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ON THE SEASONAL DYNAMICS OF THE PELAGIC ZOOPLANKTON OF LAKE PEIPSI-PIHKVA

A short characteristics of Lake Peipsi-Pihkva

The area of Lake Peipsi-Pihkva is 3,550 sq. km. Hydrologically and biologically, the lake consists of three entirely different parts. The northern part of the lake — Lake Peipsi (2,670 sq. km in area) forms about 75 per cent, and the southern part — Lake Pihkva (710 sq. km in area) about 20 per cent of the total area of the water body. Only 5 per cent of the total area falls to the share of the narrow Lake Lämmijärv (170 sq. km) connecting the two larger parts of the lake.

The biggest depth of Lake Peipsi-Pihkva is 15.2 m, the average depth 6.9 m, the length of the lake is 143 km, the biggest width 48.8 km, the average width 24.6 km (Куллус, Мерила, 1966). About 30 rivers flow into the lake, of which the Velikaya (427 km in length) and the Emajõgi (108 km in length) are of the greatest importance. The outflow is effected via the River Narva into the Gulf of Finland.

Hydrobiologically, Lake Peipsi-Pihkva belongs to moderately eutrophic lakes, while its different parts have different trophic degrees. The most eutrophic one is Lake Pihkva, being followed by Lake Lämmijärv and Lake Peipsi in this sense. Peipsi has preserved some characteristics of mesotrophic lakes (Соколов, 1941, Мяэметс, 1966). From the point of view of fishery, Lake Peipsi-Pihkva may be classified as a habitat of bream and smelt (Кожин, 1934).

On the history of investigations on the zooplankton in Lake Peipsi-Pihkva

The seasonal dynamics of zooplankton in Lake Peipsi-Pihkva, the biggest and most important one from the point of view of fishery in the Baltic republics, has not been extensively investigated. Several authors have studied the zooplankton in summer, but sufficient data on the qualitative and quantitative composition of zooplankton in spring, autumn and winter are still missing.

The first fragmentary notes on the zooplankton in Lake Peipsi are to be found in the works of a popular-scientific character by Samsonov (Самсонов, 1912, 1913). In the years 1935—1941 the hydrobiology of Lake Peipsi was investigated by the All-Union Research Institute of River and Lake Fishery (VNIORH). Data from that period are available in the work by Petrov (Петров, 1947). Some notes on the zooplankton of Lake Peipsi are given in an article on the Peipsi vendace by Voore (1939). A rather profound survey of the zooplankton in summer is given in the works by Sokolov (Соколов, 1941), Maksimova and Korytova (Максимова, Корытова, 1963) and Mäemets (Мяэметс, 1966). Sokolov's materials concerning the zooplankton were worked through by Rylov. The only work on the seasonal dynamics of the zooplankton in Lake Peipsi-Pihkva to be mentioned is a manuscript by Sokolova (Соколова, 1951). The latest study of the lake that has appeared in print is an article by Denissenko (Денисенко, 1968), concerned with the zooplankton in the southern part of Lake Pihkva in summer.

None of the above-mentioned researches gives an exhaustive survey of the seasonal dynamics of the zooplankton in Lake Peipsi. The present article is an attempt to partially fill this blank.

Material and methods

The present article is based on 660 quantitative zooplankton samples. The samples were taken in 1965—1966 in 8 sample spots of the pelagic part Lake Peipsi (Fig. 1). The samples were taken in 8 different months of 1965 (February, March, April, May, June, July, September, October). In 1966, the corresponding numbers were 8 for Lake Peipsi (January, February, March, April, May, June, July, October) and 7 for Lakes Lämmi and Pihkva (January, February, March, May, June, July, October).

The samples were taken during the day-time, by means of a small quantitative closable Juday plankton net (silk No. 49), with an orifice of 100 sq. cm. The number of samples depended on the depth of water in the sample spot, since one sample was taken from each 3-m-thick layer (3 — 0 m, 6 — 3 m, 9 — 6 m, 12 — 9 m, 15 — 12 m). Most of the samples from the shallow Lake Pihkva come from the layer 3 — 0 m, those from Lake Lämmijärv (spot 12, depth 15.2 m), as a rule, come from 5 water layers and most of the samples from Lake Peipsi are taken from 3 layers.

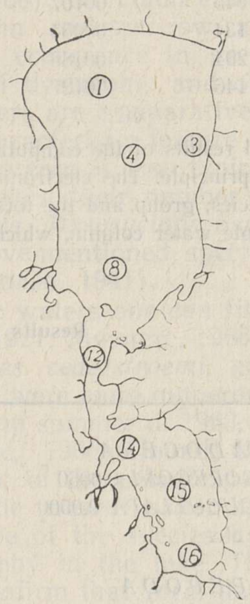

Fig. 1. Places of sample-spots in Lake Peipsi-Pihkva.

The samples were fixed with 2 — 4 per cent formalin; standard counting method was applied, using 2.5 ml portion pipettes and the Bogorov chamber (Киселев, 1956). 1/20 or 1/10 of the sample was counted. The biomass was found by means of multiplying the number of individuals by their average weight; the weights of zooplankters given by Mordukhai-Boltovski were mainly used (Киселев, 1956). To ascertain the average length of the species, 20 individuals of each species were measured during all months, on the average.

Necessary computing was done by the electronic computer "Ural-4" (Хаберман, 1969).

In order to make the initial data suitable for elaboration by the computer, each species (in case of an inequality of weight — seasonal, sexual and age differences — also each form of a species with a different weight) was marked by a three-digit number cipher. The first number marks the systematic group to which the species belongs (*0 — Cladocera, 1 — Copepoda, 2 — Rotatoria, 3 — Mollusca*), the two following numbers mark the number of order in the list of forms of the given systematic group. For example: *Bosmina c. coregoni* ♀ with the weight of 0.013 mg got the cipher 016, *B. c. coregoni* ♂ 018, *Leptodora kindti* 059, *Heterocope appendiculata* 130, *Conochilus unicornis* 204, etc.

In addition to ciphers, an abbreviated list of the "machine names" of plankters was composed (no name could contain more than 18 letters) and a list of the weights of plankters, e. g. ACANTH. VIRIDIS 0.03 (mg). Both lists were elaborated by the electronic computer: the weights were used in computing, the list of species when printing the results.

The applied programme does not make use of the outer memory (which would decrease the speed of computation). Therefore the volume of the lists is limited — as a maximum they may contain 219 lines, and, accordingly, the plankton under investigation may contain 219 species on weight classes, bigger systematic groups

(*Cladocera, Copepoda,* etc.) included. All the forms can be divided into 8 groups at the utmost, none consisting of more than 99 forms. The programme allows to analyze nine (incl.) vertical horizons.

Table 1

Initial data for electronic computer
(explanations in the text)
P 12 14. 07. 66.

666	
03 — 00	3
017	00023
301	00013
210	00023
045	00107
134	00054
204	00189
146	00127
etc.	

