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New Data on the Fish *Coregonus peled* (Gmelin, 1788) in Some Water Bodies of Mongolia

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Abstract

In connection with the planned establishment of a coregonid fishery and the construction of a specialized hatchery in the area of Western Mongolia a study was undertaken with the aim of studying some parts of the reproductive biology of population of *Coregonus peled* inhabiting the lake Ulaagchnii Khar (Zavhan aimag). This species was introduced into this Mongolian lake, originally lacking any fish stock, in the period from 1980–1982. 11,230 fish were collected and examined during the periods from 1993–1999 and 2005–2011 and consisted partly of the fish originating from imported and introduced larvae and partly of the individuals belonging about 25th generation, already born in the lake. Most of the parameters studied, such as absolute size, weight, population dynamics, reproduction biology, food analyses, and body fat percentage were taken during observations and collections made during the vegetation period (November – December and first half of January), when the minimum daily waters temperature drops to 4 °C or less. The sex ratio is fairly balanced when all material from all collection events is considered. During the period of peak-spawning, females predominate. The average individual standard length of spawners was 400 mm in males and 420 mm in females; the average weight 700 g in males and 900 g in females. Nevertheless, all parameters studied tended to decrease slightly through time, which is evidently a result of the gradually increasing numerical density of the fish and of the corresponding decrease in quantity of food available in the lake. In Khuisiin Naiman Nuur (Aimag Övörchangaj) fish became sexually mature at the age of 2+, and exceptionally, at the age of 1+, at the minimum total length 323 mm and minimum weight 295 g, respectively. The gonadosomatic index of mature females ranged from 9.0 to 25.0 %, and the mean absolute fecundity averaged 58,060 eggs.

Key words: *Coregonus peled*, acclimatization, reproduction biology, fish production, lake Ulaagchnii Khar, Khuisiin Naiman Nuur, Khongor Ulen, Darhad Valey

Introduction

In recent years, increasing pressure (over fishing) on fish populations has resulted in a decrease in numerical density and production of some valuable species in Mongolia. This decrease has resulted in demands for improvement of fisheries management, especially as regards to the establishment of a fish culturing operation for fishes of the family Coregonidae. To address these problems it was determined that it was necessary to conduct basic ichthyological research on the population dynamics and reproduction biology of the introduced species *Coregonus peled* (Gmelin, 1789).

Coregonus peled is doubtless one of the most successful objects of indtroduction in fish management and at present this species is spread over numerous countries of Europe and Asia. In Mongolia introduction began only in 1978 (DULMAA 1984, ANON 1983) namely in the following water bodies: lakes Shireet, Haliut and Muchar in 1978 and 1979 (the lake-system Khuisiin Naiman Nuur (Aimag Övörchangaj), lake Ulaagchnii Khar in 1980, 1982, 1986 (Aimag Zavhan), and lake Khongor Ulen Nuur in 1981 (Aimag Bajan-Ulgij).

The introduction of some coregonid fishes into certain lake systems of Mongolia has occurred with the purpose of intensification of fish production in these lakes. This introduction was studied in Lake Ulaagchnii Khar and from some other lakes of the Khuisiin Naiman Nuur lake-system (DULMAA & PENAZ 1986a).

Material and methods

We examined specimens of fish collected at 12 stations in the Lake Ulaagchnii Khar (n = 11230) comprised of age classes 2+ to 13+ (table 1). A set of 4 gillnets with a mesh size ranging from 35 to 60 mm and total length of 100–300 m was used for experimental collecting. The nets were usually laid on the bottom of the lake, both in pelagic and littoral parts. From each fish, all length measurements (TL, SL, FL) were taken from the tip of the snout. Otherwise, standard ichthyological procedures (PRAVDIN 1966) were used in studying the reproductive properties and age composition. The material of *Coregonus peled* larvae used for introduction in Mongolian lakes was imported from the Bolshrechnsky coregonid hatchery in Buryatya (Russia) near its mouth in Lake Baikal in 1980 and 1982.

Table 1: Survey of *Coregonus peled* analyzed for age and size (1996–2011)

age	n	length, mm						body mass (g)					
		M	± m_M	SD	CV	Pt	± tm_M	M	± m_M	SD	CV	Pt	± tm_M
1+	11	271	7.915	13.75	5.035	2.9	15.545	320	7.19	12.5	4.065	2.34	14.125
2+	837	313.3	17.043	32.252	19.166	5.3812	35.078	449.77	25.757	157.62	28.103	4.4266	50.98
3+	1023	347.43	14.711	24.233	18.706	4.3846	29.06	641.36	37.632	159.23	20.835	8.8313	69.79
4+	616	381.19	18.338	38.804	22.157	4.5987	36.571	862.09	67.126	320	30.319	23.098	118.51
5+	793	399.94	12.172	17.724	5.7747	3.0078	27.473	959.35	48.532	133.75	12.857	17.734	87.576
6+	304	435.62	21.127	61.184	13.507	4.4116	41.283	1206	118.87	580.23	33.677	31.366	106.4
7+	287	449.61	18.625	53.533	11.884	3.8104	36.586	1471	125.9	495.97	21.177	25.815	228.65
8+	194	455.54	30.093	72.235	15.554	6.2981	58.782	1472.5	93.767	283.02	14.254	61.746	329.06
9+	150	465.52	25.39	44.13	8.5438	4.8944	49.883	1407.3	94.719	166.14	10.908	19.97	177.15
10+	50	475.75	37.45	65.721	12.473	7.1356	74.735	1744.9	96.742	178.38	9.7417	20.729	200.56
11+	25	537	62.077	109	19.787	11.263	121.63	2057.7	116.73	227.33	11.093	57.633	177.21
12+	12	581.33	51.433	90.267	16.117	9.14	100.4	2455	101.63	186.67	7.5167	84.207	118.22
13+	9	630	69.2	120	19	10.9	135	3100	57.5	100	3.22	1.86	113

explanations: M = average, ± m_M = error of average, SD = standard deviation, CV-coefficient variation, Pt = accuracy indicator, ± tm = confidential interval P_{005}

