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Abstract

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50 YEARS OF ICHTHYOLOGICAL AND HYDROBIOLOGICAL RESEARCH IN MONGOLIA – A REVIEW

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Abstract: Exactly 50 years ago, an ichthyological and hydrobiological team was established within the framework of the Joint Soviet-Mongolian Complex Biological Expedition by the Academy of Sciences of the USSR and the Mongolian Academy of Sciences. All these years, this team has been conducting regular ichthyological and hydrobiological research in Mongolian waters. During this work in aquatic ecosystems of Mongolia by Mongolian and Russian scientists, a number of breakthrough results were obtained that were fundamentally new for biological science. These include diversity and adaptations of aquatic organisms to the specific conditions of waters in the semi-arid zone, the dynamics of ecosystems during cyclic climate changes, the microevolution of living organisms, and the peculiarities of the formation of ecosystems of reservoirs in semi-arid regions. For the first time, the abundance and biomass of bacterioplankton, phototrophic picoplankton, and heterotrophic nanoflagellates has been determined in lakes, rivers, and reservoirs of Central Asian Internal Drainage Basin. As a result of joint research, it was concluded that the waters of Mongolia are inhabited by 78 species of fish, and one species of lamprey; four new for science species of fish from the family Balitoridae and mechanisms of formation and adaptations of intraspecific "forms flocks" of fish of the genus *Oreoleuciscus* have been described. Studies of planktonic organisms, in particular Cladocera (Crustacea), have helped to clarify the taxonomy and distribution of a number of species. The ecosystems of periodically drying lakes in the semi-arid zone have been studied in detail. Unique cyclical microevolution of *O. humilis* have been discovered. Prospects team's studying are seen in continuing research into aquatic ecosystems in Mongolia in the context of climatic and anthropogenic impacts. Work will continue on the problem of providing Mongolian people with clean water. In terms of fundamental research, genetic, epigenetic and ecological studies of aquatic organisms are of great interest.

Keywords: Mongolia, aquatic ecosystems, aquatic organisms, fishes, adaptations, cyclic diversification

Introduction. Scientific research of biota of Mongolia's rivers and lakes began about 150 years ago. Detailed reviews of earlier periods of these studies have been published previously (Dulmaa, Dgebuadze, 1983; Dgebuadze et al., 2010). If we talk about systematic regular studies of aquatic ecosystems in Mongolia, the first (1959-1960) and second (1970s) a Joint Hovsgol Lake Biological Expeditions of the Irkutsk and Mongolian State Universities were of great importance. As a result of the work of these expeditions, data were obtained on the diversity and production of phyto, bacterial and zooplankton, benthos and fish of Hovsgol Lake and the Selenga River (Dashdorzh, Demin, 1977; Kozhova, 1983; Zagorenko, 1983).

In 1975 ichthyological team was established in frame of the Joint Soviet-Mongolian Complex Biological Expedition by the Academy of Sciences of the USSR and the Mongolian Academy of Sciences (since 1991 - Joint Russian-Mongolian Complex Biological Expedition by the Russian and Mongolian Academies of Sciences - JRMCBE). Initially, the main tasks of the team were a complete inventory of fish fauna, studying their ecology and identifying the possibilities of their economic use. However, from the first years of the team's work, the range of research significantly expanded and began to include issues of the productivity of aquatic ecosystems, issues of taxonomy and distribution of not only fish, but also all aquatic organisms, as well as issues of morphogenesis and evolution. Soon this research group began to be called the team for ichthyology and hydrobiology of JRMCBE. It should be noted that the original direct participation in the development of the plan for research of aquatic ecosystems in Mongolia was taken by outstanding scientists, Corresponding Member of the USSR Academy of Sciences, professor G.V. Nikolsky and Professor of the Mongolian State University, professor Anudarin Dashdorzh (Dgebuadze, 2018).

Over 50 years of work, a large number of scientists from Mongolia, the USSR and Russia took part in the study of Mongolian waters. They represented mainly the Institute of Biology, Mongolian Academy of Sciences (with academician MAS A. Dulmaa as the leader of the Mongolian part of the team); Institute of Geography and Geoecology, Mongolian Academy of Sciences; Severtsov Institute of Ecology and Evolution, Russian Academy of Sciences; Zoological Institute, Russian Academy of Sciences; I.D. Papanin Institute for Biology of Inland Waters, Russian Academy of Sciences; Lomonosov Moscow State University.

It is important that the team's research is conducted on an uninterrupted, long-term basis. This made it possible to obtain a number of breakthrough results, which are the subject of this review.

