MEMOIRS OF THE COLLEGE OF SCIENCE, KYÔTO IMPERIAL UNIVERSITY, SERIES B
VOL. V, NO. 1, ARTICLE 3, 1930

A Comparison of the Diurnal Migration of Plankton in Eight Japanese Lakes

By

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With 2 Text-figures

(Received January 22, 1930)

The present account of the diurnal migration of plankton is based upon occasional surveys carried on during 1925–1929, in eight lakes of middle Japan. Six of these are fresh water lakes, one is of brackish water and the last is of sea-water and is closely connected with the Japan Sea by means of a small canal.

The physical features of the lakes are given in Table 1 :*

TABLE 1

Lake	Ina	Aoki	Naka-tuna	Kizaki	Noziri	Biwa	Suigetu	Hiruga
Prefecture	Nagano	do.	do.	do.	do.	Siga	Fukui	do.
Altitude (m)	1123	822	815	764	654	86	0	0
Surf. area (km^2)	0.08	1.9	0.14	1.4	3.9	689.2	5.0	0.95
Max. length (km)	0.4	1.8	0.6	2.6	3.4	64.0	2.9	1.4
Mean width (km)	0.2	1.1	0.23	0.54	1.1	10.8	1.7	0.7
Shore line (km)	1.5	6.7	2.2	6.5	14.1	243.3	14.8	4.2
Max. depth (m)	8	62	12	29	38	96	34	37
Mean depth (m)	—	29.2	5.4	17.9	21.0	39.5	25.2	22.5
Total vol. (km^3)	—	0.054	0.0008	0.025	0.08	27.2	0.12	0.02
Transparency (m)	3.5	12	—	4.5	9.5	8	3	10

* For the soundings of Lake Biwa here adopted I am indebted to the Siga Fisheries Experiment Station and the Kobe Marine Meteorological Observatory, and for those of the other lakes, to Viscount A. TANAKA.

In all the lakes, the temperature, the oxygen content and the hydrogen-ion concentration of the water were measured on the same day as the catches of plankton were made. The content of chlorine and hydrogen sulphide were determined in the cases of Lake Suigetu and Lake Hiruga. The results are given in Tables 2–9 :

TABLE 2

Lake Ina (Lake Matubara). August 23, 1927

Depth (m)	Temp. (°C)	Oxygen		pH
		(cc/l)	(%)	
0	23.2	5.74	101	6.8
2	21.5	5.89	100	6.7
3	20.8	5.91	100	6.6
5	19.4	5.05	83	6.5
6	17.2	2.52	40	6.4
7.5	14.9	1.52	23	6.4

TABLE 3

Lake Aoki. August 20, 1927

Depth (m)	Temp. (°C)	Oxygen		pH
		(cc/l)	(%)	
0	25.1	5.49	103	7.1
2	25.0	—	—	7.1
5	24.8	5.62	105	7.2
8	18.2	—	—	7.2
10	15.5	8.25	116	7.2
12	10.8	—	—	7.2
15	10.6	8.69	121	7.1
20	9.9	7.75	107	6.9
25	9.1	—	—	6.8
30	8.6	7.25	97	6.7
48	8.3	6.79	90	6.6

TABLE 4

Lake Nakatuna. August 16, 1925

Depth (m)	Temp. (°C)
0	25.2
2	25.2
5	24.2
8	18.1
10	13.2
12	10.8

TABLE 5

Lake Kizaki. July 26, 1927

Depth (m)	Temp. (°C)	Oxygen		pH
		(cc/l)	(%)	
0	25.9	5.51	105	7.1
2	25.8	—	—	7.0
5	22.1	6.39	114	7.0
8	17.1	7.00	113	7.0
10	12.8	7.37	109	7.0
12	10.4	—	—	6.8
15	9.9	6.20	86	6.6
20	9.2	5.40	73	6.5
25	8.7	4.71	63	6.4
28	8.6	2.80	37	6.4

TABLE 6

Lake Noziri. July 21, 1928*

Depth (m)	Temp. (°C)	Oxygen		pH
		(cc/l)	(%)	
0	22.0	5.59	99	7.3
5	21.9	5.61	100	7.3
8	20.5	—	—	—
10	17.3	6.71	109	7.3
12	11.8	—	—	—
15	8.5	8.03	107	—
20	6.3	7.33	93	7.2
25	5.7	—	—	—
30	5.3	5.38	66	6.7
35	5.2	2.58	30	6.6

* The observations were made by K. SUGAWARA and S. YOSHIMURA.

TABLE 7

Lake Biwa (Off Minami-Omatu). September 1, 1929

Depth (m)	Temp. (°C)	Oxygen		pH
		(cc/l)	(%)	
0	28.1	5.70	105	7.3
10	26.7	5.75	104	7.2
12	24.1	—	—	7.2
15	16.6	7.35	109	7.1
20	11.8	7.46	100	7.0
30	9.1	7.67	96	7.0
40	9.0	7.43	93	6.9
48	7.5	7.60	92	6.9

TABLE 8

Lake Suigetu. July 14, 1927

Depth (m)	Temp. (°C)	Oxygen		pH.	Cl (gm/l)	H_2S (gm/l)
		(cc/l)	(%)			
0	29.2	7.26	132	7.8	0.27	0.000
2	27.0	7.44	134	7.6	0 32	—
4	23.2	4.21	74	7.6	—	—
5	20.7	3.81	64	7.4	0.63	—
6	18.8	3.33	54	7.1	—	—
8	16.0	2.11	32	6.7	0.78	—
10	14.0	1.30	19	6.6	1.07	Trace
12	14.6	0.69	10	6.6	1.46	—
14	14.6	0.31	5	6.6	1.68	0.002
15	14.3	0.00	0	6.8	1.92	0.003
16	13.4	0.00	0	6.9	2.29	0.012
18	12.4	—	—	7.0	2.88	0.022
20	12.7	—	—	7.0	3.12	0.026
25	13.0	—	—	7.0	3.36	0.044
32	13.2	—	—	7.0	3.36	0.061

TABLE 9

Lake Hiruga. September 18, 1926

Depth (m)	Temp. (°C)	Oxygen		pH	Cl (gm/l)	H_2S (gm/l)
		(cc/l)	(%)			
0	24.8	4.90	99	8.4	14.6	0.0
2	25.1	—	—	8.4	—	—
5	25.9	4.15	87	8.4	16.9	—
10	26.0	4.28	90	8.4	16.7	Trace
15	21.1	4.14	78	8.4	16.4	—
20	18.3	2.57	45	8.4	16.4	Trace
22	15.9	3.18	53	8.2	16.6	—
25	15.7	0.39	7	7.8	16.5	Trace
30	14.7	0.00	0	7.8	16.8	0.2
35	14.7	0.00	0	7.6	16.8	0.4

To collect plankton from various depths, about fifty liters of water were pumped up through a hose and strained through a silk net. It took some thirty minutes to make a series of catches. The first series of catches was made at 1 p.m. or not later than 2 p.m. in order to determine the vertical distribution of plankton in the daytime and then the following series were made at various intervals throughout that night. All the planktonts in each catch were examined and counted after they were brought back to the laboratory. In this way the change in the vertical distribution of plankton at various times in a day were studied. To determine the maximum abundance of plankton on the surface, surface catches were made at intervals of an hour or half an hour throughout a day and a night in Lake Kizaki and Lake Hiruga.

In order to find the error involved in using the pump method, twentyfive trial catches of plankton were made at the same place and from the same depth in Lake Biwa, which took about fifty minutes. All the copepods in them were counted and the results were as follows :

285, 275, 250, 270, 305, 300, 240, 265, 250, 285, 255, 245, 220, 285, 265, 325, 265, 215, 390, 260, 285, 350, 290, 245 and 225. The numbers range from 215 to 390, with 282 as the mean. The probable error computed is ±36, or ±13% of the mean.

In the following table is indicated the number of individuals in each liter of water. When only a few individuals were present in a catch, the number per fifty liters of water are given in brackets.

MAXIMUM NUMBER OF PLANKTON-CRUSTACEA ON THE SURFACE

In order to ascertain whether the plankton reaches the maximum abundance at the surface shortly before sunrise, as was observed by BLANC, FORDYCE and FUHRMANN, or in the early part of the night as has been shown by some recent investigators, or further whether some species come up to the surface twice, at dawn and at dusk, leaving the surface layer during both the day and the night, as was stated by RUTTNER, it was necessary to make the surface collection at various times of day.

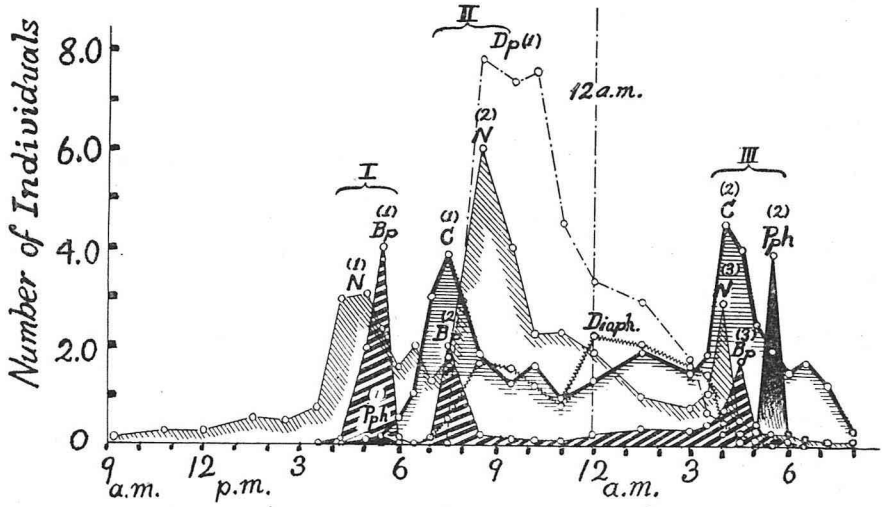

Fig. 1. The diurnal change in the number of plankton-crustacea on the surface of Lake Kizaki on August 6–7, 1929. (*N.*=Nauplius of *Diaptomus*, *Dp.*=*Diaptomus*, *C.*=*Cyclops*, *Bp.*=*Bosminopsis*, *Pph*=*Polyphemus*, *Diaph.*=*Diaphanosoma*).

