

## ZONALITY OF OCCURRING AND SPECIES COMPOSITION OF ZOOPLUSTON IN TWO EUTROPHIC WATER RESERVOIRS ON ŁĘCZNA-WŁODAWA LAKELAND

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**Abstract.** The aim of research carried out was to describe the zonality and structure of zoopluston in shallow eutrophic reservoirs. Zoopluston structure discovered in examined reservoirs was quite different than in depression reservoirs and lakes on Łęczna-Włodawa Lakeland. It was related to morphometry of reservoirs and plant richness of shallow littoral zone. Higher species richness in the water/land contact zone was found which confirms previous studies, however, sometimes zoopluston abundance showed the opposite pattern. Most differences occurred in dominants composition as in water/land contact zone and on the depth of 0.5 m dominated mainly by small species of Heteroptera: *Micronecta minutissima* and *Cymatia coleoptrata*.

**Key words:** zoopluston, zonality, water reservoirs, water/land zone, shallow littoral

### INTRODUCTION

Usually in the shallow littoral zone of lakes is a clear differentiation horizontal biocenoses existing there. Factors affecting this zone are depth and shape of the lake basin which affects to range of littoral and its surface spatial differentiation aquatic vegetation creating refuges for aquatic invertebrates. A group of animals particularly sensitive to these conditions is zoopluston. Zoopluston is a group of organisms containing many predatory species. Those species fare not only benthic invertebrates and small planktonic crustaceans but even small fish. Being a regular part of the lake littoral biocenoses zoopluston has a significant impact on of food interactions in this zone of the water reservoirs [Blaustein 1998, Gilbert and Hampton 2001, Saha *et al.* 2010].

This scientific description is a continuation of research on the zoopluston zonality occurrence in shallow littoral eutrophic and mesotrophic lakes and de-

pression reservoirs in Łęczna-Włodawa Lakeland. Until now it showed a clear reference to specific taxa in investigated littoral zones and found the relationship of abundance and species richness to specific habitats in different trophic lakes and depression reservoirs [Płaska 2002, 2007, 2012]. The aim of this study is to analyze this issue in the anthropogenically transformed reservoirs included in the system Wieprz-Krzna Channel.

#### STUDY AREA, MATERIAL AND METHODS

Researches were carried out on two eutrophic water-retaining reservoirs (Dratów and Krzcień) included in the system Wieprz-Krzna Channel on Łęczna-Włodawa Lakeland (south-east of Poland). Research were carried out from April to October in 2012. Samples were collected monthly in three repetitions from two shallow littoral zones: water/land contact zone (depth 0–0.1 m) and on the depth of 0.5 m. The surface of sample was 0.25 m<sup>2</sup>. The samples were collected using metal frame and hand net.

The area of Dratów Reservoir is 168 ha and its maximal depth is 3.2 m (N: 51°20'9'', E: 22°57'23''). It is strongly eutrophic reservoir [Radwan and Kornijów 1998]. In examined water/land contact zone occurred: *Hydrocharis morsus-ranae* and *Lemna minor*. On the depth of 0.5 m *Phragmites australis* dominated.

The area of Krzcień Reservoir is 174 ha and its maximal depth is 5.2 m (N: 51°23'30'', E: 22°55'39''). That strongly eutrophic reservoir is sometimes rated among hypertrophic reservoirs [Radwan and Kornijów 1998]. In examined contact zone dominated: *Hydrocharis morsus-ranae*, *Lemna minor* and *Carex* sp. On the depth of 0.5 m dominated: *Phragmites australis* and *Ceratophyllum demersum*.

#### RESULTS

##### **Taxonomical composition**

In both reservoirs the taxa number was nearly the same (14–15). In Dratów Reservoir the largest taxa number in water/land contact zone was found in summer (9). Slightly fewer species occurred on the depth of 0.5 m in summer (8). The least taxa in water/land contact zone were found in spring and autumn (4). The less number of taxa was found on the depth of 0.5 m in spring and autumn (2) (Fig. 1).

