquaria in March, noticeably in those which contained a number of other types.

No Mougeotia was observed in the material first collected. But in December, when the temperature of many of the aquaria was allowed to rise considerably, it developed in great quantities in a large number. Ulothrix was noticed early in February in many of the aquaria where it had not been previously observed. *Cladophora glomerata* (L.) Kütz, which was growing attached to a stone, lived in a uniformly healthy condition all winter. So did *Microsporia crassior* (Hansg.) Hazen, which seemed to be especially hardy and flourished under every condition of light and temperature.

One aquarium contained a lump of clay on which a quantity of Stigeoclonium was growing. This began to die down in December and by the beginning of January none was to be found· The lump of clay was then placed in a two per cent. Knop's solution. In four weeks it was covered with a most luxuriant growth of Stigeoclonium. Cladophora also responded promptly to the nutritive effects of Knop's solution.

Some twenty of the aquaria contained Spirogyra, generally associated with several other genera, but usually forming the bulk of the material in each. When collected, Zygnema andŒdogonium were usually present with Spirogyra, but they soon died out. Spirogyra continued to live for three or four months in a comparatively healthy condition, but after this it showed signs of degeneration, the filaments became etiolated, the cytoplasm broke up into bodies somewhat resembling cysts. These were, however, very small and never secreted a wall and this stage was immediately followed by the disintegration of the whole filament. It was remarkable that in the large amount of Spirogyra collected during October none was found in a fruiting condition, nor were any spores observed. This material was watched carefully throughout the winter in the hope that conjugation might take place later on. By placing filaments in various culture media, attempts were made to induce conjugation by artificial means, but none gave the slightest success. Distilled water proved distinctly toxic, causing plasmolysis and death. Neither a two nor a four per cent. Knop's solution had any effect. Both a five per cent. and a one per cent. solution of ammonium nitrate were tried, and appeared only to accelerate the death of the filaments. In a culture of Desmids, on the contrary, the five per cent. solution caused luxuriant growth. In the majority of those cultures which contained nothing but Spirogyra, the plants had died by the end of March. On the other hand, in aquaria where there was a large number of forms associated, growth at this time was becoming more and more luxuriant. Quantities of Œdogonium, Chætophora and Stigeoclonium, some Anabæna and a little Spirogyra began to appear towards the end of this month. Vaucheria resisted comparatively well the disadvantages of growth under artificial conditions, and was found throughout the winter in various stages of development. Desmids and members of the Protococcaceæ occurred in all the aquaria, the varieties of Scenodesmus being especially plentiful. A number of Diatoms were found either floating in chains or attached to filaments of Cladophora and Vaucheria. They were most abundant at a low temperature.

An aquarium containing a number of Cyanophyceæ collected from the floor of the Conservatory at Mount Royal Cemetery, showed an interesting development.

When the film was scraped off the damp tiles, it presented the appearance of a blackish green scum. This was found to be composed of Calothrix, Tolypothrix, Oscillatoria, Lyngbya, Desmids and various other unicellular forms. During the winter, the aquarium containing them was not kept under the same conditions of light and warmth as had obtained in the conservatory. Although it was maintained at a higher temperature than the others, a marked difference in the color and relative numbers of the algal constituents had taken place. The contents of the culture were now a much lighter green, and while formerly the majority of the individuals had been blue-green, now the green unicellular forms predomniated and many of the blue-greens had entirely disappeared. This is an excellent illustration, on a small scale, of the dominance of the Cyanophyceæ under tropical conditions, and the greater adaptation of the Chlorophyceæ to conditions of less light and lower temperature which Dr. Fritsch has pointed out in his study of the Tropical Algæ.[1]

A good deal of animal life existed in the aquaria throughout the winter. In October, several small crayfish were noticed and. removed, as well as innumerable tiny snails, which were feeding upon the unicellular algæ. Vorticella was found in practically every culture, especially in connection with Vaucheria and Ulothrix. Paramœcia were also frequently noticed, often containing unicellular forms of algæ which they had engulfed. Amœboæ were not so plentiful and no Hydra were observed in any of the cultures, although a special search was made for them. Daphnia, Crypris and Cyclops were quite plentiful in aquaria which contained a quantity of water-weed. It was interesting to observe that apparently Oscillatoria was not used by any of these forms as food, and that in several small aquaria where it appeared in large quantities the animal life disappeared shortly after the unicellular green algæ had been exhausted. This may be due to the toxic qualities of the Oscillatoria which are suggested by the disagreeable gas that it gives off.

PERIODICITY IN SPIROGYRA.

A brief consideration of the theories advanced by several botanists who have studied the question of periodicity in the occurrence and sexual reproduction of Spirogyra may serve to summarize and explain some of the results which have been noted in the foregoing pages.

Benecke[2] has advanced the theory that conjugation in Spirogyra is due to the failure of ammonium salts, supposed to be removed from the the water by angiosperms which increase in size and abundance as the season advances. He placed *Spirogyra communis* (Hass.) Kütz, in various media, in bright light, with temperatures from 12°—20° C., and found that in nitrogen-free solutions conjugation took place at once or in a short time. If parallel cultures were run, in which NH_4 or NO_3 had been added in appropriate amounts (.05%) to any of the above media or substituted for one of the constituent salts, no conjugation took place, but good vegetative growth ensued generally.

Danforth[3] repeated these experiments, using other species. Of the five species investigated, three failed entirely to give the same results as had been obtained in Benecke's work, the fourth failed in every case but one, and the remaining species, *S. Grevilleana* (Hass.) Kütz seemed to agree more closely with S. *communis*, but even here the agreement was not complete. Apparently, Benecke did not find any specific stimulus which would induce conjugation unless the absence of ammonium salts be taken as such. Danforth also found that some species of Spirogyra did not respond by vegetative growth as did others when NH_4NO_3 (Ammonium nitrate) was added to the media. *Spirogyra stetiformis*

(Roth) Kütz was killed when placed in cultures of tap water and distilled water containing NH_4NO_3, even when a trace of this salt was added to a nutrient culture of five months' standing. His experiments seem to show clearly that in many cases at least the absence of ammonium salts is not enough to bring about conjugation. These results show considerable similarity to those which were given by my cultures, both in the deleterious effect of NH_4NO_3 on *S. setiformis* (Roth) Kütz, and the failure of all artificial methods to induce conjugation.

Copeland's work consisted in a study of Spirogyra both under natural and artificial environment. In the laboratory, he found that very satisfactory cultures could be made with tap-water, and even a .04 per cent. Knop's solution gave favourable results. But no particular advantage was observed from the use of nutrient solutions. It was noticed that it was a decided advantage to shade the aquaria with dark paper when first started. The good effect was especially noticeable in the south-east windows, where the light was strongest. The proximity of Œdogonium and Chara proved beneficial to Spirogyra, Œdogonium being invariably present and often the predominating form in the aquaria where Spirogyra lived for several months or a year. Oak leaves and charcoal also appeared to be beneficial factors.

In field work he collected thirteen species of Spirogyra, of which twelve fruited abundantly. Ten of these passed their period of maximum abundance in May, one in August and one in October. One reliable example of a second fruiting was *S. dubia,* which fruited in May and again in July. The period of maximum abundance was proved in every case to correspond with the period of maximum conjugation. After conjugation, the fruiting filaments and the vegetative forms disappeared at the same time. One species was observed during several years, but never found in fruiting condition. Copeland concludes, from notes taken in the field and supplemented by work in the laboratory, that conjugation results not so much from external as internal conditions. He, therefore, concludes that Spirogyra has definite periods of growth and activity.

In regard to the possibility of satisfactory cultures in tap-water, the advantage of a certain amount of shade and the beneficial effects of an association with other forms, especially Œdogonium, my results agree fully with those of Copeland.

Fritsch and Rich, in their "Preliminary Observations on Spirogyra," base their theories on observation of this genus under a natural environment.

Of the species examined, some appeared to be purely vernal or else to exhibit both a vernal and an autumnal phase with an intervening period of scarcity or complete disappearance. The factors for the disappearance of Spirogyra after the vernal phase are enumerated as follows:

(a) The increase in the intensity and duration of the light.
(b) The increase in the temperature of the water and the consequent diminution of the amount of dissolved gases in the water.
(c) The gradual concentration of the salts dissolved in the water owing to the heat and the the lack of rain-fall in a normal summer.
(d) The increase in the amount of higher vegetation present.

The autumnal appearance of certain species of Spirogyra may be due, they think, to the influence of certain combinations of external factors causing a small number of zygospores to germinate. In the absence of these conditions there may be no autumnal phase. Abnormal meteorological conditions may bring about abnormal absence or occurrence of Spirogyra.

Reproduction takes place ordinarily in the vernal phase. They consider it to be the result of certain periodically recurring combinations of factors which vary for different species. The nature of the stimulus causing reproduction is, therefore, an intensification of these conditions which is liable to occur in spring. Such intensification taking place at other times in the year would lead to exceptional cases of reproduction.

In a study of this nature, it is out of the question to attempt to confirm either the theory of Copeland that conjugation results from internal rather than from external conditions, or that of Fritsch that conjugation results from a periodically recurring combination of external factors. However, the appearance of numerous species of Spirogyra in October, and the entire absence of any fruiting material at that time, as well as my failure to obtain any conjunction in the laboratory during the winter, incline me to believe that while certain conditions of light, temperature and density of water, as Fritsch suggests, probably induce the second appearance of Spirogyra in the fall, conjugation results from certain periodically recurring internal conditions.

The Formation of Rhizoids in Spirogyra.

An interesting development was observed in an aquarium containing *Spirogyra fluviatilis* Hilse, collected from one of the quarry holes in Amherst Park. This vessel contained a large amount of the alga and, in examining some of the filaments in January, it was observed that at the end of many there was an abnormal growth. The end cell seemed to have lost most of its chlorophyll, the characteristic spiral chromatophore was broken up, and the cell had branched into two or more narrow root-like prolongations. Further search revealed filaments in all stages, from an almost imperceptible beginning of the forking to long colorless processes which were always found in contact with other filaments or with masses of slime. An examination of a large number of specimens showed that only the end cell was thus affected, though the cell next to it might lose some of its chlorophyll. These root-like processes were continuous with the end cell, they appeared to have a slightly laminated cell-wall, and usually showed a sort of mucilaginous excretion with which bacteria were frequently associated.

An examination of material preserved from the same aquarium in October showed that a few of the filaments had possessed these branches when collected, although in a less developed stage. Several other cultures of Spirogyra from different localities showed the same phenomenon, but it appeared in every case to be the same species, other species in the same aquaria showing no trace of the rhizoid-forming tendency.

From these observations, and after a number of experiments with various culture media which apparently did not effect the form in any definite way, I concluded that this tendenccy to form root-like projections must be a specific response to some physiological stimulus which occurs in nature as well as under artificial conditions. In Borge's "Uber die Rhizoidenbildung"[11] it is stated that rhizoids can be produced in Spirogyra filaments by the action of certain culture media. After citing various instances where the phenomenon of rhizoid formation has been observed in certain members of the Chlorophyceæ, which are ordinarily not supposed to possess these organs, Borge describes a large number of experiments which he made in order to study the cause of its occurrence. He found that, when grown in a number of culture media, such as cane-sugar, asparagin, agar-agar and glycerine solutions, *Spirogyra fluviatilis* could be induced to form rhizoids, while in pure water cultures it did not. This species, as well as two others, which were unnamed for lack of fruiting material but which greatly resembled it, were found in different places growing fastened to stones in the water. Experiments were made next with *S. inflata* Vauch, *S. orthospira* Naeg. and two unnamed species, all of which were found free-swimming in nature. None of these were apparently grown in culture media, but all were used in contact cultures. While neither the attached nor the free-swimming forms produced rhizoids when grown in ordinary water cultures, it was found that all could be induced to form these organs in a few days by growing them in contact with some object like a microscope-slide or cover-glass, in a drop-culture.