The purpose of this article is to present an overview of the main (not all) results of the work of the Mongolian-Russian team for ichthyology and hydrobiology over the past 50 years.

Research of biodiversity in Mongolian waters. The first step in describing the biodiversity, distribution and ecology of aquatic organisms was the publication of two books: "Fishes of the Mongolian People's Republic" (1983) and "Ecology and Economic Importance of Fishes of the Mongolian People's Republic" (1985). In the first one, is given, the species composition of phyto and zooplankton, benthos, fish in lakes and rivers of three basins: Central Asian Internal Drainage Basin (Central Asian Closed Basin), Basin of Arctic Ocean and the Basin of Pacific Ocean (Fig.1). As for fish, identification keys, morphological description, chromosomal set, comparison with relative species and distribution of 58 fish and one lamprey species were provided, along with information on paleontological data on Mongolian fish fauna formation is considered. Currently, the number of fish species found in Mongolian waters has reached 78. This is connected with the description of new species for science, with new discoveries of fish of the local ichthyofauna, and with the penetration of alien species. (Dgebuadze et al., 2012; Mendsaikhan at al., 2017). Some results of research of team for ichthyology and hydrobiology of JRMCBE were included in articles and monographs on ichthyology about territories adjacent to Mongolia (Golubtsov et al., 1999; Golubtsov, Malkov, 2006; Reshetnikov et al., 2002; Dgebuadze, 2010; Fish in the nature reserves…, 2010; Makeeva et al., 2011).

Later (after the publication of the book in 1983) investigations of team for ichthyology and hydrobiology of JRMCBE have also significantly advanced the study of the diversity of macrophytes, algae, zooplankton organisms, benthos and bacterioplankton of rivers and lakes of Mongolia. These results are summarized in the books Aquatic Ecosystems of the Selenga River Basin (2009), Limnology and paleolimnology of Mongolia (2014) and as a review in Dgebuadze et al. (2010).

In the 21st century, the team expanded and deepened its research into Mongolian aquatic ecosystems. In particular, data were obtained for the first time on the so-called microbial "loop". The abundance and biomass of bacterioplankton, phototrophic picoplankton, and heterotrophic nanoflagellates has been determined in lakes, rivers, and reservoirs of Central Asian Internal Drainage Basin (Kosolapov, Kosolapova, 2018). The species richness of the heterotrophic flagellates and their consumption of bacteria are estimated. Pico and nanoplankton are the most abundant in shallow lakes Orog and Taatsiin-Tsagaan (Fig.1) and in the newly built Durgun Reservoir. Heterotrophic nanoflagellates consume 26–92% (on average 66%) of the daily bacterioplankton production. Thus, flagellates are important in the transfer of bacterial carbon to the higher levels of planktonic trophic webs. A total of 30 species and their forms of heterotrophic flagellates from 14 large taxa are identified.

Studies of planktonic organisms, in particular Cladocera (Crustacea), have helped to clarify the taxonomy and distribution of a number of species (Bekker et al., 2016; Popova et al., 2016; Kotov et al., 2016; Bekker et al., 2018; Zuykova et al., 2018; Kotov, Taylor, 2019; Zuykova et al., 2019a, 2019b; Taylor et al.,2020; Garibian et al, 2020; Kotov et al., 2021; Neretina et al., 2024; Kotov et al., 2025). Many of the results of studies of aquatic crustaceans in Mongolian waters have been included in books on aquatic invertebrates (Rogers et al., 2019; Korovchinsky et al., 2021a, 2021b).

As a result of research, four new for science species of fish from the family Balitoridae have been described (Prokfiev, 2003; 2007, 2016).

Adaptations of aquatic organisms to the specific conditions of waters in the semi-arid zone. Over the course of long-term research, the team for ichthyology and hydrobiology of JRMCBE identified a number of previously unknown adaptations of aquatic organisms to the specific conditions of Mongolian water bodies. This applies

