2012

# Diversity and Distribution of Mongolian Fish: Recent State, Trends and Studies

Yuri Dgebuadze
*Severtsov Institute of Ecology and Evolution, RAS*, dgebuadze@sevin.ru

Bud Mendsaikhan
*Institute of Geoecology MAS*, bmendee@yahoo.com

Ayurin Dulmaa
*Institute of Biology MAS*, adulmaa@yahoo.com

Erforsch. biol. Ress. Mongolei (Halle/Saale) 2012 (**12**): 219–230

# Diversity and distribution of Mongolian fish: recent state, trends and studies

Yu. Dgebuadze, B. Mendsaikhan & A. Dulmaa

## Abstract

The studies in recent years (2000-2011) have allowed to make more precise the list and ranges of Mongolian fish. This is connected with new findings as well as the continuing process of invasion of alien species. Climate change and increase of human impact transformed ranges and local distribution of fish during last 30 years. Bias on ratio of ecological guilds, number of pathological findings are increasing, and declining of local diversity, rate of growth and fecundity of many species of fish are observed. In the course of long-term observation was confirmed periodically drying of waters of the Central Asian Lake Valley and temporal extinction of some populations of Altai osmans (genus *Oreoleuciscus*). The gold mining as a main anthropogenic factor in rivers of Arctic Ocean basin cause substantial silting of the grounds, increase of water turbidity, the lowering of flow velocity and heterogeneity of environment at separate sections led to a drastic fall in number of such species as taimen, lenok, grayling, minnows, burbot and to a growth of populations of the species adapting to new environments (golden carp, dace). Construction of hydraulic structures (dams in the basins of the Kobdo and Dzabkhan rivers), increase of pollutions, and intensification of fishery are new challenges for Mongolian fish populations.

**Key words:** fish diversity, Mongolian waters, climate change, anthropogenic impact

## Introduction

The first generalization on Mongolian fish fauna was published 20 years ago (BAASANZHAV et al. 1983, 1985). It was a result of synthesis of previous data of Amur expedition of Moscow State University (NIKOLSKY 1956), Hubsugul expedition of Mongolian and Irkutsk State Universities (DASHDORZH & DEMIN 1977, TUGARINA 2002), and materials received by ichthyological team of Joint Soviet-Mongolian Complex Biological Expedition of USSR and Mongolian Academies of Sciences (since 1992 the Russian-Mongolian Complex Biological Expedition RAS and MAN) carrying out field work in Mongolian waters since 1975. The studies and results of this team were obtained by other researches during recent years (2000–2011) and have allowed enlarging the list of fish living in Mongolian waters. This is connected with new findings as well as the continuing process of invasion of alien species. In addition distribution and life history of several Mongolian fishes were specified.

The present paper is an attempt to represent an overview of up to date situation with diversity and main trends of development of fish populations in Mongolian waters.

## Material and methods

Data for this review obtained during the three last decades within the frame of Russian-Mongolian Complex Biological Expedition between 1975 and 2011, projects of the Russian Foundation for Basic Research and programs of the Russian Academy of Science as well (DGEBUADZE et al. 2010). All available literature connecting original particular data on Mongolian fish composition and distribution were used also.

Observations and sampling in Central Asian closed basin were made mainly in summer time in the three Mongolian water basins. Fish were collected from gill nets (10–55 mm mesh size) in the lakes. Riverine fish were sampled using frame nets, hook and lines, casting net, and electro fishing.

## Results & Discussion

### Up to date list of Mongolian fish species

In recent years in Mongolian waters were found: 8 species as a new for science; 11 species as a new for Mongolia; 5 as an alien (introduced from outside of Mongolian waters) species. According to recent studies 11 species of Mongolian fish were renamed (DGEBUADZE et al. 2003, BATSAIKHAN & BATTULGA 2004, DULMAA et al. 2004, NEELY et al. 2006, ERDENEBAT 2006, PROKOFIEV 2007a, b, c; KNIZHIN 2009, ERDENEBAT & DGEBUADZE 2010, SLYNKO et al. 2010, and our unpublished data). Thus list of Mongolian fish and lamprey includes now 78 species and subspecies (table 1).

Table 1: List of fish species of Mongolia

| N | species | Central Asian closed basin | Arctic ocean rivers basin | Pacific ocean rivers basin |
|---|---|---|---|---|
| **I** | **Petromyzonidae** | | | |
| 1 | *Lethenteron reissneri* | - | - | + |
| **II** | **Acipenseridae** | | | |
| 2 | *Acipenser baerii* | - | + | - |
| 3 | *Acipenser schrenckii* | - | - | + |
| **III** | **Salmonidae** | | | |
| 4 | *Brachymystax lenok* | - | + | + |
| 5 | *Hucho taimen* | - | + | + |
| **IV** | **Coregonidae** | | | |
| 6 | *Coregonus chadary* | - | - | + |
| 7 | *C. peled* | + (A) | + (A) | - |
| 8 | *C. lavaretus pidschian* | - | + | - |
| 9 | *C. migratorius* | + (A) | +(A) | - |
| **V** | **Thymallidae** | | | |
| 10 | *Thymallus brevirostris* | + | - | - |
| 11 | *Th. baicalensis* | - | + | - |
| 12 | *Th. nigrescens* | - | + | - |
| 13 | *Th. grubii* | - | - | + |
| 14 | *Th. svetovidovi* | + | - | - |
| **VI** | **Esocidae** | | | |
| 15 | *Esox lucius* | + (A) | + | - |
| 16 | *E. reichertii* | - | - | + |
| **VII** | **Cyprinidae** | | | |
| 17 | *Acheilognathus asmussii* (= *Acantorhodeus asmussii*) | - | - | + |
| 18 | *Rhodeus sericeus* | - | - | + |
| 19 | *Carassius carassius* | - | + | - |
| 20 | *Carassius auratus gibelio* | - | + | + |
| 21 | *Chanodichthys erythropterus* (= *Erythroculter erythropterus*) | - | - | + |