To complicate matters, however, it was found that several other species failed entirely to respond to the contact treatment. These were *S. Weberi*, *S. varians* and several unnamed forms, all of which were found free-swimming in nature. Although all of these were grown in contact cultures for over a month none showed any sign of rhizoid formation.

Spirogyra fluviatilis appeared to be the most highly sensitive of all the forms examined, and readily formed strong rhizoids. Other forms produced rhizoids more or less freely in contact culture, *S. orthospira* showing the least response to treatment. It was on this account, as the author explains, that *S. fluviatilis* was used for the majority of the experiments with culture media. In no case could he discover the cause of this phenomenon. In the rest of the paper, he discusses this rhizoid-forming tendency in other genera, such as Mougeotia, Ulothrix and Vaucheria, which show similar differences to those observed in various species of Spirogyra.

A consideration of all the evidence, both in this work and that furnished by my own observations of the rhizoid-forming power of Spirogyra, leads me to conclude that, in the first place, this phenomenon is due to a certain specific sensitiveness rather than to the nature of the stimulus. That there must be a stimulus of some sort is evident, but it seems to be rather the sensitiveness of the organism than the nature of the stimulus which determines the degree of the response.

The stimulus, both in Borge's culture media and in drop-cultures, was very probably the same, namely, a certain amount of irritation due to contact. In my cultures, the stimulus was apparently due to irritation caused by contact with other forms in a crowded aquarium, this being sufficient to produce marked rhizoid formation in the highly sensitive *S. fluviatilis.* In the second place, it may be suggested that this sensitiveness among certain species of algæ, which expresses itself in a more or less strongly marked tendency to form rhizoids, may have some connection with the thigmatropism shown by some of the higher plants.

This view is in harmony with the results of Prof. Derick's study of the early development of many of the red algæ[5]. In them the stimulus determining the point of origin of holdfasts and rhizoids seemed to her to be undoubtedly that supplied by contact irritation.

Systematic List.

I. Chlorophyceæ.

Order I. Conjugatæ.

Family 1. Desmidiaceæ.

Closterium Jenneri, Ralfs.

Crescent shaped, small, slightly tapering, six to eight times longer than broad, ends obtusely rounded, vacuole large, containing many active granules, cell wall colorless, smooth· Diam. about 14 micr.

Verdun, Bout de l'Ile, Amherst Park.

Cosmarium Botrytis, Menegh.

Cells nearly twice as long as broad, sinus narrowly linear, semi-cells with nearly straight base inclining to reniform, sides converging from inferior rounded angles to truncate end. Cell-wall granular. Diam. 35-36 micr.

Verdun, Amherst Park.

Micrasterias americana, (Ehrenb.) Ralfs.

Semicells three-lobed, lateral lobes broad margins, incised serrate, subdivisions narrow and dentate at extremities. Diam. 100-115 microns. Length one-third greater.

Verdun, Amherst Park.

Family 2. Zygnemaceæ.

Zygnema Vaucherii, Ag.

Cella 10-22 micr. 2½ or 3 to 5 times as long as broad.

Zygospores subglobose or broadly elliptical.

Verdun.

*Zygnema insigne, Kütz.

No fruiting material. Vegetative cells 26-30 micr. diam. Length equal or up to 2 diam.

Verdun.

*Spirogyra fluviatilis, Hilse.

Filaments 36 micr. diam. cells 5-6 diam. long.

Chromatophores, slender, very pale green, making 1½-2½ turns in the cells. No fruiting material; found sterile attached to stones; formed rhizoids when cultivated in water, in laboratory.

Amherst Park, Back River.

*Spirogyra setiformis, Kütz, of Collins or

Spirogyra orbicularis of Cooke.

Cells 110-140 micr. diam. about as long as broad, 4 rather broad chromatophores, with many large pyrenoids, making ½-1 turn in the cell. No fruiting material.

Mount Royal.

Family 3. Mesocarpaceæ.

*Mougeotia nummuloides, Hass.

No fruiting material, vegetative cells 16 micr. diam. 102 micr. long.

Verdun, Mount Royal, Back River, Amherst Park, etc.

*Several forms of Zygnema and Mougeotia and a great many of Spirogyra were collected, but as no fruiting material was obtained, save in the case of one Zygnema, it was found impossible to decide with certainty to which species they belonged. Only a few forms are, therefore, named, the structure of which appeared to be sufficiently characteristic to admit of listing them as accurately determined species.

Order II. Volvocales.

Family 1. Chlamydomonadaceæ.

Chlamydomonas sp?

Verdun.

Family 2. Volvocaceæ.

Pandorina morum, Müll.

Colony globose to ellipsoid, up to 220 micr. broad, 16 cells, rarely more or less, cells 9-15 micr. diam.

Amherst Park, Verdun, etc.

Eudorina elegans, Ehrenberg.

Colonies 50-200 micr. diam. usually 32 arranged in 3 parallel circles of 8 each with four at each pole, cells 12-24 micr. diam.

Amherst Park.

Family 3. Tetrasporaceæ.

Tetraspora lubrica. Roth.

Frond at first attached, soon splitting and forming irregular expansions, often with many rounded openings up to 20 cm. long and wide. Very gelatinous, usually yellowish in color, cells 7-11 micr. diam. Generally in fours.

Mount Royal, Amherst Park, Verdun.

Order III. Protococcales.

Family 1. Protococcaceæ.

Characium Sieboldii, A. Braun in Kützing.

Cells 15-25 x 4-9 micr. erect, lanceolate when young, when adult short and broad. Stripe short, without basal disk. On Vaucheria.

Bout de l'Ile.

Family 2, Scenodesmaceæ.

Raphidium falcatum, Corda.

Cells bright yellowish-green, slender, fusiform, ends acute. 1.5-3.5 micr. diam. 15-25 diam. long, usually 2-32 united in a bundle.

R. falcatun var. aciculare, A. Br.

Very slender, 1.5-3 micr. diam., 15-20 diam. long, acicular, straight or slightly curved. usually solitary.

Very plentiful in every locality.

Scenodesmus bijuga, Turp.

Colonies of 4-8 cells oblong-ellipsoidal, with rounded ends 7-18 x 4-7 micr., arranged in a single or double row.

Every locality.

S. bijuga var. alternans, Reinsch.

Cells broader than in the type, in two rows alternately placed.

Every locality.

Scenedesmus obliquus, Turp.
Colonies of 4-8 cells, cells fusiform with acute ends, usually in a single series. 5-27 x 3-9 micr.
Every locality.

S. denticulatus, Lagerheim.
Colonies, 4-8 cells, in a nearly straight line. 4-5 micr. wide, to 15 micr. long, each end with two minute teeth.
Every locality.

S. quadricauda, Turp.
Colonies of 2-8 cells, oblong-cylindric with rounded ends, 9-33 x 3-12 micr. arranged in a single series, end cells with long filiform projections.
Every locality.

Crucigenia rectangularis, A. Br.
Cells 4-6 x 5-7 micr. 4-8-16-32 in a colony 13 to 35 micr. square with rounded angles, always in groups of 4, cells oval or oblong, touching near the outer end.
Amherst Park, Back River.

Selenastrum minutum, Näg.
Cells crescent shaped, usually uniformly curved. 7-9 micr. from tip to tip, 2-3 micr. wide at middle, cells usually free.
Back River, Amherst Park.

Kirchneriella lunaris, Kirchner.
Cells crescent shaped with rounded ends. 3-5 micr. diam. at middle, 6-10 micr. long.
Mount Royal, Amherst Park.

Family 3. Hydrodictyaceæ.

Hydrodictyon reticulatum (L.).
Cells usually several diameters long, length up to

1 cm. 100-200 micr. wide; families 1 to 2 dm. long.

Back River, Verdun, Bout de l'Ile.

Pediastrum Boryanum, Turp.

Cells 4-64, 10-20 micr. wide, forming a continuous circular disk, disk-cells 4-6 angled, marginal cells bi-lobed, each lobe ending in a short obtuse projection.

Verdun, Mount Royal.

P. constrictum, Hass.

Cells of periphery irregularly 2-lobed, sinus narrow, lobes unequal produced into an obtuse horn; central cells, polygonal. 16-32 cells.

Verdun, Amherst Park.

P. Ehrenhergii, Braun.

Coenobium orbicular, composed of 8-16 cells or quadrate of 4 wedge-shape cells, cells of periphery cuneate, truncate at base, deeply bilobate, lobes obliquely truncate, central cells polygonal, yellow green.

Verdun.

Order IV. Ulothricaceæ.

Family 1, Ulothricaceæ.

Ulothrix variabilis, Kützing.

Filaments 5-6 micr. diam. cells cylindrical, ½-1½ diam. long wall, thin, delicate, pyrenoid, single, small.

Mount Royal, Bout de l'Ile.

U. aequalis, Kützing.

Filaments 13-16 micr. diam. cylindrical cells 1-2 diam. long.

Mount Royal, Verdun.

U. tenerrima, Kützing.

Filaments 7-9 micr. diam., cells cylindrical, chromatophore contracted to one side of cell, pyrenoid, single. In light green, silky masses.

Mount Royal, Amherst Park.

Microspora crassior, Hansg.

Filaments long, dark green, nearly cylindrical. 28-33 micr. diam. cells 1-16 diam. long, with wall 2.5-3 micr., thick, chromatophore dense, covering whole cell wall.

Bout de l'Ile, Mount Royal.

Family 2. Œdogoniaceæ.

Œdogonium sp?

Bout de l'Ile, Back River.

Family 3. Chaetophoraceæ.

Chaetophora incrassata (Huds.) Hazen.

Thalli irregularly extended, branched, closely packed, main filaments elongate, secund branches, setiferous ramuli, cells of main filaments 8-16 micr. diam. 2-6 diam. long, ramuli 6-11 micr. diam. cells 1-2 diam. long.

Verdun.

Stigeoclonium tenue (Ag.) Kütz.

Tufts up to 1 cm. high, bright green, filaments slender, 7-10 micr. diam. below, 5-6 micr. in ramuli, cells cylindrical 1-3 diam. long, about equal in ramuli, main branches opposite, ramuli numerous, tapering to slender seta.

Bout de l'Ile

S. æstivale, Hazen.

Light green, palmelloid base, branching alternate, main filaments 7-9 micr. diam. cells 2-6 diam. long below, equal in ramuli, thin walled, somewhat swollen, ramuli near summit few.
Verdun.

Gleocystis gigas, Kütz.

Cells globose, 9-12 micr. diam. solitary, membrane thick and lamellate, contents green.
From floor of conservatory, Mount Royal.

Family 4. Coleochaetaceæ.

Coleochæte sp?
Verdun.

Order V. Siphonocladiales.

Family 1. Cladophoraceæ.

Cladophora glomerata (L), Kütz.

Fronds up to 30 cm. high, branches more and more frequent towards the top, filaments cylindrical, 75-100 micr. diam. below, 6-7 diam. long. 35-50 micr. in ramuli, 3-6 diam. long, ramuli not tapering, tips rounded. (An extremely variable species—Collins).
Verdun, Back River, Bout de l'Ile.

C. Kuetzingiana, Grunow in Rabenhorst.

Soft, loose, feathery tufts, up to 30 cm. high, filaments 45-85 micr. diam. below, ramuli 25-35 micr. diameter, cells cylindrical, slightly swollen ramuli, 6-10 diam. long below, 2-4 diam. long in ramuli, branching erect, opposite, or alternate below, ramuli with acute tips.
Bout de l'Ile, Back River.

Order VI. Siphonales.

Family 1. Vaucheriaceæ.

Vaucheria sessilis, Vauch.

Filaments 50-85 micr. diam. oogonia usually two, sessile ovoid, 70-85 x 75-100 micr. more or less oblique. Short beak, antheridium between the oogonia on short pedicel, circinate, ripe oospore with triple membrane, filling the oogonium.
Back River, Amherst Park, Bout de l'Ile.

V. geminata (Vauch.) var. racemosa.

Filaments 50-90 x 60-75 micr. or smaller, corymbosely arranged about antheridium, which is hooked.
Bout de l'Ile.

