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Short Communication

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THE SEASONAL POPULATION DYNAMICS OF THE CYCLOPOID COPEPODS (CYCLOPOIDA, CYCLOPIDAE) IN PONDS OF KYIV REGION (UKRAINE)

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The Seasonal Population Dynamics of the Cyclopoid Copepods (Cyclopoida, Cyclopidae) in Ponds of Kyiv Region (Ukraine). Gaponova, L. P. — The seasonal variation of faunistic complexes of cyclopids has been monitored over 2007–2010 in ponds of tributary of the Vita River. The results of our investigation showed that eurythermal complex of cyclopid species dominated in all seasons except for summer period. In contrast to the previous studies, in summer period warm-water stenothermal complex of cyclopid species were the most abundant and reached the highest cyclopid numbers.

Key words: Cyclopidae, Copepoda, seasonal dynamics, warm-water stenothermal species, eurythermal species, Ukraine.

Сезонная динамика популяций циклопоидных копепод (Cyclopoida, Cyclopidae) в прудах Киевской области (Украина). Гапонова Л. П. — Сезонная смена фаунистических комплексов циклопид прослежена в прудах на притоке реки Вита за период 2007–2010 гг. Результаты наших исследований показывают, что комплекс эвритермных видов циклопид доминировал во все сезоны года кроме летнего периода. В отличие от результатов предыдущих исследований тепловодные стенотермные виды в летние месяцы были наиболее многочисленными и достигали наибольших численностей среди циклопид.

Ключевые слова: Cyclopidae, Copepoda, сезонная динамика, тепловодные стенотермные виды, эвритермные виды, Украина.

Introduction

Cyclopoid copepods have invaded a variety of aquatic environment and microhabitats. Although cyclopids in artificial water bodies have been studied over 130 years (Reid, 2001), investigations of these organisms are sparse worldwide.

In Ukraine, there are only few former faunistic data concerning cyclopoid copepods in human-modified and artificial habitats (Grebnitskii, 1873–1874, Sovinskii, 1888). More detailed study on cyclopids of these types of habitats, such as different type of ponds, was carried out in 1950s (Monchenko, 1962). Among them there were water bodies of tributary of the Vita River (Kyiv Region, Ukraine) which were modified to ponds after reconstruction in 2000s.

This paper describes the results of the study of artificial ponds of the Vita River tributary. Species composition, variation of faunistic complexes and cyclopid numbers were investigated and compared with the data of previous investigation in 1956 (Monchenko, 1962).

Material and methods

The material was collected in five artificial ponds of the Feofaniya Park and in the pond near the village Khotov in the vicinity of Kyiv (Ukraine). These six ponds are the components of one water system — a tributary of the Vita River which is the right tributary of the Dnipro River (Ukraine). All ponds have maximum depth of 3 m.

Zooplankton samples were collected at monthly intervals from May 21, 2007 to July 22, 2009 in ponds of the Feofaniya Park and from April 22 to October 14, 2010 in the pond near the village Khotov. The water volume of studied ponds was filtered using mesh net from one meter depth up to the water surface. Each sample was concentrated with a 70 μm mesh net and preserved in glass jars with 4 % formalin or 95 % alcohol.

The cyclopoid copepods were counted under a dissecting microscope SZM–45T2 using standard counting method (Methodological…, 1984). The specimens of cyclopids were identified under Olympus BX51 Microscope. Identification to the species level was done on the basis of the current keys (Monchenko, 1974).

Results and discussion

Nineteen species of cyclopoid copepods were recorded in ponds of tributary of the Vita River of Kyiv Region (table 1). Besides nine species that were registered in the previous investigation (Monchenko, 1962), we found ten more species — *Cryptocyclops bicolor* Sars, 1963, *Cyclops kikuchii* Smirnov, 1932, *Cyclops furcifer* Claus, 1857, *Eucyclops denticulatus* (Graeter, 1903), *Eucyclops macrurus* (Sars, 1863), *Eucyclops speratus* (Lilljeborg, 1901), *Ectocyclops phaleratus* (Koch, 1838), *Macrocyclops fuscus* (Jurine, 1820), *Thermocyclops oithonoides* (Sars, 1963), *Thermocyclops crassus* (Fischer, 1853). One species, recorded earlier — *Acanthocyclops viridis* (Jurine, 1820), was not found in our samples.

