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Seventh Report of the Regular Limnological Survey of Lake Biwa (1973) II. Phytoplankton[1)]

By

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This is the report of the regular limnological survey on the phytoplankton in Lake Biwa in 1973. The methods used were principally the same as those described in our former reports (1, 2), except the following points:

1. counting plate for brood corpuscle was used this time for counting the cell or filament number of phytoplankters instead of using ordinary counting slide.
2. *Melosira* and *Asterionella* were counted so far by the number of filaments and colonies, but this time they were counted by the number of cells.
3. counting was done after condensing a collected sample to 5 or 10 ml, so that it was necessary to count with much more cell numbers than before. More reliable result seemed to be obtained by this method.

The series of reports were edited by the Director of the Station, Syuiti Mori, and the present part, on the phytoplankton, was arranged especially by Masami Nakanishi. The samples were collected by T. Narita, T. Ueda and A. Kawabata, and other members of the Station have aided this survey in many ways.

A. List of algae found through this survey

The following algae were found in the samples. An abridged name of each phytoplankter is given in parenthesis behind its full specific name. The phytoplankters with no abridged names were very rare, so that they are not cited in the following tables (Tables 1 and 2).

Chrysophyta

1) Contribution from the Otsu Hydrobiological Station, Kyoto University, No. 266

Melosira solida (*M. sol.*)
Melosira italica (*M. ital.*)
Melosira granulata (*M. gran.*)
Melosira sp. (*M.* sp.)
Stephanodiscus carconensis (*S. carc.*)
Asterionella formosa (*A. form.*)
Fragilaria crotonensis (*F. crot.*)
Synedra spp.
Nitzschia sp.
Dinobryon bavaricum

Pyrrophyta

Ceratium hirundinella (*C. hirun.*)

Chlorophyta

Staurastrum dorsidentiferum (*S. dors.*)
Staurastrum tohopekaligense (*S. toho.*)
Staurastrum limneticum (*S. limn.*)
Closterium aciculare (*C. acic.*)
Pediastrum Biwae (*P. Biwa.*)
Pediastrum duplex (*P. dupx.*)
Scenedesmus sp. (*Scend.* sp.)
Sphaerocystis Schroeteri (*S. Sch.*)
Eudorina elegans (*E. eleg.*)
Oocystis sp. (*Oocy.* sp.)
Spirogira sp. (*Spirog.* sp.)
Closterium sp.
Coelastrum cambricum

Cyanophyta

Anaebaena sp. (*Anaeb.* sp.)
Chroococcus sp. (*Chroc.* sp.)
Oscillatoria sp. (*Oscil.* sp.)
Lyngbya tenuis
Aphanocapsa elachista
Aphanothece sp.

B. Quantitative composition of phytoplankton communities

Tables 1 and 2 show the results obtained at the main basin (northern basin) and the sub-basin (southern basin) respectively.

In the tables the following abbreviations are used.

- : organism which was not observed in 4 or 5 subsamplings.

r : organism which was found once in 8 or 10 repeated detection by microscope.
c : organism which was very abundant but was unable to count because of remarkably biassed distribution.
* : number of colony or filament.
( ) : number of filament.
× : uncounted due to failure in formalin fixation.

Table 1. Numbers of phytoplankters per m^3 of lake water at Station Ie-1 (northern basin). A unit of number corresponds to ten thousand (10^4).