II. Diatomaceæ.

Found with Vaucheria and Cladophora from all the localities.

Order Pennatæ.

Family 1. Tabellariaceæ.

Tabellaria flocculosa (Roth) Kütz.

Family 2. Fragilariaceæ.

Fragillaria capucina.

Length of valves 30-60 micr.

Synedra ulva, Nitzsch.

Length of valves 150-250 micr.

Family 3. Naviculaceæ.

Navicula sp?

Family 4. Gomphonemaceæ.

Gomphonema geminatum.
On filaments of Mougeotia.

G. constrictum.
On filaments of Mougeotia.

III. Cyanophyceæ.

Order I. Hormogoneales.

Family 1. Scytonemaceæ.

Tolypothrix trunciola, Rab.

Diam. of filaments 11-14 micr.

Dull æruginous, articulatious ⅓ as long as broad. Heterocysts subsperical, singly at the base of the branches, making a velvety black, fuscous surface.
Mount Royal.

Family 2. Nostocaceæ.

Nostoc Sp?
Verdun.

Anabæna oscillarioides, Bory.

Forming bluish-green stratum. Trichomes elongated, joints sub-quadrate, distinct, heterocysts barrel shaped. Cells 4-5 x 4-6 micr. Heterocysts 6-8 x 7-9 micr. Spores 7-8 x 8-12 microns.
Bout de l'Ile.

A. inaequalis, Kütz.

Trichomes vary in thickness, about 4 microns in diam.

Amherst Park.

Family 3. Oscillatoriaceæ.

Lynghya æstuarii, Lieb.
(Oscillatoria insignis, Cooke.)
Thickness of trichomes 24 microns.

Bout de l'Ile.

Oscillatoria tenuis, Ag.

Trichomes straight, active, motile, joints half as long as broad, apex obtuse, cell contents pale blue, forming dark blue green stratum. Filaments 3 microns diam.

Bout de l'Ile, Back River, Amherst Park.

O. leptotricha var. splendida, Kütz.

Trichomes 2 micr. diam. indistinctly articulate, joints twice as long as broad, minutely punctate at periphery, cell-contents pale bluish-green.

Verdun.

Family 4, Rivulariaceæ.

Calothrx confervicola, Ag.
Tufts fasciculate, filaments dark bluish purple, attenuated, 18 microns in diam. heterocysts all basal, generally few in number.

Mount Royal.

Rivularia h..matites ,Ag.).

Heterosysta basal, extremities of filament piliferous, no spores. Globose thallus attached to stones in streams and to Myriophyllum.

Amherst Park.

Order II. Coccogoneales.

Family 1. Chamaesiphoniaceæ.

Chamæsiphon incrustans, Grun.
Diam. of cells 3.5-4.8 micr.
On filaments of Vaucheria from Bout de l'Ile.

Chroococcus turgidus, Kütz.
Diam. cells 13-25 microns.
Mount Royal.

Merismopedia glauca, Ehring.
Diam. of cells 3.3-3.8 microns.
Mount Royal.

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McGILL UNIVERSITY, APRIL, 1912.

NOTE.

By periodically renewing the water in Miss Miller's aquaria, so as to prevent the undue concentration of the mineral contents and by guarding against excessive exposure to strong light, many of the cultures were kept in good condition, during the summer of 1912, and furnished excellent material for class-work throughout the following winter. Towards the spring of 1913, hardy forms like Scenodesmus crowded out less resistive genera and the cultures were allowed to die during the summer.

Similar cultures started in October, 1913, were comparatively unsuccessful, the summer having been unfavorable to the majority of the groups. Spirogyra, Zygnema, Mougeotia, Œdogoniums and several of the Protococcaceæ began to grow after a few weeks. In December, practically all were attacked by disease, bacilli, vibrios, spirilla and water moulds abounding in the aquaria. These conditions were probably due in part to the high temperature which was maintained in the laboratories, in 1913-14, possibly in part to a less rigorous use of hypochlorite of lime in connection with the water-works of the city.

Miss Miller's results show that where water-supplies are freed from deleterious bacteria, a luxuriant development of algae will cause pollution unless preventive measures, such as treatment with copper sulphate, are taken.

C. M· D.

January, 1915.

THOUGHTS AND FACTS ON RIGHT AND LEFT-HANDEDNESS AND AN ATTEMPT TO EXPLAIN WHY THE MAJORITY OF MEN ARE RIGHT-HANDED.

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That the average man is right-handed is so well known, that it would appear hardly worth noting the fact, but left-handed men are so common that the question why are all men not right-handed must frequently have been asked, and up to the present date diligent search and enquiry by the writer has not resulted in finding that anyone has published a satisfactory reply; this is the excuse for bringing the subject before you again.

In the proceedings of this society are two able and exhaustive articles upon right-handedness, by the late Sir Daniel Wilson.

In Section II, paper VII, page 119, Vol. No. 3, 1885, Sir Daniel writes on "Paleolithic Dexterity." In this beautiful and interesting article, he goes over all the evidence of the stone implements of the paleolithic age and of the stone arrow heads and tools, knives and daggers, and the articles he has been able to obtain or reach an account of, and although finding some places where there seems to have been a larger number of left-

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* Read before the Royal Society of Canada, May 26th. 1908, and now reprinted by permission in the "Record of Science."

handed workmen, he still comes to the conclusion that in those localities men at that period were as a rule right-handed, some were ambidextrous, and others were left-handed; as Sir Daniel himself was naturally left-handed, his opinion on the effect of education as a reason for right-handedness is especially valuable, and he says that "my own experience as one originally left-handed is "that in spite of very persistent efforts on the part of "teachers to suppress all use of the left hand, I am "now thoroughly ambidextrous, though still with the "left the more dextrous hand."

On page 130, Sir Daniel says, "But the entire num-"ber of left-handed warriors of the tribe appears to have "barely amounted to 2.7 per cent. Out of 26,000 "Benjamites, as we are told, all warriors, there were "700 chosen men of the tribe, every one of whom was "left-handed and could sling a stone at a hair's breadth "and not miss. The instinctively left-handed is more "dextrous in the true sense of that term. He is not "only an exception to many right-handed men, he is "still more an exception to the large majority in whom "the bias is so slight and the dexterity so partial that "their practice is little more than a compliance with "the usage of the majority."

Still more, the fact of the difficulty of overcoming by education the natural predilection of some individuals to use the left hand instead of the right, so far goes to destroy the theory that education is the reason why men are mostly right-handed, and points out that there is some other reason why there is a natural inclination to use the right hand in preference to the left.

Sir Daniel Wilson also quotes from Froude's Thos. Carlyle, whose "sad misfortune it was to lose the use "of his right-hand when he had reached the advanced "age of 75. The period of life was all too late to turn "with any hope of success to the unaccustomed and "untrained left hand, and in his journal more than one "entry refers to the irreparable loss." But one curious embodiment of the reflections suggested by this privation is thus recorded in his journal upwards of a year after experience had familiarized him with all that the loss involved: "Curious to consider the institution of the " right hand among universal mankind; probably the " very oldest human institution that exists, indispensable " to all human co-operation whatsoever. He that has " seen three mowers, one of whom is lelt-handed, trying " to mow together and how impossible it is, has witnessed " the simplest form of an impossibility, which but for " the distinction of a right hand could have pervaded " all human things. Have often thought of all that, " never saw so clearly as this morning, while out walking, " unslept and dreary enough, in the windy sunshine. " How old? old! I wonder if there is any people bar- " barous enough not to have this distinction of hands; " no human cosmos possible to be even begun without it. "Oldest Hebrews, etc., writing from right to left, are as " familiar with the world-old institution as we, why that " particular hand was chosen is a question not to be " settled, not worth asking except as a kind of riddle; " probably arose in fighting; most important to protect " your heart and its adjacencies and to carry the shield " on that hand."

It has been suggested that right-handedness is hereditary and so it certainly is, so also is left-handedness which runs in families[1]

The world is made up of right-handed men the majority, left-handed men the minority, but between the two there are probably many who use either hand indiscriminately. These would soon become right-handed by example and education and so throw their weight with the right-handed number.

It is also suggested that the lower animals, the apes and quadrupeds, do not exhibit any peculiarity of right and left-handedness; this statement is perhaps due to

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[1] Judges, 20 Chap., 16 verse.

want of closer observation of the habits of the lower animals. The monkeys are quadrumanous animals, using their fore hands as feet as well as prehensible organs, and indifferently right or left as occasion may require. So quadrupeds use all four feet as medium of support and progression and there is apparently no reason why they should make use of one side more than the other. Yet as we shall see there are reasons why there is a possible difference of the two sides with them also.

In man, in very early childhood, the mother carries her infant on her left arm and thus the child's right arm is compressed against the mother's breast; this would leave the child's left hand and arm free to move and would give the child the earliest tendency to use its left hand most.

This habit pervades most civilized races who are more right-handed than the more uncivilized, the females of which latter races carry their babies slung over the shoulders in some way; and hence there is no special inducement for the child to use either hand more than the other.

It is the late Dr. Gilbert Finlay Girdwood, of London, the writer's father, to whom the writer is indebted for many suggestions and thoughts on the habits and instincts of the lower animals, and to whom the writer now desires to give all credit for whatever of value may be in these thoughts and facts on this subject, and whose death in 1870 prevented his carrying out what he doubtless would have done far better than his son.

Amongst other things he observed was the fact that in horses where there is one white leg it will probably be the near hind-leg, if two, these will likely be the two hind-legs, and if three, the two hind and near foreleg; this observation has been extended and an official list of 3,000 horses is examined which was obtained by writing to all the veterinary offices in the United States Army in cavalry regiments and horse artillery and to the veterinary officers of the Northwest Mounted Police, to all of whom the writer's indebtedness is here acknowledged and thanks returned, as well as to Dr. Higgins, Bacteriologist to the Veterinary Department at Ottawa.

The numbers obtained from this list, although only just 3,000 horses, are a sufficient average to call for further attention. These numbers were obtained by direct application to the different veterinary officers in charge, and their personal examination and answers. It is a pity more answers were not forth-coming. A similar application to the forces in England and to the Royal College of Veterinary Surgeons received for answers, no records of the kind were obtainable. It may be asked what has this observation to do with right and left-handedness in man; to those who would ask, the answer is, that as man gets older and the vital forces are lessened, the man becomes gray haired, and if his life be continued he at last becomes quite white and the powers of life have become much weaker.

This is apparently the case, not only in animal, but in vegetable life. The fact that absence of pigment in life where pigment usually is seen is evidence of weakness.

There is a common saying about white-footed horses:

> One white leg buy him,
> Two white legs try him,
> Three white legs deny him,
> Four white legs, throw him to the dogs.

As the hind-legs are those most commonly white the weakness is more observable in the fore-legs than in the hind and the remarks made by the different veterinarians go to show that a tendency to navicular disease is common in the white fore-legged horses—that the white-legged horses are generally washy — that the roan-coloured horses and the buff are constitutionally the strongest, with brown next.

Report comes this spring from the west communicated by Dr. McEachran, from which the following is quoted:

"In the car this morning, I met Mr. D. N. Campbell, "live stock agent, who asked me if I had noticed last "winter and spring whether or not the greatest mor- "tality among our range cattle was in the light-coloured "ones. He said, George Lane, of Gordon & Ironsides' "U ranch, told him that with them 90 per cent of the "dead cattle from the severity of the winter were white "and light roan in colour."

Absence of pigment where pigment is usually found is an evidence of lessened vitality.

Potato shoots grown in the dark are thin, long and white, easily destroyed.

All plants grown in the dark are weakly and are deprived more or less of chlorophyl.

What are called variegated varieties in plants have less vitality than normal plants.

One variety of the Coleus is cultivated for the variety of colour in its leaves, and for the white patches on its leaves; a whole branch will be spotted more or less with white, brown, red and green, and by making cuttings from the variegated branch, where white predominates, for all branches are not equally coloured, the variety may be made constant and this is carried out to obtain more white, till at last the leaves become almost white and the stem pink, then the plant will gradually fade away and die.