In Krzcień Reservoir the largest number of taxa in water/land contact zone was in the spring (11), and on the depth of 0.5 m it occurred in the spring (6). The

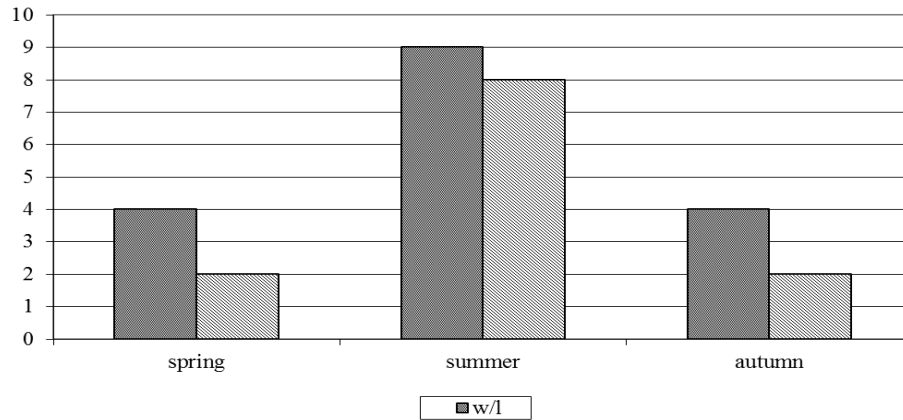


Fig. 1. Number of zoopluston taxa in investigated zones Dratów Reservoir

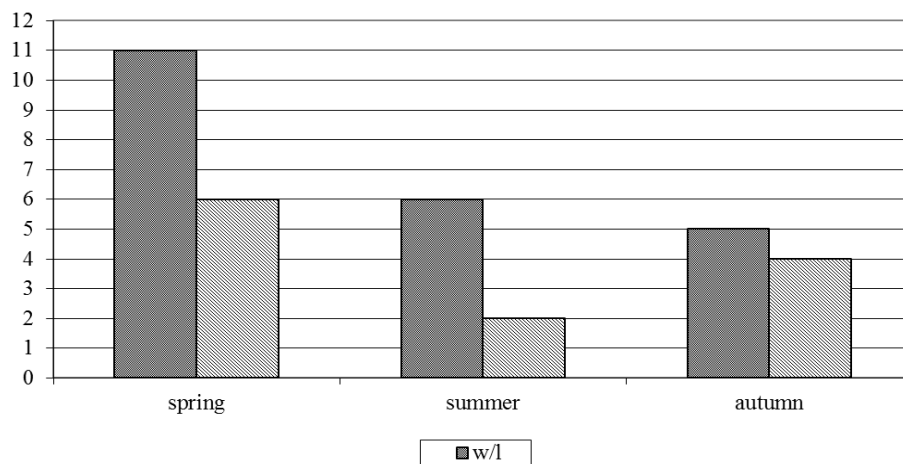


Fig. 2. Number of zoopluston taxa in investigated zones Krzcień Reservoir

less number of species in both zones occurred in summer and autumn and it amounted from 4 to 6 taksons in land/water zone and 2 to 4 taksons in 0.5 m depth. (Fig. 2).

### Abundance

In Dratów Reservoir in contact zone there was the highest density of zoopluston 242 ind. m<sup>-2</sup> in summer. The largest taxonomic group in water/land zone were Collembola, their mean density was 108 ind. m<sup>-2</sup> (Tab. 1). On the depth of 0.5 m maximum density of zoopluston was observed in summer on the 0.5 m depth (322 ind. m<sup>-2</sup>), with the domination of *Micronecta minutissima* (mean density