Fig. 1 and Table 10 show the diurnal change in the number of individual planktonts on the surface of Lake Kizaki on August 6–7, 1929. Before examining the curves it is necessary to bear in mind the time at which the illumination changed. During the day the sun shone brightly. In the evening the light gradually faded until the sun sank beyond the mountains at 5.30 p.m. The true sunset was at 6.30 p.m. After sunset the light intensity decreased suddenly and it was dark at 8 p.m. There was no moon all through the night. At 4 a.m. the eastern sky began to glow and at 5 a.m. the sun rose. At 5.30 a.m. the sun threw its first beam upon the lake.

From these descriptions it is clear that there were three periods of change in the intensity of sunlight: (1) in the evening when the sun sank beyond the mountains, (2) at dusk and (3) at dawn. In the curves it is apparent that the upward migration of the plankton took place when the illumination changed. At the first period (1) of change in illumination, the nauplius of *Diaptomus*, *Bosminopsis* and *Polyphemus* appeared at the surface. Later there appeared in them a tendency to leave the surface. At the second period (2), there was the maximum abundance of the nauplius and the adults of *Diaptomus*, *Bosminopsis* and *Cyclops*. Then after 10 p.m. the number of the Crustacea suddenly decreased and at 3.30 a.m. i.e. shortly before dawn, the fewest were found. The maximum abundance for *Diaphanosoma* and some rotifers was attained before midnight and great numbers were obtained throughout the night. At the third period (3), *Bosminopsis*, *Polyphemus*, *Cyclops* and the nauplius of *Diaptomus* came up to the surface. The nauplius of *Diaptomus* and *Bosminopsis* had three maximal periods and *Cyclops* and *Polyphemus* too. The migrations of these species therefore belong to the category of what is called "*twilight migration*" and seem to afford good evidence that their daily vertical migrations were due largely to the change in the intensity of sunlight. *Diaptomus*, *Diaphanosoma*, *Leptodora*, *Anuraca* and *Ploesoma*, on the contrary, had only one maximal period, so that they afford examples of "*nocturnal migration*." Such variation in frequency

of appearance on the surface seems to be closely related to the depth to which planktonts descend in the daylight, since the animals distributed in the higher levels during the daytime have three maxima while those found in the deeper strata have two maxima or only one.

The facts observed in Lake Kizaki in two summers, 1925 and 1927, are in agreement with the above-mentioned data. In Lake Biwa, Lake Aoki and Lake Noziri, although there were some differences in the migration, the period when the maximum number of Crustacea was found on the surface was in each case before midnight. In Lake Suigetu, on the other hand, the maximum abundance for the Crustacea was noted before dawn.

The difference in the diurnal migration of adults, copepodids and nauplii of *Diaptomus* was studied. During the daytime small numbers of nauplius were found on the surface while both the copepodids and the adults vacated that level. In the evening the number of the nauplius gradually increased until the first period of maximum abundance was attained a few hours before sunset, while the copepodids first appeared near the surface at 7.30 p.m. and the adults at 8.30 p.m.. In the morning, the adults left the surface at 4 a.m. when the eastern sky began to glow, while a few copepodids remained there till 4.30 a.m. The nauplii were still found at 8.00 a.m. The data obtained in this lake in 1925 and 1927 as well as in Lake Biwa and Lake Aoki show that the younger the forms the nearer the surface they are distributed during the day as far as *Diaptomus* is concerned. (Tables 12, 13 and 14)

BIRGE, BURCKHARDT and JUDAY made similar observations on the different stages of *Daphnia*. On the other hand, SOUTHERN and GARDINER found that the adult *Daphnia* were distributed in the surface layer day and night, while the young descended to deeper strata during the day and came up to the surface after sunset.

Fig. 2 and Table 11 show the variation in the number of individuals of plankton in Lake Hiruga on the surface on September 19–20, 1926.

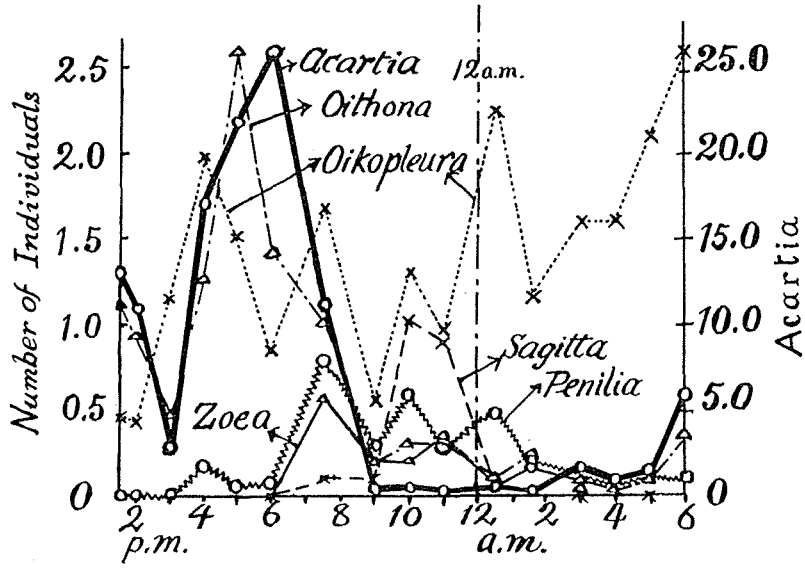

Fig. 2. The diurnal change in the number of plankton on the surface of Lake Hiruga on September 19–20, 1926.

Differing from the diurnal migration of freshwater Crustacea, marine genera, *Acartia, Oithona*, and *Evadne* were found to be abundant on the surface in the afternoon, the maximum period being shortly before sunset. After 9.00 p.m. only a small number of individuals remained there. The period of maximum abundance for the zoea of crabs, *Penilia* or *Sagitta*, was within a few hours after sunset. *Corycaeus, Euterpe, Oikopleura, Rhizosolenia* and *Chaetoceras* showed no marked diurnal migration.

DIURNAL CHANGE IN THE VERTICAL DISTRIBUTION OF VARIOUS PLANKTONTS

1) *Diaptomus pacificus* (Tables 12 and 13)

The vertical distributions of the adult, the copepodid and the nauplius were studied separately. In Lake Aoki, the adults were distributed evenly from 10 meters downwards, the copepodids from 8 meters and the nauplius from 2 meters downwards. In Lake Kizaki they were at higher levels than in Lake Aoki.

In Lake Aoki the majority came up to the surface after sunset, while in Lake Kizaki only a small group moved upwards, the majority remaining in the lower strata. The downward migration began before midnight. The adults left the surface before dawn and assumed the diurnal vertical distribution up to sunrise. The results obtained in Lake Kizaki in 1925 are in agreement with the migration above mentioned. Only a few individuals were obtained in Lake Nakatuna,

2) *Diaptomus japonicus* (Tables 14 and 15)

In Lake Biwa the young forms are found from the surface downwards during the day and the adults from 2 meters. In Lake Suigetu they rang from 2 to 5 meters below the surface during the day. In both lakes there is a marked nocturnal upward migration. The maximum abundance on the surface in Lake Suigetu is before dawn, but in Lake Biwa the maximum occurs before midnight.

3) *Pseudodiaptomus japonicus* (Table 16)

Only 22 specimens from Lake Suigetu, ranging from 8 to 12 meters. No diurnal migration.

4) *Limnocalanus sinensis* (Table 17)

Extending from 2 to 12 meters in Lake Suigetu. The majority of the adults between 8 and 12 meters, the copepodids between 8 and 10 meters and the nauplii at 5 meters. In the dark, a small number came up to the surface, but the majority between 5 and 8 meters. No indication of nocturnal upward migration of the nauplius.

7) *Acartia clausi* (Table 18)

The majority very near the surface in Lake Hiruga. A tendency to move upwards in the evening. After 7.30 p.m. suddenly decreased on the surface and only a few individuals remained there at night. No change in the number of individuals below 5 meters. In the morning, a slight tendency to the upward movement.

6) *Oithona nana* (Table 19)

In the daytime evenly distributed from the surface downwards in Lake Hiruga. Marked downward movement at night and only a few individuals remained on the surface. No upward migration in the evening.

7) *Cyclops strenuus* (Tables 20, 21 and 22)

In Lake Kizaki the adults were evenly distributed deeper than 2 meters, coming up to

the surface at night. The nauplii below 15 meters presenting no diurnal migration. The diurnal migration in the summer of 1925, however, showed that both the adult and the nauplius were distributed below 10 meters and that there was no diurnal migration. In Lake Noziri and Lake Biwa from the surface downward. An marked ascent in the evening, reaching the maximum abundance on the surface within a few hours after sunset. At night evenly distributed from the surface downwards. In Lake Aoki a small number below 12 meters during the day. A trace of nocturnal ascent, though never so far as the surface.

8) *Mesocyclops oithonoides* (Table 23)

In Lake Ina, the adults below 2 meters during the day and the younger forms and the nauplius from the surface downwards. Came up to the surface at night.

9) *Limnocalanus* sp.

A few individuals from the surface strata of Lake Suigetu, Lake Biwa, Lake Kizaki and Lake Noziri. No diurnal migration.

10) *Eurytemora acutifrons* (Table 24) and
11) *Corycaeus* sp. (Table 25)

A small number from Lake Hiruga, evenly distributed from the surface down to 15 meters. No diurnal migration.

12) *Bosminopsis deitersi* (Tables 26, 27, 28 and 29)

In Lake Kizaki the plarimum in the daytime at 2 meters. The majority went up to the surface both at dusk and dawn, and moved down to between 5 and 8 meters at night, only a few remaining on the surface. The mode of the migration in Lake Aoki and Lake Noziri quite different from that in Lake Kizaki, having a range from 5 to 8 meters during the day and coming up to the surface at night. No tendency to leave the surface at night. In Lake Nakatuna great numbers from the surface to 8 meters. A trace of upward movement at night.