It is impossible to obtain a specimen of this plant just now, but a dried specimen of the Phyllanthus Nivosus, a Euphorbiacious plant, shows the tendency to grow white leaves is a strongly marked characteristic. The leaves are alternate and at the base of the stalk are green and of full size. They show their tendency to become white, increasing as they get nearer the end of the stalk, till they become nearly or quite white and suddenly drop in size. In this specimen the leaves become smaller as the white increases, and at last, when quite white, they are much smaller and die early and drop off. Here are two leaves which have dropped. In the branch on which the leaves become white, the stem at the same time assumes a pink colour.

As people get older, there is usually a decreasing amount of pigment in the hair, and the older the whiter the hair becomes. The whitening may be the result of some sudden stay in vitality from shock, when the vitality is greatly suspended, so that whiteness, where pigment should be, may be accepted as evidence of slightly lessened vitality.

Information received from a lady who is a cat-fancier is to the effect that white Persian cats are more or less deaf and that the lighter coloured breeds are less healthy than pigmented varieties, the hardiest being the black.

If, then, white hair may be taken as an index of weakness, and it would appear that it is so, it would imply that the side on which white hair is most frequent would be the weaker and the figures quoted above would show a preponderance of strength on the right side.

In man it has been observed that deformities and arrest of development occur more frequently on the left side.

Notably, hare lip most frequently on the left side. Here is a set of skiagraphs showing deformity in both arms and legs. The young lad from whose hands these two were made is a Russian Jew. On the left arm there are only two middle fingers which are complete to the base of the metacarpal bones, the unciform bone is present and what appears to be the cuneiform bone. There is but one bone to represent radius and ulnar and that is united to the humerus without any elbow joint, and there is a long, extended internal condyle to the humerus.

On the right arm the same arrangement for humerus, radius and ulnar is present, but the one bone representing radius and ulnar is somewhat longer than the left. There is a rudimentary scaphoid, a trapezoid, os magnum and unciform and a cuneiform, but the other carpal bones are absent. There are three metacarpal bones; to the one is attached a double phalanx made by the union of the proximal phalanx of thumb and index-finger, and then there are thumb, index, middle and ring-fingers but no little finger and no metacarpal bone of the thumb. In this case the greater deformity is on the left side.

Here is a similar deformity in a man of 55 years of age. On the left side he has both radius and ulna with an apparent tendency to fusion of humerus and ulna with lengthening of the internal condyle of humerus. At the wrist joint, there is a scaphoid bone and rudimentary trapezium; there is apparently an os magnum and unciform, the other bones of carpus rudimentary, three metacarpal bones for fore-finger, middle and ring-finger, none for thumb or little finger and the same arrangement as in the boy's fingers of right hand. In the man's right hand the radius and ulna are nearly perfect. There is a scaphoid, semi-lunar and cuneiform blended, a pisiform but no trapezium, there is a trepezoid os magnum and unciform, there is present a complete index, middle and ring-finger with a rudimentary thumb, and the metacarpal bone of the right finger.

The next is a club-foot on the left side and not on the right.

The next is a deformity of the left leg, the tibia and fibula end in expanded bony growths, and the bones of the foot are represented by rudimentary points of ossification, and here is a case of congenital absence of the left fibula.

Here is a picture of another abnormal left arm recorded by Dr. Jubb,[1] Glasgow Royal Infirmary. In this case the deformity is absence of radius in its greater extent and of the carpal and metacarpal bones of the thumb. This deformity is again on the left side.

When a student, in 1853, the writer had the opportunity of seeing a specimen of hermaphrodite organs as a preparation now in the museum of St. Mary's,

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[1] Copied from the archives of the Roentgen Ray of London, Rebman & Co.

London, in which there was a penis, a vagina and uterus, with a testicle in the right vulvum and an ovary on the left side. Again showing the left the weaker side.

These cases are too few in number to make any very strong statement as to the difference of frequency of deformity on the left side as against the right, but they do tend to show a leaning to deformities more frequent on the left side and to a greater extent on the left side than the right.

Paralysis or hemiplegia is more frequent on the right side than on the left, and in this case the injury to the brain is on the left side, while the effect is on the right side, due to the decussation of the fibres.

All these observations tend to the idea that the right side is a little stronger than the left, and hence the use of the right hand more than the left.

The carpenter and stonemason and blacksmith, like the majority, are mostly right-handed men and they hold their chisels when they want to direct the cut, in the left hand, and strike with the heavy mallet with the right hand.

In his second article on this subject, Sir Daniel Wilson says, page 3, section 2, papers for 1886: "The " phenomenon to be explained is not merely why each " individual uses one hand rather than another. Ex- " perience abundantly accounts for this. But if, as " seems to be the case, all nations, civilized and savage, " appear from remotest times to have used the same " hand, it is in vain to look for the origin of this as an " acquired habit. Only referring it to some anatomical " cause can its general prevalence among all races and " in every age be satisfactorily accounted for. Never- " theless, this simple phenomenon cognisant to the ex- " perience of all and brought under constant notice in " our daily intercourse with others, seems to baffle the " physiologist in his search for any entirely satisfactory " explanation."

He goes further into the habits of man in different countries and into the various reasons assigned for the predominant condition of right-handedness, by physicians, anatomists and physiologists, some giving an opinion as Sir C. Bell, that not only is man right-handed, but also right-footed, and that the right side is stronger than the left physically, others stating that the blood supply is better to the right side than the left, again that it is due to the difference in the blood supply to the brain, and even to the difference in size of the two sides of the brain.

If the course of the blood be, starting from the apex of the left ventricle through the ventricle into the aorta, and then a line be drawn as it were through the left ventricle and the course of the ascending aorta, through the arch of the aorta, and down to the promentary of the sacrum, it will be found to be represented thus, and if a plan were made looking down from above, it would be represented as a circle drawn from left to right, passing upwards and to the right in a curved manner, then still upwards and back at the same time passing gradually to the left side of the vertebral column, then down the left side of vertebral column, gradually passing to the centre thereof opposite the promontory of the sacrum, where it divides into two common iliac arteries.

In this course the aorta gives off the two small branches to supply the heart, the coronaries, then it passes on and where it begins to turn back and to the right side it gives off the large arteria innominata which divides into the right common carotid and subclavian, the carotid supplying the right side of the head and brain and the subclavian the right upper extremity. Passing on the arch of the aorta gives off from the upper side of the arch the left common carotid and the subclavian, the carotid supplying the right side of the head and brain and the subclavian the right upper extremity. Passing on the arch of the aorta gives off from the upper side of the arch the left common carotid and a little further on the left subclavian, and then passing down the left side of the vertebral column gradually coming forwards from the left side of the column to the centre of the front of the column where it divides into the right and left common iliacs to supply the lower limbs, the trunk and internal organs being supplied by other branches on its way down. Now in this course it does seem that the blood supply to the right side through the larger conjoined vessel the arteria innominata does receive a more direct current and the two vessels being united and a little better positioned to receive the more direct current, than on the left side where the two vessels common carotid and subclavian are separate in their origin, and given off at an angle not quite so favourable to the supply in directness.

In the supply to the lower extremities by the two common iliac vessels, the right iliac seems to get a little more direct supply than the left, not from difference in blood pressure in either case; for it has been found that there is no difference in the pressure on the two sides, as indeed, the physical law that liquids press equally in all directions would preclude a difference in pressure, but simply in direction, and the difference in direction being more easy for the current is the only difference, but with the multiplication of 120 beats a minute, the rate of pulse of the newly born and before birth, would make a multiplication of the slight difference of

120 per minute.
60
———
7,200 per hour.
24
———
28800
14400
———
172,800 per 24 hours.

and that continued for a few years would easily establish

[1] Dr. Janeway, Blood Pressure.

a little stronger vitality on the right side over the left, and would fully account for the difference previously noted.

The hindlegs in the horse which are so commonly white as compared with the number of fore-legs white may be due to the greater distance from the heart, the centre of force of the supply.

The conclusion the writer comes to from the observations recorded are that the right side of the bodies of man and the quadrupeds are a trifle stronger than the left, that this difference is caused by the little difference in the directness of the blood supply.

And that this difference accounts for the preponderance of right-handed men over left-handed.

And that the habit once established by natural causes has been increased in man by heredity and education.

But the cause of this determination of a slightly increased supply of blood is still unexplained.

Still the question, Why? remains.

Reference and illustration has been made to plants and a weakness shown to exist there when the normal colour is absent. If now we go further, we find the snail shell all rotating in the direction of the hands of a watch, that is, from left to right, but if the snail be watched in its egg during development it will be found to slowly rotate in the opposite direction, the direction from right to left; the writer has often watched them under the microscope for hours before they passed from the shell.

If now we take a hyacinth or an onion and strip off the leaves, we find the scars left on the flattened disk arranged so as to produce an appearance like the back of an engine turned watch with curves proceeding from the outside to the centre in the direction of the hands of a watch. The same appearance is found in the sunflower disk (Helianthus annuus) when the flowers are fallen, and the seeds are ripened they will be found to be arranged in similar lines. In these cases the axis of growth instead of being elongated, is flattened down into a disk, with the leaves in their normal places and with the buds in the axils of the leaves; in the sunflower the seeds are largest at the outside of the circle and get smaller as they go up to the top of the stem represented by the centre of the disk further away from source of supply.

If the fine point of a young pine or larch tree be looked at from the upper end towards the root, the branches or leaves will be seen to have a similar spiral arrangement.

In the Bryophyllum Peltatum the leaves are thick and fleshy and are deeply crenated on the edge and stay hanging on the plant till they are quite old and then fall off. If the leaf happens to fall on a damp place and is allowed to lie there, in a short time a root will be protruded from the angle of each of the deep crenations, and shortly a second and a third root find their way into the moisture and a bud will be protruded on the upper side which will grow up to become a new plant, hence the common name for this plant is the life plant. This same characteristic to a less degree is enjoyed by the begonia, the coleus and others.

In seed-bearing plants, a flower is produced. The various parts or envelopes of the flower consist only of modified leaves, and it may be expected that they occasionally take on other functions than the simple flower duties. And flowers or clusters of flowers are seen, especially in the primulaceæ, in which the flower is converted into a new branch, hence the common appearance known as the hen and chickens; in this case, the leaves which began as flower leaves have returned to their duties as ordinary leaves, but when the flower goes on to maturity we find the calyx or outside covering, comes a whorl or more of stamens; all these parts are the corolla, more or less gaudy, to attract insects, then leaves modified to perform their functions; lastly, in the centre, is the carpel or fruit or seed vessel; also a leaf, the fleshy part of which constitutes the fruit; this leaf is called the carpellary leaf or carpel, which has its midrib prolonged to form what is called the style, and terminated by the stigma. There may be one or more carpellary leaves constituting the fruit; in the plum one leaf only constitutes the fruit, and the inner surface of the plum stone represents the upper surface of the leaf, the outer skin of the plum represents the under surface, and the flesh of the plum, the cellular matter between the two layers of the leaf, upper and lower, the thin line down the one side of the plum represnts the part where the edges of the carpellary leaf are joined, and inside the cavity is the seed or kernel.

In the apple there are usually five such carpellary leaves united to form the fruit and again the inside of the five cavities seen when the apple is cut across, looking somewhat like a five-pointed star, are the representatives of the upper surface of these five carpellary leaves,—the outside being the representative of the under surface of the leaves, and the outside points represent the mid-ribs of these five leaves, and the five inner points will be observed to be double and represent the edges of neighbouring carpellary leaves joined together on the edges of which little seeds begin to grow. These are only like the buds on the Bryophyllum leaf, but in this modified form they require impregnation; if that operation takes place they grow to be perfect seeds, but if not they waste away and dry up.

