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# MIGRATION OF *OSTRACODA (CRUSTACEA)* IN THE FLOOD ZONE OF A BIG LOWLAND RIVER IN THE CASE OF A RAPID WATER RISE

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## SYNOPSIS

The phenomena of Ostracoda migration were investigated in the recently flooded areas during the flood in the middle course of the big River Odra (Poland). The investigation carried out within 24 h after the appearance of the flood wave included a river stretch regulated with groins. The mean density of Ostracoda from the river bed zone was 590 ind/$m^2$; from the medial zone 280 ind/$m^2$; and from the flood zone (the recently flooded area) 54 ind/$dm^2$. In the river bed zone the crawling forms of Ostracoda (Limnocythere inopinata and representatives of the genus Iliocypris) predominated while the swimming forms (Cyptiodopsis vidua, Physocypria kraepelini and Cypria ophtalmica) prevailed in the flood zone. The bottom life mode and a higher specific gravity of the crawling forms did not favour the drift in this ecological group. The swimming forms were subjected to drift to a higher degree. Apart from the swimming forms the less prone to drift crawling forms (Candonidae, Darwinula stevensoni, Iliocypeis bradyi, I. decipiens and Limnocythere inopinata) were also encountered in the flood zone. Compared with the adult forms juvenile individuals Potamocypris variegata and P. smaragdina were prone to a greater degree to colonize newly flooded areas.

## INTRODUCTION

The River Odra is 854 km in length, its basin covers 118 thousand sq kilometers and the average flow is 573m$^3$/s. The last stage of fall is found at Brzeg Dolny. Below, an almost 350km long river stretch, homogeneous in terms of hydrologic characteristics, includes the middle and lower river courses. Its homogeneity is decided by the following factors: the river banks are almost continuously covered with groins and no damming disturbs the homogeneity of this area. The groins are sufficiently long and high to form coves with gently descending bottoms between them, where the fluctuation of the water level uncovers large parts of the river bottom. In addition, the groins increase the bank storage thus creating favourable conditions for the development of fauna, also of *Ostracoda (Crustacea*).

The aim of the study was to investigate the migration capability of various *Ostracoda* taxa in newly developed habitats. The rapid water rise in the river brings about the flooding of previously uncovers zones and forms new habitats of fauna which present excellent testing grounds for the study of migratory phenomena.

## STUDY AREA AND METHODS

The investigation was carried out in an almost 350km long course of the River Odra from the village of Ścinawa to Czelin. 15 stations were uniformly positioned in the investigated river stretch whose banks are almost continuously covered with groins. In summer 2006 the water level in the River Odra was very low. A great expanse of the bottom between the groins was uncovered and this situation was maintained for a long period. Early in August 2006 in the investigated part of the River Odra the water level rapidly rose by 30-50cm daily. This situation was brought about by the heavy rainfall in the upper river course and in its tributaries. The formerly uncovered areas were flooded again and new habitats developed where the fauna of the river could migrate to. The investigation was carried out within 24h after the previously uncovers areas had been flooded. At each station samples were taken from the areas between the groins both from habitats constantly under water (the river bed zone) and from the recently flooded ones (the flood zone). A few samples were also taken from the medial zone, i.e., from that on the borderline between the river bed zone and the flood zone.

The samples were taken from the surface layer of bottom sediment using a net possessing a triangular metal rim (Meisch 2000). The samples were fixed using 70% ethanol.

Solid preparations of soft parts of *Ostracoda* body were fixed in Hydro-Matrix preparation. The identification was carried out using a key (Meisch 2000).

## RESULTS

The similarity dendrogram of Ostracoda density in different sampling zones on different sampling sites (fig. 1) grouped the sample sites in two distinct groups at the probability level exceeding 50%. The most homogeneous block forms the group at the bottom of the dendrogram (from R-Sc1 to R-Ei3) and includes the sampling sites from the river bed zone, apart from R/F-Ei2 from the middle zone. In the second group (from R-Sc2 to F-Brz3) the sampling sites from the flood zone and the medial zone predominate. Samples taken from the individual zones considerably differed by the density of Ostracoda: the mean density and standard deviation were 590 (+-1171)ind/$m^2$ from the river bed zone; 280 (+-355)ind/$m^2$ from the medial zone; and 54(+-94)ind/$m^2$ from the flood zone.

