ISSN: 0975-8585

Research Journal of Pharmaceutical, Biological and Chemical Sciences

Ecological Features Of The Hydrobiocenoses Of Some Lakes Of The Onon-Torey Plain In Different Hydrological Periods.

Natalya A Tashlykova*, Ekaterina Yu Afonina, Alexey P Kuklin, Balzhit B Bazarova, Petr V Matafonov, Gazhit Ts Tsybekmitova, Eugenia P Gorlacheva, Mydygma Ts Itigilova, and Maria N Butenko.

Laboratory of aquatic ecosystems, Institute of Natural Resources Ecology and Cryology Siberian Branch of Russian Academy of Sciences, Russian Federation, 672006, Chita, Nedorezov st., 16a

ABSTRACT

For the Onon-Borzinsky system of lakes, there are typical cycles of 27-35 years old, controlled by the course of atmospheric humidification, when relatively moist and very cold periods alternate with dry and relatively warm periods. As a result of filling and drying of reservoirs, the main hydrochemical characteristics change, leading to the transformation of the biological parameters of hydrobionts and the restructuring of lake ecosystems as a whole. The aim of the work is to assess the ecological state of aquatic communities (phytoplankton, zooplankton, macroalgal, macrophytes, zoobenthos, fish) of some lakes of the Onon-Torey plain in different hydrological periods. The results of the works are based on long-term collections (years with high water levels – 1999, 2003 and low – 2007, 2011, 2014, 2016) hydrobionts in the mineral lakes Zun-Torey, Barun-Torey, Bain-Bulak, Tsagan-Nor, Bain-Tsagan – relating to the South Tsasuchchey and Torey group. Sampling of water for the study of hydrophysical, hydrochemical and hydrobiological indicators was carried out according to standard methods. It is established that the water and physico-chemical regime of lakes is unstable. Hydrological and hydrochemical changes due to climatic fluctuations determined the change in the hydrobiological regime. In the plankton with a decrease in the water level, an increase in mineralization, pH, and water temperature, there was a decrease in species richness, a restructuring of the dominant complex toward the prevalence of salt-tolerant and alkaliphil species (taxa), and a simplification of the trophic structure. For higher aquatic vegetation and fish, there is a decline in the qualitative composition and numerical characteristics.

Keywords: Onon-Torey lake system, Zun-Torey, Barun-Torey, Bain-Bulak, Tsagan-Nor, Bain-Tsagan, phytoplankton, zooplankton, macroalgae, macrophytes, zoobenthos, ichthyofauna.

**Corresponding author*

INTRODUCTION

There are various brine and salt-water lakes not only in hot-climate and draughty regions but also in some moderate- and cold-climate regions, in particular, in Eastern Siberia. Typically, such lakes are grouped into closed basis to be primarily featured with location in semiarid climatic zones, absence of any surface flows, shallow depth, and confined catchment basin. Their dimensions and salt load is significantly varied [1]. The southeast Trans-Baikal territory that borders to China and Mongolia contains a few hundred similar water bodies – i.e. Onon-Borzya system specific lakes. With minor exceptions (Barun-Torey and Zun-Torey), their water-surface area varies within the range of 0.01 to 10 km^2, salt load – 0.1 to 300 g/L. Since flooding or desiccation affect basic hydrochemical characteristics (cationic and anionic composition, salinity), some kind of transformation of biologic hydrocole parameters occurs with the ecological system of lakes to be entirely rearranged [2].

On surveying five water bodies (i.e. Zun-Torey, Barun-Torey, Bain-Bulak, Tsagan-Nor, Bain-Tsagan referred to the South-Tsasutcheysk and Toreysk groups), complete hydrobiological data were obtained. The above water bodies were systematically studied in 1982-1983, 1986 [3], 1999, 2003 [4, 5], 2011, 2014 [1, 6] and in 2016 [7]. The purpose of this paper is to estimate an ecological state of aquatic communities (phytoplankton, zooplankton, macroalgae, macrovegetation, zoobenthos, and fish) inhabiting some lakes of the Onon-Torey plain throughout various hydrologic periods.

MATERIALS AND METHODS OF RESEARCH

The water bodies subject to the studies are situated in the south of East Trans-Baikal territory (Fig. 1) and they are covered by Amur catchment basin and Torey blind region. They are concentrated within the Tsasutcheysk depression located in the middle course of Onon River [3, 8]. Such lakes are featured with their morphometric characteristics as those to have flat basins of round or egg-like shape with a constrained catchment area and saucer-shaped bottom contour. The Barun-Torey and Zun-Torey lakes are found to be remains of a large lake that covered the entire area of the Torey-Borzinsk watershed. The both bodies make up a single hydrologic system and communicate to each other through the Utotchy channel. The Bain-Bulak, Tsagan-Nor, Bain-Tsagan lakes are situated along Onon River within the Central-Asian desert and steppe region entering into the closed region of the Onon-Priargunsk hydrologic area.

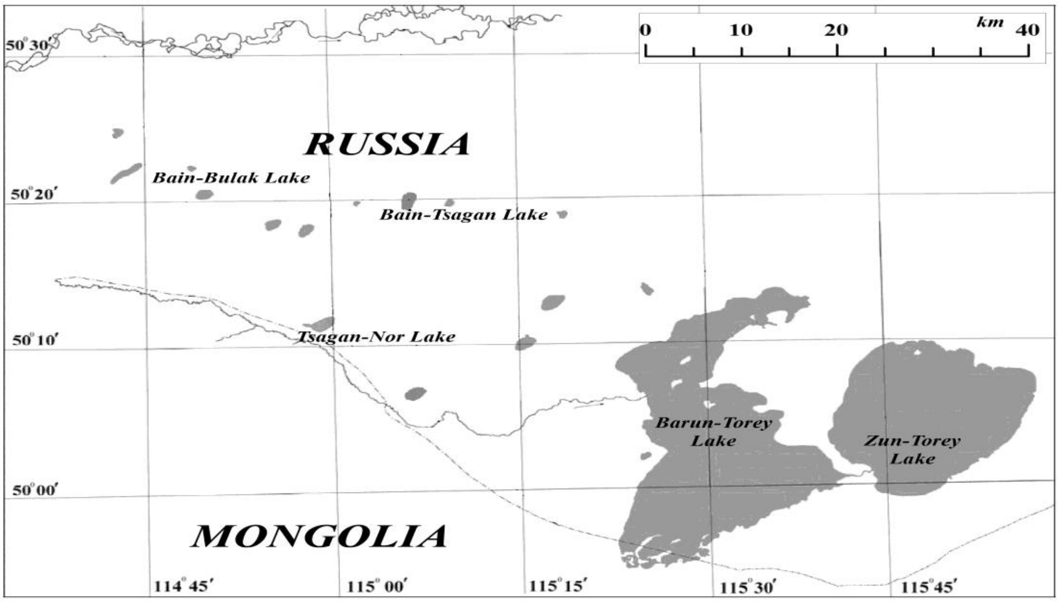


Fig. 1. Map-scheme of the studied lakes
(according to 2003-2004)

The water-surface area, specific morphometric and physicochemical characteristics obtained throughout various survey periods are shown in Table 1.