**table 1 continued**

| | | | | |
|---|---|---|---|---|
| 22 | *Ch. mongolicus* (= *Erythroculter mongolicus*) | - | - | + |
| 23 | *Culter alburnus* | - | - | + |
| 24 | *Ctenopharyngodon idella* | - | - | + |
| 25 | *Cyprinus carpio haematoptrus* | - | - | + (A) |
| 26 | *Gnathopogon strigatus* (= *Paraleucogobio strigatus*) | - | + (A) | + |
| 27 | *Gobio gobio acutipinnatus* | - | + | - |
| 28 | *Gobio soldatovi* (= *G. soldatovi tungussicus*) | - | - | + |
| 29 | *Gobio albipinnatus tenuicorpus* | - | - | + |
| 30 | *Rinogobius* sp. | - | - | + |
| 31 | *Hemibarbus labeo* | - | - | + |
| 32 | *H. maculates* | - | - | + |
| 33 | *Hemiculter* spec. | - | - | + |
| 34 | *Hypophthalmichthys molitrix* | - | - | +(A) |
| 35 | *Ladislavia taczanowskii* | - | - | + |
| 36 | *Leuciscus leuciscus baicalensis* | - | + | - |
| 37 | *L. dzungaricus* | - | + | - |
| 38 | *L. idus* | - | + | - |
| 39 | *L. waleckii* | - | - | + |
| 40 | *Microphysogobio anudarini* (= *Rostrogobio amurensis*) | - | - | + |
| 41 | *Oreoleuciscus potanini* | + | - | - |
| 42 | *O. humilis* | + | - | - |
| 43 | *Oreoleuciscus* sp. | - | + | - |
| 44 | *Phoxinus phoxinus* | - | + | + |
| 45 | *Ph. perenurus* | - | + | + |
| 46 | *Ph. lagowskii* | - | + | + |
| 47 | *Ph. czekanowski* | - | - | + |
| 48 | *Pseudoaspius leptocephalus* | - | + | + |
| 49 | *Psudorasbora parva* | - | - | + |
| 50 | *Rutilus rutilus* | - | + | - |
| 51 | *Abramis brama* | - | + (A) | - |
| 52 | *Sarcocheilichthys soldatovi* (= *Chilogobio czerskii*) | - | - | + |
| 53 | *Squalidus chankaensis* (= *Gnathopogon chankaensis*) | - | + (A) | - |
| 54 | *Saurogobio dabryi* | - | - | + |
| 55 | *Abbottina rivularis* | - | - | + |
| 56 | *Tinca tinca* | - | + | - |

**table 1 continued**

| | | | | |
|---|---|---|---|---|
| **VIII** | **Bolitoridae** | - | - | + |
| 57 | *Orthrias dgebuadzei* Prok. | + | - | - |
| 58 | *Orthrias golubtsovi* Prok | + | - | - |
| 59 | *Orthrias* [*barbatulus*] *toni* | + | + | + |
| 60 | *Orthrias* sp. n. 1 | + | - | - |
| 61 | *Orthrias* sp. n. 2 (= *O. altayensis* (nec Zhu, 1992) | + | - | - |
| 62 | *Orthrias sawadai* | - | + | - |
| 63 | *Triplophysa gundriseri* (= *Nemacheilus dorsalis humilis* Gundr., *N. strauchi* (non Kessler)) | + | - | - |
| 64 | *T. g. chandagaitensis* | + | - | - |
| 65 | *T. arnoldii* | + | - | - |
| 66 | *Lefua costata* | - | - | + |
| **IX** | **Cobitidae** | | | |
| 67 | *Cobitis melanoleuca* (= *C. taenia* & *C. taenia sibirica*) | - | + | - |
| 68 | *C. olivai* | - | + | - |
| 69 | *C. lebedevi* | - | - | + |
| 70 | *Misgurnus mohoity* (= *M. anguillicaudatus*) | - | - | + |
| **X** | **Siluridae** | | | |
| 71 | *Parasilurus asotus* | - | +(A) | + |
| **XI** | **Lotidae** | | | |
| 72 | *Lota lota* | - | + | + |
| **XII** | **Cottidae** | | | |
| 73 | *Cottus szanaga* ( = *C. poecilopus*) | - | - | + |
| 74 | *C. sibiricus* | - | + | - |
| 75 | *Paracottus kesslerii* | - | - | + |
| 76 | *Mesocottus haitej* | - | - | + |
| **XIII** | **Percidae** | | | |
| 77 | *Perca fluviatilis* | - | + | - |
| **XIV** | **Odontobutidae** | | | |
| 78 | *Perccottus glenii* | - | - | + |
| | **total** | **15 (3A)** | **31 (5A)** | **45 (2A)** |

Footnote: A = alien species

## Mongolian fish local distribution

In general there are several factors which determine fish assemblage diversity in any water basin (locality). The main factors are:

- physical and chemical (so-called “abiotic”) factors
- biotic factors
- historical and biogeographic factors
- biological invasion of alien species.

The first two groups of factors are obvious. With regard to the third, there are many good examples, especially for freshwater fish, where historically isolated water basins with similar environmental conditions can demonstrate high differences in species composition and variability. Mongolian waters are one of such cases.

Freshwater ecosystems in the limits of Mongolia belong to three water basins: Pacific Ocean Rivers, Arctic Ocean Rivers, and Central Asian closed basin (fig. 1). Fish species number varied in Mongolian waters from 15 in Central Asian closed basin to 45 in Pacific Ocean basin. The waters of the Arctic Ocean basin are inhabited by 31 species of fish.