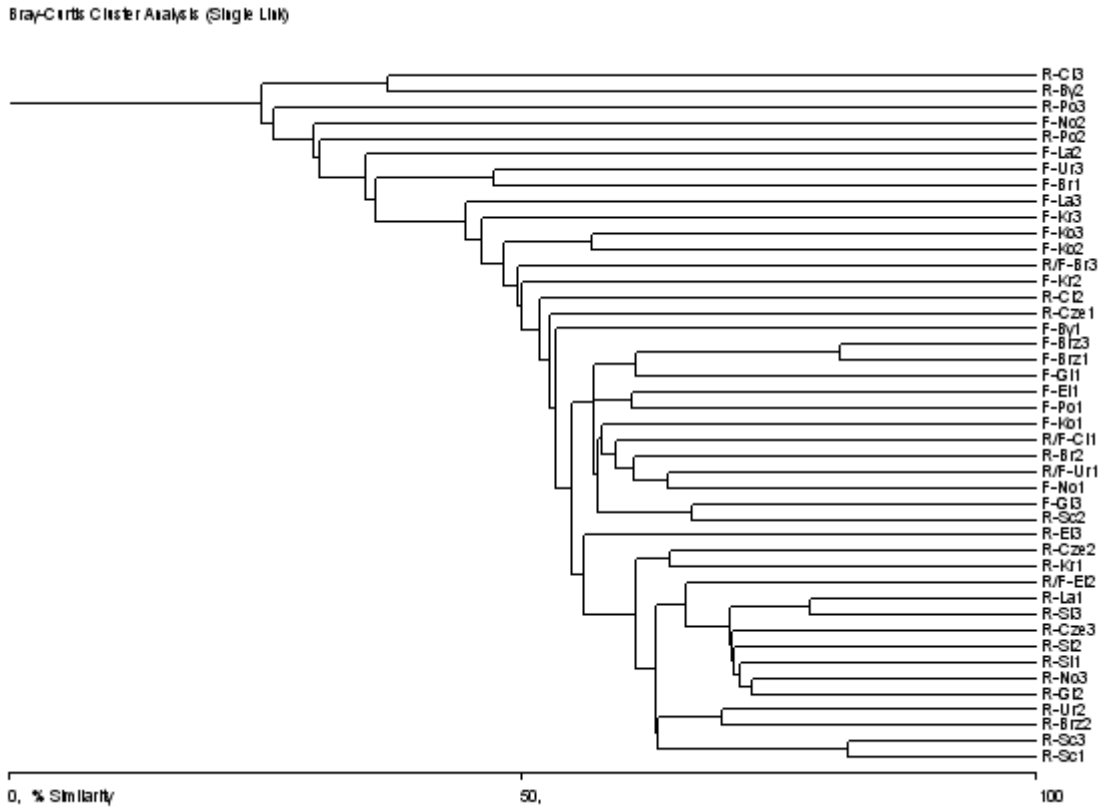



**Fig.1. Similarity dendrogram of Ostracoda density at different sampling sites in different sampling zones. R-river bed zone; F-flood zone; R/F-medial zone**

Samples taken in different zones considerably differed by the percentage participation of various Ostracoda taxa (fig.2). In the river bed zone and in the medial zone *Limnocythere inopinata* (Baird, 1843) and representatives of the genus Iliocypris predominated. The flood zone was characterized by the domination of *Cypridopsis vidua* (O.F. Müller, 1776), *Physocypria kraepelini* G.W. Müller, 1903 and *Cypria ophtalmica* (Jurine, 1820).