For the electronic computer initial data are presented in the form of a list (Tab. 1). The first three lines characterize the plankton sample: sample spot (P12 = Lake Peipsi, sample spot 12), time, coefficient of recomputation (666), horizon (03 — 00, i. e. 3 m — 0 m), thickness of horizon in metres (3). Beginning with the fourth line, the number of forms in the investigated part of the sample is given. For instance, 017 00023 means that the number of female individuals of *Bosmina c. coregoni* (cipher 017) in the investigated part of the sample was 23 (00023). Likewise, data on each horizon (3 — 0 m, 6 — 3 m, 9 — 6 m, etc.) are given separately.

Data from the electronic computer are given in the form of a table (Tab. 2).

In the given examples (Tab. 1 and 2), the initial data and results of the computation of other horizons are not presented since they are similar in principle. The electronic computer also gives the average data (the number of each species, group and the total zooplankton, also biomass in 1 cubic metre of water) on the whole water column, which are not presented in the example either.

Table 2

Results of computing got from electronic computer
P 12 14. 07. 66. 03 — 00

CLADOCERA	0128000	10000	02598	0414166	10000	06977
B. COREGONI 0,0060	0015333	01197	00311	0009200	00222	00154
D. CUCULLATA 0,0500	0071333	05572	01447	0356666	08611	06008
etc.						
COPEPODA	0189333	10000	03843	0168933	10000	02845
M. LEUCKARTI JUV.	0036000	01901	00730	0036000	02131	00606
NAUPLIUS	0084666	04471	01718	0033866	02004	00570
etc.						
ROTATORIA	0166666	10000	03382	0010326	10000	00173
CONOCH. UNICORNIS	0126000	07560	02557	0003780	03660	00063
KELL. LONGISPINA	0015333	00920	00311	0003833	03712	00064
etc.						
MOLLUSCA	0008666	10000	00175	0000173	10000	00002
DREISSENA POL. JUV.	0008666	10000	00175	0000173	10000	00002
ZOOPLANKTON	0492666	10000	10000	0593600	10000	10000
Abbreviated name of forms or weight classes	Number	Per cent of the number of the group	Per cent of the number of the total zooplankton	Biomass: 0593600 = 5 g and 936 mg	Per cent of the biomass of the group	Per cent of the biomass of the total zooplankton

There are almost no mistakes in machine computing, and it saves much time. Therefore all computations in the quantitative analysis of the zooplankton should be done by machines.

On the qualitative composition of the pelagic zooplankton of Lake Peipsi-Pihkva

In the pelagic part of Lake Peipsi-Pihkva, 99 taxonomic units of zooplankton were stated (Tab. 3) (*Cladocera* 41, *Copepoda* 12, *Rotatoria* 45, *Mollusca* 1), of which cladocerans formed 41.4, copepods 12.1, rotifers 45.5 and molluscs 1.0 per cent.

The composition of the zooplankton in all pelagic parts of the lake is almost the same. Species characteristic of eutrophic lakes occur in all parts (Соколов, 1941; Мяэметс, 1966; Денисенко, 1968). Of cladocerans, *Daphnia cucullata* and subspecies of the *Bosmina coregoni*-row are numerous, as well as *Chydorus sphaericus,* whose occurrence in great numbers in the pelagic part is not characteristic of dystrophic and oligotrophic lakes (Соколов, 1941). The species of rotifers are comparatively abundant, which also may be considered as a characteristic feature of eutrophic waters. The occurrence of the genus *Trichocerca* is also typical of eutrophic water bodies, while in oligotrophic lakes their number is negligible or they are completely absent. Of copepods, *Mesocyclops leuckarti* is abundant in all parts of the lake. The above-mentioned species prefers eutrophic lakes which warm up easily (Соколов, 1941).

Alongside of the forms characteristic of eutrophic waters one can find some forms typical of oligotrophic ones (Nordqvist, 1921; Мяэметс, 1966): *Limnosida frontosa, Daphnia cristata, Bythotrephes cederstroemi,* etc. According to Mäemets (Мяэметс, 1966), these species were more numerous in the cold and rainy summer of 1962 than in the warm summer of 1963.

Earlier some authors (Соколов, 1941; Мяэметс, 1966) found the species *Holopedium gibberum* which is characteristic of the pelagic part of oligotrophic-mesotrophic waters. The author of the present paper has not succeeded in finding it. Probably the abundance of the species has decreased in connection with the increase of eutrophy in the lake. The results of the analysis of nourishment of fish also confirm that (oral data by Evi Pihu).

Mäemets (Мяэметс, 1966) stresses the wide-spread polyoxybionthic *Bosmina c. thersites* and *Bosmina c. berolinensis* in the lake, which is a proof of excellent oxygen conditions in Lake Peipsi-Pihkva.

In spite of the great similarity of some parts of Lake Pepsi-Pihkva in respect to the composition of species in 1965 and 1966 there were still several species which were connected with one part of the lake only. And yet we are of the opinion that some of these species may occur in all pelagic parts of the lake; further investigations may well prove that. From the point of view of further investigations, the author finds it necessary to present the specific features.

Connected with Lake Peipsi, exclusively, were *Bosmina kessleri, Bythotrephes cederstroemi, Ceriodaphnia quadrangula, Cyclops abyssorum* and *Schizocerca diversicornis.*

Bosmina obtusirostris, Chydorus piger, Drepanothrix dentata, Ilyocryptus, acutifrons, Leydigia acanthocercoides, Pleuroxus uncinatus, Rhynchotalona falcata, Scapholeberis mucronata, Trichocerca porcellus major and *Trichocerca weberi* were found in Lake Lämmijärv only. The occurrence of littoral and profundal species in the Lämmijärv may be explained by the big depth of the sample spot (15.2 m) and the proximity of the shore.

