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luminous coal, as well as those of the carboniferous age in the locality just referred to. The "Turtle Mountain," "Sims" and "Toston" coals, on the other hand, would fall outside of the ordinary class of bituminous coals in virtue of their composition. Corresponding to the difference in composition between the five whose analyses are here first given and the other three, we observe also differences in physical properties, in aspect and texture. In the "Turtle Mountain" a wood-like texture is very plain; in the "Sims" it is perceptible, though not striking. These are unmistakably *lignites* or brown coals. In the "Toston" coal we have good specimens of the small lumps of resinous matter which is often found in these western coals.

Other qualities of these various coals have to be taken into consideration, besides their composition as learned by analysis, in order to settle their value for domestic use, or for mechanical purposes. Some of these coals crumble very badly when mined, or after exposure to the air, or when thrown upon the fire. Perhaps arrangements may be made for utilizing such crumbling varieties. One thing seems certain, that these coals are destined at some time to be much used in the Northwest. Their discovery in localities where other fuel is scarce has already promoted settlement and business. Their quantity appears to be very considerable, and their distribution quite extensive.

April 7, 1885.

[*Paper O.*]

SOME ALGÆ OF MINNESOTA, SUPPOSED TO BE POISONOUS.

J. C. Arthur.

The history of the investigation conducted in 1882 for the purpose of ascertaining the cause of a sudden mortality among domestic animals at Waterville, Minnesota, has been given in a former report.* The facts elicited were that quite a number of the animals, largely cattle, had died at a time when the lakes at that place were filled with a minute alga (then called *Ricularia flultans*, but now referred to *Glaotrichia Pisum*), disseminated through the water and forming a thick dark-green scum when

*See vol. II, Bul. IV, Appendix.

collected by the wind. That some of the animals had drunk of the water and scum a few hours only before they died was positively known, and that all had done so seemed from the circumstances quite probable. After the most careful examination the only plausible hypothesis that could be advanced to account for the death of the animals was that the alga present possessed some toxic or other baneful properties sufficiently powerful to kill a cow in a half hour or more after drinking freely of it. The well-established reputation of all the algæ for innocuousness made this hypothesis appear from the very first extremely improbable, but for want of the slightest hint in any other direction it was thought worth while to bear it in mind, and to investigate the matter further.

In 1883 I again visited Waterville, but owing to delays did not reach there till July 26th, at which time the lakes had become quite clear of the suspected algæ. I found that two calves had died at Waterville on June 4th, and about the same time five cows at Cordova, twelve miles distant, on Lake Gorman. The most careful examination into the circumstances attending these cases threw no additional light on the subject. I arranged, however, to receive a prompt notice the next season, should any more cattle die in the same manner.

The middle of June, 1884, word was received that eight cattle had died on the shore of Lake Tetonka. I at once started for Waterville, arriving on the twentieth and found the algæ less abundant than in 1882, but still making the water green some fifty feet or more out from the shore toward which the wind had been blowing several hours. Although the conditions were not the most favorable, yet it seemed best to attempt a direct experiment by giving animals water charged with the algæ. After much delay the services of Prof. M. Stalker, state veterinarian of Iowa and professor of veterinary science in the Iowa Agricultural College, were secured to conduct the experiment. A horse and calf were employed. On June 30th, Prof. Stalker, with the assistance of Prof. Edward D. Porter of the university of Minnesota, and in the presence of citizens of Waterville, made the tests, the writer being unable to remain. The animals had not been permitted to drink for some twenty-four hours previous, and were consequently thirsty enough to take a large amount of water well charged with the algæ. No bad results of any sort followed.

The thorough and able manner in which this test was made leaves no reasonable doubt of the perfect harmlessness of the algæ *in a growing condition*. I append this last clause, because the citizens of the place still believe that the algæ are at the root of the trouble, and that the tests did not show it because they were not made at the right stage of their occurrence. Although no sufficient study of the habits of this plant has yet been made to enable one to speak with certainty, yet it does not appear from present data that in some other stage it would give different results, unless it be when decaying, when it turns brown or reddish brown and gives off a peculiar stench. At this time the microscope shows the cells of the algæ to be swarming with bacteria. Whether these are other than the common and harmless bacteria of putrefaction is at present impossible to say. The probabilities are, however, entirely against the hypothesis that the decaying algæ or the accompanying bacteria have anything to do with the trouble.

We are therefore obliged to sum up the economic part of this investigation by stating that the death of the animals is probably not due to the suspected algæ, and that no clue to the real cause has yet been obtained.

