Teka Kom. Ochr. Kszt. Środ. Przyr. – OL PAN, 2013, 10, 200–210

ZOOPLANKTON COMMUNITIES IN THE WARTA RIVER OXBOWS (ROGALIN LANDSCAPE PARK): THE EFFECT OF HABITAT AND TYPE OF CATCHMENT AREA[1]

Natalia Kuczyńska-Kippen, Tomasz Joniak, Barbara Nagengast

Department of Water Protection, Adam Mickiewicz University
Umultowska str. 89, 61-614 Poznań, kippen@hot.pl

Co-financed by National Fund
for Environmental Protection
and Water Management

Summary. Research on zooplankton species diversity and abundance was performed in the spring and summer of 2008 on 18 oxbows situated in the valley of the Warta river. These water bodies differed in respect to catchment area (forest and pastoral) and studied habitats (the open water area and elodeids).

As a result of the study a total number of 198 zooplankton taxa was recorded with rotifers (72% of zooplankton taxa) prevailing over crustaceans (28%).Taxonomic structure was more diverse in the elodeids compared to the open water zone, which reflects the creation of many ecological niches in the complex stand of aquatic vegetation.

Even though the examined oxbows represent the same origin, are located within the same region and all undergo periodic floodings, enabling mixing of fauna, their structure of dominating species was very various (30 species). Only 9 such species occurred with a frequency of over 25% which suggests very variable environmental conditions prevailing in oxbows. Moreover, a large number of dominating species occurred in association with certain type of catchment area. In forest oxbows mainly littoral species dominated (e.g. *Acroperus harpae, Colurella uncinata*), while the majority of species in pastoral ponds was of pelagic character (e.g. *Anuraeopsis fissa*, *Daphnia longispina*).

Key words: crustaceans, elodeids, littoral species, open water zone, pelagic species, rotifers

---

[1] This work was partly supported by the Polish Committee for Scientific Research (KBN) under grant No. N N305 042739.

INTRODUCTION

Oxbows located in the valleys of large lowland rivers, created as a result of cutting off the main stem of a river or by regulating the river bed [Jezierska-Madziar 2005], perform many important functions on the local and environmental scale. Among oxbows, lakes of large area, such as Piotrowice Duże oxbow (60.9 hectares) in the Vistula valley [Turczyński *et al*. 2006], can be found. However, a second group refers to very small water bodies of an area of less than one hectare, such as the oxbows of the river Pilica (0.015 ha) [Penczak *et al*. 2005]. Both biologists and hydrologists appreciate the very essential role they play in the landscape. From a biological point of view their role as centres of biodiversity should be especially emphasized [Obolewski and Glińska-Lewczuk 2011, Špoljar *et al*. 2011]. The results of many authors [e.g. Wojciechowska and Pasztaleniec 2006] indicate that their species composition may also be determined by the period in which the oxbow is at a particular time: potamophase – the period of flooding or limnophase – oxbow is isolated from the influence of the river.

Although vertical variation is restricted due to usually shallow depth, very often the entire surface is overgrown by vegetation, therefore a variety of habitats may be found [Wilk-Woźniak 2012]. The co-occurrence of various groups of organisms associated with the river as well as typically heleoplanktonic is a typical phenomenon. Biodiversity may be therefore very high due to the presence of a complex interaction between various habitats and their inhabiting biocoenoses, such as fish, benthos, periphyton, phytoplankton and especially zooplanktonic organisms [Carvalho *et al*. 2005, Špoljar *et al*. 2012], which are the object of the present study carried out on a group of 18 oxbows. Hence the question arises as to what extent the macrophyte coverage, represented by elodeids, has an effect on the composition and abundance of the zooplankton communities?

Another factor which may influence the specificity of organisms is the type of catchment area surrounding a water body [Dodson *et al*. 2005]. Since little attention has been given to the significance of oxbows located within different landscapes we have decided to find out whether zooplankton communities inhabiting ponds within pastoral and forest catchment areas differ?