	Jan. 17, 1973			
	M. sol.	*M. ital.*	*S. carc.*	*S. dors.*
0- 2m	206, 250 (13, 750)	2, 906 (104)	391	391
2- 5m	154, 200 (10, 280)	r	105	—
5-10m	76, 512 (4, 782)	r	r	—
10-20m	82, 415 (5, 150)	r	r	—
20-30m	62, 390 (3, 899)	289 (38)	r	—
30-50m	35, 850 (2, 241)	r	r	—
50-70m	23, 070 (1, 440)	r	r	r
	Feb. 14, 1973			
	M. sol.	*M. ital.*	*S. carc.*	*S. toho.*
0- 2m	121, 500 (7, 594)	r	42	—
2- 5m	63, 000 (2, 100)	—	—	r
5-10m	44, 200 (2, 760)	—	r	—
10-20m	64, 640 (4, 040)	2, 700 (200)	r	r
20-30m	42, 080 (2, 630)	r	r	—
30-50m	70, 800 (3, 540)	r	—	26
50-70m	195, 000 (6, 500)	r	r	29
	Mar. 17, 1973			
	M. sol.	*M. gran.*	*A. form.*	*S. toho.*
0- 2m	14, 960 (940)	126 (21)	r	r
2- 5m	4, 980 (311)	—	r	r
5-10m	4, 670 (290)	—	r	r
10-20m	4, 240 (270)	—	—	—
20-30m	3, 200 (200)	—	—	—
30-50m	2, 720 (170)	—	—	r
50-70m	3, 520 (220)	—	300	5
	Apr. 17, 1973			
	M. sol.	*M. ital.*	*A. form.*	*S. dors.*	*C. acic.*
0- 2m	2, 080 (130)	730 (42)	6, 460	—	—
0- 2m	r	r	2, 380	—	—
5-10m	272 (17)	230 (25)	750	r	10
10-20m	104 (10)	r	365	r	—
20-30m	290 (10)	r	156	—	—
30-50m	224 (10)	r	63	r	r
50-70m	5, 760 (360)	50 (5)	42	5	8

May 14, 1973

	A. form.	*F. crot.*	*C. hirun.*
0- 2m	27,080	2,500	26
2- 5m	14,825	r	r
5-10m	5,920	1,080	8
10-20m	3,000	540	—
20-30m	1,420	r	—
30-50m	480	r	r
50-70m	670	—	—

June 14, 1973

	M. sol.	*S. carc.*	*S. dors.*	*S. toho.*	*C. acic.*	*S. Sch.*
0- 2m	r	—	208	r	r	420
2- 5m	r	390	70	13	50	890
5-10m	r	20	100	21	r	—
10-20m	r	—	17	r	r	—
20-30m	—	—	10	—	5	r
30-50m	20	—	5	5	5	80
50-70m	30	—	5	—	5	—

July 16, 1973

	S. dors.	*S. toho.*	*C. acic.*	*P. Biwa**
0- 2m	1,480	115	80	70
2- 5m	940	120	110	90
5-10m	1,330	80	60	r
10-20m	470	83	96	—
20-30m	100	30	20	r
30-50m	20	r	5	r
50-70m	20	r	r	—

Aug. 9, 1973

	S. dors.	*S. toho.*	*C. acic.*	*P. Biwa**
0- 2m	1,880	90	40	390
2- 5m	660	60	60	180
5-10m	210	20	r	40
10-20m	1,270	110	10	40
20-30m	150	70	10	10
30-50m	40	10	r	r
50-70m	40	10	r	5

Sep. 11, 1973

	M. so .	*M. gran.*	*S. dors.*	*S. toho.*	*S. limn.*	*C. acic.*	*P. Biwa**
0- 2m	460 (25)	—	1,690	160	50	40	570
2- 5m	300 (20)	r	780	170	40	70	290
5-10m	130 (10)	—	450	70	20	10	200
10-20m	r	200 (20)	180	40	7	7	70
20-30m	—	—	105	20	r	7	30
30-50m	—	r	40	8	r	r	14
50-70m	r	—	30	7	1	2	9

Oct. 15, 1973

	M. sol.	*S. dors.*	*S. toho.*	*S. limn.*	*C. acic.*	*P. Biwa.**	*C. hirun.*	*Chroc.* sp.*
0- 2m	2,600 (104)	10,570	350	—	130	1,150	—	220
2- 5m	x	x	x	x	x	x	x	x
5-10m	r	2,290	50	—	r	280	—	52
10-15m	310 (26)	1,290	40	—	60	170	—	16
15-20m	540 (31)	2,700	80	—	21	391	—	31
20-30m	83 (6)	640	38	r	6	88	3	8
30-50m	r	112	9	2	5	11	—	—
50-70m	76 (5)	133	6	2	5	11	—	—

