New York State Department of Environmental Conservation
Ray Brook, NY 12977

Commissioner
Robert F. Flacke

November 15, 1979

Mr. Robert C. Stevens
One Green Ridge Road
Pittsford, NY 14534

RE: Algae Problem, Eagle Lake, Ticonderoga and Crown Point (T), Essex (Co)

Dear Mr. Stevens:

I am sorry it took so long to answer your letter of October 19, 1979; we were very busy this past summer and I'm just beginning to catch up.

We were able to identify the algae in question down to the genus level, (i.e., Family Rivulanaceae, Order Nostocales, Phylum Cyanophyta, Genus Gleotrichia). As you can see from the enclosed literature there is some question as to the species, however, I believe this is an irrelevant point. The different species involved exhibit very similar physiological characteristics and the separation of species is, in my opinion, an academic discussion. While we seem to both be on similar tracks concerning this algae, I cannot agree that it is a "good" algae. In fact, it has been my experience that no blue-green, i.e., Cyanophyta, algae are "good".

Gleotrichia generally require high levels of total phosphorus and because of the low population density around Eagle Lake my initial "guess" would be that the influx of total phosphorus is from natural sources, e.g., surface storm water runoff. However, this should be determined before any conclusions are reached. The ban on phosphates in detergents in New York has been very effective and unless detergents are being brought in from elsewhere I would disregard this as a source of the nutrient enrichment which seems to be occurring.

As a first step in determining the cause and extent of the problem,a sanitary survey should be initiated as early in the spring of 1980 as is possible. As I have previously stated,I can make myself available to the lake association for training of their personnel and direction of the survey. Due to the lack of manpower in DEC the burden of actually performing the necessary work would fall on the lake association.

With regards to your questions about the nature of phosphates, simply speaking, phosphates will settle into the sediments of a lake and remain trapped there as long as there are concentrations of dissolved oxygen at the sediment/water interface. This can be determined rather easily next summer. There is a strong possibility that phosphates will be recycled into the water column during spring

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and fall turnover, that is, when a change in temperature of the lake causes the warmer, bottom layer of water to rise to the surface stirring up the sediments. In short, we are not dealing with a mobile compound. I am enclosing some information which should help and if we can get together this spring to begin training any volunteers from the association, I will be able to explain the phosphate phenomena more specifically. In the meantime, if you have any questions, please call me at (518) 891-1370.

I look forward to meeting with you next year. Have a good winter.

Sincerely,

Richard J. McCormick, P. E.
Senior Sanitary Engineer

TH

By: Thomas Higginbotham
Engineering Technician

RJM:TH:lal
Enclosures

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590b **Filaments not enclosed by abundant mucilage to form a thallus of definite shape**.....593

591a **Sheath containing 2 or more trichomes. Fig. 427**.....
.....*Sacconema*

Trichomes in this genus are tapering from a basal heterocyst as in *Gloeotrichia* (Fig. 428), but there is more than 1 trichome within a sheath and the gelatinous colony is very irregular in shape as it occurs on stones (sometimes in very deep water). The sheaths are wide, lamellate, and are flaring at the outer end. The species illustrated seems to be the only one reported from the United States, and possibly the only one known for the genus.

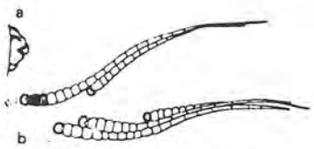

Fig. 427. *Sacconema rupestre* Borzi. (a) habit of colony; (b) filaments from colony.

591b **Sheath containing 1 trichome**.....592

592a **With cylindrical spores adjoining a basal heterocyst; colonial mucilage soft in floating species, firm in attached species which form hemispherical or globular thalli 1-3 mm. in diameter. Fig. 428**.....*Gloeotrichia*

In this genus the tapering trichomes are encased in mucilage which is usually relatively soft in the planktonic species, but firm and relatively hard in the attached forms. The trichomes are radiately arranged in the mucilage, but are not so closely compacted as in *Rivularia* (Fig. 429). *Gloeotrichia* has filaments with large, cylindrical akinetes adjoined to the basal heterocyst. When immature, species may be mistaken for *Rivularia* which never produces akinetes. Doubtless many of the records of *Rivularia* are *Gloeotrichia* in which the akinetes have not yet developed. One of the more common species is *G. echinulata* (J. E. Smith) P. Richter which occurs in abundance in the plankton of hard-water lakes. The colonies are globular and appear as tapioca grains, making the