Table 3

The qualitative composition of the zooplankton in Lake Peipsi-Pihkva

Taxonomic units	Lake Peipsi	Lake Lämmijärv	Lake Pihkva
1	2	3	4
Cladocera			
Alona affinis	x	x	
Alona quadrangularis		x	x
Alona rectangula		x	x
Alonella nana	x	x	x
Acroperus harpae	x	x	x
Bosmina coregoni berolinensis	x	x	x
Bosmina c. berol. x *thersites*	x	x	x
Bosmina c. coregoni	x	x	x
Bosmina c. gibbera	x	x	x
Bosmina c. gibbera x *berol.*	x	x	x
Bosmina c. gibbera x *thers.*	x	x	x
Bosmina c. thersites	x	x	x
Bosmina c. obtusirostris		x	
Bosmina crassicornis	x	x	x
Bosmina kessleri	x		
Bosmina longirostris	x	x	x
Bythotrephes cederstroemi	x		
Bythotrephes longimanus	x		x
Ceriodaphnia pulchella	x	x	x
Ceriodaphnia quadrangula	x		
Chydorus gibbus	x	x	x
Chydorus latus			x
Chydorus piger		x	
Chydorus sphaericus	x	x	x
Daphnia cristata	x	x	x
Daphnia cucullata	x	x	x
Daphnia longispina galeata	x	x	x
Diaphanosoma brachyurum	x	x	x
Drepanothrix dentata		x	
Ilyocryptus acutifrons		x	
Leptodora kindti	x	x	x
Leydigia acanthocercoides		x	
Limnosida frontosa	x	x	x
Monospilus dispar	x	x	
Pleuroxus trigonellus	x	x	
Pleuroxus uncinatus		x	
Polyphemus pediculus		x	x
Rhynchotalona falcata		x	
Rhynchotalona rostrata	x	x	
Scapholeberis mucronata		x	
Sida crystallina			x
Copepoda			
Acanthocyclops viridis	x	x	x
Cyclops abyssorum	x		
Cyclops kolensis	x	x	x
Cyclops vicinus	x	x	
Eucyclops serrulatus	x	x	x
Eudiaptomus gracilis	x	x	x
Heterocope appendiculata	x	x	x
Mesocyclops crassus	x	x	x
Mesocyclops leuckarti	x	x	x
Mesocyclops oithonoides	x	x	x
Nitocrella hibernica	x	x	x
Paracyclops fimbriatus	x	x	x
Rotatoria			
Argonotholca foliacea	x		x
Asplanchna priodonta	x	x	x

Table 3 (cont.)

1	2	3	4
Brachionus angularis			x
Brachionus calyciflorus			x
Conochilus hippocrepis		x	
Conochilus unicornis	x	x	x
Encentrum sp.		x	x
Euchlanis dilatata lucksiana	x	x	x
Euchlanis dilatata uniceta		x	
Euchlanis incisa	x	x	x
Filinia limnetica	x	x	x
Filinia longiseta	x	x	x
Filinia terminalis	x	x	x
Gastropus stylifer	x		
Kellicottia longispina	x	x	x
Keratella cochlearis	x	x	x
Keratella hiemalis	x	x	x
Keratella quadrata	x	x	x
Lecane luna		x	x
Notholca cinetura	x	x	x
Notholca labis			x
Notholca squamula	x		x
Notholca squamula frigida	x	x	x
Ploesoma hydsoni	x	x	x
Ploesoma truncatum	x	x	x
Ploesoma sp.	x	x	x
Polyarthra dolichoptera	x	x	x
Polyarthra euryptera	x		x
Polyarthra luminosa	x	x	x
Polyarthra major	x	x	x
Polyarthra vulgaris	x	x	x
Pompolyx sulcata			x
Schizocerca diversicornis	x		
Synchaeta sp.	x	x	x
Trichocerca capucina	x	x	x
Trichocerca cylindrica	x	x	x
Trichocerca porcellus	x	x	x
Trichocerca porcellus major		x	
Trichocerca pusilla		x	x
Trichocerca rattus	x	x	x
Trichocerca similis		x	x
Trichocerca tenuior	x	x	x
Trichocerca weberi		x	
Trichotria pocillum	x	x	x
Trichotria tetractis			x
Mollusca			
Dreissena polymorpha juv.	x	x	x

In the pelagic part of Lake Pihkva, only *Chydorus latus, Sida crystallina, Nitocrella hibernica, Brachionus angularis, Brachionus calyciflorus, Pompholyx sulcata* and *Trichotria tetractis* occurred.

On the basis of materials obtained in 1934, Sokolov (Соколов, 1941) lays special stress on the absence, in Lake Peipsi-Pihkva, of the genus *Brachionus,* which is a pond form. However, according to data of 1965 and 1966, the genus *Brachionus* is represented in the Pihkva, which fact leads to the assumption that the eutrophy of the lake has increased since 1934. The same phenomenon has also been stated by Timm (Тимм, 1966).

The role of separate species in the plankton is subject to seasonal changes. Taking the seasonally predominating species as a basis, we could conclude that the zooplankton of Lake Peipsi-Pihkva belongs to the *Synchaeta — Daphnia cucullata — Conochilus unicornis — Bosmina core-*

goni-row type. As the seasonal investigations of predominating species have been scarce, there may arise the necessity of adding some more species to the list of the typical species of the community.

Seasonal dynamics of the number and biomass of zooplankton in the Lake Peipsi-Pihkva

A survey of the dynamics of the number and biomass of zooplankton in the Lake Peipsi-Pihkva in 1965 and 1966 is given in Figs 2—5.

Both the number and biomass of zooplankton in Lake Peipsi-Pihkva are subjected to seasonal dynamics, the amplitude of fluctuations being rather considerable. Since the different parts of Lake — Peipsi, Lämmi and Pihkva — differ from each other to a considerable extent, the seasonal dynamics and its amplitude in them are different, as well.

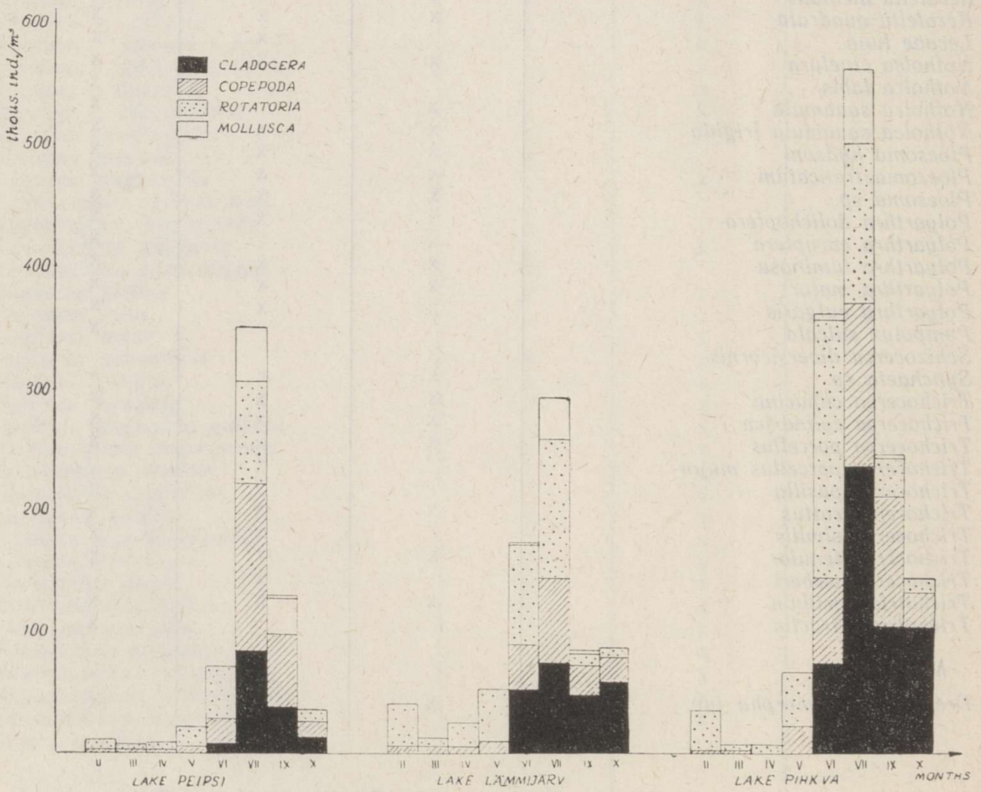

Fig. 2. The number of zooplankton in Lakes Peipsi, Lämmijärv and Pihkva in 1965.