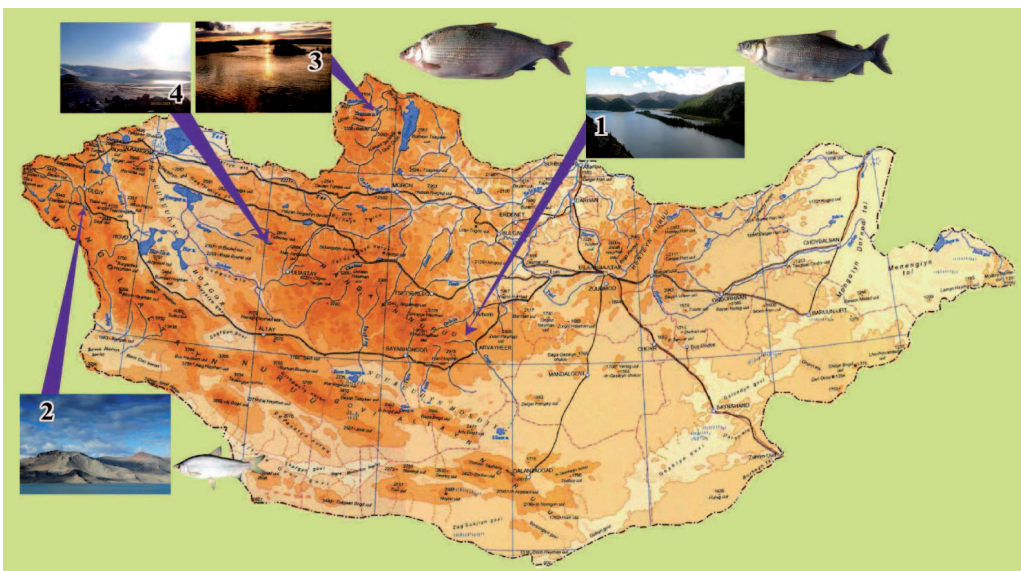

Fig. 1: Distribution of *Coregonus peled* in Mongolia (1 – Khusiin Naiman Nuur, 2 – Khongor-Ulen, Tolbo Nuur, 3 – Darhad Valey (Targan Nuur), 4 – Ulaagchnii Khar Nuur.

Study sites

The main object of introduction for our country is *Coregonus peled*. For experimental works, the following reservoirs were selected (fig. 1); the ecological characteristics of some of them are given below.

A group of endorheic lakes is located in the north-western part of the Hangayn Plateau of the Central Asian endorheic basin, at the absolute height of 1700–2150 m a.s.l. One of the largest of these is the lake Ulaagchnii Khar (fig. 2) located in Zavhan aimag, NW from the district Uliastay, Erdenehairhan soum (DULMAA et al. 1986a). The lake is situated in the famous Mongolian great Sand Valley "Bor-Har", which stretches for 550 km. The lake has an oblong shape consisting of several reaches with big bays and in the western part with two Islands with a height of 1980 m above the sea level.

Fig. 2: Lake Ulaagchnii Khar.

The area of lake Ulaagchnii Khar is 84.5 km^2, the length 36 km, maximum width 7 km and maximum depth 50 m, average 25 m. The littoral zone, with a depth of 5 m, includes more than 15 % of the total area. The zone limited by isobat of 10 m occupies 19 % of the area, 12 m – 19 %, 20–30 m – 22 %, over 30 m – 24 %.

The lake's bottom to a depth of about 5 m consists of gravel and sand, with clay existing exclusively at depths > 10 m. In its deepest parts, the bottom is covered with a mixture of very fine clay and a high proportion of organic matter. The lake is almost completely isolated, with only a single periodic tributary, the Ulaagchnii Creek, to the north. A small stream, Telj Creek flows out from the lake's eastern part, however it disappears into the steppe after about 50–150 m. Springs of fresh water exist on several sites of the lake and thus create water circulation within (DULMAA et al. 1998). The banks of the lake are low and rocky and in some places the rocky mountains run abruptly into lake, where the substantial depths result. The W and NW sides are surrounded by sand dunes reaching sometimes a height of 200 m or more.

The water in the lake Ulaagchnii Khar is fresh, the total mineralization ranges from 200 to 542.5 mg/l and is covered by ice in the end of November beginning of December. The thickness of ice reaches 120–180 cm. The water temperature under the ice is 1.0–2.0°C, with a transparency of 4 to 7 m. The ice in the lake is broken completely at the end of June. In summertime (July – August) water warms at the surface from 15 to 25° C, and at a depth of 40–50 m the temperature reaches 8–12°C.

The oxygen concentration is 7.74–8.29 mg/l and saturation up to 85.8–97.5 %. Photosynthesis speed was in average 0.10 mg O_2/l per day, with destruction 0.16 mg O_2/l per day. The chlorophyll content ranged within 0.78 and 0.47 mg/m^3. The primary production is 105 mg C/m^2 or 115 kcal/ year (DULMAA & PENAZ 1986).