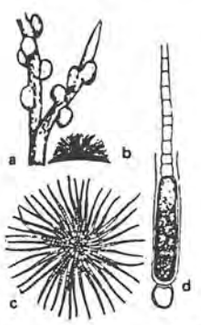

Fig. 428. (a) *Gloeotrichia Pisum* (Ag.) Thur., habit on *Ceratophyllum*; (b) diagram of filament arrangement; (c) *G. echinulata* (J. E. Smith) Richter, diagram of filaments in colony; (d) diagram of base of a single filament showing heterocyst and spore.

water buff-colored. When abundant along bathing beaches this plant causes a severe skin irritation among some persons which has been mistaken for 'swimmer's itch.' *G. natans* (Hedw.) Rab. is also fairly common. It begins development as an attached thallus but later appears at the surface in brown, gelatinous and amorphous masses, either expanded and flat or somewhat globular. *G. Pisum* Lag. forms hard, green or black balls, 1 or 2 mm. in diameter on submersed vegetation, sometimes completely covering the host plant. Nine species have been reported from the United States.

592b Spores absent; trichomes embedded in hard mucilage to form globular thalli which may coalesce, thus producing a continuous, lumpy stratum; trichomes radiate, or more often densely compacted and nearly parallel. Fig. 429..... ***Rivularia***

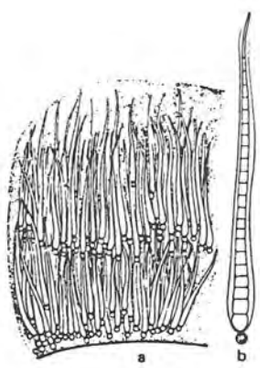

Fig. 429. *Rivularia* sp. (a) diagram of portion of attached colony to show arrangement of filaments; (b) one filament showing basal heterocysts.

This genus may be differentiated from *Gloeotrichia* (Fig. 428) by its lack of akinetes at the base of the trichome, by the compact (almost parallel arrangement of the trichomes) and by the extreme firmness of the colonial mucilage. All species are attached, mostly to logs and stones in the water, sometimes forming extensive, pebbled patches. Some large colonies show a 'zonation' resulting from successive generations of false branches. Twenty-four species have been reported from the United States but many of the names seem to be confused with *Gloeotrichia*.

593a (590) Filaments freely branched, the branches usually lying several within the sheath of the main filament for some distance, then diverging. Fig. 430..... ***Dichothrix***

sufficient importance, however, to justify the establishment of a distinct family, as has been proposed by certain phycologists.[1]

N. lobatus Wood (Fig. 62), the only American species, has been found in several of the Eastern states. It is generally found growing on stones in more or less rapid water of brooks.

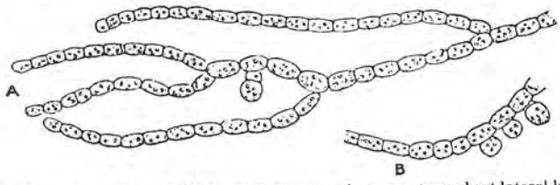

FIG. 62.—*Nostochopsis lobatus* Wood, with immature heterocysts on short lateral branches. Drawn from a herbarium specimen. (× 860.)

FAMILY 4. RIVULARIACEAE

Genera belonging to this family have uniseriate trichomes that are conspicuously attenuated from base to apex, or from the middle toward both extremities. There may be a single trichome within an unbranched sheath, or the sheath may be falsely branched and contain several trichomes. Sheaths surrounding the trichomes are of a firm texture, homogeneous or lamellated, and hyaline or colored. Frequently they are more gelatinized at their distal ends and broader, or the gelatinization is so extensive that they are wholly confluent with one another and they are united to form a homogeneous colonial envelope.