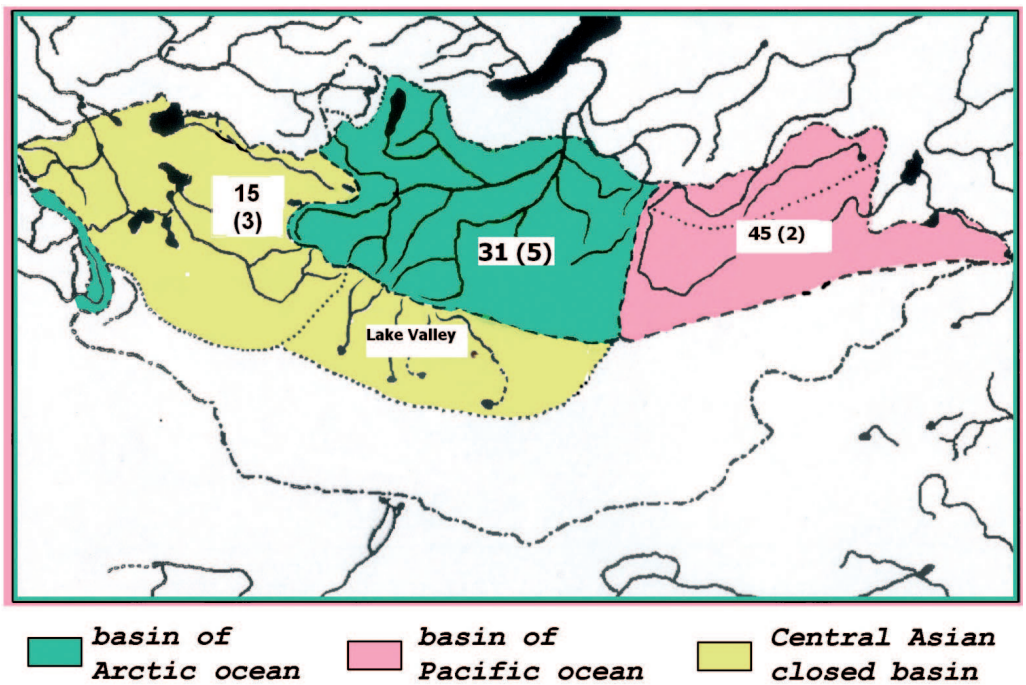


Fig. 1: Hydrological net and fish distribution of Mongolia.

The fish fauna of Central Asian closed basin is comparatively poor and includes 15 species with 3 aliens. Historically determined low diversity partly compensated by intraspecies morphotypes formation. Thus *Oreoleuciscus potanini* in Grate Lake Hollow has three forms: herbivorous, piscivorous and acute snouted (BASANZSHAV et al. 1983). Another species of Altai osmans, *Oreoleuciscus humilis* in Lake Valley make two forms: lake and dwarf (DGEBUADZE 1995). Mongolian grayling *Thymallys brevirostris* probably has piscivorous and benthivorous forms (KNIZHIN et al. 2008).

Our long-term observations revealed substantial changes in the pattern of morphological diversity of Altai osmans in Lake Valley. These studies affirm that morphological and ecological differentiation of Altai osmans proceeds within a single species. Forms of *O. humilis* from Mongolian Lake Valley have a difference in morphology and life history strategy. The dwarf form is characterized by a relatively small maximum size (SL about 200 mm) and by early maturation (SL = 70 mm, at four years of age). The fecundity of Altai osman of the dwarf form varies between 2400 and 12200 eggs. It inhabits small desert rivers in drought periods and both rivers and the riparian zone of lakes during wet periods. The diet of the dwarf form consists of invertebrates (mainly insect larvae) and plants. The dwarf form in rivers prefers sections with slow water: raceways and pools. The individuals of the lake form reach SL 450 mm and during the early years of life use the same foods as the dwarf form. After their SL exceeds 180 mm the individuals of the lake form become

piscivorous. The fecundity of the lake form varies from 33 720 to 105 300 (BASANZHSAV et al. 1985, DGEBUADZE 1995). There are some morphological differences between the dwarf and the lake forms, particularly in the external morphology of the head: relative size of eyes, length of mandible, length of operculum and interorbital distance (BORISOVETZ et al. 1985).

According to our observations in 1975, 1979, 1980, 1981, 1982 and in 2002, during the two wet periods (1970$^{th}$–1986 and 2004–2012) both the dwarf and the lake forms inhabit all the four main lakes of Lake Valley. In the another time when some lakes disappeared (our observations in 1986, 1988, 2010) fish populations of Lakes Orog-nur and Taytzyn-Tzagan-nur were perished from the drought, lake form was lost, and dwarf form survived using the upper reaches of tributaries. Thus in July 1991 this lake was 0.5–1.0 m deep and the Tuyn-gol River reached the lake. The dwarf form of *O. humilis* came to the lake from the river. The analysis of growth of fish colonizing the lake gave us unexpected results. The larger individuals of the dwarf form, which came to the lake from the Tuyn-gol River, became cannibals after about 1 year in the lake, and their growth rate increased drastically. Also, part of the dwarf population after maturation sharply changed its life history, the guts of most individuals > 186 mm SL contained small fish, thus they became piscivorous (DGEBUADZE 1995).

The situation in Mongolian Lake Valley helps us to understand mechanisms of intraspecific life history differentiation. During the dry period both the dwarf and the lake forms of *O. humilis* disappear from the lakes. Only the river populations of the dwarf form remain, which use rivers as a refuge. The lake populations of *O. humilis* are restored after the dry period, originating new from the river populations.

Our recent studies showed prolongation of both dry and transition periods of the Orog-nur Lake cycle because warming. Orog-nur Lake has been filling with water in summer time in 2007, 2008, 2009 and 2010, but depth of lake was not more than 0.3 m and dwarf form which came with water from the river probably couldn't survived in the winter (fig. 2, 3). Thereby actually the lake is not restoring and process of fish diversification is not starting. In addition, Altai osmans in Lake Valley have lost part of their range for several years at least. Mineralization of many lakes of Central Asian closed basin which didn't disappear increased during "dry period" (fig. 4, 5). Fish rate of growth significantly declined in some of such lakes that illustrated by data from biggest water body of the Lake Valley – Bon Tzgan-nur Lake (fig. 6).