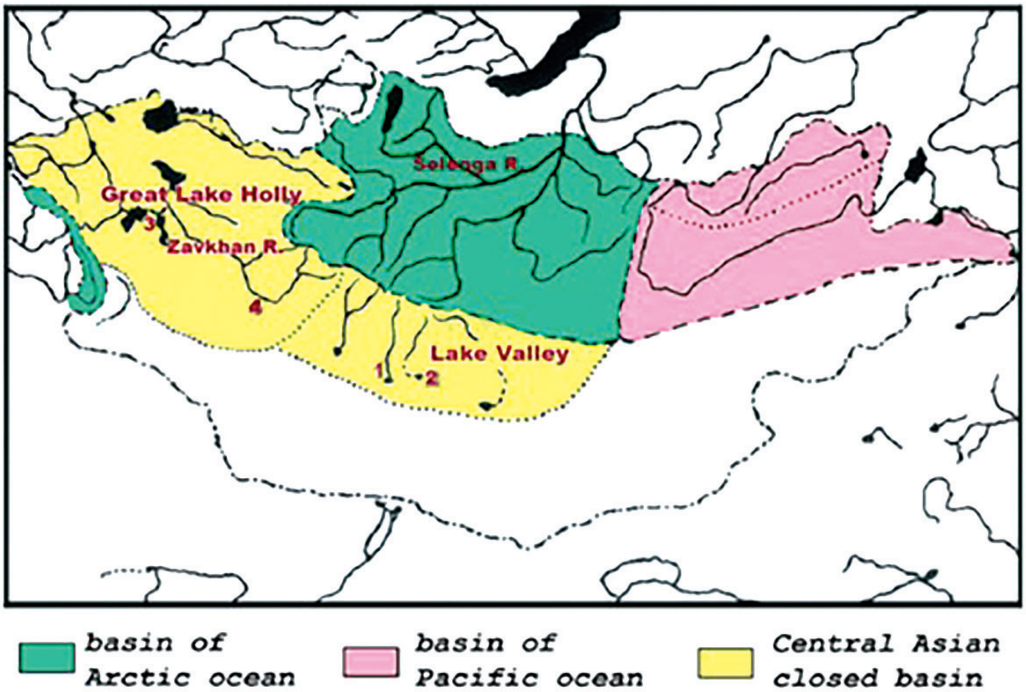

Figure 1. Hydrographic net of Mongolia. 1 – Orog Lake, 2 - Taatsiin-Tsagaan Lake, 3 – Durgun Reservoir, 4 – Taishir Reservoir.

primarily to the Central Asian Internal Drainage Basin (Central Asian Closed Basin), which is characterized by a sharply continental climate of the semi-arid and highlands. Harsh conditions required organisms to develop special adaptations at all stages of the life cycle. Thus, the most numerous fish of western Mongolia, the Altai osmans (genus *Oreoleuciscus*), have adapted to the severe conditions of the waters of the Central Asian Internal Drainage Basin, acquiring specific features of spawning and embryogenesis. These fish spawn from May to August at water temperatures of 7 to 25ºC in rivers and lake shores, often at night to capture the period of flood water inflow from the mountains and rising temperatures. The eggs of Altai osmans are sticky and are laid on any substrate: sand, gravel, aquatic plants. During embryogenesis, at the morula stage, the eggs clearly exhibit cytoplasmic motility, which is completed by the end of gastrulation. Cytoplasmic motility is an important adaptation that allows the embryo to develop in oxygen-poor conditions (Dgebuadze, Ryabov, 1978; Baasanjav et al., 1985).

Another problem that fishes have to deal with is the relatively low primary productivity in the waters of western Mongolia (Boulion, 1985). And again, Central Asian fish successfully solve this problem. Among the Altai osmans there are benthophages, planktophages, detritus and mud feeders, herbivores, and piscivorous (including cannibals) (Baasanjav et al., 1985). For a long time, it remained a mystery how the most abundant herbivorous form of *Oreoleuciscus potanini*, whose gut content mainly (up to 80%) consists of the «stonewort» algae *Chara* spp. digests and assimilates these algae. Recently stable isotope analysis (SIA) and fatty acid (FA) analysis, that *O. potanini* obtained bulk carbon from periphytic microalgae rather than from *Chara* spp. FA analysis generally confirmed the results of SIA. Specifically, biomarker FAs of diatom algae were found in the biomass of *O. potanini*, while characteristic biomarkers of *Chara* spp. were absent. Thus, the herbivorous form of *O. potanini* appeared to ingest «stonewort» for assimilating periphytic microalgae during gut passage (Dgebuadze et al., 2025).