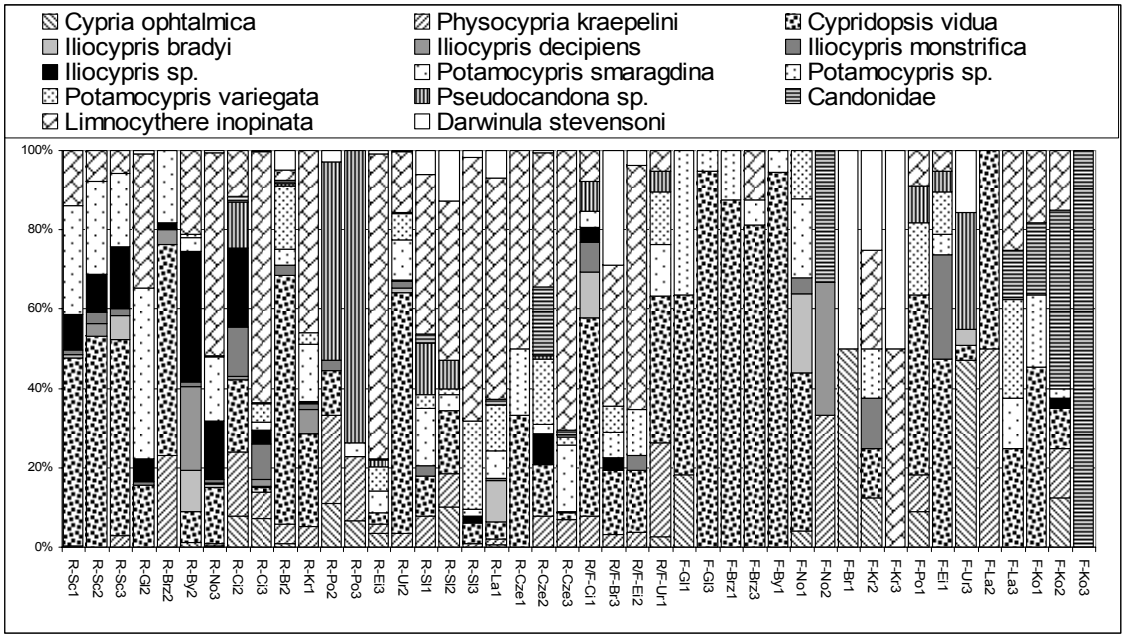



**Fig.2. Percentage participation of different Ostracoda taxa at different sampling sites in different sampling zones. R-river bed zone; F-flood zone; R/F-medial zone**

The list of two ecological forms (swimming and crawling) of Ostracoda occurring in different sampling zones at different sampling sites was presented (fig.3). Most sampling sites from the river bed zone and the medial zone were characterized by a great participation of the crawling forms of Ostracoda. The exceptions were: R-Sc(1, 2, 3), R-Brz2, R-Br2 and R-Ur2. In the flood zone the swimming Ostracoda forms occurred numerously apart from F-Kr3, F-Ko2 and F-Ko3.