In 1965 the number of zooplankton in Peipsi fluctuated from 7,600 ind. per cubic metre (March) to 350,000 individuals per cubic metre (July), and the biomass 0.030 g/m³ (April) to 2.830 g/m³ (July). In 1966 the amplitude of fluctuations was somewhat smaller. The number fluctuated from 2,700 to 300,000 ind./m³, the biomass from 0.014 to 1.640 g/m³. The minimum number occurred in March 1965 and January 1966, the maximum in July (1965 and 1966). The biomass was smallest in April 1965 and in January 1966, the maximum biomass was observed in July during both years.

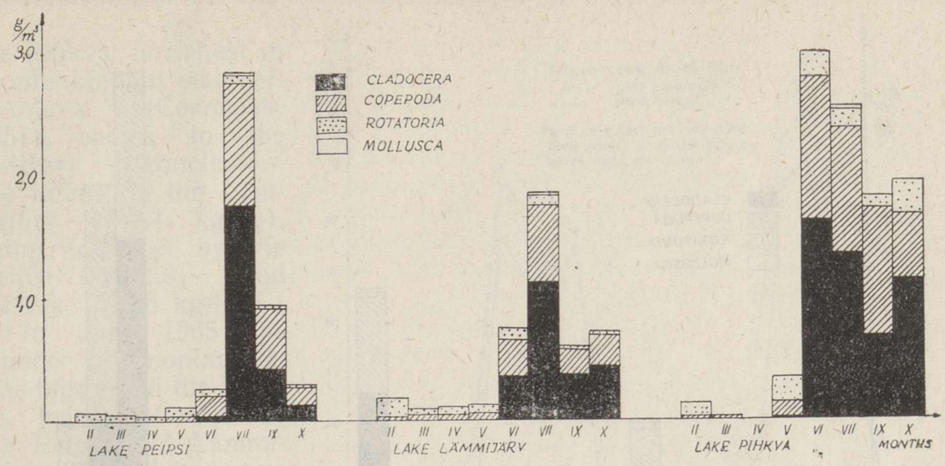

Fig. 3. The biomass of zooplankton in Lakes Peipsi, Lämmijärv and Pihkva in 1965.

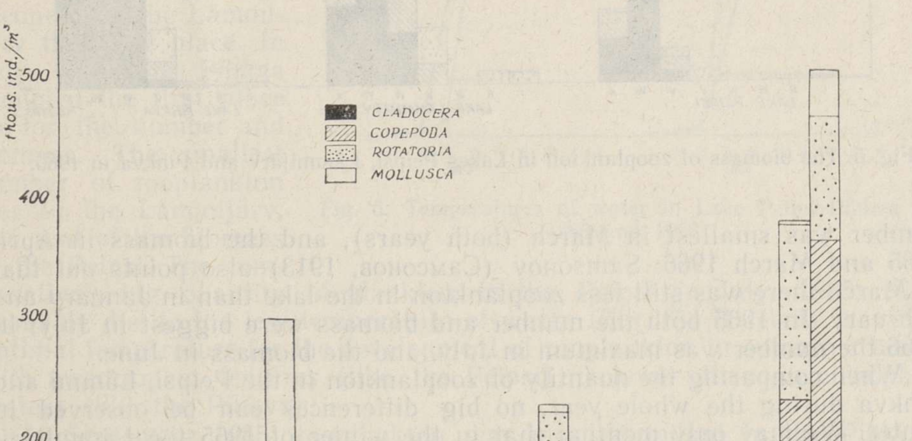

Fig. 4. The number of zooplankton in Lakes Peipsi, Lämmijärv and Pihkva in 1966.

The number of zooplankton in Lämmijärv in 1965 was 13,300—292,000 ind./m³ and 14,800—230,900 ind./m³ in 1966, the biomass 0.075—1.838 g/m³ and 0.033—2.774 g/m³, respectively. The minimum number and minimum biomass occurred in March (both years), the maximum in July.

The biggest changes in the number and biomass occurred in Lake Pihkva. The number fluctuated from 7,400 to 564,000 ind. /m³ in 1965 and from 11,200 to 503,600 ind./m³ in 1966. Corresponding data on the biomass were 0.009—2.562 g/m³ in 1965 and 0.050—4.599 g/m³ in 1966. The

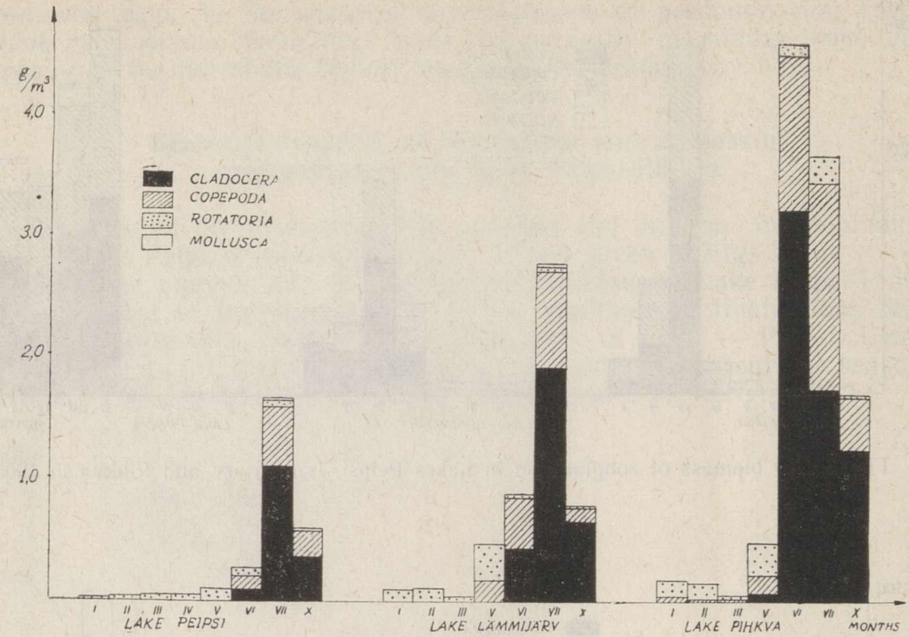

Fig. 5. The biomass of zooplankton in Lakes Peipsi, Lämmijärv and Pihkva in 1966.

number was smallest in March (both years), and the biomass in April 1965 and March 1966. Samsonov (Самсонов, 1913) also points out that in March there was still less zooplankton in the lake than in January and February. In 1965 both the number and biomass were biggest in July; in 1966 the number was maximum in July, and the biomass in June.