Lake Ulaagchnii Khar is harbouring at least 43 species of zooplankton including 11 species of Copepoda, Cladocera – 10, and Rotatoria – 22 species. In the main, most forms are eurybiontic, with wide geographical spread. The prevailing complex of zooplankton during the year is Rotatoria-Copepoda with leading species of *Arctodiaptomus (Rhabdodiaptomus*) *bacillifer*, Hirudinea and Chironomidae. Their population reaches from 1.4 to 6.2 thousand/m^3. *Mixodiaptomus incrassatus, Cyclops abyssorum, Daphnia (Daphnia) longispina, and Keratella quadrata,* are to found around the year. In benthos are dominating *Gammarus lacustris* and Mollusca with biomass from 200 to 570 kg/ha. The most richly population zone is the zone of silted sands and silts with *Chara foetida* and *Fontinalis antipyretica*, which is strongly represented by *Gammarus lacustris* that occupies over the half of the total biomass weight. The most poorly population is the depth zone, where test samples give 15-75 kg/h^{-1}, exclusively of *Gammarus lacustris* and Chironomidae with mainly *Chironomus plumosus*. The biomass of the mentioned zone is probably higher, mainly due to the fact bottom drawer does not draw completely the *G. lacustris*.

The lake Ulaagchny Khar has very good nutrition conditions for fish. In phytoplankton are dominating diatomic and blue-green algae. The zooplankton biomass is sufficiently high, in summer 6.9–10.1 g/m^3, in winter 1.26–3.05 g/m^3. Considerable feed resources of the lake were not used because there wasn't any fish in the lake. On the basis of theses biological data it was recommended to install into the lake larvae of *Coregonus peled* in 1980 and 1982, in total 100000 million larvae were released (DULMAA et al. 1998).

Lake Khuisiin Naiman (fig. 3) consists of a system of eight linearly joined lakes (Shireet, Muchar, Halyut, Bugat, Haja, Shanaa, Doroo, Khuis) and is situated in a valley of the southeast part of the Hangai mountains, 120 km north of the administrative centre of Arvajheer, Uburchangajskij aimag.

Fig. 3: Lake Khuisiin Naiman.

Its surface elevation is 2450 m.s.l., the water area varies from 100 to 325 hectares, the maximum depth occurring in the SE part of the lake is 17–25 m, and the most frequent depth is 5–10 m. The bottom relief is saucer-like. The lake is closed (endorheic) and no streams flow into or from it. Water feeds the lake through precipitation, flood events, and ground water inflow. The transparency of water varies from 2.5 to 4.5 m and the surface water temperature reaches a maximum of between 15 to 18° C during the summer. Relative to water chemistry, the lake is of the hydro-carbonate type and according to the degree of mineralization the "ultra-fresh" type, the total amount of salts being 58.1 to 69 mg/l. The oxygen content is very suitable reaching 7.41– 8.91 mg O_2/l^{-1} (107.2–112.4 % saturation) during May and July, 9.60 mg O_2/l (101.5 % saturation) in October. Under the ice (February – March) the surface concentration of O_2 changed from 7.2 to 8.0 mg O_2/l (saturation 69–74.2 %). Daytime oxygen concentration showed some over-saturation at the surface, but no other remarkable signs of eutrophication of 0.37 O_2/l per day. The ph-value ranges from 6.97 to 7.20. The chlorophyll a concentrations of the lakes Shireet and Muhar were between 3.25 and 5.96 mg/m^3, phytoplankton biomass 3.91–1.49g/m^3 and primary production was 605 mg C/m^2 or 730 kcal/m^2 during the year. These lakes may be considered as mesothrophic.

Studies of phytoplankton of the lakes have resulted in identification of 33 species and ultra specific taxa of algae belonging to 5 groups. At the head was Chlorophyta – 13 species, then following Bacillariophyta – 11, Cyanopyta – 7, Pyrrophyta – 1, Euglenophyta – 1 species. Among the five phytoplankton taxa, dominant algae were *Cyclotella comta* (37.3 mg/m^3), *Oocystis submarina* (0.25 mg/m^3), *Synedra ulna* (200 mg/m^3), *Melosira islandica* (250 mg/m^3), and *Scenedesmus quadricauda* - 0.11 mg/m^3.

The benthic vegetation is well developed, with up to 40 % of the bottom supporting macrophytic growth. The mesotrophic lakes of Khusiin Naiman chain show rich developed submerged vegetation with well developed under water meadows of varies *Chara vulgaris* and *Fontinalis antipyretica.* The following macrophytes were identified: *Ceratophyllum demersum, Lemna minor, L. trisulca, Myriophyllum spicatum, Polygonium hydropiper, Phragmites australis, Spirogira sp., Zygnema sp.* In the shallows of lake Shireet the dominant species were*: Myriophyllum verticillatum, Ranunculus aquaticus, Polygonium amphibium, Potamogeton pectinatus, P. praelongus, P. lucens.* Helophytes were sparse but diverse, mostly *Eleocharis palustris, Scirpus lacustris, Alisma lanceolata, Juncus bufonius.*

Lakes of the Khuisiin Naiman chain have the highest quantity of food availability among the water bodies on the Hangai mountain Lake Plateau (DULMAA & PENAZ 1986a). The zooplankton is composed of 20 species: *Arctodiaptomus denticornis, Cyclops lacustris, Daphnia longispina, Kellicottia longispina, Conochilus unicornis* are abundant of them. The biomass of zooplankton, excluding sufficiently abundant gammarids, varied from 1.0 to 2.3 g/m^3 (average = 1.28 g/m^3) in the period prior to stocking of *C. peled* larvae into the lakes during the summer season, and 0.7–1.0 g/m^3 (average = 0.81) during winter. The abundant trophical sources were not formerly utilized due to the complete absence of fish, particularly the planktonophages. The seasonal productivity of crustacean plankton reached 73 kcal/m^2.