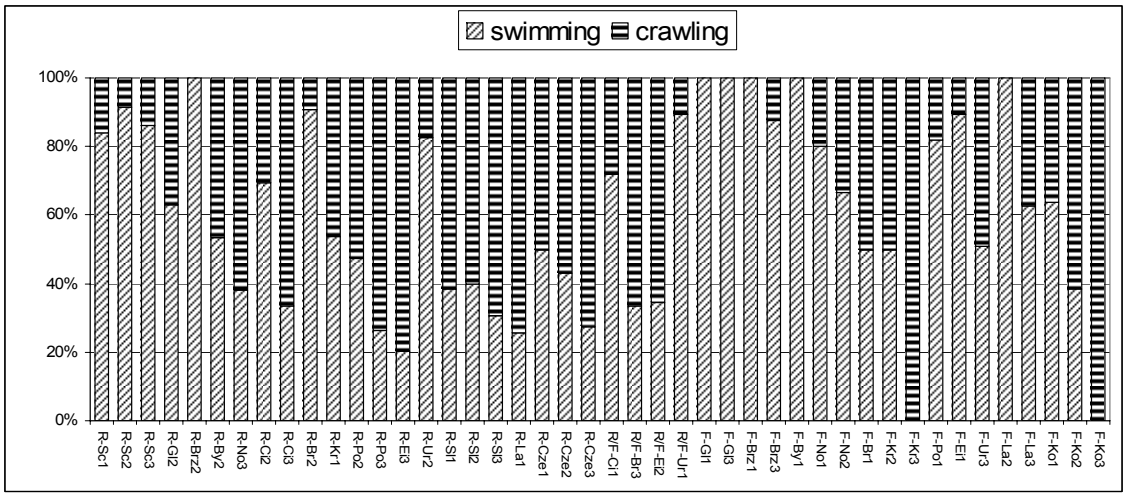
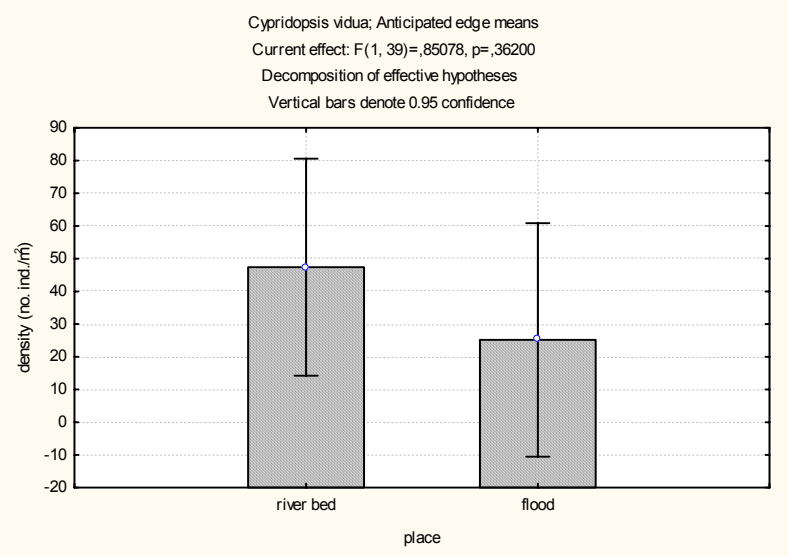
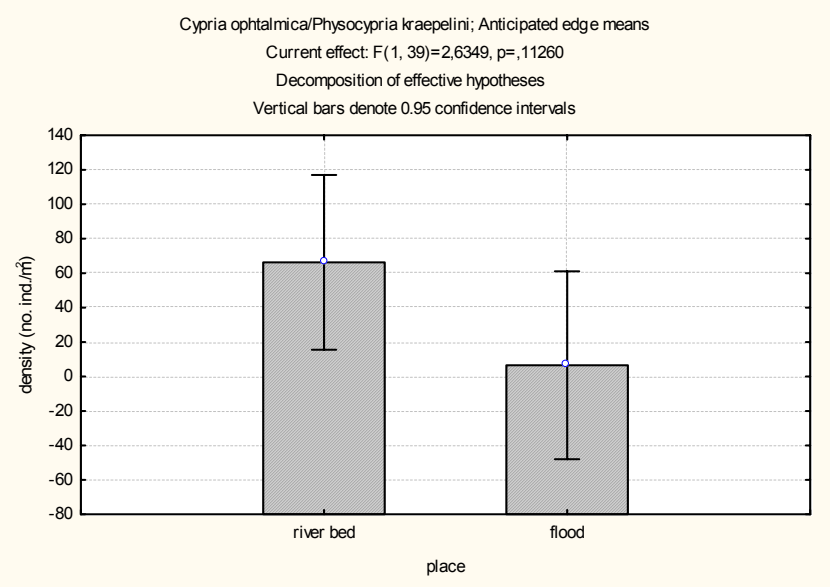