When comparing the quantity of zooplankton in the Peipsi, Lämmi and Pihkva during the whole year, no big differences can be observed in winter. We may only mention that in the winter of 1965 the Lämmijärv was a little richer in zooplankton than others, and in 1966 the same applied to Lake Pihkva. The conclusion: in winter, the southern parts of Lake Peipsi-Pihkva are richer in zooplankton than the northern part — the Peipsi.

On the month of April, only the data of 1965 are available. They witness to the usual winter aspect and there is no rise in the zooplankton. In this point, our data do not coincide with those by Samsonov. According to Samsonov (Самсонов, 1913), the second half of April may be considered the beginning of spring in the Peipsi, and the end of April/beginning of May — in the Pihkva. The period from the second half of March till the beginning of April is called a transitional period from winter to spring by Samsonov.

In April, the Lämmijärv was the richest in zooplankton.

In May and June, the water in the Lämmijärv and Pihkva warms up much more quickly than in the Peipsi (Fig. 6), and therefore there was more zooplankton in the southern parts of the lake than in the Peipsi. Such regularity is not proved by the data obtained by Maksimova, Korytova in 1960 (Максимова, Корытова, 1963).

In July the temperature of water was more or less the same in all parts of the lake, and there were no noticeable differences in the zooplankton. Materials by Sokolov (Соколов, 1941) also prove it. According to Samsonov (Самсонов, 1913) and Mäemets (Мяэметс, 1966), the Pihkva is richest in zooplankton in summer. Sokolova (Соколова, 1951) comes to the contrary conclusion: the richest is the Lämmijärv (145.4 kg/ha), being followed by the Peipsi (111.3) and Pihkva (51.46 kg/ha).

In July 1965 the number of zooplankton was biggest in the Pihkva, being followed by the Peipsi and Lämmijärv. The Peipsi was richest in the biomass, the Pihkva occupied the second, and the Lämmijärv the third place. In July 1966 the Pihkva occupied the first place as for the number and biomass. The smallest number of zooplankton was in the Lämmijärv, and that of the biomass in the Peipsi. The comparatively big quantity of plankton in the Peipsi in July, 1965, was probably due to the low temperature of water (Fig. 6). It seems that the optimal temperature for the development of zooplankton in eutrophic lakes with mesotrophic features (like the Peipsi) is lower than in eutrophic waters (like the Pihkva).

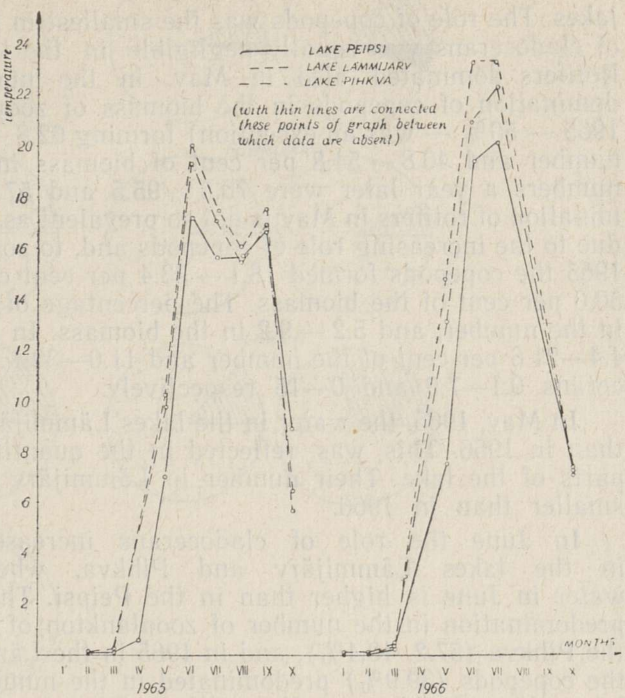

Fig. 6. Temperatures of water in Lake Peipsi-Pihkva in 1965 and 1966.

In September 1965, zooplankton was most abundant in the Pihkva, being followed by the Peipsi and Lämmijärv. In October (both years) the Pihkva (before the Lämmijärv and Peipsi) was the richest in zooplankton as well.

The role of different groups of zooplankton *(Cladocera, Copepoda, Rotatoria, Mollusca)* in plankton is subject to seasonal changes (Figs 7—9).

In January, February, March and April rotifers predominated both in the number and biomass of zooplankton in all the three parts of the lake. Their percentage in the number of zooplankton was 63.8 — 100 in 1965, 78.6 — 96.4 in 1966, their percentage in biomass being 59.6 — 100 in 1965 and 44.1 — 92.5 in 1966. Samsonov (Самсонов, 1912) also refers to the predomination of rotifers. The prevalence of copepods (64%) in the biomass of zooplankton of Lämmijärv in March 1965 was the only exception. Copepods formed 2.4 — 33.8 per cent of the number during the winter months of 1965, 3.6 — 19.1 in 1966, 6.2 — 64.0 of the biomass in 1965, 7.5 — 40.8 in 1966. The role of cladocerans in winter plankton was negligible. In 1965 their percentage in the number was 0 — 2.5, in biomass 0 — 1.0; in 1966 the corresponding numbers were 0 — 2.2 and 0 — 15.1.

When comparing the zooplankton of winter months in the three parts of the lake, we can see that the role of *Rotatoria* was biggest in the Pihkva and the smallest in the Lämmijärv. The role of *Copepoda* and (especially) *Cladocera* in the Lämmijärv was more considerable than that in the other lakes. The role of copepods was the smallest in the Lake Pihkva. The role of cladocerans was equally negligible in the lakes Peipsi and Pihkva. Rotifers dominated also in May, in the number and biomass (the domination of copepods in the biomass of zooplankton in the Peipsi in 1965 — 50% — was an exception) forming 62.8 — 80.5 per cent of the total number and 40.8 — 54.8 per cent of biomass in 1965; the corresponding numbers a year later were 70.5 — 95.5 and 57.3 — 89.0. Still the predomination of rotifers in May is not so prevalent as during the winter months, due to the increasing role of copepods and, to some extent, cladocerans. In 1965 the copepods formed 18.1 — 33.4 per cent of the number and 38.7 — 50.0 per cent of the biomass. The percentage of cladocerans was 1.3—4.3 in the number, and 5.2 — 9.2 in the biomass. In 1966 the copepods formed 4.4—21.6 per cent of the number and 11.0—30.1 of the biomass, the cladocerans 0.1—7.9 and 0—15 respectively.

In May, 1965, the water in the lakes Lämmijärv and Pihkva was colder than in 1966. This was reflected in the quantity of *Cladocera* in these parts of the lake. Their number in Lämmijärv and Pihkva in 1965 was smaller than in 1966.

