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First Report of the Regular Limnological Survey of Lake Biwa (Oct. 1965 - Dec. 1966)

I. General Remark*

By

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Lake Biwa, the largest lake in Japan situated in the middle of Shiga Prefecture, is practically a depression lake, and its history is believed to go back as far as several million years. The general morphometric characters are as follows :

Latitude (N)	Longitude (E)	Altitude (m)	Length (km)	Maximum Breadth (km)	Length of Shoreline (km)	Area (km ²)	Shore Development
35° 15'	136° 05'	85.6	68.0	22.6	188.0	679.5	2.04

Maximum Mean		
Depth (m)	Depth (m)	Volume (km ³)
104.0	41.2	27.8

The general characteristics of the lake follows its long history and its topographical complexity, with alluvial sanddunes and deltas, long sandy shores, rocky headlands, and towering islets, that have contributed to form the cradle of the particular biota. The northern part is about eleven times as large as the southern; its depth exceeds 30 meters for its greater part (more than 64% of the area of the northern part) and the water is generally clear and oligotrophic with some exceptions at several inlets. It has been found that distinct thermal stratification usually occurs from April to December and the water temperature at the surface layer rises to about 28-30°C in summer, while the temperature at the hypolimnion remains at about 7°C. In winter, water comes into circulation so as to show a nearly uniform temperature of about 6-7°C. Contrary to the northern part, the southern part is evenly shallow, less than 6-7 meters in depth, with rather turbid and mesotrophic water, or even polluted to some extent near Ôtsu City. Water temperature fluctuates between about 30°C in

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summer and 2°C in extreme winter for the whole layer and sometimes the surface freezes in the sheltered places around the shore.

Provided with these geological, physical and climatic situations, Lake Biwa retains hues of both temperate and sub-tropical lakes and secures richness and heterogeneity of habitat for lives. These dominant characteristics of the lake admittedly have shared in establishing and differentiating organisms of many kinds, and as a result, many endemic species here are found. For example, about 100 species of freshwater fish are found in Japan, of which about 60 species, including 6 or 7 endemic species, are living in Lake Biwa. Also, as regards the freshwater molluscs, about 40 species out of 60 Japanese species can be found in this lake, of which about 18 species are endemic.

Reflecting these circumstances, a great deal of limnological works have hitherto been made in Lake Biwa, most parts of which are shown in the literature list edited by Dr. M. Uéno (1943), Drs. T. Taketani, Y. Shiraiishi, M. Tanaka (1958) and by the Research Group for Biotic Resources of Lake Biwa (1962). Except only two, however, they are all short term works, covering not more than 3 or 4 years, and so they can not reveal long term variations or trends in limnological conditions of Lake Biwa*.

The exceptional works mentioned above have been performed by the Fisheries Experiment Station of Shiga Prefecture. This Station was founded in 1900 and since 1910 the fundamental data on water temperature were published. In 1931 the observation on water temperature, transparency, pH, dissolved O₂ content and plankton content was performed once a month selecting 4 points across the lake from Hikone (east coast) to the mouth of River Ado-gawa (west coast) in the northern part of the lake, and in the next year (1932) the general survey was executed at scores of points covering the whole lake at each season. From 1933 to 1947 various modes of observations were tried year after year. Relatively regular survey was commenced since 1948, once a month, selecting 5 points traversing from Hikone to the mouth of River Ado-gawa. The items for observation were weather, water temperature, transparency, color of water, wave, pH, O₂ content, NH₃-N, NO₂-N, NO₃-N, PO₄-P and planktons. During 1955 to 1966 other 6 points were added to the above points, all in the northern part of the lake, of which 3 were situated on the line traversing from the mouth of River Ane-gawa to the mouth of River Chinai-gawa and the other 3 were on the line traversing from the mouth of River Echi-gawa to Omatsu-zaki.

All works mentioned above were scarcely done in the southern part of the lake, but in 1961 the points of observation, 6 in total, were so arranged as to distribute longitudinally from northern end to southern end of the lake, of which 2 were situated in the southern part of the lake. The items of observation were principally the same as before. However, this method was tried only in this year, and from the next year up to the present time the general method was

*Long term variation of geological scale was recently studied by Dr. S. Horie (unpublished), but this kind of work is not touched in the present paper.

returned to the former traditional one.

Besides this work, they have been making regular observation on some sides of life history, such as fecundity and body size of spawning adult at the spawning places near river mouth, and distribution of fry in the whole lake, and so on, of the fish, Ayu (*Plecoglossus altivelis* Tem. & Schl.), the most important commercial fish in this lake. This work has been continued since 1946.

Needless to say of the superior value of all these works mentioned above, not only from the fundamental scientific point of view but also from the commercial fishing practices. However, there are some weaknesses in their works. First, they have no data on benthic animals, which is indispensable not only for knowing lake conditions but also food materials for fish. Secondly, they have scarcely regular data about the southern part of the lake, where the character of the lake is remarkably different from the northern part, richer in nutritional conditions or more advanced in eutrophication and more closely related to the lives of not only citizens of Ôtsu City (the capital of Shiga Prefecture) but also the people inhabiting alongside of effluent River Yodo-gawa (the second densely populated area in Japan).

