DIVERSITY OF AQUATIC ORGANISMS IN THE LOWLAND WATERCOURSES: A CASE STUDY IN TRANSBOUNDARY RIVERS, TRANSBAIKALIA, RUSSIA

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Planktonic communities have important roles in aquatic ecosystems, including rivers. But studies of plankton organisms in lotic systems are infrequent. The present research has been performed in transboundary rivers (River Uldza and River Imalka), flowing through the Daursky State Nature Biosphere Reserve (Transbaikalia, Russia) during the beginning runoff and increasing discharge (2020–2022). Aquatic organisms (algae, cyanobacteria, rotifers, and crustaceans) in the surveyed watercourses have been studied for the first time. We collected phytoplankton and zooplankton samples to explore species and functional diversity and temporal trends in the studied rivers. The total species composition included 134 phytoplankton taxa ranked below the genus level; the order of dominance was Bacillariophyta (49 taxa) > Chlorophyta (47 taxa) > Cyanophyta (18 taxa) > Charophyta (10 taxa) > Chrysophyta (4 taxa) = Euglenophyta > Cryptophyta (1 taxon) = Dinophyta) and 116 zooplankton taxa (Rotifera (64 taxa), Cladocera (35 taxa), and Copepoda (17 taxa). Not determined Bdelloida (Rotifera) and juvenile Copepoda and Anostraca were also encountered in zooplankton. Algal flora and fauna of invertebrates were formed mainly by cosmopolitans, 68.0% and 61.4% of the total composition respectively. Functional diversity of planktonic communities was determined by 19 Functional Groups of phytoplankton (FG_{ph}), 7 Morphologically Based Functional Groups of phytoplankton ($MBFG_{ph}$) and 17 Functional Groups of zooplankton (FG_{zoo}). In phytoplankton, codons MP (epiphytic and epilithic species drifted in the plankton that prefer frequently stirred up, inorganically turbid shallow lakes) and X1 (species, which prefer shallow, eu-hypertrophic environments, resistant to stratification, sensitive to nutrients deficiency) and groups IV (organisms of medium size lacking specialised traits) and VI (non-flagellated organisms with siliceous exoskeletons) dominated in species composition and abundance. In zooplankton, littoral and phytophilic species, filter feeders and species with swimming and crawling locomotion were the most diverse and abundant. *Plationus polyacanthus* (Rotifera) and *Megafenestra aurita* (Cladocera) have been found for the first time in the fauna of Zabaikalsky Krai. In the River Uldza, the phytoplankton and zooplankton species diversity and quantitative parameters showed seasonal variations. Cyanobacteria, Chlorophyta, and Bacillariophyta dominated phytoplankton biovolume with peaks in Cyanobacteria (*Anabaena* spp., *Coelomoron pusillum*, *Gloeocapsa minima*, *G. minor*) and Chlorophyta (*Monoraphidium griffithii*, *Willea apiculata*, *W. irregularis*) occurring during summer and peaks in Bacillariophyta (*Ulnaria ulna*) occurring during spring and autumn. Seasonal patterns in zooplankton structure included peaks in larval stages of Copepoda and Anostraca during spring, Rotifera (*Trichocerca elongata*, *Hexarthra mira*, *Euchlanis dilatata*) during mid-summer and Chydoridae (*Chydorus sphaericus*, *Pleuroxus aduncus*, *Coronatella rectangula*) during autumn. Based on our results, we recommend undertaking a comprehensive study on transboundary rivers in order to research biodiversity and gain a clear understanding of the impact anthropogenic activities (dams) and climatic factors (the intensity and duration of flood) could have on aquatic communities.

Key words: algae, Cladocera, Copepoda, Cyanobacteria, River Imalka, River Uldza, Rotifera, species composition

Introduction

Lotic ecosystems turn out to be more complexly organised natural systems and poorly studied compared to lentic systems due to the hydrology peculiarities and the various length of rivers (Reynolds, 2000). Rivers are important aquatic ecosystems supporting diverse life forms (Dudgeon et al., 2006), but understanding of aquatic biota dynamics in lotic systems is still incomplete, because the composition of the aquatic communities that inhabit flowing waters is poorly predictable (Vdovina et al., 2025). Lower trophic organisms, including phytoplankton and zooplankton, as essential components of aquatic food webs, play an important role in the structure and functioning of aquatic ecosystems, including rivers. Phytoplankton is a critical primary producer and the foundation of the whole trophic level plays a pivotal role in nutrient cycling (Arrigo, 2005; Zhang et al., 2021). Zooplankton takes part in the transformation and circulation of organic matter (Ejsmont-Karabin et al., 2004), regulates the biomass of phytoplankton (Lair, 2006; Kentzer et al., 2010), and forms a critical link between the primary producers and higher trophic levels in the food chain (Jeppesen et al., 2011). The relationship between phytoplankton and zooplankton is a fundamental aspect of the functioning of aquatic ecosystems (Wilk-Woźniak et al., 2001; Gilbert, 2022). The species composition and community structure of the biological units are very important characteristics of the planktonic assemblages (Padisák et al., 2006; Hébert et al., 2016), and of crucial importance for understanding ecosystem functioning because they can affect ecosystem processes, functioning and stability (Suikkanen et al., 2007). Data on changes in species and structural changes of planktonic organisms can be used to detect the impact anthropogenic activities and the influence of global climate changes on ecosystems (Dziuba et al., 2013; Feng et al., 2021; Sindt & Wolf, 2021; Bilous et al., 2024). The study of riverine systems occupying large territories is necessary in terms of the biodiversity (Krylov, 2005; Romanov & Kirillov, 2009; Napiórkowski & Napiórkowska, 2013; Karpowicz, 2017; Korneva et al., 2024), spatial and temporal distribution patterns (Holst et al., 2002; Dickerson et al., 2010; Wu et al., 2011; Zhao et al., 2017; Sindt & Wolf, 2021; Zinchenko et al., 2023), and relationships between environmental conditions and aquatic biota (Reynolds, 2000; Lair, 2006; Kentzer et al., 2010; Deksne & Škute, 2011; Feng et al., 2021). In order to obtain adequate knowledge about the structural organisation of the biotic communities of lotic systems, detailed studies of the main connecting links in aquatic ecosystems are needed.

The Dauria Ecoregion is one of the most extensive and well-preserved expanses of steppes in the world. It has been highlighted as one of the most important ecological regions of the planet (WWF Global 200 initiative), and it was recently listed as a World Natural Heritage Site (within the «Landscapes of Dauria») (Kirilyuk A. et al., 2021). Daursky State Nature Biosphere Reserve and its buffer zone are located in the southeast of the Zabaikalsky Krai (Russia) on the border with Mongolia (Dornod Aimag) and China (Hulunbuir Province). The central part of the Dauria landscapes consists of the drainless Lake Barun-Torey and Lake Zun-Torey, which are characterised by an unstable water regime, having dried up and been filled each 30-year-long period over the past 200 years (Obyazov, 1996). The main rivers of the Daursky State Nature Reserve are the River Uldza and River Imalka. The River Uldza is a unique river in Central Asia, as it does not connect to any of the ocean basins, forking in front of the mouth into two beds feeding Lake Khukh-Nur in Mongolia and the Torey lakes in Russia (Kirilyuk et al., 2009). Water resources of the River Uldza basin, as of defining importance in the preservation of the Torey lakes and of the nature of the Dauria steppe ecological region in general (Obyazov et al., 2021), ensure high species diversity and abundance of many species of plants and animals throughout East Asia (Kirilyuk V. et al., 2012, 2021).

Data on aquatic biota (algae, Cyanobacteria, Rotifera, Copepoda, and Cladocera) in the River Uldza and River Imalka are absent and limited to information from saline lakes, which are gathered during ecological monitoring (Dulmaa, 1966; Itigilova et al., 2014; Afonina & Tashlykova, 2023). The present study was aimed to comprehensively survey the species and functional diversity and structure of aquatic organisms in the natural lowland rivers during wet years (2020–2022) characterised by beginning runoff and increasing water discharge after complete drought of the riverbeds. The received data could be important in transboundary rivers catchment management and could act as pilot survey data for monitoring plans and to understanding how lower trophic communities and the riverine ecosystem will respond to ongoing and future changes. During monitoring studies, ecosystems of the Protected Areas can serve as reference sites for assessing the disturbance degree (Vdovina et al., 2025). This is especially important in relation to the dam reservoir construction on the River Uldza in Mongolia (Dolgorsuren, 2013; Navchaa, 2013), that could cause a great change in the water balance of the River Uldza and consequently Torey lakes (Kirilyuk V. et al., 2021; Obyazov et al., 2021; Kashnitskaya & Bolgov, 2022; Nikitin et al., 2023). Therefore, the problem of assessing the biodiversity of aquatic communities in transboundary rivers is necessary and relevant.