The botanical part of the investigation has yielded more interesting results, although far from being complete. The description of the structure of the alga, given in my first report, is sufficient for present purposes, if there be added to the account the fact that when the cylindrical spores are formed, not mentioned in my report, they occupy the base of the filaments, the single round cells at the end toward the centre of the mass being called heterocysts; or, to use a former illustration, if the filament be represented by a whip, the portion that the hand would grasp is where the spore forms, while the knob on the end is the heterocyst.

One of the methods by which such algæ multiply, besides the usual one by spores, is by the breaking of a filament into several parts, which then arrange themselves side by side, and grow into as many complete filaments. These fragmentary reproductive filaments are known as hormogonia.

At the time the alga is most abundant and conspicuous the spores are usually quite immature: and, as this is the period at which specimens have usually been gathered, the comparative study of the forms from different localities is rendered very difficult and unsatisfactory. I can not do better in this connection

than to give a translation of a portion of a letter from M. Bornet, of Paris, the most eminent authority on these plants, in which he has kindly noted the peculiarities of the specimens forwarded by Dr. Farlow and myself at various times, and which represent the several localities of Minnesota and Iowa:

1. Lake Minnetonka, Minn., Aug. 20, 1883. Plants young; the filaments are in abundant multiplication by hormogonia. The contents of the cells are granular and opaque. There is no trace of spores. It resembles a *Glœotrichia*, probably *G. Pisum*, yet I am not certain of it.

2. Lake Phalen, near St. Paul, Minn., Aug. 4, 1882. Conforms to the preceding; but its filaments are in a simple vegetative condition [i. e. not multiplying by hormogonia]. No spores.

3. East Okoboji Lake, Iowa, July 30, 1883. On *Utricularia*. This plant has commenced to form spores. The alga is still insufficiently characterized, but I have no doubt that it belongs to *Glœotrichia Pisum*.

4. Lake Tetonka, at Waterville, Minn., July 27, 1883. The spores of this plant are nearly full grown; they are short and thick, as in the form of *Glœotrichia Pisum* that has been called *Rivularia minuta*.

5. Shallow water near Lake Minnetonka, Minn., Aug, 18, 1883. On *Naias flexilis*. Spores well formed but longer than in the preceding form. Length and thickness of the spores vary much in *G. Pisum*.

As their determination rests largely upon characters drawn from the spores, it can readily be seen how unsatisfactory such specimens are for comparison, and it is largely because such imperfect specimens have been used that authors have established so many so-called species from the single true one. Of the above specimens No. 5, having the longest spores, was composed of the smallest individual masses of any that have been collected, while No. 3 had the largest masses. Nos. 1 and 4 are the usual floating form.

M. Bornet adds that "the researches which you propose to make on the floating *Glœotrichia* of your lakes are very interesting and instructive if you could follow the complete cycle of their existence and connect them with the fixed forms from which they were derived." It was with the hope of accomplishing this that several jars were sent, in June, 1885, from Waterville, Minn., with

the floating form, and from Spirit Lake, Iowa, with the fixed form, to Geneva, N. Y., where it was intended to grow them in tanks supplied with spring water, but all perished without giving any results.

The sudden appearance and disappearance of immense quantities of these minute plants, by which large bodies of water are filled with them and turned green within a few hours, is ascribed by MM. Bornet and Flahault* in a recent paper on these plants to the action of sunlight. The plants lying at the bottom of the water are started into active assimilation by strong light, which causes bubbles of gas to be given off from the cells; this is held by the gelatinous substance in which the filaments are imbedded, and when enough has accumulated the balls are rendered sufficiently light to float. When, in turn, the light becomes feeble, the gas escapes, its production stops, and the balls sink and disappear with the same suddenness with which they came into view.

More localities are now known for the algæ than at the time of my first report. The writer noticed in 1883 that the water plants of East Okoboji lake in northeastern Iowa were thickly covered with gelatinous masses. These were of various sizes up to a fourth of an inch in diameter, and often of irregular shape: otherwise they resemble the attached form of the alga, mentioned in the previous report. There were practically no free floating balls present. In June, 1884, however, the same locality yielded plenty of the floating form, which differed in no appreciable way, not even in size, from the Waterville plant. The floating form was found in August, 1883, by Dr. Farlow, with several other members of the American Association, then in session at Minneapolis, in Lake Minnetonka, although not in large quantities. It has also been reported as abundant in a lake in Minnesota (name not given) in July, 1880, and published under the name *Rivularia radians* Thur., var. *minutula* Kirch.§ What is undoubtedly the same species is reported from Iowa City, Eastern Iowa, under the name *Glœotrichia Pisum* Thur.† An alga on leaves of water plants (*Potamogeton*) was found by Rev. Francis Wolle,‡ at Bethlehem, Penn., which may be the one under discussion, as it is

*Bull. Soc. Bot. de France, xxxi, p. 80.