According to the literature (Flößner, 1985), in inland waters at the temperature conditions of temperate regions, three faunistic complexes of cyclopids could be distinguished: eurythermal, cold-water-stenothermal and warm-water stenothermal. In our study, two faunistic complexes were recorded: eurythermal species and warm-water stenothermal species.

In contrast to the previous study (Monchenko, 1962), the warm-water stenothermal cyclopid complex was the most abundant. This faunistic complex included six species of cyclopids. Among them one species (*Me. leuckarti*) was registered in previous investigation (table 1), and five more species were found — *Cr. bicolor*, *Eu. macrurus*, *Ec. phaleratus, T. oithonoides*, *T. crassus*.

The eurythermal cyclopid complex was the most numerous and included thirteen species. Besides five species (*A. vernalis*, *A. americanus*, *D. bicuspidatus, Eu. macruroides, Eu. serrulatus*) registered in the previous investigation (Monchenko, 1962), we found eight more species — *Cy. kikuchii, Cy. vicinus*, *Cy. furcifer, Eu. denticulatus*, *Eu. speratus*, *Ma. albidus*, *Ma. fuscus, P. fimbriatus* (table 1). The species *A. viridis* did not occur throughout the study period. However, it was recorded in the previous study (Monchenko, 1962).

Table 1. Species composition of cyclopids in the ponds on tributary of the Vita River

Таблица 1. Видовой состав циклопид прудов на притоке реки Вита

1956	2007–2009
Acanthocyclops vernalis (Fischer, 1853), *A. americanus* (Marsh, 1893), *A. viridis* (Jurine, 1820)	*Acanthocyclops vernalis* (Fischer, 1853), *A. americanus* (Marsh, 1893)
Cyclops vicinus Uljanin, 1875	*Cyclops kikuchii* Smirnov, 1932, *Cy. vicinus* Uljanin, 1875 *Cy. furcifer* Claus, 1857
—	*Cryptocyclops bicolor* Sars, 1963
Diacyclops bicuspidatus (Claus, 1857)	*Diacyclops bicuspidatus* (Claus, 1857)
Eucyclops macruroides (Lilljeborg, 1901), *Eu. serrulatus* (Fischer, 1851)	*Eucyclops denticulatus* (Graeter, 1903), *Eu. macruroides* (Lilljeborg, 1901), *Eu. macrurus* (Sars, 1863), *Eu. serrulatus* (Fischer, 1851) *Eu. speratus* (Lilljeborg, 1901)
—	*Ectocyclops phaleratus*
Macrocyclops albidus (Jurine, 1820)	*Macrocyclops albidus* (Jurine, 1820), *Ma. fuscus* (Jurine, 1820)
Mesocyclops leuckarti (Claus, 1857)	*Mesocyclops leuckarti* (Claus, 1857)
—	*Thermocyclops oithonoides* (Sars, 1963), *T.crassus* (Fischer, 1853)
Paracyclops fimbriatus (Fischer, 1853)	*Paracyclops fimbriatus* (Fischer, 1853)

The seasonal variation of cyclopoid copepods complexes has been monitored over four years (2007–2010) in the ponds of tributary of the Vita River (Kyiv Region, Ukraine). The seasonal changes in water temperature in ponds ranged from 0 °C to 27 °C. In summer, water temperature ranged from 21 to 27 °C. From August to December (2007–2010), water temperature gradually decreased to 1 °C. In winter the surface of studied ponds was covered with ice and snow. In winter, water temperature in studied ponds ranged from 0 °C to 3 °C. After the ice break, water temperatures gradually increased up to 18 or 22 °C in May.

In winter some species of the eurythermal complex, such as *Cy. vicinus*, *Cy. kikuchii*, *Cy. furcifer*, *D. bicuspidatus*, *Eu. macruroides*, *Eu. serrulatus*, and *Ma. albidus* were registered. Among them, some cyclopid species (*Cy. vicinus*, *Cy. kikuchii*, and *D. bicuspidatus*) were dominant. Other species (*Eu. macruroides*, *Eu. serrulatus*, and *Ma. albidus*) were found only in a small number in the winter period.