Table 1. Density of zoopluston in investigated reservoirs (mean values for studied period)

| No  | Taxon                                | Dratów Reservoir     |                      | Krzczeń Reservoir    |                      |
|-----|--------------------------------------|----------------------|----------------------|----------------------|----------------------|
|     |                                      | w/l                  | 0.5 m                | w/l                  | 0.5 m                |
|     |                                      | ind. m <sup>-2</sup> | ind. m <sup>-2</sup> | ind. m <sup>-2</sup> | ind. m <sup>-2</sup> |
| 1.  | <i>Cymatia coleoprata</i> (Fabr.)    | 13.0                 | 10.0                 | 19.3                 | 24                   |
| 2.  | <i>Notonecta glauca</i> L.           |                      |                      |                      | 0.3                  |
| 3.  | <i>Sigara striata</i> (L.)           |                      | 4.7                  |                      |                      |
| 4.  | <i>Micronecta minutissima</i> (L.)   | 12.0                 | 95.3                 |                      |                      |
| 5.  | <i>Plea minutissima</i> Leach        | 4.0                  | 1.3                  | 7.7                  | 5                    |
| 6.  | <i>Iliocoris cimicoides</i> (L.)     | 1.3                  |                      | 6.3                  | 4                    |
| 7.  | <i>Nepa cinerea</i> L.               | 1.3                  |                      |                      | 0.3                  |
| 8.  | <i>Microvelia buenoi</i> Drake       |                      |                      | 0.7                  |                      |
| 9.  | <i>Microvelia reticulata</i> (Burm.) |                      |                      | 1.3                  |                      |
| 10. | <i>Gerris argentatus</i> Schumm.     | 0.7                  |                      | 0.7                  |                      |
| 11. | <i>Mesovelia furcata</i> Musl        |                      | 1.3                  |                      |                      |
| 12. | <i>Gerris odontogaster</i> (Zett.)   |                      |                      | 0.3                  |                      |
| 13. | Corixinae larvae indet.              | 30.0                 | 16.0                 | 1.3                  | 1.6                  |
| 14. | Gerridae larvae indet.               | 0.7                  |                      | 1.3                  |                      |
| 15. | Coleoptera indet.                    | 4.7                  | 0.7                  | 8                    | 10.6                 |
| 16. | Coleoptera larvae indet              |                      | 0.7                  | 0.3                  |                      |
| 17. | Diptera indet.                       |                      |                      | 5.7                  |                      |
| 18. | <i>Podura aquatica</i> L.            | 108.7                | 12.7                 | 6                    |                      |

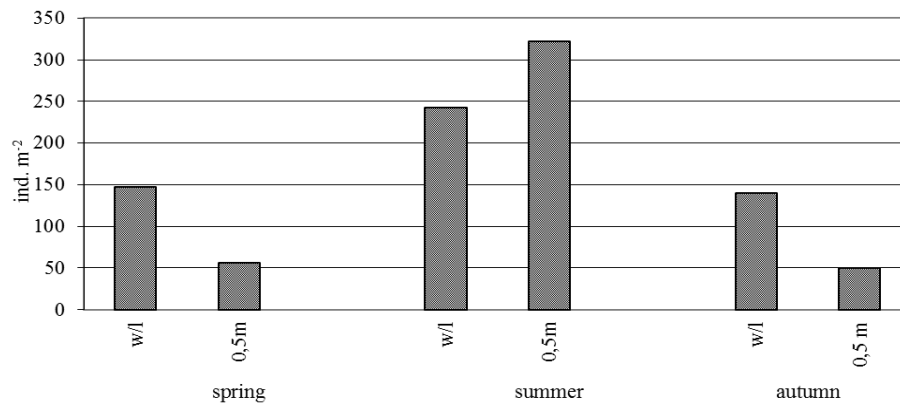


Fig. 3. Density of zoopluston in investigated zones Dratów Reservoir

95.5 ind. m<sup>-2</sup>). There were very low sample sizes of Coleoptera in 0.5 m depth in spring and autumn. These values ranged on average from 0 to 4.7 ind. m<sup>-2</sup> (Tab. 1, Fig. 3).

