Structure and dynamics of zooplankton in lakes of the Tom river floodplain

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Abstract. A study on zooplankton species composition, seasonal dynamic of numbers and biomass of three large floodplain’s lakes of the Tom River basin (near Tomsk, Western Siberia, Russia) during one year has been carried out. It has determined considerable transforming of qualitative and quantitative indicators of zooplankton communities during a year. The maximum qualitative indicators were registered in late spring and summer, the minimum ones – in winter. By the structure of zooplankton, the examined lakes water ecological status falls into class 1-2 of water quality (“moderately polluted” water). The most favourable conditions for zooplankton communities forming are in Boyarskoye and Shuchie lakes, the most unfavourable – in Kalmatskoe lake.

1. Introduction
In a context of quick development of aquaculture in the Western Siberia (Russia), the issue of natural foods for fish in the potentially suitable for aquaculture lakes is particularly relevant. By the present, in the boreal zone of the Western Siberia the main attention has been paid to the zooplankton of streams [3, 5, 12, 14], and data about zooplankton of lakes belong to the middle of the twentieth century [6, 7]. The aim of this work is to study the modern state of species composition, quantitative characteristics and seasonal dynamics of zooplankton communities in typical lakes of the Tomsk Region for estimate the possibility of pasturable aquaculture.

2. Materials and methods
Three natural origin flood-plain basins, located on the left bank of the Tom River, were selected for the study: Boyarskoye lake (56°27′13″ N, 84°54′46″ E), Shuchie lake (56°28′19″ N, 84°54′8″ E), Kalmatskoe lake (56°25′21″ N, 84°56′60″ E). The study of zooplankton in these lakes was carried out for the first time. Sampling and cameral treatment were performed using the standard methods [1, 2, 4, 8-11, 13, 15].

3. Results and discussion
The zooplankton of the lake complex differed in taxonomic diversity, significantly changing during a season. On the whole, species composition of Boyarskoye lake consists of 36 species, 8 of them – Rotifera, 11 – Copepoda, 17 – Cladocera. The minimum species diversity
was observed in winter with a predominance of cladocerans (dominant species *Daphnia pulex* Leyding, 1860); the maximum – in summer, with biodiversity maximum in June, when the quantity of three groups of zooplankton organisms was approximately the same (dominant rotifers, genera *Asplanchna* Gosse, 1850, *Euchlanis* Ehrenberg, 1832, *Keratella* Gosse, 1851; Cladocera *Chydorus* Muller, 1785, *Polyphemus* Muller, 1785, *Scapholeberis* Schoedler, 1858; Copepoda *Cyclops* Muller, 1776, *Mesocyclops* G.O. Sars, 1914). rotifers were not registered in October, December, January and March.

In Shuchie lake 40 zooplankton species were registered, 16 of them – Rotifera, 10 – Copepoda, 14 – Cladocera. The minimum diversity was observed in February (dominant species *Keratella coechlearis* Gosse, 1851, *Mesocyclops leucarti* Claus, 1857) and in April, when only copepods were registered in the lake. The biodiversity pinnacle occurred in June with a predominance of genera Cladocera different species (dominant species *Chydorus* and *Alona* Muller, 1785, and a little copepods genera *Cyclops*, *Mesocyclops*).

The species composition of Kalmatskoe lake includes minimum genera among the studied lakes (30), 15 of them - Rotifera, 3 – Copepoda, 12 – Cladocera. From December to May species diversity in the lake was insignificant (no rotifers were registered), while in summer maximum genera was observed. In June and August cladocerans prevailed (mainly *Bosmina longirostris* Muller, 1785), in July – rotifers (genera *Flinia* Ehrenberg, 1834 and *Keratella*).

Thus, the serial change of complexes, different in genera, was observed during the season. The study of species composition revealed that the maximum taxonomic diversity of zooplankton organisms was observed in Shuchie lake, the minimum one – in Kalmatskoe lake.

The dynamics of quantity and biomass of zooplankton have been monitored during the whole season. In Boyarskoye lake maximum values of quantity and biomass were observed in summer with the peak in August (quantity – 14.6 thousand individuals/m³, biomass – 1.97 g/m³). The quantity of zooplankton was determined as approximately equal shares of rotifers, copepods and cladocerans (mostly through juvenile phase), biomass - copepods and cladocerans with the highest peaks in June and August. Slight decrease of quantitative indicators was registered in July (figure 1 a). The productivity of the lake, estimated by zooplankton biomass [5] was moderate in this period (α-mesotrophic water type).

Minimum quantitative indicators were recorded in winter: quantity – 0.21 thousand ind./m³, biomass – 0.05 g/m³ in January. The change of the complexes of dominant groups was observed during this period with adults predominance (mostly, copepods), so the indicators of quantity and biomass were rather high for this period (in February-March) due to the copepods transformation out of diapauses and appearance of juvenile phase. A slight increase of copepods quantity and biomass was registered in late spring. The lake trophicity in spring and winter was “extremely low” (α-oligotrophic water type). Extraordinarily high quantity and biomass indicators (4.01 thousand ind./m³ and 1.25 g/m³ respectively) were observed in December samples due to lower crustaceans reproduction (figure 1 a).