Material and Methods

Site description

The study was conducted in the watercourses flowing through the Daursky State Nature Biosphere Reserve. We investigated River Uldza (Solovyevsk village), branch Borokholoy, channel Utochi, and River Imalka (Krasnaya Imalka village) (Fig. 1). River Uldza (or Uldza-Gol, Uldz-Gol in Mongolian) and River Imalka (Imalhin-Gol in Mongolian) are rivers in the Asian part of Russia (Zabaikalsky Krai), as well as in Mongolia (Table 1).

The River Uldza springs in the eastern spurs of the Khentei Ridge, flows through the steppe plains of northeastern Mongolia, in the interfluve of the River Onon and River Kerulen. The River Uldza enters into the Lake Barun-Torey, forming a vast delta. By coming out into a swampy plain, the River Uldza splits into branches that are lost in alluvial sediments. The River Uldza valley has an average width of 3–6 km. The riverbed is wide-bottomed and meandering (Kirilyuk et al., 2009). The River Uldza is the largest river in the catchment area of the Torey lakes in terms of length and basin area. The River Uldza partially loses moisture due to evaporation, but is actively fed by groundwater. The River Uldza is characterised by an extremely high variation in annual runoff. The coefficient of variation of the annual runoff is 1.42, which is abnormal even for arid areas. The daily runoff at the peak of high floods exceeds the annual runoff of the driest years (2007, 2018, and 2019) by 20–50 times (Obyazov et al., 2021; Kashnitskaya, 2022; Nikitin et al., 2023) (Fig. 2).

Borokholoy is a right branch of the River Uldza delta (13 km long) and has a poorly developed riverbed. A runoff is observed only in humid climatic periods. During the dry period, the watercourse is lost in the sands, 9 km to the south of the village Solovyevsk. The northern channel Utochi (200–300 m long and 40–100 m wide) provides a connection between the Barun-Torey and Zun-Torey lakes in high-water periods, bringing the River Uldza water from the first to the second lake.

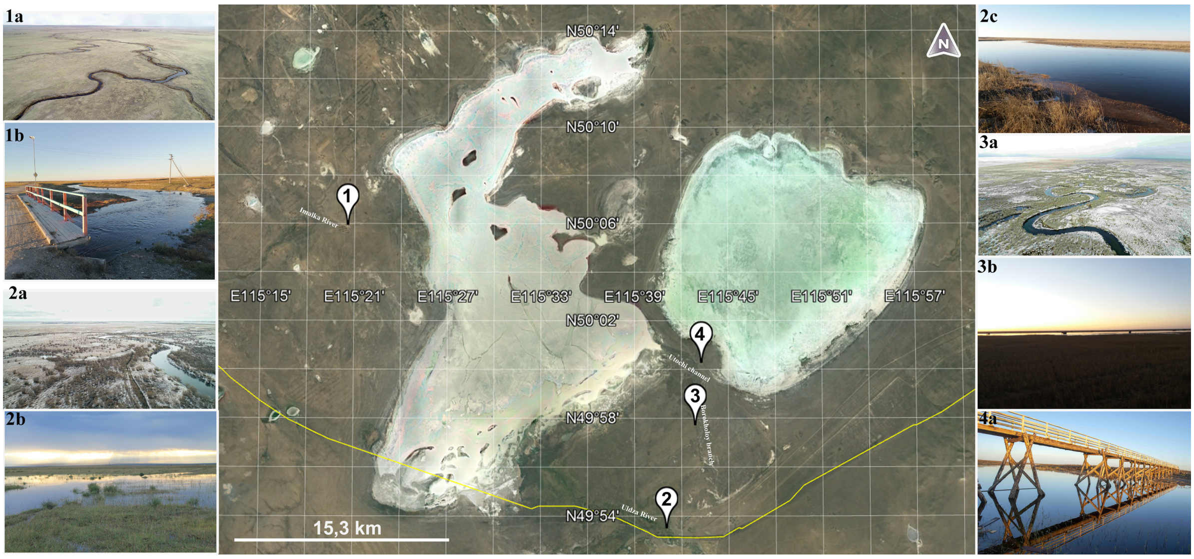

Fig. 1. The location of the study area in the southeastern Transbaikalia Region (Russia) with points of the sampling sites and photographs of the study site. Designations: 1 – River Imalka (1a – April 2021 (https://inrec-sbras.ru/fototeka/yekspediciya-na-toreyskie-ozera-daursk/), 1b – October 2021 (Author: M. Usmanov)), 2 – River Uldza (2a – April 2021 (https://inrec-sbras.ru/fototeka/yekspediciya-na-toreyskie-ozera-daursk/), 2b – September 2020 (Author: Sh. Askarov), 2c – October 2020 (Author: E. Afonina)), 3 – branch Borokholoy (3a – April 2021 (https://inrec-sbras.ru/fototeka/yekspediciya-na-toreyskie-ozera-daursk/), 3b – September 2020 (Author: E. Afonina)), 4 – channel Utochi (4a – October 2021 (Author: M. Usmanov)).

Table 1. The main hydrologic characteristics of the River Uldza and River Imalka (Transbaikalia, Russia)

River	Length (km)*	Basin area (km^2)*	Average long-term water flow (m^3/s)	Flow volume (km^3/year)	Mean flow velocity (m/s)
River Uldza	409/16	25 450/1450	5.46	0.17	0.5–1.0
River Imalka	96/60	840/640	0.43	0.02	–

Note: * – Mongolia/Russia.

The River Imalka is formed from the confluence of the River Nizhnaya Imalka and River Verhnaya Imalka and originates on the slopes of the Erman Ridge. On the Russian territory, the River Imalka upper and mouth are located. The River Imalka flows into the Barun-Torey Lake from the west (Table 1).

The hydrological regime of the River Uldza and River Imalka is characterised by an uneven distribution of runoff within a year. In winter, there is no runoff due to the freezing to the bottom. Winter low water is the longest phase of the water regime. The duration of the freeze-up is 155–190 days. From the second decade of April to mid-May the spring flood takes place. The low water phase takes place from mid-May to the end of June. In summer, there are rain floods which differ both in the number of peaks and in the amount of water consumption. The largest runoff is observed in August–September. Since October, the runoff has been gradually decreasing. The autumn low season begins in November, and when the rivers freeze over the river flow stops (Kashnitskaya, 2022).

The Uldza and Imalka riverbeds have been dry since 2003. Unlike the River Imalka, the River Uldza did not dry up throughout its entire length, remaining the most important river in the Mongolian steppes. The River Uldza finally dried up a few kilometres from the delta. In early September 2020, the River Uldza brought flood waters to Lake Barun-Torey. In September, the water consumption was high (7.1 m^3/s). In October, filling the main stream and small lakes of the delta, the water along the branch Borokholoy penetrated through the channel Utochi into Lake Barun-Torey. In the River Imalka, a runoff was noted in spring 2021 (Obyazov et al., 2021) (Fig. 1, Fig. 2).

Following Drebot (2023), the chemical composition of river waters is bicarbonate-sodium with a total dissolved solids (TDS) of 360–830 mg/L and pH = 7.70–8.37 (slightly alkaline waters) (Table 2). In general, TDS of the River Uldza and River Imalka is five times higher than the global average (Shvartsev, 1998).

Environmental variables

Some environmental variables of the surveyed watercourses were measured (Table 3). Water temperature ranged within 5.4–16.9°C in autumn, 3.1–7.6°C in spring, and 19.1–23.8°C in summer. The sampling depth did not exceed 1.3 m. Aquatic vegetation was observed along the banks of the watercourses.

Sampling and analytical procedure

The study area included four sampling sites named as sites 1, 2, 3, and 4 (Fig. 1). In the watercourses samples were taken on one site. One phytoplankton sample and one or two zooplankton samples (qualitative and quantitative integral) were taken on each site (Table 4).

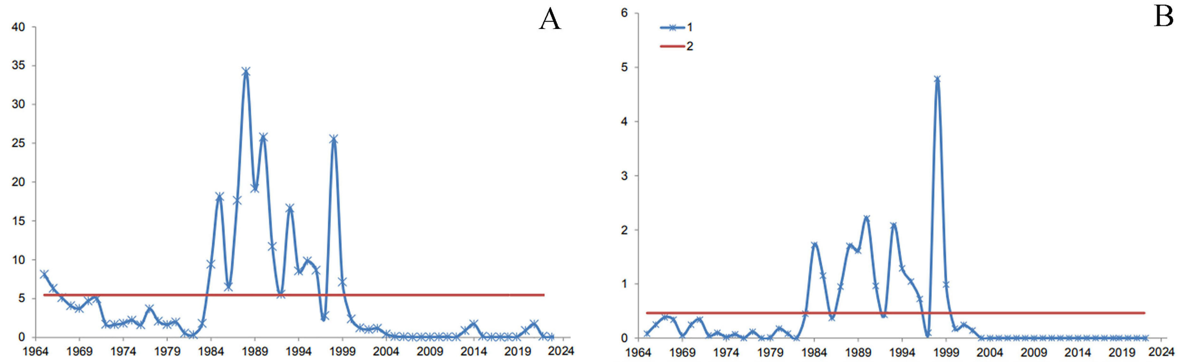

Fig. 2. Long-term changes in the annual flow of the River Uldza, Solovyevsk village (A) and River Imalka, Krasnaya Imalka village (B) (Transbaikalia, Russia). Designations: 1 – mean annual value, 2 – mean long-term value (modified from Fig. 1.3.3 in Kashnitskaya, 2022 and Fig. 2 in Nikitin et al., 2023).

