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Some Noticeable Plankton-Algae of Lake Biwa and its Effluent

Algal Indicators of a Water System

By

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1

Lake Biwa (Biwa-ko) is the largest lake in Japan, having an area of 674 sq. km and the maximum depth of 102 m. It is situated in the middle part of Honshu, and northeast of Kyoto City, occupying the bottom of the Omi depression that lies within Shiga Prefecture.

The effluent, the River Seta-gawa, starts at the southern end of the lake and discharges into Osaka Bay, after flowing down about 60 km from the outlet. It is named Uji-gawa in the middle course and Yodo-gawa in the lower course. The latter receives at the head of its course two great tributaries, namely the River Kizu-gawa and the River Katsura-gawa, the former from east and the latter from north, and flows through Osaka City near its mouth.

It is ascertained by geologists that Lake Biwa is a tectonic basin, which was formed at least 3,000,000 years ago, i.e. in Tertiary, by the fault depression of the earth's crust. In regard to the origin and age, Lake Biwa is therefore markedly different from almost all Japanese lakes of volcanic origin, whose ages scarcely exceed tens of thousands of years.

The ancient lakes have generally many endemic organisms, for such lakes, especially deep ones, form the isolated habitats as similar as the solitary islands in the oceans; and the older their origins are, the oftener the opportunities to create new species by mutation are given. This fact is clearly shown in Lake Baikal of Siberia and in Lake Tanganyika of Africa (L. S. BERG, 1925, '35; V. BREHM, 1930; J. L. BROOKS, 1950; B. W. SKVORTZOW and C. I. MEYER, 1929).

Lake Biwa is neither so deep nor old in age as in the lakes mentioned above. Nevertheless, as compared with other younger lakes of Japan, Lake Biwa has also many endemic organisms, such as fishes, mollusks, flatworms, aquatic vascular plants, etc. Plankton do not stand out of range of this rule, though lacustrine plankton have generally a large number of cosmopolitan species. Of some 70 species of plankters found in the main basin of Lake Biwa, the following eleven are regarded

as the endemic or semi-endemic elements (K. NEGORO, 1954a)[1].

The endemic zooplankters of Lake Biwa:

Difflugia biwae KAWAMURA

Difflugia sp.

This rhizopod was identified by Prof. Tamiji KAWAMURA as *Difflugia brevicola* CASH et HOPKINSON, but it seems to me probable to be an endemic new species.

Daphnia pulex biwaensis UÉNO

The endemic or semi-endemic phytoplankters of Lake Biwa:

Pediastrum Biwae NEGORO

Staurastrum Biwaensis HIRANO

Staurastrum dorsidentiferum W. et G. S. WEST var. *ornatum* GRÖNBL.

Staurastrum limneticum SCHMIDLE var. *Burmense* W. et G. S. WEST

Oedogonium sp.

Always sterile. Probably endemic!

Melosira solida EULENSTEIN

Stephanodiscus carconensis GRUNOW

Ceratium hirundinella (O. F. MÜLLER) SCHRANK

The endemic form ("Lake Biwa type")!

Of these endemic plankters, *Difflugia* sp., *Daphnia pulex biwaensis*, and *Staurastrum Biwaensis* appear relatively rare, but the others are more or less abundant, though their occurrences change in season.

2

The effluent Seta-gawa carries away a great majority of plankton organisms from the lake. The living plankters transported by the river-water, however, diminish gradually both in the number of species and in quantity, as the distance of flowing from the outlet increases. In the lowest course near its estuary, only a few species of phytoplankton remain lived (T. MIZUNO and H. FUJISHITA, 1956; S. OUMI and T. NARII, 1950). They are as follows:

Pediastrum Biwae,

Stephanodiscus carconensis,

Melosira solida.

It is a striking feature that the green alga *Pediastrum Biwae* (Pl. I, Figs. 1, 2, 3, 6, 8) occurs abundantly and in a perfect condition at every station of the effluent throughout 60 km, except in the cold season.