Table 1: **Some morphometric and physico-chemical parameters of lakes at the different investigated periods**

Lake/GPS	H, m	Catchment area, km²		Area of the lake, km²			Date	Station	h, м	TR, м	T, ºC	TDS, г/л	pH
		1998	2014	1983-1986**	1998***	2015***							
Barun-Torey 50°4'6"N 115°32'16"E	598,0	26000	25700	580	536,3	<1,5	05.08.1999	1	2,65±0,8	0,45±0,3	21,2±0,2	-	-
								2	4,0	0,4	24	2,1*	9*
							06.08.2003	1	1,1±0,07	0,3±0,07	19,2±1,3	-	-
								2	3,0	0,3	23,1	-	-
Zun-Torey 50°4'31"N 115°48'46"E	598,0		300	300	298,2	193,03	05.08.1999	1	2,45±0,6	0,5±0,03	21,1±0,1	-	-
								2	6,5	0,5	23,0	2,12*	9*
							06.08.2003	1	2,4±0,92	0,5±0,03	20,8±0,4	-	-
								2	5,6	0,5	23,4	-	-
							26.07.2011	1	1,7±0,00	0,3±0,00	23,4±1,8	8,1±0,04*	9,4±0,00*
							23.07.2014	2	0,65±0,2	0,3±0,03	23,4±2,1	14,5±0,1	9,9±0,00
								1	1,5	0,2	21,7	14,3	9,9
							02.08.2016	2	0,2±0,00	0,2±0,00	21,1±0,1	19,9±1	9,4±0,04
Tsagan-Nor (the village of Builesan) 50°11'59"N 114°59'36"E	676,1	89,26		3,0	4,63	2,97	08.08.1999	1	3,3 ±1,77	1,05 ±0,3	19,2 ±0,6	2,4 ±0,21*	-
							10.08.2003	2	7,8	0,4	17,8	-	-
							29.07.2007	1	2,2	0,5	-	-	-
								2	6,0	0,5	22,9	-	-
							27.07.2011	1	2,5	2,5	22,6	4,3*	9,1*
							26.07.2014	2	0,8±0,26	0,8±0,26	23,9±0,4	6,6±0,08*	9,7±0,02*
								2	4,1	4	24,2	2,4 ±0,21	9,6
Bain-Tsagan 50°20'00"N 115°06'28"E	652,2	65,24		4,0	3,5	2,79	08.08.1999	1	6,0	3,7	21,0	-	-
								2	11,0	3,7	21,5	2,1*	9,1*
							10.08.2003	2	10,2	4,5	18,8	-	-
							29.07.2007	2	9	2,5	-	4,5*	9,3*
							28.07.2011	2	7,8	1,5	22,0	4,3*	9,4*
							27.07.2014	1	2,96±0,9	0,8±0,00	23,2±0,8	6,5±0,04	9,6±0,02
								2	7,1	0,9	25,2	6,2*	9,7*
Bain-Bulak 50°22'33"N	663,1	7,24		0,5	3,67	2,52	09.08.1999	3	2,2	1,0	20,5	-	-
								2	6,0	1,0	20,5	0,67*	8,5*

114°48'80"E						10.08.2003	2	6,2	0,6	17,8	-	-
						31.07.2007	2	3,5	0,5	-	1,8*	-
						27.07.2011	2	3,4	0,5	21,5	1,8*	9,0*
						29.07.2014	1	1,45±0,2	0,3±0,02	25,4±0,1	-	-
							2	3,1	0,3	23,0	2,7	9,3

Note: "-" – no data; H - height above sea level; h – depth, TR – transparency, T – water temperature, TDS – salinity (mineralization); "*" – according to [2, 8]; "**" – according to [3]; "1" – stations in the coastal region; "2" – is the center; "3" – the bay; "***" – calculated by Google Maps.

Qualitative and quantitative information about biota in the explored lakes were obtained by summer expedition teams within the period of 1999-2016 (see Table 1).

Sampling of water for the study of hydrophysical, hydrochemical and hydrobiological indicators was carried out according to standard methods (Table 2).

Table 2: Methods used in the study of lakes

Range	Options	Methods / Devices		Literature
Hydrology (hydrophysics)	Deph	Lot / Depth sounder		
	Transparency	Secchi disk		
	Temperature	thermoelectric thermometer	Aquareader*	–
	Active hydrogen index	pH-meter		
	Mineralization	TDS-meter		
Hydrochemistry	nitrites	photometric method (spectrophotometer SPEKOL 1300)	with a Griss reagent	
	nitrates		recovery to nitrites with a Griss reagent	
	ammonium ions		with Nessler reagent	
	phosphates		with a mixed reagent	
	total phosphorus		burning with potassium persulphate	
	macrocomponents (CO_3^{2-}; HCO_3^-; Cl^-; SO_4^{2-}; Na^+)	atomic absorption, photometric, gravimetric, titrimetric		JSC «LICIMS» **

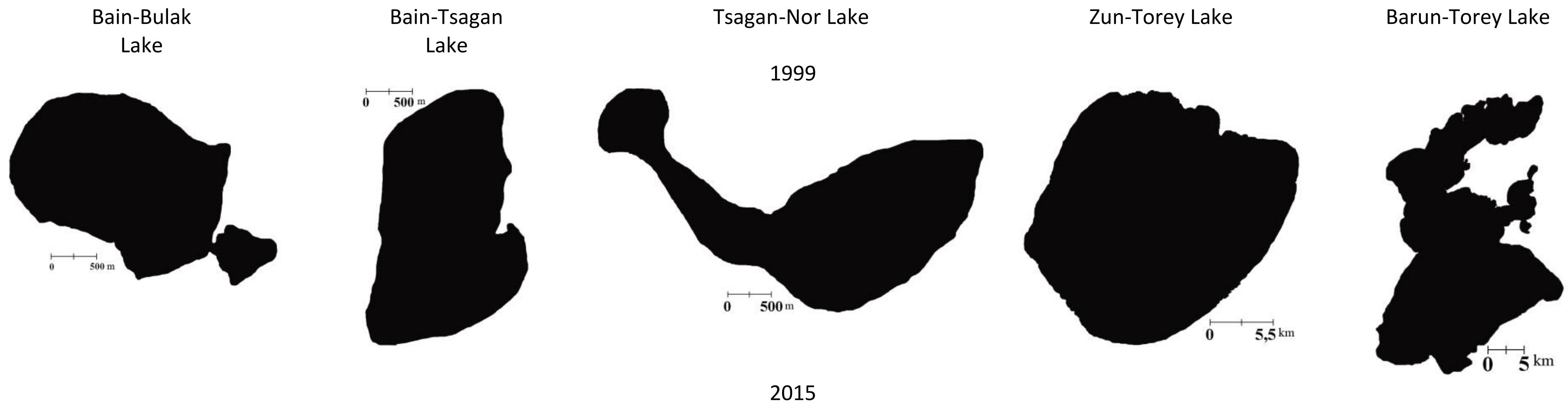
Phytoplankton	sample collection	Patalas bathometer, a 1 liter sample was taken	
	conservation	fixed in 4% formalin	
	sample preparation	sediment method	
	species identification	microscope Nicon Eclipse E200-F (1000×) (Japan)	
	abundance	was made in a counting plate (0.01 ml volume) by using the Hansen method	
	biomass	with geometric figures method	
	production	by the oxygen method	
Hydrophytes	species identification	microscope Altami CMO745-T (270×) (Russian), microscope Carl Zeiss Axio Scope A1 (1000×) (Germany)	
	spatial structure	profile method, test sites	
	phytomass	weighted	
Zooplankton	sample collection	a Judy net with a filtering cone made of Capron mesh (125 µm) from 60 to 100 L of water was filtered through the net during sampling Samples were taken from the whole water column (bottom-to-surface).	
	conservation	fixed in 4% formalin	
	species identification	microscope Carl Zeiss Axio Scope A1 (1000×) (Germany)	
	abundance	Abundance and biomass were calculated for each species in each sample. The biomass of zooplankton was determined considering the size of zooplankters.	
	biomass		
Zoobenthos	sample collection	Petersen bottom grab 1/40 m^2, ground washing through a sieve with mesh 0.270 mm	
	conservation	fixed in 4% formalin	
	species identification	microscope Carl Zeiss Axio Scope A1 (400×) (Germany), MBS-10 (70×; Russia), Mikmed-1 (400×, Russia)	
	abundance	counting and weighing	
	biomass		

Ichthyofauna	sample collection	gill nets (mesh 12-60 mm), small finger net (mesh in wings 5 mm)	
	species identification	microscope MBS-10	
	structure:		
	dimension-weight	linear-weight	
	age-related	registration structures (scales, gill covers, otoliths)	
	sexual	biological analysis, Kiselevich scheme	

Note: "*" – multiparameter Aquareader water quality monitor; "**" – is an accredited laboratory of JSC "Laboratory and Research Center for the Study of Mineral Raw Materials" (JSC LICIMS, Chita) (accreditation certificate No. RA.RU.510387, issued May 27, 2015).

RESULTS

The explored lakes have unstable water and physiochemical regimes (see Table 1). Orbital surveys of Barun-Torey Lake were made in summer 2009 for mapping small water bodies. It was found that the lake dried out in 2010. Thereafter Barun-Torey Lake was steadily filled in 2013 and its water-surface area could reach 400 km^2 by the autumn of 2013 (http://water-rf.ru/водные_объекты/876/Барун-Торей). In the summer of 2014, waters flowed off down Uldza River. The lake could not regain its water in the spring of 2015 and, as a result, Barun-Torey had dried out again. In 2016, the basic lake bed was covered by small scattered ponds of different salinity which area did not exceed 50 m^2 and depth – 0.5 m. It is assumed that water is taken from permafrost along with groundwater supplied over the split running down to the western lakeside. Today, the Zun-Torey, Tsagan-Nor, Bain-Tsagan and Bain-Bulak lakes lose their water-surface level on a permanent basis (Fig. 2).



