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BIODIVERSITY HOT SPOT AND IMPORTANT REFUGIUM OF THE POTAMOCOEN? AQUATIC BEETLES (COLEOPTERA: ADEPHAGA, HYDROPHILOIDEA, STAPHYLINODEA, BYRRHOIDEA) OF THE RIVER BUG VALLEY BETWEEN WŁODAWA AND KODEŃ (EASTERN POLAND)

Abstract

Between 2004 and 2007, aquatic beetles of the River Bug Valley between Włodawa and Kodeń (65 km of the course of the river) were studied. As a result of the study, 118 species were recorded. More than 20 of those were found for the first time in Podlasie as a faunistic region, are very rare in Poland, and/or data on the species are important for the determination of their distribution areas. The following were the most valuable: *Aulonogyrus concinnus*, *Rhantus incognitus*, *Hydrochus flavipennis*, *H. megaphallus*, *Ochthebius flavipes*, *Potamophilus acuminatus*, and *Macronychus quadrituberculatus*. Oxbow lakes were the most significant for fauna species diversity, and the River Bug was inhabited by the most valuable and the most natural fauna. The hypothesis that the middle course of the River Bug is a refugium of potamocoen fauna was partially confirmed.

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The studied area turned out to be equally significant for the preservation of beetles as the part of the valley studied earlier (Przewoźny *et al*. 2006). Between 1999 and 2007, along the Gołębie-Kodeń river section (246 km of the river course), a total of 166 species were found. The Middle River Bug Valley was found to be an area of supranational significance for the preservation of beetles at the level of species diversity, species assemblages, and occurrence of protected and endangered species. Its values are comparable to those of the Białowieża Primeval Forest, and are higher than those of Polish national and landscape parks studied so far. The significance of the Middle River Bug Valley is also confirmed by the determination of a number of species included in the Red List of endangered animals of Germany (43 species), Czech Republic (35 species), and Slovakia (13 species).

Key Words: Coleoptera, aquatic beetles, faunistics, assemblages, river valley, preservation, endangered species, Poland

Introduction

Between 1993 and 2003, a study was conducted concerning aquatic beetles of the Polish part of the River Bug Valley along the section of a length of 204 km: from Gołębie, where the River Bug constitutes the border between Poland and Ukraine, to the Pawluki village (12 km north of Włodawa) (Przewoźny et al. 2006). Fauna very rich in qualitative and quantitative terms was found, abundant in species rare and endangered in Poland, typical of untransformed river valleys.

The most valuable feature of the fauna of the River Bug Valley, noticeable in the studies by Przewoźny et al. (2006), was the presence, although not always in high numbers, of species of potamocoen – endangered assemblage of organisms of large rivers (Klausnitzer 1996). It was assumed that the assemblage is better developed further down the river, i.e. it is richer in specific species and/or includes their higher numbers. Further works were undertaken in order to verify the hypothesis. The objective was to gain a more thorough insight into the northernmost and still little studied part of the area analysed (Włodawa-Pawluki, 23 km of the river course – where only a few common species were determined – Przewoźny et al. 2006), and to collect data from the further 42 km (Pawluki-Kodeń). The study also aimed at the assessment of the entire species diversity of the fauna of the River Bug Valley along that section, and its significance for preservation of beetles.

Study area

The study area is located at the western fringe of Polesie Brzeskie (Brest Polessye) – the mesoregion of Polesie Zachodnie (Western Polessye), situated mainly in Belarus and Ukraine, as well as in Poland, comprising the River Bug Valley from Wola Uhruska to Terespol (Kondracki 2002). The study concerned the area from 51°32' to 51°55' N. According to the Catalogue of Fauna of Poland (Burakowski et al. 1976), the entire area belongs to the faunistic region of Podlasie.

The River Bug is the longest right-bank tributary of the Vistula River (755 km), and the largest unregulated river of Middle Europe. The territory of Poland includes its middle and lower course with a total length of 587 km (Michalczyk & Wilgat 1998).