MATERIAL AND METHODS

The studied oxbows were located within the glacial valley of the Warta river which lies entirely in the area covered by conservation: Nature 2000 PLH300012 Rogalin Warta Valley, PLB300017 Rogalin Refuge, Rogalin Landscape Park. Additionally three oxbows were situated within the Krajkowo Reserve. The area of examination covers about 900 hectares, i.e. about 25% of the Rogalin Warta Valley [Stachnowicz 2009]. In 2007 and 2008 hydrobiological studies were conducted on 18 oxbows located on both sides of the river Warta, stretching from the village of Rogalinek up to Czmoniec. They varied in respect to: size (from

0.018 to 5.75 ha), depth (from 0.4 to 3.5 m), trophic conditions of water, the distance from the river (from 112 to 523 m) and the kind of immediate catchment area. Eight oxbows located on the right bank of the Warta river had a direct agricultural catchment area, whereas in the case of the water bodies located on the left side of the river four oxbows had forest surroundings and six pastoral.

Zooplankton samples were collected in triplicate (n = 96) in 2008 in two seasons (spring and summer) by passing five litres of water through a plankton net (45 μm) after which they were preserved in 4% formalin. 32 stations within 18 oxbows were sampled with additional stations dominated by macrophytes (elodeids) in the case of five oxbows. Samples were collected from the open water area in each oxbow and additionally from the dominating phytocoenosis of aquatic vegetation in the case of five water bodies.

To compare number of species and abundance of zooplankton communities between the two types of oxbow catchment area: forest (F) and pastoral (P), and between the open water area (Water) and macrophytes (Elodeids) the non-parametric U Mann-Whitney's test was used.

RESULTS

During both periods of examination carried out on 18 oxbows 143 taxa of Rotifera and 55 of Crustacea were identified. There were 26 (±12) taxa of rotifers and 10 (±6) taxa of crustaceans found on average in each sample. Species diversity of both rotifers ($Z = -3.01$; $p < 0.01$) and crustaceans ($Z = -2.91$; $p < 0.01$) differed significantly between habitats, reaching higher values in the zone of macrophytes (Fig. 1). At the same time 198 taxa in total were identified in the open water area and among elodeids. No significant changes were found between the number of taxa in oxbows located within the forest catchment area and pastoral ponds. However, taxonomic diversity of rotifers was slightly higher in the forest ponds, while crustaceans built more various communities in pastoral oxbows (Fig. 2).

The total numbers of zooplankton communities reached values from 56 up to 59815 ind. $\cdot$ l^{-1} in the case of rotifers and from 4 up to 7880 ind. $\cdot$ l^{-1} in the case of crustaceans. Zooplankton abundance revealed no significant variation in reference to station. However, higher densities were observed in the open water area compared to elodeids, both for rotifers and crustaceans (Fig. 1). Analysing oxbows located in two different types of catchment area it was noticed that pastoral ponds were characterised by higher abundance of rotifers and crustaceans (Fig. 2). Only densities of crustaceans revealed statistically significant variation ($Z = -2.40$; $p < 0.05$).

The structure of dominance was created by 30 zooplankton species – 16 rotifers and 14 crustaceans. Only 9 dominating species occurred with high frequency (> 25% of the samples): *Keratella cochlearis* (67%), *Bosmina longirostris* (59%), *Bosmina coregoni* (37%), *Keratella quadrata* (33%), *Polyarthra vulgaris* (33%), *Keratella cochlearis* f. *tecta* (26%), *Polyarthra remata* (26%),