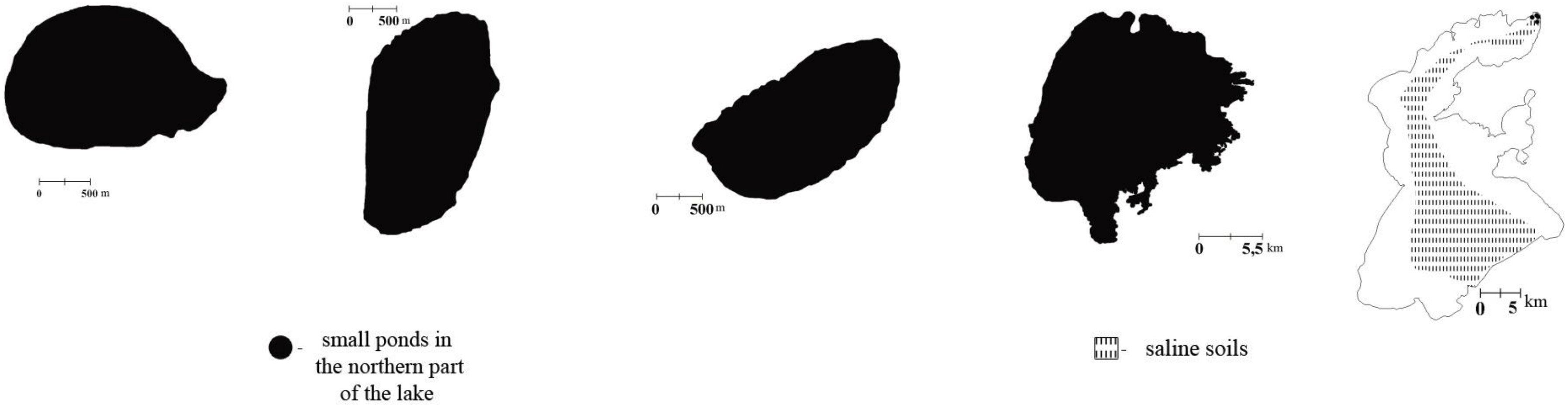


Fig 2: The area of lakes for 1999 and 2015.
According to space images from the site www.bing. com/maps.

The mineral water lakes subject to the studies have similar chemical composition (all of them contain sodium and have anionic hydrogen carbonate-chloride or chloride-hydrogen carbonate composition) [4] (Fig. 3), though, individual phases of a hydrologic cycle differ in salinity (see Table 1).

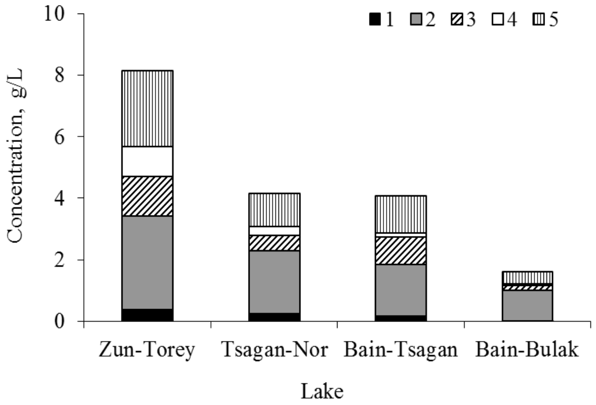


Fig 3: Hydrochemical characteristics of the some studied lakes in July 2011.
1 – CO_3^{2-}; 2 – HCO_3^-; 3 – Cl^-; 4 – SO_4^{2-}; 5 – Na^+.

Need to say that the salinity of the lakes is highly variable and it is ranged from 3.5 to 13 g/L throughout the period of low-water level of 1982-1983 [3]. Information obtained within the exploration period (1999-2016) showed that the total salinity varied from 0.67 to 19.9 g/L. As it was duly classified by N.I. Tolstkhin, the salinity of water bodies had changed from fresh (Bain-Bulak lake) or light saltish (Barun-Torey, Zun-Torey, Tsagan-Nor, Bain-Tsagan lakes) to light saltish (Bain-Bulak lake), moderately saltish (Tsagan-Nor, Bain-Tsagan lakes), and light salted (Zun-Torey lake). The least indices were obtained in 1999 (1.87 g/L) and the largest ones – in 2014 (7.6 g/L) and in 2016 for Zun-Torey lake (19.9 g/L). As concerns the acid-base balance, the above lakes are predominantly characterized by high concentration of sodium dissolved salts (see Table 3). They have a pH value between 8.9 and 9.65. Minimum values were obtained in 1999 (8.9) and maximum ones – in 2014 (9.65). The dynamically varied content of biogenic elements in the explored Torey depression lakes is shown in Figure 4. The data obtained had demonstrated that a low-water level period is characterized by enlarged content of total phosphorus, as well as with reduced content of total nitrogen in contrast to previous high-water level yearly periods.

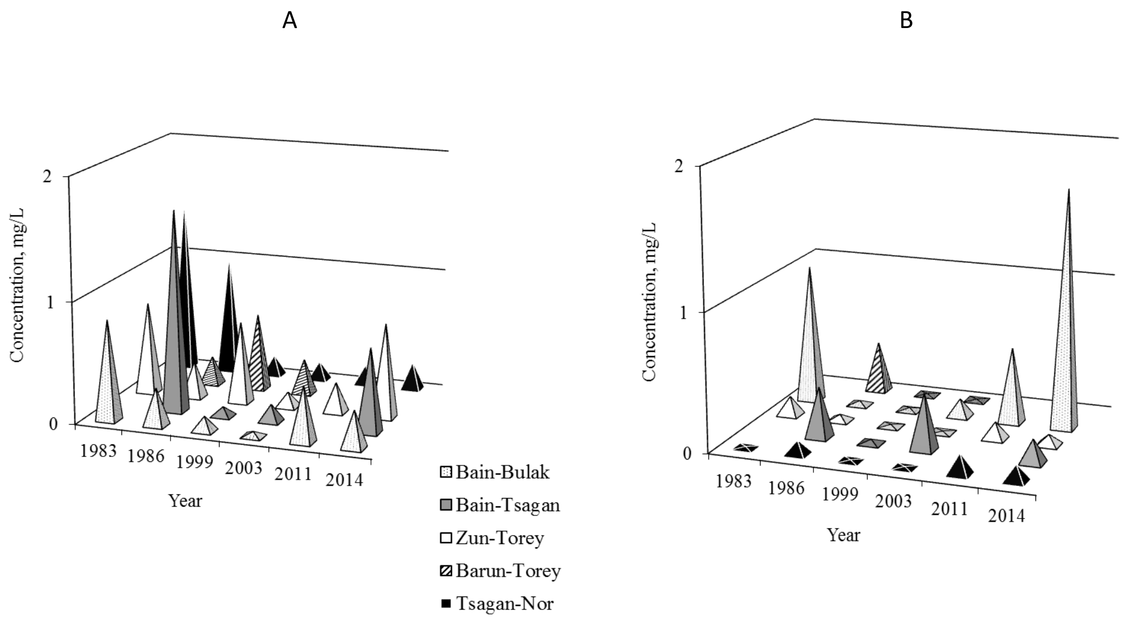


Fig 4: The total amount of biogenic elements (N and P) in the lake water
A – total nitrogen; B – total phosphorus

Peak values of organic substance composition were stated in 1983. That composition was reduced twice and greater for the next few years (Fig. 5).

