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the basin of Belchia brook east of Gheorgheni, in the vicinity of Voşlăbeni and Izvoru Mureşului, in the Racului valley, in the vicinity of Frumoasa, Mihăileni, Livezi, in the valley of Fişag, in the Sânmartin, Ciucsângeorgiu, Armăşeni sectors and in the south of the Ciuc Depression in the areas of Tuşnad şi Lăzăreşti.

Adopting a new legislation in the last two decades and finding the proper instruments for the protection and conservation of the ecosystems was a big accomplishment. But regardless improper exploitation is still practiced. In the last decade finally new reforestation activities were engaged vith spruce, fur, pine and beech species.

Among the spontaneous flora of the Giurgeu-Ciuc system we have to enumerate some endangered endemic species like *Betula humilis* şi *Betula nana, Salix aurita, Viola epipsila L.d.b., Euonymus nana M.B., Spiarea salicifolia L., Angelica palustrias L., Achillea impatiens L.* etc. Even though some faunictic elements got extinct in the region like the chamois *(Rupicapra rupicapra)* and the alpine marmot *(Marmota marmota)*, there are others which became protected within the Caliman Mountains, like the western capercaillie *(Tetrao urogallus)* and the black grouse *(Tetrao tetrix)*.

One of the most significant impacts of the human activity is manifested in the soil erosion which is mainly due to forest exploitation, intense grazing, substituting species, agricultural techniques, irrigations, fires, constructions, creating gravel pits, waste water management, general waste management, and draining swamps and marshlands etc.

CONCLUSION

The biopedogeographic characteristics of a regional system are in a close connection with the variety and manifestation of the relief (its variability in altitude, the exposure of the slopes and ridges, the presence of depressions etc.) and of the elements of the climate (expressed through climatic influences and the differences produced by the elevation of the relief, creating differentiated micro and topo climates). Based on the previously mentioned determiners the vegetation and the soil structure of the Giurgeu-Ciuc regional system presents a structure in levels, being integrated in the pattern which is characteristic to the entire extent of the Eastern Carpathians, with a well pronounced and differentiated vertical structuring which is easy to detect for even the unexperienced observers. We have to conclude, that the relationship between the human population and the natural environment represents the most important factor in the balanced evolution of the regional system Giurgeu-Ciuc [3]. The inhabiting stages, the appearance, evolution and development of the human settlements; the development of the industry and agricultural activities, the establishment and modernization of the communication and transport infrastructures and their relationship with all the other natural components are significant parts in the evolutionary stages of the geographic environment in the Giurgeu-Ciuc region.

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THE CURRENT STATE OF ZOOPLANKTON IN REMOTE COLD LAKES OF THE PECHORA DELTA (RUSSIA)

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ABSTRACT

Zooplankton plays a significant role in organic and mineral components accumulation and vertical organic matter fluxes in lake ecosystems of the Pechora delta. The composition and structure of zooplankton in four small remote tundra lakes of the Pechora delta (Russia) during the summer of 2017 were analyzed. All tundra lakes under study are characterized by low conductivity and nutrients content. A total of 82 zooplankton taxa were identified, of which the most frequently occurring ones were rotifers (*Conochilus unicornis, Notholca acuminata, Kellicottia longispina*, and *Keratella cochlearis*), cladocerans (*Bosmina longirostris, Bosmina (Eubosmina) longispina, Chydorus sphaericus, Daphnia galeata*), and copepods (*Eudiaptomus graciloides, Heterocope appendiculata*, and immature stages of copepods). Rotifers (40 species) and Cladocera (30 species) were dominant in zooplankton of the studied lakes; they were marked by the highest values of diversity and abundance. The biomass of zooplankton is formed mainly by cladocerans. The entire population is dominated by rotifers. From 8 and 49 species were found in the studied lakes (mean number =24.4±4.8). The species diversity was estimated using the Shannon-Wiener species diversity index (mean H=3.0±0.9). The quality and pollution of surface waters was assessed with the Pantle–Buck index modified by Sladecek. The obtained data on the studied lakes show that the index values vary from 1.2 to 1.6 (with an average of 1.4).