Heterocysts are regularly formed by the majority of genera in the family, but some genera never form them. If the genus is one with heterocysts, certain of them are always basal in position and borne singly or in short series of two, three, or more. There may also be intercalary heterocysts. The false branching so characteristic of the family may result from the breaking of the trichome just below an intercalary heterocyst; the upper portion of the lower half then growing through the original sheath and secreting a sheath of its own. Indefinite repetition of this process results in repeatedly and falsely branched filaments which are united with one another into spherical, hemispherical, penicillate, or caespitose colonies. The false branching may also result from a germination of hormogones within the sheath of the parent trichome. Hormogones are usually formed toward the attenuated end of the trichome; as they germinate one end becomes attenuated to a hairlike point, the other develops a heterocyst. After the differentiation of the two extremities, further cell divisions are restricted to the lower portion of the trichomes and are most numerous in the portion next the heterocyst.

[1] GEITLER, 1925.

Sometimes both ends of the hormogone become attenuated, and the young trichome breaks transversely into two parts at a plane where two adjoining heterocysts have been formed in its median portion.

Some of the genera which regularly form heterocysts also form akinetes; others lack akinetes. Akinetes are generally formed singly and next the basal heterocysts. They are much longer and somewhat broader than the vegetative cells.

Genera of the Rivulariaceae found in the United States differ as follows:

Heterocysts lacking:
- Trichomes with pointed ends parallel ..... 1. **Amphithrix**
- Trichomes with pointed ends not parallel ..... 2. **Calothrix** (*p.p.*)

Heterocysts present:
- Filaments united into spherical or hemispherical thalli:
  - One trichome within a sheath:
    - Trichomes without akinetes ..... 4. **Rivularia**
    - Trichomes with akinetes ..... 5. **Gloeotrichia**
  - Two to several trichomes in a sheath ..... 6. **Sacconema**
- Filaments solitary or united in thalli of indefinite shape:
  - False branching scarce or lacking, trichomes single within a sheath ..... 2. **Calothrix** (*p.p.*)
  - False branching profuse, several trichomes in a common sheath ..... 3. **Dichothrix**

1. **Amphithrix** Kützing, 1843; emend. Bornet and Flahault, 1886. The trichomes of *Amphithrix* are distromatic and consist of a lower portion composed of densely interwoven trichomes (so closely packed that they appear to be parenchymatous) and of an upper portion with numerous erect trichomes attenuated to hairlike points at their distal ends. The erect trichomes are parallel to one another. Heterocysts and akinetes are never formed. Reproduction is by means of hormogones, which may be formed singly or in series.

FIG. 63.—*Amphithrix janthina* (Mont.) B. and F. Drawn from a herbarium specimen. (× 1300.)

This genus is included in the Rivulariaceae because of the marked attenuation of the branches. It is exceptional in that it does not form heterocysts.

A. janthina (Mont.) B. and F. (Fig. 63) has been found growing on stones in a brook in Connecticut[1] and at Williamstown, Massachusetts. According to European workers this alga grows as a thin, expanded layer and has a purplish color.[2]

2. **Calothrix** Agardh, 1824 [*Mastigonema* Schwabe, 1837 (*p.p.*); *Mastigothrix* Kützing, 1843; *Homoeothrix* (Thuret) Kirchner, 1900].

[1] COLLINS, 1905. [2] BORNET and FLAHAULT, 1886.

The trichomes of *Calothrix* may taper from base to apex and terminate in a fine hairlike point, or the basal portion may be cylindrical and the hairlike attenuation restricted to the upper portion of trichome. In a few species the attenuation at the distal end is quite abrupt. Sheaths surrounding the trichomes are generally cylindrical and of the same thickness throughout. They are homogeneous or distinctly stratified, and hyaline or colored. There is but a single trichome within a sheath, but the filaments may be simple or with false branches here and there. Vegetative cells toward the base of the trichome are discoid and with or without constrictions at the transverse walls; cells toward the apex of the filament are often cylindrical. Protoplasts of the cells usually have a granulose structure. Heterocysts may be intercalary in position, but the typical *Calothrix* trichome always has a basal heterocyst, which, not infrequently, lies external to the sheath surrounding the trichomes. A few species never form heterocysts. Akinetes are known for a few species only.