13) *Polyphemus pediculus* (Tables 30 and 31)

In Lake Kizaki from 2 to 5 meters during the day. A diurnal migration quite similar to that of *Bosminopsis* in the same lake. Since no catch was made in the evening it is hard to judge the upward movement at sunset but the downward movement at night and the upward movement at dawn were obvious. In Lake Aoki from 2 to 15 meters during the day. Upward movement at night, remaining on the surface till morning. In Lake Noziri and Lake Nakatuna only a few individuals from the surface downwards.

14) *Diaphanosoma brachyurum* (Tables 32, 33, 34, 35 and 36)

In Lake Aoki and Lake Noziri, ranging from 8 to 12 meters in the daytime, and congregated on the surface at night. In Lake Kizaki and Lake Biwa from 2 meters downwards and in Lake Suigetu from the surface downwards. In all the lakes obvious upward moving at night. Only a few individuals from Lake Nakatuna.

15) *Holopedium gibberum* (Tables 37, 38 and 39)

In Lake Kizaki ranging from 2 to 8 meters in the daytime, coming up to the surface at night. In 1929, strange to say, found only in the deeper strata and never appearing near the surface. In Lake Aoki and Lake Noziri in the mesolimnion, showing a slight tendency to move upwards at night but not reaching the surface.

16) *Leptodora kindtii* (Tables 40, 41 and 42)

In the mesolimnion of Lake Kizaki, Lake Biwa and Lake Suigetu during the day and on the surface at night.

17) *Daphnia longispina* (Tables 43 and 44)

In or below the thermocline of Lake Biwa, Lake Kizaki, Lake Aoki and Lake Noziri. A slight tendency to the upward movement at night, apparently retarded above the thermocline, owing in all probability to the sudden change in temperature.

18) *Bosmina longirostris* (Tables 45, 46, 47, 48 and 49)

In all the freshwater lakes studied, but with dissimilar vertical distribution and mode of migration according to each. Namely, in Lake Biwa below 15 meters in the daytime with a slight tendency to move upwards at night, though no individual captured above 10 meters as is the case in *Daphnia*. In Lake Kizaki and Lake Aoki from 2 meters downward, most members from 8 to 10 meters in Lake Kizaki, and from 15 to 25 meters in Lake Aoki. Few individuals on the surface at night but no upward migration in the case of the majority. In Lake Noziri and Lake Ina evenly from the surface downwards, with only a slight tendency to the nocturnal upward movement.

19) *Evadne* sp. (Table 50)

Ranging from the surface to 10 meters in Hiruga Lake. Apparent moving down at night.

20) *Penilia schmackeria* (Table 51)

Ranging from 5 to 20 meters in Lake Hiruga in the daytime. Up to the surface at night, becoming evenly distributed from the surface downwards.

21) Crab zoea (Table 52)

In Lake Hiruga having a range from 2 to 5 meters in the daytime. The majority taken near the surface at night.

22) Spinoid post-larva of Annelid (Table 53)

Only a few individuals at a depth of 25 meters in Lake Hiruga during the day. Presumably living very close to the bottom in the daytime. A marked tendency to move upward after sunset, reaching 15 meters. Its downward movement seems to take place before midnight, only one individual being caught at 25 meters at 3,30 a.m..

23) *Mesostoma* sp. (Table 54)

In Lake Biwa, ranging from 5 to 8 meters during the day. At night the majority in upper 2 meters.

24) *Oikopleura* sp. (Table 55)

In Lake Hiruga, evenly distributed from 0 to 15 meters. No diurnal change in the vertical distribution.

25) *Fritillaria* sp. (Table 56)

In Lake Hiruga, ranging from 2 to 10 meters during the day. At night evenly distributed from 0 to 10 meters.

26) *Ploesoma truncatum* (Tables 57, 58 and 59)

In Lake Biwa and Lake Kizaki small numbers above a depth of 5 meters during the day. A slight tendency to nocturnal sinking. In Lake Aoki, on the other hand, abundant between 5 and 8 meters during the day showing a marked nocturnal ascent.

27) *Ploesoma hudsoni* (Tables 60, 61 and 62)

In Lake Noziri and Lake Aoki distributed from the surface downwards, but in Lake Kizaki in the middle layers. No diurnal migration in all lakes.

28) *Anuraea cochlearis* (Tables 63 and 64)

In Lake Kizaki, Lake Nakatuna, Lake Noziri and Lake Biwa, specimens with long posterior spines only. In Lake Suigetu and Lake Ina a variety, *tecta*, only.

In Lake Aoki and Lake Kizaki the majority ranged from 2 to 5 meters in the daytime and came up in great abundance to the surface at night. In Lake Suigetu the plurimum of

this species was found at 8 meters during the day and rose to from 5 to 8 meters at night. In other lakes so few that no vertical movement was detectable.

29) *Notholca longispina* (Tables 65, 66, 67 and 68)

In Lake Aoki, Lake Nakatuna, Lake Noziri and Lake Kizaki, below the thermocline. No diurnal migration.

30) *Triarthra longiseta* (Tables 69, 70 and 71)

In the hypolimnion of Lake Aoki, Lake Kizaki and Lake Noziri. No upward migration at night. In Lake Suigetu, a few specimens from the surface layer, showing a slight tendency to the nocturnal upward movement.

31)* *Diffulugia biwae*

In Lake Biwa from the surface downwards, the majority between 2 and 15 meters in the daytime. In the surface layer increased at night.

32) *Nebela kizakiensis*

Great number in the epilimnion of Lake Kizaki and Lake Aoki. Only a slight increase near the surface at night.

33) *Ceratium hirundinella*

In the upper layers of all the freshwater lakes studied. Increased at night on the surface but no change below 2 meters.

34) *Ceratium fusus*

Abundant below 20 meters in Lake Hiruga. No diurnal migration.

35) *Dinobryon cylindricum* and 36) *Melosira italica*

Abundant in the hypolimnion of Lake Biwa. No diurnal migration.

37) *Rhizosolenia* sp.

In great abundance in the epilimnion of Lake Hiruga. No diurnal migration.

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* As for Protozoa and phytoplanktonts, it is impossible to give the details in tabular form, owing to the irregularity of their vertical distribution.

THE VERTICAL DISTRIBUTION OF PLANKTON IN RELATION TO THE TRANSPARENCY OF THE WATER

POOL and ATKINS showed that illumination in sea-water at a depth where the Secchi disc is just visible, is around 16% of that in air. If the vertical distribution of plankton is due largely to the change in the light intensity at different depths, there should be a direct relation between the transparency of the water and the depth to which the plankton descends in the daytime.

The following table shows such a relation observed in *Diaphanosoma brachyurum*. It will be seen that the more transparent the water is, the deeper the animals descend in the daytime.

Lake	Aoki	Biwa	Aoki	Noziri	Biwa	Kizaki	Kizaki	Suigetu	Suigetu
Date	Aug. 1927	July 1927	Aug. 1925	July 1928	Sept. 1927	Aug. 1925	July 1927	July 1927	Sept. 1926
Tran p.	12m	12m	10m	9.5m	8m	6m	4.5m	3m	1m
0	0	0	0	0	0	0	0	0.2	8.6
2	0	0	0	0	1.2	1.0	12.6	0.6	10.9
3	—	—	—	—	—	—	—	—	12.4
5	0	0.3	0.4	0	10.8	19.0	6.9	0.9	2.1
8	4.5	—	—	0.8	9.2	—	0.7	0.4	0.1
10	15.4	1.2	16.0	0.4	7.6	0	0	0.1	0
12	16.4	—	—	0.1	1.3	—	0	0.2	0
14	—	—	—	—	—	—	—	0	0
15	0	1.1	0	0	1.2	0	0	—	—
20	0	0.4	0	0	0.4	0	0	—	—
25	0	0	0	—	0.1	0	0	—	—

The vertical distribution of the other species of such Crustacea as *Diaptomus pacificus* (Tables 12 and 13), *Diaptomus japonicus* (Tables 14 and 15), *Bosminopsis deitersi* (Tables 26, 27 and 28),

Polyphemus pediculus (Tables 30 and 31), *Holopedium gibberum* (Tables 37, 38 and 39), *Leptodora kindtii* (Tables 40, 41 and 42) also showed the same relation. A similar observation was made by Burckhardt for *Daphnia* in Vierwaldstättersee. On the other hand, Juday could not find such relation for any of the migrating Crustacea in Wisconsin lakes. My observations on *Cyclops strenuus* (Tables 20, 21 and 22) and *Bosmina longirostris* (Tables 45, 46, 47, 48 and 49) showed that their vertical distribution was indefinite in this respect.

THE VERTICAL DISTRIBUTION OF PLANKTON IN RELATION TO THE TEMPERATURE OF WATER

In Lake Aoki and Lake Kizaki the thermocline was between 5 and 12 meters below the surface, in Lake Noziri between 8 and 15 meters and in Lake Biwa between 12 and 20 meters. The difference between the temperature above and that below the thermocline exceeded 10°C.