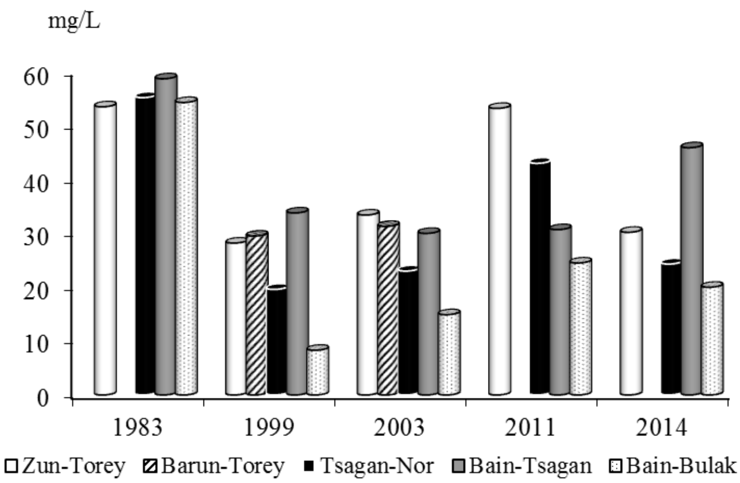


Fig 5: Dynamics content of organic matter

Phytoplankton studied in the lakes explored within the stated hydrologic periods was characterized by low taxonomic diversity (Table 3).

Table 3: **The structure and diversity of phytoplankton in studied lakes at the researched periods**

Lake	Zun-Torey				Barun-Torey				Tsagan-Nor			
Research period	n	D	N	B	n	D	N	B	n	D	N	B
1983-1986*	21	CT; SS; OS; BB;GL	–	0,36	21	OS; AP	–	0,46	68	AP; SR; CV; OS; LS; GL; SA	–	0,28
2003	18	SS; RG	95,9±21,8	65,5±35	26	CC; OB;OS	944,5±391	1301,8±802,3	11	MA; SR	121,54	40,8
2014	9	OB; GL; AA	50,48±14,83	15,14±4,22	–	–	–	–	7	AF	8,7±4,72	1,55±0,64
2016	3	CP	26,06±9,69	0,55±0,3	–	–	–	–	–	–	–	–
Lake	Bain-Tsagan				Bain-Bulak							
Research period	n	D	N	B	n	D	N	B				
1983-1986*	52	SS;PN; CR	–	0,31	105	TM;CV; OG;TM; AM	–	6,76				
2003	6	OB	23,8	31,92	28	TM;CC	1036,8	1996,7				
2014	20	GL; LK; SQ; MM	1694,4±517,33	191,48±94,99	23	LK;OB; EU	475,9±43,1	324,61±44,45				
2016	–	–	–	–	–	–	–	–				

Note: «*» – data on [3]; «–» – there are no data; n – he number of species; D – prevailing species; N – abundance (in 10^3 cells/L); B – biomass (for 1983-1986 in g/m^3; for 2003, 2011, 2014 in mg/m^3); CT – *Crucigenia tetrapedia* (Kirchner) Kuntze, SS – *Synechocystis salina* Wislouch, OS – *Oocystis submarina* Lagerheim, OB – *Oocystis borgei* J.W.Snow, BB – *Beckia bella* (Beck-Mannagetta) Elenkin, GL – *Gomphosphaeria lacustris* Chodat, RG – *Rhopalodia gibberula* (Ehrenberg) Otto Müller; AA – *Ankyra ancora* (G.M.Smith) Fott, AP – *Ankistrodesmus pseudomirabilis* Korshikov (*Monoraphidium arcuatum* (Korshikov) Hindák); CC – *Cyclotella comta* Kützing (*Lindavia comta* (Kützing) Nakov, Gullory, Julius, Theriot & Alverson); SR – *Schroederia robusta* Korshikov (*Pseudoschroederia robusta* (Korshikov) E.Hegewald & E.Schnepf), CV – *Chlorella vulgaris* Beyerinck [Beijerinck]; LS – *Lyngbya spirulinoides* Gomont ex Gomont; SA – *Synechocystis aquatilis* Sauvageau; MA – *Monoraphidium arcuatum* (Korshikov) Hindák; PN – *Pinnularia* sp.; LK – *Lemmermannia komarekii* (Hindák) C.Bock & Krienitz in Bock et al., *Ankyra ancora* (G.M.Smith) Fott; SQ – *Scenedesmus quadricauda* Chodat (*Desmodesmus communis* (E.Hegewald) E.Hegewald); MM – *Merismopedia minima* G.Beck in G.Beck & Zahlbruckner; AF – *Aphanizomenon flosaquae* Ralfs ex Bornet & Flahault; EU –

Euglena sp.; PC – *Planktolyngbya contorta* (Lemmermann) Anagnostidis & Komárek; CP – *Cocconeis placentula* Ehrenberg

In the studied lakes the phytoplankton consisted 64 species of algal. Depending on the phase of observations, the structure of the plankton algae was formed by representatives of the Bacillariophyta, Chlorophyta and Cyanobacteria (> 78 % of the total number of algal taxons). During the period of increased water content (2003), the qualitative composition of algae was determined in 54.6 ± 14.1 taxons of algae, reduced (in 2011, 2014) – 17.8 ± 3.8 and 12.4 ± 3.5 taxons of algae. The most common species are: *Merismopedia minima* G.Beck in G.Beck & Zahlbruckner*, Aphanizamenon flosaquae* Ralfs ex Bornet & Flahault*, Cyclotella* sp.*, Cocconeis placentula* Ehrenberg, *Cryptomonas marsonii* Skuja*, Oocystis borgei* J.W.Snow*, O. submarina* Lagerheim*, Lemmermannia komarekii* (Hindák) C.Bock & Krienitz in Bock et al.*, Ankyra ancora* (G.M.Smith) Fott*, Schroederia robusta* Korshikov, *S. setigera* (Schröder) Lemmermann, *Euglena* sp. [7]. As to ecological and geographic factors, a bulk of algae is represented by plankton-bento dwellers (70.2 %), those to be featured with wide geographic spread occurrence (87.5 %) and salinity indifference (88.8 %), and by alkaphyles in respect of pH (61.5 %).

In the 1980s, the yearly average biomass varied from 0.28 to 6.76 g/m^3. The peak of germination fell on the summer period (July – August) [3]. Some kind of qualitative algal germination (Table 4) was found to be changed within the period of 2003-2016 as caused by specific hydrological and hydrochemical factors occurred in the explored lakes (decrease of water and increase of salinity (Table 1, Fig. 2)). But not Bain-Tsagan Lake which salinity level remained actually unchanged (2.1-6.5) (see Table 1).

On studying the producing capacity of phytoplankton in the Torey depression lakes, the information obtained demonstrated growth of primary plankton productivity within the period of 1982 to 1999 thanks to less salinity. Phytoplankton in Tsagan-Nor Lake showed the total producing capacity of 38 C/m^2 in 1983, 86.5 C/m^2 in 1986, and – ≈ 132 g C/m^2 in 1999. As for Bain-Bulak Lake, the productivity was 39 gC/m^2 – 61 gC/m^2 – ≈ 72, respectively. Bain-Tsagan Lake had the productivity of 79.6 g C/m^2 – 68.4 g C /m^2 – ≈93 g C/m [2]. High amount of mineral suspension occurred in periods of low water is actually caused by water clarity and, subsequently, by low phytoplankton productive capacity.

Lower diversity of macroscopic algal species was stated in the explored lakes [1]. *Cladophora fracta* that is featured with widely varied phytomass (0.05-400 g/m^2 in wet weight) prevail (Mühl. ex Vahl). Lakeside zones, aquatic vegetation are typical localities of these species at 0.5 to 3 g/L salinity. *Stigeoclonium* species were significantly extended throughout the high-water phases. These species largely inhabited Barun-Torey Lake rocky littoral and occurred on reed at Tsagan-Nor Lake (Buelesan) in 1998. Last years, the species tend to disappear from their habitat due to water salinity growth. Similarly, *Ulothrix* species could generate. Wide spread of *Enteromorpha intestinalis f. prolifera* occurred with salinity increased in water bodies (L.) Link. In 2005-2007, these species propagated in Utocha river flow channel. *E.* In June, 2014, *E. intestinalis* species got predominated over *C. fracta* in Tsagan-Nor with an amount of phytomass produced in the lakeside aquatic region. These species were sporadically found in spring water ponds of the Barun-Torey Lake bed in 2016. *Spirogyra* species are frequently associated with accumulated macroalgae though larger amount of phytomass are found at spring water and low-saline water bodies.

The studies demonstrated that salt load is the very factor that makes it effect on amount of hydrophytic plants varied from 1 to 16 species (Fig. 6).