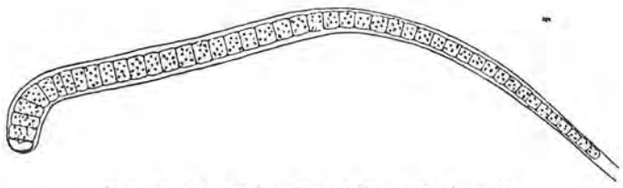

FIG. 64.—*Calothrix fusca* (Kütz.) B. and F. (× 975.)

The filaments may occur singly or united with one another to form strata of microscopic or macroscopic size. Sometimes the stratum is pencilliform, pulvinate, or stellate.

Calothrix generally grows attached to submerged rocks or to woodwork and in flowing or standing water. The thalli may be encrusted with, or free from, lime. Certain species grow epiphytic on other algae. The genus is divided into two sections: *Homocothrix*, whose trichomes lack heterocysts; and *Eucalothrix*, whose trichomes have heterocysts. *C. Juliana* (Menegh.) B. and F. is the only one of the 12 American species that belongs to the section *Homocothrix*. Of the species belonging to the section *Eucalothrix*, *C. calida* P. Richter and *C. Kuntzei* P. Richter are strictly thermal species and differ from each other in the structure of their sheaths. *C. parietina* (Näg.) Thur. may occur in either thermal or non-thermal waters. *C. stagnalis* Gom. is the only species that regularly forms akinetes. *C. scytonemicola* Tilden, *C. epiphytica* W. and G. S. West, *C. adscendens* (Näg.) B. and F., and *C. fusca* (Kütz.) B. and F. (Fig. 64) grow on other algae. *C. fusca* is the commonest of these epiphytic species and grows in the gelatinous envelope of Palmellaceae, or of *Batrachospermum*, *Chaetophora*, or *Nostoc*. Of the species growing on submerged stones and woodwork, *C. parietina* (Näg.) Thur. differs from the others in having brownish sheaths. The other species [*C. Braunii* B. and F., *C. Castellii* (Mass.) B. and F., and *C. Kawrayskyi* Schmidle]

have colorless sheaths. *C. Kawrayskyi* has trichomes 4 μ broad, *C. Braunii* has them 6 to 7 μ broad, and *C. Castellii* has them 8 to 10 μ broad.

3. Dichothrix Zanardini, 1858 [*Schizosiphon* Kützing, 1843 (*p.p.*)]. *Dichothrix* is closely related to *Calothrix* but differs from it in having several trichomes, each enclosed by its own sheath, that lie more or less parallel to one another within a common sheath. The filaments of *Dichothrix* are freely and falsely branched, but the ultimate branchlets usually contain one trichome only. Trichomes of *Dichothrix* may show the same attenuation from base to apex as is found in *Calothrix*, or they may be attenuated in the distal portion only. Sheaths surrounding the trichomes may be hyaline, yellowish, or deep orange-brown; homogeneous or stratified. If stratified, the lamellae may be parallel or divergent. The heterocysts are usually solitary and basal, but there may be additional intercalary heterocysts.

Species of *Dichothrix* are not uncommon upon submerged rocks in streams and ponds and on moist rocky cliffs. Submerged plant masses may be smooth and plushlike, or distinctly tufted. Eight species have been reported from the

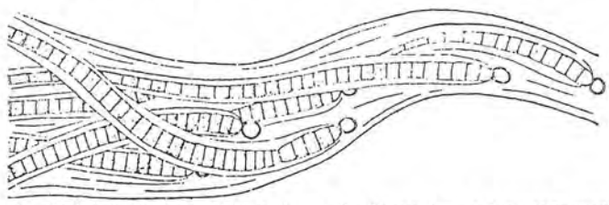

FIG. 65.—*Dichothrix Orsiniana* (Kütz.) B. and F. Drawn from a herbarium specimen. (× 400.)