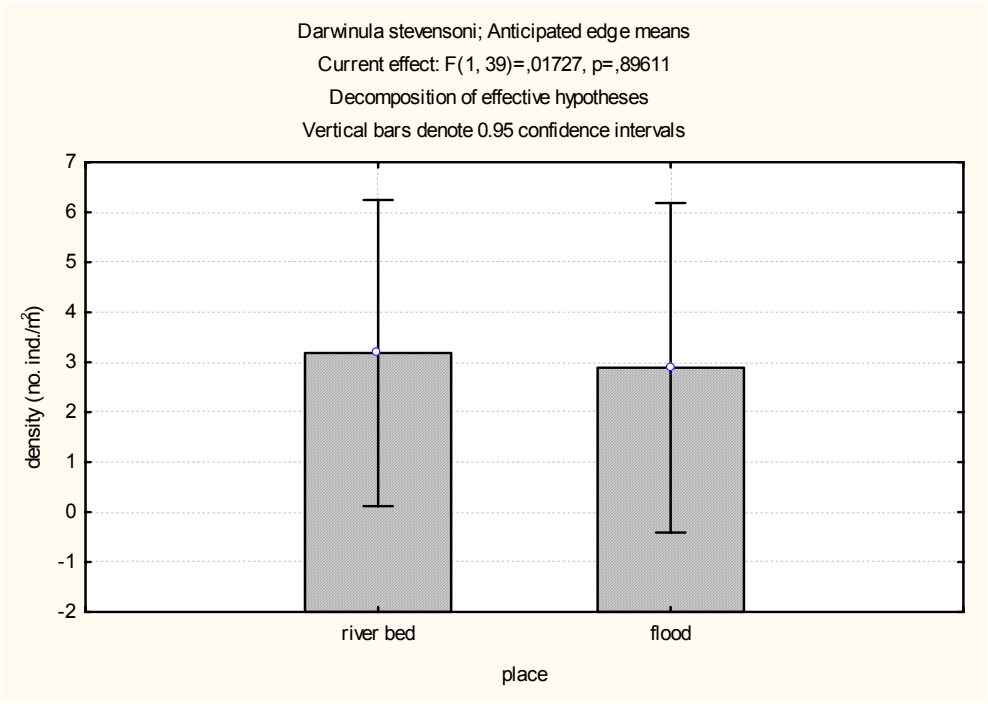

**Fig.3. The list of participation of two ecological forms of Ostracoda (swimming and crawling) in different sampling zones at different sampling sites. R-river bed zone, F-flood zone, R/F-medial zone**

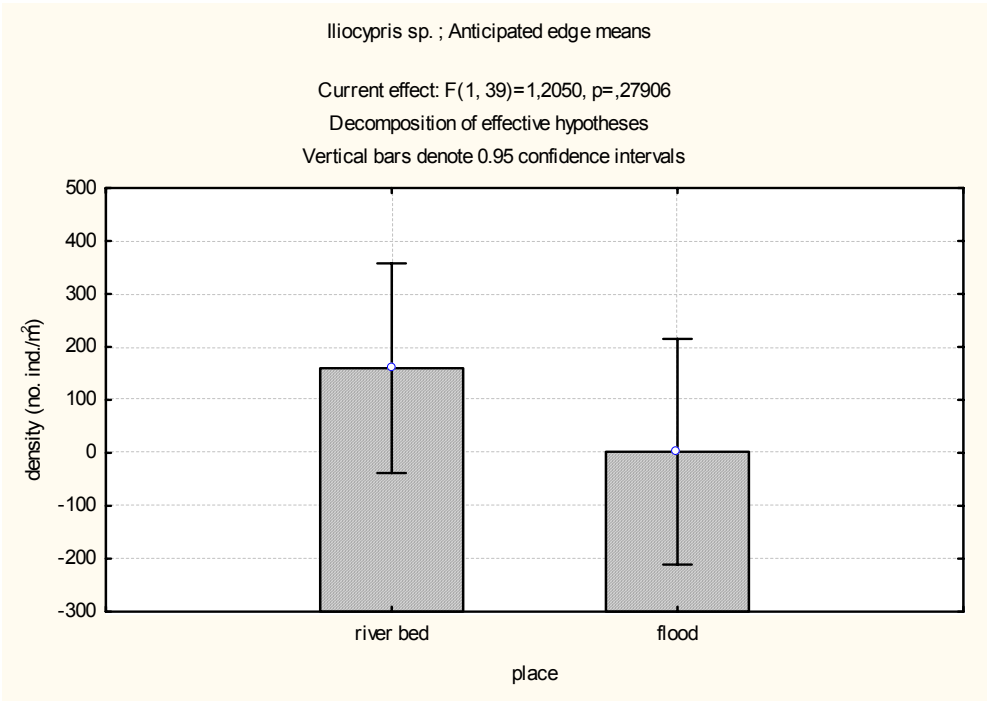
In most cases analysis of variance carried out for the number of individual Ostracoda taxa occurring in the river bed zone and in the flood zone showed significant differences. *Darwinula stevensoni* (Brady & Robertson, 1870) was an exception, being equally numerous in the river bed zone and in the flood zone (p=0.896). Juvenile individuals of *Potamocypris variegata* (Brady & Norman, 1889) and *P. smaragdina* (Vávra, 1820) (*Potamocypris juv*.) occurred more numerously in the flood zone (p=0.111). The remaining taxa were much more numerous in the river bed zone: *Cypridopsis vidua* (p=362), *Potamocypris variegata* and *P. smaragdina* (p=0.003), Iliocypris sp. (p=0.279), *Cypria ophtalmica* and *Physocypria kraepelini* (p=0.112) and *Limnocythere inopinata* (p=0.096).