The benthic invertebrates include planktonic crustacean, most Gammaridae, and Ostracoda. Lake insects are also numerous. Many nektonic Heteroptera and Coleoptera feed on the bottom and breathe at the surface, mostly in the shallow water near shores. The planktonic larvae and nymphs of mosquitoes thrive in these lakes. In the macrophyte belts above muddy bottoms lives a rich and diverse animal benthic community comprising Hydracarina, Molluscs *(Lymnaea peregra, Planorbis planorbis, Gyraulus* spec.*, Physa acuta, Radix ovata, Valvata* spec. and *Pisidium casertanum.* Among the insects, mostly Chironimidae with a biomass 0.05–0.71 g dry weight per/m^2 (*Mictopsetra, Polypedilum brevianteunatum, Microtendipes, Tanytarsus, Chironomus salinaius*), dragonflies and some mayflies are adapted to muddy substrata. But caddisflies are restricted to hard substrata as are the stoneflies. Muddy bottoms are also occupied by numerous mollusks (0.12–0.48 g dry weigth/m^2) such as *Lymnaea, Planorbis* and *Pisidium*. Benthic animal biomass in lake Shireet was measured as 5.2, and in lake Muchar 0.62-5.30 dry g/m^2.

The potential commercial productivity of fish was estimated to be 10-20 kg/ha. There are also vast suitable spawning sites on sandy or gravel banks.

On the basis of these biological data it was recommended to stock into lakes Schireet, Muchar, Chaljut, Khuis and Bugat larvae of *Coregonus peled* in a quantity 1500 individuals/ha. In May 1978 into the system of lakes Khuissin Najman were brought 50 thousand, and in 1979, 100 thousand larvae of *Coregonus peled*.

Into Altaj reservoirs of the Khongor-Ulen system in Bayan-Ulgii aimag (Har, Toson, Khongor and Tolbo Nuur, (fig. 4) with exclusively poor ichtyofauna *Coregonus peled* was introduced in mid-May 1981. In summer of the same year the individuals reached up to 50 g.

Fig. 4: Lake Tolbo.

Coregonus peled, owing to ecological plasticity, has spread has far beyond the limits of its original range in reservoirs of Central Asia. In Mongolia introduction began in 1978 (DULMAA & PENAZ 1986b). At present, *C. peled* has acclimatized well and settled all over the lake Ulaagchnii Khar (fig. 5). A spawning migration towards the lake side starts at the beginning of October – November. In winter the fish go into deeper parts of the lakes. 0+ yearlings weight from 75 to 120 g.

The age range of captured *C. peled* (fig. 6) was from 1+ to 14+ groups, the major part of the stock consisted of individuals 2+ to 10+ age in lake Ulaagchnii Khar, in Khuisiin Naiman individuals of *C. peled* captured from 3+ to 5+ years old. In water bodies of the Darhad valley *C. peled* has an age composition from 3+ to 11+ years, and in the stocks dominate 5+ year old fish. Adult fish weight varies from 350 to 3620 g occurring in the age of 1+ up to 14+, but dominating are the age classes 3+ – 5+ (87.1 %). *Coregonus peled* matures under the conditions of sharply continental climate rather early in the second life year, in some cases at the age of 1+ with achieving minimum length of 323 mm and minimum weight of 295 g.

Fig. 5: *Coregonus peled* from the lake Ulaagchnii Khar.

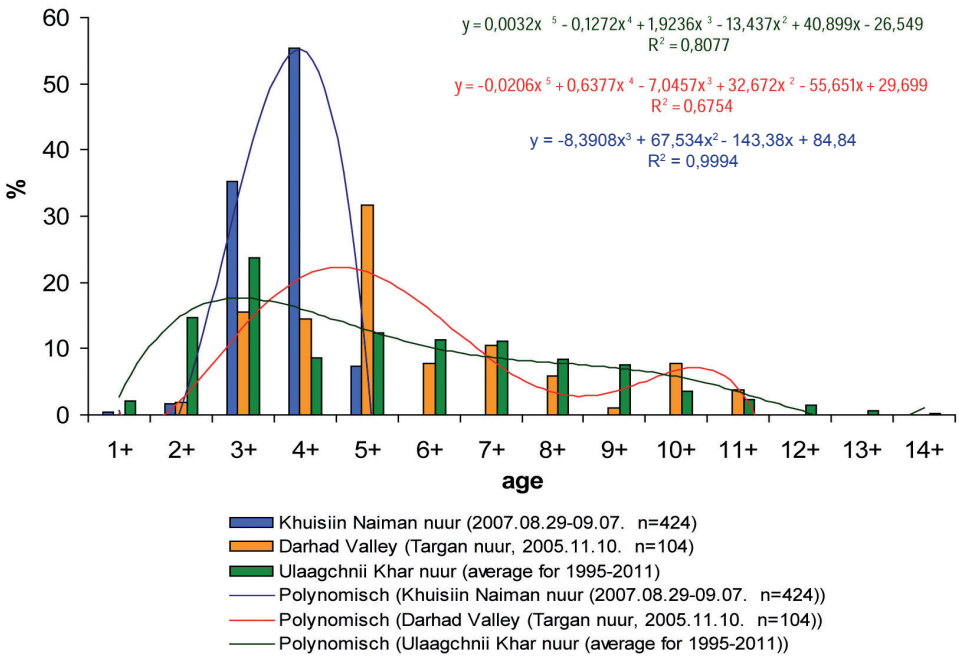

Fig. 6: Age composition of *Coregonus peled* from several Lakes in Mongolia.