Dynamics of water ecosystems during cyclic climate changes. More than a hundred years ago it was discovered that some lakes in the Mongolian Lake Valley periodically dry up (Potanin, 1893; Kozlov, 1905; Murzaev, 1952). Now the scientists of the ichthyology and hydrobiology team of JRMCBE have decided to find out what happens to aquatic organisms during these periodic dryings. Long-term observations during 40 years (1975-2015), space photo analysis, using literature data and information received from local people, made it possible to establish how the alternation of "dry" and "wet" periods affects aquatic organisms in waters of the Lake Valley. During this time, two complete drying-ups of the Orog and Taatsiin-Tsagaan lakes were observed, followed by their complete restoration. When the lakes dried up, all aquatic organisms including fish died. These lakes inhabited by two forms of *Oreoleuciscus humilis*: dwarf form and lake form. During the "dry" period, the lake form dies, and the dwarf form survives in the rivers flowing into the lakes, which it uses as refugia. During the "wet" period, the fish population of the lakes filled with water is restored at the expense of river fish and the Altai osmans diversify into two forms (Dgebuadze, 1995, Dgebuadze et al., 2012).

The change in water content (the transition from a "dry" to a "wet" period) in the Orog and Taatsiin-Tsagaan lakes also significantly affected the number of species and the biomass of planktonic organisms: Rotifera, Cladocera and Copepoda and trophic status of waters. (Krylov et al., 2011; Krylov, Dulmaa, 2014; Krylov, Chugunov, 2015; Krylov et al., 2020).

The composition and long-term changes in the species composition and quantitative characteristics of macrozoobenthos and macrozooophytos of Orog Lake, and macrozoobenthos and nekton of Taatsiin-Tsagaan Lake is studied. During the "wet" period a total of 27 species of macroinvertebrates is recorded for Orog Lake and 23 species for Taatsiin-Tsagaan Lake. During the study period, Orog Lake showed an increase in the diversity and abundance of benthic communities that exhibit multi-annual fluctuations due to changes in water level. The macroinvertebrate communities of Taatsiin-Tsagaan Lake are typical of a temporary water body, in each year of research, being dependent on the area of the lake and water budget, which in turn depends on changing patterns of its filling (Prokin et al., 2019).

Microevolution of fish in Mongolian waters. The specific conditions of Mongolia and the complex history of the emergence of ichthyofauna (Sytchevskaya, 1986; Limnology and paleolimnology of Mongolia, 2014) have created a unique situation in the formation of fish diversity. In the conditions of the initially poor ichthyofauna of Eastern Mongolia, the formation of intraspecific morpho-ecological forms is observed.

In the course of long-term studies by the team for ichthyology and hydrobiology of JRMCBE and other researchers of the taxonomically complex group of Altai osmans (genus *Oreoleuciscus*), a wide variety of methods were used: analysis of external morphological and osteological characters using multivariate analysis (Borisovets et al., 1985; Dgebuadze et al. 2008, Mina et al. 2024; Mironovsky et al. 2014; Mironovsky et al. 2019; Mironovsky, Slynko, 2023, 2024) genetic analysis (Slynko, Dgebuadze, 2009; Slynko, Borovikova, 2012), chromosomal analysis, studies of spawning behavior and embryogenesis, artificial hybridization, studies of feeding, growth and parasitic fauna (Dulmaa et al., 1977; Dgebuadze, Ryabov, 1978; Trofimenko, Perenleizhamts, 1978; Dulmaa, Nansalmaa, 1981; Baasanjav et al., 1985; Dgebuadze et al., 2024; Dgebuadze et al., 2025).

According to modern concepts, the genus *Oreoleuciscus* includes three taxa with non-overlapping ranges: *O. potanini* (waters Great Lake Holly (Fig.1)), *O. humilis* (waters of the of the Lake Valley) and *Oreoleuciscus* sp. (Selenga, Orkhon, and Tes rivers and Uvs Lake). It turned out that in conditions of small in numbers ichthyofauna, each of these species forms intraspecific forms that differ in morphology and life cycle strategies. *O. potanini* has four intraspecific forms, piscivorous, herbivorous, sharp-snouted, and riverine, differing in morphology and ecology (Baasanjav et al., 1985; Mendsaikhan et al. 2017). Within of *O. humilis* and *Oreoleuciscus* sp. small dwarf and large lake forms are distinguished. According to osteological diagnostics, within the river form *O. potanini* in the Zavkhan River and the dwarf form *O. humilis* in the Tuin-Gol River, two forms are distinguished that cannot be recognized by external morphological features (Dgebuadze et al., 2017; Mironovsky et al., 2019). For the river population of *Oreoleuciscus* sp. from the Urt River, three forms were identified that also differed only in osteological characters (Mironovsky, Slynko, 2023).