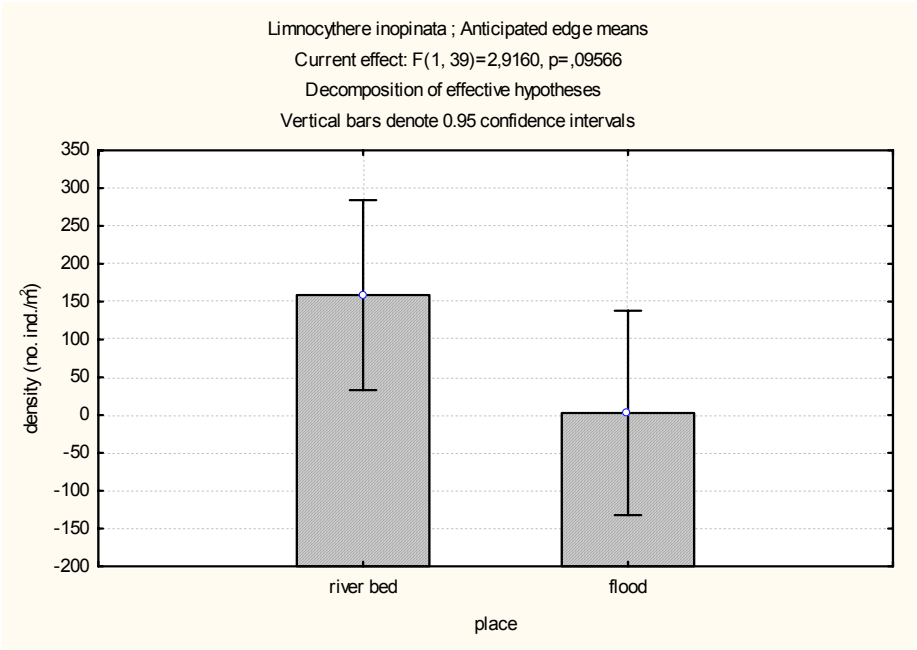
**Fig.4 Analysis of variance for the number of individual Ostracoda taxa occurring in the river bed zone and the flood zone**