In (100) one hundred apples of the northern spy variety examined, there were five carpellary leaves in each apple, and on the margin of each leaf there were either one or two, occasionally three, matured pips; but on each side of each leaf were little brown tubercules in number sufficient to make up (4) four pips in each cell, two on either side counting mature seeds or rudimentary immature seeds.

One hundred apples with five carpels to each would give (500) five hundred cells or carpellary leaves, and each leaf having four seeds or pip, mature or immature, would give a total of 2,000 pips that would be the proper full number of seeds; but the results of the examination gave only 972 mature seeds, of which number (556) five hundred and fifty-six were on the right side of the leaf, and 416 on the left, or 48.6 per cent. of the total number grew to full maturity as seeds; of these 556—57.09 per cent.—were grown on the right side of the leaf, 42.8 per cent. nearly on the left.

These numbers are all too small to make a general average of so large a subject, but they are so striking as to call attention to the subject and induce further observations in the same direction.

Now, if these pips be examined in the apple more closely, they will be found attached: first, the lowest, on the right side of the carpellary leaf, next a little higher on the left side, the third a little higher on the right side, and last, for there are seldom more than four, on the left side and a little higher, as the numbers that come to maturity.

From these observations, it seems then that there is something apparently determining the why these happenings are as they are, and it is the business of science to find out the why and wherefore for everything.

In the present instance there is no apparent reason why one side should have the preference over the other, but if the cause be hidden the more reason to search for it.

Suggestions or hypotheses might be made: there are so many notes or arrangement, and motion, in the direction of the hands of a clock that thoughts are directed to some cosmic influence which appears to dominate both animal and vegetable growth, and possibly also mineral growth amongst crystaline substances.

Amongst such forces as appear on the surface the rotation of the earth itself, its alteration of heat and cold every (24) twenty-four hours by exposure to and absence of the heat of the sun's rays, the magnetization of the atmospheric oxygen thereby producing a diurnal variation of the needle. There is the negative condition of the earth and the positive condition electrically speaking of the upper atmosphere keeping up a constant current of different electrical conditions, and the effect of a sudden thunder storm destroying a whole sitting of eggs shows the influence of electrical phenomena on early life, and then there is the constant radiation from the earth's surface of radium, any of which might be sufficient cause. Or must we still go back to protoplasmic memory.

If the averages noted in these thoughts and observations are borne out and verified by other observers, the natural result would be to breed out white-legged horses, and in the meantime for governments to refuse to purchase them. In the selection of seeds for the propagation of plants, seek out those that have been grown earliest and on the right side of carpellary leaf.

The first evidence which may solve the riddle found in Crystalline bodies—it is well known that the asymmetric carbon atom in organic compounds determines whether the plane of polarized light be rotated to the right or to the left, or whether the amount of asymmetric right and left-handed rotation be equal we have an inactive compound which does not affect the plane of polarized light.

Starch and sugar are most plentifully present in the vegetable kingdom.

Starch has the formula, $C_6H_{10}O_5$
in endless varieties of plants.
Dextrin in varieties of plants, $C_6H_{10}O_5$
Inuline, Dahlias and Artichokes, $C_6H_{10}O_5$
Moss starch.
Inuline, Dahlias and Artichokes, $C_6H_{10}O_5$
Glycogen animal starch, $C_6H_{10}O_5$
Glycogen, being found in the mollusca—in the surroundings of the infant in embryo—and is leave notary.

Both converted into grape sugar by the action of acids, and as sugar turns the ray of polarized light to the left or right, according as it is dextrose or levulose, here is a connecting link between the animal and the vegetable, and from its action, as rotating the plane of polarized light, it might be the means of determining the growth to one side or the other. These are only hints, not even hypotheses.

REPORT OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

SESSION 1907-1908.

Presented by Dr. Robert Bell, F.R.S.

In last year's report to the Royal Society of Canada, it was stated that the Natural History Society of Montreal, having sold its old building, had been obliged to store its library, collections and other effects and get along as best it could in the two old dwelling houses on its new lot on Drummond Street, but that it was hoped that its new building would very soon be under course of construction. Owing to the recent financial depression, however, no work has as yet been done on the new structure, and the society is still in the same uncomfortable situation with respect to an abiding place as it was a year ago. But the funds necessary for the construction of the basement and ground floor of its new home, with temporary roof and permanent heating system, etc., are now in hand, and the building committee has been instructed to start operations as soon as possible, and it is confidently hoped that the additional funds for the completion of the building will be forthcoming in time to prevent any pause in the work.

Meanwhile, the society has been by no means idle. The regular monthly meetings were held as usual during the winter at the temporary quarters of the society, the attendance and interest being gratifying. The following papers were presented:—

Oct. 26th.—"The New Permanent Biological Station at St. Andrews, N. B.," by Dr. D. P. Penhallow.

Jan. 27th.—"The Collection and Rearing of Dragon Flies, at the Marine Biological Station, Georgian Bay," by Dr. E. M. Walker.

Feb. 24th.—"Quebec and the Rock Slides from Cape Diamond," by Professor Carrie M. Derick, M.A.

Mar. 31st.—"History of the Natural History Society of Montreal, With a Description of the Proposed New Building," by Dr. D. P. Penhallow.

Apl. 27th.—"The New North West of Canada," by Fred. G. Lawrence, F.R.G.S.

In accordance with its usual custom, the society arranged for six Somerville Lectures and six Saturday Half-hour Talks to Children, and in addition a joint committee of the Natural History Society and the Local Council of Women planned thirty-four free illustrated lectures, delivered at various points in the city and suburbs, in the carrying out of which they were assisted by the Arts and Handicrafts Guild, The Cooking School of the Y.W.C.A., Ecole Menagere, The Pure Milk League, The Tuberculosis League, The Victorian Order of Nurses. At all these lectures and demonstrations, the attendance was very satisfactory, and the interest elicited of such a nature as to thoroughly justify the society in continuing the work next year. The programme of these lectures is here appended.

Somerville Lectures, delivered in the Lecture Hall of the Y.M.C.A., Dominion Square.

"Coal Mining," by J. Bonsall Porter, Ph.D.

"Education for the Improvement of Rural Conditions," by J. W. Robertson, L.L.D., C.M.G.

"A Botanist's Rambles in Spain," by Thep. L. Wardleworth, F.L.S.

"British Columbia and Its Possibilities," by Harry Bragg, Esq.

"Forestry," by Dr. B. E. Fernow (Dean of the Forestry School, University of Toronto).

"The Fiords of British Columbia," by J. Austen Bancroft, M.A.

Saturday Half-hour Talks to Children.

Delivered in the Lecture Hall of St. Andrew's Church, Beaver Hall Hill:—

"How Plants Get Their Food," by Prof. Carrie M. Derick, M.A.

"Just a Piece of Coal," by J. Austen Bancroft, M.A.

"Air," by J. S. Buchan, K.C.

"The Life of a Frog," S. Kirsch, M.A.

"Rubbers," by W. G. MacNaughton, B.A., B.Sc.

"*Books and Their Bindings,*" by C. E. H. Phillips, Esq.

TECHNICAL LECTURE.

"Chemistry of Iron and Steel Manufacture," by Prof. Nevil Norton Evans, in the Chemistry Building, McGill University (two lectures).

"Principle of the Electric Motor and of the Electric Dynamo," by Prof. John Cox, Physics Building, McGill University (two lectures).

ARTS AND HANDICRAFTS.

"Our Canadian Handicrafts," by Prof. Henry Armstrong, in St. George's School House, 15 Stanley Street.

"House Furnishing and Decoration," by Prof. Henry Armstrong, in Victoria Hall, Westmount.

"Beauty of the Home," by Cecil E. Burgess, A.R.I.B.A., in Chalmers Church, Cor. St. Lawrence and Prince Arthur Streets.

"Art in Our Households," by Cecil E. Burgess, A.R.I.B.A., in the Grand Trunk Literary Institute, Point St. Charles.

"The Furnishing of a Modest Home," by Prof. Henry Armstrong, in Taylor Church, Papineau Avenue.

PURE MILK.

"Pure Milk," by Dr. F. M. Fry, at St. Lambert, Que.

"Pure Milk," by Dr. F. M. Fry, in St. Mary's Church, Cor. Prefontaine and Rouville Streets.

BREAD.

"Ancient Bread Making," by Dr. D. P. Penhallow, in the Grand Trunk Literary Institute, Point St. Charles.

"Modern Bread Making," by Dr. D. P. Penhallow, in the Grand Trunk Literary Institute, Point St. Charles.

"Ancient Bread Making," by Dr. D. P. Penhallow, in Taylor Church, Papineau Avenue.

"Modern Bread Making," by Dr. D. P. Penhallow, in Taylor Church, Papineau Avenue.

COOKING.

"Substitutes for Meat and Fish," by Miss McLennan (Y.W.C.A.), in St. George's School House. 15 Stanley Street.

Ecole Menagere (in French), Montcalm Street. DeMontigny Street (two lectures).

"A Well Balanced Dinner," by Miss McLennan (Y.W.C.A.), in Chalmers Church, Cor. St. Lawrence and Prince Arthur Streets.

TUBERCULOSIS.

"Tuberculosis," by Dr. C. N. Valin (in French), in Montcalm School, DeMontigny Street; Dr. J. G. Adami, in Victoria Hall, Westmount, Dr. T. A. Starkey, in Old Brewery Mission, Craig Street; by Dr. J. E. Laberge, in St. George's School House, 15 Stanley Street; by Dr. T. A. Starkey, Victoria Hall, Westmount.

VICTORIAN ORDER-NURSING.

Grace Church, Point St. Charles; Victoria Hall, Westmount; "Care of Sick at Home" (in French), by Dr. Eug. St. Jacques; in Montcalm School, DeMontigny Street; Taylor Church, Papineau Avenue; Chalmers Church, Cor. St. Lawrence and Prince Arthur Streets; St. George's School House, 15 Stanley Street.

The annual field day was held on Saturday, 8th June, at Isle aux Noix, on the Richelieu River, near St. John's, and was a pronounced success.

The officers of the Society are:—

Patron—His Excellency the Governor General of Canada.

Hon. President—Lord Strathcona and Mount Royal.

President—D. P. Penhallow, D.Sc., F.R.C.S.

Vice-Presidents—Frank D. Adams, Ph.D., F.R.C.S., J. S. Buchan, K.C., B.C.L.; Rev R. Campbell, M.A., D.D.; Carrie M. Derick, M.A; E. W. MacBride, M.A., Sc.D.; Wesley Mills, M.A., M.D.; C. S. J. Phillips; Major G. W. Stephens, M.L.A.; Miss Van Horne.

Hon. Recording Secretary—Prof. N. N. Evans.

Hon. Corresponding Secretary—F. W. Richards.

Hon. Treasurer—Jas. W. Pyke.

Hon. Curator—A. E. Norris.

Members of Council—John Harper, Chairman; J. A. U. Beaudry, C.E.; Prof. Jos. Bemrose, F.I.C., F.C.S.; Henry Birks, Joseph Fortier, A. Holden, E. P. Lachapelle, M.D.; James Morgan, Alex. Robertson, B.A.

Superintendent—Alfred Griffin.

REPORT OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

1908-1909.

Presented by Alfred Griffin.

On behalf of the Natural History Society of Montreal, the following report is submitted for the consideration of the Royal Society of Canada.

It was earnestly hoped that the society would have been in its new quarters as announced in our report of last year, but owing to the commercial depression that has prevailed for some time, the necessary funds have not been forthcoming to warrant us in commencing building operations. However, our work, though somewhat hampered by the cramped quarters we at present occupy, has been attended with a greater measure of success, than far several years past. The subjects treated at the Monthly Meetings were, as usual, original communications, and the attendance on several occasions was such that many were turned away. This, though very gratifying as showing an increased interest in the study of Natural Science, is a condition of things much to be deplored, and, it is hoped, remedied in the very near future. The following is a list of the papers read at the Monthly Meetings:—

Monday, Nov. 2nd, 1908—The Possibilities of Oyster Culture in the Maritime Provinces of Canada— E. W. MacBride, M.A., D.Sc.