The mechanism of intraspecific diversification is most likely the food specialization of Altai osmans, which is facilitated by their high reproductive potential and weak competition from other fish species. Thus, intraspecific forms of *O. potanina* are differentiated by feeding as follows: piscivorous mainly consumes fish, herbivorous - algae, sharp-snouted - plankton, riverine - benthos. The lake intraspecific forms of *O. humilis* and *Oreoleuciscus* sp. mainly consume fish (cannibalism), the dwarf form – benthos.

The microevolutionary process of Altai osmans in different parts of the range of the genus and in different species varies in the degree of development of differences in morphological characteristics. Using of osteological analysis pattern of forms differences of *O. potanini* in lakes of Great Lake Holly characterizes stable stationary coexistence of one piscivorous form and two non-piscivorous forms was revealed. The pattern of differences of two forms of *O. humilis* in Orog Lake (Lake Valley) reflects not a stationary situation, but an incomplete process of its developing repeatedly interrupted by the death of the population during "dry" periods when the lake disappear (Mironovsky, Slynko, 2024).

Long-term studies of Orog Lake of the Central Asian closed basin, conducted during two cycles of "wet", "dry" and "transitional" periods, made it possible to discover a unique cyclical microevolution of *O. humilis* (Dgebuadze, 2015).

The situation in Mongolian Orog Lake helps us to assume possible mechanisms of sympatric speciation as a whole. One of the ways of such formation of new forms could be by dramatic increase of growth rate by large individuals of fish, due to cannibalism (Dgebuadze, 1995). The lake environments of which formed after the drought are rather homogeneous and food supply for fish is very low. This has stimulated increasing fish competition, the appearance of cannibalism and eventually led to the diversification of their life history strategies and morphology changes. Thus the *O. humilis* which penetrate from the rivers to the lakes in the "transitional" periods are finding their conditions promoting new morpho-ecological form creation.

Specific conditions of the Central Asian closed basin were most likely the cause of intraspecific differentiation not only of the Altai osmans, but also of other fish species. It turned out that in the lakes of the upper reaches of the Khovd River, the Mongolian grayling *Thymallus brevirostris* forms two morpho-ecological forms (Knizhin et al., 2008).

Formation of ecosystems of reservoirs in semi-arid regions. At the beginning of the 21st century, two reservoirs appeared in Mongolia: Durgun and Taishir (In-depth review …, 2011). The Durgun Reservoir, located in the Great Lake Holly (48°19'33" N, 92°48'25" E), was created in 2008 by blocking the Chono-Kharaikh channel, which connects Khar-Us, Dalai and Khar lakes (In-depth review …, 2011). The height of the dam is 20 m, the length is 252 m, the length of the reservoir is ~4 km, the maximum width is ~400 m, the maximum depth is 17 m, the average is 5.5 m.

The Taishir Reservoir was built in the upper reaches of the Zavkhan River. A dam was built, 50 m high and 190 m long (46°41'39" N, 96°39'57" E). Filling of the reservoir bed began in 2007, and the operation of the hydroelectric power station began in November 2008. The length of the reservoir is ~35 km, maximum width ~6 km, maximum depth 37 m, average depth 8.1 m (Dulmaa, 2013).

The team for ichthyology and hydrobiology of JRMCBE began comprehensive studies of reservoirs biology in 2010. Material was collected annually in August in the littoral and pelagic zones of reservoirs.

Phytoplankton of the Taishir Reservoir. The study of phytoplankton in the Taishir Reservoir was conducted over nine years, starting in 2010. These studies revealed that in the first decade of the Taishir Reservoir existence, the phytoplankton of the reservoir increased in abundance and biomass compared to the native the Zavkhan River, which is usually observed during changes in the hydrological regime of rivers during the creation of reservoirs. The trophic level of waters in the reservoir passed from the oligotrophic phase to the mesotrophic stage. The structure of its plankton complexes showed an increase in the abundance of centric diatoms, cyanobacteria and mixotrophic phytoflagellates, mainly dinophyte algae, which is typical of many lowland reservoirs. In the distribution of phytoplankton along the longitudinal profile of the reservoir, a significant increase in its abundance was observed in the dam section, which was ensured by an increase in mineralization and a decrease in flowage. Unlike European reservoirs located in the temperate zone, the plankton of the studied reservoirs, in addition to diatoms and cyanobacteria, has a high proportion of dinophyte and green algae. Among cyanobacteria, non-nitrogen fixers dominated. The last two groups, non-heterocyst cyanobacteria and green algae, usually actively develop under conditions of high saturation with nitrogen forms (Korneva, 2023).