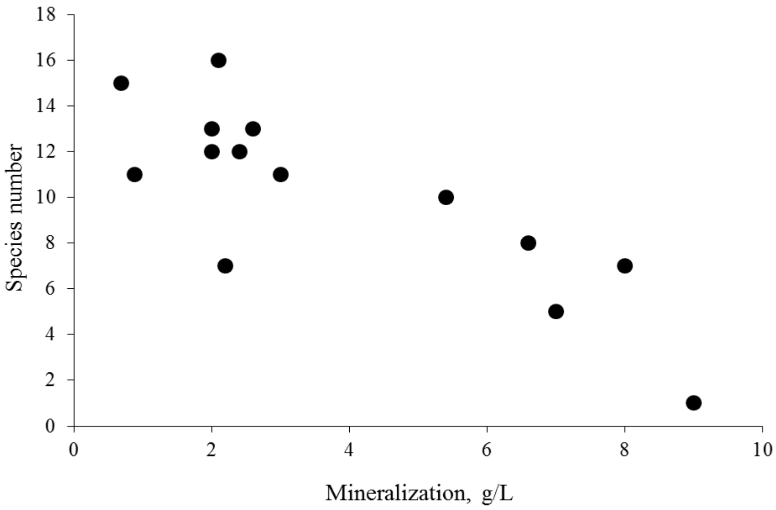


Fig. 6. Distribution of hydrophytes depending on mineralization in the studied lakes

Saline lakes are predominantly inhabited by *Stuckenia chakassiensis* (Kashina) Klinkova and *S. pectinata* (L.) Börner. Halotolerant *S. chakassiensis* is rated within 1.112-10.901 g/dm^3 and *S. pectinata* – 0.16-6.253 g/dm^3 in the Trans-Baikal lake regions [9].

Subject to the existent materials, specific alternative aquatic vegetation association schemes were used against respective water levels. High water level in lakes (1999) is to be considered with reference to the following plant complex: helophytes (*Phragmites australis* (Cav.) Trin. Ex. Steudel, *Bolboschoenus planiculmis* (Fr. Sch.) Egor, *Scirpus sp.*) → neustophytes (*Saggitaria* sp., *Persicaria* sp.) → hydatophytes (*Potamogeton perfoliatus* L, *Myriophyllum sibiricum* Kom., *S. pectinata, S. chakassiensis*, and other species). The reduction-phase water level (2003, 2005, and 2007) was represented by the following community: helophytes (*Ph. australis, B. planiculmis*) → hydatophytes (*S. chakassiensis, S. pectinata,* charophytes, filamentous algae and other species occurred in fresh water ponds). Low waters (2011 and 2014) were predominantly inhabited by helophytes (*Ph. australis.* – in the form of thinned patches, heads are not developed). A complex of halophyte ground vegetation prevailed in drying ponds.

In the studied lakes the zooplankton consisted 63 species, of which 25 Rotifera, 19 Cladocera, 18 Copepoda and 1 Branchiopoda. According to ecological and geographic characteristics, eurybiontic and cosmopolitan species dominated on specie composition. Species numbers of 10.4±0.9 were found in the lakes with mineralization 0.67-4.3 g/L. There were haloxens inhabiting primarily in fresh- and saline-water lakes. Species numbers of 5.5±0.9 (mainly euryhaline species) were found in the lakes with mineralization 5.4-11.36 g/L. Zooplankton contained 3 halobiont species in lakes with salinity 18 g/L. On distributing zooplankton species to a salinity gradient, the following complex was structuralized: *Filinia longiseta, Hexarthra mira, Asplanchna silvestris, Diaphanasoma mongolianum, Daphnia similis, Arctodiaptomus bacillifer, Cyclops vicinus* – within 0.67-4.5 g/L, *Daphnia magna, Arctodiaptomus neithammeri, Cyclops strenuus* – within 6.2-14.6 g/L, *Moina brachiata, Metadiaptomus asiaticus* within 18.08-19.9 g/L.

Season-specific zooplankton population and biomass extension peaks (subject to 1980) were registered in spring (February – March), summer (June – August) and autumn (October). Maximum abundance and biomass of zooplankton was in summer (400 10^3 ind./m^3 and 11 g/m^3) [3]. To our data (from 1999 to 2016) density of rotifers and crustaceans population increased with water level and salinity decreasing. In high-water level periods, the total quantitative parameters were 100±21.21 10^3 ind./m^3 and 2.19±0.56 g/m^3 (average abundance varied from 12.26 to 227±15.72 10^3 ind./m ^{3} and average biomass varied from 0.38 to 7.11±1.76 g/m^3). In low-water level periods, the average abundance was 277.1±64.98 10^3 ind./m^3 (within the range of 76.47±12.65 to 855.57±566 10^3 ind./m^3); average biomass was 8.69±3.11 g/m^3 (within the range of 3.46±0.11 to 43.3±29.8 g/m^3) (Table 4).

ISSN: 0975-8585

Table 4: **Structure and diversity indicators of zooplankton in saline lakes of the Onon-Torey plain**

Lake	Year	N, 10^3 ind./m^3	B, g/m^3	n	Structure and forming complex, % (at≥ 20 %)			
					By abundance (min-max)		By biomass (min-max)	
Barun-Torey	1999	80,67±10,72	1,74±0,32	18	*C. strenuus*	23-39	*M. brachiata*	21-29
					A. neithammeri	19-34	*A. neithammeri*	15-56
					M. brachiata	12-21	*C. strenuus*	11-44
	2003	199,73±46,9	7,11±1,76	12	*A. neithammeri*	17-71	*M. brachiata*	31-57
					M. brachiata	16-37	*A. neithammeri*	8-63
Zun-Torey	1999	46,03±4,15	1,35±0,18	16	*F. longiseta*	11-43	*D. mongolianum*	10-26
					D. mongolianum	11-34	*M. brachiata*	5-22
					M. brachiata	6-22	*M. incrassatus*	3-62
	2003	56,49±25,28	1,9±0,96	10	*A. bacillifer*	11-49	*A. bacillifer*	10-36
					M. brachiata	6-37	*M. brachiata*	4-66
					F. longiseta	1-69	*D. mongolianum*	2-22
	2011	76,47±12,65	3,46±0,11	6	*M. brachiata*	53-58	*M. brachiata*	70-75
					M. asiaticus	30-38	*M. asiaticus*	25-27
	2014	204,45±26	5,72±1,26	3	*M. brachiata*	36-71	*M. brachiata*	35-76
					M. asiaticus	29-64	*M. asiaticus*	24-65
	2016	855,57±566	43,3±29,8	3	*M. brachiata*	88-96	*M. brachiata*	88-97
Bain-Tsagan	1999	38,73±9	1,26±0,46	7	*H. mira*	86-88	*H. ignatovi*	37-51
							D. magna	44-57
	2003	12,26	0,38	6	*A. neithammeri*	46	*D. magna*	58
					H. mira	38	*H. ignatovi*	21
							A. neithammeri	20
	2007	76,89	3,75	5	*A. neithammeri*	56	*D. magna*	61
					D. magna	22	*A. neithammeri*	24
	2011	368,09	5,85	7	*C. strenuus*	36	*A. neithammeri*	48
					H. mira	32	*C. strenuus*	33
					A. neithammeri	31		
	2014	169,05±17,67	4,92±0,58	5	*A. neithammeri*	26-63	*A. neithammeri*	35-68
					C. strenuus	11-55	*C. strenuus*	5-56
					H. mira	7-43		
Bain-Bulak	1999	227±15,72	1,71±0,02	10	*H. mira*	46-52	*D. similis*	37-43
					A. bacillifer	16-22	*A. bacillifer*	30-42

ISSN: 0975-8585

					C. vicinus	1-22	*C. vicinus*	6-22
	2003	120,94	1,9	14	*A. bacillifer*	39	*A. bacillifer*	45
					A. silvestris	20	*D. mongolianum*	27
							A. silvestris	20
	2007	174,66	5,81	6	*A. neithammeri*	55	*A. neithammeri*	90
					C. strenuus	35		
	2011	461,29	5,88	10	*H. mira*	42	*A. neithammeri*	50
					A. neithammeri	32	*D. mongolianum*	39
	2014	519,17±55,8	4,09±0,72	10	*H. mira*	21-37	*A. neithammeri*	43-72
					A. neithammeri	14-52	*M. brachiata*	12-45
					M. brachiata	3-43	*C. strenuus*	6-22
Tsagan-Nor	1999	138,13±13,26	1,45±0,89	11	*Arctotiaptomus*	7-30	*D. similis*	18-28
					H. mira	3-78	*Arctotiaptomus*	17-43
					C. strenuus	1-50	*H. mira*	1-47
	2003	80,07	3,13	9	*C. strenuus*	44	*M. brachiata*	64
					M. brachiata	29	*Arctodiaptomus*	25
					Arctotiaptomus	25		
	2007	66,63±1,68	4,14±0,36	8	*M. brachiata*	53-61	*M. brachiata*	78-79
					Arctotiaptomus	32-33	*Arctotiaptomus*	14-21
	2011	167,56	13,67	9	*Arctotiaptomus*	27	*D. magna*	79
					H. mira	15	*Arctodiaptomus*	6
	2014	185,08±33,62	8,39±2,89	8	*Arctotiaptomus*	31-78	*D. magna*	46-87
					H. mira	20-56	*Arctodiaptomus*	12-93
					E. serrulatus	1-23		

Note: N – abundance, B – biomass, n – species number.