United States. Four of these [*D. Orsiniana* (Kütz.) B. and F. (Fig. 65), *D. calcarea* (Tilden), *D. Baueriana* (Grun.) B. and F., and *D. montana* Tilden] have homogeneous sheaths. Of these species with unstratified sheaths, *D. montana* is recognizable by its restriction to hot springs and *D. calcarea* by the dense encrustation of the plant mass with lime. *D. Orsiniana* and *D. Baueriana* differ chiefly in the diameter of the trichomes in the ultimate branchlets of the filaments; 10 to 12 μ in the former, 15 μ in the latter. Among the species with stratified sheaths, *D. Hosfordii* (Wolle) Born. differs in having divergently stratified sheaths and trichomes with a bulbous base; *D. compacta* (Ag.) B. and F., in the constrictions at the apex of the funnel-shaped sheath; *D. Meneghiniana* (Kütz.) Forti, in its short trichomes; and *D. gypsophila* (Kütz.) B. and F., in the encrustation of the plant mass with lime.

4. Rivularia Roth, 1797; emend. Agardh, 1812 [*Zonotrichia* J. G. Agardh, 1842; *Schizosiphon* Kützing, 1843 (*p.p.*)]. *Rivularia* differs from the preceding members of the family in having the sheaths surrounding the individual trichomes partially or wholly confluent with one another

and in having the trichomes radiately arranged within a hemispherical, globose, or irregularly expanded plant mass of macroscopic size. The trichomes are usually attenuated from base to apex and have basal heterocysts. The sheaths surrounding them may be distinct toward the lower portion of the trichome and either homogeneous or lamellated, but they are always more or less confluent with one another at their distal ends. The radiate arrangement of the trichomes within the thallus is the result of repeated false branching in the basal portion of the trichomes, but there is usually so much displacement of the branches that the false branching can be demonstrated only in juvenile colonies. Akinetes are not formed by species of *Rivularia*.

Rivularia, like many older genera of the algae, has suffered many vicissitudes since first established. The two species first described both

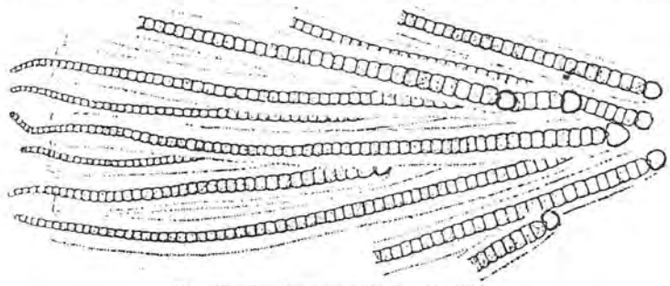

FIG. 66.—*Rivularia dura* Roth. (× 485.)

belong to *Chaetophora;* the next species to be described were of an entirely different type. The removal[1] of the *Chaetophora* species from the genus left *Rivularia* much as we now know it, except for the later removal of certain species to found the genus *Gloeotrichia*.

Species of *Rivularia* grow upon submerged stones, woodwork, and upon submerged stems of water plants. They are also of frequent occurrence on the wet rocks of cliffs. The thalli are of an exceedingly firm consistency and often so tough that they can only be crushed with difficulty. Sometimes they are heavily encrusted with lime. There are seven species in this country. *R. nitida* Ag. differs from all others in having thalli which are hollow instead of solid when mature. *R. compacta* Collins differs from other species with solid colonies in its lack of encrustation with lime. *R. haematites* (DC) Ag. can be distinguished from other lime-encrusted species by the distinctly zonate interior. *R. dura* Roth (Fig. 66) and *R. minutula* (Kütz.) B. and F. have calcified colonies that are always more or less hemispherical; the former has trichomes 4 to 9 μ broad, the latter 9 to 12.5 μ. *R. Biasolettiana* Menegh., which is found in both fresh and salt water, has a hemispherical thallus when young, but a verrucose,

[1] AGARDH, 1812.

broadly expanded thallus when old. *R. Bornetiana* Setchell, known only from a coastal pond in Rhode Island, has spherical thalli and trichomes 4 to 16 μ broad.