Keywords: zooplankton, Pechora delta, Arctic lakes

INTRODUCTION

The environmental conditions for organisms in Arctic freshwater ecosystems are harsh-short ice-free periods, low temperatures, high levels of ultraviolet radiation, and often low nutrient and food levels [1]. In northern regions of the Russian Arctic, a fragile balance between food chains and the self-clearing ability of water ecosystems substantially depends on zooplankton organisms. Their communities are formed in high latitudes within a short growing season, and they have species-specific preferences for habitat conditions and abiotic factors. Thus, the dynamics of these zooplankton communities reflects the development pattern of lakes and adjacent catchment areas in what concerns their spatial and temporal structure [2-4]. The Pechora delta and the

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surrounding areas belong to a specially protected zone. The objects of the oil and gas condensate complex are a source of pollution here, which have a negative effect on the unique tundra ecosystems. The data available currently on the ecological status of water bodies in the region under investigation are insufficient [5]. This study aims to provide an important contribution to our knowledge of the poorly investigated composition of zooplankton of the Pechora delta.

MATERIALS AND METHODS

The study area is located in the Polar Circle, within the Pechora delta, at the territory of the Nenets Nature Reserve. The Pechora River has mixed nourishment with the predominance of snow component (up to 75%) and is characterized by the prolonged period of spring-summer high water [6]. The climate is continental, with extremely low temperatures in winter (from -45 to -50°C). In summer, the average temperature reaches 17°C, with maximum up to 30°C. Rainfall depends very much on the geographical location, varying from 500-550 mm in the tundra zone. Of these, only 30-40% falls on the winter season. Plant communities are represented by a closed layer of mosses and lichens and a thin shrub-grass layer [7].

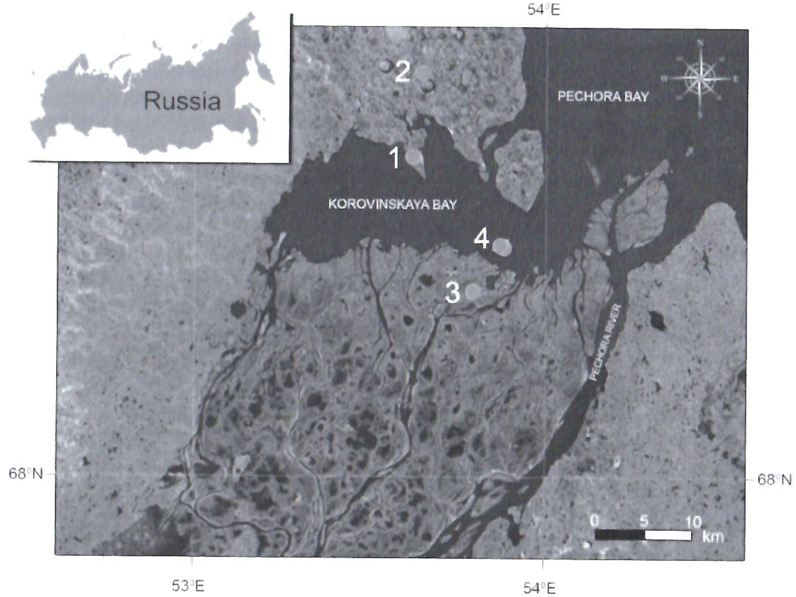

Fig.1 Location of study area (Pechora Delta River, 2017)(1- 17-Pe-01, 2- 17-Pe-02, 3- 17-Pe-03, 4- Lake on Kashin Island)

A total of 11 qualitative and quantitative zooplankton samples were collected from 4 lakes (Fig. 1) in the Pechora delta (68°17′N, 058°43′E) during the summer expeditions with colleagues from the Institute of Biology of the Komi Science Centre, Ural Branch, Russian Academy of Sciences. Zooplankton samples were collected in the deepest parts of the lakes either by filtering 100 l of water through plankton nets (with diameter of 25 cm and mesh size of 100 μm) from a rubber dinghy, or by tossing a net attached to a line out into a lake and then pulling it slowly to the shore. The obtained samples were preserved using either 4% neutral formalin or 70% alcohol. All zooplankton individuals were identified to species. Their molting stage was determined. The naupliar stages of Cyclopoida and Calanoida were counted separately without species identification. Identifications were based on zooplankton and subfossil Cladocera keys [8-15]. Zooplankton abundance (ind. / m³) and biomass (mg / m³) were calculated for each species, for different age stages, for principal taxa, and for the total of organisms in each quantitative sample. Identifications were based on zooplankton and subfossil Cladocera keys.. The species diversity was estimated with the Shannon-Wiener species diversity index. The quality and pollution of surface waters was assessed with the Pantle–Buck index modified by Sladecek and the Zelinka–Marwan index. The similarity between species of the studied lakes has been measured with the Jaccard index.

