The restoration of benthic fauna in small "Lamba" lakes after treatment with polychloropinene

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The restoration of benthic fauna in small humic "lamba" lakes after treatment with polychloropinene by O.N. Gordeev, M.N. Rusanova

This report is part of a series "Fisheries exploitation of small forest 'lamba' lakes" undertaken by the Department of Zoology and Darwinism of Petrozavodsk University.

Our work is based on experiments in the use of "lamba" lakes for the culture of commercial fishes and includes the study of the benthos food resources for fish stocked, their seasonal dynamics, the effect of chemical modification and ichthyocides on bottom fauna and the processes of restoration of fauna after detoxication.

Work along these lines is being done by a number of research institutes: GosNIORKh and its branches, Belorussia University, the Institute of Zoology and Botany of the Estonian SSSR and others.

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

1"lamba" is a term used for a lake without an outlet, especially in a forest, for which no English equivalent could be found.
In contrast to the work of the above-mentioned institutions, our research was carried out in dystrophic bodies of water which were subjected to the influence of swamp waters. These bodies of water are characterized by a gradual transition from mesohumic eutrophic to typically acidic and have the following features.

Linda lamba is a typical eutrophic mesohumic body of water with an average depth of 3.7 m. It has a clearly defined zone of macrophyte beds up to 30 m in width. The most abundant of the macrophytes are the reed, bulrush, horsetail, a few species of pondweed, the water-lily, etc.

Maximum water transparency is 2.2 m; pH is close to neutral; comparatively low indicators of oxidizability are characteristic due to the low humic content in the water of the lake. Biogenic elements - nitrogen and phosphorus - are present in negligible quantities even in the summer. Benthic fauna presented considerable variety in the peripheral macrophyte zone before treatment of the water with polychloropinene.

Insect larvae fauna are very abundant here: dragon-fly, caddis fly, beetles, dipterons, mayflies, etc. Of the mollusks, Galba palustris, Limnaea stagnalis, Radix ovata, R. auricularia, planorbids, valvatas, Bithynia leachi and bivalves are common. In addition, oligochaetes, turbellaria, leeches, sponges, water mites, micro-benthic crustaceans, etc., are found.

The composition of the population in the mud zone is more uniform and is represented mainly by chironomid larvae (Psectrocladius gr. medius, Tendipes plamosus), Chaoborus and bivalve mollusks. The average biomass of benthos for March, May and June 1962, before treatment with polychloropinene, was 29.3 kg/hectare with an abundance of 4682 thousand organisms per hectare.

Kover lamba differs from Linda Lamba in having a higher humic
content and is a dystrophic mesohumic body of water. Average depth is 3 m. The macrophyte beds zone is comparatively less developed. Usual among aquatic macrophytes are the bur reed, several species of pondweed, horsetails, Nuphar, Nymphaea, the reed. The shores are very swampy. The reaction of the environment is more acidic (pH 5.9 – 6.8). The waters are not very transparent because of the large humus content (9.9 according to the Secchi disc). Oxidizability is high (up to 29.6 mg O/1) due to the presence of humic matter. Phosphorus and nitrogen content are minimal.

The littoral macrophyte bed zone differs from the same zone in Linda lamba lake in having a less varied population. Found here are turbellaria, insect larvae (caddis flies, dragon-flies, mayflies, chironomids) water mites, oligochaetes, gastropods, bivalve mollusks, (lake limpet (Ancylus), common pond snails, physas, planorbis mollusks, Pisidium amnicum, orb shells). The mud zone is poorer in fauna and presents mainly chironomid larvae (54.4%), Chaoborus, mollusks of the genus Pisidium and oligochaetes. Average biomass before poisoning of the lake with polychloropine ran to 15 kg/hectare.

The Voronovskaya "lamba-1" is a typical dystrophic acidic body of water and is mainly spring fed. Large depths extend right up to the shores. Maximal depth of the lamba is 7.5 m. The water is a greenish-yellow color, transparency amounts to as much as 3 m, pH is 5.4. Low pH readings are apparently caused by the large sulphate content in the water. The waters of the lake also have an extremely low organic matter content, and for this reason the oxidizability of the water is negligible (7.15 mg O/1). Aquatic vegetation consists mainly of mosses. The benthic population of the lake is uniform and consists almost exclusively of insect larvae (chironomids,
Chaoborus, mayflies, orlfies, and caddis flies), oligochaetes and Pisidium are found singly. The biomass of benthic fauna before treatment of the lake with polychloropinine was 3.2 kg/hectare with abundance of 820 thousand specimens/hectare.

Treatment of the lakes with polychloropinine took place at different times. First treated was Kover lamba (August 22, 1961 with a polychloropinine concentration of 0.0625 mg/l). The lake was treated a second time with polychloropinine at a concentration of 0.375 mg/l. Linda lamba and Voronovskaya lamba were treated in July 1962 with a polychloropinine concentration of from 0.09 to 0.11 mg/l.

