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Basic features of the distribution of zooplankton in the Karelian lakes

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Basic features of the distribution of zooplankton in the Karelian lakes

By L.I. Gordeeva-Pertseva, L.N. Gordeeva

Data on zooplankton in 360 lakes made up the material for this report. 140*
Lake Onega and Ladoga were not included among the lakes studied because of their exceptional environmental conditions and size. The Karelian lakes divide into northern and southern lakes according to species composition and quantitative development of forms of zooplankton. This division, as earlier observed by V.V. Urban /1962/, is determined by natural and historical conditions. The boundary between the northern and southern parts of Karelia is taken along the line of the White Sea-Baltic Sea watershed (except for the lakes in the Lendery and Reboly area, which were assigned to the northern part).

For convenience of survey, the following conventional division of lakes according to area was adopted /Smirnov, 1954/, km^2:

a) large lakes with area from 50 to 1000;

b) average lakes with area from 10 to 50;

* Numbers in the right-hand margin indicate the corresponding page numbers in the original.

c) small lakes with area from 0.1 - 10;

d) "lamba"[1] lakes with area less than 0.1.

From data taken from 37 lakes, S.V. Gerd /1946/ deduced 73 species (119 forms) of cladocerans and 39 species (45 forms) of copepods (including harpacticoids) for Karelia. Z.I. Filimonova /1963/, on the basis of analysis of 110 lakes, cites 119 species (157 forms) of lower crustaceans (112 forms of cladocerans and 43 forms of copepods).

One hundred and eight lakes were studied in the north of Karelia. According to I.V. Baranov's classification /1961/, large lakes can be classified as oligotrophic (Pyaozero, Topozero, Segozero) or polyhumic ultraoligotrophic (Kuito).

The zooplankton of large lakes of northern Karelia is marked by considerable homogeneity of composition and consists basically of Bosmina obtusirostris obtusirostris, B. obtusirostris lacustris, B. longispina, Holopedium gibberum, Daphnia cristata, Mesocyclops oithonoides, Cyclops strenuus, Eudiaptomus gracilis, E. graciloides, Eurytemora lacustris, Heterocope appendiculata, and Limnocalanus macrurus.

The latter is found in all of the large lakes of the northern part of Karelia which were studied.

The biomass of zooplankton of large lakes in Northern Karelia fluctuates from 0.06 to 0.1 g/m^3 with an abundance of 1.2-11.7 thous. spec/m^3 excluding Kuito Lake, where the biomass was 0.3-0.7 g/m^3 /Filimonova, 1963/.

The surface layer of water from 0-2 to 0-5 m is the most rich. Thus, in the two-meter layer of water in Topozero Lake is concentrated 45% of the total abundance of zooplankton and no less than 35% of the biomass of entomostracans. In Segozero, with an average abundance of zooplankton of

[1] A "lamba" is a lake without an outlet, especially in a forest. - transl.

1.2 thous. spec/m^3, the number of entomostracans in the upper 0-2 m layer of water was 3.2 thous. spec./m^3. Z.I. Filimonova for Kuito Lake and V.V. Urban for Ondozero Lake cited similar data on the distribution of zooplankton in the water column. Underlying layers of water in large lakes are as a rule poor in zooplankton and only in separate areas is an increase in plankton in bottom layers observed (Segozero, Pyaozero). A number of authors point to concentration of zooplankton in surface water layers for lakes in different areas of the Soviet Union (Rylov, 1941; Greze, 1948; Eggert, 1961; Kumsare and Laganovskaya, 1959; Zabolotskii, 1961 and others).

The concentration of organisms in the surface layer is due basically to the effect of driving winds and features of the biology and ecology of different species of zooplankton.

The distribution of zooplankton over the area of the lake is also irregular in large northern lakes. Shallow isolated bays, littoral areas overgrown with macrophyte beds, and also the areas around the mouths of rivers where accumulation of biogenic substances imported in tributaries takes place, are more rich.