Table 2. The hydrochemical composition of River Uldza (Solovyevsk village) and River Imalka (Krasnaya Imalka village), Transbaikalia, Russia

River	pH	EC	TDS	HCO_3^-	SO_4^{2-}	Cl^-	Ca^{2+}	Mg^{2+}	Na^+	K^+
		µS/cm	mg/L							
River Uldza	8.08–8.37	178–605	390–830	456.30	133	8.40	92.10	45.90	45.0	2.36
River Imalka	7.70–7.79	208–758	360–700	411.30	67.90	37.90	85.10	26.50	49.80	23.20

Note: EC – electrical conductivity, TDS – total dissolved solids.

Table 3. Some abiotic characteristics (sampling depth (H, m), Secchi transparency (TR, m), and water temperature (T, °C)) in the River Uldza (Solovyevsk village), River Imalka (Krasnaya Imalka village), channel Utochi, and branch Borokholoy (Transbaikalia, Russia) during study seasons in 2020–2022

Watercourses	H, m	TR, m	T, ºC	Note
Autumn				
River Uldza	0.3–1.2	0.5–0.8	10.5–16.7	The water was yellow and turbid. **Mass l**ong strands of filamentous algae were observed. Ground vegetation was flooded.
River Imalka	0.2–0.3	to bottom	11.8–16.9	
Channel Utochi	0.3–0.4	to bottom	5.4	Filamentous macroalgae and semi-aquatic vegetation were noted.
Branch Borokholoy	0.2–0.3	to bottom	9.8	The water was clear and transparent.
Spring				
River Uldza	0.5–1.0	to bottom	3.1–6.3	The water was clear and transparent.
River Imalka	0.3–0.5	to bottom	5.2–7.6	
Summer				
River Uldza	0.5–1.3	0.5–1.0	19.1–23.8	The water was yellowish in colour. Aquatic and semi-aquatic vegetation were noted.
River Imalka	0.2–0.9	0.2–0.5	19.9–22.2	

Table 4. Sample identification, number of samples collected and co-ordinates of each site in Transbaikalia, Russia

Site	Watercourses	Sampling data (month, year)	Number of samples collected	Co-ordinates
1	River Imalka, Krasnaya Imalka village	April 2021	2	50.285278° N, 115.015000° E
		August 2021	3	
		September 2021	3	
2	River Uldza, Solovyevsk village	September 2020, 2021	6	N 50.023333° N, 115.693333° E
		October 2020, 2021	6	
		April 2021	2	
		May 2022	3	
		July 2021, 2022	6	
		August 2021, 2022	6	
3	Branch Borokholoy	October 2020	2	50.064444° N, 115.923889° E
4	Channel Utochi	September 2021	2	50.082222° N, 115.720833° E

To phytoplankton account, we took samples in the near-surface layer and used 4% formaldehyde solution to preserve samples. In the laboratory the phytoplankton samples were prepared by the sedimentary method. After two weeks we examined samples under a Nikon Eclipse E200 microscope (1000×). Algae were counted according to the Hansen method using a counting plate. Biomass was determined based on the volume of individual algae cells or colonies and their geometric figures (Sadchikov, 2003). We used taxonomic literature for identifying algae according to Tashlykova (2009). Taxon classification and synonymy of each group of algae were given according to Guiry & Guiry (2024). Phytoplankton species were grouped into Functional Groups (FG$_{ph}$) (Reynolds et al., 2002; Padisák et al., 2009) and morphologically based functional groups (MBFG$_{ph}$) (Kruk et al., 2010; Kruk & Segura, 2012). The number FG$_{ph}$ was considered as a measure of functional diversity (FD$_{ph}$).

Zooplankton samples were collected by water filtration through a net (mesh sizes of 0.064 and 0.087 mm) (Kiselev, 1969). Samples fixed with 4% formaldehyde solution were examined in the Bogorov and Kolkwitz chambers using microscopes MBS-10 (32 ×) and Axio Scope A1 (400 ×). Zooplankton biomass was determined according to the methods by Ruttner-Kolisko (1977), Balushkina & Vinberg (1979), and Ejsmont-Karabin (1998). Bdelloida (Rotifera) was identified and presented as Bdelloida gen. sp. Nauplii and copepodites were identified to the order only. Species that actually represented groups of related species were identified as species (sensu lato) according to descriptions in taxonomic keys. The following guide and keys were used for identifying zooplankters (Kutikova, 1970; Borutsky et al., 1991; Tsalolikhin, 1995; Korovchinsky et al., 2021; Alekseev, 2024). The valid names of taxa were checked according to WoRMS (2024). Zooplankton taxa were divided into Functional Groups (FG$_{zoo}$) based on a combination of locomotion type, feeding type and food sources (Gavrilko et al., 2020; Branco et al., 2023). Functional diversity (FD$_{zoo}$) was calculated as the number of FG$_{zoo}$.

The biodiversity of phytoplankton and zooplankton communities was expressed by the number of species (n, total and average) and Pielou's index (e) (Magurran, 1988). Whittaker's measure (βw) was used to express β-diversity between watercourses (Whittaker, 1972). Species comprising more than 10% and 20% of the total phytoplankton and zooplankton density respectively were considered to be dominant (Fedorov & Gilmanov, 1980; Korneva, 2015). We applied the frequency occurrence (pF, i.e. the number of times a species/taxon is present in a given number of sample sites).

Data analysis

We calculated the mean values and standard deviation for each variable (mean ± SD). To determine the extent of variability in relation to the mean of the population, we used the coefficient of variation (CV, %). Biological variables were normalised prior to calculations and to achieve normal distribution. Variations in phytoplankton and zooplankton species number, abundance, and biomass were tested statistically using a one-way analysis of variance (ANOVA). Values were considered significant at $p < 0.05$ levels. We considered statistically significant Pearson correlation coefficients $r \geq 0.50$ and $p < 0.05$ indicative of strong and significant relationships between variables. The tests and statistical analyses were performed using XLSTAT (Addisonsoft, USA) and OriginPro 2022 (OriginLab, USA).

Results

Diversity and structure of phytoplankton

Overall, 134 algal taxa ranked below the genus level, represented by eight divisions, were recorded. Of them, 47 and 49 taxa belong to Chlorophyta and Bacillariophyta, respectively, constituting the most dominant groups with 35% and 37% of the total list, followed by Cyanobacteria (18 taxa or 13%), Chrysophyta (four species, 3%), Cryptophyta (one species, 1%), Dinophyta (one taxon, 1%), Charophyta (ten taxa, 8%), and Euglenophyta (four taxa, 3%). Among Bacillariophyta, the genera *Cymbella* (six species), *Gomphonema* (five species) as well as two Chlorophyta genera *Monoraphidium* (five species) and *Scenedesmus* (five species) had the highest species richness. The genus *Closterium*, consisting of six taxa, was the most richly represented among Charophyta. Species such as *Nitzschia acicularis* (Kützing) W. Smith and *Ulnaria ulna* (Nitzsch) Compère (Bacillariophyta) were commonly present in all the surveyed watercourses (pF = 100%). The species *Fragilaria radians* (Kützing) D.M. Williams & Round, *Lindavia comta* (Kützing) T. Nakov et al., *Cosmarium* sp., *Chlamydomonas globose* J.W. Snow, *Monoraphidium contortum* (Thuret) Komárková-Legnerová, *M. komarkovae* Nygaard, *M. minutum* (Nägeli) Komárková-Legnerová, *Oocystis lacustris* Chodat had a pF of 75%. Most of the species (50% of the total species list) were classified as rare or accidental (Table S1).