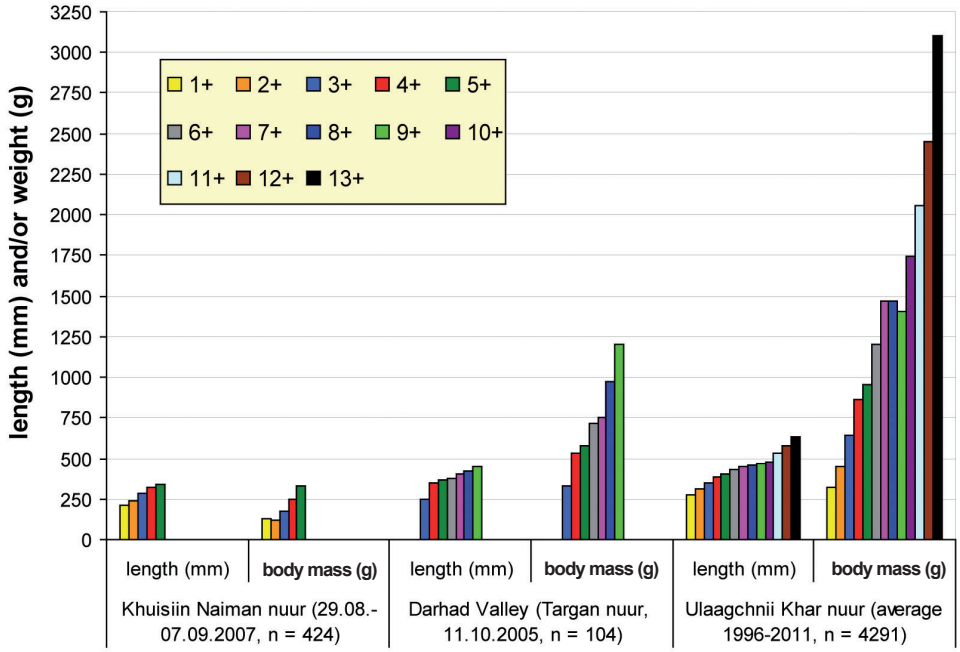

Fig. 7: Body length and body mass of *Coregonus peled* in different ages.

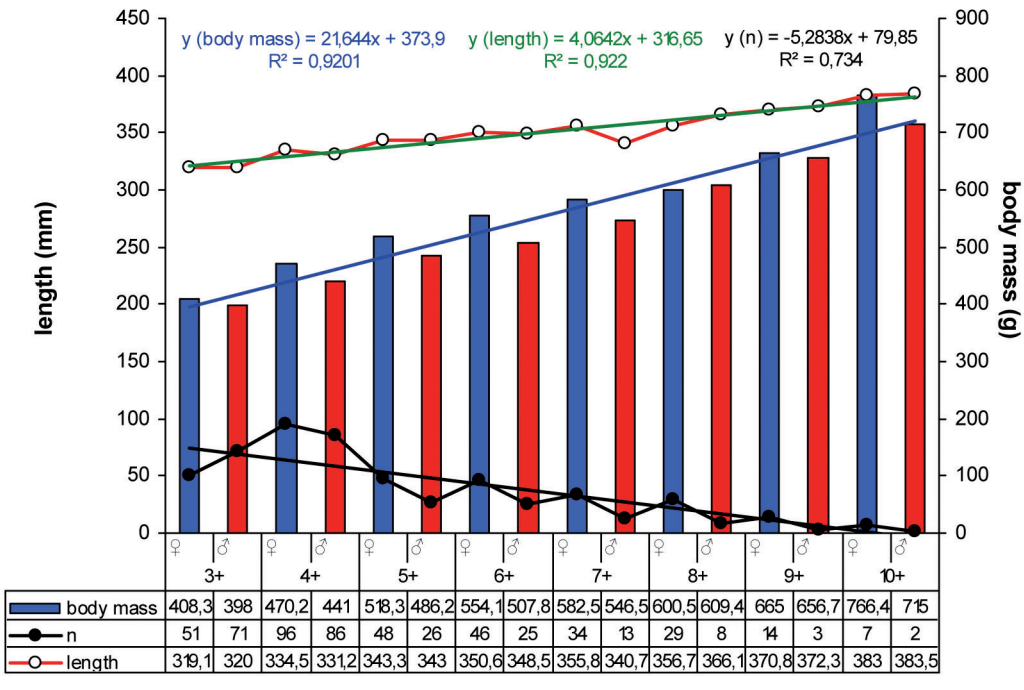

Fig. 8: Growth of female and male *Coregonus peled* in the lake Ulaagchnii Khar.

In Khuisiin Naiman Nuur, yearling C. peled weighted 120 g and adult fish of 1+ – 5+ ages between 230 and 335 g, corresponding to a length of 214 and 341.2 mm, respectively. In the Darhad valley individuals with an age of 3+ – 9+ had a body length of 245–450 mm and weighted from 330 to 1200 g in summer. In lake Ulaagchnii Khar the individuals of the age 3+ to 9+ had in average 323–520 mm and 397–2560 g.

The growth rate of acclimatized *C. peled* population is high and closely related to temperature and feeding features of reservoir. According to available data, the comparatively intensive growth is noticed for *C. peled* whitefish in the system of Khuisiin Naiman, Ulaagchny Khar and Baga. When comparing the figures of growth of *C. peled* whitefish from Mongolian lakes (fig. 7, 8) with several reservoirs of Siberia, one can easily see – the growth rate of fishes of population-acclimatizants is rather high. The increase of the growth rate of *C. peled* in the early years after introduction in reservoirs outside their natural areas, under the condition of a good supply of food, has been mentioned often in the literature (KARACEV et al. 1979).

A temporary increase in *C. peled* catches due the overexploitation. The effort resulted in extra catch about 20000 – 50000 t in the period from 2010 till 2012. Perhaps, this may result in a decrease of the size, weight and in changing age composition of *Coregonus peled* in the lakes Ulaagchnii Khar and Khuisiin Naiman in comparison to the year 2009.