Bacterioplankton and heterotrophic flagellates of the Durgun and the Taishir reservoirs. Bacterioplankton and heterotrophic flagellates of the Durgun and the Taishir reservoirs studies were conducted in August 2011-2015.

It has been revealed that the greatest species diversity of protozoa is observed in the Durgun and Taishir reservoirs compared to natural lakes in Western Mongolia. (Kosolapov, Kosolapova, 2018). The highest species diversity of these protists is found in in the newly created Durgun and Taishir reservoirs (Kosolapov, Kosolapova, 2018). Using the method of pyrosequencing a fragment of the 16S rRNA gene, the first data on the diversity of bacterioplankton in two of Western Mongolia Taishir and Durgun reservoirs were obtained (Kuznetsova et al., 2020).

A total of 145 phylotypes (with a cluster distance of 0.03) belonging to 18 phyla were identified in the communities. According to the Simpson indices, the species abundance of different species in the community characterized the mesotrophic and eutrophic pelagic zones of the Taishir and Durgun reservoirs, respectively, as areas with the most equality. The reservoir systems differed significantly in taxonomic diversity, but their representation was not uniform along the rivers (Kuznetsova et al., 2020).

At the end of summer, the Taishir and especially the Durgun reservoirs were characterized by a high level of quantitative development of bacterioplankton, the values of which are typical of meso and eutrophic waters. The number and biomass of bacteria in the Durgun Reservoir were on average 1.4 times higher than in the Taishir Reservoir. Apparently, during the period of our studies in these recently formed reservoirs, their bacterial communities were still in the process of formation. In the future, we should expect a period of stabilization and a decrease in the number and activity of bacteria, although the rate and nature of this process in the Taishir and Durgun reservoirs will probably differ, which is due to differences in their origin, morphometry, hydrological and hydro chemical regimes and the composition of communities of aquatic organisms (Kosolapov et al., 2023).

Diversity, quantity and biomass of heterotrophic flagellates in the Durgun Reservoir were higher compared to the Taishir Reservoir. The number of heterotrophic flagellates in the Durgun Reservoir in different years of research was 2.5–6 times (on average 4.2 times) higher, and their biomass was 2–8 times (on average 4.4 times) higher than in the Taishir Reservoir (Kosolapov et al., 2023).

Zooplankton of the Durgun and the Taishir reservoirs. At the beginning of these works it was revealed that the first stage (establishment) of the formation of the reservoir biota, i.e., changes in the composition and quantitative development of invertebrate species recorded in flow conditions to communities' characteristics of limnic systems, took place in newly formed reservoirs during the first 2–3 years (Krylov, 2012, 2013; Krylov, Mendsaikhan, 2012; Krylov et al., 2012). In general, the changes in zooplankton that occur during the regulation of the Chono-Kharaikh channel and the Zavkhan River correspond to the previously described patterns for lowland reservoirs: compared to watercourses, the diversity, abundance and biomass of planktonic invertebrates increase, mainly due to copepods and cladocera. In the reservoirs, a decrease in the values of trophicity coefficients was observed, which, in all likelihood, is associated with an increase in the volume of water, as well as the intensification of biological self-purification processes, including due to the development of zooplankters. Below the dams, a sharp increase in the values of the trophicity coefficient was recorded, which apparently occurs due to the constant flow of waters rich in organic and biogenic substances from the reservoirs, as well as a significant load from grazing farm animals. There are a number of differences between the zooplankton of the two studied reservoirs. Thus, in terms of the number of species and abundance, the community of the Durgun Reservoir significantly exceeded the indicators of the Taishir Reservoir. Obviously, this is determined by the close connection of the Chono-Kharaikh channel, characterized by a slow water flow, with Khar-Us Lake, which serves as the main source of formation of the zooplankton of the Durgun Reservoir. The studied reservoirs also differed in the time of zooplankton formation: in the Durgun Reservoir this process took 2 years, in the Taishir Reservoir – 4 years (Krylov et al., 2014). The peculiarities of reservoir formation determined the main differences in the quantitative representation of zooplankton in them. Thus, the average indicators of the Durgun Reservoir communities for seven years of observations exceeded the indicators in Taishir Reservoir in a number of parameters, in particular, in specific species richness, the number of rotifer and cladoceran species, total abundance, the number of Rotifera, Copepoda and, to a lesser extent, Cladocera (Krylov et al., 2023).

Bottom macroinvertebrates of the Durgun and the Taishir reservoirs. Macrozoobenthos samples were collected in August 2010-2019 (excluding 2011). During the studies of the benthos of the Durgun and Taishir reservoirs, 167 species were identified based on quantitative samples of macrozoobenthos.