In Krzczeń Reservoir zoopluston occurred in highest concentrations in the contact zone of the water/land in spring, reaching a density of 93 ind. m<sup>-2</sup>. The largest

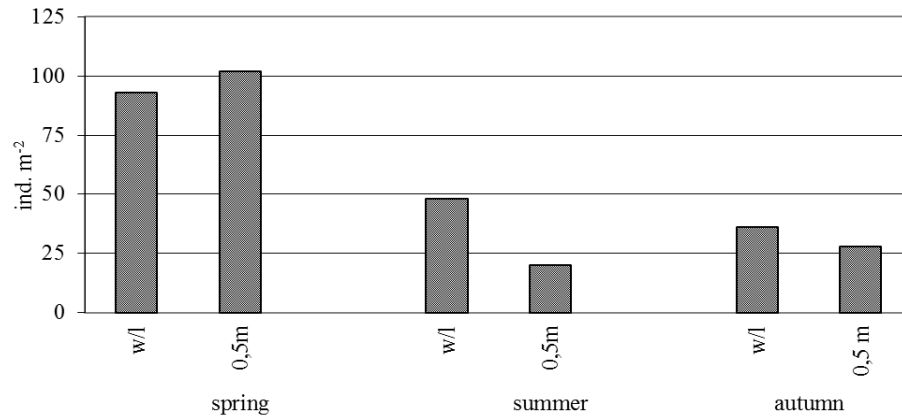


Fig. 4. Density of zoopluston in investigated zones Krzcień Reservoir

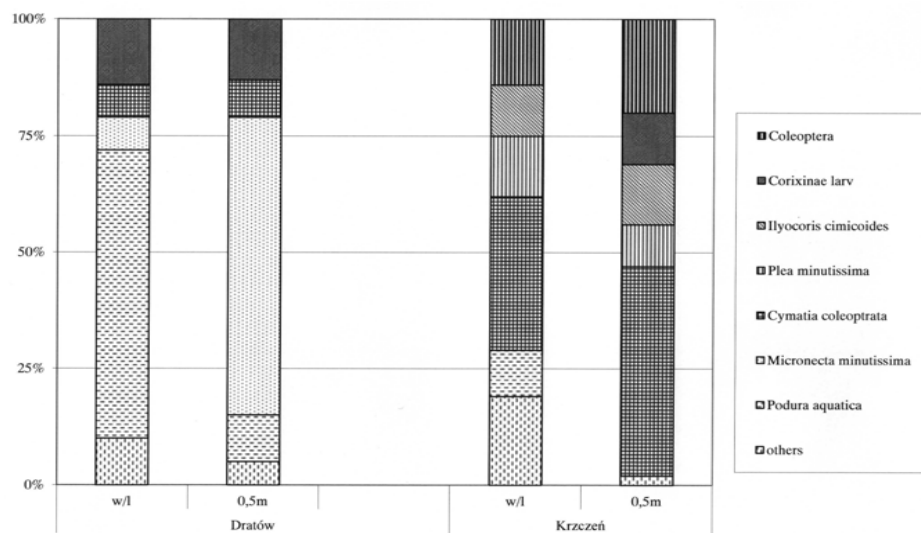


Fig. 5. Percentage avarande dominated zoopluston taxa in investigated zones Dratów and Krzcień Reservoirs

species was *Cymatia coleoptrata* wich achieved more than 19 ind. m<sup>-2</sup>. At a depth of 0.5 m in spring zoopluston density was slightly higher and they obtained 102 ind. m<sup>-2</sup>, and the most frequently taxa were also *C. coleoptrata* – 24 ind. m<sup>-2</sup> (Tab. 1, Fig. 4).

### Domination

In Dratów Reservoir in contact zone *Podura aquatica* was dominated species – 71%. Among Heteroptera Corixinae larvae predominated – 17%, slightly less were *M. minutissima* 7% and *C. coleoptrata* 7%. The remaining taxa were 10% of total zoopluston number. On the depth of 0.5 m *M. minutissima* (64%) clearly dominated. Others taxa group from quantity point of view appeared *Corixinae* larv. 13%. *P. aquatica* occurred 10% and *C. coleoptrata* 10%. The percentage contribution of other taxa was 5% (Fig. 5).