Nov. 14, 1973

	M. sol.	*M. gran.*	*S. dors.*	*S. toho.*	*C. acic.*	*P. Biwa**	*Chroc.* sp.*
0- 2m	13,670 (615)	490 (26)	9,940	430	340	990	r
2- 5m	6,230 (227)	530 (17)	3,470	105	507	420	17
5-10m	4,380 (163)	—	3,860	177	180	380	r
10-20m	2,346 (86)	—	2,040	104	96	190	2
20-30m	667 (31)	r	979	71	26	109	—
30-50m	72 (3)	r	124	16	7	21	1
50-70m	194 (8)	—	235	20	6	29	—

Dec. 12, 1973

	M. sol.	*S. dors.*	*S. toho.*	*C. acic.*	*P. Biwa**
0- 2m	30,344 (1,604)	667	391	1,789	182
2- 5m	17,657 (1,056)	315	203	1,042	114
5-10m	14,842 (608)	229	156	517	73
10-20m	6,990 (269)	167	115	335	13
20-30m	6,302 (227)	177	71	135	29
30-50m	1,985 (90)	85	30	35	13
50-70m	2,149 (29)	51	15	40	5

Table 2. Numbers of phytoplankters per m^3 of lake water at Stations Nb-2, Nb-5 and Na-3 (southern basin). A unit of number corresponds to ten thousand (10^4).

Nb-2 1973

	Jan. 17	Feb. 14	Mar. 17	Apr. 17	May 14	June 14
M. gran.	—	—	—	—	—	—
M. ltal.	—	r	50 (10)	950 (81)	171 (30)	2,016 (202)
A. form.	—	20	r	1,250	4,778	242
F. crot.	—	—	393	1,008	907	r
S. dors.	—	—	—	—	—	20
S. toho.	—	—	—	20	r	—
*P. dilpx.**	—	—	—	—	—	20
Oocy. sp.	—	—	—	40	—	—
Spirog. sp.*	—	—	—	81	—	30
*A. elach.**	—	30	20	20	—	—

	July 16	Aug. 9	Sep. 11	Oct. 15	Nov. 14	Dec. 12
M. ital.	323 (45)	383 (30)	1,068 (202)	242 (30)	15,766 (1,514)	302 (20)
M. gran.	—	686 (81)	r	r	4,375 (302)	r
M. sp.	—	—	202 (40)	1,008 (121)	r	r
S. dors.	152	50	282	3,720	810	323
S-toho.	18	r	r	101	121	30
C. acic.	72	—	101	353	1,855	1,391
*P. Biwa.**	332	2,006	17,218	5,544	6,815	252
*P. dupx.**	18	222	—	—	—	—
Scend. sp.*	—	20	—	—	—	—
*E. eleg.**	81	—	—	—	—	—
Anaeb. sp.*	—	40	1,452	—	—	—
Oscil. sp.*	—	—	200	—	—	—

Nb-5 1973

	Jan. 17	Feb. 14	Mar. 17	Apr. 17	May 14	June 14
M. sol.	2,852 (181)	x	—	48 (8)	—	101 (10)
M. ital.	—	x	242 (20)	132 (11)	r	1,361 (126)
M. gran.	r	x	—	—	—	—
A. form.	r	x	—	1,051	2,843	50
F. crot.	—	x	—	629	—	352
S. dors.	—	x	r	—	r	20
C. acic.	—	x	—	5	—	30
Cl. sp.	—	x	—	5	—	—
*P. Biwa.**	—	x	—	5	—	35
Spirog. sp.*	—	x	—	11	—	r
Oscil. sp.*	30	x	—	—	—	—