The next noticeable plankter is *Stephanodiscus carconensis* (Pl. I, Figs. 4, 5, 11). This disc-like diatom is found in a relatively small quantity except in winter, but the frequency of its appearance is fairly high.

Another diatom *Melosira solida* (Pl. I, Figs. 7, 9, 10) is found as a long chain

1) See also HOKURYUKAN Co., 1947; Tamiji KAWAMURA, 1918; K. NEGORO, 1954b, '54c, '54d, '56a, '57b, '58; B. W. SKVORTZOW, 1936; M. UÉNO, 1937; H. YAMAGUCHI and M. HIRANO, 1953.

form in the plankton of the lake, but in the effluent it occurs in most cases in a short chain form, frequently in one or two cells or half-cells. Furthermore its quantity in the river is pretty little. Therefore this alga is not so conspicuous in the effluent as the two plankters mentioned above.

Some fishes, mollusks, and larvae of aquatic insects in the effluent feed on the plankton organisms in the stream as well as their deposits on the surface of river bed. Consequently, the plankton algae mentioned above are commonly found in the digestive tructs of these animals (A. NAKAGAWA, 1952).

By contrast, the endemic plankton algae of Lake Biwa are never found even in the tributaries of the effluent. Therefore, by examining the contents of digestive tructs of aqauatic animals, it becomes obvious that those animals belong to the water system of Lake Biwa or not.

3

Finally I should like to refer more a noteworthy fact.

Only 1.5 km distant from the northern shore of Lake Biwa there lies a small lake called Yogo-ko (Lake Yogo) that has an area of 1.63 sq. km and the maximum depth of 13.5 m. It occupies the northernmost part of the same depression as Lake Biwa, from which it is isolated by a low range called Mt. Shizu-ga-dake (422 m above sea level). Its surface of water, which is 134 m high above the sea, is 48 m higher than that of Lake Biwa (86 m above sea level). The effluent, the River Yogo-gawa, starts at the northeastern corner of the lake and flows into Lake Biwa, after running down about 15 km along the eastern foot of Mt. Shizu-ga-dake.

The plankton of Lake Yogo is very similar to that of Lake Biwa, having many plankters in common with the latter. But in some respects the two are fundamentally different. It seems to me probable that this fact will be due to the same origin and to the different limnological types of the two lakes. Lake Biwa is of a typical oligotrophic water, while Lake Yogo is in a state of progressive eutrophication (K. NEGORO, 1956b, 57a, MS).

In Lake Yogo the water-bloom caused by two species of plankton blue-green algae, viz. *Anabaena macrospora* KLEBAHN and *Lyngbya limnetica* LEMMERMANN, occurs in late summer, while in Lake Biwa such a phenomenon has never been found. *Pediastrum Biwae, Staurastrum dorsidentiferum* var. *ornatum, Staurastrum limneticum* var. *Burmense*, and *Stephanodiscus carconensis* appear also in the plankton of Lake Yogo. *Melosira solida* are, however, never found, instead, *Melosira granulata* and *Melosira italica* abundantly occur.

The following chain of waters may be called the water system (or the drainage system) of Lake Biwa.

Lake Yogo → the River Yogo-gawa → Lake Biwa → the River Seta-gawa → the River Uji-gawa → the River Yodo-gawa → (Osaka Bay).

As indicatory algae of the water system of Lake Biwa, *Pediastrum Biwae* and *Stephanodiscus carconensis* may be recognized.