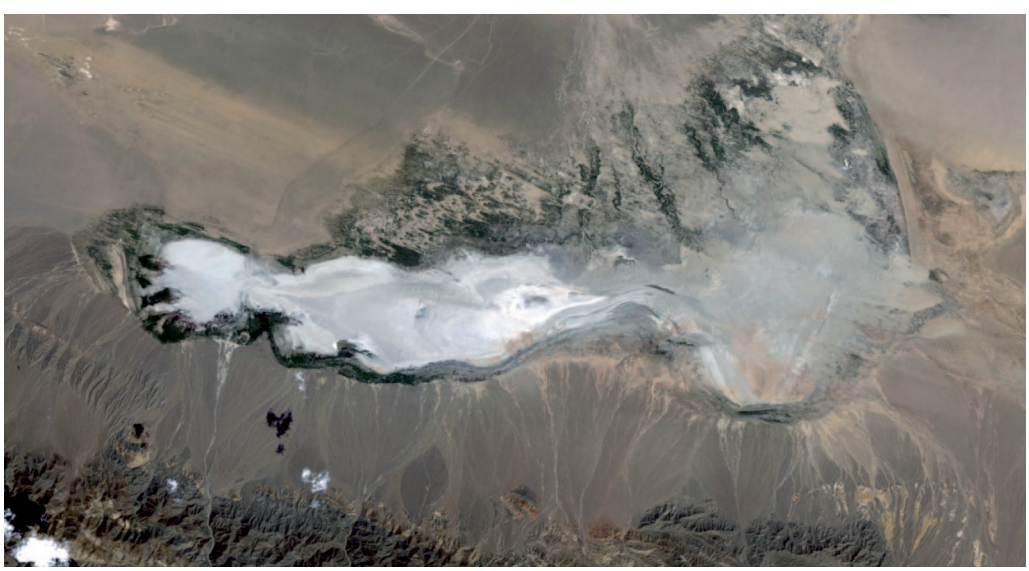

Fig. 2: Space picture of Orog-Nur, August 2006 (Credit: U.S. Geological Survey Department of the Interior/USGS).

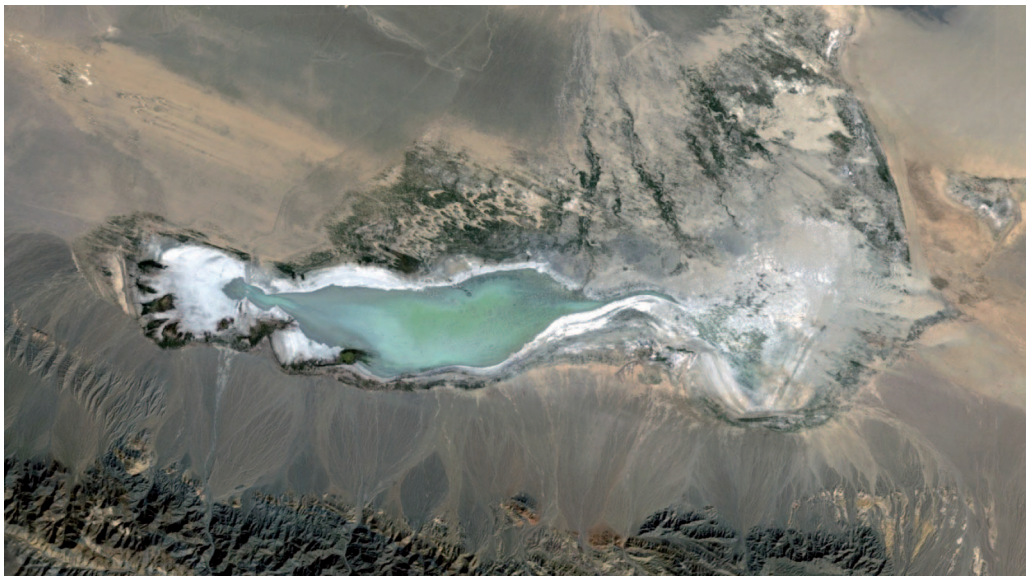

Fig. 3: Space picture of Orog-Nur, September 2010 (Credit: U.S. Geological Survey Department of the Interior/USGS).

Three alien species of fish of Central Asian closed basin waters were intentionally introduced in last century (in 1980th). Baikal omul *Coregonus migratorius* was introduced to Ulaagchnii Khar Lake (Zavkhan aimag); peled *C. peled* was released in Ulaagchnii Khar, Baga and Zhaahan lakes (Zavkhan aimag); pike *Esox lucius* was introduced to Terekhol Lake (Mongolian-Russia border). All introduced species established self-reproductive populations.

Anthropogenic load on the water bodies of the Central-Asian closed basin is connected, first of all, with the construction of hydraulic structures (dams in the basins of the Kobdo and Dzabkhan rivers), increase of pollutions, and intensification of fishery. Evaluation of modern condition of water ecosystems and fish population parameters of this basin remains the main purpose of research for the years immediately ahead.

As to a main tributary of Baikal Lake the Selenga River 26 species of fish inhabit their waters. The following four species were found in the Selenga River basin quite recently: Baikal omul (native population in limits of Mongolia), bream, and Altai osman *Oreoleuciscus* sp. Stable numerous populations of last one were found in the floodplain waters of the Selenga River midstream (DGEBUADZE et al. 2003) and its large tributaries, the Orkhon and Tuul rivers (DULMAA et al. 2004, ERDENEBAT 2006). It is known that the range of genus *Oreoleuciscus* predominantly relates to the waters of the Central Asian closed basin and upstream part of the Ob River (DASHDORZH et al. 1969, BAASANZHAV et al. 1983, DGEBUADZE 1986, GOLUBTSOV et al. 1999). At the same time, the specificity of the hydrographic network in Mongolia and adjacent regions of Russia provides the opportunity to exchange components of fish fauna if the ranges of their species are determined by physical and geographical but not ecological factors. In particular, bogs in the river valleys may have allowed for penetration of Altai osman to the Ob River basin from the Central Asian closed basin. It is quite likely that, under certain climatic situations, the contact between the upstream part of the Selenga and the waterbodies of the Central Asian closed basin is possible (ERDENEBAT & DGEBUADZE 2010). This is why the species of genus *Oreoleuciscus* are not considered invaders in rivers and lakes of the Selenga River. The new genetic data indicate that *Oreoleuciscus* sp. from the Arctic Ocean basin in Mongolia probably doesn't belong to species of Central Asian closed basin (SLYN'KO & BOROVIKOVA 2012).