In the composition of the macrozoobenthos of the Durgun Reservoir, 110 species were noted. The maximum species richness was recorded in the Chono-Kharaikh channel above the reservoir, the minimum - in the reservoir.

In the Taishir Reservoir, 112 species were noted. The maximum species richness is characterized by the section of the Zavkhan River below the reservoir, the minimum – above (Prokin et al., 2023).

The formation of the macrozoobenthos of the Taishir Reservoir is characterized by weak changes in the total biomass after regulation, which is determined by the landscape features of the region, where gravel soils with a low content of organic matter act as a "landscape filter", leading to a slowdown in succession.

The Durgun Reservoir belongs to a special type of formation, in which at the initial stage the benthos community is poorer than in the river before flooding, but then its biomass increases significantly. However, after this, the reservoir has a tendency to decrease the biomass to a level below the initial one. In addition, the Durgun Reservoir is characterized by accelerated formation of the ground complex and benthos of the littoral zone due to the transport of organisms and suspended organic matter by reed beds from the upstream lakes of Dalai and Khar-Us.

Fish population of the Durgun and the Taishir reservoirs: species composition, morphology, age, growth, nutrition, parasites. At the Durgun reservoir, studies were conducted in August 2011-2015 and 2017-2019. At the Taishir reservoir, ichthyological material was collected in August 2010-2015 and 2017-2019.

As a result of the research, it was established that the ichthyofauna of the Durgun Reservoir is represented by two species: Mongolian grayling *Thymallus brevirostris* Kessler, 1879 and Potanin's Altai osman *Oreoleuciscus potanini*. At the same time, the basis of the reservoir's fish population is made up of three morpho-ecological forms of Potanin's Altai osman, which were observed in the Khar-Us - Khar - Nogoon - Durgun lake system before the hydroelectric construction: piscivorous, herbivorous, sharp-snouted. After filling the reservoir, Potanin's Altai osman in test catches made up 91.7–100%. At the present stage of the formation of the Durgun Reservoir, a more than 3-fold increase in the proportion of fish of the sharp-snouted form is observed compared to the adjacent reservoirs, which is most likely due to the relatively large pelagic zone (with a depth of up to 17 m) compared to the lakes where this form was discovered before the hydroelectric construction. In the diet of the fish-eating form of Potanin's Altai osman in the Durgun Reservoir, insects and fish dominated in frequency of occurrence, the herbivorous form - plants (macrophytes and algae), and the sharp-snouted form - plankton. The ratio of representatives of different morpho-ecological forms and their diets are most likely related to the fact that the benthos of the Durgun Reservoir has not yet fully formed (Prokin, 2018) and the forms of the Altai osman are mostly oriented towards the pelagic zone of the reservoir.

The creation of the Durgun Reservoir had a significant impact on the Mongolian grayling. The construction of the dam led to the loss of a significant part of the spawning grounds in the Chono-Kharaikh channel for this species, as well as a limitation on the ability to perform spawning, feeding and wintering migrations in the lake system of the lower reaches of the Khovd River.

There are only three species of fish inhabit the Taishir Reservoir: Potanin's Altai osman (*Oreoleuciscus potanini*), Mongolian grayling (*Thymallus brevirostris*) and Siberian stone loach (*Orthrias barbatulus toni*). Altai osmans dominate in terms of numbers and biomass (Mendsaikhan et al., 2016).

During the first years of its existence, a lake-type ecosystem was formed in the Taishir Reservoir. During the formation of the reservoir, its trophic level increased: the reservoir moved from the oligotrophic phase to the mesotrophic stage. After filling the Taishir Reservoir, favorable conditions were created for the Mongolian grayling and Potanin's Altai osman. Benthic organisms dominated in the nutrition of the reservoir fish. The sizes of the Mongolian grayling and Altai osman in the reservoir increased compared to the river populations. Probably, the increase in the growth rate of the Potanin's Altai osman in the reservoir, which has already been observed in older age groups of fish, which is associated with the transition to a piscivorous diet (cannibalism), will lead to morphological and ecological differentiation of fish, as is observed in the periodically drying lakes of the of Lake Valley in the closely related species *Oreoleuciscus humilis* (Dgebuadze, 1995; Dgebuadze et al., 2012; Dgebuadze, 2015).