Altogether, a total of 23 FG_{ph} and 7 $MBFG_{ph}$ were determined (Table S1). Codons MP (16% of total species composition, metaphysics, epiphytic and epilithic species drifted in the plankton (mainly sporadic occurrences Bacillariophyta) preferring frequently stirred up, inorganically turbid shallow lakes), X1 (10%, species preferring shallow, eu-hypertrophic environments, resistant to stratification, sensitive to nutrients deficiency and filter feeding), and J (6%, species preferring shallow, mixed, highly enriched systems, including low-gradient rivers) dominated in species composition and abundance. Phytoplankton was mainly represented by unicellular non-flagellated algae (64%) and by species with a high maximum axial linear size (49%). Groups IV (26%, organisms of medium size lacking specialized traits) and VI (26%, non-flagellated organisms with siliceous exoskeletons) prevailed. The algal flora was formed mainly by cosmopolitans (68%) (Fig. 3). The extent of variability of the Whittaker's measure was uniform (CV = 10%). *βw* varied from 0.86 (between River Uldza and River Imalka) to 0.91–0.98 (between River Uldza and its tributaries).

The River Uldza showed the highest number of phytoplankton taxa, 123. The dominant divisions were Bacillariophyta (44 taxa) and Chlorophyta (43 taxa). FD_{ph} was determined by 19 FG_{ph}. Codons MP (17% of total list), X1 (8%), and J (7%) prevailed. There were 7 $MBFG_{ph}$. Groups IV, represented by Chlorophyceae and Zygnemaphyceae and VI, represented by Bacillariophyta predominated. The basis of species composition (46%) consisted of unicellular non-flagellated forms with a high proportion of colonial non-flagellated and coenobia (13%) (Table S1).

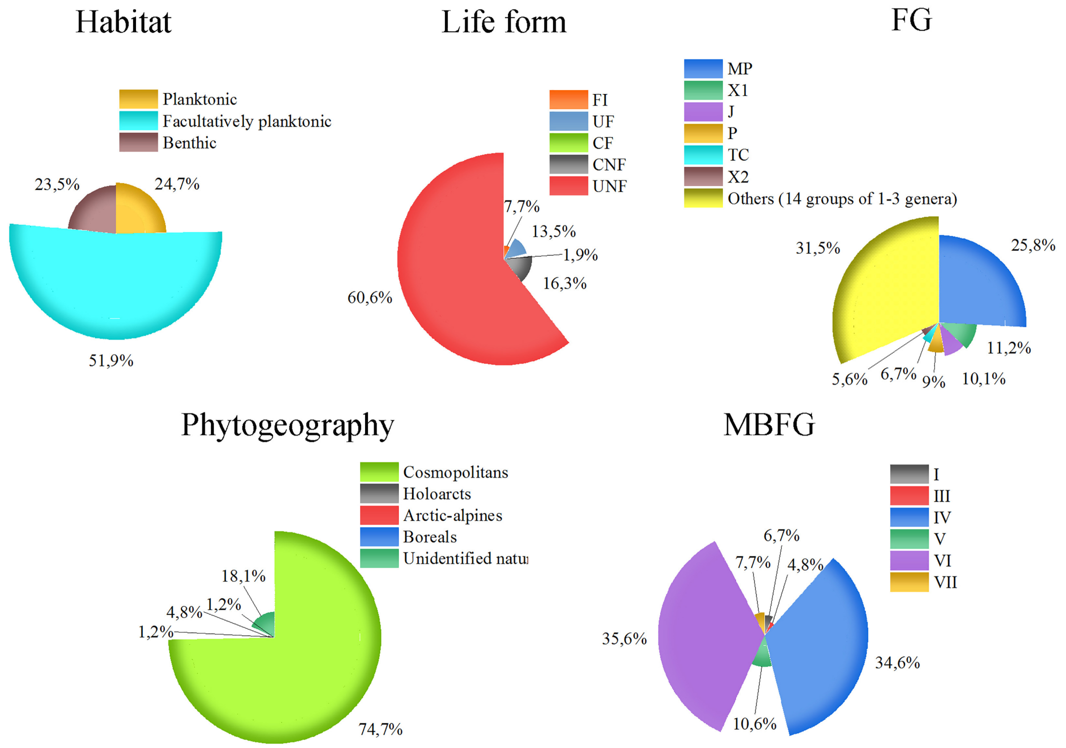

Fig. 3. Ecological and geographical characteristics of phytoplankton of the surveyed watercourses (Transbaikalia, Russia). Designations: Designations of life forms: FI – filaments, UF – unicellular flagellates, CF – colonial flagellates, CNF – colonial non-flagellated (including coenobia), UNF – unicellular non-flagellated; FG – functional groups (codons are named according to Reynolds et al., 2002; Padisák et al., 2009); MBFG – morphologically based functional groups (groups are named according to Kruk et al., 2010; Kruk & Segura, 2012).

The ANOVA results showed that the species diversity, density and biomass did not vary significantly among the research periods ($p > 0.05$). The species richness in 2020–2021 (19 ± 8 taxa; CV = 42%) did not differ considerably from that in 2021–2022 (17 ± 12; CV = 72%). The values of the total abundance and biomass were determined within the same limits (CV < 100%): $57.95 \pm 30.19 \times 10^3$ cells/L and 100.69 ± 64.35 mg/m^3 in 2020–2021 and $88.67 \pm 78.91 \times 10^3$ cells/L and 79.28 ± 48.08 mg/m^3 in 2021–2022 ($p > 0.05$). The Pielou's index ranged between 0.78–0.98 in 2020–2021 and 0.65–0.93 in 2021–2022 (CV < 30%).

The phytoplankton species diversity and quantitative parameters showed seasonal variations (Fig. 4). The species number varied from 16 ± 11 in spring to 23 ± 4 in summer. High values of abundance and biomass ($85.54 \pm 37.42 \times 10^3$ cells/L and 102.47 ± 61.37 mg/m^3) were observed in spring as well as in autumn ($71.77 \pm 91.19 \times 10^3$ cells/L and 122.67 ± 62.86 mg/m^3). In summer, the average values of quantitative indicators were $68.75 \pm 34.75 \times 10^3$ cells/L and 51.07 ± 15.29 mg/m^3. Medium and large unicellular forms of Bacillariophyta and Chlorophyta as well as large filamentous and small colonial species of Cyanobacteria considerably contributed to the total abundance and biomass. The species *Ulnaria ulna* was present in all seasons, but it was abundant during autumn and spring. Cyanobacteria (species of the genus *Anabaena*, *Coelomoron pusillum* (Van Goor) Komárek, *Gloeocapsa minima* (Keissler) Hollerbach, *G. minor* (Kützing) Hollerbach) as well as Chlorophyta (*Monoraphidium griffithii* (Berkeley) Komárková-Legnerová, *Willea apiculata* (Lemmermann) D.M. John, M.J. Wynne & P.M. Tsarenko, *W. irregularis* (Wille) Schmidle) vegetated abundantly in summer.

In the Borokholoy branch, phytoplankton was recorded by Bacillariophyta (two species) and Chlorophyta (four taxa). Abundance and biomass were low and amounted to 4.48×10^3 cells/L and 16.22 mg/m^3. Phytoplankton was mainly represented by *Monoraphidium* spp., *Nitzschia acicularis*, and *Ulnaria ulna* (Table S1, Table 5).

In the channel Utochi, 30 phytoplankton taxa were identified. There were 7 FG$_{ph}$ and 3 MBFG$_{ph}$ (Table S1). The values of total abundance and biomass reached 96.80×10^3 cells/L and 68.85 mg/m^3. Bacillariophyta and Cyanobacteria accounted for 32% and 61% of total abundance, while Chlorophyta and Bacillariophyta accounted for 30% and 60% of total biomass, respectively (Table 4). Large-sized unicellular non-flagellated Bacillariophyta (*Ulnaria* *ulna*, *Fragilaria radians*, *Nitzschia* sp.) and filamentous Cyanobacteria (*Anabaena minima* Tschernov and species of the genus *Oscillatoria*) dominated.

A total of 37 phytoplankton taxa belonging to six phyla (two Cyanobacteria taxa, 17 Bacillariophyta taxa, one Charophyta taxon, 12 Chlorophyta taxa, four Chrysophyta taxa, and one Euglenophyta taxon) were found in the River Imalka. 12 FG_{ph} and 6 $MBFG_{ph}$ were registered. Medium- and large-sized unicellular non-flagellated algae (64%) dominated in the phytoplankton composition. Codons MP (16%), D (16%), and X1 (33%) and groups IV (44%) and VI (52%) were the most diverse and abundant (Table S1). Distribution of abundance and biomass values were highly heterogeneous, ranging from 56.00 × 10^3 cells/L to 315.52 × 10^3 cells/L and 15.66 mg/m^3 to 347.42 mg/m^3, respectively. Bacillariophyta (mostly *Fragilaria crotonensis* Kitton, 66% in abundance) and Chrysophyta (mostly *Dinobryon divergens* O.E. Imhof, 16%) were dominants in April, while Chlorophyta (*Monoraphidium* and *Scenedesmus*, 53%) in August and Bacillariophyta (*Ulnaria ulna* and *Nitzschia acicularis*, 71%) in September (Table 6).