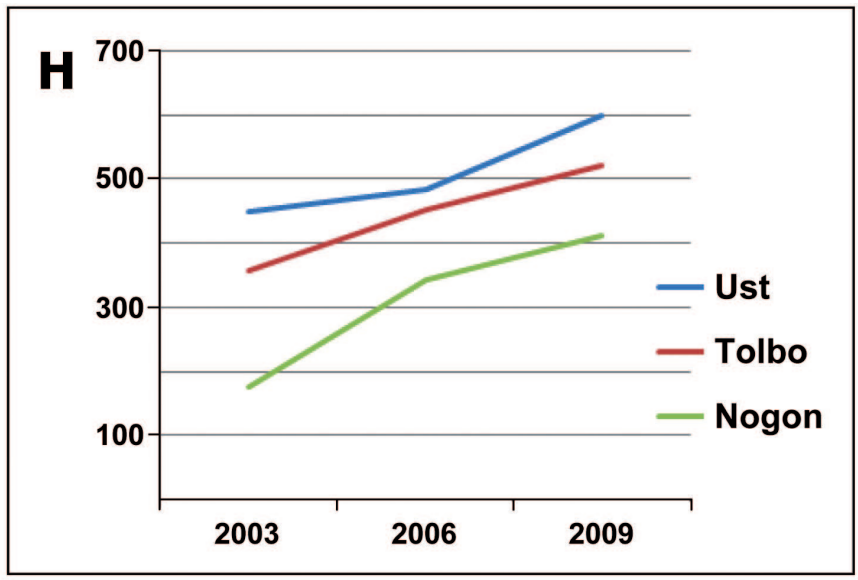


Fig. 4: Dynamic of mineralization of Mongolian lakes: Ust (middle reaches of the Selenga River), Tolbo and Nogon (Central Asian closed basin) (H, ppm).

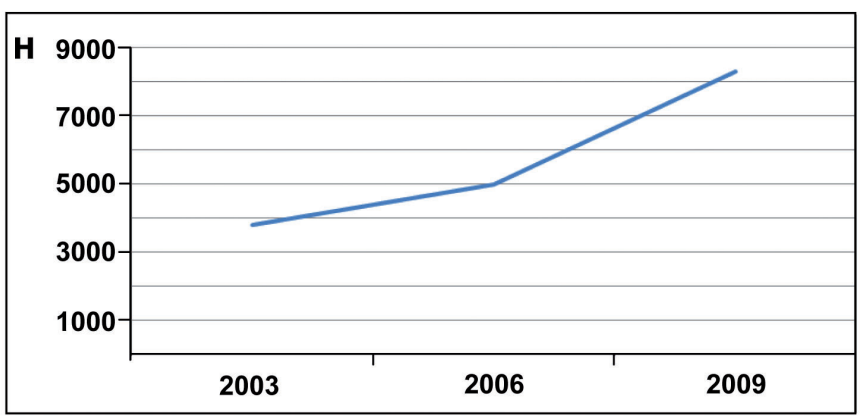


Fig. 5: Dynamic of mineralization of Bon-Tzagan-Nur Lake (Central Asian closed basin) (H, ppm).

Fish distribution and local diversity of fish of Arctic Ocean basin depend on warming, intentional introduction, self-spreading, and human impact (mainly gold mining). As a result the southern species bream *Abramis brama* introduced in Russia in 1950$^{th}$ and 1960$^{th}$ and established new population in Irkutsk, Bratsk and Ust-Ilim reservoirs penetrated to the Selenga and was found in the limits of Mongolia in the beginning of XXI century (BATSAIKHAN, BATTULGA 2004). Now 19.2 % of Selenga basin fish fauna is alien species. There are only two vectors of invasion of non-indigenous species in the Selenga basin: intentional introduction with sequential self spreading and occidental introduction. Peled, Baikal omul (in Hubsugul Lake), Amur carp *Cyprinus carpio haematoptrus*, bream *Abramis brama*, Amur catfish *Parasilurus asotus* were introduced in the Russia and wide spread in almost all basin including Mongolian water. Amur sleeper *Perccottus glenii* occasionally penetrated to Selenga waters and occupied lower part of the basin in Russian territory. This species didn't found In limits of Mongolia yet (ERDENEBAT & DGEBUADZE 2010).

The alien fish originate mainly from Amur River basin (57.1 %) and Arctic Ocean basin (28.6 % of all invaders). Only one species (14.3 %), bream, represents the western fauna that was formed in relatively warm climatic conditions.