At the end of July sexual products of female *C. peled* are at the IInd - IIIrd stage of maturity, in August at the IIIrd – IVth, in September at the IVth, in October – November at the IVth – Vth, by the and of December and the beginning of January were found individuals with gonads at Vth – VIth stages. The gonadosomatic coefficient before spawning of females in the age 2+ varies from 9.1 to 20.0 %. At the end of October/mid-November some female individuals have the maximum coefficient of maturity – 25 %, and the minimum was found in February – 0.8 %.

Spawning happens in November-December during the period of getting ice-bound or after it. Spawners are starting when the temperature of water is 2.5–1.8 °C and the peak falls in the time with water temperature of 1.5–1.0 °C under the ice. *C. peled* spawns at a depth of 1.5–4.0 m on sandy or pebbly-sandy grounds. The sex ratio of *C. peled* among same age producers in selected water bodies is close 1:1 (fig. 9).

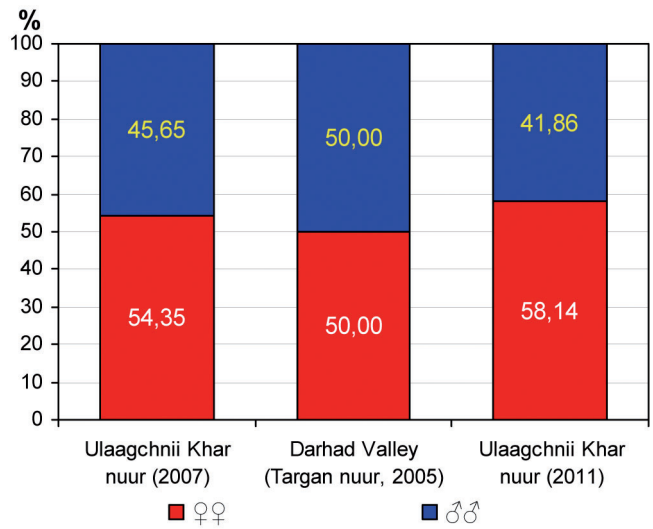

Fig. 9: Male-female proportions of introduced C. peled populations in some waterbodies of Mongolia.

The fluctuation level of fecundity depends rather not only on the age, but on the producer's sizes. The growth of length and weight of fish leads to the increase of the absolute fecundity (table 2). The absolute fecundity of fish of the 2nd year fluctuates within 5.6 – 62.5 thousand eggs, of three-year-lings within 7.4 – 77.6 thousand eggs, of four-yearlings within 10.8 – 92.2 thousand eggs,

and of five-yearlings within 18.6 – 120.0 thousand eggs. The number of eggs accounting per 1 g of testicle is depending on the level of mature of gonads, age and mass of fishes, and fluctuates within 300 to 1,325 eggs. The eggs are yellowish – orange, the sperm is of thick consistence and white coloured. The average diameter of unswollen eggs is 1.5 mm and of the ripened eggs reached 2.0 mm. The absolute fecundity of naturalized *Coregonus peled* varies strongly from 4.4 to 120 thousand eggs with average of 58.0 thousand.

The relative fecundity of peled whitefish ranges from 25.2 to 95.0 eggs per 1 gram of body mass without viscera (sculled weight). The minimum indicator was observed in July - 10.6 and the maximum in October-November with up to 95 eggs. Therefore, the absolute fecundity of the *C. peled* whitefish under conditions of the lake system of Mongolia is relatively high.

In the Khuissin Naiman Nuur, *C. peled* spawns in November – December. Fecundity is from 8,795 to 24,781 eggs. In the Darhad valley, females produce between 23,999 and 75,113 eggs. The spawning season of *C. peled* in lake Ulaagchnii Khar takes place in December and January and under water temperature descends to 1.8 – 2.1 °C with spawning peaks at temperatures of 1.5 – 1.0 °C. Females produce between 28,836 and 58,453 eggs. Fecundity increases with the length, body mass and age (fig. 10).

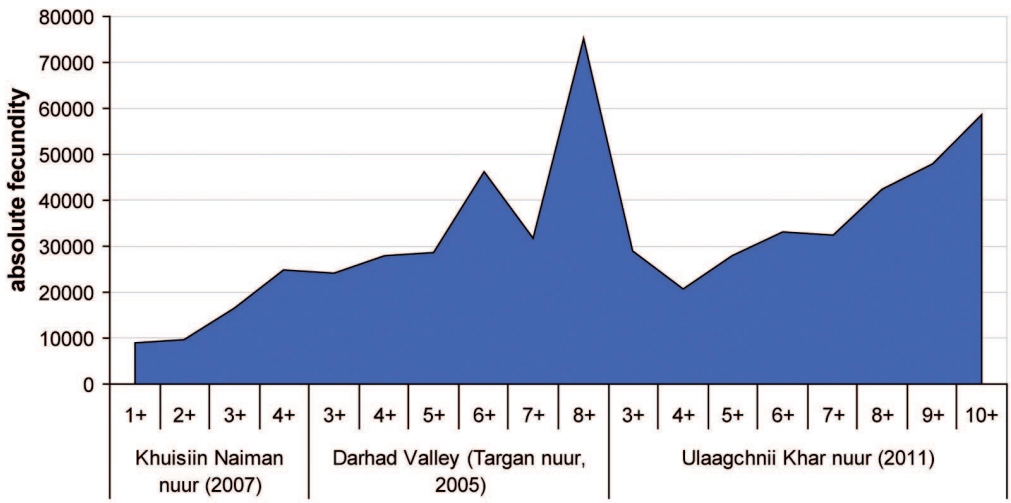

Fig. 10: Fecundity of *Coregonus peled* in some selected water bodies of Mongolia.