Diversity and structure of zooplankton

In total, we registered 116 taxa below genus level within the groups Rotifera (64 taxa or 55% of the total species list), Cladocera (35 taxa, 30%), and Copepoda (17 taxa, 15%). Not determined Bdelloida (Rotifera) and juvenile Copepoda and Anostraca were also encountered. The FD_{zoo} was determined by 17 FG_{zoo} (Table S2). Zooplankton species belonged to three trophic groups: non-predatory (bacteriovores, herbivores, and detrivores, 97 taxa or 80.8%), facultative predatory (omnivores, 17 taxa or 14.2%), and predatory (carnivores, six taxa or 5%). Filter feeders (primary filtration, secondary filtration, vertication on feeding type, in sum 59.2%) and species with swimming and crawling locomotion (71.7%) were the most diverse. According to ecological and geographical analyses, most of the species were cosmopolites (61.4%) in distribution and littoral and phytophilic (65.1% in sum) species in habit (Fig. 5).

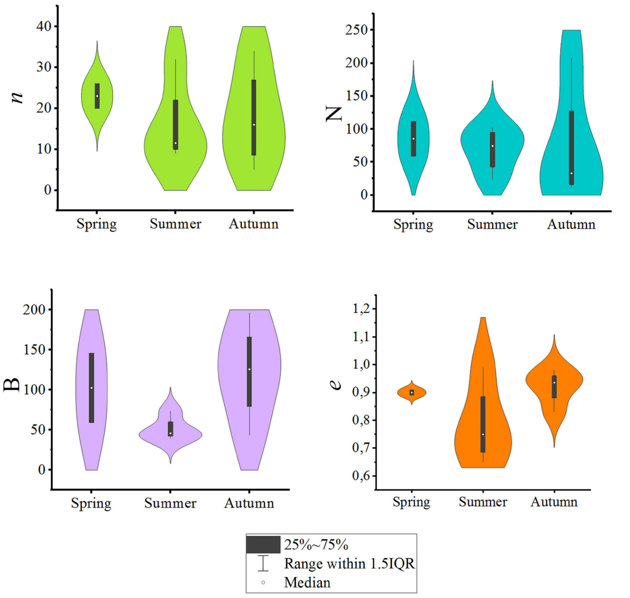

Fig. 4. Seasonal changes in biological indicators of phytoplankton in the River Uldza (Transbaikalia, Russia). Designations: n – species number; N – abundance (× 10^3 cells/L); B – biomass (mg/m^3); e – the Pielou's index.

Table 5. Abundance (N, × 10 cells/L) and biomass (B, mg/m^3) of phytoplankton in branch Borokholoy and channel Utochi, Transbaikalia, Russia

Watercourse	Cyanobacteria		Bacillariophyta		Charophyta		Chlorophyta		Euglenophyta		Total	
	N	B	N	B	N	B	N	B	N	B	N	B
Branch Borokholoy	0.00	0.00	2.04	7.32	0.00	0.00	2.44	8.90	0.00	0.00	4.48	16.22
Channel Utochi	60.28	5.33	30.80	39.20	2.20	1.24	3.08	18.86	0.44	4.22	96.80	68.85

Table 6. Phytoplankton diversity (n – species number) and structure (N – abundance, × 10^3 cells/m^3, B – biomass, mg/m^3) indicators in the River Imalka (Krasnaya Imalka village, Transbaikalia, Russia) in 2021

Divisions	April			August			September		
	n	N	B	n	N	B	n	N	B
Cyanobacteria	1	0.82	0.02	1	42.90	3.03	1	0.20	0.04
Chrysophyta	4	50.80	35.90	0	0.00	0.00	1	0.20	0.24
Bacillariophyta	13	209.00	253.00	0	0.00	0.00	15	39.60	8.77
Charophyta	0	0.00	0.00	1	0.78	5.88	2	2.20	1.26
Chlorophyta	7	54.90	58.50	10	49.10	9.04	11	13.20	4.33
Euglenophyta	0	0.00	0.00	0	0.00	0.00	1	0.60	1.02
Total	25	315.52	347.42	12	92.78	17.95	31	56.00	15.66

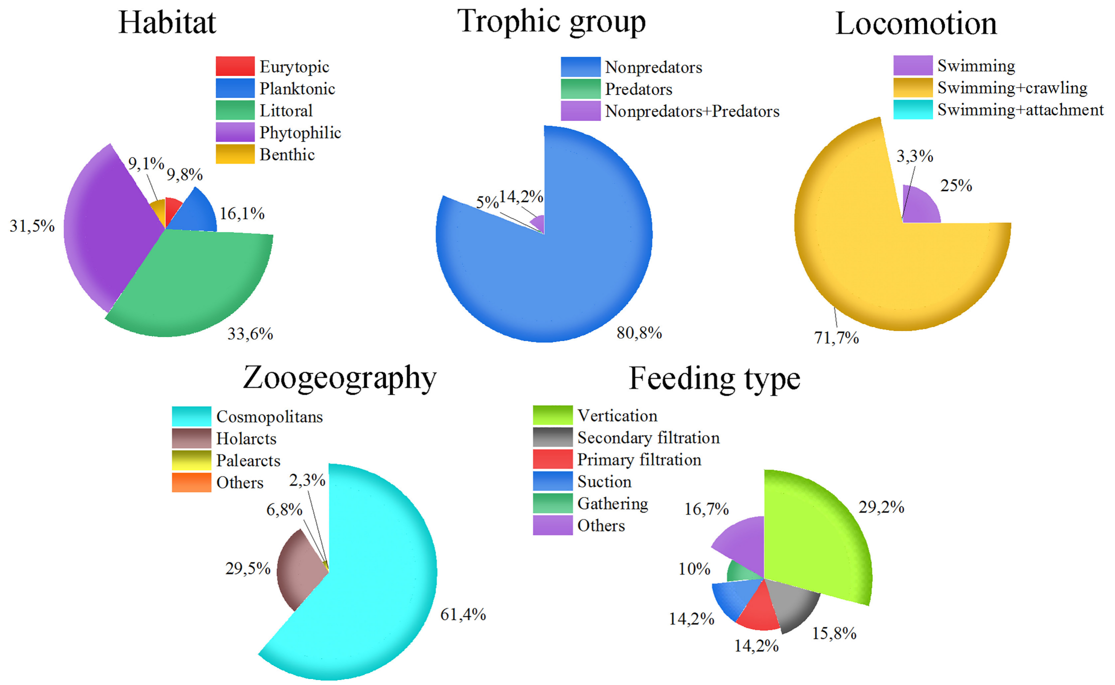

Fig. 5. Ecological and geographical characteristics of zooplankton of the surveyed watercourses (Transbaikalia, Russia).

Rotifera species of the Brachionidae, Lecanidae, and Euchlanidae families had the highest species richness (12 species and varieties from five genera, eight species from one genus, and six species from one genus respectively). Among Cladocera, Chydoridae and Daphniidae were the most species-rich families, with 17 species from 11 genera and ten species from five genera respectively. Among Copepoda, Cyclopidae was represented by 14 species from ten genera. *Plationus polyacanthus* (Ehrenberg, 1834) (Rotifera) and *Megafenestra aurita* (Fischer, 1849) (Cladocera) have been recorded for the first time in the fauna of the Zabaikalsky Krai. Such species as *Notommata doneta* Harring & Myers, 1924, *Resticula gelida* (Harring & Myers, 1922), *Epiphanes clavulata* (Ehrenberg, 1831), *E. macroura* Barrois & Daday, 1894, *Mytilina trigona* (Gosse, 1851), *Testudinella patina triloba* (Hermann, 1783) are rare in the studied region. Immature copepods were present on all sites and in all sampling data (pF = 100%). The species *Chydorus sphaericus* (O.F. Müller, 1785) had a pF of 93%. Cyclopoid nauplii and *Pleuroxus aduncus* (Jurine, 1820) were classified as constant taxon/species (pF of 73% and 60%, respectively). Many species (50% of the total list) are reported once and/or only in one watercourse (Table S2). The degree of dispersion of the Whittaker's measure was negligible (CV = 7%). βw varied from 0.71 (between rivers) to 0.82–0.83 (between main stream and tributaries).

We detected a diverse zooplankton community in the River Uldza and found totally 105 taxa, including 61 taxa of Rotifera, 31 taxa of Cladocera and 13 taxa of Copepoda. FD_{zoo} were determined by 17 FG_{zoo}. Among them, group 10, represented by Rotifera (27 taxa or 26%) and group 9, represented by Cladocera (19 species or 18%) included the highest species richness. Most of the species were littoral and phytophilic species (59%) as well as filter feeders (65%, microphagous algivores, microfagous to polyphagous rotifers, herbi- and detritivores crustaceans) and swimming and crawling species (76%) (Table S2). Among all the pairwise comparisons, the species richness in 2020–2021 (34 ± 21 taxa; CV = 60%) was significantly (ANOVA, $p < 0.05$) higher than in 2021–2022 (13 ± 4 taxa; CV = 32%). The abundance and biomass of invertebrates varied within wide limits (CV > 100%) and were higher in 2020–2021 ($11.11 \pm 12.73 \times 10^3$ individuals/m^3 and 82.85 ± 86.70 mg/m^3) than in 2021–2022 ($2.27 \pm 2.26 \times 10^3$ individuals/m^3 and 50.03 ± 68.61 mg/m^3), but not significantly (ANOVA, $p > 0.05$). The Pielou's index varied within 0.78–0.98 in 2020–2021 and 0.61–0.91 in 2021–2022 (CV < 30%; $p > 0.05$).