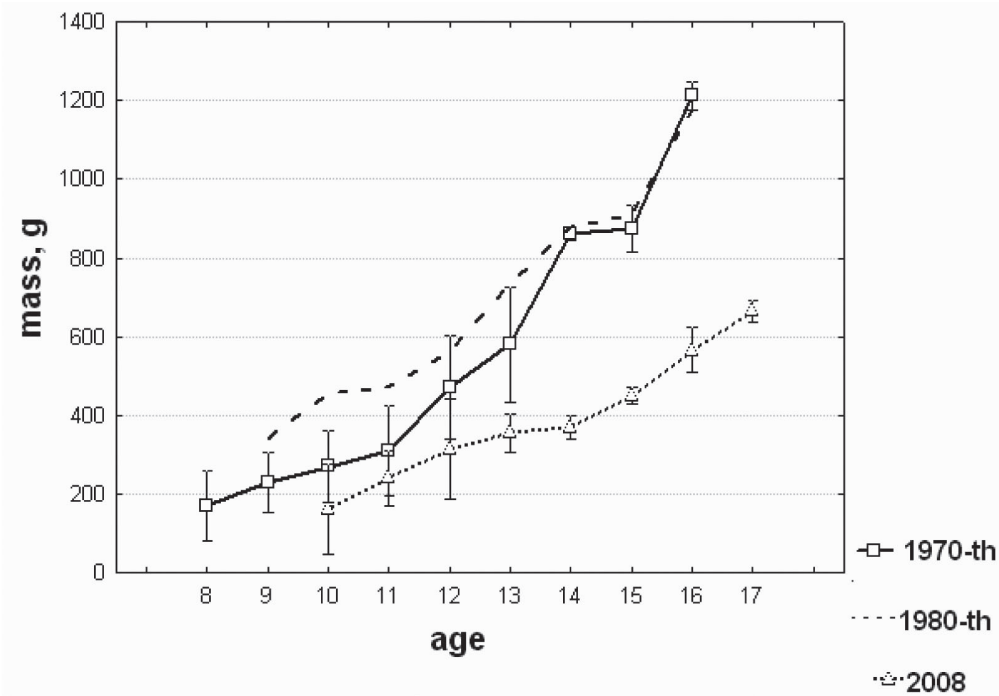


Fig. 6: Growth of Lake form of Altai osman in Bon-Tsagan-nur Lake.

The transition of Mongolia to a market economy that took place in the 1990s along with presence on its territory of considerable mineral (mining) and biological (forests, pastures, hunting, and fishing) resources as well as development of the transport infrastructure provided fast uncontrolled growth of agriculture and industry. In turn, this resulted in a sharp growth of the human population density in the region. By the beginning of the XXI century, the population had grown by almost 60 % compared to the 1980s. The share of the urban population increased noticeably. The majority of the main industrial cities of the country are situated on the banks of rivers of the Selenga basin: Orkhon, Tuul, Khara, and Sharyn. The largest industrial enterprises are situated in these cities (Ulan-Bator, Sukhe-Bator, Erdenet, Darkhan). Since the 1990s, the intensity of gold mining (predominantly in the Selenga River basin) has sharply increased. The technology of gold mining of the gravel deposits demands large amounts of water. This results in the modification of hydrological regime and pollution of the river basins. These factors caused considerable changes in the fish fauna and in the Selenga basin ecosystems in general. In particular, in rivers of Arctic Ocean basin, where gold mining is going on, substantial silting of the grounds has led to violation of spawning condition of valuable (game) fishes (taimen *Hucho taimen*, lenok *Brachymystax lenok*, grayling *Thymallus baicalensis,* and burbot *Lota lota*). An increase of water turbidity, the lowering of flow velocity and heterogeneity of environment at separate sections, chemical pollution led to a drastic fall in number of these species, and to a growth of populations of the species adapting to new environments (golden carp *Carassius auratus gibelio*, Siberian dace *Leuciscus leuciscus baicalensis*).

It was shown previously that fish living forms and ecological guilds by nature of reproduction peculiarities compositions are quite useful indicators for freshwater environment conditions (DGEBUADZE 1986). As a result of anthropogenic transformation of rivers of the Selenga River basin

significant changes in ratio of these forms and guilds are observed. In the Tuul River which was subjected to gold mining activity during last decades the percent of fluvial fish decreased and part of limnophil fish increased (fig. 7). In consequence of anthropogenic hydrological regime modification and rise of sedimentation representatives of lithophil ecological guild by nature of reproduction peculiarities have lost their spawning grounds (fig. 8).

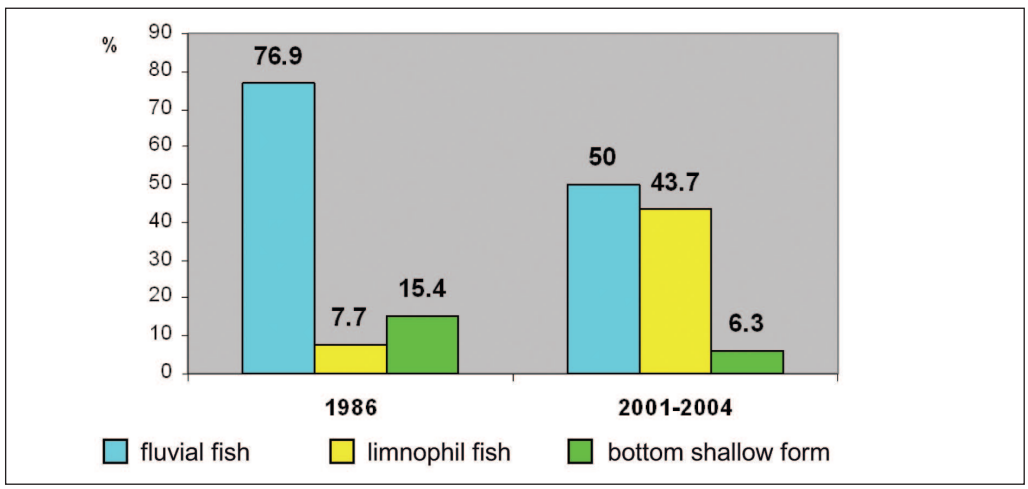


Fig. 7: Changes in ratio of living forms composition of fish in the Zamar area of the Tuul River.