In Mongolian lakes *C. peled* feed year-round. The main food is planktonic crustaceans (especially planktonic gammarids), chironomidae, and mollusks. The oldest *C. peled* of rivers and lakes in selected reservoirs feed mostly on benthic organisms. Plankton is the major source of food for young fish up 0+ to 1+ years old. Some 20 species of organisms have been identified as food items of *C. peled* from the Khuisiin Naiman Nuur, Darhad valley and basin of lake Ulaagchnii Khar. The index of stomach fullness ranges from 10 to 75 ‰.

The fatness coefficient by CLARK (1928) is rather high and ranges within 1.4 – 2.67. The fatness coefficient of mature *peled* whitefish in places of its natural area varies within 1.1 – 1.8.

The coefficient fatness of *C. peled* in selected lakes is very different. Lower coefficients of fatness of *C. peled* were observed in lakes Khuissin Naiman (0.85 – 1.15), in Darhad valley 1.40 – 2.25 by FULTON (1902). The highest coefficient of fatness is found in *C. peled* from water bodies Ulaagchnii Khar Nuur (1.65 – 2.4 by FULTON, fig. 12).

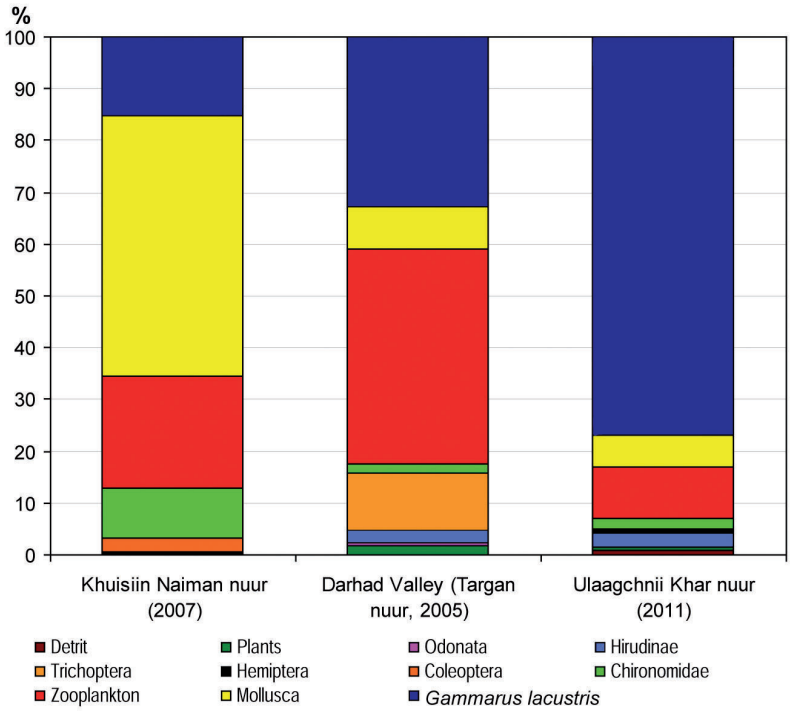

Fig. 11: Food components of *Coregonus peled* in some selected water bodies of Mongolia.

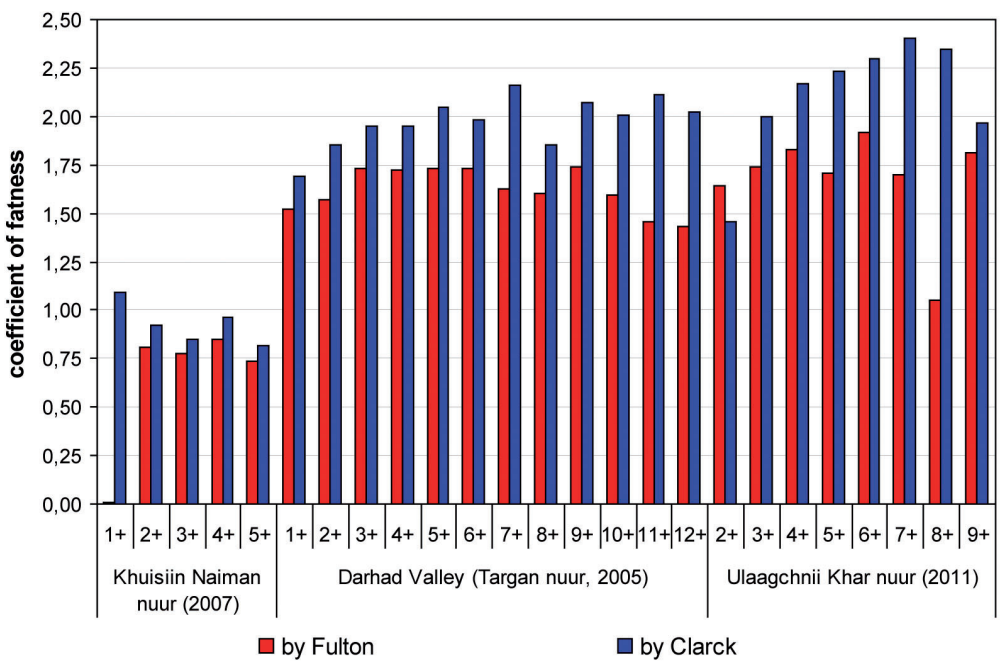

Fig. 12: Coefficient of fatness of *Coregonus peled* by FULTON (1902) and CLARK (1928).