In June the role of cladocerans increased noticeably, especially in the lakes Lämmijärv and Pihkva, where the temperature of water in June is higher than in the Peipsi. The rotifers retained their predomination in the number of zooplankton of the Peipsi (59.8, 65.6%), the Pihkva (57.2, 40.4%), and in 1965 in the Lämmijärv (46.4%). In 1966 the copepods (39.9%) predominated in the number of zooplankton in the Lämmijärv. In biomass, the rotifers did not prevail any longer. During that month (both years), the copepods predominated in the Peipsi (58,9, 48.9%) and the Lämmijärv (45.8, 50.6%); the cladocerans — in the Pihkva (54.6, 70.2%). According to Greze (Петров, 1947), the copepods also predominated in the Peipsi at the end of June and at the beginning of July in 1938, whereas the cladocerans were the predominating species in the Pihkva, during the same period. The rotifers occupied the last place in biomass in all parts of the lake during both years — 2.0—23.2 per cent. It is interesting that in June the role of the rotifers in the zooplankton biomass was much greater in the Peipsi (20.6, 23.2%) than in the Lämmijärv (10.0, 3.0%) and the Pihkva (6.3, 2,0%). It is evidently due to the fact that relatively bigger thermophobic species of the genus *Synchaeta* were preserved, while they began to disappear in the southern parts of the lake. According to Sokolova (Соколова, 1951), the *Crustacea* predominated all over the water body in June, whereas the rotifers were not numerous. The contradiction seems to be due to the fact that Sokolova did not count the small rotifers which are very numerous, e. g. *Conochilus* (Максимова, Корытова, 1963).

In June the larvae of the mollusc *Dreissena polymorpha* appeared in the zooplankton of the Lämmijärv and the Pihkva, while in the Peipsi they did not occur because of the lower temperature of water.

In the number of zooplankton, the molluscs formed 0.3—1.5 per cent, their role in the biomass being quite negligible.

The cladocerans predominated in the biomass of zooplankton in July (1965: in the Peipsi 61.5, the Lämmijärv 61.4, the Pihkva 52.6; 1966: the Peipsi 65.6, the Lämmijärv 69,5, the Pihkva 47.5%). As for the number, the copepods occupied the first place (39.0%) in the Peipsi in 1965, and the larvae of *Dreissena polymorpha* in 1966 (39.2%). In the Lämmijärv, the rotifers dominated in 1965 (38.7%), the copepods in 1966 (39.9%). Only in the Pihkva, the cladocerans predominated in 1965 (42.2%), and the copepods in 1966 (39.8%).

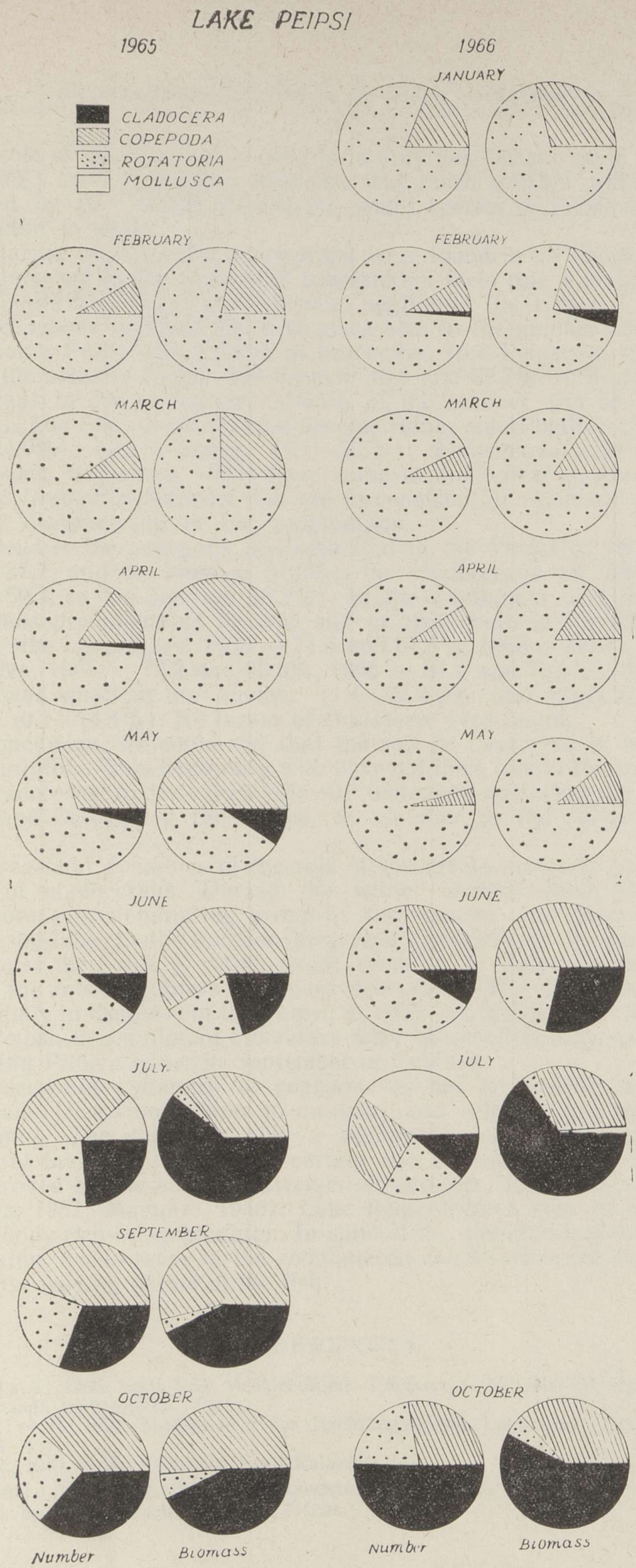

Fig. 7. Dynamics of the role (%) of the groups of zooplankton in Lake Peipsi in 1965 and 1966.