In seasonal aspect, the species richness (40 ± 28) was the highest in September and the lowest (10 ± 1) in April–May. The total abundance peaked in July ($14.84 \pm 20.75 \times 10^3$ individuals/m^3) and September ($12.25 \pm 9.71 \times 10^3$ individuals/m^3). Small filter feeders and collector-gatherers (Cladocera *Chydorus sphaericus*, *Pleuroxus aduncus*, *Coronatella rectangula* Sars, 1862 and Rotifera *Testudinella patina* (Hermann, 1783) in autumn as well as Rotifera *Trichocerca elongata* (Gosse, 1886), *Hexarthra mira* (Hudson, 1871), *Euchlanis dilatata* Ehrenberg, 1832 in summer) were the main components of the zooplankton community. In terms of biomass, the highest values (151.57 ± 114.61 mg/m^3) were formed by large-sized crustaceans (large unselective filter feeders *Simocephalus vetulus* (O.F. Müller, 1776), *Daphnia* sp. and selective filter feeders copepodits of Cyclopoida) were observed in September. In spring, the total diversity and density of zooplankters was minimal, and larval stages of Copepoda and Anostraca nauplii of numerically dominated. Although the number of predators was found to be very low, this also showed clear increasing trends after summer (Fig. 6).

In the branch Borokholoy, there were 13 zooplankton taxa (Table S2) with a total abundance of 8.10 × 10^3 individuals/m^3 and biomass of 210.43 mg/m^3. Macrophagous algivores of the soft-bodied Rotifera (*Cephalodella*, *Proales*, *Epiphanes*) were dominants (66% in abundance) (Table 7).

In the channel Utochi, the zooplankton consisted of 15 taxa. The total abundance and biomass were 105.17 × 10^3 individuals/m^3 and 40 318 mg/m^3. The community was formed by littoral large-sized filter feeders of Cladocera (*Daphnia curvirostris* Eylmann, 1887, *Simocephalus vetulus*, *Ceriodaphnia quadrangula* (O.F. Müller, 1785), and *Scapholeberis mucronata* (O.F. Müller, 1776)) (Table 5).

We identified a total of 25 zooplankton taxa (eight Rotifera taxa, 11 Cladocera taxa, six Copepoda taxa) in the River Imalka. There were 11 FG$_{zoo}$. Functional group 9 (Rotifera, five taxa or 20%), group 12 (Rotifera, five species or 16%) and group 16 (Cladocera and Calanoida, five species or 16%) dominated. Phytophilic species (39%) as well as filter feeders (60% in sum) and species with swimming and crawling locomotion (40%) were the most divers (Table S2). Abundance and biomass were characterised by high values in April (17.44 × 10^3 individuals/m^3 and 881.50 mg/m^3) and low in August (1.41 × 10^3 individuals/m^3 and 13.32 mg/m^3). However, summer zooplankton was the most diverse (21 taxa) (Table 8). Copepoda nauplii (73% in abundance and 83% in biomass) were the major contributor to the total biovolume in spring, while immature individuals of Copepoda (39% in abundance and mature individuals, 59 % in biomass) and Rotifera (30% in abundance, mostly *Filinia longiseta* (Ehrenberg, 1834) and *Euchlanis dilatata*) in summer and Cladocera (*Chydorus sphaericus*, *Pleuroxus aduncus*) (88% and 79% in abundance and biomass, respectively) in autumn.

Discussion

As the outcome of this study we found 134 phytoplankton taxa and 116 zooplankton taxa in the surveyed watercourses during the beginning runoff and increasing discharge. In the River Uldza, the biodiversity (123 taxa of algae and 105 taxa of invertebrates) was quite high compared to other lowland streams, which is most likely caused by flooding (increasing river discharge) and water residence time. These hydrological factors have a generally dominant role in structuring lotic plankton communities (Reynolds, 2000; Lair, 2006; Salmaso & Braioni, 2008). Floods considerably contribute to the regional biodiversity of small to large lowland rivers (Reynolds, 2000; Karpowicz, 2017), which are characterised by fluvial dynamics that create complex habitats and connectivity gradients, which result in high biodiversity (Ward & Tockner, 2001; Deksne & Škute, 2011; Górski et al., 2013; Mihaljević et al., 2013; Krylov, 2015; Wang et al., 2022; Yanygina et al., 2024). Water residence time (or «age of water» (Baranyi et al., 2002)) is very important for plankton community development and increases with the increasing river length and there is often a tendency for plankton to be more diverse and abundant downstream (Zimmermann-Timm et al., 2007; Dickerson et al., 2010; Istvánovics et al., 2010; Sindt & Wolf, 2021).

Table 7. Abundance (N, × 10^3 individuals/m^3) and biomass (B, mg/m^3) of zooplankton in branch Borokholoy and channel Utochi (Transbaikalia, Russia)

Watercourse	Rotifera		Copepoda		Cladocera		Total	
	N	B	N	B	N	B	N	B
Branch Borokholoy	5.36	27.44	0.03	0.41	2.72	182.59	8.10	210.43
Channel Utochi	3.33	0.91	11.78	20.07	88.39	40297.02	105.17	40318.0

Table 8. Zooplankton diversity and structure indicators in the River Imalka (Krasnaya Imalka village, Transbaikalia, Russia) in 2021

Month	Number of species	Abundance, × 10^3 individuals/m^3				Biomass, mg/m^3			
		Rotifera	Copepoda	Cladocera	Total	Rotifera	Copepoda	Cladocera	Total
April	9	0.57	16.15	0.72	17.44	0.74	728.07	152.69	881.50
August	21	0.43	0.82	0.16	1.41	0.46	11.41	1.45	13.32
September	4	0.00	1.18	8.70	9.88	0.00	11.83	43.58	55.41

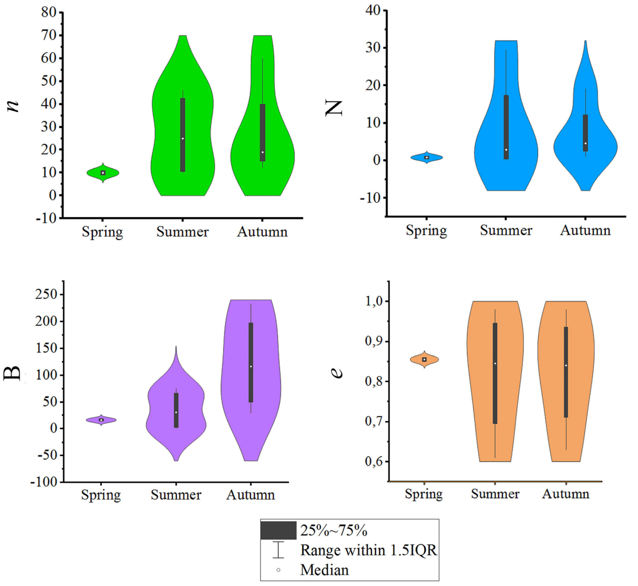

Fig. 6. Seasonal changes in biological indicators of zooplankton in the River Uldza (Transbaikalia, Russia). Designations: n – species number; N – abundance (× 10^3 individuals/m^3); B – biomass (mg/m^3); e – the Pielou's index.

The low taxonomic richness of phytoplankton (37 taxa) and zooplankton (25 taxa) in the River Imalka compared to the River Uldza may be related to the sampling frequency (three sampling compared to ten), morphometric features (length and basin area) and other hydrological conditions (long-term water flow, flow volume, flow velocity) (Table 1). A reduction in the species diversity of aquatic organisms with decreasing size (morphometry) of water body and with low sampling frequency are consistent with the results of Alimov (2008) and Kiselev (1969). In addition, this trend is associated with natural depletion of the taxonomic composition in some types of watercourses previously noted in other research (Krylov, 2005; Korneva et al., 2024). Generally, more «heterogeneous» habitats, such as small oxbow lakes and tributary streams (as in the River Uldza), have higher species richness of algae and invertebrates while the quite «homogeneous» single sampling station in the River Imalka had much lower species richness in the plankton community. Following Sheldon et al. (2002) in response to hydrological regimes (punctuated periods of dry riverbed and floods), drying out rivers tend to contain low species richness. The communities of such rivers have been observed to be inhabited predominantly by taxa that are better adapted for re-colonisation after hydrological disturbance through faster generation time, wider dispersal ability, and greater fecundity than the taxa in hydrologically more stable wetter systems (Lair, 2006; Díaz et al., 2008).