Table 3: Coefficient of fatness of *Coregonus peled* from lake Ulaagchnii Khar

age	n	sex	by FULTON							by CLARK						
			M	± m_M	SD	CV	m_{CV}	Pt	± tm_M	M	± m_M	SD	CV	m_{CV}	Pt	± tm_M
2+	186	♀	1.72	0.08	1.16	67.3	3.49	4.94	0.16	1.19	0.02	0.32	16.9	0.81	1.24	0.04
	80	♂	1.57	0.02	0.2	12.8	1.01	1.43	0.04	1.72	0.03	0.24	13.7	1.08	1.53	0.05
3+	118	♀	1.80	0.02	0.22	12.3	0.80	1.14	0.04	2.15	0.02	0.26	12.3	0.80	1.14	0.04
	104	♂	1.68	0.02	0.23	13.8	0.95	1.35	0.04	1.84	0.02	0.27	14.6	1.01	1.43	0.05
4+	42	♀	1.82	0.03	0.19	10.6	1.16	1.65	0.05	2.34	0.03	0.24	10.5	1.14	1.61	0.07
	45	♂	1.83	0.03	0.19	10.5	1.11	1.57	0.05	1.99	0.03	0.21	10.8	1.10	1.6	0.06
5+	6	♀	2.15	0.09	0.23	11.1	3.20	4.53	0.25	2.44	0.09	0.22	9.25	2.67	3.78	0.26
	10	♂	1.27	0.06	0.21	16.7	3.73	5.27	0.13	2.02	0.06	0.2	9.76	2.18	3.08	0.12
6+	11	♀	1.86	0.08	0.28	15.3	3.26	4.61	0.16	2.38	0.09	0.32	13.7	2.92	4.14	0.19
	15	♂	1.98	0.04	0.17	8.47	1.54	2.18	0.08	2.21	0.06	0.25	11.5	2.10	2.97	0.13
7+	26	♀	1.93	0.03	0.19	10.2	1.41	2.00	0.07	2.58	0.04	0.23	8.96	1.24	1.75	0.08
	16	♂	1.46	0.14	0.58	39.9	7.07	9.99	0.28	2.23	0.04	0.17	7.71	1.36	1.92	0.08
8+	14	♀	0.93	0.16	0.6	64.2	12.1	17.1	0.31	2.61	0.11	0.42	16.1	3.04	4.3	0.22
	8	♂	1.18	0.07	0.22	18.6	4.65	6.58	0.15	2.09	0.06	0.19	8.99	2.25	3.18	0.13

explanations: M = average, ± m_M = error of average, SD = standard deviation, CV-coefficient variation, m_{CV} = error of coefficient variation, Pt = accurary indicator, ± tm = confidential interval P_{005}

Conclusions

At present, the introductions of *C. peled* appear successful and this species has naturalized to several lakes in Mongolia. Thus, in the reservoirs in fact has appeared an additional trophic chain – consumers of first and second sequence. Based on our work and others, in the lakes in Mongolia, an outlook and perhaps prediction can now be made of the changes in population numerical density in *C. peled* over time. In all lakes, natural reproduction appears to be sufficient for development of a relatively stable population of this species. In addition, it appears that these fishes are reproducing well enough that these stocks can be used for additional stocking of other lakes in Mongolia. Their numerical density is substantially increasing on the account of natural reproduction and fishes are growing well.

In the future the populations of fish are likely to grow steadily and after achieving a certain level, it will probably stabilize. It also appears that as the numerical density of the fish increase, with concomitant decrease in food availability due to intraspecific competition, the growth rate of *C. peled* will slow, but this is only a prediction for the lakes of Mongolia at this time.

While organizing the industrial exploitation of *peled* whitefish, it is more reasonable to orient the fishery to the exploitation of fishes under three to six years of age, as growth during this period is most intensive. Taking into account the high growth rate of C. peled during the first – five years of life, the fishery is planned to be organized by the pasture fishery type, where by the reproduction process is carried out artificially and the younglings released into the reservoir, is cached already in 1–2 years time.

In Naiman Nuur all individuals became sexually mature at the age of 2+ exceptionally already at the age of 1+, at a minimum total length of 214 mm and a minimum body mass of 295 g. The gonadosomatic index of mature females ranged from 9 to 25 %, mean absolute fecundity averaged 58,060 eggs.

The first spawning of *C. peled* after its introduction in the Najman Nuur lake system was observed in 1980, i.e., at an age of 2+. During the autumn excursions carried out in following years

1981–1983 it was found that all 2+ year-old fish and exceptionally also 1+ old individuals were mature and ready to take part in the following spawning (gonads occurred in the maturity stage IV-V according to NIKOLSKIJ (1953). This early sexual maturation of the males and females seems to be normal in the majority of acclimatized and fast growing populations (RESHETNIKOV 1980, RESHETNIKOV et al. 1989). The earlier maturation appears to be a result of plentiful food resources rather than of geographical latitude. The gonadosomatic index of mature females varied in the range 9 %–20 % and in extreme cases reached 25 % at an absolute weight of gonads of 160 to 250 g. The size (total length) of spawners ranged from 323 to 560 mm and their body mass 295–1700 g. The absolute fecundity varied in the range 23920 to 98160 eggs *(*average = 58060), the relative fecundity ranged 35200–81800 eggs/kg. The average diameter of the ripened eggs reached 1.3–2.0 mm. In 1982, an abundant spawning shoal formed and the first spawning took place of the offspring already born in the Najman-nuur lakes.

Coregonus peled is a valuable commercial target. It is relatively expensive. In the 1995–2005 catches varied from 3.5 to 50 tons/year. By at the end of 2005, the abundance of *C. peled* significantly decreased to 25 tons/year. An annual ban on fishing was instituted during the spawning period and this is to consider as a sufficient conservation measure.

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