Cladocera, Ostracoda and Copepoda assemblages in different side-arms of the Danube in Gemenc floodplain (Danube-Dráva National Park, Hungary).

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Keywords: microcrustacean assemblages, Danube, river-floodplain system

Introduction

The Gemenc floodplain (river km 1497-1467) is one of the last remaining extensive inundated floodplain of the Danube. Due to the river regulation works in the 19th century this area have changed, the floodplain remained more or less isolated from the main stream, the length of the side arms decreased and a drying-out process was observed during the 20th century. The most important human impacts, which changed the hydrological condition of the floodplain, were formerly the building-up of the drainage canals (fok-system) and later the river regulations for flood control and navigation (GUTI 2001).

Detailed analysis was accomplished in the floodplain which incorporated water chemical, algological, zooplankton and fish studies to monitor the actual condition of the floodplain and examine the river-floodplain relationships (BERCZIK 2003, DINKA 2003, GUTI 2005). The results of microcrustacean assemblages were summarized in this paper.

Methods

The study was carried out from April 2002 to October 2004. Samples were collected usually bi-monthly, from the different functional types of the floodplain hydrosytem. The ROUX (1982) system based on geomorphological, hydrological and ecological aspects was used to separate the different types. Following sampling sites were studied (see details GUTI 2001):

1. Eupotamon: The main channel of the Danube (river km 1489) with permanent flow and absence of macrophytes. The bottom is composed of stones, gravel and coarsy sand.

2. Parapotamon: The Vén-Danube (VDU) and the Rezéti-Danube (RDU) which side-arms are permanently connected to the main arm at their downstream section. Semi-stagnant floodplain waters cut off and silted up at their upstream section. In the Vén-Danube the lotic conditions (maximum 0.4 m/s) have been consolidated since 1998 after the revitalization processes. Macrophytes are scarce.

3. Plesiopotamon: 4 sites of the Grébeci-Danube (GDU). This side-arm has no permanent direct connection to the main channel. It is connected during high water level and is notably influenced by the discharge of the river. Macrophytes grow densely especially at the end of the side-arm.

4. Paleopotamon: Within this functional type the Nyéki oxbow (NYHD) and the Cserta-Danube (CSDU) were studied. These are permanent standing water bodies that were former anatomised channels or meanders, with no direct connection to the river. Macrophytes grow very densely.

5. Fok-sytem: The Sáfrány fok (SÁF) and the Cimer-fok (CIF) as drainage canals connecting the oxbow lakes and watercourses in the floodplain. These water bodies are not part of the Roux-system and were formed by the water regulation processes in the Danubian floodplains.

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These water bodies, together with the paleopotamon, are isolated in the floodplains and have no direct connection with the Danube.

During the sampling process 50 litres of water were collected in each site from the water column as well as from the macrovegetation in the paleopotamon, filtered with a 70 μm mesh net and preserved in 5% formaldehyde. Microcrustaceans were identified to species level and enumerated using an inverted microscopy. Very dense samples were subsampled. PCA analyses with transformed data was carried out using the SYN-TAX 5.1. program package (PODANI 1997). Mann-Whitney test was used to compare the diversity, taxon number and density of assemblages of the different side-arms.