As our observations and those of other researchers (Zabolotskii, 1966; Mantel'man, 1963) have shown, the destructive effect of the polychloropinine ichthyocide on the organisms of benthic fauna varies. The least resistant to the action of polychloropinine were Chaoborus larvae, caddis fly larvae, dragon-fly larvae, some species of microbenthic crustaceans (for example Eury cercus lammelatus) and oxyphilic forms of chironomids.

The most resistant to the action of polychloropinine were oligochaetes, different species of gastropods, Sphaerium and Pisidium and some species of chironomid larvae adapted to living in conditions of oxygen deficit (Procladius, Tendipes plumosus).

These observations entirely agree with findings cited by A.A. Zabolotskii (1966) for lakes of the Veshkelitsy group. The dying off of fauna took place gradually in all of the lakes studied, and for this reason, a sharp decrease in the abundance and biomass of organisms was not observed at first, and in some cases an increase was even observed, which apparently is due to the loss of mobility of organisms and disturbance of the usual oxygen regime not only in benthic layers but also in
the subsoil. Thus, for example, oxygen content at the bottom in Kover lamba before treatment with polychloropinene was 6.53 mg/l, which after the introduction of the ichthyocide decreased to 2.84 mg/l. This caused mass migrations of organisms from the subsoil to the surface. For this reason, a small increase in the abundance and biomass of organisms is observed initially in some cases.

The direct action of the polychloropinene on organisms appears more retarded with low water temperatures (in fall), as was observed in Kover lamba, and for this reason sharp decrease in the abundance and biomass of organisms in this lamba appeared only in April and particularly in May when the water warmed up. A sharp decrease in abundance and biomass of organisms was observed in the Voronovskaya lamba as soon as 1.5 months after the introduction of the ichthyocide into the body of water.

Not all benthic fauna disappeared in the lakes studied as the result of the polychloropinene ichthyocide (used in concentrations ranging from 0.09 to 0.375): some forms, mainly oligochaetes and mollusks (Pisidium, limmaeids), survived.

The natural restoration of the benthic fauna took place at varying rates and greatly depended on the type of water body. This process took place most rapidly in Linda lamba, where aquatic vegetation is well developed, especially in the littoral macrophyte zone. A marked restoration of fauna was observed in May, when larvae of different insects (dragon-flies, chironomids, tabanids and other diptera) appeared among the population. However, the dominant group during the first year was Pisidium mollusks (up to 57%).

In Kover lamba, marked restoration of fauna also began in May. However, insect larvae (chironomids, Chaoborus, etc.) had somewhat less
importance here. The dominant benthic forms were Pisidium mollusks.

In the Voronovskaya lambda, where the littoral zone is barely developed, the restoration of fauna was not observed for 1.5 years. This is apparently explained by peculiarities of the hydrological cycle and the absence of a littoral zone of macrophyte growth.

In Linda lambda, a year after treatment with polychloropinene, in June 1963, the fauna was restored to 25% of its original abundance and 20% of its original biomass. The composition of the fauna was more varied here, although the dominant species in the mud zone were still mollusks (57%).

In Kover lambda, also after a year in June 1962, abundance of bionts was restored to only 5.5% of its initial value and the biomass to 33.3%. The relatively large biomass value was caused by the prevalence of Pisidium mollusks, which at that time made up 90% of the total biomass. Replacement of the dominant forms of chironomids by mollusks and oligochaetces took place here. The role of secondarily aquatic organisms declined relatively.

In the second year, in June 1963, after treatment of Kover lambda with polychloropinene, the role of secondarily aquatic organisms had already increased, and the proportion of mollusks gradually decreased (from 60 to 29%). The total average abundance of bionts rose to 11%, although a certain decrease in biomass (down to 25%) was observed, which can be explained by the consumption of fauna by stocked-in carp. Research showed that the role of benthic fauna in the feeding of the carp increased considerably.

By fall 1963, the biomass and abundance of benthic fauna had increased considerably in Linda lambda but had barely increased in Kover
lamba (due to grazing by carp). Given below is a table which illustrates this (table 1).

### Table 1

Restoration of fauna in terms of initial values (P — abundance, spec./m², B — biomass mg/m²), %.

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<td>-</td>
<td>-</td>
<td>25</td>
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**Key**

1 - lake  
2 - date of polychloropinene treatment  
3 - June 1962  
4 - July 1963  
5 - October 1963  
6 - Linda Lamba  
7 - Kover Lamba  
8 - Voronovskaya "lamba-1"  
9 - July 23, 1962  
10 - August 22, 1961  
11 - September 15, 1961  

Average indicators of abundance and biomass of benthos for 1963 have the following values (table 2).

In all lakes studied, the process of restoration of benthic fauna took place more rapidly in the littoral macrophyte zone than in the mud zone. More species diversity was observed here especially because of secondarily aquatic organisms (gastropods, mollusks and insect larvae). Enrichment with fauna took place due both to the development and reproduction
of forms remaining in the body of water, and to replenishment from adjacent lakes.