The studies of zoobenthos were carried out in the 1980s – i.e. in a low-water period [3]. The above studies were finalized by surveys held in 2003 for describing features of taxonomic zoobenthos species inhabited the Torey lake region in high water periods (Table 5).

Table 5: **Species number of zoobenthos in studied lakes of the Onon-Torey plain in 1980s and 2003**

Taxon	Lake				
	Zun-Torey	Barun-Torey	Tsagan-Nor	Bain-Bulak	Bain-Tsagan
Oligochaeta	*	+	2*	2*	1
Hirudinea				1	
Hydracarina				+	+
Artemia	1		1		1
Conchostraca		1			
Amphipoda	*	1	1	*	1*
Hymenoptera	+		+	+	
Trichoptera	3	4	4	2	8*
Ephemeroptera				*	
Tipulidae				+	

Chaoboridae		*	1	2*	
Ephydridae	+	2	+		1
Ceratopogonidae	2*	2*	2	2*	6*
Limonidae		1			
Chironomidae	18*	13*	48*	45*	35*
Culicidae			1		
Lepidoptera			+		
Odonata			2	2	1*
Heteroptera	3	1	5	3	3
Coleoptera	5	2	1	4	2*
Gastropoda	2	1	7	3	3
Всего (в 1980-х гг.)	36	29	78	69	63

Note: «*» – taxon, found in 2003; «+» – presence of a taxon.

In total, 41 taxa of species and superspecies level were found out in Zun-Torey, Tsagan-Nor and Barun-Torey lakes zoobenthos in June 2014.

Zoobenthos of Zun-Torey Lake were represented by 13 species of amphibiotic insects including 7 chironomids. More than 50% of samples contained chironomid larvae *Procladius* gr. *ferrugineus* and ceratopoginidae larvae *Palpomyia* (Gluhovia) sp. (*tuvae* Remm?) along with other species occurred to be below 30%. All 13 species were found in shallow water less to 0.2 m depth. As for 0.8 m depth and greater, *Pr.* gr. *ferrugineus* and *P.* (G.) sp. sp. (*tuvae* Remm?) only were found. Maximum zoobenthos density and biomass were specified in the central lake area – 3840-3920 ind./m^2 and 6.16 g/m^2. The zoobenthos structure of 2014 was combined with the zoobenthos features of 1983-1986: dominance of predatory chironomids in the presence beetles and bugs (Table 6). In July 2014, the *Procladius* gr. *ferrugineus* density and biomass ware rated at 75 % and 70.4 %, respectively; *Berosus* (E.) *fulvus* – 13.3 % of biomass; *Hesperocorixa parallela* (Fieber) and *Paracorixa* sp – 6,5 % of biomass.

***Table 6:* The density (N ± SD, ind./m^2) and biomass (B ± SD, g/m^2) of zoobenthos in Zun-Torey Lake in July**

Group	N			B		
	1983	1986	2014	1983	1986	2014
Chironomidae $_p$	80	930	1162± 1408	0,089	0,508	1,440±1,850
Chironomidae $_f$	487	–	69± 185	0,060	–	0,040±0,010
Ceratopogonidae	33	30	–	0,008	0,008	0,100±0,200
Diptera	20	10	2± 9	0,025	0,045	0,00±0,010
Trichoptera	20	–	–	0,080	–	–
Coleoptera	100	–	64± 140	0,623	–	0,290±0,720
Heteroptera	33	–	96± 279	0,215	–	0,130±0,320
Artemia sp.	–	30	–	–	0,653	–
Total	780	1000	1493±1327	1,100	1,213	1,990±1,770

Note: «Chironomidae $_p$» – predatory chironomids; «Chironomidas $_f$» – peaceful chironomids; «–» – no data.

In total, 25 zoobenthos species found in Tsagan-Nor Lake contain 24 amphibian insects (15 chironomids) and 1 species of water mites. The *P.* (G.) sp. (*tuvae* Remm?) и *H. parallela* (Fieber) species exhibit their 100% occurrence. Chironomid larvae *Abllabesmyia* gr. *monilis* (phatta?) were found in 63 % of samples. Zoobenthos population in the lake is rated at 2177 ind./m^2 and biomass – 6.23 g/m^2. The most large biomass of zoobenthos was registered down to the depth of maximum 0.5 m. It was stated that 45 % of the lake zoobenthos density is represented by *P.* (G.) sp. (*tuvae* Remm?) larvae. The structure of zoobenthos biomass is featured with 35 % of *H. parallela* (Fieber) and 33 % of chironomid larvae. The samples taken at the nearshore zone and at the maximum depth contained the population of chironomid larvae to have the following average biomass characteristics: *Psectrocladius barbimanus* – 2.4 g/m^2 and *Procladius (Psilotanipus) rufovittatus* – 1.56 g/m^2, respectively.

ISSN: 0975-8585

If to consider all the lakes subject to the studies, the greatest diversity of zoobenthos inhabitants was found in a small pond of the Barun-Torey lake bed – 26 taxa of zoobenthos species to have been identified in a qualitative sample taken at the water area of approximately one squire meter: chironomids (11), beetles (5), oligochaetes (2), limneid mollusks (1), water mites (1), spiders (1), Ceratopogonidae (1), tipulidae (1), Brachycera (1), mayflies (1), and dragonflies (1).

The fish fauna of the lakes subject to the studies is characterized with low species diversity. In total, 9 fish species were identified as those to be divided into 4 families (Table 7). *Carassius auratus gibelio* is a prevalent species (Bloch, 1782).

Table 7: ***Species composition of fish in the studied lakes***

Species	Lake									
	Zun-Torey		Barun-Torey		Tsagan-Nor		Bain-Bulak		Bain-Tsagan	
	FF	LW	FF	LW	FF	LW	FF	LW	FF	LW
Family Карповые – Cyprinidae *Carassius auratus gibelio* (Bloch, 1782)	+	+	+	–	+	+	+	+	+	–
Cyprinus carpio Linnaeus, 1758	–	–	–	–	+	–	+	+	–	–
Leuciscus waleckii (Dybowski, 1869)	–	–	–	–	+	–	+	–	–	–
Phoxinus perenurus (Pallas, 1814)	+	–	+	–	+	–	–	–	+	–
Pseudorasbora parva (Temminck et Schlegel, 1846)	–	–	–	–	+	–	–	–	–	–
Family Сомовые – Siluridae *Parasilurus asotus* (Linnaeus, 1758)	–	–	–	–	+	–	–	–	–	–
Family Вьюновые – Cobitidae *Misgurnus fossillis* (Linnaeus, 1758)	+	–	+	–	+	–	–	–	+	–
Cobitis melanoleuca Nichols, 1925	–	–	+	–	–	–	–	–	+	–
Family Балиторовые – Balitoridae* *Lefua costata* (Kessler, 1876)	+	–	+	–	–	–	–	–	+	–

Note: "+" – presence of the species in the lake; "-" – absence of a species in the lake; "*" - according to G.L. Karasev; "FF" - full-fledged years; "LW" - low-water years.

Maximum 7 fish species occurred in the high-water ichthyocoenosis period (1999, 2003): *C. auratus gibelio, C. carpio*, *L. waleckii*, *P. parva*, *P. perenurus*, *P. asotus*, and *M. fossiulis*. Fish were aged 1+ to 7+ but 3+ prevailed (up to 50% of the total catch) (Fig. 7, A).