Lake	Kizaki	Kizaki	Aoki	Aoki	Noziri	Biwa	Biwa	Kizaki
Date	Aug. 1925	July 1927	Aug. 1925	Aug. 1927	July 1928	Sept. 1927	Oct. 1926	Dec. 1925
Thermocl. (m)	5–12	5–12	5–12	5–12	8–15	12–20	12–20	None
Transp. (m)	4.5	6	10	12	9.5	8	8	4
0	0	0	0	0	0	0	0	0.1
2	0	0	0	0	0	0	0	0.3
5	0	0	0	0	0	0	0	0.5
8	—	0.9	—	0	0	0	—	—
10	10.4	1.5	1.2	0	0	0	0	0.5
12	—	1.2	—	0.8	0	0	—	—
15	7.0	0.2	1.8	3.5	0.1	0	0	0.5
20	0.1	0.3	0.8	2.6	0.1	0.1	0	0.2
25	0.1	0.3	0.5	1.4	—	0.2	0.2	0.1
30	0.1	—	0.2	—	—	—	0.8	—
	(28)							

The vertical distribution of the plankton Crustacea generally seems not to be affected by the thermocline. However, *Daphnia longispina* showed a noteworthy exception. The foregoing table shows that *Daphnia longispina* were found below the thermocline in all the lakes studied. They apparently showed a tendency to move upwards at night, but further upward movement was retarded when they reached the thermocline and not a single individual was taken in the epilimnion (Table 43 and 44). But when the water was cooled in winter, *Daphnia* were uniformly distributed from the surface downwards, as is seen in the last column of the table. Similar observations were made by Juday on *Limnocalanus macrurus* in Green Lake and on some species of *Daphnia* in certain Wisconsin lakes. Birge also states that the vertical distribution of *Daphnia pulicaria* in Lake Mendota is confined to the hypolimnion.

Certain rotifers and some phytoplanktonts, such as *Notholca* (Tables 65–67), *Triarthra* (Tables 69–70), *Dinobryon*, *Melosira* and *Ceratium fusus*, were also confined to the hypolimnion in their vertical range.

TYPE OF THE DIURNAL MIGRATION

Diurnal migration is a very complex phenomenon. It has been shown not only that there are great variations in the movements of different species but that the type of movement of a single species is not the same in all lakes. If the diurnal migrations observed in Lake Kizaki on August 12–13, and 18–19, 1925, on July 26–27, 1927 and on August 6–7, 1929 respectively are compared, it can be seen that the type of migration of a species was generally similar in all cases, with a few exceptions such that *Bosmina* and *Cyclops* showed quite a different type of migration in the subsequent years.

There seem to be various types of diurnal migration: (1) Some species actually congregate near the surface at night, leaving the deeper layers of the water, as in the cases of *Diaptomus* (Tables 12) in Lake Aoki; *Diaphanosoma* (Tables 32 and 33) in Lake Aoki and in Lake

Noziri; *Leptodora* (Tables 40 and 41) in Lake Biwa and Lake Kizaki. (2) Some forms merely move about at night up into the surface layer which the animals vacate during the day and as a result the animals are more or less uniformly distributed in both the shallower and the deeper strata, as in the cases of *Polyphemus* (Table 31), *Bosminopsis* (Table 27) and *Anuraca* (Table 63) in Lake Aoki; *Cyclops* (Table 21) and *Bosminopsis* (Table 28) in Lake Noziri; *Diaptomus* (Table 14), *Cyclops* (Table 22), *Diaphanosoma* (Table 35) and *Mesostoma* (Table 54) in Lake Biwa; *Diaptomus* (Table 13), *Diaphanosoma* (Table 34) and *Holopedium* (Table 37) in Lake Kizaki; *Diaptomus* (Table 15), *Diaphanosoma* (Table 36) and *Leptodora* (Table 42) in Lake Suigetu; *Penilia* (Table 51) and *Fritillaria* (Table 56) in Lake Hiruga; *Bosminopsis* (Table 29) in Lake Nakatuna; *Mesocyclops* (Table 23) in Lake Ina. (3) In some species the vertical distribution of the daytime is more or less modified at night, but only a few individuals ascend up to the surface as in the cases of *Cyclops* (Table 20) and *Bosmina* (Table 46) in Lake Kizaki; *Bosmina* (Table 47) in Lake Aoki; *Limnocalanus* (Table 17) and *Anuræa* (Table 64) in Lake Suigetu. (4) Some forms show a tendency to move upwards at night but not to the surface, their movements being hindered by the thermocline, as in the cases of *Daphnia* (Tables 43 and 44) in Lake Kizaki, Lake Aoki, Lake Noziri and Lake Biwa; *Pseudodiaptomus* (Table 16) in Lake Suigetu; the nauplius of *Cyclops* (Table 20) in Lake Kizaki; *Holopedium* (Table 38 and 39) in Lake Aoki and in Lake Noziri; *Bosmina* (Table 45) in Lake Biwa; *Notholca* (Tables 65, 66 and 67) in Lake Aoki, Lake Noziri and Lake Kizaki; *Triarthra* (Tables 69 and 70) in Lake Aoki and Lake Kizaki. (5) Some forms come up to the surface both at dusk and dawn and swim down to the deeper strata during the day and night as in the cases of *Bosminopsis* (Table 26) and *Polyphemus* (Table 30) in Lake Kizaki. (6) Some species are found abundantly near the surface in the afternoon, and a marked downward movement takes place at night, as in the cases of *Acartia* (Table 18), *Oithona* (Table 19) and *Evadne* (Table 50) in Lake Hiruga and *Ploc-*

soma (Tables 57 and 58) in Lake Biwa and Lake Kizaki. (7) Some species are evenly distributed from the surface downwards and show no diurnal migration at all, as in the cases of *Eutcrpe* (Table 24), *Corycaeus* (Table 25) and *Oikopleura* (Table 55) in Lake Hiruga; *Ploesoma* (Tables 60 and 61) in Lake Aoki and Lake Noziri.

It is clear from these data that *Diaptomus*, *Diaphanosoma* and *Leptodora* generally show the first type of migration when they are located in the deep layers during the day while these animals present the second type of migration when they are in the upper layers. *Polyphemus*, *Bosminopsis*, *Holopedium*, *Bosmina*, *Cyclops* and certain rotifers show the second type of migration when they are located in the upper layer, while they show either the third or the fourth type of migration (and in a few cases the second type), when they are in the deeper layers. *Polyphemus*, *Bosminopsis* and *Cyclops*, which generally show the second type of migration, may present the fifth type when distributed very near the surface during the day.

SUMMARY

1) The diurnal migrations of the plankton in eight representative lakes of middle Japan are compared.

2) There are not only great differences among the various species in the migrations between different species but also the type of the movement is not constant in the same species in all the lakes.

3) There appears to be a close relation between this type of migration and the vertical distribution of the plankton in the daytime.

4) The vertical distribution of plankton in the daytime is affected presumably by the turbidity of the water.

5) In a few cases the thermocline layer of the water seems to determine the upper limit of both the diurnal vertical distribution and the nocturnal ascent.

6) The upward movement of Crustacea takes place when the intensity of sunlight is changed. The nauplii of *Diaptomus* and *Bosminopsis* in Lake Kizaki have three maxima on the surface; first

in the evening when the sun sinks beyond the mountains, second, after sunset, and third at dawn. *Cyclops* and *Polyphemus* have two maxima, namely at dusk and at dawn. The adult forms of *Diaptomus* have only one maximum, after sunset. Great numbers of *Diaphanosoma* and *Leptodora* are obtained on the surface throughout the night.

7) In Lake Hiruga such marine genera of Crustacea as *Acartia, Oithona* and *Evadne* are abundant near the surface in the afternoon but only a few remain there at night. The maximum abundance for crab zoea, *Sagitta* and *Penilia* is found a few hours after sunset.

8) The younger forms of *Diaptomus pacificus* and *Diaptomus japonicus,* are distributed nearer the surface than the old animals in the daytime and also they appear on the surface earlier in the evening. The reverse is true in regard to the order of leaving the surface in the morning,

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APPENDIX

TABLE 10

The diurnal change in the number of individuals of various planktonts on the surface of Lake Kizaki on August 6–7, 1929

	9.10 a.m.	10.45	12.00 p.m.	1.30	2.30	3.30	4.15	5.00	5.30	6.00	6.30	7.00	7.30	8.30	9.30
Diapt.															
Naup.	0.1	0.2	0.3	0.6	0.3	0.8	2.9	3.1	2.3	1.6	2.0	1.3	1.7	6.0	4.1
Young	0	0	0	0	0	0	0	0	0	0	0	0	0.2	3.7	6.3
Female	0	0	0	0	0	0	0	0	0	0	0	0	0	2.4	0.7
Male	0	0	0	0	0	0	0	0	0	0	0	0	0	1.6	0.4
Cyclops															
Young	0	0	0	0	0	0	0	0.1	0.3	0.4	0.9	1.2	1.1	0.5	0.4
Female	0	0	0	0	0	0	0	0	0.1	0.2	0.1	1.5	2.1	0.6	0.5
Male	0	0	0	0	0	0	0	0	0	0.1	0.1	0.3	0.7	0.7	0.5
Leptodora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(1)
Diaph.	0	0	0	0	0	0	0	0	0	0	0.1	0.1	0.6	1.7	1.6
Bosminop.	0	0	0	0	0	0	0.1	1.9	4.1	0.1	0	0.1	2.0	0.2	0.2
Polyph.	0	0	0	0	0	0	0	0.1	0.5	0	0	0	0	0	0.1
Anuræa	0.2	0.8	0.2	0.2	0.1	0.3	0.7	0.5	0.3	0.3	0.8	4.6	4.1	4.9	9.3
Ploe. t.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0	0	0.1	0.1	0.1	0.2	0.2	0.3
Ploe. h.	0	(1)	(1)	0	0	(1)	0	0	(2)	(4)	(3)	(4)	(3)	(4)	(1)