On the occasion of the Ôtsu Hydrobiological Station moved to the new site in autumn of 1964, where was much more suitable for performing this kind of field work than it had been at the old site, we planed to begin a new regular limnological survey. We are thinking to perform this work permanently and to offer regular limnological data as long as it continues.

After trying several preliminary surveys, the first regular survey was performed on the 1st of October, 1965. As the survey points, we selected one point, Ie1, in the northern part of the lake and three points, Nb2, Nb5 and Na2, in the southern part (Fig. 1). Up to June of 1966 the survey was performed once a month at Ie1, and twice a month at three points in the southern part, but after that time the latter was changed to perform once a month. Among these points, Na2 was shifted to Na3, about 0.8 km south of the former, after March of 1966, because the area around Na3 was designated to be a *specialy conserved area* in 1966 by the Prefectural Government. Similar environmental and biotic conditions were observed at both Na2 and Na3.

Most of the observations and collections were done in the beforenoon. At the point Ie1 our boat was always moored to the station-buoy which was fastened by long chains to the lake bottom, and at other three points it was usually anchored directly.

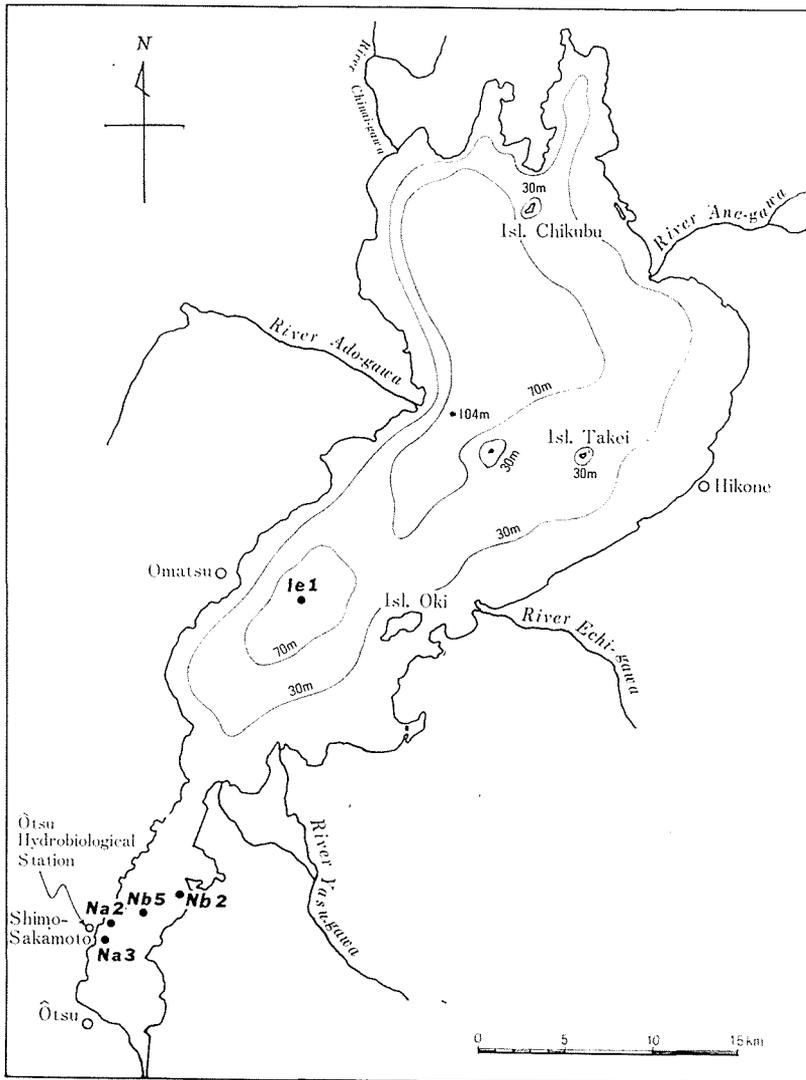


Fig. 1. Map of Lake Biwa with survey points
For further explanations see text.

Situations and conditions of the survey points are listed in Table 1.

Table 1. Conditions of survey points and items

Survey point		Position	Depth	Bottom	Survey items
Northern part	Ie1	3.5 km off the coast of Omatsu. Typical condition of the northern part of the lake is seen.	About 74 m	Muddy clay	Weather Air temperature Wind Cloud
Southern part	Nb2	0.1 km off the east coast of the southern part of the lake.	About 2 m	Sand or Sandy mud	Transparency Wave condition Mud temperature Water temperature
	Nb5	Middle part of the southern part of the lake.	About 4.5 m	Mud	pH Dissolved O ₂ content
	Na2, later Na3	0.1 km off the west coast of the southern part of the lake.	About 2 m	Mud	Plankton Benthos

Other methods are particularly explained in detail in the following articles.

As this is the first report, it is inevitably confined only to present the actual data; after accumulating 2 or 3 year's data we should like to make general discussions.

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