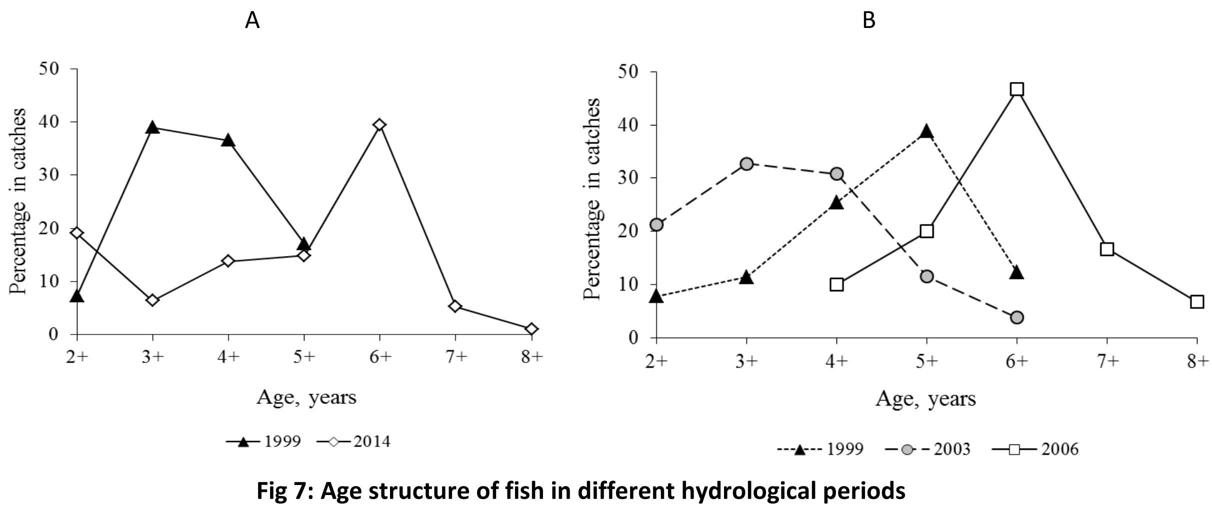


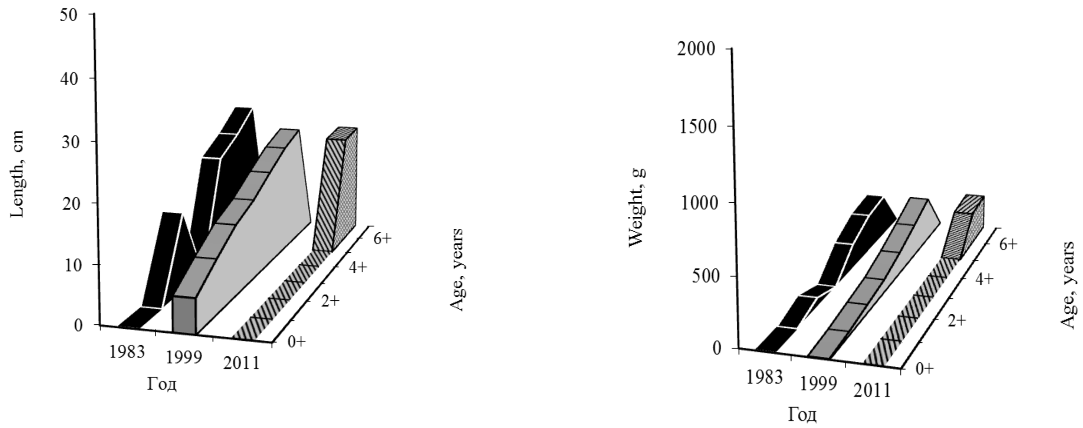
Fig 7: Age structure of fish in different hydrological periods
A – *C. auratus gibelio* (for example, Zun-Torey Lake);
B – *C. carpio* (for example, Bain-Bulak Lake).

Species diversity was reduced down to 1-2 species in low-water yearly period (1983-1986, 2006 and 2011): *C. auratus gibelio* and *C. carpio.* Senior aged fish groups could predominantly keep safe (up to 70-90% of the total catch) but younger aged fish groups were absent (Fig. 7, B). With salt load permanently growing up, *C. auratus gibelio* species got gradually disappeared. No fish was identified when salinity exceeded 8 g/L.

The peculiarities of the hydrological regime of water bodies exert a significant influence on the linear-weight parameters of fish: in comparison with the years of water, the length and mass of fish (Fig. 8).

1 2

A



B

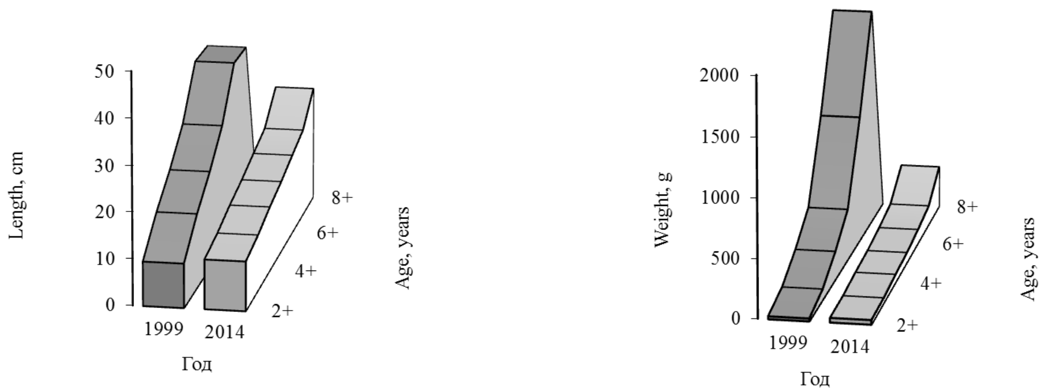


Fig 8 Linear-weight structure of fish different hydrological periods
1 – linear growth; 2 – weight growth;
A – *C. auratus gibelio* (for example, Tsagan-Nor Lake);
B – *C. carpio* (for example, Bain-Bulak Lake).

DISCUSSION

Long-term change of ambient temperature, underlying surface, territory humidification characteristics makes an adverse effect on water balance elements and, at the same time, influences specific morphometric water body characteristics. According to the information obtained from papers and orbital surveys, the lakes subject to the studies exhibit variability of water level behavior: lakes dry out down to the bottom and flooded in a certain sequence.

Some inter-secular cycles ranged from 8-10 to 35 years are specified with due reference to long-term water level variation [8]. High water level was identified in Torey lakes throughout the periods of 1936-1937, 1971, 1962-1963, 1989-1990 and 1998; low water level – 1901-1903 (Torey lake depression areas contained no water), 1920-1922 (waterless lakes), 1945-1946 (waterless lakes), 1951 (low Barun-Torey water level; Zun-Torey dried out), 1981-1982 (Barun-Torey dried out; low Zun-Torey water level) and 2009-2011.

Water level and area are varied differently in every particular body against the common trend of change of climate within the territory of Onon-Torey depression. Water bodies fed from atmospheric and/or ground surface sources respond to any change of climatic conditions promptly. As for those water bodies that are additionally watered from underground sources, their level and area are not profoundly varied. Some fresh water springs are situated close to such lakes, thereby forming low-water ponds. They operate as refugia throughout a low-water phase saving fresh water species and improving species diversity.

The lakes subject to the studies are featured with similar chemical water composition held in low- and high-water periods (soda lakes, anionic hydrogen carbonate-chloride or chloride-hydrogen carbonate composition). With salinity increased in one water bodies, relative chloride content goes up, but other lakes exhibit rapid accumulation of carbonate components. As concerns the acid-base balance, the above lakes are predominantly characterized by high concentration of sodium dissolved salts but sometimes pH value tends to set off to an alkalescencent rate. As far as salinity is reduced, the content of phosphorus goes up. As for nitric compounds, the picture is different. Unstable hydrochemical regime of the water bodies is caused either by desalination in high-moisture periods or by drying up in dry periods [1].

Periodic water level variation making effect on water body area, lakeside line irregularity, hydrochemical water composition, salinity and some physicochemical characteristics governs dynamics of species composition, productivity and structural arrangement of hydrocole communities.