The development of zooplankton in areas around the mouths of rivers depends on the amount and nature of run-off. Thus, in Pyaozero in the area of the mouth of the Sof'yangi River, the abundance of zooplankton reached a record figure for the lake of 50 thous. spec/m^3 as against an average abundance for the lake of 3.3 thous. spec/m^3. The same was observed by V.V. Urban /1962/ in Elmozero and Ondozero lakes and by L.N. Gordeeva /1963/ in arctic Norilsk lakes.

The development of beds of aquatic vegetation in large lakes is basically confined to shallow well heated areas of bays and inlets. Beds

Table 1

Quantitative development of zooplankton of large lakes in northern Karelia.

1 Озера	2 Зоопланктон: 3 численность, тыс. экз/м³	2 Зоопланктон: 4 биомасса, г/м³	5 Автор
6 Пяозеро	3,3	0,11	Гордеев, Гордеева, 1959 16
7 Топозеро	3,5	0,06	Александров, Новиков, 1959 17
8 Энгозеро	3,7	—	Потапова, 1959 18
9 Тикшозеро	2,4	—	Потапова, 1959 18
10 Сегозеро	1,2	—	Гордеева-Перцева, 1959 19
11 Ондозеро	3,2	0,11	Урбан, 1959 20
12 Нюкозеро	11,7	—	Потапова, 1959 18
13 Верхнее Куйто	23,7 / 18,5	0,71 / 0,78	Филимонова, 1963 21
14 Среднее Куйто	18,3 / 9,5	0,95 / 0,24	
15 Нижнее Куйто	28,1 / 2,4	1,15 / 0,05	

Key
1 - lakes
2 - zooplankton
3 - abundance, thous. spec/m^3
4 - biomass, g/m^3
5 - author
6 - Pyaozero
7 - Topozero
8 - Engozero
9 - Tiksheozero
10 - Segozero
11 - Ondozero
12 - Nyuk
13 - Upper Kuito
14 - Middle Kuito
15 - Lower Kuito
16 - Gordeev, Gordeeva, 1959
17 - Aleksandrov, Novikov, 1959
18 - Potapova, 1959
19 - Gordeeva-Pertseva, 1959
20 - Urban, 1959
21 - Filimonova, 1963.

Note: Numerator gives abundance and biomass of the surface 2-meter layer of water, denominator of layers below 2 meters.

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of aquatic vegetation in northern lakes occupy small areas from 0.04% of the area in Segozero to 0.75% in Pyaozero. Topozero is the most obvious example 142
of increase in abundance of zooplankton in bays and littoral areas: the average abundance of entomostracans in the open part was 6.6 thous. spec/m^3, as against 4.2 thous. spec/m^3 in open areas (sic!); in the shallow Sondal'-skii Bay of Segozero Lake, the abundance of entomostracans ran to 5 thous. spec/m^3, while in the open areas of the lake, it was equal to 1.2 thous.

spec/m^3 on the average.

Driving winds have considerable effect on the abundance of plankton in surface layers of large lakes in Northern Karelia, causing either scattering or large accumulations of entomostracan plankton. Thus, in Pyaozero, the entire eastern area of the central deep, including Nikol'skaya Bay, due to the prevalence of driving northwest winds in the summer of 1954, had enriched plankton by comparison with western areas. The abundance of entomostracans was 4 - 8 thous. spec/m^3, while in western areas it was 1-2 thous. spec/m^3. Biomass showed a correspondingly marked increase. The high concentration of entomostracan plankton in this part of the lake created more favorable conditions for foraging concentrations of plankton-eating fishes, especially ciscoes.

Large northern lakes, having extensive water areas, have great reserves of planktonic entomostracans despite seeming zooplankton poverty. It is advisable to acclimatize valuable kinds of plankton-eating fishes (omul and others) in them.

Average and small lakes of Northern Karelia belong to different limnological types. Some of them, shallow and well heated, belong to the eutrophic type (Rugozero, Topozero, Punozero, Boyarskoe and others). Despite differences in hydrology and morphology, zooplankton of large and average lakes in Northern Karelia have a similar composition of dominant forms. As in large lakes, forms of Bosmina, Holopedium, Daphnia, Cyclops, Eudiaptomus and others are widely distributed. The only difference is the mass development of the entomostracan Chydorus sphaericus in a number of small lakes.