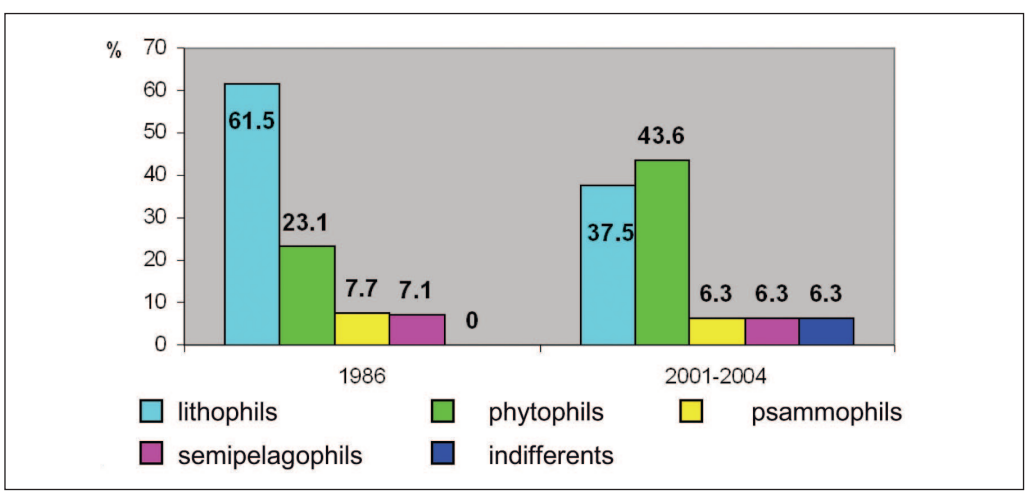


Fig. 8: Changes in ratio of guilds by nature of reproduction peculiarities composition of fish in the Zamar area of the Tuul River.

Recent increasing of fish species composition of Pacific Ocean basin waters (eastern Mongolia) connected mainly with new findings. Three species were found in the Khalkhin-gol River – Buyr-nur Lake system: *Rinogobius* sp., *Abbottina rivularis*, and *Perccottus glenii* (NEELY et al. 2008; SLYNKO et al., 2010). *Hemiculter leucisculus varpachovskii* was observed in the middle reaches of the Kerulen River (SLYNKO et al. 2010). There is no evidence about reasons of these record-ing. Are these species accidentally introduced or occur in their native ranges? Indeed not so many observations were undertaken in Eastern Mongolian waters.

## Acknowledgements

The study facilitated through the Joint Russian-Mongolian Complex Biological Expedition (JRMCBE). We thank M. Erdenebat, Yu.V.Slynko, A.V.Krylov, and D.P.Karabanov for assistance in material collecting. This study was carried out partly with financial support from the Russian Foundation for Basic Research (Projects: 11-04-00109-a; 11-04-91188-GFEN-a, 11-04-92006-NNC-a) and the Programs of Presidium of Russian Academy of Sciences “Animate Nature”.

## References

BAASANZHAV, G.; DGEBUADZE, Yu.Yu.; DEMIN, A.N. et al. (1983): Obzor vidov ikhtiofauny MNR (Review of Fish Fauna Species of MPR). – In: Ryby Mongol’skoi Narodnoi Respubliki (Fishes of Mongolian People’s Republic). – Nauka, Moscow, pp. 102–224 [in Russian].

BAASANZHAV, G.; DGEBUADZE, Yu.Yu.; DEMIN, A.N.; DULMAA, A.; ERMOKHIN, V.YA.; LAPIN, V.I. et al. (1985): Ekologicheskoe i khozyaistvennoe znachenie ryb MNR (Ecological and economical importance of MPR fish). – Nauka, Moscow [in Russian].

BORISOVETS, E.B.; DGEBUADZE, Yu.Yu.; ERMOKHIN, V.Ya. (1985): Morphometrical Analysis of Altai osmans (*Oreoleusiscus*; Pisces, Cyprinidae) from Water Bodies of the Mongolian People’s Republic: A Multivariate Approach. – Zool. Zh. **64** (8): 1199–1212 [in Russian].

DASHDORZH, A.; DULMA, A.; PIVNICKA, K. (1969): Contribution to the systematics of the genus *Oreoleuciscus* Warpachowski, 1989; (Cyprinidae). – Vestnik Ceskoslovenske spoiecnosti zooiogicke **33** (4): 289–299.

DASHDORZH, A.; DEMIN, A.I. (1977): Zoogeograficheskii analiz ikhtiofauny Mongolii (Zoogeographic Analysis of the Mongolian Fish Fauna). – In: Prirodnye Usloviya I Resursy Prikhubsugul’ya (Natural Conditions and Resources of Pre-Hovsgol Region). – Irkutsk; Ulan-Bator; IGU **5**: 141–154 [in Russian].

DGEBUADZE, Yu.Yu. (1986): On the investigation of fish communities of the water-bodies of Mongolian People’s Republic. – In: Zoogeographical Zoning of the Mongolian People Republic. Moscow, p. 52–90 [in Russian].

DGEBUADZE, Yu.Yu. (1995): The land/inland-water ecotones and fi sh population of Lake Valley. Hydrobiologia, 303: 235–245.

DGEBUADZE, Yu.Yu. (2004): The Selenge River as invasion pathway for alien species. – In: Science for Watershed Conservation: Multidisciplinary Approaches for Natural Resource Management. – Proc. Int. Conf. Ulan-Ude; Ulan-Bator: 13–14.

DGEBUADZE, Yu.Yu (2010): Diversity of freshwater fish communities: conservation and utilsation examples from Ethiopia, Mongolia and Russia. – In: SPELLERBERG, I.; SLOWIK, J.; MÜHLENBERG, M.; DGEBUADZE, Yu.Yu. (eds.): Biological diversity and nature conservation: theory and practice for teaching (eds.). – Moscow. KMK Scientific Press Ltd.: 156–167.

DGEBUADZE, Yu.Yu.; DOROFEYUK, N.I.; KRYLOV, A.V. (eds.) (2009): Aquatic Ecosystems of Selenge River Basin. – Moscow, 401 pp. [in Russian].

