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COLONIZATION OF NEW CREATED ANTHROPOGENIC SMALL PONDS BY WATER BUGS

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Abstract. The aim of the study was to determine species structure of aquatic bugs in four anthropogenic water reservoirs. Heteroptera structure observed in studied reservoirs was clearly differentiated, which refers to age of the ponds. Newly created water reservoirs become quickly colonized mainly by pioneering species Corixinae, which led to formation of taxonomic group population of density exceeding 2700 indiv. m^{-2}. In older reservoirs there were fish, which potential predation pressure led to almost a complete decline of bugs. The reason of bugs poverty in water reservoirs colonized by fish was also probably a small habitat diversity, leading to lack of refuges from predators.

Key words: water bugs, small water reservoirs, colonization, predation pressure

INTRODUCTION

Colonization is a process during which organisms are spreading and colonizing new areas and environment. It occurs in a wide and variable spatial and temporal scales [Smock 2006]. Numerous studies have shown that invertebrates are able to quickly colonize new areas, and an indicator of colonization is different for species, seasons and it changes with distance from the source of organisms dispersion [Lake and Doeg 1985, Smock 2006, Płaska 2007a]. According to Varel and Bourgine [1992] colonization is an important and widespread phenomenon common at almost every level of biological systems. Therefore it seems to be important to determine environmental conditions and composition of invertebrate macrofauna, which leads to appearance of highly associated, strongly interacting groups of organisms during the initial phase of succession in reservoirs newly filled by water. A period of species structure formation of Heteroptera, created in unstable anthropogenic habitats is also related to a very important aspect of seasonali-

ty. It is often associated with the appearance of pioneer species and is particularly important in the early stages of succession habitats and therefore has become one of the most important objectives of this work. Due to the low degree of natural habitats and anthropogenic origin, special attention was paid to the structure of Heteroptera species, which indicates the influence of such habitat conditions on the rate of colonization. The aim of this study was to determine progress and rate of habitats colonization by water bugs in the early years of the anthropogenic water reservoirs drainage lanes.

STUDY AREA, MATERIAL AND METHODS

The studies were carried out in four anthropogenic ground water reservoirs used for drainage of the roadway near the town of Puławy and Kurów (south--eastern Poland). Reservoir I (N: 51°26'11.31", E: 21°54'56.27"), Reservoir II (N: 51°24'53.54", E: 21°50'55.43"), Reservoir III (N: 51°24'2.21", E: 22°12'37.62"), Reservoir IV (N: 51°24'6.52", E: 22°12'36.03").

Studies were carried out from April to October 2014. The samples were taken three times, in triplicate at a depth of 0.2 m. The samples were taken on the area of 0.25 m^2 by using a metal frame and hydrobiological hand net.

The area of investigated ponds is approx. 1500 m^2, they have unstable water level (depth) with maximum at 1.2 m, depending on atmospheric precipitation. Water organisms vegetation in ponds III and IV was absent as they were water bodies in the first year of existing. In reservoir I and II vegetation were in an initial stage of succession because those reservoirs have functioned from 3 years, significant fluctuations in the water level (depth) was characteristic during long drought in the summer. Small fish (prussian carp and stickleback) were found in samples in reservoirs I and II. Water reservoirs characterized considerable turbidity of water coming from the mineral suspension, there were also blooms of phytoplankton in the summer. The reservoirs had relatively low levels of oxygen and high levels of COD (Table 1), which could be related to their initial stage of development and poor water plants appearance.

Table 1. Phisical and chemical characteristic of water in investegated water bodies (mean values for studied period)

Water body	Conductivity $\mu S \cdot cm^{-1}$	O_2 mg dm^{-3}	pH	COD	SUR
I	114	5.1	8.7	17	3.5
II	181	5.4	8.6	21	8.4
III	476	5.7	7.6	9.1	3.1
IV	314	4.8	7.2	32	9.7

The electrolytic conductivity, water oxygenation and pH were measured by the use of multiparameters probe YSI. In the laboratory by the use of spectrophotometer Pastel UV were determined SUR and COD.