RESULTS

In the present study, 82 zooplankton species were recorded, of which there were 40 rotifer species (13 families with Brachionidae, Synchaetidae, and Trichocercidae having the highest diversity), 12 copepod species (4 families with Cyclopidae having the highest diversity), and 30 cladoceran species (9 families with Chydoridae and Daphniidae having the highest diversity) in four lakes under study (Table 1).

Table 1 The species composition and distribution of zooplankton in four lakes of the Pechora delta

Species	**Lake on Kashin Island**	**17-Pe-01**	**17-Pe-02**	**17-Pe-03**
ROTIFERA				
Asplanchna priodonta (Gosse, 1850)	+	+	+	
Bipalpus hudsoni (Imhof, 1891)	+		+	
Brachionus angularis (Gosse, 1851)	+		+	
Br. calyciflorus (Pallas, 1766)			+	
Br. diversicornis (Daday, 1883)			+	
Br. quadridentatus (Hermann, 1783)	+		+	
Cephalodella gibba (Ehrenberg, 1830)	+	+		+
Colurella obtuse (Gosse, 1886)	+			
Conochilus unicornix (Rousselet, 1892)	+	+	+	
Dicranophorus robustus (Harring, 1928)	+			
Euchlanis lyra (Hudson, 1886)	+			
E. meneta (Myers, 1930)	+	+	+	
E. dilatata (Ehrenberg, 1832)	+			

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Filinia cornuta (Weisse, 1847)			+	
F. longiseta (Ehrenberg, 1834)	+		+	
Gastropus stylifer (Imhof, 1891)			+	
Kelicottia longispina (Kellicott, 1879)	+	+	+	
Keratella cochlearis (Gosse, 1851)	+	+	+	
K. quadrata (Muller, 1786)	+		+	
Lecane luna (Müller, 1776)	+	+		
L. lunaris (Ehrenberg, 1832)	+		+	
Lepadella ovalis (Müller, 1786)	+			
Notholca acuminata (Ehrenberg, 1832)	+	+	+	
N. caudata (Carlin, 1943)	+			
N. labis (Gosse, 1887)	+			
Plaesoma truncatum (Levander, 1894)			+	
Polyarthra dolichoptera (Idelson, 1925)	+			
P. major (Burckhardt, 1900)		+	+	+
P. vulgaris (Carlin, 1943)	+		+	+
Synchaeta pectinata (Ehrenberg, 1832)	+	+	+	
Testudinella mucronata (Gosse, 1886)	+			
T. patina (Hermann, 1783)	+	+		
Trichocerca capucina (Wierzejski,1893)			+	
Tr. cylindrica (Imhof, 1891)	+		+	
Tr. pusilla (Jennings, 1903)	+		+	
Tr. rattus (Müller, 1776)	+			
Tr. similis (Wierzejski, 1893)	+		+	
Tr. taurocephala (Hauer, 1931)	+			
Tr. weberi (Jennings, 1903)	+		+	
Tr. truncata (Whitelegge, 1889)	+			
CLADOCERA				
Acroperus harpae (Baird 1834)	+			
Alona affinis (Leydig, 1860)	+			
A. costata (Sars, 1962)	+			
A. guttata (Sars 1862)	+			
Alonopsis elongatus (Sars, 1862)	+			
Bosmina coregoni (Baird, 1857)	+		+	
B. longirostris (Muller, 1785)	+	+	+	+
B. longispina (Leydig, 1860)	+	+	+	+
Bythotrephes crassicadus (Sars, 1890)	+			
Ceriodaphnia pulchella (Sars, 1862)	+			
C. quadrangula (Müller, 1785)	+			
C. megops (Sars, 1862)	+			
Chydorus ovalis (Kurz, 1874)	+	+		
Ch. sphaericus (Muller, 1785)	+	+	+	+
Daphnia cristata (Sars, 1862)	+		+	
D. cucullata (Sars, 1862)	+			
D. galeata (Müller, 1776)	+	+	+	+
Diaphanosoma brachyurum (Lievin, 1848)	+			
Disparalona rostrate (Koch, 1841)	+			+
Eurycercus lamellatus (Müller, 1776)	+			