Taxonomic plankton composition and division/group ratio in the studied lakes are typical other saline lakes [10–15]. Larger species number of phyto- and zooplankton which are haloxens occurred in high-water level years. In law-water level years the species composition of planktonic algae and invertebrates decreased due to missing of fresh-water and stenohaline species. There mainly were euryhaline species. The dependence of phyto- and zooplankton from salinity is described in other papers [16–20]. Transformation of the planktonic communities was different depending on water salinity increasing. With salinity increased, the density of Cyanobacteria, Euglenophyta, Rotifera and Crustacea multiplied but the density of Bacillariophyta, Charophyta, Dinophyta and Chlorophyta decreased. Cryptophyta and Chrysophyta occurred in fresh-water and brackish-water lakes only. On studying saline lakes situated in Argentina, Canada, New Zeeland and West Siberia, it was stated that the total abundance and biomass of planktonic hydrobionts may both go up [21-23] and go down [15, 19, 24, 25] against varied chemical water composition. E.B. Balushkina [25] et al. and M.T. Itigilova et al. [15] could demonstrate that qualitative parameters of zooplankton are primarily governed by trophic state. While a population of species is decreased due to growing salinity, the behavior of species is differentiated by flourishing one species and by deterioration (full disappearance) of other species [17, 19].

Macroscopic algae population was featured with its species diversity. The dominant species ware represented by *Cladophora fracta* and accompanying species – by *Spirogyra sp*., *Stigeoclonium sp*., *Enteromorpha intestinalis f. prolifera.* A filamentous alga dominating scheme may be generally specified as follows (in proportion to salinity growth): *Stigeoclonium* sp. / *Spirogyra* sp. → *Cladophora fracta* →*E. intestinalis f. prolifera*.

Higher aquatic plants have a tendency of unification and uniformity as far as water level in lakes goes down. A succedent macrophyte line as specified to a salinity gradient is formulated as follows: helophytes + neustophytes + hydatophytes → helophytes + hydatophytes + charophytes → helophytes → disappearance of macrophytes.

Zun-Torey zoobenthos is closely coupled with ecosystems of small non-drying waterbodies and, therefore, its composition and quantitative structure is capable to get recovered irrespective of any significant changes in water level and dry-out intensity. In high-water period of 2003, there were such organisms found in Zun-Torey Lake as oligochaetes and amphipods to have been probably sourced from the remained ponds in the Barun-Torey depression. Benthos organisms could penetrate to Zun-Torey Lake due to the increasing depth and lowering extremality environmental conditions in high-water periods. The most optimality habitats of Zun-Torey Lake inhabited by zoobenthos population in low-water periods are limited by narrow range of depths within the water transparency. Littoral habitats accessible for benthos population is extended in high-water yearly periods with increasing water transparency.

Fish population is varied against seasonal water levels; its growth rate decreases with morphological indices changed. It is stated that *Carassius auratus gibelio* is featured the best salinity resistance in the lakes where salt load varied from 0.67 to 8.1 g/L. In low-water yearly periods, when lake surface area is reduced and solute composition goes up, senior aged fish is found only, particularly *C. auratus gibelio* and *Cyprinus carpio*. Actually, linear-weight characteristics are reduced. As for growth characteristics, they are reduced in *C. carpio* more rapidly than in *C. auratus gibelio.* A salinity value above 8 g/L is specified as a critical one for fish and this hydrocole species drops out of the population.

CONCLUSION

Thus, the aquatic regime was shaped up by specific hydrological and hydrochemical changes caused by climatic fluctuations. With water level going down, as well as with salinity, pH and temperature increased, species population was reduced thereby rearranging the dominant complex so that salt-tolerant and alkaliphilic species (taxa) prevailed and trophic structure got simplified. Higher aquatic plants and fish tend to lose their qualitative and quantitative characteristics.

Ecosystems are featured with cyclic and successive existence going back to their actually original state in a particular period of time. But there are particular extreme factors that can in critical periods affect such ecosystems making their existence unidirectional.

REFERENCES

[1] Kuklin A.P., Tsybekmitova G.T., Gorlacheva E.P. *Arid Ecosystems* 2013; 3 (3): 122-130. DOI: http://dx.doi.org/10.1134/S2079096113030062
[2] Sklyarov E.V., Sklyarova O.A., Men´shagin U.V., Danilova M.A. *Geography and Natural Resources* 2011; 4: 29-39. DOI: 10.1134/S1875372811040044
[3] *Soda Lakes of Transbaikalia: ecology and productivity*. 1991. 216 p. (In Russian) URL: https://elibrary.ru/item.asp?id=21135109
[4] Matafonov D.V. *Biology Bulletin* 2007; 34 (2): 148-155. DOI: http://dx.doi.org/10.1134/S1062359007020070
[5] Matafonov D.V. *Bulletin of Buryat State Academy of Agriculture* 2015; 2 (39): 59-65. (In Russian) URL: https://elibrary.ru/item.asp?id=23562602
[6] Afonina E.Yu., Itigilova M.Ts. *Bulletin of BSU* 2015; 4: 104-115. (In Russian) URL: https://elibrary.ru/item.asp?id=23373503
[7] Tashlykova N.A. *Scholarly Notes of Transbaikal State University* 2017; 12 (1): 52-59. (In Russian) DOI: http://dx.doi.org/10.18411/2500-1701-2017-12-1-52-59
[8] Zamana L.V., Borzenko S.V. *Geography and Natural Resources* 2010; 31 (4): 370-376. DOI: http://dx.doi.org/10.1016/j.gnr.2010.11.011
[9] Kipriyanova L.M., Dolmatova L.A., Dyachenko A.V., Bazarova B.B., Tsybekmitova G.T., Naydanov B.B., Romanov R.E. *Inland Water Biology* 2017, 10 (1): 73-82. DOI: http://dx.doi.org/10.1134/S1995082917010096
[10] Hammer U.T., Shamess J., Haynes R.C. *Hydrobiologia* 1983, 105: 1-26.
[11] Williams W.D**.** *Hydrobiologia* 1991, 210: 39-66.
[12] Zhao W., He Z. *Journal of the Salt Lake Research* 1999; 8: 267-285.
[13] Vesnina L.V., Mitrofanova E.Yu., Lisitsyna T.O. *Contemporary Problems of Ecology* 2005; 2: 221-233.
[14] Zhao W., Zheng M., Xu X., Liu X., Guo G., He Z. *Hydrobiologia* 2005, 541: 189-203. DOI: http://dx.doi.org/10.1007/s10750-004-5707-0
[15] Itigilova M.Ts., Dulmaa A., Afonina E.Yu. *Inland Water Biology* 2014; 7 (3): 249-258. DOI: http://dx.doi.org/10.1134/S1995082914030109
[16] Williams W.D., Boulton A.J., Taffee R.G. *Hydrobiologia* 1990; 197: 257-266.
[17] Yermolaeva N.I., Burmistrova O.S. *Contemporary Problems of Ecology* 2005; 2: 235-247.
[18] Ivanova M.B, Kazantseva T.I. *Russian Journal of Ecology* 2006; 37 (4): 267-270. DOI: http://dx.doi.org/10.1134/S1067413606040084

[19] Litvinenko L.I., Litvinenko A.I., Boyko E.G., Kutsanov K.V. *Contemporary Problems of Ecology* 2013; 6: 252-261. DOI: http://dx.doi.org/10.1134/S1995425513030104

[20] Echaniz S.A., Cabrera G.C., Aliaga P.L., Vignatti A.M. *International Journal of Ecosystems and Ecology Sciences* 2013; 3 (4): 72-81. DOI: http://dx.doi.org/10.5923/j.ije.20130304.03

[21] Larson C., Belovsky G.E. *Journal of Plankton Research* 2013; 35 (5): 1154-1166. DOI: http://dx.doi.org/10.1093/plankt/fbt053

[22] Echaniz S.A., Cabrera G.C., Aliaga P.L., Vignatti A.M. *International Journal of Ecosystems and Ecology Sciences* 2013; 3 (4): 72-81. DOI: http://dx.doi.org/10.5923/j.ije.20130304.03

[23] Vignatti A., Cabrera G., Canosa M., Echaniz S. *Universitas Scientiarum* 2017: 22 (3): 177-200. DOI: http://dx.doi.org/10.11144/Javeriana.SC22-3.eazp

[24] Schallenberg M., Hall C.J., Burns C.W. *Marine Ecology Progress Series* 2003; 251: 181-189.

[25] Balushkina, E.V., Golubkov, S.M., Golubkov, M.S., Litvinchuk, L.F., Shadrin, N.V. *Journal Of General Biology* 2009; 70 (6): 504-514. WOS:000273187500005