RESULTS

The quality structure

The quality structure in the studied reservoirs was differential in number of species. There were 3 taxa in the reservoir I and up to 8 taxa in the reservoir III. Generally, reservoirs I and II were characterized by a small number of taxa, and in the reservoirs III and IV were observed a clear seasonal dynamics in the structure of quality associated with the migration of species – their emergence and lowering reservoirs. The greatest number of taxa was found in August in reservoirs III and IV of respectively (8 and 7 taxa). The smallest number of taxa were found at spring, in April and it was 1 for reservoirs I, III and IV and 2 species in reservoir II (Fig. 1).

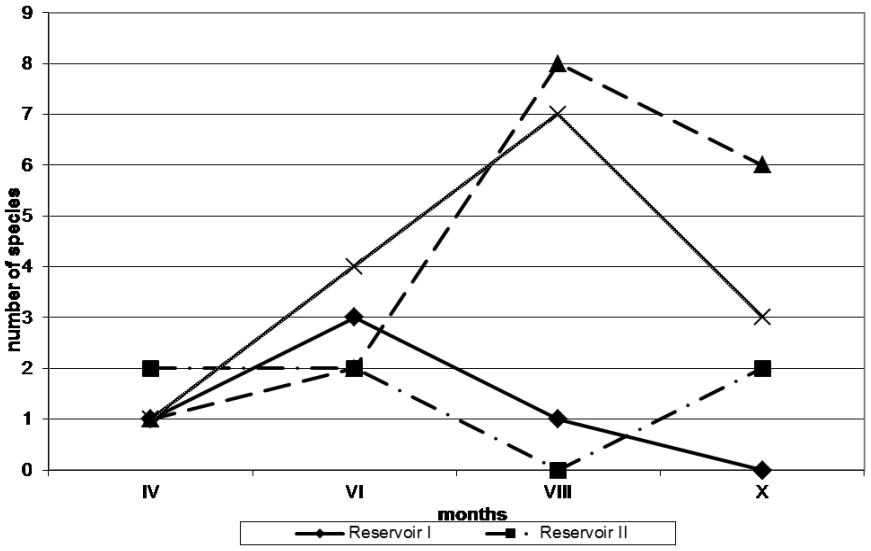

Fig. 1. Number of taxa water bugs in investigated water bodies

Quantitative structure

Reservoirs depending on the density of Heteroptera were distinguished into two groups. First one, including reservoirs I and II with average numbers on relatively low level, amounted up to 69 and 13 ind. m^{-2}. Higher density occurred in the second group and averaged 501 and 1,145 ind. m^{-2}. Seasonal variability in the studied reservoirs was very clear and strongly associated with the cycle of

development and colonization of reservoirs. The lowest density occurred in reservoirs III (4 ind. m^{-2}) in April and IV (102 ind. m^{-2}) and in June. Then sharp increase became in the number reaching the density of 940 to 2700 ind. m^{-2}. In reservoirs I and II, the higher density occurred at spring of 16 to 240 ind. m^{-2}. In VIII and X months they had very low water level and periodically dried. In that period between 0 to 4 ind. m^{-2} (Fig. 2) were only observed.