Results

74 microcrustacean (38 Cladocera, 13 Ostracoda, 23 Copepoda) species were found in the different functional units (eupotamon: 20 species, parapotamon: 44, plesiopotamon: 34, paleopotamon: 45). Most of the collected species are characteristic of eutrophic, stagnant waters. *Monospilus dispar* Sars, 1962, *Pleuroxus denticulatus* Birge, 1879, *Pleuroxus uncinatus* var. *balatonicus* Daday, 1891, *Cyclops scutifer* Sars, 1863 and all 13 Ostracoda species (*Bradleycypris obliqua* (Brady, 1868), *Bradleystrandesia reticulata* (Zaddach, 1844), *Candona weltneri* Hartwig, 1899, *Cyclocypris laevis* (O. F. Müller, 1776), *Cyclocypris ovum* (Jurine, 1820), *Cypria ophtalmica* (Jurine, 1820), *Cypridopsis obesa* Brady & Robertson, 1869, *Cypridopsis vidua* (O. F. Müller, 1776), *Cypris pubera* O. F. Müller, 1776, *Notodromas monacha* (O. F. Müller, 1776), *Paracandona euplectella* (Robertson, 1889), *Physocypria kraepelini* G. W. Müller, 1903, *Pseudocandona compressa* (Koch, 1838)) are new species for this region. In 2003 *Pleuroxus denticulatus* reported as new invader species in the Danube Basin (HUDEC & ILLYOVÁ 1998), occurred at the same time in the Hungarian part of the Danube at Szigetköz and at the Gemenc floodplain. The most frequent species were *Bosmina longirostris* (O. F. Müller1785), *Chydorus sphaericus* (O. F. Müller, 1776), *Eucyclops serrulatus* (Fischer, 1851) and *Mesocyclops leuckarti* (Claus, 1857) but their relative abundance differed in the different functional types.

Significant differences were detected in the composition, diversity, relative abundance and total density of assemblages especially between the isolated floodplain sites and the eu-, para- and plesiopotamon of the Gemenc floodplain. The relative abundance of the pelagic *Bosmina longirostris* was higher in the eupotamon and gradually decreased to para-, plesio and paleopotamon ($p<0.01$) (Figure 1).

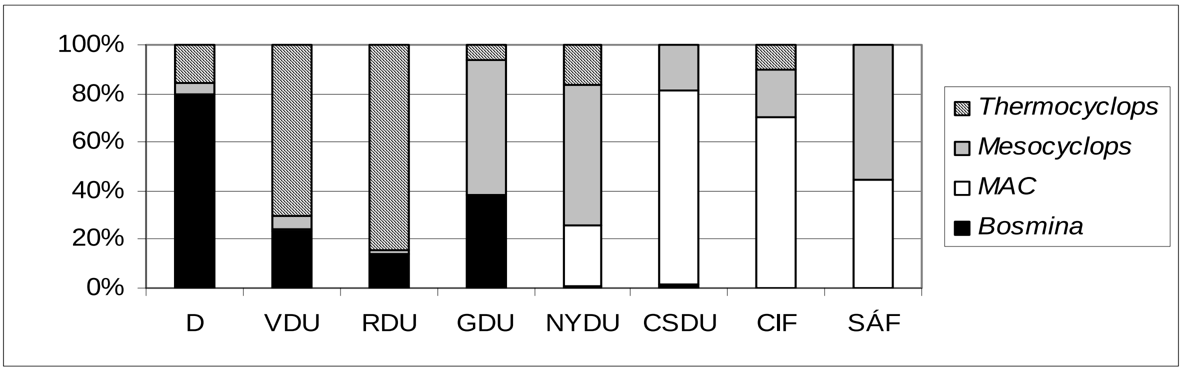

Figure 1. The relative abundance of the *Bosmina*, *Mesocyclops* and *Thermocyclops* taxa as well as the macrophyta-associated cladocerans (MAC) in the eupotamon (D), parapotamon (VDU, RDU), plesiopotamon (GDU) and the isolated floodplain sites (NYDU, CSDU, CIF, SÁF).

Opposite to that, the relative abundance of the macrophyte-associated Cladocera taxa (*Graptoleberis*, *Pleuroxus*, *Sida*, *Simocephalus*) and Ostracoda were the highest in the paleopotamon and the other isolated floodplain sites, which were the furthest and most isolated sampling sites from the Danube. The relative abundance of Copepoda species were notably higher in the para- and plesiopotamon (VDU: 75.7%, RDU: 72.1%, GDU: 78.9%) than in the isolated floodplain (CSDU: 37.7%, CIF: 34.7%) except the Nyéki oxbow (98.4%). The density peaks of copepods usually occured in spring, at high water level.