In the present study we confirmed that some species *(Cy. vicinus*, *Cy. kikuchii*, and *D. bicuspidatus)* were registered in all seasons except summer in a wide range of temperatures: *Cy. vicinus* — 0 °C to 23 °C (according to Röben, 1970 — 2,5 °C to 23 °C), *Cy. kikuchii* — 0 °C to 6 °C (according to Monchenko, 1974 — 3 °C to 21 °C), *D. bicuspidatus* — 0 °C to 18 °C (according to Monchenko, 1974 — 2 °C to 23 °C), but these species had a population peak in the winter period with water temperatures between 0 °C and 3 °C.

In winter we observed the reproduction period of these species. The egg-bearing females of *Cy. kikuchii* and *D. bicuspidatus* were abundant in December (2007–2010). The densities of juvenile individuals of both copepods were high in January (2007–2010). The density of *Cy. vicinus* females increased in December–January (2007–2010). In February (2007–2010) high densities of egg-bearing females of *Cy. vicinus* and juvenile individuals were registered. According to the previous investigation, the species *Cy. vicinus* was found in the winter period only in a small number, and the reproduction period with population peak of this species was registered in March (Monchenko, 1962).

The analysis of our samples (2007–2010) showed that the abundance of some species (*Cy. vicinus*, *Cy. kikuchii*, and *D. bicuspidatus*) was decreasing from April to June; these species nearly disappeared from the water column in June. According to the literature data (Kobari, Ban, 1998) the species *Cy. vicinus* disappeared from the water column from the late June to October, because this species had the diapause stage in the summer period.

In contrast to the previous research (Monchenko, 1962), in summer period (2007–2010) *D. bicuspidatus* was not recorded in water column but it was found in a small number from October to late March. We observed that species *Cy. kikuchii* disappeared from the water column from late March to November (2007–2010). In our study the species *Cy. furcifer* was present only for short period: in late November 2008.

At the beginning of spring we observed that species which reproduce during warm season began to increase in number in water column. Among them, *Eu. macruroides* and *Eu. serrulatus* were the most abundant. In late March, adults of *Eu. macruroides, Eu. serrulatus*, *Ma. albidus* that developed from arousal CVs (the fifth stage copepodite) started to reproduce until mid of June and two increases of copepodite stage densities occurred in the water column (in mid of April and in late June). Other species of the eurythermal complex such as *A. americanus* was recorded in spring in small number. *Paracyclops fimbriatus* was present only for a short period: at the end of June 2008.

During the subsequent water heating warm-water eurythermal species are replaced by warm-water stenothermal species — *Cr. bicolor, Ec. phaleratus, T. oithonoides, T. crassus, Me. leuckarti, Eu. macrurus.* Among them the key species was *T. oithonoides*. This species occurred from late May to late October in the water temperature interval 9–25 °C and was the most abundant in June-August (in the water temperature interval 23–25 °C). In summer *T. oithonoides* was dominant species throughout the study period in ponds. Other warm-water-stenothermal species *Me. leuckarti* occurred from late March to late October in the water temperature interval 7–25 °C. Both *T. oithonoides* and *Me. leuckarti* were abundant in summer 2008. In 2007 and 2009 *Me. leuckarti* was found in small number. Other species of cyclopids were present only for short period: *Cr. bicolor* and *T. crassus* at the end of March 2008 in water temperature 8 °C; *Eu. speratus* — in June 2008, *P. fimbriatus* — at the end of June. *Ec. phaleratus* occurred in 2008 from late June to late September in the water temperature interval 14–24 °C and its population density was low that is typical of this species (Monchenko, 1974). The species *Eu. macrurus* occurred in 2007 and was numerous in May.

We revealed that in summer dominant faunistic complex which according to previous investigation (Monchenko, 1962) had been represented by eurythermal cyclopoid copepods was replaced with the warm-water stenothermal complex of cyclopid species. This complex of species was the most abundant in June-August. The replacement of the eurythermal complex with the warm-water stenothermal complex of cyclopid species in summer may relate with creation of shallow, slow-moving and well-warmed water bodies on the tributary of the Vita River.

In late August, the warm-water stenothermal species complex was supplemented with eurythermal cyclopoid copepods, such as *Eu. denticulatus*, *Eu. macruroides*, *Eu. serrulatus*, *Ma. albidus*. The densities of polycyclic such species as *Eu. macruroides*, *Eu. serrulatus* increased again and the adults reproduced. The species *Eu. denticulatus* occurred from late August to late October in water temperature interval 9–22 °C that justified the data on eurythermicity of this species (Šramek-Hušek, 1954). In late October, densities of such eurythermal cyclopoid copepods as *Cy. vicinus*, *Cy. kikuchii*, *Cy. furcifer*, *D. bicuspidatus* increased again but warm-water stenothermal species disappeared from the water column.