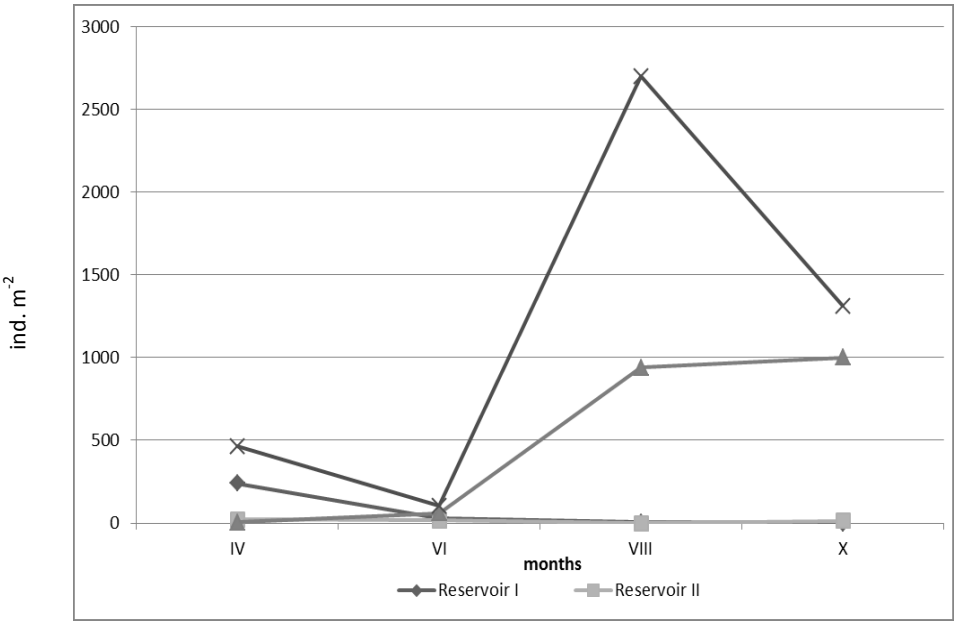

Fig. 2. Density of water bugs in investigated water bodies

Domination in density

In the studied reservoirs Corixinae were the dominating group. A significant part in all reservoirs were larvae of Corixinae representing from 30% to 96% in different months of the study. Among the imaginal form Corixinae in reservoir III Cymatia coleoptrata predominated representing up to 24% *Sigara falleni* 26%, a smaller share was *Sigara concinina* 5%. In the fourth reservoir similar species structure appeared, which dominated the Corixniae: mainly *S. falleni* 38% Corixinae larv. 29% as well *Sigara lateralis* 15% and 12% *Callicorixa praeusta*. In both reservoirs rare species *Corixa punctata* were also found, representing from 0.6% to 1.7%. Among the predatory species only *Notonecta glauca* were found representing less than 0.8% in reservoirs III and IV.

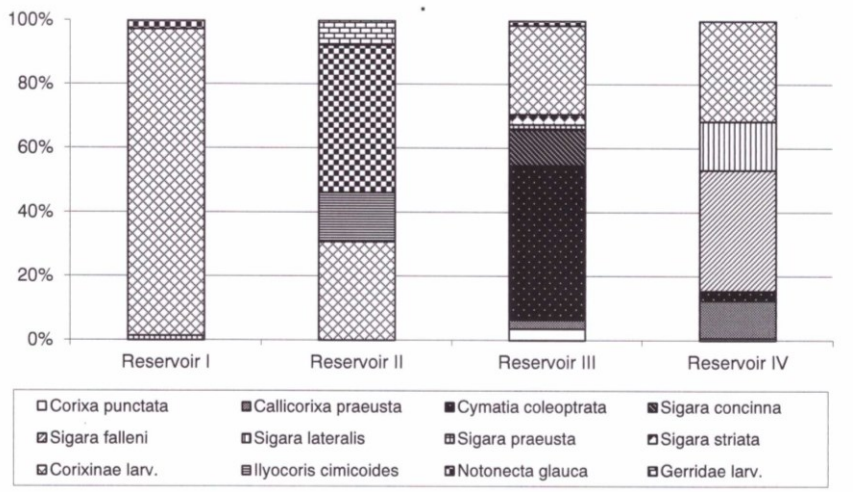

Fig. 3. Percentage share of species water bugs on in investigated water bodies

In reservoirs I and II in group of dominants larvae Corixinae were also observed, but had not finished the lifecycle and rapidly left habitat because in the form of imaginal almost did not occur in later months. Moreover, *N. glauca* had a significant share representing from 2.7% to 46% in the second reservoir. Also in this reservoir other predatory taxa were found, represented by *Iliocoris cimocoides* to 15% and larval Gerridae 8% (Fig. 3).

DISCUSSION

In the studied reservoirs relatively low number of species of aquatic bugs occurred amounting to a total of 12 taxa, which represents only 19% of the polish fauna [Cmoluchowa and Mielewczyk 1992]. In other waters in Poland and Europe Heteroptera species were found achieving from 13 to 28 species, depending on diversity of tested habitats, and resulting in studies with high number usually mainly because of typical pioneering taxa such as, for example *S. falleni* or *C. colepotrata* [Płaska 2002, 2007b, Ilte and Olosutean 2009].

Such structure is typical for the species in newly created reservoirs in which there is no diversity of habitat, what results in occurring of eurytopic species and typical of small water reservoirs [Płaska 2007a].

