Distribution of planktonic copepods of Lake Baikal

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Abstract

Net samples taken in the pelagic zone of Lake Baikal have revealed 6 Calanoidea species, 14 Cyclopoida species and 1 Harpacticoida species. The paper reports the occurrence and abundance of these species in different pelagic biotopes of the lake in 1988–1995. © 1998 Elsevier Science B.V. All rights reserved.

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1. Introduction

At present, 114 benthic, planktonic and phytophilous Copepoda species and subspecies are known to inhabit Lake Baikal (Tsimoshkin et al., 1995). Of these, 21 species have been found in plankton net samples (Sheveleva et al., 1995): 6 Calanoidea species (all of them planktonic), 14 Cyclopoida species (only 4 of which—Cyclops kolensis, C. vicinus, Mesocyclops leuckarti, Thermocyclus cassus—are obligate planktonic forms according to Murepov (1978)) and 1 benthic endemic species—Harpacticella aquatica (Harpacticoida).

So far, two planktonic species, dominating in the open waters of the lake, have been given most of the attention by researchers: Epischura baikalensis (Calanoidea)—the only endemic among planktonic copepods; and Cyclops kolensis (Cyclopoida). Other species, living in the lake’s shallower parts, have not been studied regularly or for long periods (Tsimoshkin et al., 1995). Nevertheless, biological peculiarities of these species of Lake Baikal are of an undoubted interest, particularly for evaluating the state and dynamics of the lake’s ecosystem. This concerns, first of all, the phenomenon of their spreading into open waters of the lake in some years. The purpose of this paper is to assess the occurrence and abundance of copepods in various pelagic biotopes of Lake Baikal in the recent years (based on the 1988–1995 data).

2. Materials and methods

The samples were taken from 1988–1995 in the pelagic zone of Lake Baikal in shallow water regions, where the bottom was from 1 m to 20–50 m deep and in the deep-water regions. An 80–100 micron mesh Juday net was used, with a 1/9 or 1/10 m² mouth. In open waters the samples were taken from the 0–50 m water layer, near the shore—from bottom to surface. Two periods were under study: (11
June, when winter-spring communities stop their development in Lake Baikal and horn-thrifty sets in, and (2) July–October, when summer-autumn species develop.

In accordance with the existing scheme of ecological zoning (Kortov, 1963) six distinguished lake regions as examples of different types of planktonic biotopes. Type I—open waters—includes: (1) deep-water pelagic zone of the southern, central and northern basins with depths ranging from 50 m to 1600 m (Fig. 1); and (2) the water mass over a shallow and narrow bottom platform along open coastline, where there are no tributaries or deepset coves or bays and where the influence of cold water from deep water regions dominates. Type II biotopes are shallow water regions near the coast of Lake Baikal around small tributaries and so-called 'sors' (well-warmed water areas isolated from the open water by sand spits and islets). Regions around the estuaries of big tributaries—the biggest of them being the Selenga River (Fig. 1), where the so-called Selenga shallow lies—are also included into this group of biotopes.

Type II biotopes includes large bays (Chisvyrykay, Baryuzin) and Malaya More strait (Fig. 1).

Fig. 1. Map of Lake Baikal.
The total number of samples taken in all of the above biotopes is 216. The occurrence (9%) was calculated dividing the number of samples where the species was found by the total number of samples taken in that region of the lake.

3. Results

Open waters of Lake Baikal is a cold water biotope. Even in summer the temperature of surface layers reaches only 12–15°C (Kozhov, 1963), while our 1988–1995 data put it at 0.5–5.8°C in June and 7.0–17.3°C in July–October. In shallows and estuary zones the warming effect of tributaries and sors is felt, they warm up quicker so that the surface temperature here is higher (3.2–11.2°C) in June. In the summer–autumn period these areas are often influenced by cold open waters due to storms and winds so that both high and low temperature values may be observed here (6.3–17.6°C). In the shallower parts of Chivyrkuy, Barguzin Bays and Mal’yo More Strait the water temperature in summer may exceed 20°C (Kozhov, 1963), but the deeper parts are also af-

![Diagram](image-url)

Fig. 2. Percentage of algal community coverage number for 1988–1995 (July–October) in various regions of Lake Baikal. I = open waters; II = shallow waters; III = deep zones; IV = Chivyrkuy bays; V = Barguzin bays; VI = Mal’more bays; 1 = species of second and third groups; 2 = *Cyclops kolaicus*; 3 = *Epithemia balanodes*. 
ected by open waters. So the water temperature distribution here is not uniform either; the values vary from 3.1 to 10.4°C in June and from 3.9 to 18.0°C in July–October.