Holopedium gibberum (Zaddach, 1855)		+		
Ilyocryptus agilis (Kurz, 1878)	+			
Leptodora kindtii (Focke, 1844)	+			
Limnosida frontosa (Sars, 1862)	+	+	+	
Monospilus dispar (Sars, 1861)	+			
Pleuroxus truncates (Müller, 1785)	+			
P. uncinatus (Baird 1850)	+			
Polyphemus pediculus (Linnaeus 1761)	+			+
Rhynchotalona falcate (Sars, 1861)	+			
Sida cristallina (Müller, 1776)	+	+		+
COPEPODA	+			
Cyclops furcifer (Claus, 1857)			+	
C. vicinus (Uljanin, 1875)			+	
Diacyclops bicuspidatus (Claus, 1857)		+	+	
Eucyclops serrulatus (Fischer, 1851)	+			
Eudiaptomus graciloides (Lilljeborg,1888)	+	+		+
Eurytemora affinis (Poppe, 1880)	+			
E. lacustris (Poppe, 1887)	+		+	
Heterocope appendiculata (Sars, 1863	+	+		+
Mesocyclops leuckarti (Claus, 1857)	+		+	
Moraria duthiei (Scott T. & A., 1896)	+			+
Pesceus schmeili (Mrazek, 1893)	+			
Thermocyclops oithonoides (Sars, 1863)	+			

The highest species diversity was registered in the lake on Kashin Island (73 species). The lowest diversity of species (13 species) was found in the 17-Pe-03 lake. The most frequently occurring were rotifers (*Conochilus unicornis*, *Notholca acuminata*, *Kellicottia longispina*, and *Keratella cochlearis*), cladocerans (*Bosmina longirostris*, *Bosmina (Eubosmina) longispina*, *Chydorus sphaericus*, and *Daphnia galeata*), and copepods (*Eudiaptomus graciloides*, *Heterocope appendiculata*, and immature stages of copepods). Brachionidae, Synchaetidae, Trichocercidae, Cyclopidae, and Daphniidae were the families with highest diversity. The obtained data show that rotifers account for 64% of the total zooplankton abundance, while cladocerans and copepods for 20 and 16%, respectively. The average value of zooplankton abundance in the lake was 138.79 thousand ind./m^3. *Brachionus angularis*, *Keratella cochlearis*, and *Chydorus sphaericus* were dominant in terms of abundance. The average biomass of zooplankton of the Pechora delta was 1747.04 mg/m^3. Cladocerans, especially large *Limnosida frontosa* and *Polyphemus pediculus*, accounted for 76 % of the total biomass, and copepods and rotifers for 22 % and 2 %, respectively. *Diacyclops bicuspidatus* also appeared to be dominant by biomass. A high peak of abundance and biomass was observed in the pelagic zone of the 17-Pe-02 lake. In this lake, high abundance values were recorded for rotifers (*Asplanchna priodonta*, *Brachionus angularis*, and *Keratella cochlearis)*. The biomass was high for cladocerans (*Chydorus sphaericus*, *Limnosida frontosa*) and copepods (*Diacyclops bicuspidatus*).

The Shannon-Wiener index was calculated. The results of the calculation show that the lake lies on the border between pure and moderately polluted waters (mean H=3.0±0.9).

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According to the Pantle–Buck index modified by Sladecek and the Zelinka–Marwan index, the studied lakes are β-mesosaprobic (1.4) and oligosaprobic with deviation in the β-mesosaprobic zone. The similarity between species of the lakes based on to the Jaccard index is 27%. The communities were dominated by widespread zooplankton species with Holarctic and Palearctic organisms were represented approximately in equal proportions. According to the biotopic distribution, planktonic species represent 55% of the specific composition. Littoral (29%) and eurytopic (16%) species were represented in a smaller quantity.

CONCLUSIONS

The composition and structure of zooplankton have been studied in four small remote tundra lakes in the Pechora delta during the summer period of 2017. The study area is located in the Polar Circle, within in the Pechora delta, at the territory of the Nenets Nature Reserve. In northern regions of the Russian Arctic, a fragile balance between food chains and the self-clearing ability of water ecosystems substantially depends on zooplankton organisms. A total of 82 zooplankton taxa (40 rotifer taxa, 30 cladoceran taxa, and 12 copepod taxa) from the investigated lakes were identified. Rotifers were most abundant. Cladocerans were dominant based on biomass. The biomass depended mainly on cladocerans (*Limnosida frontosa* and *Polyphemus pediculus*). *Brachionus angularis*, *Keratella cochlearis*, and *Chydorus sphaericus* determined the total abundance. The composition of zooplankton species was richer in the lake on Kashin Island and lower in the 17-Pe-03 lake. Rotifers, such as Brachionidae, Synchaetidae, and Trichocercidae, were characterized by the highest diversity. The investigated lakes are clean or moderately polluted, β-mesosaprobic and oligosaprobic with deviation in the β-mesosaprobic zone. Zooplankton was dominated by species with a wide distribution area.

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