Monday, Nov. 30th, 1908—Man as an Animal—Dr. F. Slater Jackson.

Monday, Jan. 25th, 1909—The Scot in Canada and an Old Time New Year—J. S. Buchan, K.C.

Monday, Feb. 22nd, 1909—A vain quest in Zoology—Rev. I. J. Kavanagh, S.J.; Some aspects of the Forestry Problem—Dr. D. P. Penhallow.

Monday, Mar. 29th, 1909—The possibilities of the

Cobalt and the Montreal River District—Dr. Alfred Barlow.

Monday, Apl. 26th, 1909—The Natural History of the Canadian Oyster, Dr. J. Stafford, B.A., M.A.

The Lectures of the Somerville Course were delivered in the lecture hall of the Young Men's Christian Association. The subjects dealt with were of unusual interest and great value to Canada from an economic point of view, dealing as they did with matters of live importance of today with immense possibilities for the future.

The following is the list:—

Thursday, Jan. 21st.—The Introduction of Reindeer into Canada for Domestic Purposes—F. S. Lawrence, F.R.G.S.

Thursday, Jan. 28th.—Matter and Ether—Professor John Cox, M.A., LL.D. This lecture was given in the Physics Building, McGill College.

Thursday, Feb. 4th—Early History of Man as determined by Biology—Dr. E. W. MacBride.

Thursday, Feb. 11th.—Food, Body, Heat and Animal Calorimetry—Prof. J. H. Snell, Ph.D.

Thursday, Feb. 18th.—Radium—Howard L. Bronson, Ph.D.

Thursday, Feb. 25th.—Science and Education—Prof. J. A. Dale, M.A.

The Saturday Half Hour Talks to Children were also given in the Lecture Hall of the Y.M.C.A., every seat being occupied on each occasion.

A glance at the following list will give some idea of the subjects dealt with, and it was generally conceded that it was one of the best courses that had ever been given since these lectures were instituted.

Saturday, Jan. 23rd.—Some Common Birds—I. Gammell, M.A.

Saturday, Jan. 30th.—The Flame of a Candle—Prof. Nevil Norton Evans.

Saturday, Feb. 6th.—The Story of a Lobster—S. Kirsch, M.A.

Saturday, Feb. 13th.—The Story of a Coal Mine—Dr. J. Bonsall Porter.

Saturday, Feb. 20th.—The Story of a Dew Drop—Mrs. McIntosh, M.Sc.

Saturday, Feb. 27th.—The Story of a Pine Tree—Prof. Carrie M. Derick, M.A.

The usual donations to the library have been received in the shape of exchanges from kindred societies, but the need of our Library becomes more acute as time goes on. Many enquiries are made, references are sought, and a great deal of labor is involved in supplying the information owing to the Library being inaccessible.

Many valuable donations are promised as soon as we have a fitting home to receive them . A valuable collection of Shells, Minerals, Fossils, etc., has been received from Mrs. J. H. R. Molson, being specimens gathered together by the late J. H. R. Molson during his lifetime. These will be specially valuable in filling the blanks in our collection.

The Annual Field Day was held on Saturday, the 13th of June, a visit being made to Oka. A party of about 200 enjoyed the hospitality of the polite and gentlemanly monks of La Trappe, the return trip through the Lachine Rapids bringing a pleasant and most enjoyable day to a close.

Fourteen new members have been added to the roll during the year, but death has removed the following:—James Coristine, F. S. Lyman, James Williamson, Angus W. Hooper, Miss Catherine N. Macfarlan.

The Society has every reason to feel satisfied with the result of its crusade against the Tussock Moth, both as regards the abatement of the pest, and the consequent danger to our trees, also the awakened interest on the part of the civic authorities, and the public generally.

In reviewing the work done during the last twenty-one years that I have been connected with the Society, I cannot help thinking that considering the limited means at our disposal, we have no reason to be discouraged, and that a new era of increased usefulness will be opened up just as soon as our new building is erected, one that shall be worthy of the past traditions of the Society, and of the City of Montreal.

I cannot close this report without a tribute of thanks to our good friends of McGill University, who are ever ready to give us a helping hand, particularly as regards the Somerville Course of Lectures and Saturday Half-Hour Talks to Children; also to the press of Montreal who gratuitously notice our lectures from time to time.

The list of officers for the Session of 1908-9 is as follows:—

Patron—His Excellency, the Governor General of Canada.

Hon. President—Lord Strathcona and Mount Royal.

President—Dr. D. P. Penhallow.

Hon. Vice-President—Hon. J. K. Ward.

Vice-Presidents—Frank D. Adams, Ph.D., F.R.C.S.; J. S. Buchan, K.C., B.C.L.; Rev. Robert Campbell, M.A., D.D.; Miss Carrie Derick, M.A.; E. W. MacBride, M.A., D.Sc.; Wesley Mills, M.A., M.D.; C. S. J. Phillips, Major G. W. Stephens, Miss Van Horne.

Hon. Recording Secretary—Albert Holden.

Hon. Corresponding Secretary—F. W. Richards.

Hon. Treasurer—Jas. W. Pyke.

Hon. Curator—A. E. Norris.

Members of Council—John Harper, Chairman; J. A. U. Beaudry, C.E.; S. W. Ewing, Joseph Fortier, Dr. Milton L. Hersey, Albert Holden, H. Lampard, Alex. Robertson, B.A., Farquhar Robertson.

Superintendent—Alfred Griffin.

REPORT OF THE NATURAL HISTORY SOCIETY OF MONTREAL.

1909-1910.

Presented to the Royal Society of Canada by Harry Bragg, M.J.I., Honorary Librarian.
September, 1910.

Mr. President and Gentlemen:—

Herewith I have the honour to present to you the Annual Report of the Natural History Society of Montreal, which is now in the eighty-fourth year of its age.

It is very pleasant to be able to state that the work of the Society during the year, so far as the regular courses of Free Public Lectures is concerned, has been carried on very energetically and successfully, and that the larger attendance of the public has continued to show increasing interest in the questions chosen for these lectures. The Saturday Afternoon Lectures for Children were so popular that a larger room had to be secured to accommodate the audience, while the larger Hall of the Y.M.C.A. Building was crowded at several of the Somerville Course.

The Programmes of the three Courses given by the Society were as follows:—

REGULAR MONTHLY MEETINGS OF THE SOCIETY.

"The work of the St. Andrew's Biological Station," Dr. D. P. Penhallow.

"Animal and Plant Life in the Mackenzie Basin," Fred. S. Lawrence, F.R.G.S.

"The Natural History of Death," Prof. J. C. Simpson.

"The Mineral Resources of Northern Ontario and Quebec," Dr. Alfred E. Barlow.

SOMERVILLE LECTURES.

"Halley's Comet," Rev. I. J. Kavanagh, S.J., M.A.

"The Ice Problem of the St. Lawrence," Dr. Howard T. Barnes, F.R.C.S.

"The Nature and Origin of Ore Deposits," Dr. Frank D. Adams, Ph.D., F.R.C.S.

"The Quebec Bridge," Henry Holgate, C.E.

"Eight Months in the Swamps of West Africa," Hilder Daw, C.E.

"Heredity and Environment," Prof. Carrie M. Derick, M.A.

"Darwin's Centennial," Rev. Robert Campbell, D.D.

Owing to the sudden illness of Prof. Derick, a blank evening would have occurred, but one of the lectures of the Saturday Afternoon Course was given, so as to provide a lecture for the expectant audience, and Miss Derick gave her promised one at a later date.

SATURDAY HALF-HOUR TALKS TO CHILDREN.

"The Story of a Dandelion," Prof. Carrie M. Derick.

"The Story of a Glacier," J. O'Neill, Esq.

"The Ferns of Montreal," Rev. Robert Campbell, M.A., D.D.

"Mushrooms and Toadstools," Mrs. F. H. Pitcher.

"The Story of the Coral Builders," Harry Bragg, M.J.I.

"Some Birds of the Sea," I. Gammell, B.A.

The Annual Picnic of the Society was held at Grand Mere, and a very pleasant feature of the day was the presentation of a Silver Medal to Mr. Alfred Griffin, the only permanent official, in consideration of his completion of twenty-one years' service for the Society, as a small recognition of his zealous and devoted work.

The Society has made another very important move by purchasing the lot of land immediately behind its new property, the lot facing on Drummond Street. So that the Society now owns about twenty thousand square feet, with frontage on both Mountain and Drummond Streets, midway between St. Catherine and Sherbrooke Streets. This property is most desirable for the purpose for which it has been secured, and is centrally situated, with a good car service near to it, yet not so near as to be an annoyance.

What is lacking now is a suitable building, where the splendid collection of specimens could be seen free of cost, every day in the year; where the fine library of books could be available to the student, and where the courses of free lectures could be delivered in properly designed halls, all the property of the Society.

This is a consummation devoutly to be wished, for the Commercial Capital of the Dominion is incomplete as a great city without a Free Natural History Museum, and the Society the oldest in Canada, and the parent of the Geological Survey, as well as of the kindred societies, should be housed in a home suitable to its history and traditions.

The Directors live in hopes that sufficient public spirit may be found to secure this desirable object, within a short time.

It would be very pleasant if this could be accomplished while His Excellency, Lord Grey, continues to grace the position of Governor General, so that as he and Lady Grey honoured the last function in the old building, they could also lend their presence at the opening of the New Museum.

Before concluding with the list of Officers, it is satisfactory to note that our Ex-President, Dr. D. P. Penhallow, has returned from a long absence, greatly improved in health, and that we can still count him among our active members.

THE OFFICERS FOR THE YEAR ARE AS FOLLOWS:

Honorary Patron—His Excellency, Lord Grey, the Governor General.

Honorary President—The Rt. Hon. Lord Strathcona and Mount Royal.

President—Milton L. Hersey, M.Sc., LL.D.

Hon. Vice-President—Hon. J. K. Ward.

Vice-Presidents—Frank D. Adams, Ph.D., F.R.S.C., J. A. U. Beaudry, C.E.; J. S. Buchan, K.C., B.C.L.; Rev. Robert Campbell, M.A., D.D.; Miss Carrie M. Derick, M.A.; John Harper, C. S. J. Phillips, Major G. W. Stephens, Miss Van Horne.

Secretary—Albert Griffin.

Hon. Corresponding Secretary—F. W. Richards.

Hon. Treasurer—Jas. W. Pyke.

Hon. Librarian—Harry Bragg, M.J.I.

Hon. Curator—A. E. Norris.

Members of Council—Chas. S. M. Brown, S. W. Ewing, H. Lampard, Hilder Daw, C. E., Joseph Fortier, Alex. Robertson, B.A.; Prof. Nevil Norton Evans, Albert Holden, Farquhar Robertson.

Superintendent—Alfred Griffin.

ERRATA

in Vol. IX No. 6

p. 327 (10 lines from top) for "trafficing" read "trafficking."
p. 336 (17 lines from bottom) for "escutenta" read "esculenta."
p. 343 (designation of plate) for "cemetry" read "cemetery."
p. 244 (10 lines from the top) insert of before "which."
p. 347 (near middle of page) for "pre-natal of the beaver" read "pre-natal life of the beaver."
p. 348 (10 lines from top) for "J. B. Tyrell" read "J. B. Tyrrell."
p. 351 (4 lines from top) for "benedicta fibri sars" read "benedicta fibri caro."
p. 351 (6 lines from bottom) for "principle as to preservation" read "principle as the preservation."
p. 352 (5 lines from top) for "tail is not the external" read "tail is not the only external."
p. 353 (10 lines from top) for "Chilion" read "Chilian."
p. 354 (6 lines from top) for "wind" read "wing."
p. 354 (3 lines from bottom) for "or" read "of."
p. 355 (5 lines from bottom) omit one "the."
p. 356 (16 lines from top) for "re" read "he" and for "ris" read "his."

ABSTRACT FOR THE MONTH OF APRIL, 1914.