In the average and small lakes of Northern Karelia which we studied, we distinguished between shallow lakes with average depths no greater than 5 m and deep lakes with average depths of over 5 m.

The productivity of deep lakes is low and their biomass fluctuates from 0.07 to 0.54 g/m^3. In deep average and small lakes, the qualitative composition of zooplankton is similar to the composition in large lakes in Northern Karelia. The relict entomostracan Limnocalanus macrurus is found in some of them.

Zooplankton biomass in shallow lakes fluctuates from 0.24 to 1.8 g/m^3. Zooplankton in shallow lakes in Northern Karelia has features in common with the composition in both large northern and southern lakes. Shallow depth and good heating in lakes does not affect qualitative composition, but does affect quantitative development of zooplankton.

Thus, plankton composition in large and small lakes in Northern Karelia is essentially identical. However, a form which is characteristic of lakes in Southern Karelia, Chydorus sphaericus begins to appear in mass in the dominant complex of zooplankton in some small lakes.

Two hundred fifty-two lakes from the basins of Lake Onega and Lake Ladoga were studied in the southern part of Karelia. Most of the large and average lakes studied are shallow; average depths in them do not exceed 2-5 m (Vodlozero, Syamozero, Lizhmozero, Lososinoe, Pyalozero, and others); deep lakes are few (Sandal, Putkozero, Ukshezero, Munozero and others).

According to Baranov's classification /1961/, the majority of shallow 143
lakes are meso- and polyhumic mesotrophic lakes (Vodlozero, Syamozero, Vedlozero, Lizhmozero and others) and polyhumic oligotrophic (Pyalozero, Shotozero).

Deep lakes are few: they belong to different limnological types, which has an effect on the food supply of fishes. Most of the deep lakes studied in Southern Karelia belong to the mesotrophic type (Putkozero and others) and only a few to the polyhumic ultraoligotrophic type (Sandal).

Table 2

Quantitative development of zooplankton in some average and small lakes in Northern Karelia.

Наименование озер 1	Численность, тыс. экз./м³ 2	Биомасса, г/м³ 3	Автор 4
Глубоководные 5			
Лексозеро 6	5,5	0,12	Урбан и др., 1959 22
Охтенъярви 7	10,2	0,17	Гордеева, Гордеева-Перцева 23
Колонг 8	29,2	0,50	Гордеева-Перцева, 1964 24
Хижъярви 9	10,8	0,17	"
Микколя (большое) . 10	6,1	0,07	"
Копоти 11	11,2	0,14	"
Бабье 12	15,6	0,22	"
Мелководные 13			
Ругозеро 14	129,8	1,6	"
Ванчозеро 15	22,2	0,4	"
Венъярви 16	43,4	1,83	"
Восточная Новинка . 17	25,4	0,56	"
Боярское 18	77,4	1,7	"
Торосозеро 19	—	0,55	"
Мальвияйнен 20	17,5	0,23	Гордеева, Гордеева-Перцева 23
Нижний Шауляй . . 21	21,8	0,22	"

Key
1 - name of lakes
2 - abundance, thous. spec/m^3
3 - biomass, g/m^3
4 - author
5 - deep
6 - Leksozero
7 - Okhten"yarvi
8 - Kolong
9 - Khizh"yarvi
10 - Mikkolya (large)
11 - Kopoti
12 - Bab'e
13 - shallow
14 - Rugozero
15 - Vanchozero
16 - Ven'yarvi
17 - Vostochnaya Novinka
18 - Boyarskoe
19 - Torosozero
20 - Mal'viyainen
21 - Lower Siauliai
22 - Urban and others, 1959
23 - Gordeeva, Gordeeva-Pertseva
24 - Gordeeva-Pertseva, 1964