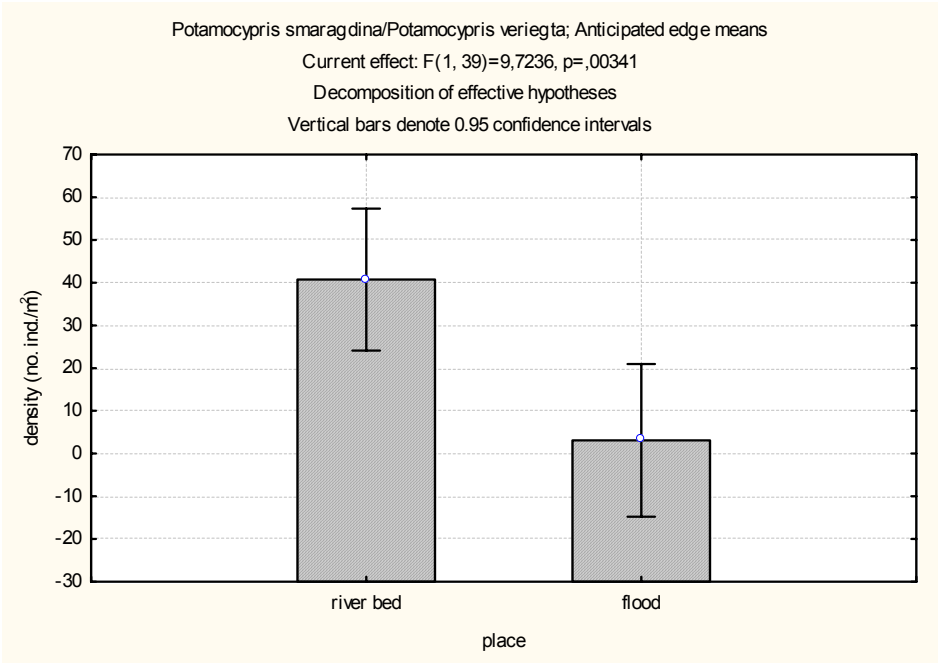


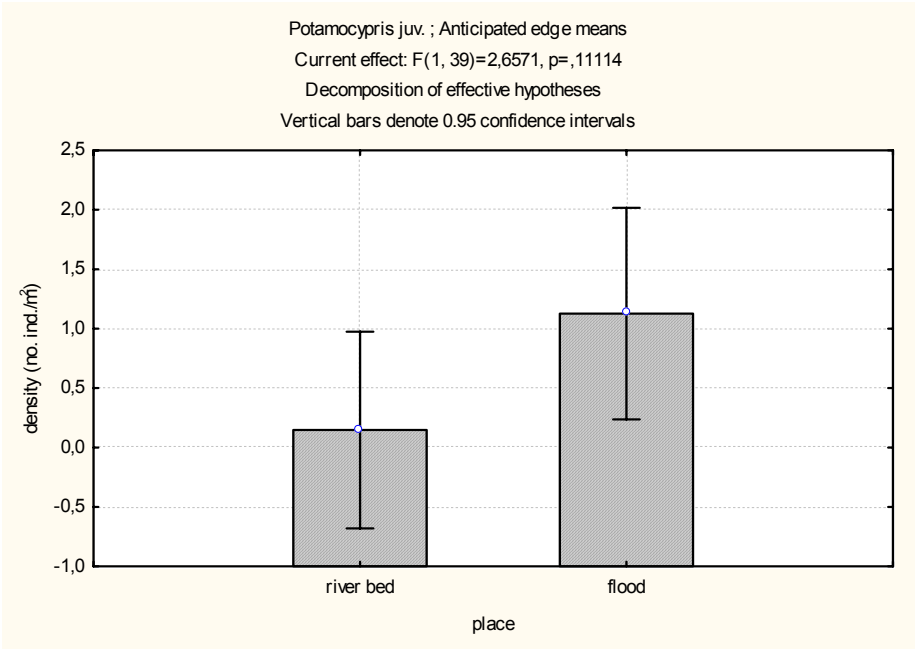




Darwinula stevensoni; Anticipated edge means
Current effect: F(1, 39)=,01727, p=,89611
Decomposition of effective hypotheses
Vertical bars denote 0.95 confidence intervals
density (no. ind./m²)
7
6
5
4
3
2
1
0
-1
-2
river bed
flood
place


Iliocypris sp. ; Anticipated edge means
Current effect: F(1, 39)=1,2050, p=,27906
Decomposition of effective hypotheses
Vertical bars denote 0.95 confidence intervals
density (no. ind./m²)
500
400
300
200
100
0
-100
-200
-300
river bed
flood
place


Limnocythere inopinata ; Anticipated edge means
Current effect: F(1, 39)=2,9160, p=,09566
Decomposition of effective hypotheses
Vertical bars denote 0.95 confidence intervals
density (no. ind./m²)
350
300
250
200
150
100
50
0
-50
-100
-150
-200
river bed
flood
place


Potamocypris smaragdina/Potamocypris veriegta; Anticipated edge means
Current effect: F(1, 39)=9,7236, p=,00341
Decomposition of effective hypotheses
Vertical bars denote 0.95 confidence intervals
density (no. ind./m²)
70
60
50
40
30
20
10
0
-10
-20
-30
river bed
flood
place