10.15	11.00	12.00 a.m.	1.30	3.00	3.30	4.00	4.30	5.00	5.30	6.00	6.30	7.15	8.00
2.2	2.3	1.9	1.0	0.8	1.1	2.9	0.5	0.3	0.2	0.2	0.1	0.1	0.2
6.0	3.4	3.2	2.1	1.5	0.5	0.3	0.4	0	0	0	0	0	0
0.8	0.7	0.1	0.4	0.1	0.1	0	0	0	0	0	0	0	0
0.7	0.3	0.1	0.4	0.1	0.1	0	0	0	0	0	0	0	0
0.3	0.4	0.4	0.6	0.9	1.3	2.7	3.6	2.1	2.4	2.1	1.4	1.2	0.3
0.8	0.3	0.5	0.8	0.4	0.4	0.9	0.2	0.2	0.3	0.2	0.2	0.1	0
0.6	0.1	0.4	0.6	0.2	0.1	0.8	0.2	0.1	0.2	0.2	0	0	0
(3)	(1)	(1)	(1)	0	(4)	(6)	0	0	0	0	0	0	0
1.2	0.9	2.2	2.1	1.6	1.4	0.5	0.4	0.2	0.1	0.1	0.1	0	0
0.1	0.1	0.2	0.4	0.3	0.4	0.8	1.7	0.3	0.2	0.1	0	0	0
0.1	0	0	0	0.1	0	0.1	0	0.1	3.9	0.1	0.1	0.1	0
14.0	24.0	36.0	34.0	14.0	19.0	21.0	21.0	16.0	21.0	13.0	20.0	17.0	4.0
0.2	0.2	0.3	1.0	1.0	0.7	1.1	1.0	0.4	0.5	0.4	0.3	0.2	0.1
(3)	0	(2)	(3)	(4)	(4)	(3)	(6)	(4)	(3)	0	(2)	0	0

TABLE 11

The diurnal change in the number of individuals of various planktonts on the surface of Lake Hiruga on September 19–20, 1926

	1.30 p.m.	2.00	3.00	4.00	5.00	6.00	6.30	7.30	9.00	10.00
Crab zoea	0	0	0	0	0	0	0.3	0.6	0.2	0.2
Acartia	13.0	11.2	13.0	17.0	22.0	26.0	10.2	11.0	0.4	0.6
Oithona	1.1	1.0	0.4	1.3	1.6	1.4	0.6	1.0	0.2	0.3
Corycaeus	0.2	0.1	0.2	0.4	0.1	0.1	0.2	0.1	0	0.1
Euterpe	0	0.1	0	0.1	0.1	0.1	0.2	0.2	0	0.1
Evadne	0.1	0.3	0.4	0.1	0.1	0.2	0.1	0.2	0	0
Penilia	0	0	0	0.2	0.1	0.1	0.3	0.8	0.3	0.6
Sagitta	0	0	0	0	0	0	0	0.1	0.1	1.0
Oikopleura	0.5	0.4	1.2	2.0	1.5	0.8	1.1	1.7	0.6	1.3
Fritilaria	0	0	0	0	0	0	0	0	0	0

10.30	11.00	12.00 a.m.	12.30	1.30	3.00	3.30	4.00	5.00	5.30	6.00
0.2	0.4	0.4	0.1	0.2	0.1	0.3	0.1	0	0	0
1.8	0.2	0.9	0.7	0.3	2.0	1.3	1.0	1.5	3.2	5.5
0.7	0.3	0.2	0.1	0.3	0.1	0.2	0	0.2	0.3	0.4
0.3	0.1	0.1	0	0.1	0.1	0.1	0	0.1	0.1	0.5
0.3	0.1	0.2	0.2	0.1	0.1	0	0.1	0.1	0.1	0
0	0.1	0	0.1	0.1	0	0	0	0	0	0
0.6	0.3	0.9	0.5	0.2	0.2	0.1	0.1	0.1	0.1	0.1
0.8	0.9	0.2	0.1	0.1	0	0	0	0	0	0
1.0	1.0	2.2	2.3	1.2	1.6	1.3	1.6	2.1	1.8	2.6
0	0	0.1	0	0.1	0	0.1	0.1	0.1	0	0

TABLE 12

The vertical distribution of *Diaptomus pacificus* in Lake Aoki on August 20–21, 1927

a) Nauplius

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0	4.0	13.0	4.8	3.5
2	1.8	5.5	10.5	8.8	4.0
5	1.2	5.0	4.0	4.3	8.3
8	10.2	—	—	—	—
10	2.8	1.2	1.3	2.0	1.8
12	0.4	—	—	—	—
15	0.2	0.2	0.2	0.3	0.5
20	0.2	0.1	0.1	0.1	0.3
25	0.1	—	—	—	—

b) Young

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0	0	14.0	5.0	0
2	0	0	9.5	3.5	0
5	0	0.5	5.5	6.5	0.1
8	0.5	—	—	—	—
10	18.0	16.5	6.5	6.3	12.5
12	5.8	—	—	—	—
15	3.2	3.5	4.0	4.5	5.5
20	2.5	2.3	5.5	4.8	4.3
23	1.3	—	—	—	—

c) Female

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0	0	0.8	0.5	0
2	0	0	1.5	1.0	0
5	0	0	0.6	0.7	0
8	0	—	—	—	—
10	0.2	0.5	0.9	0.6	0.2
12	0.2	—	—	—	—
15	0.5	1.8	0.6	0.7	1.4
20	0.9	0.5	0.7	0.6	0.5
25	0.7	—	—	—	—

d) Male

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0	0	1.0	0.5	0
2	0	0	0.8	0.8	0
5	0	0	0.5	0.6	0
8	0	—	—	—	—
10	0.2	0.2	0.9	0.4	0.3
12	0.3	—	—	—	—
15	0.2	1.5	1.2	0.9	0.8
20	0.4	0.6	0.8	0.3	0.5
25	0.3	—	—	—	—

TABLE 13

The vertical distribution of *Diaptomus pacificus* in Lake Kizaki on July 26–27, 1927

a) Nauplius

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0.1	5.8	2.5	1.5	0.9	0.1
2	3.6	3.6	2.1	1.6	0.8	0.8
5	4.5	2.4	1.4	4.4	4.0	3.8
8	0.5	—	—	—	—	—
10	0.2	0.6	0.1	0.2	0.2	0.6
12–25	0	0	0	0	0	0

b) Young

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	0	1.5	2.8	0.4	0
2	0	0.1	1.7	4.0	1.3	0
5	0.2	2.3	4.0	3.2	3.0	0.1
8	10.1	—	—	—	—	—
10	6.3	8.6	8.0	10.2	4.8	8.0
12	3.8	—	—	—	—	—
15	4.6	7.3	4.0	5.9	7.4	7.6
20	7.4	6.3	7.7	7.2	8.6	8.0
25	—	—	—	—	—	—

c) Female

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	0	0.1	0.1	0	0
2	0	0	0.1	0.1	0	0
5	0	0.1	0.3	0.4	0.1	0
8	0.4	—	—	—	—	—
10	0.5	0.5	0.1	0.3	0.2	0.3
12	0.2	—	—	—	—	—
15	0.3	0.4	0.2	0.5	0.3	0.2
20	0.3	0.5	0.2	0.1	0.1	0.2
25	0.2	—	—	—	—	—

d) Male

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	0	0.2	0.1	0	0
2	0	0	0.1	0.1	0.1	0
5	0	0.1	0.2	0.4	0.3	0
8	0.3	—	—	—	—	—
10	0.3	0.7	0.4	0.6	0.9	1.3
12	0.3	—	—	—	—	—
15	0.2	0.2	0.1	0.2	0.2	0.1
20	0.1	0.1	0.1	0	0.1	0
25	0	—	—	—	—	—

TABLE 14

The vertical distribution of *Diaptomus japonicus* in Lake Biwa on September 1–2, 1927

a) Young

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0.2	10.0	8.4	2.2
2	1.1	6.0	4.2	1.0
5	3.0	4.8	8.4	2.0
8	1.8	—	—	—
10	0.8	1.0	8.0	2.4
12	0.9	—	—	—
15	1.0	1.0	3.0	3.2
20	0.8	0.3	0.8	0.6
25	0.2	—	—	—

b) Female

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0	1.2	1.4	0.7
2	0.5	1.0	1.2	1.0
5	3.3	1.8	1.2	1.5
8	1.9	—	—	—
10	0.4	0.6	1.8	1.0
12	0.2	—	—	—
15	0.3	0.2	0.4	0.7
20	0.4	0	0.2	0.1
25	0.2	—	—	—

c) Male

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0	1.2	1.0	1.0
2	0.1	0.6	0.7	0.6
5	1.3	1.4	1.0	1.0
8	2.0	—	—	—
10	0.2	0.4	0.8	0.6
12	0.1	—	—	—
15	0.1	0	0.2	1.4
20	0	0	0	0.2
25	0	—	—	—

TABLE 15

The vertical distribution of *Diaptomus japonicus* in Lake Suigetu on July 14–15, 1927

a) Young

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0	1.0	1.5	1.3	2.0	1.2	1.4
2	3.0	1.3	1.9	0.8	1.0	1.5	2.4
5	0.1	0.2	0.3	0.3	0.1	0.2	0.2
8–14	0	0	0	0	0	0	0

b) Female

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0	0	0	0.1	0.2	0.2	0.1
2	0.4	0.3	0.3	0.2	0.2	0.2	0.3
5	0.1	0.1	0.1	0	0	0.1	0.1
8	0.1	0	0	0	0	0	0
10–14	0	0	0	0	0	0	0

c) Male

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0	0	0.1	0.1	0.1	0.3	0.1
2	0.4	0.2	0.5	0.2	0.3	0.3	0.2
5	0.1	0.1	0	0	0	0	0
8–14	0	0	0	0	0	0	0

TABLE 16

The vertical distribution of *Pseudodiaptomus japonicus* in Lake Suigetu on July 14–15, 1927

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0–5	0	0	0	0	0	0	0
8	0	0	(1)	0	(2)	(2)	0
10	(2)	0	(2)	(1)	(2)	(1)	0
12	0	(2)	(1)	0	(2)	(1)	(3)
14	0	0	0	0	0	0	0