[redacted] only differs from *Rivularia* in its regular formation of akinetes and in the gelatinous texture of its thalli. Trichomes of *Gloeotrichia* have the same regular attenuation from base to apex, but they are enclosed by more gelatinous sheaths, which are often wholly confluent with one another. This genus always has basal heterocysts and sometimes intercalary heterocysts in addition. The akinetes are always elongate and at the base of the trichomes. There may be but a single akinete, in which case it lies next the heterocyst, or more than one akinete. If more than one is present they may be formed in short catenate series or separated from one another by two or three intervening vegetative cells.

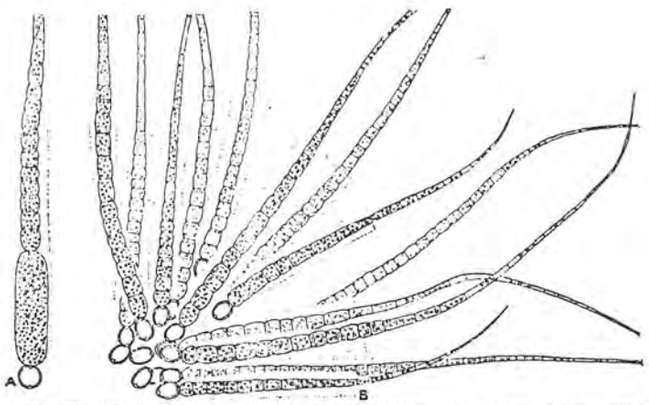

FIG. 67.—*Gloeotrichia echinulata* (J. E. Smith) P. Richter. *A*, filament with an akinete. *B*, portion of a sterile colony. (× 400.)

Many phycologists[1] do not recognize the genus but consider its species as belonging to *Rivularia*. Such a position is quite logical when one recalls that a similar presence or absence of akinetes is not held of sufficient importance to warrant a breaking up of *Calothrix* into two genera. The retention of *Gloeotrichia* and *Rivularia* as separate genera has the sanction of Bornet and Flahault.[2]

Gloeotrichia is always aquatic and may be free floating or sessile at all stages of its development; or it may be sessile at first and free floating later on. There are three American species. *G. Pisum* (Ag.) Thur., which grows on the stems of

[1] For example, TILDEN, 1910; SETCHELL and GARDNER, 1919.
[2] BORNET and FLAHAULT, 1886*A*.

submerged aquatics, has firm hemispherical thalli that are 2 mm. or less in diameter when mature. The statement is frequently made that the colonies of this species break away and become free floating. This is undoubtedly erroneous and the planktonic individuals of *Gloeotrichia* so often found in the lakes of this country belong to another species, *G. echinulata* (J. E. Smith) P. Richter (Fig. 67). This latter species has colonies which are never over 2 mm. in diameter and which are macroscopically distinguishable from other plankton algae by the aureole of whitish threads, which surrounds them. It is the only species in which the cells regularly contain pseudovacuoles. The third species found in this country, *G. natans* (Hedw.) Rab., grows attached to submerged stems of aquatics and has solid or hollow, spherical or irregularly swollen, gelatinous colonies which may be up to 10 cm. in diameter.

6. **Sacconema** Borzi, 1882. This imperfectly understood genus has a gelatinous thallus much like that of *Rivularia* and *Gloeotrichia*, but there

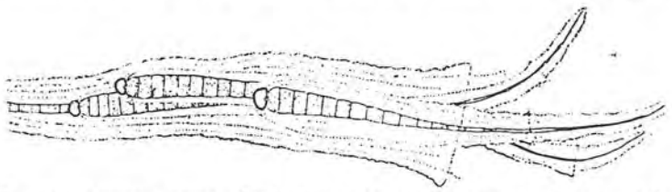

FIG. 68.—*Sacconema rupestre* Borzi. Drawn from a herbarium specimen. (× 325.)

are usually two or more trichomes within a common sheath. The individual trichomes are attenuated and the sheaths surrounding them are lamellated and have expanded, funnel-like apices. The heterocysts are basal and solitary. Akinetes are formed at the base of the trichomes.

The sole American record for the single species of the genus, *S. rupestre* Borzi (Fig. 68) is from a lake in Massachusetts.[1]

[1] COLLINS in TILDEN, 1910.