The width of the River Bug in the study area is from 30–100 m (the upper part of the section studied) to 50–100 m (the lower part). In the vicinity of Włodawa, the river valley has the form of a gorge with a width of approximately 3 km, as compared to a width of 10 km above that section. Below Włodawa, it widens to 4–8 km. It cuts through a typical valley of Polesie, with a monotonous relief and elevation of up to 155 m above sea level. The River Bug meanders strongly. Few of its sections are straight. The width of the meander belt amounts to 1.5 km (Szwajgier et al. 2002).

The study area is located in the part of the River Bug Valley belonging to the botanic region of Podlasie, beginning in Skryhiczyn (Urban & Wójciak 2002). A major part of the area is under cultivation of cereals, root plants, and vegetables. In contrast to the Polesie part located upstream, soils are sandy and not loess. The valley also includes less peats and forests, and the valley bottom has a more varied relief, with lesser degree of melioration. Numerous oxbow lakes occur here, inhabited by aquatic and rush vegetation a lot of which is postulated to be covered by protection (Urban & Wójciak 2002). Small permanent and temporary water bodies on the flood plain are also numerous. Stagnant waters are transformed to very little extent. Small rivers and streams are mostly unregulated.

The catchment area of the River Bug is among the least polluted river systems in Poland. During the study, the waters of the Bug River were identified as quality class IV, in Włodawa and Stawki periodically as quality class V. The factor with the highest values was "a" chlorophyll concentration related to the agricultural catchment of the river. The following values were also high: COD5, colour, phosphorates, nitrogen compounds, total organic carbon, and sanitary indices. The values of water oxygenation and electrolytic conductivity varied between class I and II (Iwaniuk & Piebiak 2008; Miazga et al. 2006; Miazga & Parcheta 2007).

Small river were included in water class IV (Kałamanka and Włodawka) or in the class V (Hanna). Here it was also determined by factors related to eutrophication and sanitary indices (Iwaniuk & Piebiak 2008; Miazga et al. 2006; Miazga & Parcheta 2007).

The studied area is located in the climatic region of Podlasie (Stopa-Boryczka & Boryczka 2005). It is cool, particularly in winter; the mean temperature in January amounts to –4°C. The duration of winter is 90–100 days. The snow cover is present for over 70 days. The duration of the vegetation period is 200 –210 days. Annual precipitation amounts to 520–600 mm.

Research sites

The material was collected at 30 sites (Fig. 1). Those included: 1) Włodawa, the dam reservoir on the River Włodawka; 2) Suszno, the River Bug; 3) Szuminka, the River Bug; 4) Szuminka, a small temporary water body; 5) Szuminka, a meadow canal (Kanał Partyzantów); 6) Różanka, the River Bug; 7) Stawki, the River Bug; 8) Stawki, a water body on the bottom of a temporary flowing ditch; 9) Pawluki, the River Bug; 10) Pawluki, a small temporary water body; 11) Pawluki, an oxbow lake of the River Bug; 12) Dołhobrody, the River Bug; 13) Dołhobrody, a small temporary water body; 14) Dołhobrody, an oxbow lake of the River Bug; 15) Dołhobrody, a small water body – rivulet backwater; 16) Dołhobrody, a small permanent water body; 17) Hanna, a regulated meadow stream; 18) Hanna, the River Hanna; 19) Kużawka, a meadow stream; 20) Sławatycze, an oxbow lake of the River Bug; 21) Sławatycze, the River Bug; 22) Nowosiółki, an oxbow lake of the River Bug; 23) Jabłeczna, the River Bug; 24) Jabłeczna, an oxbow lake of the River Bug; 25) Kolonia Szostaki, the Stream Sajówka (regulated); 26) Szostaki, the River Bug; 27) Szostaki, a small temporary water body; 28) Kodeń, the River Kałamanka; 29) Kodeń III – the Łęgi Range, an oxbow lake of the River Bug; 30) Kodeń, the River Bug.