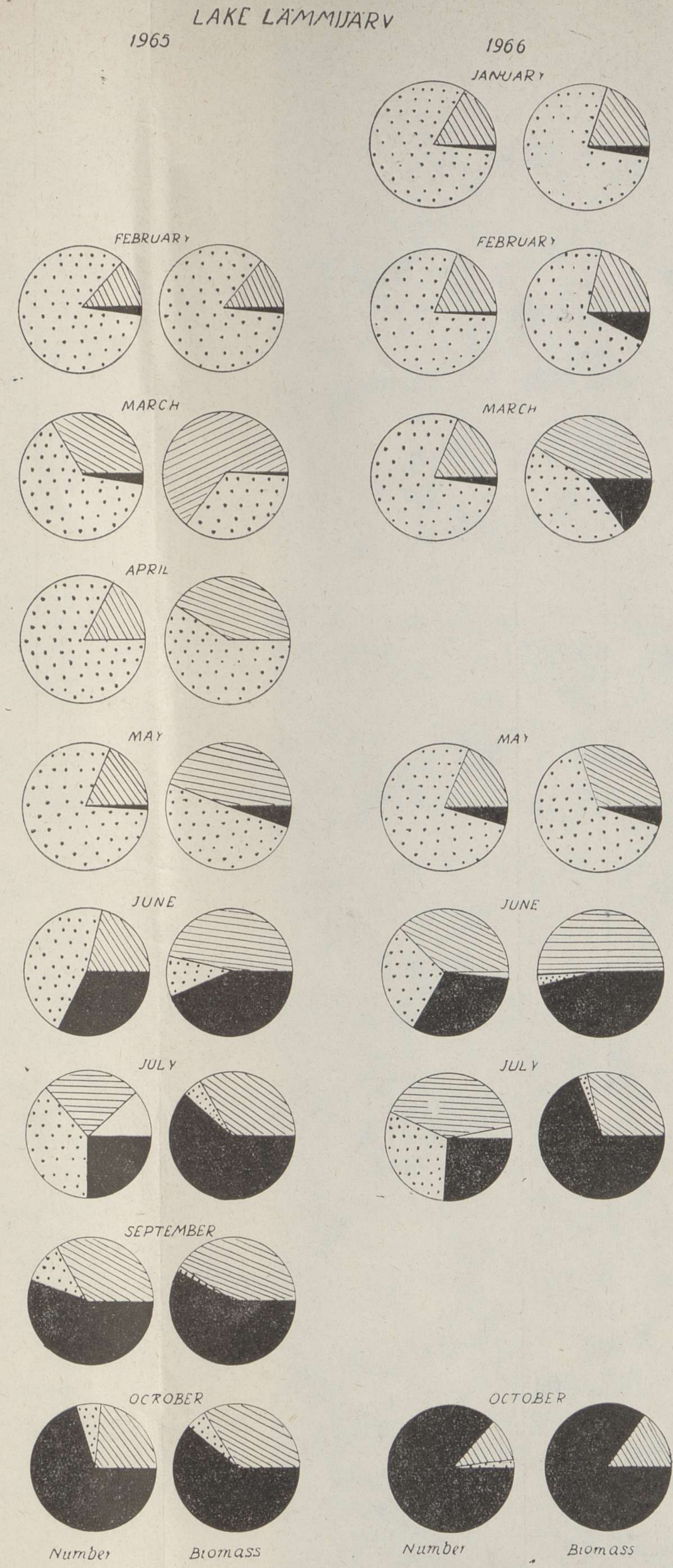

Fig. 8. Dynamics of the role (%) of the groups of zooplankton in Lake Lämmijärv in 1965 and 1966.

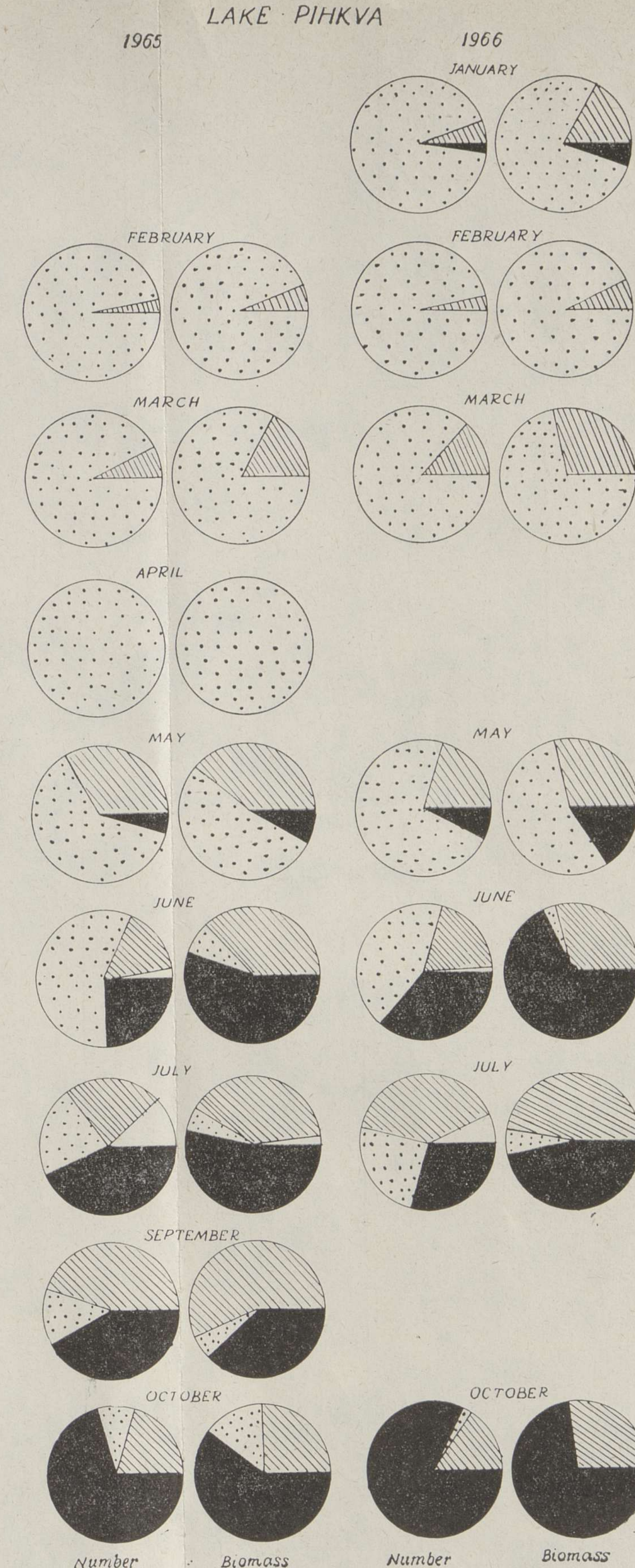

Fig. 9. Dynamics of the role (%) of the groups of zooplankton in Lake Pihkva in 1965 and 1966.

The role of the biomass of rotifers in July has become quite negligible (1.9—5.8%). In the number, their role was much greater, which may be explained by the abundance of the small species of *Polyarthra* in the zooplankton in July.

The larvae of *Dreissena polymorpha* were found in all the parts of the lake in July and in the number of zooplankton their role was essential, as well (2.7—39.2%). Their biomass was negligible (0—1.4%).

The copepods occupied the first place both in the number and biomass in the Lakes Peipsi and Pihkva in September (the Peipsi: in the number 45.1, in the biomass 53.6%; the Pihkva: 43.6 and 57.7%, respectively); the cladocerans in the Lämmijärv (56.5% of the number and 58.2% of the biomass). The role of rotifers had become rather small both in the number (10.3—24.0%) and biomass (1.1—5.2%). Maksimova and Korytova (Максимова, Корытова, 1963) have come to analogical conclusions. The larvae of *Dreissena* occurred, but not in considerable numbers. They were probably disappearing in the zooplankton.

In October the copepods predominated in the Peipsi in 1965 (in the number 37.7, and the biomass 51.2%), the cladocerans in 1966 (in the number 50.7, in the biomass 58.2%). In the Lämmijärv and Pihkva, the cladocerans predominated in 1965 and in 1966, both in the number and biomass (the Lämmijärv: 1965 — 71.5 and 61.5%, 1966 — 86.4 and 84.7%; the Pihkva: 1965 — 72.2 and 60.3%, 1966 — 81.4 and 73.0%). The role of rotifers was small in the number (1.4—26.2%), and especially in the biomass (0.1—14.4%). No larvae of *Dreissena* were found.