The southern lakes differ from the lakes in Northern Karelia in having greater diversity in qualitative composition of zooplankton. Besides the Bosmina mentioned for Northern Karelia (Bosmina obtusirostris obtusirostris, B. longispina), Bosmina coregoni coregoni, B. coregoni gibbera, B. longirostris are of prime importance in the dominant complex of zooplankton. Of the other cladocerans, besides Daphnia cristata, found in mass are D. cucullata, D. longispina, and also Diaphanosoma, Limnosida, Holopedium and Chydorus sphaericus. Of the copepods, besides the species named for Northern Karelia - Mesocyclops oithonoides, Cyclops strenuus, Eudiaptomus gracilis, E. graciloides, Heterocope appendiculata - very frequently found in southern lakes are Mesocyclops leuckarti and Cyclops scutifer. The relict entomostracan Limnocalanus macrurus inhabits some deep southern lakes, as it does northern lakes (Sundozero, Vakhvayarvi, Ukshezero, Putkozero).

The shallowness and good heating of southern lakes has affected the nature of quantitative development of zooplankton. The biomass of zooplankton of large lakes in Southern Karelia fluctuates from 0.17 to 0.8 g/m^3 with an abundance of 10.8 - 24.4 thous.spec/m^3 (Vodlozero, Shotozero, Gimoly, Syamozero). As in most of the Karelian lakes, the bulk of zooplankton is 144
concentrated in the surface layer of water. Strong winds in shallow lakes, mixing the entire water column, cause evening-out in the quantitative distribution of entomostracans from the surface to the bottom.

In deep large lakes in Southern Karelia, the quantitative indicators of zooplankton are much higher than in the large lakes of Northern Karelia. Thus, zooplankton of the Sandal lake-reservoir have an abundance of 21.4 thous. spec/m^3 with a biomass of 0.35 g/m^3, while Pyaozero has an abundance of 3.1 thous. spec/m^3 and a biomass of 0.11 g/m^3.

The abundance of zooplankton in average lakes in Southern Karelia fluctuates from 4.2 to 27.4 g/m^3 and biomass fluctuates from 0.09 to 0.59 g/m^3.

Table 3

The quantitative development of zooplankton in some large and average lakes in Southern Karelia.

Наименование озер 1	Численность, тыс. экз/м^3 2	Биомасса, г/м^3 3	4 Автор	
Водлозеро 5	24,0	0,88	Урбан, 1959	22
Сямозеро 6	16,0	0,55	Филимонова, 1961	23
Сандал 7	21,2	0,35	Гордеева, 1961	24
Лижмозеро 8	25—40	—	Урбан, 1959	22
Ровкульское 9	10,8	0,26	Урбан, 1959	22
Гимольское 10	6,6	—	Соколова, 1959	25
Шотозеро 11	12,4	0,17	Гордеева, 1967	26
Суоярви 12	22,7	—	Гордеев, 1959	27
Ведлозеро 13	37,9	—	Гордеева, 1959	28
Ватчельское 14	25,3	—	Александров, 1959	29
Вагатозеро 15	19,5	0,29	Вебер, 1959	30
Сундозеро 16	4,2	—	Александров, 1959	29
Пялозеро 17	17,2	—	Александрова, 1959	31
Мунозеро 18	11,1—22,8	—	Гордеева-Перцева, 1957	32
Пертозеро 19	7,3	—	Гордеев, 1959	27
Лососинное 20	27,4	0,59	Гордеев, Александров, Заболоцкий, 1958	33
Ладмозеро 21	4,4	0,09	Гордеева, Гордеев, 1963	34

Key

1 - lake
2 - abundance, spec/m^3
3 - biomass, g/m^3
4 - author
5 - Vodlozero
6 - Syamozero
7 - Sandal
8 - Lizhmozero
9 - Rovkul'skoe
10 - Gimoly
11 - Shotozero
12 - Suoyarvi
13 - Vedlozero
14 - Vatchel'skoe
15 - Vagatozero
16 - Sundozero
17 - Pyalozero
18 - Munozero
19 - Pertozero
20 - Lososinoye
21 - Ladmozero
22 - Urban, 1959
23 - Filimonova, 1961
24 - Gordeeva, 1961
25 - Sokolova, 1959
26 - Gordeeva, 1967
27 - Gordeev, 1959
28 - Gordeeva, 1959
29 - Aleksandrov, 1959
30 - Veber, 1959
31 - Aleksandrova, 1959
32 - Gordeeva-Pertseva, 1957
33 - Gordeev, Aleksandrov, Zabolotskii, 1958
34 - Gordeeva, Gordeev, 1963