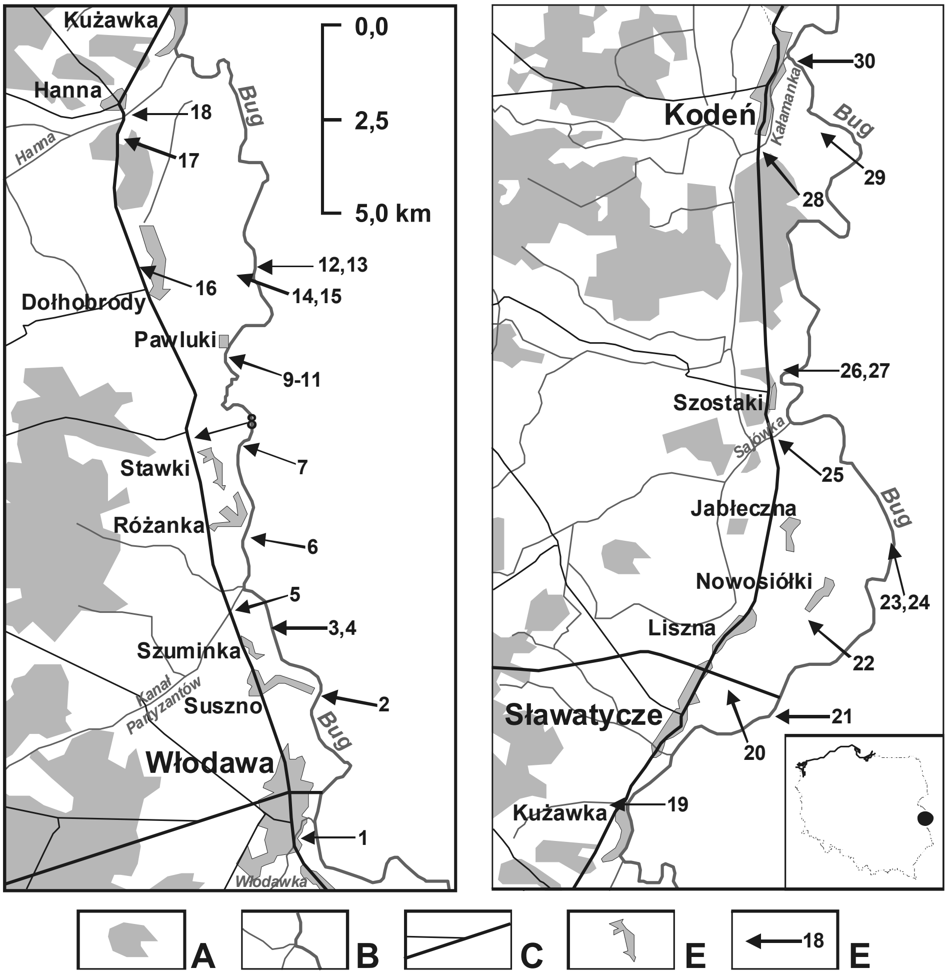

Fig. 1. Study area. A – forests and larger tree stands, B – flowing waters, C – roads, D – towns, E – study sites

According to own measurements, the warmest habitat was the River Bug: its waters in the coastal zone reached up to 29.6°C in summer. All of the stagnant waters were also warm (24.1–27.8°C). Small rivers, streams, and canals were moderately warm (20–21°C).

Water analysis revealed pH from slightly alkaline to alkaline. In the River Bug, pH amounted to 7.46–8.59 (8.14 on the average), in smaller running waters – 7.40–8.50 (7.90 on the average), and in stagnant waters – 7.27–8.54 (7.83 on the average).

Values of electrolytic conductivity were somewhat more varied. In the River Bug, they amounted to 627–876 $\mu S \cdot cm^{-2}$ (723 on the average). The value of 376 $\mu S \cdot cm^{-2}$ was recorded only once (Stawki, spring 2007). In other flowing waters, its values varied between 274 and 840 $\mu S \cdot cm^{-2}$ (531 on the average), and in running waters: 356–875 $\mu S \cdot cm^{-2}$ (579 on the average), whereas the lowest electrolytic conductivity was determined for oxbow lakes in Pawluki and Kodeń III (< 500 $\mu S \cdot cm^{-2}$).