In conclusion, we could say that the role of *Cladocera* in winter was quite negligible. Only beginning with May did their role in the zooplankton begin to increase. In June their role still increases, achieving the maximum in July and October in the Peipsi, in October in the Lämmijärv and Pihkva.

The seasonal dynamics of the role of rotifers is inversely proportional to that of cladocerans. During the winter months (both years), the rotifers are a predominating group in the number and biomass in all parts of the lake. In the number, they still predominate in June, but in the biomass their role is rather small, already. In July, September and October the role of rotifers continues decreasing. The minimum numbers occur mainly in October; in the Peipsi, in 1965, this happened in September. In the Peipsi, the minimum biomasses were observed in July, in the Lämmijärv and Pihkva either in September or October.

The seasonal dynamics of copepods is not so distinct as that of cladocerans (rise from winter to autumn) and rotifers (fall from winter to autumn). The copepods play a noticeable role in the zooplankton throughout the year (showing a certain rise in summer/autumn).

As proved by the earlier materials (Самсонов, 1913; Соколов, 1941; Соколова, 1951; Мяэметс, 1966), Lake Peipsi-Pihkva may be considered a water-body rich in zooplankton. In spite of the abundance of fish feeding on plankton, no decrease in the zooplankton can be observed even during the intense feeding period of the fish.

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PEIPSI-PIHKVA JÄRVE PELAGIAALI ZOOPLANKTONI SESOONSEST DÜNAAMIKAST

Resümee

Uuriti 1965. ja 1966. aastal Peipsi-Pihkva järvest kogutud 660 kvantitatiivset zooplanktoni proovi (joon. 1).

Peipsi-Pihkva järve pelagiaalis tehti kindlaks 99 zooplanktoni taksonoomilist üksust (tab. 1), millest kladotseerid moodustavad 41,4, kopepoodid 12,1, rotatoorid 45,5 ning molluskid 1,0%. Zooplanktoni liigiline koostis näitab, et Peipsi-Pihkva järv on mõõdukalt eutroofne veekogu, kusjuures järve kolmel osal (Peipsi, Lämmijärv, Pihkva järv) on mõnevõrra erinev troofsuse aste. Kõige eutroofsem on Pihkva järv, järgnevad Lämmijärv ja Peipsi. Peipsi on veel säilitanud mõningaid mesotroofsetele vetele iseloomulikke jooni.

Aluseks võttes eri sesoonidel domineerivad liigid, arvatakse provisoorselt, et Peipsi-Pihkva järve zooplankton kuulub *Synchaeta — Conochilus unicornis — Daphnia cucullata — Bosmina coregoni* tüüpi.

Nii zooplanktoni arvukuses ja biomassis kui ka üksikute zooplanktoni rühmade (*Cladocera, Copepoda, Rotatoria, Mollusca*) osatähtsuses zooplanktonis esineb Peipsi-Pihkva järves tugev sesoonne dünaamika (joon. 2—5 ja 7—9). Kuna Peipsi-Pihkva järve osad (Peipsi, Lämmijärv, Pihkva järv) on küllalt erinevad, on ka zooplanktoni sesoonne dünaamika ning selle amplituud neis mõnevõrra erinev. 1965. aastal kõikus zooplanktoni arvukus Peipsi järves 7600—350 000 eks/m^3 ja biomass 0,030—2,830 g/m^3, 1966. aastal olid vastavad arvud 2700—300 000 eks/m^3 ja 0,014—1,640 g/m^3. Lämmijärves kõikus zooplanktoni arvukus 1965. aastal 13 300—292 000 eks/m^3 ja biomass 0,075—1,838 g/m^3, 1966. aastal aga oli arvukus 14 800—230 900 eks/m^3 ja biomass 0,033—2,774 g/m^3. Kõige suuremad on arvukuse ja biomassi kõikumised Pihkva järves. 1965. aastal kõikus siin arvukus 7400—564 000 eks/m^3 ja biomass 0,009—2,562 g/m^3, 1966. aastal oli arvukus 11 200—503 600 eks/m^3 ja biomass 0,050—4,599 g/m^3.

Nii varasemate kui ka käesoleva uurimise tulemused lubavad Peipsi-Pihkva järve pidada zooplanktonirikkaks veekoguks.

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Toimetusse saabunud
3. X 1969

ЮТА ХАБЕРМАН

О СЕЗОННОЙ ДИНАМИКЕ ЗООПЛАНКТОНА ПЕЛАГИАЛИ ЧУДСКО-ПСКОВСКОГО ОЗЕРА

Резюме

Исследовано 660 количественных проб зоопланктона, собранного из Чудско-Псковского озера в 1965 и 1966 гг.

В пелагиали Чудско-Псковского озера установлено 99 таксономических единиц (табл. 1) зоопланктона, в том числе ветвистоусых 41,4, веслоногих 12,1, коловраток 45,5 и моллюсков 1,0%. Видовой состав зоопланктона показывает, что Чудско-Псковское озеро — умеренно эвтрофно, причем по трофности его три части (Чудское, Теплое и Псковское озера) несколько различны. Самое эвтрофное — Псковское озеро, следуют Теплое и Чудское. Чудское озеро сохранило еще некоторые черты, характерные для мезотрофных водоемов.

На основе видов, доминирующих в разные сезоны, зоопланктон Чудско-Псковского озера провизорно считается относящимся к типу *Synchaeta* — *Conochilus unicornis* — *Daphnia cucullata* — *Bosmina coregoni.*

Численность, биомасса, а также роль разных групп (ветвистоусые, веслоногие, коловратки, моллюски) в Чудско-Псковском водоеме подвергаются сильной сезонной динамике (рис. 2—5 и 7—9). Так как части Чудско-Псковского озера довольно различны, сезонная динамика зоопланктона в разных частях озера также несколько различна.

В 1965 г. численность зоопланктона в Чудском озере колебалась от 7600 до 350 000 *экз/м*^{3}, биомасса от 0,030 до 2,830 *г/м*^{3}, в 1966 г. соответственно 2700—300 000 *экз/м*^{3} и 0,014—1,640 *г/м*^{3}. Численность зоопланктона в Теплом озере колебалась в 1965 г. от 13 300 до 292 000 *экз/м*^{3}, биомасса — от 0,075 до 1,838 *г/м*^{3}; в 1966 г. численность — от 14 800 до 230 900 *экз/м*^{3}, биомасса — от 0,033 до 2,774 *г/м*^{3}.

Самые большие колебания численности и биомассы наблюдаются в Псковском озере. В 1965 г. численность зоопланктона колебалась от 7400 до 564 000 *экз/м*^{3}, биомасса — от 0,009 до 2,562 *г/м*^{3}; в 1966 г. соответственно 11 200—503 600 *экз/м*^{3} и 0,050—4,599 *г/м*^{3}.

Как предыдущие исследования, так и настоящая работа позволяют считать Чудско-Псковское озеро водоемом, которое богато зоопланктоном.

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