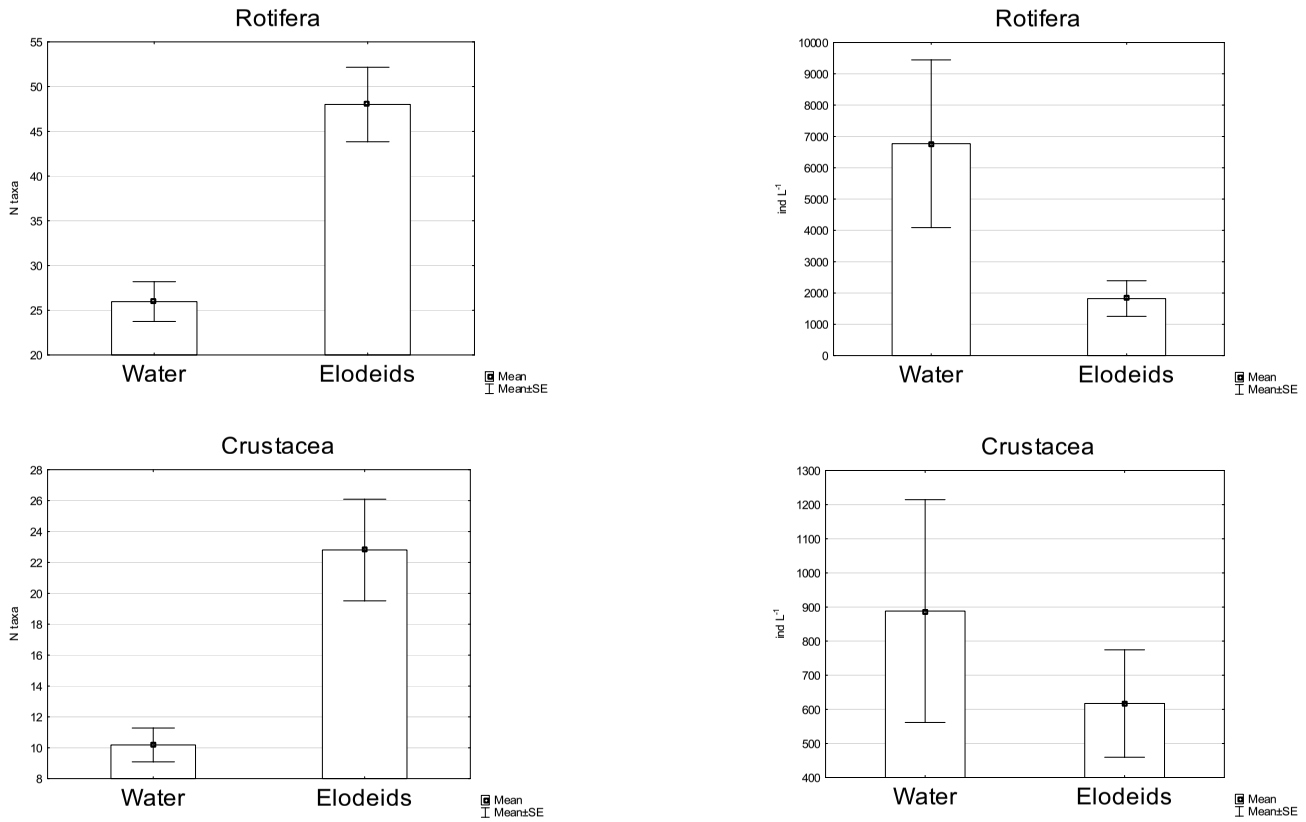

Fig. 1. Rotifer (Rotifera) and crustacean (Crustacea) number of taxa and densities in two types of habitats – in the open water area (Water) and among macrophytes (Elodeids)