River habitats can be attributed to mixed areas of ecosystem, in which it is generally difficult to divide communities into plankton, benthos, and periphyton (Protasov, 2010). For this reason, in rivers, besides tychoplankton (accidental plankton from adjacent habitats) and meroplankton (organisms that are planktonic for only a part of their life cycles), there is a native plankton community made up of truly planktonic species (eupotamoplankton) (Reynolds, 2006). Potamoplankton is mainly composed of small sized and ubiquitous taxa, which are capable to survive the selective forces acting in the main flow of rivers (Devercelli, 2006), overcome «the inexorable tendency to be removed permanently» due to unidirectional flow (Reynolds, 2000), and filter small particles most efficiently (Lair, 2006). The surveyed watercourses were shallow with aquatic plants and filamentous macroalgae in the shoreline and main riverbeds, which determined the small number of euplankton forms of algae (25% of the entire list) and invertebrates (16% of the entire list). Potamoplankton is characterised by a relatively few dominant genera and a high participation of sporadic species. The latter taxa rarely occurred in the main flow, washed from periphytic or plankto-benthic communities or introduced from other water bodies. A greater part of the plankton community represented by partially planktonic algae (49%) and littoral (34%) and phytophilic (31%) species of invertebrates. However, both truly planktonic, bentic and littoral-phytophilic species were numerous.

In the studied watercourses, phytoplankton was characterised by a high abundance and number of species of the Chlorophyta and Bacillariophyta, as is usual in the lowland rivers of temperate latitudes (Leland et al., 2001; Romanov & Kirillov, 2009; Istvánovics et al., 2010; Kentzer et al., 2010; Wu et al., 2011; Korneva, 2015; Zinchenko et al., 2023; Korneva et al., 2024). Bacillariophyta and Chlorophyta are very diverse and common in rivers, like those living on hard substrata, epiphytically on aquatic plants or other algae, and a few free-floating forms. They are sensitive to a variety of ecological conditions and always dominate whether high, low, or normal hydrologic conditions prevailed (Burliga & Kociolek, 2016; Sherwood, 2016). Dominant species, such as *Monoraphidium*, *Scenedesmus*, *Ulnaria*, *Nitzschia*, *Fragilaria* are widespread (ubiquistic) organisms with a broad ecological valence. Cyanophyta and Chrysophyta were the second in terms of diversity and abundance. Cyanobacteria are a group of oxygenic prokaryotes present in nearly all aquatic ecosystems. They are common under conditions of light limitation and a lack of or poor availability of mineral nutrients in water and prefer waters, which are rich of nutrients and easily oxidisable organic matter (Casamatta & Hašler, 2016). *Anabaena*, *Oscillatoria*, *Merismopedia* occur worldwide, being benthic or epiphytic, but they may become free-floating after dislodging. *Dinobryon divergens* (Chrysophyta) is a common microscopic chromist in fresh waters, a cold-loving and free-floating species (Vasser et al., 1989).

In our study, watercourses were dominated by Rotifera and/or Cladocera as is usual for most rivers (Reynolds, 2000; Lair, 2006). Rotifera taxa are more successful than Crustacea under lotic conditions because of their shorter development time (Reynolds, 2000), a life history trait which confers resilience (Townsend et al., 1997). Following King (2004), the crustacean density is typically low, with most populations augmented by recruits from other habitats. Cladocera and Copepoda inevitably decrease in abundance down river, through mortality and advection and/or because conditions prevent successful reproduction (Lair, 2006; Havel et al., 2009). But microcrustaceans may be occasionally abundant in rivers (as in the channel Utochi) because they may re-establish larger population sizes and biomasses only when lentic conditions prevail over longer periods (Baranyi et al., 2002). Following Lair (2006), Cladocera, including typically euplanktonic species and littoral forms living in nearshore areas, among macrophytes or in benthic boundary layers, are able to swim. Cladocera is better adapted to river conditions than Copepoda because of their shorter development times and the possibility of reproducing parthenogenetically, a mode common to rotifers. Apart from the typically planktonic forms, rotifer species inhabit the littoral zone and superficial sediments, where their foot may act as an anchor, preventing displacement, a useful adaptation in flowing water (Baranyi et al., 2002).

In the Rotifera fauna, only a few species, such as *Cephalodella gibba* (Ehrenberg, 1832), *Trichocerca rattus* (Müller, 1776), *Synchaeta pectinata* (Ehrenberg, 1832), *Lecane lunaris* (Ehrenberg, 1832), *L. luna* (Müller, 1776), *Lepadella patella* (Müller, 1773), *Euchlanis dilatata*, *Brachionus quadridentatus* Hermann, 1783, and *Keratella quadrata* (Müller, 1786), occur in all biogeographical regions. The species *Mytilina mucronata spinigera* (Ehrenberg, 1773) and *Plationus polyacanthus* have a narrow distribution (Palearctic region) (Segers, 2007). They are found in shallow marshy lakes, between aquatic vegetation in the littoral zone (Kutikova, 1970). All identified Cladocera taxa belong to two faunal complexes (Kotov, 2016), namely a widespread Eurasian faunal complex (taxa occurring widespread both in Eurasia and on other continents) and unrevised widespread species (taxa widely distributed in Eurasia from the Atlantic to the Pacific coast, but absent in North America). The relatively rare *Megafenestra aurita* is common in North Eurasia, although it prefers more southern regions. Its biology has been little studied; this species is thermophilic (Korovchinsky et al., 2021). We found *Megafenestra aurita* near the water edge between filamentous algae in the channel Utochi. Two species, *Chydorus sphaericus* and *Pleurixus aduncus*, were the most common, often frequent and abundant. They are characterised as widely distributed, highly adaptive species, reported from all types of water bodies (Błędzki & Rybak, 2016). Registered species of Cyclopoida have a relatively wide distribution. They are found in ponds, lakes, reservoirs, slowly flowing rivers, usually in littoral between vegetation and near the bottom (Błędzki & Rybak, 2016). Two Calanoida species, namely *Neutrodiaptomus incongruens* (Rylov, 1925) and *Metadiaptomus asiaticus* (Uljanin, 1875), have a narrow distribution (Borutsky et al., 1991). *Neutrodiaptomus incongruens* is an oriental element of the Palearctic fauna. *Metadiaptomus asiaticus* is a halobiont, distributed in arid and semiarid territory of Asia. It inhabits mass in meso- and polyhaline lakes of Transbaikalia (e.g. Afonina & Tashlykova, 2024).

The zooplankton community consisted mainly of non-predatorial animals (herbivorous and detritovorous) that mode reflecting the favourable conditions for their development in terms of resource availability in the surveyed rivers. The most numerous predators were immatures of Copepoda taxa (older copepodites of Cyclopoida). This is typical for rivers with thickets of aquatic vegetation (Krylov, 2005; Gavrilko, 2024). In general, our results showed that in zooplankton, the most widespread genera of Rotifera (*Brachionus*, *Lecane*, *Trichocerca*, *Euchlanis*, and *Testudinella*), Chydoridae species (*Chydorus*, *Pleuroxus*, *Coronatella*, *Alona*), and larval stages of Cyclopidae were the most divers and abundant representatives of potamoplankton, similarly as it was found during the surveys of lowland rivers in Europe (Baranyi et al., 2002; Lair, 2006; Deksne & Škute, 2011; Karpowicz, 2017), Russia (Krylov, 2005; Afonina, 2012, 2018; Zinchenko et al., 2023), and China (Zhao et al., 2017).