By their abundance and occurrence in the pelagic zone 4 groups of Copepods species may be distinguished: (1) rare and not numerous (up to tens of specimens per m³), (2) not numerous but found in various parts of the lake and practically every year; (3) mass (up to hundreds–tens of thousands of specimens per m³) but found in particular areas of the lake; (4) mass, found every year in all types of biotopes.

The first group includes Acartia raffae and Neorodiaptomus incognitus as well as benthic species caught in the plankton net by incident (Hypocylops profunda, Eucyclops macrurus, Paracyclops fimбриatus, Microcyclops bicolor, Acanthocyclops konstantini). The species of this group were not found in any part of the lake in June, and in the summer–autumn period they were encountered only in Barguzin Bay and the Streltza shallow. They account only for 0.1% of the total number of copepods and so were not included in Figs. 2 and 3.

The following species can be included into the second group: Heterocylops appendiculatus, Neorodiaptomus pachypleura, Cyclops vicinus and benthic and phytophilous forms more or less widespread in the lake (Harpacticella lepini, Macrocylops albula, Dacycylops bipinatus, Acanthocyclops vernalis, A. viridis and Eucyclops serrulatus). In August at one station in Chivyrkuy Bay, the latter two species were found in quantities of several thousands of specimens per m³. Net samples taken in June did not contain species of this group. In July–October they did not exceed 1% of the total number of copepods (Fig. 2), their occurrence did not exceed 50% (Fig. 3: 3, 4, 6) and they were absent from some areas of the lake.

The species of the third group (Eudiaptomus gracilipes, Mesocyclus leucym, Thermocyclops

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**Fig. 3.** Occurrence (%) of planktonic copepods in various regions of Lake Baikal in July–October 1988–1993. 1 = open waters; 2 = shallow waters; 3 = Shushensh shallow; 4 = Chivyrkuy bay; 5 = Barguzin bay; 6 = Mylona island. (A) Lake Baikal: 1 = Eudiaptomus gracilipes; 2 = Eudiaptomus minutus; 3 = Heterocylops appendiculatus; 4 = Neorodiaptomus pachypleura; 5 = Cyclops vicinus; 6 = Mesocyclus leucym, 7 = Thermocyclops ovarius;
crassus) are dominant and subdominant in the Baikal sea zooplankton (which was not the subject of our investigation) and in shallower areas of bays, estuaries and Maloye More. In our samples from the shallower part of Chivykhoy Bay (Fig. 2: IV), they accounted for 19% of the total quantity (in other areas they did not exceed 1-2%). When water temperature exceeded 20°C their numbers reached tens of thousands per m³ (Mazepova, 1978). In June (our data) they can already be found in shallow water plankton though in single specimens. In August—September of unusually warm years during long-lasting spells of calm weather these species spread into open waters. Thus, the occurrence of E. granulatus, M. leuckarti and P. crassus in the years under consideration was high in all parts of the lake, and in the open waters it reached 43, 52 and 29%, respectively (Fig. 3: 2, 7, 8).

The fourth group includes Cyclops hudsonicus and Ceratophylus kolensis, inhabiting the pelagic zone of the lake the year round. They are the most widespread copepod species in Lake Baikal (Fig. 3: 1, 5). They dominate in most part of the water area but the cyclopic E. hudsonicus lives mainly in open waters (Fig. 2: I) and is also numerous in areas where shallow and open waters mix (Fig. 2: II, III). Cyclops kolensis is particularly numerous in large bays and shallows (Fig. 2: IV, V, VI). Where water temperature exceeds 14-15°C E. hudsonicus, as a rule, ‘displays plerion’ to C. kolensis or disappears from the plankton; its abundance in these areas falls dramatically (Fig. 3: 4). On the other hand, C. kolensis, in periods of maximum water warming (> 20.2°C) in the Baikal seas and in the shallower parts of bays that vanishes from the plankton and is replaced by species of the third group.

4. Conclusion

The general situation in respect to copepod distribution in Lake Baikal is the same in any part of the lake; the most diverse both in number of species and life forms are shallow water communities. In areas unaffected by the cold open waters widespread Palearctic species dominate. In areas where open waters mix with nearby waters or those of the ria-riviers the eutelic E. hudsonicus dominates, as a rule, though some non-eutelic species can also reach high numbers. In 1985-1995 we have found 15 copepod species (both planktonic and benthietric) in such areas. Open waters in contrast have the smallest number of species living there: E. hudsonicus and C. kolensis. Other copepod species were very rarely encountered here during the 60-80’s (Timoshchik et al., 1995). But in the period under consideration here a rise in open water temperatures was registered (M. Shimoako, pers. communt., 1990). This accounts for a comparative widespread of comparatively thermophilic species from shallow into deep water areas. In 1993-1994 we found 11 copepod species in open water areas. The occurrence of Eulimnogammarus granulatus and Mysis relicta leuckarti reached 43 and 52%. This is the peculiarity of the period of our investigations.

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