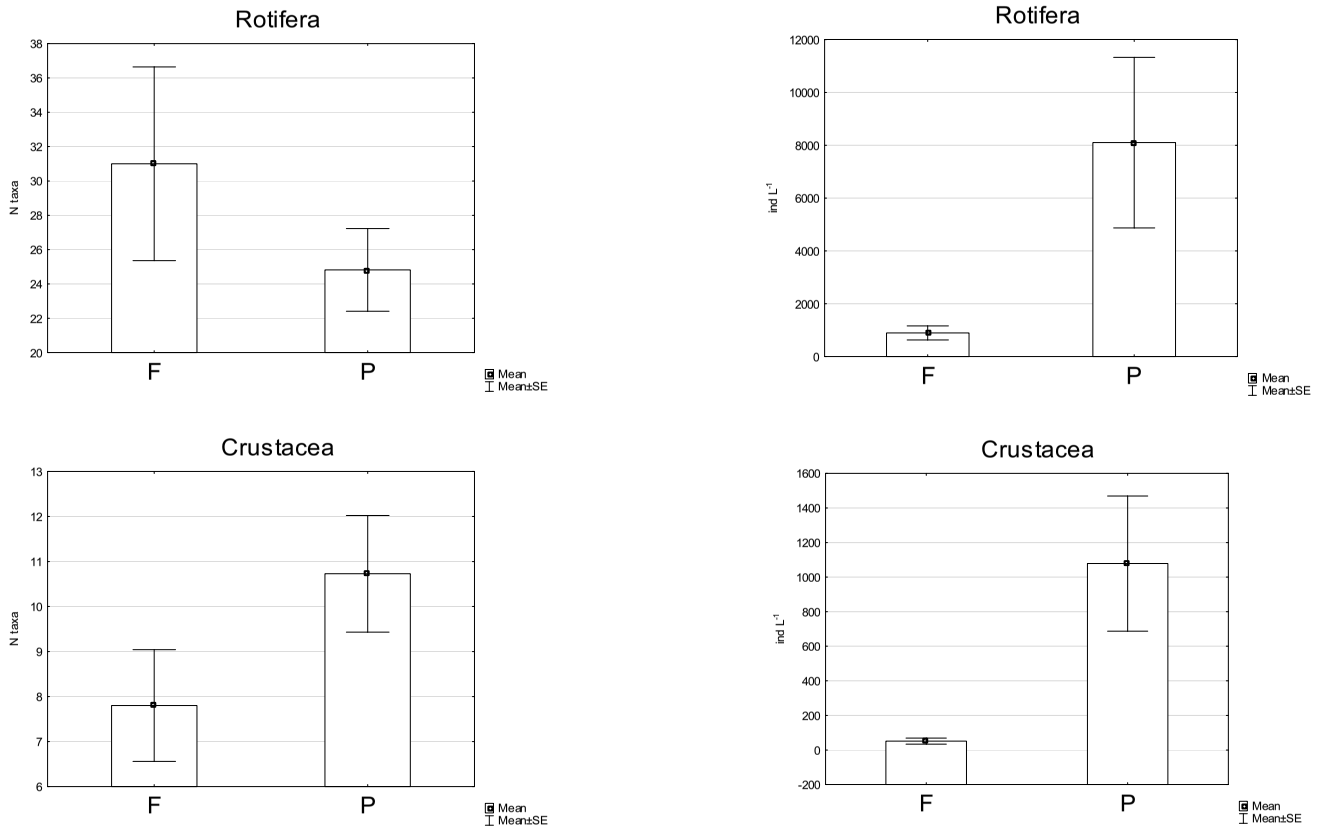

Fig. 2. Rotifer (Rotifera) and crustacean (Crustacea) number of taxa and densities in two groups of oxbows – in the forest (F) and in pastoral (P) catchment area

Pompholyx complanata (26%) and *Chydorus sphaericus* (26%). Species such as *Colurella uncinata*, *Polyarthra major, Acroperus harpae* and *Megacyclops viridis* dominated exclusively in the ponds surrounded by forest, while *Anuraeopsis fissa*, *Ascomorpha ecaudis*, *Asplanchna priodonta*, *Filinia longiseta*, *Gastropus stylifer*, *Keratella cochlearis* f. *tecta*, *Pompholyx complanata*, *Trichocerca similis*, *Ceriodaphnia pulchella*, *Chydorus sphaericus*, *Daphnia longispina*, *Scapholeberis mucronata* and *Thermocyclops oithonoides* were dominant in the pastoral ponds (Tab. 1).

DISCUSSION

In the investigated oxbows rotifers dominated over crustaceans on average, both in respect to their taxonomic diversity as well as abundance. There was a markedly differentiated structure of dominating species (16 rotifers and 14 crustaceans) recorded, which suggests very diverse conditions in those oxbows, despite the fact that they are water bodies of the same origin, closely situated and they all undergo periodic floodings, when mixing of plankton species is possible. Therefore, only 9 species occurred with a frequency of over 25%. The highest dominating level was reached by *Keratella cochlearis* and *Bosmina longirostris*. Both these species belong to eurytopic organisms, characterised by a high range of ecological scale [Flößner 2000, Radwan *et al*. 2004, Rybak and Błędzki 2010]. Moreover, among dominating species a large proportion of eutrophic species occurred [Karabin 1985]: *Anuraeopsis fissa, Bosmina longirostris, Chydorus sphaericus, Diaphanosoma brachyurum, Filinia longiseta, Keratella cochlearis* f. *tecta* and finally *Keratella quadrata*, which indicates eutrophic conditions in most of the examined water bodies.