The best oxygen conditions occurred in the River Bug: 4.9–15.9 mg $O_2 \cdot dm^{-3}$ (10.2 on the average). Oxygen concentration below 5 $mg \cdot dm^{-3}$ was determined only once (Dołhobrody, autumn 2006). Significantly worse conditions were revealed in the case of other running waters: 1.2–14.1 mg $O_2 \cdot$dm–3 (5.4 on the average), whereas 60% of the measurements were below 5 mg $O_2 \cdot dm^{-3}$. The worst conditions occurred in stagnant waters: 0.9–15.2 mg $O_2 \cdot dm^{-3}$ (4.1 on the average) and 73% of measurements below 5 mg $O_2 \cdot dm^{-3}$.

Methods and material

In 2004 and 2006, each time one sample was taken from the dam reservoir in Włodawa. The remaining sites were studied in the years 2005–2007. In 2005, two faunistic recoinnaisances of the studied area were performed: in July and August. In following years, material was collected regularly three times at each site: in spring (V–VI), summer (VII–VIII), and autumn (IX–X).

Adult beetles and larvae were collected from the bottom, vegetation, and detritus using a hydrobiological net (semi-quantitative samples). 2778 individuals were collected: 2702 imagines and 76 larvae.

At the sites studied, the following was measured: water temperature, pH, electrolytic conductivity, and dissolved oxygen concentration. The measurements were performed by means of: a Slandi TM204 thermometer, Slandi PH204 pH-meter, Slandi CM204 conductometer, and Hanna Instruments HI 9145 oxygen meter.

For the analysis of the material, the dominance index was applied (Szujecki 1983), determining 5 categories of species: eudominants (numbers > 10%), dominants (5–10%), subdominants (2–5%), recedents (1–2%), and accessory species (< 1%). Qualitative faunistic similarities were calculated by means of Jacquard's formula (Szujecki 1983), and quantitative similarities – according to Biesiadka's formula (1977).

The study by Przewoźny et al. (2006) was used in the analysis of ecological elements.

The following was used for the sozological analyses: list of protected species (Rozporządzenie... 2011), Red List of beetles of Poland (Pawłowski et al. 2002), Red List of beetles of the Lublin District (Staniec et al. in press), list of umbrella species (Czachorowski et al. 2000). Based on those sources, the following species were distinguished in the material collected: a) species endangered at the national scale, of high importance (≥ VU), obtaining 5 points; b) endangered at the national scale, of low importance (categories LC and NT) – 4 points; c) endangered at the regional scale, of high importance – 3 points; d) endangered at the regional scale, of low importance – 2 points; e) having only indication significance – 1 point. Each species was taken into account only once, considering only the highest ones from the relevant groups.

Results

118 species were found, belonging to 11 families: Gyrinidae (8 species), Haliplidae (9 species), Noteridae (2), Dytiscidae (58), Helophoridae (6), Hydrochidae (4), Spercheidae (1), Hydrophilidae (19), Hydraenidae (7), Elmidae (3), and Dryopidae (1) (Table 1).

tab. 1

The following information concerns species the most interesting due to sozological (species protection, entries in Red Lists) and/or zoogeographical reasons (localities at the border or near the border of distribution, rare occurrence in Poland):

- *Aulonogyrus concinnus* – species collected frequently (15 samples) throughout the vegetation period, although in various numbers: the most numerous in summer (67.2% of material collected), less numerous in spring (32.3%), and scarce in autumn (0.4%). Very numerous in the coastal zone of the River Bug: aggregations of a few hundred individuals were often found here. In other environments, rare and scarce, collected one at a time in a small river (site 18, 15.05.2007, 3 exx.) and oxbow lake (site 20, 26.05.2006, 1 ex.).
- *Gyrinus distinctus* – collected a few times in the coastal zones of small running waters: the River Hanna (26.07.2005, 33 exx., 10.05.2006, 1 ex.), the meadow ditch being its tributary (26.07.2005, 6 exx.), and the River Kałamanka

(27.08.2005, 1 ex.). It developed aggregations together with *G. aeratus* and *G. substriatus*, constituting the most numerous species in the aggregations.