Seasonal plankton succession includes a sequential change of species, which is caused by resource constraints and is the result of interspecific competition and/or the influence of predation and competition (Sommer et al., 1986). Seasonal changes in rivers are a cyclical succession triggered by the spring flood (Krylov, 2005). Community dynamics depend on environmental influences (Krylov, 2005; Khaliullina & Khaliullin, 2022), trophic interactions (Kenitz et al., 2017), and habitat characteristics (Fu et al., 2021; Gavrilko, 2024). In the present scenario, the spring and autumn plankton communities comprised of extra-large unicellular non-flagellates (> 100 µm) and grazing filter-feeders with various body sizes. Codons MP (*Ulnaria ulna*, *Nitzschia apiculata* (W. Gregory) Grunow) and D (*Nitzschia acicularis*, *Fragilaria radians* and small centrics in minor proportion) and primary filter-feeders (Daphniidae and larval stages of Cyclopoida and Anostraca) and collector-gatherers (Chydoridae) dominated. In summer, both unicellular and colonial and filamentous species were numerous. The highest density of codons H1 (*Anabaena*), TC (*Gloeocapsa*, *Oscillatoria*), X1 (*Monoraphidium*), F (*Willea*), and J (*Scenedesmus*), and microphagous to macrophagous algivores (*Trichocerca*, *Hexarthra*, *Polyartra*, *Synchaeta*) and polyphagous (*Brachionus*, *Platyas*, *Euchlanis*) were exhibited. This complements the results of other studies (Wilk-Woźniak et al., 2001; Reynolds et al., 2002; Krylov, 2005; Devercelli, 2006; Lange & Makushenko, 2018; Gilbert, 2022; Bilous et al., 2024; Gavrilko, 2024). In addition, rotifers and microcrustaceans being important grazers of bacteria, detritus/organic aggregates, and phytoplankton in rivers are themselves important food for larger grazers such as large sized obligate Cyclopoida (*Cyclops*, *Megacyclops*, *Acantocyclops*, *Diacyclops*) and fish. A high proportion of mixed and genetically interpenetrating ecological groupings in the species composition and abundance of the studied watercourses shows the complexity of topical and trophic relations in planktonic communities (Salmaso & Braioni, 2008; Lazareva, 2017). Recent studies demonstrate the importance of biological interactions on lower trophic communities (Thorp & Casper, 2003; Guelda et al., 2005; Sindt & Wolf, 2021), including various types of relations between algae and invertebrates in the natural associations (Wilk-Woźniak et al., 2001; Lazareva, 2017).

Flow management of rivers has multiple benefits for humans, including flood prevention, irrigation, recreation and navigation. These changes result in heterogeneous longitudinal patterns in physical, chemical and biological descriptors. Undoubtedly, the creation of the dam construction can result in considerable changes in the natural hydrological conditions in the River Uldza and the Torey lakes (Kirilyuk V. et al., 2021; Obyazov et al., 2021; Nikitin et al., 2023) and in negative consequences for aquatic and terrestrial ecosystems (Kirilyuk et al., 2012), in particular, in the loss of diverse and unique planktonic flora and fauna of transboundary rivers of the Daursky State Nature Reserve. Any hydrotechnical operations must take into consideration protection of the existing wetlands and floodplains. Wetlands not only influence the increase of biodiversity in the river valley, but they also constitute a natural geochemical barrier (Hernandez & Mitsch, 2007). A floodplain is a critical element of the river-floodplain system providing flood mitigation, water quality improvement as well as support of temporal and spatial habitat variability, high productivity, and biodiversity (Serra-Llobet et al., 2022; Petsch et al., 2023). Previous research has proven that alterations to the natural flow regime affect the structure and function of rivers and wetlands and contribute worldwide to a loss of biodiversity (Bunn & Arthington, 2002; Allan & Castillo, 2007; Havel et al., 2009; Kentzer et al., 2010; Rolls et al., 2012).

Conclusions

Data on the planktonic community in lowland transboundary rivers reveal a high diversity of algae (134 taxa: 49 Bacillariophyta taxa, 47 Chlorophyta taxa, 18 Cyanobacteria taxa, ten Charophyta taxa, four Chrysophyta species, four Euglenophyta taxa, one Cryptophyta species, one Dinophyta taxon) and invertebrates (116 taxa: 64 Rotifera taxa, 35 Cladocera taxa, 17 Copepoda taxa). Potamoplankton was represented by 123 taxa of phytoplankton and 105 taxa of zooplankton in the River Uldza, with 37 taxa and 25 taxa respectively in the River Imalka. The aquatic biota structure depicted by the prevailing organisms of medium size lacking specialised traits and non-flagellated organisms with siliceous exoskeletons in phytoplankton as well as filter feeders and littoral and phytophilic species in zooplankton. There were considerable seasonal variations in plankton composition and density with summer and autumn peaks. The spring and autumn plankton communities comprised of extra-large unicellular non-flagellates and filter-feeders with various body sizes. In phytoplankton, codons MP (epiphytic and epilithic algae species that prefer frequently stirred up, inorganically turbid shallow waterbodies) and X1 (algae, that prefer shallow, eu-hypertrophic environments) as well as in zooplankton, littoral and phytophilic species and primary filter-feeders and collector-gatherers dominated. In the summer, both unicellular and colonial and filamentous species were numerous. The highest densities of codons H1, TC, X1, F, and J and microphagous to macrophagous algivores and polyphagous were exhibited.

This study provides a baseline understanding of lower trophic communities (phytoplankton and zooplankton) in the drying out lowland rivers of Transbaikalia (Russia) that will contribute to understanding responses of lotic ecosystems associated with a changing climate, landscape, and species assemblage. We believe the creation of the dam construction on the River Uldza can result to negative consequences for riverine ecosystems and contributes to a loss of aquatic biota diversity.

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Supporting Information

Data on the phytoplankton and zooplankton species lists in the studied watercourses may be found in the **Supporting Information**.

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РАЗНООБРАЗИЕ ГИДРОБИОНТОВ РАВНИННЫХ ВОДОТОКОВ (НА ПРИМЕРЕ ТРАНСГРАНИЧНЫХ РЕК ЗАБАЙКАЛЬЯ, РОССИЯ)

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Планктонные сообщества играют важную роль в водных экосистемах, включая и реки. Однако организмы планктона в лотических системах изучаются фрагментарно. Данные исследования проводились на трансграничных реках Улдза и Ималка, протекающих по территории Даурского государственного природного биосферного заповедника (Забайкалье, Россия), в годы начала и последующего увеличения речного стока (2020–2022 гг.). Гидробионты (водоросли, цианобактерии, коловратки и ракообразные) в изученных водотоках обследовались впервые. Были проведены исследования видового и функционального разнообразия, а также сезонных сукцессий фитопланктона и зоопланктона данных водотоков. Общий видовой список потамопланктона включал 134 таксона фитопланктона (Bacillariophyta (49 таксонов) > Chlorophyta (47 таксонов) > Cyanophyta (18 таксонов) > Charophyta (10 таксонов) > Chrysophyta (4 таксона) = Euglenophyta > Cryptophyta (1 таксон) = Dinophyta) и 116 таксонов зоопланктона (Rotifera – 64 таксона, Cladocera – 35 таксонов, Copepoda – 17 таксонов). В фауне также обнаружены коловратки из Bdelloida и ювенильные стадии Copepoda и Anostraca, идентификация которых не представляется возможным. Основу альгофлоры и фауны беспозвоночных формировали космополитные виды (68% и 61% от общего видового состава, соответственно). Функциональное разнообразие планктонных сообществ определяли 19 функциональных (FG_{ph}) и 7 морфофункциональных ($MBFG_{ph}$) групп фитопланктона и 17 функциональных групп зоопланктона (FG_{zoo}). В фитопланктоне в видовом составе и по численности преобладали кодоны MP (эпифитные, эпилитные и планктоне виды, предпочитающие часто взбаламучиваемые мелководные с высокой мутностью водоемы) и X1 (виды, предпочитающие мелководные эвтрофно-гипертрофные водоемы, устойчивые к расслоению, чувствительные к дефициту биогенных веществ) и группы IV (водоросли среднего размера без специализированных признаков) и VI (без жгутиков с кремнистым экзоскелетом). В зоопланктоне наиболее разнообразными и обильными были представители литорального и фитофильного комплексов, по типу питания – фильтраторы, по типу локомоции – виды, сочетающие плавание и ползание. *Plationus polyacanthus* (Rotifera) и *Megafenestra aurita* (Cladocera) были впервые найдены в фауне Забайкальского края. Для фитопланктона и зоопланктона р. Улдза характерны сезонные вариации видового разнообразия и количественных характеристик. В фитопланктоне по численности и биомассе доминировали Cyanobacteria, Chlorophyta и Bacillariophyta. При этом пик Cyanobacteria (виды рода *Anabaena*, *Coelomoron pusillum*, *Gloeocapsa minima*, *G. minor*) и Chlorophyta (*Monoraphidium griffithii*, *Willea apiculata*, *W. irregularis*) приходился на лето, а пик Bacillariophyta (*Ulnaria ulna*) – на весну и осень. Весной в зоопланктоне превалировали личиночные стадии Copepoda и Аnoctraca, в середине лета – Rotifera (*Trichocerca elongata*, *Hexarthra mira*, *Euchlanis dilatata*) и осенью – Chydoridae (*Chydorus sphaericus*, *Pleuroxus aduncus*, *Coronatella rectangula*). Полученные результаты в дальнейшем станут основой для всестороннего исследования трансграничных рек с целью изучения биоразнообразия и оценки воздействия антропогенной деятельности (строительство гидросооружений) и климатических факторов (интенсивность и продолжительность паводков) на сообщества водных организмов.

Ключевые слова: Cladocera, Copepoda, Cyanobacteria, Rotifera, видовой состав, водоросли, река Ималка, река Улдза