	July. 16	Aug. 9	Sep. 11	Oct. 15	Nov. 14	Dec. 12
M. sol.	—	—	—	x	2,349 (111)	—
M. ital.	r	383 (30)	201 (20)	x	8,901 (726)	766 (30)
M. gran.	—	261 (21)	r	x	1,089 (61)	—
M. sp.	8	—	—	x	202 (30)	202 (20)
S. dors.	514	112	575	x	2,329	282
S. toho.	r	14	—	x	413	50
C. acic.	—	—	20	x	2,207	655
*P. Biwa.**	413	706	9,184	x	6,754	453
Anaeb. sp.*	—	—	20	x	—	—

Na-3 1973

	Jan. 17	Feb. 14	Mar. 17	Apr. 17	May 14	June 14
M. sol.	319 (35)	—	—	—	—	—
M. ital.	86 (14)	r	r	469 (30)	151 (20)	126 (20)
M. gran.	—	161 (20)	—	r	—	—
A. form.	—	—	—	1,651	2,702	—
F. crot.	r	413	—	302	r	252
S. dors.	r	—	r	—	—	5
*P-Biwa.**	—	—	—	—	—	35
*P. dupx.**	—	—	—	—	—	15

Spirog. sp.*	—	r	25	15	r	15
*E. eleg.**	—	—	—	—	—	5
Osil. sp.*	—	—	—	—	—	10

	July. 16	Aug. 9	Sep. 11	Oct. 15	Nov. 14	Dec. 12
M. ital.	—	—	242 (20)	—	1,855 (171)	1,497 (76)
M. gran.	—	—	—	—	252 (30)	—
M. sp.	—	—	—	—	131 (20)	—
S. dors.	363	45	272	615	1,905	333
S. toho.	r	r	—	—	91	20
C. acic.	101	127	81	181	695	1,316
*P. Biwa.**	40	182	4,849	3,135	2,359	131

C. Change in number of cell or colony of phytoplankton with march of season

The seasonal change of dominant phytoplankters at the main basin (Ie-1) in 1973 is illustrated in Fig. 1. The phytoplankton community during January to March was practically composed of only *Melosira solida* and the density was higher than

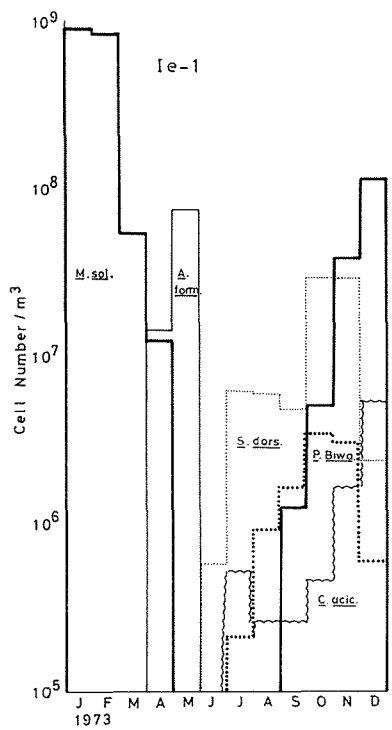

Fig. 1. Seasonal change of dominant phytoplankters at Ie-1 in 1973.