26 of the 75 species appeared only in one functional type of the river-floodplain system. *Acroperus harpae* (Baird, 1834), *Alona costata* Sars, 1862, *Alona rectangula* Sars, 1862, *Alonella excisa* (Fischer, 1854), *Ceriodaphnia megops* Sars, 1862, *Eurycercus lamellatus* (O. F. Müller, 1785), *Eucyclops macruroides* (Lilljeborg, 1901) and *Macrocyclops albidus* (Jurine, 1820) were recorded in the paleopotamon, *Alona guttata* Sars, 1862 and *Cyclops insignis* Claus, 1857 in the plesiopotamon together with *Alona quadrangularis* (O. F. Müller, 1785), *Daphnia hyalina* Leydig, 1860, *Iliocryptus sordidus* (Liévin, 1848), *Leydigia leydigi* (Schoedler, 1863), *Macrothrix hirsuticornis* Norman & Brady, 1867 and *M. laticornis* (Fischer, 1848) in the parapotamon. Three species (*Daphnia cucullata* Sars, 1862, *Diaphanosoma brachyurum* (Liévin, 1848), *Disparalona rostrata* (Koch, 1841)) appeared in the eu-, para- and plesiopotamon but they have not colonized the isolated floodplain sites.

The average taxa number was notably higher in the paleopotamon (15.4) and the fok-system (11.7) than the other river-floodplain system types (eupotamon: 4.6, parapotamon: 4.5, plesiopotamon: 5.3) ($p<0.01$). The average Shannon diversity was higher ($p<0.01$) in the isolated floodplain (NYHD: 1.34, CSDU: 1.65, CIF: 1.37, SÁF: 1.37) than in the other types and the differences were not significant between the eupotamon (0.64), parapotamon (0.84) and plesiopotamon (0.53).

The total density of assemblages ranged from 0 to 95.7 ind. dm^{-3} (highest value at Sárkány-fok, July 2003). The average density was significantly higher in the isolated floodplain sites (17.8 ind. dm^{-3}) and in the plesiopotamon-type Grébeci-Danube (14 ind. dm^{-3}) than the eu- (0.87 ind. dm^{-3}) and parapotamon (2.5 ind. dm^{-3}) ($p<0.01$).

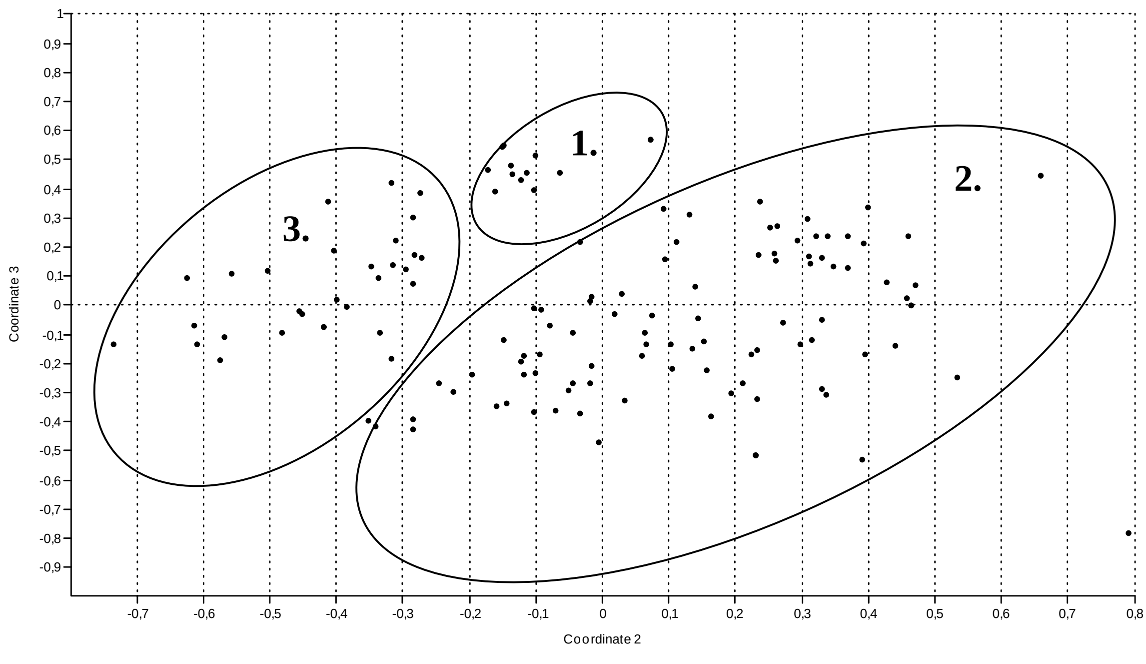

Figure 2. The PCA plot of the samples (1. main stream, 2. para- and plesiopotamon, 3. paleopotamon and the two arms of the fok-system).