TABLE 17

The vertical distribution of *Limnocalanus sinensis* in Lake Suigetu on July 14–15, 1927

a) Nauplius

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0	0	0	0	0	0	0
2	0.1	0	0.1	0	0.1	0	0
5	0.7	0.9	0.6	0.7	0.6	3.6	3.8
8	0.2	0.1	2.5	0.2	0.8	0.3	0.4
10	0.1	0.1	0.3	0.1	0.2	0.1	0.1
12	0.1	0.1	0.2	0.1	0.1	0	0
14	0	0	0	0	0	0	0

b) Young

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0	0	0	0.1	0.2	0.1	0.1
2	0.1	0	0.1	0.1	0.1	0.1	0.1
5	0.2	0.2	0.3	0.5	0.5	0.8	0.4
8	1.0	1.0	1.9	1.4	1.4	1.4	1.8
10	0.6	0.2	0.1	0.1	0.1	0.1	0.1
12	0.2	0.1	0.1	0.1	0.2	0.1	0.1
14	0	0	0	0	0	0	0

c) Female

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0	0	0	0.3	0.2	0.9	0.1
2	0.1	0.4	0.1	0.3	0.3	0.6	0.3
5	0.5	0.3	0.3	1.3	2.4	2.4	0.9
8	1.7	1.9	2.7	1.2	1.3	1.8	2.7
10	1.4	1.7	0.8	0.4	0.6	0.7	0.6
12	1.0	0.1	0.4	0.7	0.2	0.7	0.4
14	0.1	0	0	0	0	0	0

d) Male

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0	0	0	0.1	0.1	0.5	0.1
2	0.1	0.3	0.1	0.1	0.1	0.3	0.3
5	0.5	0.3	0.4	2.3	3.8	2.7	1.5
8	2.0	3.9	2.5	1.0	1.2	1.4	1.6
10	0.9	0.5	0.3	0.1	0.3	0.3	0.4
12	0.8	0.6	0.2	0.2	0.1	0.2	0.2
14	0	0	0	0	0	0	0

TABLE 18

The vertical distribution of *Acartia clausi* in Lake Hiruga on September 19–20, 1926

Depth (m)	2.00 p.m.	6.30	10.30	12.00 m.	3.30
0	11.2	10.2	1.8	0.9	1.3
2	4.5	9.9	5.2	9.0	5.4
5	0.1	1.0	1.2	1.3	0.5
10	0.1	0.4	0.2	0.2	0.3
15	0.2	0.3	0.1	0.3	0.3
20	0	0.1	0.1	0	0
25	0	0	0	0	0

TABLE 19

The vertical distribution of *Oithona nana* in Lake Hiruga on September 19–20, 1626

Depth (m)	2.00 p.m.	6.30	10.30	12.00 m.	3.30
0	1.0	0.6	0.7	0.2	0.2
2	1.2	0.4	0.7	0.9	0.7
5	0.9	1.2	1.0	1.3	0.9
10	1.5	2.0	1.6	1.6	1.0
15	0.8	2.0	1.4	3.3	1.3
20	0.7	2.9	5.0	3.4	3.2
25	0.5	4.5	1.6	2.6	4.8

TABLE 20

The vertical distribution of *Cyclops strenuus* in Lake Kizaki on July 26–27, 1927

a) Nauplius

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3 30	5.00
0–8	0	0	0	0	0	0
10	0.1	0.1	0.1	0.3	0.2	0.2
12	0.8	—	—	—	—	—
15	19.4	14.2	14.8	21.0	15.2	16.8
20	34.0	29.8	26.2	36.4	30.8	32.0
25	27.4	—	—	—	—	—

b) Female

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	0.1	0.1	0.2	0.3	0.2
2	0.5	0.1	0.1	0.1	0.3	0.3
5	0.5	1.6	0.5	0.1	0.2	0.1
8	0.9	—	—	—	—	—
10	0.5	2.7	1.7	2.3	2.3	2.7
12	0.7	—	—	—	—	—
15	0.6	0.7	0.8	1.3	1.0	0.8
20	0.6	0.7	0.7	0.7	0.8	1.2
25	0.4	—	—	—	—	—

c) Male

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	0	0	0.2	0.1	0
2	0.1	0.1	0	0.1	0.1	0
5	0.2	0.5	0.4	0.1	0.2	0.1
8	0.2	—	—	—	—	—
10	0.2	0.8	0.6	0.7	0.6	0.5
12	0.5	—	—	—	—	—
15	0.3	0.3	0.6	0.4	0.7	0.5
20	0.4	0.3	0.3	0.3	0.6	0.7
25	0.2	—	—	—	—	—

TABLE 21

The vertical distribution of *Cyclops strenuus* in Lake Noziri on July 23–24, 1928

a) Young

Depth (m)	4.30 p.m.	7.00	10.00	12.40 a.m.	3.00	4.30	7.00
0	5.8	9.0	2.0	2.0	2.2	2.0	1.0
2	2.2	10.0	3.6	3.8	3.0	4.4	1.6
5	6.8	3.2	3.2	5.2	4.6	5.0	3.6
8	1.0	—	—	—	—	—	3.2
10	1.2	0.1	0.4	2.4	1.6	2.0	1.8
12	0.8	—	—	—	—	—	0.7
15	0.3	0.1	0	1.0	0.3	0.4	0.4
18	0.5	0.1	0	0	0.1	0.1	0

b) Female

Depth (m)	4.30 p.m.	7.00	10.10	12.40 a.m.	3.00	4.30	7.00
0	1.9	22.8	6.0	1.2	1.2	0.6	0.1
2	1.0	9.2	4.4	1.6	1.0	0.8	0.1
5	4.2	4.4	2.4	3.8	1.6	2.2	1.0
8	9.3	—	—	—	—	—	3.2
10	8.3	0.6	2.4	4.8	4.4	1.8	4.0
12	10.0	—	—	—	—	—	5.6
15	3.6	1.4	1.2	4.8	2.4	3.6	5.6
18	4.5	0.2	0.1	0.3	0.6	1.2	0.8

c) Male

Depth (m)	4.30 p.m.	7.00	10.10	12.40 a.m.	3.00	4.30	7.00
0	1.6	17.4	1.6	1.2	1.0	0.4	0.1
2	1.8	8.4	3.8	2.2	1.8	0.4	0.2
5	3.9	1.2	1.4	4.0	2.0	2.4	1.2
8	7.2	—	—	—	—	—	7.4
10	1.6	0.1	0.1	0.6	0.5	0.1	3.2
12	2.5	—	—	—	—	—	0.8
15	0.1	0.1	0.1	0.2	0	0	0
18	0.1	0	0	0	0	0	0

TABLE 22

The vertical distribution of *Cyclops strenuus* in Lake Biwa on September 1, 1927

a) Young

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0.1	0.6	0.6	1.0
2	0.4	1.2	1.0	2.0
5	2.1	4.4	2.0	4.0
8	1.6	—	—	—
10	1.7	3.6	2.0	4.6
12	2.1	—	—	—
15	2.6	4.4	1.8	2.8
20	4.4	3.6	0.6	2.0
25	6.2	—	—	—

b) Female

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0.1	1.8	0 8	0.7
2	0.2	0.6	0.5	0.8
5	0.8	0.8	1.2	0.9
8	0.9	—	—	—
10	1.1	1.2	2.0	1.5
12	0.8	—	—	—
15	0.6	1.0	1.2	1.0
20	0.8	0.6	2.2	1.0
25	0.4	—	—	—

c) Male

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0	1.8	0.9	0.1
2	0.1	0.6	0.1	0.5
5	1.2	2.4	0.6	0.8
8	0.9	—	—	—
10	0.5	0.8	0.6	0.6
12	0.1	—	—	—
15	0.1	0.1	0.3	0.3
20	0.2	0	0.1	0.2
25	0.1	—	—	—

TABLE 23

The vertical distribution of *Mesocyclops oithonoides* in Lake Ina on August 23, 1927

a) At 1.00 p.m.

Depth	0	2	3	5	6	7
Nauplius	6.0	22.8	34.0	62.0	25.2	4.0
Young	1.2	48.0	54.0	28.8	8.2	6.4
Female	0	11.2	5.4	4.8	7.7	17.2
Male	0	7.2	5.0	1.4	0.6	0

b) At 10.30 p.m.

Depth	0	2	3	5	6	7
Nauplius	14.0	30.8	36.0	42.0	—	4.8
Young	9.2	44.8	60.0	32.0	—	2.2
Female	5.0	6.0	3.8	11.2	—	8.8
Male	2.4	4.4	8.0	2.0	—	0

TABLE 24

The vertical distribution of *Euterpe acutifrons* in Lake Hiruga on September 19–20, 1926

Depth (m)	2.00 p.m.	6.30	10.30	12.00 a.m.	3.30
0	0.1	0.2	0.1	0.2	0.1
2	0.6	0.3	0.3	0.8	0.6
5	0.4	0.9	0.3	0.5	0.2
10	0.3	0.2	0.1	0.1	0.1
15	0.1	0.1	0.2	0.1	0
20–25	0	0	0	0	0

TABLE 25

The vertical distribution of *Corycaeus* sp. in Lake Hiruga on September 19–20, 1926

Depth (m)	2.00 p.m.	6.30	10.30	12.00 a.m.	3.30
0	0.2	0.2	0.3	0.1	0.1
2	0.1	0.2	0.1	0.2	0.2
5	0.1	0.3	0.2	0.4	0.2
10	0.1	0.1	0.1	0.2	0.1
15	0.1	0	0	0.2	0.1
20–25	0	0	0	0	0

TABLE 26

The vertical distribution of *Bosminopsis deitersi* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0.1	1.5	0.1	0.2	0.4	0.7
2	5.6	1.8	0.1	0.3	1.0	5.5
5	0.3	0.5	1.2	2.1	0.5	0.4
8	0	—	—	—	—	—
10	0	0.6	0.9	0.7	2.0	1.0
12–25	0	0	0	0	0	0

TABLE 27

The vertical distribution of *Bosminopsis deitersi* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0	1.6	0.9	1.6	1.3
2	0	1.8	1.0	1.4	2.0
5	1.0	0.7	1.0	0.8	0.7
8	2.9	—	—	—	—
10	0.2	0	0	0	0
12–25	0	0	0	0	0

TABLE 28

The vertical distribution of *Bosminopsis deitersi* in Lake Noziri on July 23–24, 1928