The results of our investigation showed that seasonal variations of faunistic complexes were related to cyclopid numbers. Cyclopids were found to reached high population densities during the summer, with maximum cyclopid numbers of 21.6×10^3 ind/m^3 and 22.8×10^3 ind/m^3 (fig. 1) when warm-water stenothermal faunistic complex was dominating. Two distinct population peaks were observed: at the end of June and in mid-August.

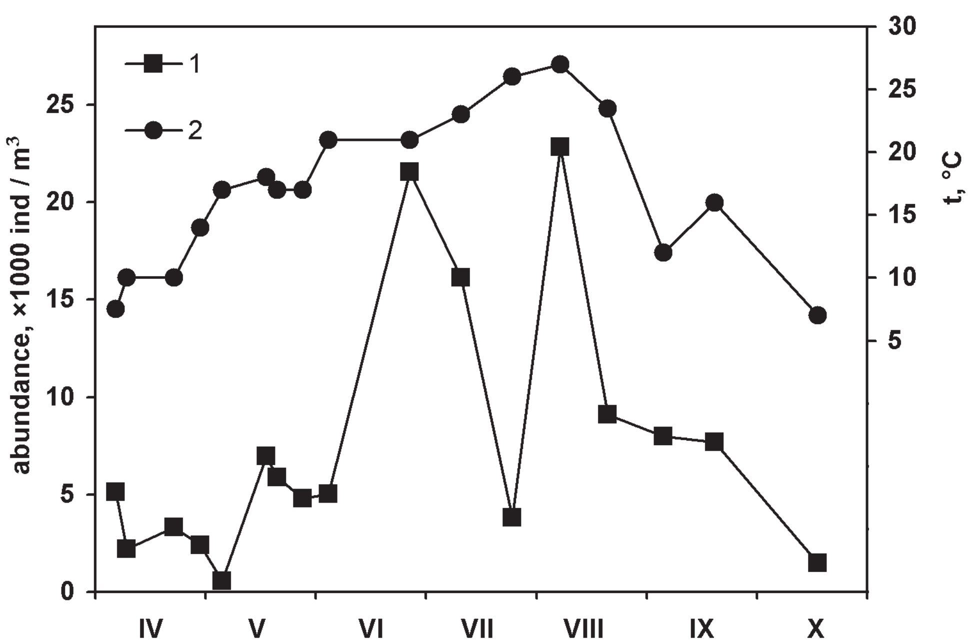

Fig. 1. Seasonal population dynamics of the cyclopids in the pond near the village Khotov: 1 — abundance of cyclopids; 2 — water temperature of pond near the village Khotov during the period of the study.

Рис. 1. Сезонная динамика циклопид в Хотовском пруду: 1 — численность циклопид; 2 — температура воды в пруду близ с. Хотов в течение изучаемого периода.

Cyclopid numbers remained low until June; the numbers increased thereafter and peaked at the end of June (fig. 1). The main species were *T. oithonoides* and *Me. leuckarti*. In July, the number of cyclopids declined because density of dominant species, *T. oithonoides* and *Me. leuckarti*, decreased during the month. Cyclopid numbers steadily declined from mid-August to October with gradual decreasing of water temperatures from 26 °C to 9 °C. The present analysis confirmed the existence of well recognized seasonality of cyclopids.

Conclusion

Thus, according to the results of previous investigation (Monchenko, 1962), eurythermal cyclopoid copepods were dominant species in all seasons. The results of our investigation showed that eurythermal species of cyclopids dominated during winter, spring and autumn months. In summer, warm-water stenothermal species were the most numerous species of cyclopids. The replacement of eurythermal complex with the warm-water stenothermal complex of cyclopid species in summer may be related to the creation of shallow, slow-moving and well-warmed water bodies on the tributary of the Vita River. It was recorded that the main species were *T. oithonoides* and *Me. leuckarti*. Our results showed that cyclopids reached high population densities during the summer 2010, with maximum cyclopid numbers of 21.6×10^3 ind/m^3 and 22.8×10^3 ind/m^3 at the end of June and in mid-August when warm-water stenothermal species (*T. oithonoides* and *Me. leuckarti*) dominated.

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