In the PCA analyses three groups were discriminated and the samples were separated by the sampling sites not the date of the sampling (Figure 2.).
In the Danube (1.) *Bosmina*-dominated assemblages were formed by with low taxa number and density. The sampling sites of the para- and plesiopotamon formed the group 2. These two types were not separated distinctly because of the similar species composition with high dominance of Copepoda in the assemblages (*Thermocyclops* in the Vén- and the Rezéti-Danube, *Mesocyclops* in the Grébeci-Danube) and the shared presence of the *Diaphanosoma brachyurum* and *Moina brachiata* species. The isolated floodplain sites (3.) assemblages with high taxon richness, Shannon-diversity and total density constituted a distinct group. The number of the macrophyta-associated species and the Ostracoda species was high in these assemblages reflecting the presence of macrovegetation and the stagnant water bodies habitats.

Discussion

It was confirmed that the main factors that influenced the microcrustacean assemblages of the different hydro-morphological types of the Gemenc floodplain were the water level fluctuations and the presence of macrophytes. The water level fluctuations produce changes in the intensity of connectivity and changes between lotic and lentic hydrological conditions. In the isolated floodplain where the lentic conditions were consolidated and the macrovegetation appeared, diverse assemblages were formed. In the Slovakian part of the Danube ILLYOVÁ & NÉMETHOVÁ (2002) investigated the Cladocera and Copepoda fauna of the Danube and Morava river floodplains recording 66 taxa from the different habitats of the floodplain. They confirmed that the community composition was influenced by the type of macrovegetation and the river basin. That agree with our studies but is opposite to SCHÖLL (2004)'s investigations, who performed rotifer studies in the same sampling sites of Gemenc floodplain; he found that the species composition of Rotifer assemblages depended more on the date of sampling than the sampling sites. These differences could be explained by the differences on reproduction stategies, ecological tolerance and habitat preference between microcrustaceans and rotifers.

GULYÁS, et al (1991) examined the zooplankton assemblages of the eu- and parapotamon (Vén-Danube, Rezéti-Danube) in the Gemenc floodplain confirming that the most important differences in faunal composition is a result of hydrological events. They collected less number of taxa than us because they examined only lotic habitats, recording 19 Cladocera and 10 Copepoda species. Like in our results they found eutrophic assemblages with *Diaphanosoma brachyurum* and *Moina brachiata* at low water periods.

Bosmina longirostris was the most frequent species in the eu-, para and plesiopotamon of Gemenc, as it have been observed in other studies (BOTHÁR 1972, VRANOVSKY 1972) in the Danube; additionally we found that its abundance was extremely low in the isolated floodplain. The ratio of copepods was high in all types of the floodplain but its presence and abundance showed seasonal differences with the abundance maxima in high water periods, usually in spring. This supports results from earlier studies on the Danube floodplain system (BOTHÁR 1972, VRANOVSKY 1972) and confirmed that copepods require more stable conditions to pass through their ontogenetic development hence their adult stages are present only at high water periods.

Summary

Significant differences were observed in the composition, diversity and density of assemblages, especially between the isolated floodplain sites and the eu-, para- and plesiopotamon of the Gemenc floodplain. These differences were explained with the

differences in connectivity and the local hydrodynamical influences as well as with the presence of macrovegetation in the isolated floodplain. These results support the efforts to restore river-floodplain system and stick out the importance of the isolated floodplain in conservation of biodiversity.

Acknowledgements

This project was supported by the KVM/KAC and the OM-00371/2002 projects.

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