In Krzcień Reservoir in water/land contact zone *C. coleoptrata* dominated – 33%. In that reservoir domination appeared Coleoptera 14%, *P. aquatica* 10% and Diptera larv. 10%. Among Heteroptera *P. minutissima* amounted 9% and *Ilyocoris cimicoides* 11%. The remaining taxa obtained together 19%. On the depth of 0,5 m dominating species were: *C. coleoptrata* 45%. Coleoptera 20%, *I. cimicoides* 13% and Corixinae larv. with level of 11 %. The other taxa were 2% of total zoopluston number (Fig. 5).

### DISCUSSION

In zonality of zoopluston occurring in examined lakes and water reservoirs higher number of taxa was noted almost always in water/land contact zone. This is confirmed by these studies as well as those carried out in previous years in depression reservoirs and natural lakes in Łęczna Włodawa Lakeland [Płaska 2002, 2007, 2012]. Large species richness of contact zone may be caused by so called „contact effect”. It appears as growth of species variety [Naiman and Decamps 1997]. Another but also important reason could be usually very complex spatiality structure in contact zone making specific refuges. It provided one efficient shelter against predators as well as allowed for easy access to food for either predators or herbivore detritusfeeding invertebrates [Biesiadka and Moroz 1996, Kurzątkowska 1999, Tolonen *et al.* 2001, 2003]. However, in the examined reservoirs morphometrical parameters and shape of the lake basin does not pose such conditions. The steep banks caused the water zone land had a very small area. Such a structure littoral was devoid of significant refuges for pleustonic macroinvertebrates. [Mittelbach 1988, Paterson 1993] It was also probably the cause of low species richness examined reservoirs.

In zoopluston of lake littoral the largest number increase appeared in water/land contact zone among Coleoptera and Heteroptera or Collembola [Płaska 2007, 2012]. However quantity structure depended in greatly on littoral diversity and dominating taxa group populating given reservoir. This was confirmed in these studies where one of the dominant taxonomic groups in the examined reservoirs were small Heteroptera having no affection for the littoral zone. But higher number of taxa in water/land contact zone were connected with occurring of species characteristic for ecoton zones and described as so called „contact effect”

[Naiman and Decamps 1997]. In investigated reservoirs that dependences were formed poorly because of not typical zoopluston composition predominated by *C. coleoptrata* and *M. minutissima*. It was caused by poor rush and submerged vegetation occurring in the studied reservoirs

Each zoopluston taxa domination is connected with littoral conditions of lakes or water bodies. That explains why significant differences may be mainly caused by littoral plants growth level so called: habitat pattern [Biesiadka and Moroz 1996, Płaska 2012]. In shallow littoral of examined water reservoirs clear domination of *M. minutissima* and *P. aquatica* in Dratów and *C. coleoptrata* in Krzceń was found. High number of Collembola occurred often in land/water zone and shallow water zone in lakes and their process is described as fluctuation and difficult to explain. They appear usually for a short term dominating above other zoopluston taxa [Stach 1955]. In the man-made reservoirs due to the lack a specific contact zone water/land Collembola much less frequently occur in high densities. In examined water reservoirs in water/land contact zone mainly small species of Heteroptera occurred. It is common dominance in other anthropogenic reservoirs in Polesie [Płaska in 2007]. This is probably due to a strong eutrophication of water reservoirs and strong phytoplankton blooms. the dominant species of bugs have high demands of oxygen and they are observed in a highly oxygenated waters [Płaska 2002].

## CONCLUSION

Zone distribution and structure of zoopluston in shallow man-made water reservoirs characterized an average abundance and poor species richness. It is slightly different than in depression reservoirs and mesotrophic or eutrophic lakes. This may be caused by simplified spatial structure of the shallow littoral reservoirs. Such a system reduces area of water/land contact zone, and does not create favorable cover for zoopluston before the waving of water surface. It contributes to this worse growth of vegetation, which could create a favorable refuges for macroinvertebrates. Phytoplankton blooms occurring at the same time gives the opportunity to the development of small species epipleustonic bugs.