§ See Wolle, Bull. Torr. Bot. Club, viii, page 38.

† Hobby, Proc. Iowa Acad. Sci.

‡ Bull. Torr. Bot. Club, vi, page 138.

given as *G. Pisum*; but if so it is the only eastern station known to the writer.

According to our present information then the plant seems most abundant in the Upper Mississippi Valley, at least in its floating form. It is not, however, peculiar to America. The paper by MM. Bornet and Flahault§ already referred to gives the result of an examination of the present sources of information regarding the Rivulariæ forming scums, all of which are referred to the single species *Gleotrichia Pisum* Thuret, the true members of the genus *Rivularia* being salt water algæ. It was observed in the British Isles as early as 1804, and described and figured in Smith's English Botany under the name *Conferva* (*Rivularia*) *echinulata*, which was changed to *Echinella articulata* by Agardh. The next record* of its occurrence is in a lake near Aberdeen, Scotland, in 1846-47-48. It was seen in the early part of July, and the description of its appearance corresponds essentially to its mode of occurrence at Waterville. Specimens gathered in Shropshire, England, are figured by Kuetzing,** and also by Phillips,†† from a later gathering. The similarity of our plant to the above was pointed out by Dr. Farlow.* Mr. Phillips stated that the fishermen believe it useless to try to fish while it is abundant because the fish appear to be made sick by it, and will not bite. Prof. Cohn † describes its occurrence on the river Neba in Pomerania, as seen by Dr. Schmidt, and the remarkable abundance and the suddenness of its appearance and disappearance are especially in accord with the observations at Waterville. He called it *Rivularia fluitans*. Through the kindness of M. Bornet I have been able to examine authentic specimens from this locality and do not find them noticeably different from the Waterville plants. In the same year (1877), Dr. Gobi ‡ found a Rivularia on the coast of

§ Bull. Soc. Bot. de France, XXXI, page 76.

Syst. Alg., page 16.

* Dickie, Botanist's Guide to Aberdeen, etc, 1880, page 310; quoted by Cooke, Grevillea, X, page 112.

** Tabulæ Phycologicæ, page 4.

†† Grevillea, IX, page 4.

* Bot. Gazette, VIII, page 246; Proc. Amer. Assoc. Adv. Sc., XXXII, page 306

† Jahres-Ber. d. Schlesischen Gesells. f. vaterl. Cultur. (1877), page 144; Hedwigia (1878), XVI, page 1.

‡ Hedwigia, XVI, page 37.

the Gulf of Finland and described it as *Rivularia Flos-aquæ*. He subsequently stated it to be the same as Cohn's plant. Dr. Gobi has also examined the Minnesota plant from specimens forwarded by Dr. Farlow, § and pronounces it to be the same as his *R. Flos-aquæ*. These, together with a single gathering in Sweden, comprise all the stations for the floating form at present known to the writer.

A phenomenon so conspicuous, and to the popular mind so mysterious, is deserving of careful study. Although the plants are probably not poisonous, a knowledge of their habits and mode of development may yet be of considerable value from a sanitary point of view.

June 2, 1885.

[*Paper P.*]

NOTICE OF THE DISCOVERY OF LINGULA AND PARADOXIDES IN THE RED QUARTZITES OF MINNESOTA.—*By N. H. Winchell.*

On the occasion of a late visit to Pipestone, in the southwestern corner of Minnesota, my attention was attracted by the aspect of a number of slabs of catlinite, or pipestone, taken from the quarry which has long been wrought by the Aborigines for the material of their calumets or peace-pipes. These slabs lay in a pile of this material gathered by Mr. C. H. Bennett, and had evidently been exposed to the weather for two or three years. They are nearly covered on one side by the impressions of small shells resembling *Discina* but which, on more careful examination, seem more likely to be a species of *Lingula*. The shell itself is wholly wanting, only the casts remain. On some smaller pieces there remains apparently a trace of the shell in the form of a white incrustation. This incrustation is quite conspicuous by reason of its contrast of color with the blood-red color of the slabs themselves, and it might at first be supposed to be the same, or analogous to the light spots which may often be seen in specimens of the catlinite, producing a kind of spottedness which has given the stone the appellation of "porphyry," by Messrs. Squier and Davis, in

§ Bot. Gaz., VIII, page 224.