In Shuchie lake maximum quantitative zooplankton indicators were registered in June with the peak of 38.59 thousand ind./m³ and 1.87 g/m³. Quantity and biomass of zooplankton estimated mainly by cladocerans, a bit less by copepods and juvenile phases. The highest quantity of Rotatoria per season was also registered (figure 1 b).
Figure 1. Season quantity and biomass dynamics of zooplankton in the lakes of the Tom River floodplain, the Western Siberia, Russia
a – Boyarskoye Lake, b – Shuchie Lake, c – Kalmatskoe Lake.
Zooplankton biomass lake trophicity was estimated as “moderate” (α-mesotrophic water type). A sharp decline of the indicators was observed in July. High quantitative indicators with Rotatoria predominance were observed in May, August and October; high biomass indicators with copepods predominance (mainly, nauplii) were observed in May and October (with cladocerans predominance), while Rotifera biomass remained persistently low during the whole season. Minimum quantitative and biomass indicators were registered in early spring and winter (minimum in April: quantity 0.01 thousand ind./m³, biomass – 0.01 g/m³, only copepods were registered in samples). At the same time, the quantity of zooplankton during these seasons was mainly related to rotifers and biomass – to copepods (figure 1b). The lake trophicity during this period estimated as “extremely low” (α-oligotrophic water type).

The study of quantitative indicators in Kalmatskoe lake has indicated that the peak values were registered in June (quantity – 17.11 thousand ind./m³, biomass – 0.73 g/m³). Quantity and biomass of zooplankton mainly consisted of copepods and rotifers. Besides, high quantitative and biomass indicators were registered in April (maximum biomass indicators 0.87 g/m³ were provided mainly by Copepoda juvenile and adult phases) and in May, August and October with Crustacea predominance (figure 1c).

The lake trophicity estimated as “low” (β-oligotrophic water type). In the ice-free water low quantitative indicators of zooplankton were registered in July due to the water temperature increase and the decrease of the oxygen dissolved in water because of the organic residues decay, that caused death and fall into a diapause of zooplankton organisms. Minimum indicators were registered in early spring and winter (minimum quantity 0.02 thousand ind./m³, biomass – 0.001 g/m³ in January) (figure 1c). The lake trophicity during this period was “extremely low” (α-oligotrophic water type).

Quantitative indicators of rotifers in Kalmatskoe lake during the season were consistently low with the peaks of quantity in June and October. High indicators of Copepoda biomass and quantity were registered from March to August with the peaks in April, May, June and August, minimum ones – in winter. Cladocera quantitative peaks were recorded in June and August (figure 1c). It was found that in Kalmatskoe lake copepods prevailed by quantity and biomass.

An average zooplankton quantity in Boyarskoye lake during the season was 4.52±1.43 thousand ind./m³, in Shuchie Lake - 6.4±3.33 thousand ind./m³, in Kalmatskoe Lake - 3.82±1.46 thousand ind./m³; biomass – 0.52±0.18 g/m³, 0.23±0.16 g/m³ и 0.19±0.09 g/m³ respectively.

Comparing the quantitative indicators of three examined lakes it was revealed that minimum zooplankton quantitative and biomass indicators during the season were registered in Kalmatskoe lake. This may be caused by small depth, immense quantity of decaying organic, lack of oxygen. Maximum hydrocoles quantitative indicators were registered in Shuchie lake, biomass indicators – in Boyarskoye lake.

Pantle-Buck saprobity index of indicated zooplankton species in studied lakes varied insignificantly. An average annual saprobity index in Boyarskoye lake was 1.68±0.11, in Shuchie lake – 1.60±0.03, in Kalmatskoe lake – 1.57±0.07, which corresponds to β-mesosaprobic conditions.

According to our study zooplankton community species diversity of three studied lakes significantly varies during the season. Maximum taxonomic variety was observed in summer with cladocerans predominance in June, minimum one – in winter with copepods predominance. Among three groups of zooplankton organisms cladocerans and rotifers had
maximum quantity of species, while copepods had the minimum. Besides, the lakes were comparable to rotifers and cladocerans species composition but at the same time, each lake varied by its unique genera.

The study of the season dynamics of quantitative zooplankton development in these lakes revealed significant change of the indicators during a year. Maximum values were registered in late spring and summer with the peak in June (a period of multiple reproduction of rotifers, copepods and cladocerans and high increase of juvenile phases) and a sharp decline in July (most zooplankton organisms undergo a diapause). Minimum values were registered in late autumn when most species underwent a diapause and adults were unable to reproduction. The basins trophicity in summer was “moderate” and “low”, the rest of the year – “extremely low”.

4. Conclusion
According to our studies, quantitative and qualitative indicators of zooplankton an zoobenthos significantly change during a season. Maximum zooplankton indicators were registered in June, minimum – in winter. The general ecological water condition by the zooplankton structure falls into class 1-2 of water quality (“moderately polluted” water).

Judging by the structure of zooplankton in the studied lakes it can be concluded that the most unfavorable conditions for the zooplankton community formation are in Kalmatskoe lake. The lake is characterized by low quantitative indicators and by reduction of its structure. Boyarskoe and Shuchie lakes have the most favorable conditions with the “moderate” trophicity in vegetation period.

In the studied lakes copepods and rotifers in equal shares were the most numerous, cladocerans were spread to a lesser extent. Copepods dominated by biomass, cladocerans were rarer. The biomass of rotifers was the minimum.

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