Table 2

Indicators of benthos abundance and biomass in "lamba" lakes in 1963

<table>
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<tr>
<th>Группы</th>
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<th>Вороновская ламба</th>
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<tr>
<td>7</td>
<td>19,0</td>
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<td>9,9</td>
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<td>12</td>
<td>176,0</td>
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Key
1 - groups
2 - Linda lamba
3 - Kover lamba
4 - Voronovskaya lamba
5 - abundance, spec/m²
6 - biomass mg/m²
7 - oligochaetes
8 - chironomids
9 - sphaeriids (Pisidium and Sphaerium)
10 - gastropods
11 - other groups
12 - total

Comparing our findings with those of Vladimirova (1963) on Zhemchuzhnoe Lake (oligohumic oligotrophic body of water), it can be stated that the processes of restoration of fauna after treatment of the lakes with polychloropinene took place at different rates. In oligohumic oligotrophic lakes, according to Vladimirova's data, a peak was observed in the development of fauna a year after the
introduction of polychloropinene and biomass increased more than 26 times in comparison with initial values, while the biomass of the major surviving form, *Radix pereger*, increased 720 times and its abundance 54 times. Such a phenomenon was not observed in the lakes which we studied: the process of restoration of fauna occurred most rapidly in the eutrophic mesohumic body of water, and fauna were scarcely restored in the dystrophic acidic body of water for 1.5 years after polychloropinene poisoning.

In all bodies of water treated with polychloropinene, liming was performed and fertilizers were added in the form of superphosphate and ammonium nitrate. This helped to change the hydrochemical cycle of the lakes (change of pH from acidic to neutral and slightly alkaline, increase in biogenic elements, increase in oxidizability, etc.), which favorably affected the development of phyto- and zooplankton and promoted rapid growth of higher aquatic vegetation, without causing an increase in the abundance and biomass of benthic fauna. The effect of fertilizers on the development of fauna appeared 3-5 years later in the form of a change in the structure and composition of benthic deposits. This is confirmed by O.N. Gordeev's experiments on the fertilization of Kover *lamba* in 1948, when the biomass of benthos grew from 2.4 to 15 kg/hectare by 1961, and by subsequent research in the above-mentioned lakes.

Our observations on the restoration of fauna after polychloropinene treatment convincingly demonstrate that it is not expedient to stock fish benthophages in dystrophic bodies of water during the first 2-3 years after chemical modification with polychloropinene since food resources are restored slowly.

In addition to fertilization of bodies of water, for faster
restoration and enrichment of bottom fauna, it is desirable to carry out acclimatization measures, primarily the spread of eggs and larvae of insects.

Seasonal dynamics in the distribution of benthos are clearly seen in the restoration of fauna in all lakes studied, and are basically determined by change in the abundance and biomass of the dominant groups: chironomids, *Pisidium* mollusks and partly oligochaetes.

In the first year after treatment of lakes with polychloropinene, chironomids in lambas were represented by only a few groups: *Procladius*, *Psectrocladius* and *Tendipes*.

The number of species does not exceed 5-7.

In the second year, chironomid the fauna was considerably enriched and was already represented by 9 species in Kover lamba.

Seasonal dynamics of this group appear most distinctly in Linda lamba and Kover lamba.

In Linda lamba, the dominant species are *Psectrocladius gr. medius* and *Tendipes plumosus*. Here decrease in the abundance and biomass of chironomids is observed twice: in May and in August, and is due to the biology of the dominant forms. The mass emergence of adult insects *Psectrocladius gr. medius* and *Tendipes plumosus* takes place in May. The second emergence of *Tendipes plumosus* is observed in August. This leads to considerable decrease in biomass and abundance of chironomids.

In Kover lamba, despite the considerably greater number of species, the dominant form is *Procladius*. It has one generation and mass emergence of adult insects is observed in the spring in April and May. This also leads to sharp decrease in the abundance and biomass of chironomids. The abundance of the remaining species is negligible and has practically no
effect on the dynamics of this group.

Increase in the abundance and biomass of *Pisidium* mollusks from spring to August is observed in all bodies of water. A certain decrease occurs in these indicators in August, followed by gradual increase towards fall. It is so far difficult to explain the decline in abundance and biomass of *Pisidium* in August without knowing the biology of the dominant forms but it can be assumed that this decline is connected with the reproduction and dying off of adult individuals after reproduction, since abundance increases towards fall, while biomass remains at the level of the summer months, which indicates a clear predominance of younger age groups in the population.

Oligochaetes populating these lakes reproduce mainly in the spring and summer, and for this reason a gradual increase in their abundance and biomass is observed in the summer and fall.

Analysis of the seasonal dynamics of benthos shows the necessity for taking account of these phenomena in carrying out fish culture measures (supplementary feeding of fish in a period of decline in abundance and biomass of bionts, cultivation of new food items having different biological features, and also when cultivating stocked-in fish).

References


Bibliography