## REFERENCES

- Biesiadka E., Moroz M., 1996. A preliminary description of water bugs (*Heteroptera*) of the Zehlau peatbog. Wyd. Uniw. w Kaliningradzie, 39–41.
- Blaustein L., 1998. Influence of the predatory backswimmer, *Notonecta maculata*, on invertebrate community structure. Ecol. Entomol. 23, 246–252.
- Gilbert J.J., Hampton S.E., 2001. Diel vertical migrations of zooplankton in a shallow, fishless pond: a possible avoidance-response cascade induced by notonectids. Freshwater Biol. 46, 611–621.

- Kurzątkowska A., 1999. Water bugs (*Heteroptera*) of high bogs and transistional moors of Masurian Lake District. Pol. Pismo Entomol. 68, 349–369.
- Mittelbach G.G., 1988. Competition among refunging sunfishes and effects of fish density on littoral zone invertebrates. Ecology 69, 614–623.
- Naiman R.J., Decamps H., 1997. The ecology of interfaces: riparian zones. Ann. Rev. Ecol. Syst. 28, 621–658.
- Paterson M., 1993. The distribution of microcrustacea in littoral zone of a freshwater lake. Hydrobiologia 263, 173–183.
- Plaska W., 2002. Zonality in the occurrence of zoopluston in the shallow littoral zone of the Piaseczno Lake (Lublin Polesie Region). Acta Agrophysica 67, 249–254.
- Plaska W., 2007. Zonal distribution of zoopluston in depression reservoirs on Łęczyńsko-Włodawskie Lakeland. Teka Kom. Ochr. Kszt. Środ. Przyr. 4, 202–206.
- Plaska W., 2012. Zonality in occurring of zoo pleuston in two eutrophic lakes on Łęczna-Włodawa Lakeland. Teka Kom. Ochr. Kszt. Środ. Przyr. 9, 173–180.
- Radwan S., Kornijów R., 1998. Hydrobiologiczne cechy jezior: stan aktualny i kierunki zmian. W: Harasimiuk M., Michalczyk Z., Turczyński M. (red.). Jeziora łęczyńsko-włodawskie. Monografia przyrodnicza. Wyd. UMCS, Lublin, 129–144.
- Saha N., Aditya G., Saha G.K., Hampton S.E., 2010. Opportunistic foraging by heteropteran mosquito predators. Aquat. Ecol. 44, 167–176.
- Stach J., 1955. Klucze do oznaczania owadów Polski. Część II. Skoczogonki – *Collembola*. Wyd. PWN, Warszawa.
- Tolonen K.T., Hämäläinen H., Holopainen I.J., Kariäläinen J., 2001. Influences of habitat type and environmental variables on littoral macroinvertebrate communities in a large lake system. Arch. Hydrobiol. 152, 39–67.
- Tolonen K., Hämäläinen H., Holopainen I.J., Mikkonen K., Karjalainen J., 2003. Body size and substrate association of littoral insect in relation to vegetation structure. Hydrobiologia 499, 179–190.

#### STREFOWOŚĆ WYSTĘPOWANIA I STRUKTURA GATUNKOWA ZOOPLUSTONU W DWÓCH EUTROFICZNYCH ZBIORNIKACH WODNYCH NA POJEZIERZU ŁĘCZYŃSKO-WŁODAWSKIM

**Streszczenie.** Celem przeprowadzonych badań było określenie strefowości występowania i struktury gatunkowej zoopluston w dwóch płytkich jeziorach eutroficznych. Struktura zoopluston była inna niż w badanych w poprzednich latach zbiornikach zapadliskowych i jeziorach różnej trofii na Pojezierzu Łęczyńsko-Włodawskim. Związane to było z morfometrią i ubóstwem makrofitów w strefie płytkiego litoralu. W strukturze gatunkowej stwierdzono większe bogactwo w strefie stykowej woda/łód, co jest zbieżne z innymi badaniami prowadzonymi w tych strefach, jednak zagęszczenie charakteryzuje się niekiedy odwróconym układem. Zasadnicze różnice występują w składzie dominantów, gdyż w strefie stykowej woda/łód i na głębokości 0,5 m dominowały głównie małe gatunki Heteroptera: *Micronecta minutissima*.

**Słowa kluczowe:** zoopluston, strefowość, jeziora eutroficzne, strefa woda/łód, płytki litoral