Depth (m)	4.30 p.m.	7.00	10.10	12.40 a.m.	3.00	4.30	7.00
0	0.2	2.2	4.4	6.6	6.8	1.4	0
2	0.2	5.0	5.0	7.2	5.0	5.2	0.9
5	4.9	6.4	3.2	5.0	4.6	5.8	3.2
8	3.1	—	—	—	—	—	2.8
10	0	0	0.1	0.1	0	0.1	0
12–18	0	0	0	0	0	0	0

TABLE 29

The vertical distribution of *Bosminopsis deitersi* in Lake Nakatuna on August 16, 1925

Depth (m)	0	2	5	8	10	12
3.00 p.m.	60.0	200.0	180.0	48.0	4.0	0.2
9.00 p.m.	120.0	150.0	160.0	62.0	18.0	0.1

TABLE 30

The vertical distribution of *Polyphemus pediculus* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	0	0	0.1	0.1	1.1
2	0.4	0.1	0.1	0.1	0.1	0.4
5	0.5	1.6	0.8	0.4	0.1	0.7
8	0.1	—	—	—	—	—
10	0.1	0.5	0.5	0.8	0.5	0.2
12	0	—	—	—	—	—
15	0	0	0	0.2	0.2	0.1
20	0	0	0	0	0.3	0
25	0	—	—	—	—	—

TABLE 31

The vertical distribution of *Polyphemus pediculus* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0	0.1	1.2	1.2	1.2
2	0.4	0.2	0.8	1.3	0.8
5	0.9	1.3	1.1	1.5	0.8
8	2.0	—	—	—	—
10	0.9	1.4	0.4	0.9	0.9
12	0.2	—	—	—	—
15	0.1	0.4	0	0	0
20–25	0	0	0	0	0

TABLE 32

The vertical distribution of *Diaphanosoma brachyurum* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0	6.0	18.0	7.8	0
2	0	5.5	19.0	8.3	0
5	0	20.5	17.5	22.3	0.2
8	4.5	—	—	—	—
10	15.4	12.5	0.6	6.5	10.5
12	16.4	—	—	—	—
15–25	0	0	0	0	0

TABLE 33

The vertical distribution of *Diaphanosoma brachyurum* in Lake Noziri on July 23–24, 1928

Depth (m)	4.30 p.m.	7.00	10.10	12.40 a.m.	3.00	4.30	7.00
0	0	0.8	0.6	0.4	0.2	0	0
2	0	0.1	0.6	0.4	0.1	0.1	0
5	0	0.6	0.5	0.6	0.2	0.1	0.1
8	0.8	—	—	—	—	—	0.2
10	0.4	0	0	0.1	0	0.1	0.1
12	0.1	—	—	—	—	—	0.2
15–18	0	0	0	0	0	0	0

TABLE 34

The vertical distribution of *Diaphanosoma brachyurum* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	19.4	22.9	19.0	11.8	0.5
2	12.6	28.0	23.0	20.0	21.6	13.0
5	6.9	8.0	9.2	8.6	10.4	18.0
8	0.7	—	—	—	—	—
10	0	0.1	0.7	0.2	0.6	0.6
12–25	0	0	0	0	0	0

TABLE 35

The vertical distribution of *Diaphanosoma brachyurum* in Lake Biwa on September 1–2, 1927

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0	1.6	1.4	5.6
2	1.2	10.3	8.8	7.8
5	10.8	11.2	12.8	10.6
8	9.2	—	—	—
10	7.6	5.2	5.6	6.0
12	1.3	—	—	—
15	1.2	2.4	1.8	5.6
20	0.4	0.6	0.2	0.5
25	0.1	—	—	—

TABLE 36

The vertical distribution of *Diaphanosoma brachyurum* in Lake Suigetu on July 14–15, 1927

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0.2	0.3	0.5	1.8	1.0	1.0	0.3
2	0.6	0.7	0.7	1.2	1.6	2.2	0.8
5	0.9	0.8	0.8	0.6	0.8	1.0	0.8
8	0.4	0.5	0.8	0.4	0.7	0.7	0.7
10	0.1	0.3	0.5	0.6	0.7	0.9	0.4
12	0.2	0	0.1	0.1	0.2	0.1	0
14	0	0	0	0	0	0	0

TABLE 37

The vertical distribution of *Holopedium gibberum* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	1.2	0.3	0.5	0.1	0.1
2	3.7	1.0	0.6	0.7	0.4	1.2
5	0.8	0.8	1.7	6.8	10.0	5.1
8	3.1	—	—	—	—	—
10	0.1	0.6	0.4	0.1	0.1	0.4
12–25	0	0	0	0	0	0

TABLE 38

The vertical distribution of *Holopedium gibberum* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0–2	0	0	0	0	0
5	0	0	0.5	0.5	0.3
8	1.9	—	—	—	—
10	1.4	1.4	1.5	2.7	1.9
12	0.4	—	—	—	—
15–25	0	0	0	0	0

TABLE 39

The vertical distribution of *Holopedium gibberum* in Lake Noziri on July 23–24, 1928

Depth (m)	4.30 p.m.	7.00	10.10	12.40 a.m.	3.00	4.30	7.00
0–8	0	0	0	0	0	0	0
10	(2)	(1)	(2)	(5)	(6)	(2)	(4)
12	(10)	—	—	—	—	—	(20)
15	(3)	(2)	(1)	(4)	(1)	(1)	(3)
18	(1)	(1)	0	(1)	0	0	0

TABLE 40

The vertical distribution of *Leptodora kindtii* in Lake Biwa on September 1–2, 1927

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0	(4)	(4)	(2)
2	0	(3)	(5)	(2)
5	0	(10)	(8)	(6)
8	0	—	—	—
10	(1)	(5)	(7)	(2)
12	(10)	—	—	—
15	(3)	(1)	(1)	(1)
20	0	0	0	0

TABLE 41

The vertical distribution of *Leptodora kindtii* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	(2)	(2)	0	(6)	0
2	0	0	(1)	(2)	(4)	(4)
5	0	0	0	(10)	0	0
8	(3)	0	0	0	0	0
10	(3)	0	0	0	0	0
12–25	0	0	0	0	0	0

TABLE 42

The vertical distribution of *Leptodora kindtii* in Lake Suigetu on July 14–15, 1927

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0	0	0	0.2	0.2	0.2	0
2	0	0	0	0.1	0.1	0.2	0.1
5	0.1	0	0.1	0.2	0.2	0.1	0.1
8	0.1	0.1	0.1	0.1	0.1	0.1	0.1
10	0	0.1	0	0.1	0.1	0	0
12	0.1	0	0	0	0	0	0
14	0	0	0	0	0	0	0

TABLE 43

The vertical distribution of *Daphnia longispina* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0–2	0	0	0	0	0	0
5	0	0	0	0	0.1	0
8	0.9	—	—	—	—	—
10	1.5	3.4	1.9	2.9	2.1	1.5
12	1.2	—	—	—	—	—
15	0.2	0.2	0.1	0.2	0.8	1.2
20	0.3	0.2	0.2	0.2	0.2	0.5
25	0.3	—	—	—	—	—

TABLE 44

The vertical distribution of *Daphnia longispina* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0–5	0	0	0	0	0
8	0	—	—	—	—
10	0	0.2	6.5	4.2	0.8
12	0.8	—	—	—	—
15	3.5	5.5	4.5	6.0	9.0
20	2.6	2.3	4.0	3.8	6.8
25	1.4	—	—	—	—

TABLE 45

The vertical distribution of *Bosmina longirostris* in Lake Biwa on September 1–2, 1927

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0–5	0	0	0	0
8	0	—	—	—
10	0	0.6	0.1	0.1
12	0	—	—	—
15	0.9	1.2	0.7	0.2
20	0.3	0.3	0.6	0.4
25	0.1	—	—	—

TABLE 46

The vertical distribution of *Bosmina longirostris* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0	0	0.1	0.1	0.2	0
2	0.1	0.2	0.4	0.1	0.1	0.1
5	0.1	0.7	0.3	0.1	0.2	0.3
8	7.2	—	—	—	—	—
10	3.1	12.0	8.8	9.6	11.2	11.6
12	0.6	—	—	—	—	—
15	0.2	0.4	0.3	0.6	2.0	2.8
20	1.1	0.3	0.8	0.6	1.0	0.8
25	1.1	—	—	—	—	—

TABLE 47

The vertical distribution of *Bosmina longirostris* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0	0	0.1	0.1	0.2
2	0.1	0.4	0.1	0.1	0.1
5	0.1	0.5	0.1	0.4	0.5
8	1.5	—	—	—	—
10	0.7	2.6	2.0	3.5	2.5
12	0.5	—	—	—	—
15	6.4	10.0	12.0	13.2	15.0
20	10.0	5.0	12.5	11.0	13.8
25	5.4	—	—	—	—

TABLE 48

The vertical distribution of *Bosmina longirostris* in Lake Noziri on July 23–24, 1928

Depth (m)	4.30 p.m.	7.00	10.10	12.40 a.m.	3.00	4.30	7.00
0	3.0	5.6	5.2	6.0	5.6	2.6	3.2
2	3.8	4.6	4.4	3.4	4.4	2.4	4.4
5	3.8	4.0	4.8	3.8	2.8	5.0	7.6
8	5.4	—	—	—	—	—	10.8
10	4.8	2.8	7.2	2.8	8.4	4.4	5.0
12	5.0	—	—	—	—	—	5.6
15	6.8	4.0	5.2	7.0	8.8	10.4	6.4
18	7.5	2.6	4.0	5.4	8.8	8.0	5.8

TABLE 49

The vertical distribution of *Bosmina longirostris* in Lake Ina on August 23, 1927

Depth (m)	0	2	3	5	6	7
1.00 p.m.	0.9	4.8	2.4	1.7	3.2	0.5
10.00 p.m.	1.8	3.2	4.6	3.6	—	0.8

TABLE 50

The vertical distribution of *Evadne* sp. in Lake Hiruga on September 19–20, 1926