The small lakes in Southern Karelia which we studied belong mainly to the mesotrophic and eutrophic types. The qualitative composition of zooplankton in them is similar to the composition of zooplankton in average and large lakes in Southern Karelia. Bosmina and Daphnia achieve great variety here, and different species of Limnosida, Chydorus, Holopedium and other species mentioned above for lakes in Southern Karelia are found in considerable quantities.

The development of zooplankton in small lakes in Southern Karelia reaches a greater extent than in large and average lakes and exceeds the indicators for small lakes in Northern Karelia.

At the same time, the quantitative indicators for small lakes fluctuate within large limits, as is illustrated by the data given in table 4.

As can be seen from the table, the range of fluctuation in quantitative indicators of zooplankton in small lakes is extremely wide - from 4.9 to 359.1 thous. spec/m^3 with a biomass from 0.09-7.23 g/m^3 - due to the varied nature of their natural conditions.

All of the small Karelian lakes which we studied were conditionally divided into three groups according to the degree of quantitative development of zooplankton:

1. Food-poor with a biomass not exceeding 0.4 g/m^3 (Lazaristo, Ekon'yarvi, Syuvyayarvi).

2. Medium rich in food with a biomass of from 0.5 to 1 g/m^3 Poros'yarvi, Mil'chan'yarvi, Matk'yarvi, Sod'yarvi).

3. Rich-in-food lakes with a biomass exceeding 1 g/m^3 (Cheden'yarvi, Kover'yarvi, Pekkol'skoe and many others).

Table 4

Quantitative development of zooplankton of small lakes in Southern Karelia

Наименование озер 1	Численность, тыс. экз./м³ 18	Биомасса, г/м³ 19	Автор 20
Пильмасозеро 2	34,4	0,33	Гордеева 21
Келкозеро 3	299,2	2,96	"
Иматозеро 4	11,3	5,90	Соколова, Филимонова, 1962
Пряжинское 5	65,6	1,95	" 22
Каскеснаволоцкое 6	5,0	0,14	"
Чеденъярви 7	359,1	4,31	Гордеева, Гордеева-Перцева, 1968 23
Лазаристо 8	13,9	0,16	"
Еконъярви 9	4,91	0,09	"
Пеккольское-1 10	264,0	7,23	Гордеева, 1964 24
Поросъярви 11	19,3	0,60	Гордеева, Гордеева-Перцева, 1968 23
Лейбъярви 12	169,6	4,71	Гордеева 21
Нинъярви 13	22,3	0,49	"
Б. Хошкинламба 14	44,5	0,50	"
Большое 15	11,4	0,27	"
Крошнозеро 16	109—86	1,7—1,5	Филимонова, 1956 25
Миккельское 17	88—49	2,1—1,5	"

Key
1 - name of lake
2 - Pil'masozero
3 - Kelkozero
4 - Imatozero
5 - Pryazhinskoe
6 - Kaskesnavolotskoe
7 - Cheden'yarvi
8 - Lazaristo
9 - Ekon'yarvi
10 - Pekkol'skoe-1
11 - Poros'yarvi
12 - Leib'yarvi
13 - Nin'yarvi
14 - B. Khoshkinlamba
15 - Bol'shoe
16 - Kroshnozero
17 - Mikkeli
18 - Abundance, thous. spec/m^3
19 - biomass, g/m^3
20 - author
21 - Gordeeva
22 - Sokolova, Filimonova, 1962
23 - Gordeeva, Gordeeva-Pertseva, 1968
24 - Gordeeva, 1964
25 - Filimonova, 1956.