Aquatic macrophytes often serve as suitable retreating grounds for the zooplankton community, also providing great availability of nutritional source in oxbow lakes [Das *et al*. 2011]. The effect of the macrophyte coverage was decisive in the composition of the animal plankton assemblages. In the case of the examined elodeids significantly higher species diversity was obtained for both groups of zooplankton – rotifers and crustaceans. This has also been proved in the case of oxbows in the investigations carried out on zooplankton assemblages in two oxbow lakes [Špoljar *et al*. 2011] as well as in the case of algae assemblages [Krasznai *et al*. 2010]. Moreover, Pasztaleniec *et al*. [2013], who carried out the investigations on the spatial differentiation of crustacean communities in the Białe oxbow lake, found that zooplankton collected from hornwort *Ceratophyllum demersum* reached the greatest species diversity compared to two remaining stations – the water column without macrophytes and pleustophytes – lemnids. However, zooplankton densities in the oxbows of the Rogalin Landscape Park were higher in the open water area where the majority of dominating species were those of pelagic association. Many of such species may even remain in the pelagic zone of water bodies with fish present, as they have evolved various anti-

Table 1. Dominating taxa in the open water of examined oxbows and their frequency (%) in reference to the type of catchment area – forest (F) and pastoral (P)

Type	F	F	F	F	F	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	P	%
Anuraeopsis fissa (Gosse)										x											x						7
Ascomorpha ecaudis (Perty)													x		x												7
Asplanchna priodonta Gosse													x														4
Bdelloidae			x							x					x												11
Colurella uncinata (O.F. Müller)			x																								4
Filinia longiseta (Ehrenberg)								x							x												7
Gastropus stylifer Imhof								x																			4
Keratella cochlearis (Gosse)	x	x		x	x	x	x	x	x		x		x		x	x	x		x				x		x	x	x	67
Keratella cochlearis f. *tecta* (Lauterborn)							x	x			x										x	x			x	x		26
Keratella quadrata (O.F. Müller)				x	x	x		x	x				x			x	x		x								33
Lecane closterocerca (Schmarda)			x																x								7
Polyarthra major Burckhardt					x																						4
Polyarthra remata (Skorikov)	x	x					x					x		x								x		x			26
Polyarthra vulgaris Carlin					x			x			x		x	x								x	x		x		33
Pompholyx complanata Gosse							x				x										x		x	x		x	x	26
Trichocerca similis (Wierzejski)											x															x		7

Acroperus harpae (Baird)			x																												4
Alonella exigua (Lilljeborg)					x													x					x								15
Bosmina coregoni Baird	x	x		x	x						x								x		x		x	x						x	37
Bosmina longirostris (O.F. Müller)	x					x	x	x			x		x		x	x			x		x	x	x		x	x	x				59
Ceriodaphnia pulchella Sars												x								x				x							11
Ceriodaphnia quadrangula (O.F. Müller)					x							x	x			x							x		x						22
Chydorus sphaericus (O.F. Müller)							x	x		x			x		x	x								x							26
Daphnia longispina O.F. Müller						x			x																					x	11
Diaphanosoma brachyurum (Lievin)	x																								x						7
Scapholeberis mucronata (O.F. Müller)								x					x		x	x															15
Megacyclops viridis (Jurine)				x																											4
Eudiaptomus gracilis (Sars)						x														x										x	11
Harpacticoidae			x	x						x																					11
Thermocyclops oithonoides (Sars)																				x									x	x	11

predator mechanisms, reducing the success of predator [Gilbert 1987, Sakamoto *et al*. 2007, Sakamoto and Hanazato 2009].

The type of catchment area surrounding a water body may also have a decisive effect on the structure of zooplankton including their composition or abundance [Jones 1986]. This has been demonstrated especially in the case of zooplankton abundance where both rotifers and crustaceans prevailed in the pastoral oxbows. A large number of dominating species was also restricted to only one type of oxbow. In the case of ponds located within the forest surroundings species such as *Acroperus harpae, Colurella uncinata*, *Megacyclops viridis* and *Polyarthra major* dominated exclusively. Three first species are representatives of littoral organisms, which suggests that macrophyte-associated species found propitious conditions in forest ponds. Contrary to this was a dominating structure of pastoral ponds where the majority of species was pelagic (e.g. *Anuraeopsis fissa*, *Ascomorpha ecaudis*, *Asplanchna priodonta*, *Filinia longiseta*, *Gastropus stylifer*, *Keratella cochlearis* f. *tecta*, *Pompholyx complanata*, *Trichocerca similis*, *Daphnia longispina* and *Thermocyclops oithonoides*).