Depth (m)	2.00 p.m.	6.30	10.30	12.00 a.m.	3.30
0	(14)	(6)	(1)	0	0
2	(4)	(4)	(1)	(4)	(2)
5	(3)	(2)	(9)	(5)	(16)
10	(1)	(1)	(4)	(2)	(21)
15	0	0	(1)	(4)	(5)
20–25	0	0	0	0	0

TABLE 51

The vertical distribution of *Penilia schmackeria* in Lake Hiruga on September 19–20, 1926

Depth (m)	2.00 p.m.	6.30	10.30	12.00 a.m.	3.30
0	0	0.7	0.6	0.9	0.1
2	0	0.3	0.3	0.7	0.1
5	0.5	0.7	0.3	0.5	0.2
10	0.4	0.6	0.4	0.4	0.3
15	0.9	0.9	0.7	1.3	0.9
20	0.9	1.4	2.2	0.5	1.3
25	0	0	0	0	0.3

TABLE 52

The vertical distribution of Crab zoea in Lake Hiruga on September 19–20, 1926

Depth (m)	2.00 p.m.	6.30	10.30	12.00 a.m.	3.30
0	0	(14)	(3)	(20)	(15)
2	(8)	(2)	(1)	(5)	(2)
5	(7)	(4)	(3)	(1)	(1)
10	0	0	0	(1)	0
15–25	0	0	0	0	0

TABLE 53

The vertical distribution of Spinoid post-larvae of Annelid in Lake Hiruga on September 19–20, 1926

Depth (m)	2.00 p.m.	6.30	10.30	12.00 a.m.	3.30
0–10	0	0	0	0	0
15	0	0.2	0	0.2	0
20	0	6.5	0.1	0.2	0
25	0.3	5.5	22.0	2.2	(1)

TABLE 54

The vertical distribution of *Mesostoma* sp. in Lake Biwa on September 1–2, 1927

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0	(6)	(8)	(25)
2	0	(4)	(20)	(35)
5	(15)	(4)	(14)	(7)
8	(3)	—	—	—
10	0	(1)	(5)	(2)
12	0	—	—	—
15	0	0	0	(4)
20–25	0	0	0	0

TABLE 55

The vertical distribution of *Oikopleura* sp. in Lake Hiruga on September 19–20, 1926

Depth (m)	2.00 p.m.	6.30	10.30	12.00 a.m.	3.30
0	0.4	1.5	1.0	2.2	1.3
2	1.5	1.5	1.8	3.1	2.4
5	1.7	0.6	0.9	1.5	0.8
10	0.9	0.2	0.3	0.6	0.3
15	0.4	0.2	0.1	0.2	0.5
20–25	0	0	0	0	0

TABLE 56

The vertical distribution of *Fritillaria* sp. in Lake Hiruga on September 19–20, 1926

Depth (m)	2.00 p.m.	6.30	10.30	12.00 a.m.	3.30
0	0	0	(1)	(5)	(2)
2	(1)	(2)	(1)	(1)	(3)
5	(10)	(12)	(10)	(2)	(2)
10	(8)	(4)	(3)	(4)	(4)
15–25	0	0	0	0	0

TABLE 57

The vertical distribution of *Ploesoma truncatum* in Lake Biwa on September 1, 1926

Depth (m)	2.00 p.m.	6.30	10.10	2.30 a.m.
0	0.6	0.1	0.2	0.1
2	0.2	0.2	0.2	0.2
5	0.1	0.2	0.1	0.2
8	0	—	—	—
10	0	0	0.1	0.2
12–25	0	0	0	0

TABLE 58

The vertical distribution of *Ploesoma truncatum* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0	0.3	0.2	0.1	0.1	0.1	0.1
2	0.9	0.1	0.2	0.1	0.3	0.2
5	0.9	1.1	1.2	0.7	0.4	0.7
8–25	0	0	0	0	0	0

TABLE 59

The vertical distribution of *Ploesoma truncatum* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	1.0	4.5	7.5	8.5	4.3
2	0.7	3.5	6.5	5.0	3.9
5	6.3	2.8	2.8	1.8	10.3
8	8.7	—	—	—	—
10	0.9	0.4	1.0	1.1	0.7
12	0.1	—	—	—	—
15	0.1	0.1	0.2	0.2	0.2
20	0	0	0.1	0.2	0.1
25	0	—	—	—	—

TABLE 60

The vertical distribution of *Ploesoma hudsoni* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0.1	0.6	0.1	0.2	0.3
2	0.2	0.2	0.3	0.3	0.1
5	0.1	0.2	0.2	0.2	0.2
8	0.2	—	—	—	—
10	0.6	0.8	0.8	0.7	0.9
12	0.4	—	—	—	—
15	0.1	0.3	0.1	0.2	0.3
20	0.1	0	0	0	0
25	0	—	—	—	—

TABLE 61

The vertical distribution of *Ploesoma hudsoni* in Lake Noziri on July 23–24, 1928

Depth (m)	4.30 p.m.	7.00	10.10	12.40 a.m.	3.00	4.30	7.00
0	0.1	0	0.1	0.2	0.1	0.2	0
2	0.1	0.2	0.1	0.2	0.1	0.2	0
5	0.2	0.2	0.2	0.2	0.1	0.1	0.2
8	0.4	—	—	—	—	—	0.2
10	0.4	0.2	0.2	0.4	0.2	0.1	0.3
12	0.5	—	—	—	—	—	0.2
15	1.2	0.8	0.6	0.9	2.0	0.6	0.8
18	1.3	1.0	1.4	1.2	1.2	1.2	1.1

TABLE 62

The vertical distribution of *Ploesoma hudsoni* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0–2	0	0	0	0	0	0
5	0.2	0.1	0.3	0.1	0.1	0.1
8	0.1	—	—	—	—	—
10	0.1	0.1	0.2	0.1	0 1	0.1
12	0.1	—	—	—	—	—
15	0	0.1	0	0	0	0.1
20–25	0	0	0	0	0	0

TABLE 63

The vertical distribution of *Anuræa cochlearis* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0	0.2	34.0	12.5	39.0	28.0
2	12.4	12.0	18.0	16.0	16.3
5	12.7	10.0	27.5	10.8	7.5
8	2.0	—	—	—	—
10	1.2	1.5	2.8	2.7	2.6
12	0.3	—	—	—	—
15	0.2	0.1	1.0	0.3	0.4
20–25	0	0	0	0	0

TABLE 64

The vertical distribution of *Anuræa cochlearis* in Lake Suigetu on July 14–15, 1927

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0.1	0.1	0	0.2	0.1	0.1	0
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5	0.7	1.9	9.6	4.9	14.2	10.0	13.6
8	10.8	12.0	11.8	8.4	14.2	10.1	11.0
10	5.6	4.6	4.0	6.4	6.0	5.4	5.3
12	2.3	2.8	2.4	4.2	3.9	3.1	5.8
14	0	0	0.1	0	0.1	0	0.1

TABLE 65

The vertical distribution of *Notholca longispina* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0–8	0	0	0	0	0
10	0.6	0.4	0.8	0.7	0.8
12	0.3	—	—	—	—
15	10.4	16.5	16.8	14.0	13.5
20	5.2	4.5	11.5	7.8	10.8
25	1.9	0	0	0	0

TABLE 66

The vertical distribution of *Notholca longispina* in Lake Noziri on July 23–24, 1928

Depth (m)	4.30 p.m.	7.00	10.10	12.40 a.m.	3.00	4.30	7.00
0–2	0	0	0	0	0	0	0
5	0.1	0	0	0.1	0.1	0	0.1
8	0.5	—	—	—	—	—	0.3
10	1.8	1.2	0.6	0.8	0.5	1.5	0.9
12	2.5	—	—	—	—	—	3.2
15	11.5	12.0	10.2	9.2	5.2	8.7	11.9
18	16.0	20.2	12.0	18.0	21.6	17.5	15.4

TABLE 67

The vertical distribution of *Notholca longispina* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0–5	0	0	0	0	0	0
8	0.5	—	—	—	—	—
10	4.4	4.9	4.5	5.0	6.4	10.4
12	1.6	—	—	—	—	—
15	0.4	0.7	0.7	0.8	2.1	2.8
20	0.7	0.3	0.6	0.6	0.8	0.8
25	1.0	—	—	—	—	—

TABLE 68

The vertical distribution of *Notholca longispina* in Lake Nakatuna on August 16, 1925

Depth (m)	0	2	5	8	10	12
1.00 p.m.	0.2	0.6	16.0	100.0	13.0	0.4
9.00 p.m.	0.3	1.5	9.0	64.0	28.0	0.2

TABLE 69

The vertical distribution of *Triarthra longiseta* in Lake Aoki on August 20–21, 1927

Depth (m)	2.00 p.m.	7.30	10.10	2.00 a.m.	5.30
0–12	0	0	0	0	0
15	0.6	0.7	1.8	0.7	0.4
20	2.2	2.3	4.0	7.3	7.4
25	6.4	—	—	—	—

TABLE 70

The vertical distribution of *Triarthra longiseta* in Lake Kizaki on July 26–27, 1927

Depth (m)	2.00 p.m.	7.00	9.45	12.30 a.m.	3.30	5.00
0–8	0	0	0	0	0	0
10	4.5	0.1	0.1	1.0	2.1	5.2
12	2.0	—	—	—	—	—
15	0.1	0.1	0.2	0.2	0.6	0.4
20	0.1	0.1	0	0.1	0.1	0.2
25	0.1	—	—	—	—	—

TABLE 71

The vertical distribution of *Triarthra longiseta* in Lake Suigetu on July 14–15, 1927

Depth (m)	2.00 p.m.	4.30	7.00	9.30	11.30	2.30 a.m.	5.30
0	0	0	0	0.1	0.1	0.3	0.3
2	0.1	0.1	0.1	0.1	0.1	0.3	0.4
5	0.3	0.2	0.1	0.1	0.2	0.1	0.2
8	0.2	0.1	0.1	0.1	0.1	0.1	0.2
10	0	0.1	0.1	0.1	0.1	0	0
12	0	0	0.3	0.2	0	0	0
14	0	0	0	0	0	0	0