## DISCUSSION

The percentage species composition and density of Ostracoda distinctly varied in the river bed zone, the flood zone and the medial zone. The mean density of Ostracoda from the river bed zone was 590 ind/m$^2$, from the medial zone 280 ind/m$^2$ and from the flood zone 54 ind/m$^2$. These great density differences between the individual zones are due to the short lapse of time - 24 hours - after the flooding of new habitats (the flood zone). Benzie (1984) investigated the colonization mechanisms of stream benthos in a tropical river and found that the invertebrates recolonized denuded substrates within 2-3 weeks, though the full diversity was not achieved until four weeks. In flowing waters Ostracoda can colonize new habitats using two methods: either passively floating in moving water masses (drift) or by active movements. Compared with individuals of higher specific weight, individuals of lower specific weight are prone to drift to a higher degree as shown by Smock (1994) who found that the drift accounted for the majority of individuals moving from channels to the floodplain, but most biomass moved onto the floodplain by crawling across the channel-floodplain boundary. The swimming species also are more liable to drift being carried off easily by water masses compared with species connected with the bottom. Among the freshwater Ostracoda two ecological groups are distinguished: the swimming and crawling forms (Meisch 2000). The swimming species have long setae on the I and II pair of antennae (natatory setae); they can swim just above the bottom or move among bottom sediment. The crawling forms do not swim but move on the surface of the sediment or in its surface layer. In the presented work the species dominance varied in the individual zones: in the river bed zone and in the medial zone

*Limnocythere inopinata*, representatives of the genus Iliocypris and in the flood zone *Cypridopsis vidua, Physocypria kraepelini* and *Cypria ophtalmica* predominated.

The species *Limnocythere inopinata* is devoid of natatory setae while in the River Odra among the representatives of the genus Iliocypris long natatory setae were only found in *Iliocypris monstrfic*a (Norman, 1862). Moreover, the genus Iliocypris includes relatively large species with a fairly heavy and thick carapace. The crawling forms of Ostracoda species which prevail in the river bed zone are less prone to drift owing to their mode of life and specific gravity. In the river bed zone the dominance of crawling forms can also result from the impoverishment of this zone by the drift of swimming forms. On the other hand the swimming forms *Cypridopsis vidua, Physocypria kraepelini* and *Cypria ophtalmica* of light and thin carapace dominate in the flood zone. Moreover, they are prone to drift owing to their swimming mode of life and low specific gravity. In a study on Ostracoda in pleuston communities Higuti et al. (2007) obtained similar results, showing that the numbers of swimming species increase during the flood and decrease in the period of draught. Trockner and Waringer (1997) investigated the drift during a receding flood and found that above the bankfull stage (water level exceeding 70 cm) animal drift densities were significantly and up to 22-times higher than during the baseflow.

The colonization of newly flooded areas, however, also occurs owing to the active movement of invertebrates. The dominance of Ostracoda swimming forms in the flood zone can result from their great movement capabilities. According to Scharf (1997) the well swimming *Physocypria kraepelini* was the most successful recoloniser of a pond after the refilling. In the presented work already 24 h after the flood wave also the crawling forms (Candonidae, *Darwinula stevensoni, Iliocypeis bradyi* Sars, 1890, *I. decipiens* Masi, 1905 *and Limnocythere inopinata)* were encountered in the flood zone. The crawling forms move slower than the swimming forms hence, maybe, their less numerous occurrence in this zone. Ostracoda are regarded as effective colonizers of newly flooded areas. Horeau et al. (1997) found that a hydroelectric reservoir after filling was colonized first by smaller species and detritivores (Cladocera Bosminidae and Cyclopidae); later by larger phytoplankton feeders (cladocera Daphinidae and Calanidae); later by carnivores (Chaoboridae) and finally by Ostracoda which dominated at the end of the filling stage.

Juvenile individuals are more apt to colonize new areas compared with adult ones. This phenomenon was observed on the example of *Potamocypris variegata* and *P. smaragdina* of swimming forms. Numbers of juvenile individuals prevailed in the flood zone and of adult animals in the river bed zone.

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