REFERENCES

Carvalho E.D., Marcus L.R., Foresti F., Silva V.F.B., 2005. Fish assemblage attributes in a small oxbow lake (Upper Paraná River Basin, São Paulo State, Brazil): species composition, diversity and ontogenetic stage. Acta Limnol. Bras., 17/1, 45–56.

Das T., Pathak K., Devi M.B., 2011. Phytoplankton and Zooplankton Communities of an Oxbow Lake in Barak Valley, Assam. Assam Univ. J. Sci. Technol., 7/1, 67–75.

Dodson S.I., Lillie R.A., Will-Wolf S., 2005. Land use, water chemistry, aquatic vegetation, and zooplankton community structure of shallow lakes. Ecol. App., 15, 1191–1198.

Flößner D., 2000. Die Haplopoda und Cladocera Mitteleuropas, Backhuys Publishers, 428 pp.

Gilbert J.J., MacIsaac H.J., 1989. The susceptibility of *Keratella cochlearis* to interference from small cladocerans. Freshwat. Biol., 22, 333–339.

Jezierska-Madziar M., 2005. Wstęp, w: Starorzecza jako istotny element ekosystemu rzecznego. M. Jezierska-Madziar (red.). Wydawnictwo Akademii Rolniczej w Poznaniu. Poznań, s. 9–10.

Jones D.H., 1986. The effect of afforestation on fresh waters in Tayside, Scotland. Zooplankton and other microfauna. Hydrobiologia, 133, 223–235.

Karabin A., 1985. Pelagic zooplankton (Rotatoria + Cladocera) variation in the process of lake eutrophication. I. Structural and quantitative features. Ekol. Pol., 33/4, 567–616.

Krasznai E., Borics G., Várbíró G., Abonyi A., Padisák J., Deák C., Tóthmérész B., 2010. Characteristics of the pelagic phytoplankton in shallow oxbows. Hydrobiologia, 639/1, 173–184.

Obolewski K., Glińska-Lewczuk K., 2011. Effects of oxbow reconnection based on the distribution and structure of benthic macroinvertebrates. CLEAN – Soil, Air, Water, 39/9, 853–862.

Pasztaleniec A., Karpowicz M., Strzałek M., 2013. The influence of habitat conditions on the plankton in the Białe oxbow lake (Nadbużański Landscape Park). Limnol. Rev. 13/1, 43–50.

Penczak T., Galicka W., Głowacki Ł., Kruk A., Kostrzewa J., Marszał L., Koszaliński H., Zięba G., 2005. Znaczenie starorzeczy dla zachowania różnorodności i obfitości ichtiofauny w ekosystemie rzecznym, w: Starorzecza jako istotny element ekosystemu rzecznego. M. Jezierska-Madziar (red.). Wydawnictwo Akademii Rolniczej w Poznaniu. Poznań, s. 95–128.

Radwan, S., Bielańska-Grajner I., Ejsmont-Karabin J., 2004. Wrotki *Rotifera*. Fauna słodkowodna Polski. (Rotifers *Rotifera*. Freshwater fauna of Poland). Oficyna Wydawnicza Tercja, 447 ss.

Rybak J.I., Błędzki L.A., 2010. Słodkowodne skorupiaki planktonowe. WUW, Warszawa, 366 ss.

Sakamoto M., Hanazato T., 2009. Proximate factors controlling the morphologic plasticity of Bosmina: linking artificial laboratory treatments and natural conditions. Hydrobiologia, 617, 171–179.

Sakamoto M., Chang K.-H., Hanazato T., 2007. Plastic phenotypes of antennule shape in Bosmina longirostris controlled by physical stimuli from predators. Limnol. Oceanogr., 52/5, 2072–2078.