In reservoirs III and IV during first year of operation pioneering species of bugs significantly increased their number in the vegetation season, colonizing new ecological niches created after flooding of reservoirs by water. Predators proportions were also improper in habitats (eg. the lack of fish), reproductive success Heteroptera in reservoirs III and IV was an evidence typical in habitats with no fish [Płaska 2010]. Quite different situation was in reservoirs I and II which functioned from 3 years and fish occurred there. There has been a decline

in a number of taxa, probably due to the pressure of predation of fish in reservoirs with low habitat diversity. Corixinae occurrence only in a form of larvae was an evidence in reservoir I. Such changes were observed in other habitats during the reconstruction of the species structure caused by habitat factors [Mittelbach 1988].

It is well known that Nepomorpha and Corixinae are predominatingly eaten by fish especially in their larval forms. Changes in distribution of Heteroptera species, as well as significant changes in structure of domination ensure under the pressure of fish. These results were obtained in Danish Lilla Lake, where quantitative surveys of aquatic bugs were conducted after removal of entire fish fauna from the lake using rotenone. Comparative studies were carried out a few days after fish introduction into the lake (mainly roach) and significant domination structures rebuild and changes in distribution of Corixinae were found [Oscarson 1987].

The seasonal dynamics in reservoirs functioning from 3 years was observed but completely reverse trend in new reservoirs III and IV. This shows the great influence of colonization from the neighboring habitats and reproductive success of taxa colonizing new habitats. An exception may be very low number of Gerridae present only in Reservoir II. These taxa willingly migrating to unstable habitats of ecological systems. Sometimes also often found in highly eutrophic reservoirs and small astatic reservoirs [Płaska 2007b, 2010].

A characteristic feature of the seasonal qualitative structure of bugs was rapidly changing the number of taxa. Observed changes in the quality suggest that in the studied reservoirs larger migrations occur probably from neighboring areas. Such changes may also be a result of potential migration of some aquatic bugs species to other habitats, or their colonization of species coming from the neighboring hydrogenic habitats [Tolonen *et al*. 2001, 2003]. This may explain the emergence of new species characteristic of such habitats, but less migrant example *Ilyocoris cimicoides*. The presence of this species in only one reservoir shows their migration from reservoirs with a larger diversity of habitat. The role of predatory bugs in such ecosystems seems to be very important the in the studied reservoirs, such species may be *N. glauca* [Biesiadka and Moroz 1996, Kurzątkowska 1999].

CONCLUSIONS

1. Clear differences in the structure of species Heteroptera between the investigated water bodies were found.

2. Based on the structure of the species Heteroptera reservoirs were divided into two groups: newly formed water reservoirs and stable water bodies have been functioning for 3 years now.

3. Rapid colonization by pioneer species, which formed very large populations were found in new reservoirs.

4. Bugs fauna was poor in older reservoirs what was caused probably by fish predation pressure and small habitat diversity.

5. Presence of rare species of *Corixa punctata* were discovered, which may suggest the presence of this species in surrounding aquatic ecosystems as a source of its dispersion.

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KOLONIZACJA NOWO POWSTAŁYCH ANTROPOGENICZNYCH ZBIORNIKÓW WODNYCH PRZEZ PLUSKWIAKI WODNE

Streszczenie. Celem przeprowadzonych badań było określenie struktury gatunkowej pluskwiaków wodnych w czterech antropogenicznych zbiornikach wodnych. Stwierdzona w badanych zbiornikach struktura Heteroptera była wyraźnie zróżnicowana, na co wpływ miał wiek badanych zbiorników. W nowo powstałych zbiornikach następowała szybka kolonizacja głównie przez pionierskie gatunki Corixinae, co prowadziło do powstania populacji tej grupy taksonomicznej o liczebnościach przekraczających 2700 osobn. m^{-2} . W zbiornikach starszych występowały ryby, których potencjalna presja drapieżnicza prowadziła do prawie całkowitego spadku liczebności pluskwiaków wodnych w zbiornikach. Powodem ubóstwa liczebności pluskwiaków wodnych w zbiornikach zasiedlonych przez ryby było również prawdopodobnie małe zróżnicowanie siedliskowe, skutkujące brakiem schronień przed drapieżnikami.

Słowa kluczowe: pluskwiaki wodne, drobne zbiorniki wodne, kolonizacja, presja drapieżnicza