The conducted osteological study showed that over the years the phenetic variability of the Taishir Reservoir population of *O. potanini* increases due to the appearance of new morphological forms. Thus, the morphological forms noted in the reservoir in 2010 correspond to the forms from the Zavkhan River ((Dgebuadze et al., 2017), and in 2015, four forms were already observed in the Taishir Reservoir. Analysis of ontogenetic channels shows that the differences in the forms of neik can be explained by a gradual change in osteological proportions as the fish grow and are either the result of independent development in different ontogenetic channels, or by the fact that the forms develop in one channel and, upon reaching certain sizes, one form passes into another through rapid transformation (Mendsaikhan et al., 2023).

In the Durgun Reservoir, 5 species of trematode metacercariae parasitizing in the eyes were found in Potanin's Altai osmans (Lebedeva et al., 2020), but the number of all types of helminths, as well as the host invasion rates, was low. In the Taishir Reservoir, the diversity of metacercariae was much lower than in the Durgun Reservoir. In the grayling, 2 species were noted in the eyes - *Diplostomum* sp. Lineage 3 and *D. spathaceum* Rudolphi, 1819.

In both reservoirs, the species composition of metacercariae included 6 species of trematodes, and in each reservoir, the fauna of metacercariae in the eyes was unique. In total, 8 species of metacercariae were found in the eyes of Potanin's Altai osman and grayling in the waters of the Great Lakes Hollow. In the parasite fauna of *O. potanini* of the Durgun Reservoir, 5 species of trematode metacercariae were preserved from those found in neighboring reservoirs of the system (Pugachev, 2003). In the Taishir Reservoir, only 2 species of metacercariae were found in 2 host species, neither of which was found in *O. potanini* of the Durgun Reservoir.

Also, a comparison of the species composition of helminths in the intestines and body cavity of the Potanin's Altai osman (*O. potanini*) and Mongolian grayling (*T. brevirostris*) in the reservoir in the 5th (2012) and 12th (2019) years after formation showed their qualitative and quantitative changes. In 2012, five species of parasites were found in *O. potanini* - cestodes *Proteocephalus torulosus* and *Dibothriocephalus dendriticus*, nematodes *Pseudocapillaria tomentosa* and *Contracaecum* spp., trematode *Hysteromorpha triloba*. In graylings, nematodes *Contracaecum* spp. and metacercariae *Hysteromorpha triloba* were found in the body cavity. In 2019, a more diverse fauna of parasites was noted in both fish species. In addition to the above-mentioned helminths, the acanthocephalan *Neoechinorhynchus rutili* was found in the intestines of both fish species. Also, a single invasion of *D. dendriticus* was detected in grayling, and multiple infestations with the cestode *Paradilepis scolecina* were found in *O. potanini*. The quantitative characteristics of infestation of both host species with nematodes *Contracaecum* spp. increased several times by 2019.

The species composition of larval stages of parasites (trematodes, nematodes, cestodes) in Potanin's Altai osman and grayling in the Taishir and Durgun reservoirs to some extent reflects the nature and character of the formation of these reservoirs. The Durgun Reservoir is flat with a calmer watercourse and a larger zone of macrophyte thickets relative to the Taishir Reservoir. This is very important for the habitat of gastropods (the first intermediate hosts for some helminths), as well as numerous colonies of fish-eating birds on the coasts of these reservoirs. All this contributes to closer parasite-host relationships and a high diversity of trematode species in the Durgun Reservoir.

Conclusion. The research of the team for ichthyology and hydrobiology of the JRMCBE in Mongolian waters has demonstrated the fruitfulness of conducting long-term, continuous observations. This approach has made it possible to obtain a number of fundamental and applied results that are new to biology.

These include diversity and adaptations of aquatic organisms to the specific conditions of waters in the semi-arid zone, the dynamics of ecosystems during cyclic climate changes, the microevolution of living organisms, and the peculiarities of the formation of ecosystems of reservoirs in arid regions. The data obtained in the semiarid reservoirs of Western Mongolia are of great theoretical significance, as they clearly demonstrate the possibilities of rapid sympatric intraspecific morphogenesis of living organisms.

Prospects team's studying is seen in continuing research into aquatic ecosystems in Mongolia in the context of climatic and anthropogenic impacts. Work will continue on the problem of providing Mongolian people with clean water.

In further studies of the waters of the Lake Valley and reservoirs of Western Mongolia, it is necessary to continue research into the genetic, epigenetic and ecological components of the discovered diversification of the Altai osmans.

The conducted research is only the initial stage of studying the patterns of formation and dynamics of ecosystems of reservoirs of Western Mongolia. In the future, it is necessary to ensure the continuation of primary material collections, increasing their number through research in all seasons of the year.

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