Špoljar M., Dražina T., Habdija I., Meseljević M., Grčić Z., 2011. Contrasting Zooplankton Assemblages in Two Oxbow Lakes with Low Transparencies and Narrow Emergent Macrophyte Belts (Krapina River, Croatia). Int. Rev. Hydrobiol., 96/2, 175–190.

Špoljar M., Fressl J., Dražina T., Meseljević M., Grčić Z., 2012. Epiphytic metazoans on emergent macrophytes in oxbow lakes of the Krapina River, Croatia: differences related to plant species and limnological conditions. Acta Bot. Croat., 71/1, 125–138.

Stachnowicz W., 2009. Wstęp: Cel i zakres opracowania, teren i obiekty badań, w: Inwentaryzacja przyrodnicza w zakresie wybranych siedlisk i gatunków roślin części Specjalnego Obszaru Ochrony Siedlisk Natura 2000 „Rogalińska Dolina Warty" (PLH300012), W. Stachnowicz (red.). Opracowanie dla Aquanet S.A. niepublikowane.

Turczyński M., Michalczyk Z., Bochra A., 2006. River lakes in the Lublin region. Teka Kom. Ochr. Kszt. Środ. Przyr., 3, 231–240.

Wilk-Woźniak E., Gąbka M., Pęczuła W., Burchardt L., Cerbin S., Glińska-Lewczuk K., Gołdyn R., Grabowska M., Karpowicz M., Klimaszyk P., Kołodziejczyk A., Kokociński M., Kraska M., Kuczyńska-Kippen N., Ligęza S., Messyasz B., Nagengast B., Ozimek T., Paczuska B., Pełechaty M., Pietryka M., Piotrowicz R., Pociecha A., Pukacz A., Richter D., Walusiak E., Żbikowski J., 2012. 3150 – Starorzecza i naturalne eutroficzne zbiorniki wodne ze zbiorowiskami z Nympheion, Potamion, w: Monitoring siedlisk przyrodniczych, W. Mróz (red.), Biblioteka Monitoringu Środowiska, Warszawa, 130–149.

Wojciechowska W., Pasztaleniec A., 2006. Struktura jakościowa i ilościowa fitoplanktonu jezior rzecznych doliny środkowego Bugu w okresie potamo i limnofazy, w: Jeziora rzeczne Doliny Środkowego Bugu. Różnorodność biologiczna i krajobrazowa, W. Wojciechowska (red.) Wydawnictwo KUL, Lublin, s. 51–53.

ZBIOROWISKA ZOOPLANKTONU W STARORZECZACH RZEKI WARTY (ROGALIŃSKI PARK KRAJOBRAZOWY): EFEKT SIEDLISKA I TYPU ZLEWNI

Streszczenie. Badania różnorodności gatunkowej i liczebności zooplanktonu prowadzono wiosną i latem 2008 r. w 18 starorzeczach, położonych w dolinie rzeki Warty. Zbiorniki te różniły się typem zlewni (leśna i polna) i badanych siedlisk (otwarta toń wodna i elodeidy).

W wyniku badań wykazano 198 taksonów zooplanktonu, przy czym wrotki (72% taksonów zooplanktonu) dominowały nad skorupiakami (28%). Struktura taksonomiczna była bardziej zróż-

nicowana w elodeidach niż w strefie otwartej wody, co odzwierciedla istnienie wielu nisz ekologicznych w złożonym siedlisku roślinnym.

Mimo że badane starorzecza charakteryzują się tym samym pochodzeniem, położone są w tym samym regionie i podlegają okresowym powodziom, umożliwiającym mieszanie się fauny, struktura gatunków dominujących była bardzo zróżnicowana (30 gatunków). Tylko 9 dominantów występowało z częstotliwością ponad 25%, co wskazuje na bardzo zmienne warunki środowiskowe panujące w starorzeczach. Ponadto duża liczba gatunków dominujących wystąpiła w powiązaniu z określonym typem zlewni. W starorzeczach leśnych dominowały gatunki litoralowe (np. *Acroperus harpae*, *Colurella uncinata*), podczas gdy w stawach polnych gatunki pelagiczne (np. *Anuraeopsis fissa*, *Daphnia longispina*).

Słowa kluczowe: elodeidy, gatunki litoralowe, gatunki pelagiczne, otwarta toń wodna, skorupiaki, wrotki