Meteorological Observations, Taken at McGill College Observatory. Height above sea-level, 187 feet. C. H. McLEOD, *Superintendent.*

DAYS.	THERMOMETER				*BAROMETER				‡ Mean relative humidity.	WIND		Per cent. of possible Sunshine	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAYS.
	† Mean.	Max.	Min.	Range.	† Mean.	Max.	Min.	Range.		General direction.	Mean velocity in miles per hour					
1	36.8	45.6	28.3	17.3	30.01	30.35	29.61	.74	67	SW	13.1	35	.14	...	.14	1
2	33.3	37.2	28.6	8.6	29.60	29.74	29.48	.26	58	NE	14.5	17	.03	T	.03	2
3	24.7	30.6	18.1	12.5	29.90	30.02	29.78	.24	44	NW	17.2	83	...	...	...	3
4	28.6	35.0	21.4	13.6	30.09	30.15	30.04	.11	53	W	15.3	91	...	T	T	4
SUNDAY.......5	31.3	37.0	27.9	9.1	30.09	30.16	30.04	.12	61	W	15.0	74	...	0.3	.02	5.....SUNDAY
6	29.7	34.0	26.6	7.4	30.14	30.16	30.10	.06	63	W	14.4	7	...	T	T	6
7	32.9	38.1	24.2	13.9	30.08	30.15	29.98	.17	65	SE	10.7	38	...	...	...	7
8	32.5	34.9	31.2	3.7	29.77	29.91	29.68	.23	87	NE	17.0	0	.42	2.6	.69	8
9	30.2	33.6	25.0	8.6	29.73	29.76	29.70	.06	69	W	19.4	50	.01	0.3	.02	9
10	34.5	42.2	25.0	17.2	29.90	29.99	29.78	.21	57	W	25.5	98	...	...	...	10
11	37.4	43.5	32.0	11.5	29.80	30.00	29.71	.29	62	SW	24.2	0	T	...	T	11
SUNDAY.......12	30.6	40.0	19.9	20.1	29.79	30.11	29.51	.60	56	NW	21.8	48	...	0.7	.06	12.....SUNDAY
13	22.2	28.0	13.9	14.1	30.30	30.36	30.17	.19	46	NW	10.4	96	...	...	...	13
14	31.5	38.0	24.4	13.6	30.19	30.25	30.13	.12	59	W	8.4	7	...	...	...	14
15	34.6	43.4	28.7	14.7	30.22	30.35	30.07	.28	59	NE	15.2	85	...	...	...	15
16	35.3	40.2	30.6	9.6	29.88	30.05	29.79	.26	71	NE	13.5	0	.04	...	0.4	16
17	46.4	56.7	34.8	21.9	29.95	30.05	29.84	.21	47	NW	11.0	90	...	...	...	17
18	53.2	62.8	43.9	18.9	29.97	30.09	29.78	.31	60	W	17.9	49	.01	...	0.1	18
SUNDAY.......19	60.1	74.2	50.5	23.7	29.64	29.76	29.56	.20	66	W	21.2	22	.11	...	.11	19.....SUNDAY
20	38.5	55.9	29.8	26.1	29.74	29.87	29.57	.30	84	NE	23.0	0	.03	0.6	.18	20
21	37.2	46.1	29.1	17.0	30.01	30.07	29.87	.20	64	W	12.2	42	...	...	...	21
22	42.0	54.6	30.6	24.0	29.98	30.25	29.85	.40	49	NW	24.8	76	...	...	...	22
23	36.4	46.5	25.9	20.6	30.35	30.41	30.27	.14	36	NW	17.6	94	...	...	...	23
24	44.1	52.2	35.3	16.9	30.36	30.42	30.27	.15	31	N	8.1	92	...	...	...	24
25	45.8	54.4	33.5	20.9	30.23	30.33	30.14	.19	44	SE	14.4	21	...	...	...	25
SUNDAY.......26	40.5	44.2	39.3	4.9	30.02	30.07	29.99	.08	81	S	17.6	0	.15	...	.15	26.....SUNDAY
27	50.7	60.5	38.8	21.7	30.14	30.19	30.06	.13	67	SE	8.5	57	T	...	T	27
28	52.7	62.2	44.0	18.2	30.10	30.15	30.03	.12	74	SW	13.2	2	.11	...	.11	28
29	38.6	44.6	35.1	8.9	30.13	30.17	30.11	.06	63	NE	18.1	0	.07	...	.07	29
30	42.9	51.7	36.3	15.4	30.13	30.16	30.09	.07	37	NE	16.8	80	...	...	...	30
31																31
Means......	37.83	45.58	30.42	15.15	30.009	30.120	29.900	.220	59.34		16.00	45.04	1.12	4.5	1.53	......Sums
40 Years means for and including this month.	40.70	48.95	33.04	15.91	29.956	.....	.....	.212	66.37		15.93§	49.01¶	1.78	5.35	2.35	40 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction..........	N	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALMS
Miles..............	533	2588	385	628	747	1522	3327	1789	
Duration in hours...	46	143	34	55	53	87	189	111	2
Mean Velocity......	11.6	18.1	11.3	11.4	14.1	17.5	17.6	16.1	

The greatest mileage in one hour was 40 on the 12th.
The greatest velocity in gusts was 48 on the 12th. Total mileage, 11519. Resultant direction, N66°W.
Resultant mileage, 3303.

The greatest heat was 74.2° above zero on the 19th. The greatest cold was 13.9° above zero on the 13th, giving a range of 60.3°.

The warmest day was the 19th. The coldest day was the 13th.

The highest barometer reading was 30.42 on the 24th. The lowest barometer reading was 29.48 on the 2nd, giving a range of .94 inches.

The minimum relative humidity observed was 20 on the 30th.

Thunderstorms on 2 days. Fog on 1 day.

Hail on 2 days. Lunar halos on 1 night.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit.

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of readings taken every four hours from self-recording hygrometer.

¶ 33 years means.

§ 28 years means.

ABSTRACT FOR THE MONTH OF MAY, 1914.

Meteorological Observations, Taken at McGill College Observatory. Height above sea-level, 187 feet. C. H. McLEOD, *Superintendent.*

DAYS.	THERMOMETER				*BAROMETER				‡ Mean relative humid-ity.	WIND		Per cent. of possible Sunshine	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAYS. *
	† Mean.	Max.	Min.	Range.	† Mean.	Max.	Min.	Range.		General direction.	Mean velocity in miles per hour					
1	40.0	49.0	31.9	17.1	30.04	30.13	29.93	.20	29	N	16.1	95	...	...	...	1
2	50.9	64.5	37.0	27.5	29.94	30.00	29.87	.13	35	N	13.4	95	...	...	...	2
SUNDAY........3	57.6	68.2	45.5	22.7	30.02	30.08	29.98	.10	40	W	10.8	79	...	...	...	3.....SUNDAY
4	58.9	68.7	49.3	19.4	29.88	29.98	29.76	.22	46	S	9.4	6	T	...	T	4
5	54.7	62.3	47.7	14.6	29.67	29.73	29.61	.12	75	NE	10.6	6	.06	...	.06	5
6	55.5	65.5	45.6	19.9	29.74	29.78	29.69	.09	53	NE	9.1	85	...	...	...	6
7	54.4	63.0	45.0	18.0	29.83	29.86	29.78	.08	50	NE	10.2	36	...	...	...	7
8	59.7	69.2	49.9	19.3	29.85	29.91	29.77	.14	48	NE	9.9	91	...	...	...	8
9	57.1	66.0	46.0	20.0	29.73	29.77	29.68	.09	62	NE	10.1	86	...	...	...	9
SUNDAY.......10	57.6	70.2	45.4	24.8	29.75	29.83	29.70	.13	55	W	10.8	61	...	...	...	10.....SUNDAY
11	50.3	56.6	41.0	15.6	30.04	30.12	29.87	.25	48	N	8.7	51	...	...	...	11
12	48.3	54.0	42.0	12.0	30.14	30.17	30.11	.06	39	N	9.5	1	...	...	...	12
13	48.0	57.4	40.4	17.0	30.12	30.18	30.05	.13	65	S	10.5	44	.06	...	.06	13
14	51.6	63.4	42.6	20.8	29.99	30.01	29.92	.12	62	W	10.7	44	.02	...	.02	14
15	48.3	55.2	39.4	15.8	30.11	30.16	30.08	.08	40	W	13.0	82	...	...	...	15
16	53.5	63.0	43.5	19.5	30.14	30.19	30.05	.11	46	W	12.2	85	...	...	...	16
SUNDAY.......17	58.0	69.7	42.6	27.1	30.28	30.32	30.21	.11	47	W	11.8	89	...	...	...	17.....SUNDAY
18	63.6	74.1	53.3	20.8	30.33	30.38	30.29	.09	46	W	20.5	73	...	...	...	18
19	65.6	76.0	55.7	20.3	30.36	30.41	30.31	.10	49	W	19.3	73	...	...	...	19
20	67.0	77.0	57.6	19.4	30.26	30.33	30.19	.14	50	W	17.6	69	...	...	...	20
21	69.5	80.0	61.3	18.7	30.06	30.16	29.94	.22	49	W	15.8	35	...	...	...	21
22	71.4	83.8	61.5	22.3	29.76	29.91	29.62	.29	53	W	18.1	68	.10	...	.10	22
23	55.3	61.9	47.5	14.4	29.75	29.91	29.60	.31	67	W	14.6	7	.10	...	.10	23
SUNDAY.......24	58.6	70.4	46.0	24.4	30.13	30.19	29.98	.21	46	W	15.6	94	...	...	...	24.....SUNDAY
25	60.7	71.3	51.4	19.9	30.01	30.18	29.93	.25	65	W	13.5	9	.01	...	.01	25
26	73.3	81.8	61.2	20.6	29.84	29.89	29.78	.11	65	W	19.6	55	...	...	...	26
27	72.6	87.2	61.8	25.4	29.87	29.96	29.74	.22	59	W	13.7	67	...	...	...	27
28	65.0	70.0	58.7	11.3	30.13	30.31	39.83	.48	48	N	9.8	93	...	...	...	28
29	64.2	75.0	51.9	23.1	30.23	30.36	30.04	.32	52	E	7.4	76	...	...	...	29
30	66.3	75.7	58.6	17.1	29.95	29.99	29.90	.09	51	NW	12.0	61	.19	...	.19	30
SUNDAY......31	63.6	77.8	53.7	24.1	29.85	29.96	29.71	.25	59	W	11.5	70	.88	...	.88	31.....SUNDAY
Means......	58.75	68.64	48.87	19.74	29.994	30.072	29.902	.170	51.71		12.78	60.38	1.42	...	1.42	......Sums
40 Years means for and including this month.	54.93	64.13	46.07	18.05	29.933	.....	.....	.176	65.40		13.56§	50.46¶	3.079	...	3.087	40 Years means for and Including this month.

ANALYSIS OF WIND RECORD.

Direction..........	N	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALMS
Miles.............	1195	649	229	39	400	706	5172	819	
Duration in hours...	132	60	36	6	43	61	336	70	0
Mean Velocity......	11.3	10.8	6.4	6.5	9.3	11.6	15.4	11.7	

The greatest mileage in one hour was 29 on the 17th, 18th and 19th.
The greatest velocity in gusts was 40 on the 16th and 31st. Total mileage, [illegible]509
Resultant direction, N74°W. Resultant mileage, 5755.

The greatest heat was 87.2° above zero on the 27th. The greatest cold was 31.9° above zero on the 1st, giving a range of 55.3°.

The warmest day was the 26th. The coldest day was the 1st.

The highest barometer reading was 30.41 on the 19th. The lowest barometer reading was 29.60 on the 23rd, giving a range of 0.81 inches.

The minimum relative humidity observed was 17 on the 2nd.

Thunderstorms on 1 day. Fog on 2 days.

Hail on 1 day.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of readings taken every four hours from self-recording hygrometer.

¶ 33 years means.

§ 27 years means.

ABSTRACT FOR THE MONTH OF JUNE, 1914.