Lakes less than 0.1 km^2 in area and forest lambas are also frequently characterized by considerable plankton development (0.3-8.22 g/m^3). The same most abundant forms from the crustacean assemblage are often found in them, as also in small and average lakes in Southern Karelia.

Table 5

The quantitative development of zooplankton in some Soviet lakes.

Наименование водоемов 1	Численность, тыс. экз/м³ 2	Биомасса, г/м³ 3	Автор 4
Ильмень, средние летние 5.	—	4,8	Эггерт, 1961 31
Цимлянское, " 6	—	7,0	Дзюбан, 1958 32
Рыбинское, " 7	—	1,4	Мордухай-Болтовская, 1956 33
Белорусские озера 8			
Рудаково . . . . . 9.	26,9	0,52	Петрович, 1954 34
Волос Южный . . . . . 10.	47,2	1,05	"
Нарочь . . . . . 11.	57,5	1,75	"
Дрисвяты . . . . . 12.	76,4	3,51	"
Вишневское . . . . . 13.	208,1	3,48	"
Мястро . . . . . 14.	230,3	5,98	"
Уральские озера 15			
Тургояк, июль — август 16.		0,27	Уломский, 1951 35
Синара " 17.		0,26	"
Чебаркуль " 18.		0,49	"
Шарташ " 19.		1,90	"
Латвийские озера 20			
Акмен . . . . . 21.	34,8	1,10	Печюлене, 1959 36
Гальве . . . . . 22.	77,0	1,47	"
Скайстис . . . . . 23.	60,6	1,49	"
Нереспинка . . . . . 24.	182,0	2,0	"
Сибирские озера 25			
Вымское . . . . . 26.	17,6	0,19	Грезе, 1955 37
Кета . . . . . 27.	8,2	0,24	Гордеева, 1963 38
Мелкое . . . . . 28.	1,8	0,06	"
Глубокое . . . . . 29.	1,6	0,06	"
Лама . . . . . 30.	4,6	0,42	"

Key

1 - lakes
2 - abundance, thous. spec/m^3
3 - biomass, g/m^3
4 - author
5 - Ilmen, average summer
6 - Tsimlyanskoye
7 - Rybinsk
8 - Belorussian lakes
9 - Rudakovo
10 - Volos Yuzhnyi
11 - Naroch
12 - Drisvyaty
13 - Vishnevskoe
14 - Myastro
15 - Ural lakes
16 - Turgoyak, July-August
17 - Sinara
18 - Chebarkul
19 - Shartash
20 - Latvian lakes
21 - Akmen
22 - Gal've
23 - Skaistis
24 - Nerespinka
25 - Siberian lakes
26 - Vymskoe
27 - Keta
28 - Melkoe
29 - Glubokoe
30 - Lama
31 - Eggert, 1961
32 - Dzyuban, 1958
33 - Mordukhai-Boltovskaya, 1956
34 - Petrovich, 1954
35 - Ulomskii, 1951
36 - Pechyulene, 1959
37 - Greze, 1955
38 - Gordeeva, 1963

For comparison of the quantitative indicators of zooplankton of Karelian lakes and lakes of other areas of the Soviet Union, we cite the following data (table 5).

On comparison of zooplankton of the Karelian lakes with the zooplankton of other lakes of the Soviet Union, we come to the conclusion that the quantitative indicators of zooplankton in large northern lakes in Karelia can be compared with lakes in the northern part of the Soviet Union, in particular with Siberian lakes (Vymskoe, Keta, Glubokoe, Melkoe), and average and small lakes are similar to the lakes in the Urals. The quantitative indicators of zooplankton in Southern Karelia are comparable with those for lakes in Belorussia. 146

Thus, in all Karelian lakes, the most favorable conditions for foraging of fishes are found in the upper five-meter layer of water, where the greatest zooplankton development was observed. Despite the seeming poverty in zooplankton from the quantitative point of view, the large lakes of the northern part of Karelia, having extensive areas, possess large food reserves for foraging of plankton-eating fishes.

Average and small lakes can basically be classified as lakes medium rich and rich in food. They can be used for the commercial culture of valuable kinds of plankton-eating fishes.

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