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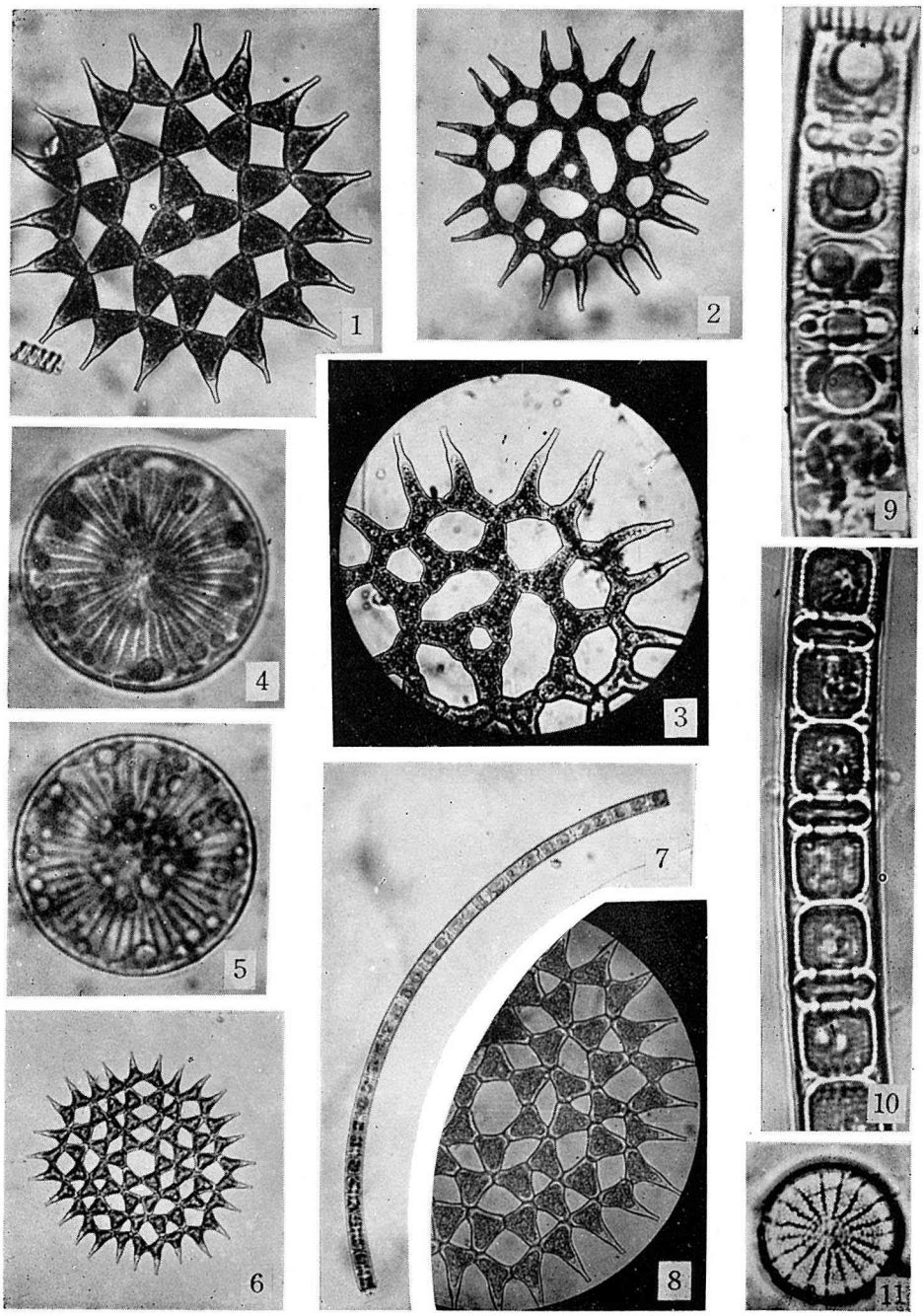
Explanation of Plate I

Figs. 1, 6, 8. ···*Pediastrum Biwae* NEGORO.
Diameter of coenobia 110–230 μ.
Figs. 2, 3. ·····*Pediastrum Biwae* NEGORO var. *triangulatum* NEGORO.
Figs. 4, 5, 11.···*Stephanodiscus carconensis* GRUNOW.
Diameter of valves 25–45 μ.
Figs. 7, 9, 10.···*Melosira solida* EULENSTEIN.
Diameter of valves 7–9 μ, Length of half-cells 10–13 μ.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