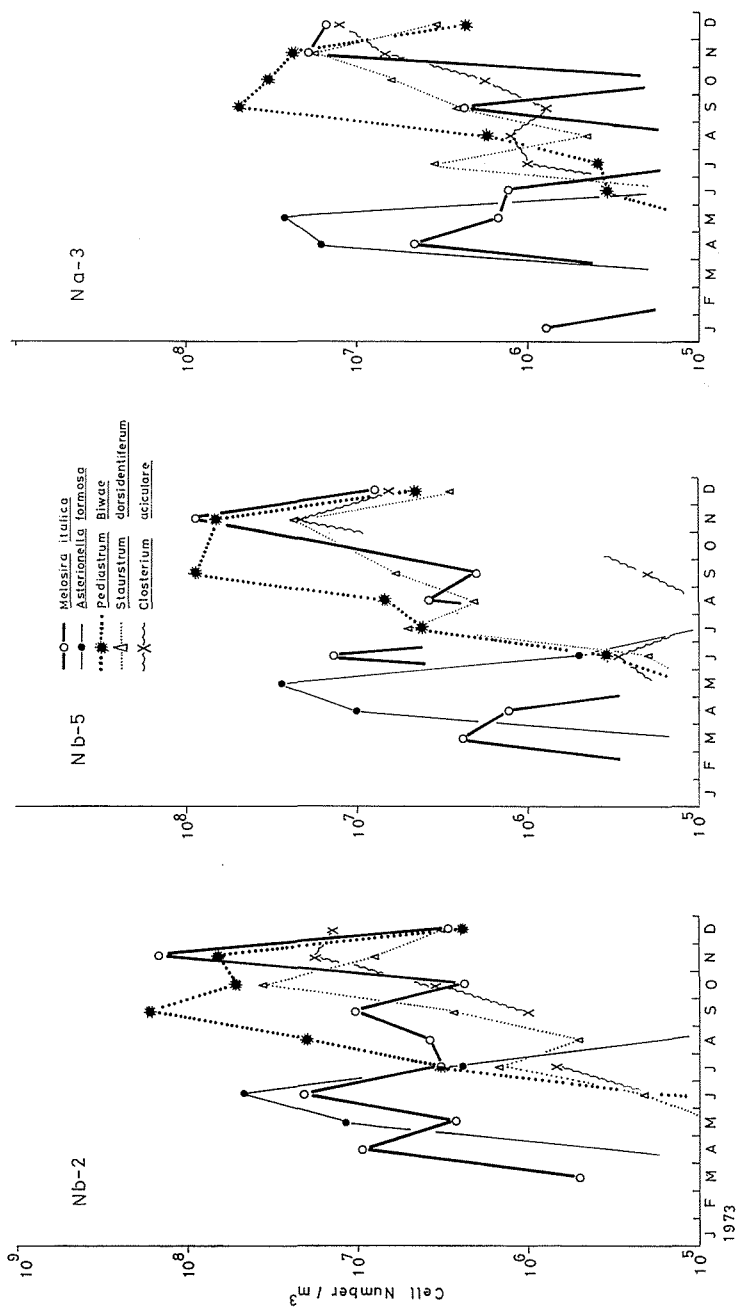

Fig. 2. Seasonal fluctuation of dominant phytoplankters at Nb-2, Nb-5 and Na-3.

those observed in 1965-1971 (1, 2, 3, 4). Sudden propagation of *Asterionalla formosa* took place in April and the mixed community of *M. solida* and *A. formosa* appeared, which was followed in May by the disappearance of the former species. In June, diatom species mentioned above disappeared and *Staurastrum dorsidentiferum*, a green alga, began to develop instead. This led next to the summer flourish of green algae such as *Closterium aciculare* and *Pediastrum Biwae* besides *S. dorsidentiferum*. Reappearance of *M. solida* was seen in September especially in the upper layer of the lake and afterwards the phytoplankton community was mainly composed of four species, *S. dorsidentiferum*, *C. aciculare*, *P. Biwae* and *M. solida*. The seasonal change of dominant phytoplankters was unusually distinctly recognized in 1973.

Fig. 2 shows the seasonal change of dominant phytoplankters in the southern basin at Nb-2 (east coast), Nb-5 (central part) and Na-3 (west coast). The same kinds of dominant phytoplankters were found at three stations, i. e., *Melosira italica* and *Asterionella formosa* as diatoms and *Staurastrum dorsidentiferum*, *Closterium aciculare* and *Pediastrum Biwae* as green algae. The principal feature of rise and fall of these species through the year was similar to that seen in the main basin; that is, in formation of diatom community during January to May, followed by the development of green algae community in July and August, and appearance of mixed community of diatoms and green algae after September.

In the southern basin, *Melosira solida*, that was the prevailing species in the main basin, was replaced by *Melosira italica*, which fluctuated remarkably and rather irregularly through the year. It must be noted also that unusual large number of *Pediastrum Biwae* was observed in 1973.

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