DGEBUADZE, Yu.Yu.; DOROFEYUK, N.I.; KRYLOV, A.V. (2010): Contributions of Russian Scientists to the Research of Aquatic Ecosystems in Mongolia. – Mongolian Journal of Biological Sciences **8** (1): 59–69.

DGEBUADZE, Yu.Yu.; DULMAA, A.; MUNKHBAYAR, Kh. (2003): Observation of a Representative of the Genus *Oreoleusiscus* (Cyprinidae) in the Selenga River Basin. – J. Ichthyol. **43** (5): 411–413.

DULMAA, A.; MUNKHBAYAR, Kh.; NAKAGAWA, M. (2004): New records of *Oreoleuciscus humilis* (Cyprinidae) in the Orkhon River Basin. – Abstracts Int. Confer. ‘Biodiversity of Euro_Asia Continental Wetlands’. – Ulaanbaatar, p. 12–13.

ERDENEBAT, M. (2006): Rybnoe naselenie vodoemov mongol’skoi chasti basseina r. Selengi v usloviyakh global’nogo izmeneniya klimata i antropogennogo vozdeistviya (Fish Populations of

Waterbodies of the Mongolian Part of the Selenga River Basin in Conditions of Global Climate Change and Anthropogenic Impact). – Extended Abstract of Cand. Sci. (Biol.) Dissertation, Moscow: IPEE RAN [in Russian].

ERDENEBAT, M.; DGEBUADZE, Yu. (2010): Alien species of fishes in Mongolian part oft he Selenga River basin. – Russian J. of Biological Invasions **1** (3): 227–231.

GOLUBTSOV, A.S.; BERENDZEN, P.B.; ANNETT, C.A. (1999): Morphological variation and taxonomic status of Altai osmans, *Oreoleuciscus*, from the upper reaches of the Ob River system. – J. Fish Biology **54** (4): 878–899.

KNIZHIN, I.B.; WEISS, S.J.; SUŠNIK, S. (2006): Graylings of lake Baikal basin *(Thymallus*, Thymallidae): Diversity of forms and their taxonomic status. – J. Ichthyology **46** (6): 418–436.

KNIZHIN, I.B.; WEISS, S.J.; BOGDANOV, B.E.; KOPUN, T.; MUZALEVSKAYA, O.V. (2008): Graylings (Thymallidae) of water bodies in western Mongolia: morphological and genetic diversity. – J. Ichthyology **48** (9): 714–735.

MENDSAIKHAN, B. (2010): Rybnoe naselenie Tsentral'no_aziatskogo besstochnogo basseina (Mongoliya) (Fish Populations of the Central Asian Inland Basin (Mongolia). – Extended Abstract of Cand. Sci. (Biol.) Dissertation, Moscow: IPEE RAN [in Russian].

NEELY, D.A.; SABAJ, M.H. & MENDSAIKHAN, B. (2008): Establishment of non-indigenous *Rhinogobius* sp. (Teleostei: Gobiidae) and *Abbottina rivulari*s (Teleostei: Cyprinidae) in Lake Buyr drainage, Mongolia. – J. Great Lakes Res. **34** (2): 334–341.

NIKOLSKY, G.Y. (1956): Fish of the Amur basin. – USSR Acad. Sci. Press, Moscow, 551 pp. [in Russian].

PROKOFIEV, A.M. (2007a): Materials to revision of the genus *Triplophysa* Rendahl, 1933 (Cobitoidea: Balitoridae: Nemacheilinae): revision of nominal taxa of Hertzenstein (1888), described in the list of the species "*Nemachilus*" *stoliczkae* and "*N. dorsonotatus*", with isolation of the new species *T. scapanognatha* sp. nov. – Voprosy Ikhtiologii **47** (1): 5–25 [in Russian].

PROKOFIEV, A.M. (2007b): *Cobitis olivai* Nalbant, Holchik & Pivnichka 1970, a valid species of spined loaches from Mongolia: redescription and comparison with *C. melanoleuca* Nichols 1925 (Osteichthyes, Cypriniformes, Cobitidae). – Senckenberg. Biol. **87** (1): 111–124.

PROKOFIEV, A.M. (2007c): Morphology, Systematic and Origin of Bearded Stone Loaches of the Genus *Orthrias* (Teleostei: Balitoridae: Nemacheilinae). – KMK Scientific Press, Moscow. 101 pp. [in Russian].

SLYNKO, Yu.V.; DULMAA, A.; ERDENEBAT, M.; MENDSAIKHAN, B.; KARABANOV, D.P.; DGEBUADZE, Yu.Yu. (2010): Fishes of Mongolia: fauna, zoogeography, current state of populations, conservation. – In: Ecological consequences of biosphere processes in the ecotone zone of Southern Siberia and Central Asia.- Proc. Int. Conf. **V**. I. – Ulaanbaaatar, Mongolia, p. 92–94.

SLYN'KO, Yu.V.; BOROVIKOVA, E.A. (2012): Phylogeography of Altai Osmans (*Oreoleuciscus* sp., Cyprinidae, Pisces) based on Sequence Variation of the Mitochondrial DNA Cytochrome *b* Gene. – Genetica **48** (6): 726–736 [in Russian].

TUGARINA, P.Ya. (2002): Fish ecology and fishery potential of Hubsugul Lake. – Irkutsk State University, Irkutsk, 210 pp. [in Russian].

## Adresses:

Yuri Dgebuadze
Severtsov Institute of
Ecology and Evolution, RAS
33 Leninskiy Prospect
117071 Moscow, Russia
e-mail: dgebuadze@sevin.ru

Bud Mendsaikhan
Institute of Geoecology MAS
Baruun selbiin gudamj 15
Chingeltei duureg
Ulaanbaatar - 15170, Mongolia
bmendee@yahoo.com

Ayuriin Dulmaa
Institute of Biology MAS
Jokov avenue - 77
Bayanzurkh district
Ulaanbaatar - 210351 Mongolia
adulmaa@yahoo.com