Meteorological Observations, Taken at McGill College Observatory. Height above sea-level, 187 feet. C. H. McLEOD, *Superintendent.*

DAYS.	THERMOMETER				*BAROMETER				‡ Mean relative humidity.	WIND		Per cent. of possible Sunshine	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAYS.
	† Mean.	Max.	Min.	Range.	† Mean.	Max.	Min.	Range.		General direction.	Mean velocity in miles per hour					
1	57.5	68.0	51.1	16.9	29.89	29.98	29.83	.15	56	NW	9.7	60	.13	...	.13	1
2	49.6	58.8	39.9	18.9	30.06	30.16	29.93	.23	49	NE	9.4	74	.01	...	.01	2
3	54.0	60.2	49.0	11.2	30.04	30.09	29.92	.17	54	W	10.8	21	T	...	T	3
4	50.9	53.2	49.4	3.8	29.91	30.04	29.80	.24	83	NE	9.5	0	.13	...	.13	4
5	55.6	64.6	45.9	18.7	29.97	30.10	29.84	.26	42	N	12.8	91	.01	...	.01	5
6	61.0	71.0	51.3	19.7	30.14	30.21	30.09	.12	37	NW	11.1	81	...	...	...	6
SUNDAY........7	64.2	76.8	51.5	25.3	30.00	30.13	29.90	.23	63	W	10.9	30	T	...	T	7.....SUNDAY
8	63.9	68.1	59.9	8.2	30.06	30.13	29.92	.21	68	NE	10.5	39	T	...	T	8
9	65.3	73.9	55.9	18.0	30.02	30.14	29.82	.32	61	S	11.6	10	T	...	T	9
10	74.6	86.2	62.0	24.2	29.71	29.77	29.67	.10	49	NW	12.8	92	...	...	...	10
11	73.1	85.8	63.5	22.3	29.73	29.77	29.70	.07	50	W	13.3	85	...	...	...	11
12	69.2	78.1	61.0	17.1	29.75	29.88	29.65	.23	53	W	11.7	73	...	...	...	12
13	62.4	73.1	50.5	22.6	29.93	30.04	29.88	.16	53	NW	10.8	87	.01	...	.01	13
SUNDAY.......14	56.8	67.3	45.5	21.8	30.00	30.10	29.87	.23	46	N	9.6	93	...	...	...	14.....SUNDAY
15	60.7	71.6	52.8	18.8	29.74	29.85	29.69	.16	51	NW	12.1	89	...	...	...	15
16	53.9	58.8	49.8	9.0	29.83	29.91	29.72	.22	66	NW	13.3	10	.29	...	.29	16
17	62.1	71.8	50.6	21.2	29.99	30.06	29.93	.13	45	W	13.1	95	...	...	...	17
18	70.1	81.6	60.1	21.5	29.91	30.02	29.78	.24	48	SW	12.0	76	T	...	T	18
19	63.9	79.4	44.4	35.0	29.67	29.79	29.50	.29	65	SW	12.8	55	.56	...	.56	19
20	51.8	63.2	42.0	21.2	29.86	29.95	29.76	.19	56	NW	14.7	45	.02	...	.02	20
SUNDAY.......21	62.0	73.7	52.1	21.6	29.96	29.99	29.90	.09	53	W	14.2	69	...	...	...	21.....SUNDAY
22	66.2	76.7	55.1	21.6	29.97	30.02	29.94	.08	57	W	7.3	89	...	...	...	22
23	70.8	80.4	57.3	23.1	29.86	29.93	29.79	.14	64	SW	9.9	49	T	...	T	23
24	75.4	87.5	66.2	21.3	29.77	29.86	29.61	.22	64	W	12.6	74	.23	...	.23	24
25	71.8	81.2	61.3	19.9	29.79	29.99	29.64	.35	52	NW	15.7	91	...	...	...	25
26	63.7	72.5	52.8	19.7	30.03	30.11	29.95	.16	45	NW	10.0	78	...	...	...	26
27	61.3	67.4	54.3	13.1	30.03	30.08	29.98	.10	44	NE	8.5	85	...	...	...	27
SUNDAY.......28	55.7	62.2	51.2	11.0	29.94	30.02	29.84	.18	64	SE	12.2	5	.50	...	.50	28.....SUNDAY
29	57.2	65.2	53.1	12.1	29.73	29.79	29.69	.10	85	SE	8.9	0	.84	...	.84	29
30	54.5	55.7	52.8	2.9	29.98	30.16	29.80	.36	81	NE	11.7	0	.17	...	.17	30
Means......	61.97	71.13	53.08	18.06	29.909	30.003	29.812	.191	56.73		11.44	58.44	2.90	...	2.90	......Sums
40 Years means for and including this month.	61.49	73.27	56.00	17.25	29.907	.....	.....	.158	69.43		12.29§	54.70¶	3.425	...	3.425	40 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction..........	N	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALMS
Miles..............	766	1053	114	358	376	1148	2369	2057	
Duration in hours...	69	108	11	34	36	102	194	165	1
Mean Velocity......	11.1	9.8	10.3	10.5	10.5	11.2	12.2	12.5	

The greatest mileage in one hour was 21 on the 10th.
The greatest velocity in gusts was 40 on the 12th. Total mileage, 8241.
Resultant direction, N66°W. Resultant mileage, 3837

The greatest heat was 87.5° above zero on the 24th. The greatest cold was 39.9° above zero on the 2nd, giving a range of 47.6°.

The warmest day was the 24th. The coldest day was the 2nd.

The highest barometer reading was 30.21 on the 6th. The lowest barometer reading was 29.50 on the 19th, giving a range of .71 inches.

The minimum relative humidity observed was 23 on the 5th.

Thunderstorms on 2 days.

Solar halos on 1 day.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of readings taken every four hours from self-recording hygrometer.

§ 26 years means.

¶ 33 years means.

ABSTRACT FOR THE MONTH OF JULY, 1914.

Meteorological Observations, Taken at McGill College Observatory. Height above sea-level, 187 feet. C. H. McLEOD, *Superintendent.*

DAYS.	THERMOMETER † Mean.	Max.	Min.	Range.	*BAROMETER † Mean.	Max.	Min.	Range.	‡ Mean relative humidity.	WIND General direction.	Mean velocity in miles per hour	Per cent. of possible Sunshine	Rainfall in inches.	Snowfall in inches.	Rain and snow melted.	DAYS.
1	60.8	69.6	49.5	20.1	30.11	30.20	29.99	.21	63	SE	8.1	75	T	...	T	1
2	56.7	58.2	55.4	2.8	29.95	30.04	29.91	.13	79	NE	10.7	2	.24	...	.24	2
3	60.7	69.8	50.9	18.9	30.11	30.13	30.07	.06	64	NE	6.7	90	...	...	...	3
4	68.1	79.2	54.8	24.4	30.06	30.12	30.01	.11	59	SW	9.9	91	...	...	...	4
SUNDAY........5	68.5	77.1	63.0	14.1	30.06	30.12	30.01	.11	69	W	8.2	38	.07	...	.07	5.....SUNDAY
6	71.7	82.0	60.0	22.0	30.11	30.20	30.03	.17	63	E	4.9	89	...	...	...	6
7	68.6	73.0	63.6	9.4	29.87	29.98	29.77	.21	74	NE	9.4	6	.03	...	.03	7
8	71.3	81.2	63.2	18.0	29.96	30.11	29.84	.27	70	NW	11.0	48	T	...	T	8
9	69.3	77.2	60.1	17.1	30.11	30.18	30.02	.16	59	NE	8.8	94	...	...	...	9
10	71.2	82.4	57.2	25.2	29.95	30.02	29.85	.17	62	NE	7.1	94	...	...	...	10
11	71.6	83.7	66.2	17.5	29.88	29 92	29.84	.08	73	SW	7.7	31	.07	...	.07	11
SUNDAY.......12	73.2	84.0	63.3	20.7	29.89	29.97	29.87	.10	48	NE	8.0	94	...	...	...	12.....SUNDAY
13	73.2	81.5	63.1	18.4	29.92	29.97	29.87	.10	49	NE	7.6	91	...	...	...	13
14	74.9	88.7	61.0	27.7	29.91	29.97	29.87	.10	53	S	6.8	94	...	...	...	14
15	77.8	87.7	65.8	21.9	29.87	29.94	29.81	.13	56	S	7.6	92	...	...	...	15
16	78.9	88 6	69.7	18.9	29.78	29.86	29.70	.16	69	SW	8.4	59	.03	...	.03	16
17	78.5	91.0	72.3	18.7	29.61	29.66	29.51	.15	72	SW	10.4	51	.02	...	.02	17
18	69.6	78.2	62.6	15.6	29.72	29.86	29.61	.25	56	NW	10.7	86	...	...	...	18
SUNDAY.......19	59.1	68.9	52.6	16 3	29.91	29.97	29.88	.09	53	NW	9.6	47	...	...	...	19.....SUNDAY
20	65.9	75.9	52.6	23.3	29.92	30.00	29.82	.18	47	NW	11.3	77	T	...	T	20
21	65.2	75.0	55.0	20.0	29.87	30.07	29.79	.28	51	NW	13.1	76	...	...	...	21
22	66.5	79.4	52.0	27.4	30.11	30.17	30.08	.09	48	NW	11.6	80	...	...	...	22
23	61.8	68.9	57.0	11.9	30.02	30.10	29.96	.14	75	SW	6.8	0	.35	...	.35	23
24	68.4	78.1	57.6	20.5	29.95	30.01	29.87	.14	66	W	6.7	64	...	...	...	24
25	72.2	85.0	64.9	20.1	29.78	29.86	29.68	.18	66	SW	12.6	74	.15	...	.15	25
SUNDAY.......26	67.9	78.8	58.0	20.8	29.92	30.01	29.86	.15	52	NW	10.4	86	...	...	...	26.....SUNDAY
27	64.3	72.0	54.4	17.6	29.98	30 04	29.92	.12	53	NE	6.8	79	...	...	...	27
28	63.4	72.5	55.3	17.2	30.01	30.03	29.98	.05	55	NE	10.0	48	...	...	...	28
29	62.0	67.9	55.0	12.9	30.11	30.20	30.01	.19	63	NE	11.5	53	T	...	T	29
30	64.5	74.0	52.8	21.2	30.22	30.30	30.17	.13	56	NE	6.4	75	...	...	...	30
31	68.5	80.0	55.3	24.7	30.09	30.16	29.97	.19	54	W	6.5	77	T		T	31
Means......	68.20	77.73	58.85	18.88	29.961	30.038	29.889	.149	60.55		8.88	68.21	0.96	...	0 96	......Sums
40 Years means for and including this month.	69.02	77.47	60.98	16.49	29.898	.....	.....	.145	71.08		12.37§	59.52¶	3.831	...	3.834	40 Years means for and including this month.

ANALYSIS OF WIND RECORD.

Direction..........	N	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALMS
Miles..............	171	1644	266	243	355	1376	672	1879	
Duration in hours...	26	183	47	32	54	141	81	177	0
Mean Velocity......	6.8	9.0	5.7	7.6	6.6	9.6	8.3	10.6	

The greatest mileage in one hour was 19 on the 21st and 25th.
Total mileage, 6609
Resultant direction, N50°W. Resultant mileage, 1803.

The greatest heat was 91.0° above zero on the 17th. The greatest cold was 49.5° above zero on the 1st, giving a range of 41.5°.

The warmest day was the 16th. The coldest day was the 2nd.

The highest barometer reading was 30.30 on the 30th. The lowest barometer reading was 29.51 on the 17th, giving a range of .79 inches.

The minimum relative humidity observed was 23 on the 12th and 14th.

Thunderstorms on 4 days.

* Barometer readings reduced to sea-level and temperature 32° Fahrenheit

† Mean of bi-hourly readings taken from self-recording instruments.

‡ Humidity relative, saturation being 100. Mean of readings taken every four hours from self-recording hygrometer.

§ 26 years means.

¶ 33 years means.