- *Gyrinus paykulli* – recorded once in the dam reservoir (site 1, 1.10.2006, 1 ex.).
- *Haliplus confinis* – recorded once in the dam reservoir (site 1, 1.10.2006, 1 ex.).
- *Haliplus varius* – very rare, collected only once among sedges at the shore of an oxbow lake (site 20, 26.07.2005, 1 ex.).
- *Agabus fuscipennis* – recorded twice: in a temporary meadow water body (site 13, 10 V 2006, 1 ex.) and in the shallow coastal zone of an oxbow lake (site 24, 16.05.2007, 4 exx.).
- *Rhantus consputus* – one individual was collected in a slightly distrophic oxbow lake located in *Ribeso nigri-Alnetum* (site 14, 10.05.2006).
- *Rhantus incognitus* – single individuals collected three times: among dense shore vegetation in a small river (site 28, 11.05.2006) and in small oxbow lakes, in places shaded by a forest (*Ribeso nigri-Alnetum*) or willow shrubs (site 11, 26.07.2005; site 14, 10.05.2006).
- *Rhantus notaticollis* – two individuals collected in the shallow coastal zone of an oxbow lake in the open area (site 24, 11.05.2006).
- *Graphoderus bilineatus* – single individuals collected in a temporary meadow water body (site 14, 20.05.2006) and shallow oxbow lakes in the open area (site 11, 26.07.2005; site 24, 27.08.2005).
- *Graphoderus zonatus* – found in a temporary meadow water body (site 13, 20.05.2006, 1 ex.)
- *Dytiscus circumflexus* – one individual collected in a slightly dystrophic oxbow lake located in *Ribeso nigri-Alnetum* (site 14, 10.05.2006).
- *Helophorus dorsalis* – one individual collected in the shallow coastal zone of the River Bug (site 3, 17.07.2007).
- *Hydrochus flavipennis* – one individual (♀) collected in a shallow temporary water body overgrown with Juncus sp. on a meadow at the River Bug (site 27, 13.07.2007).
- *Hydrochus megaphallus* – found in the coastal zone of a large oxbow lake of a lake character (site 20, 13.07.2007, 1 ex.).
- *Spercheus emarginatus* – collected in a small astatic water body on the second (higher) flood plain (site 16, 10.05.2006, 1 ex.).

- *Hydrophilus aterrimus* – recorded in a warm temporary water body on a meadow at the River Bug (site 13, 10.05.2006, 2 exx.) and in the coastal zone of an oxbow lake (site 24, 27.08.2005, 1 ex.).
- *Cercyon tristis* – collected in the coastal zone of the River Bug (site 21, 21.07.2006, 1 ex.).
- *Limnebius papposus* – one individual collected in the coastal zone of a temporary water body overgrown with *Juncus* sp. (site 27, 30.07.2006).
- *Ochthebius flavipes* – rarely recorded, mainly in the coastal zone of the River Bug (twice at sites 9 and 12). Also recorded in a small river (site 18) and in an oxbow lake (site 11). Collected mainly in summer (87.5% of material), only once in spring.
- *Potamophilus acuminatus* – one individual collected in the coastal zone of the River Bug (site 9, 13.07.2007)[1].
- *Macronychus quadrituberculatus* – found only in the River Bug, along the larger part of the study area (sites no. 3, 9, 12, 21, 26, 30). It was a numerous species in the environment (dominant, 6.7% of material collected). All of the cases recorded occurred in July and August.

The dominance structure of beetles was very even: no eudominant was distinguished, and the value of the PIE index for the entire material amounted to 0.95. Dominants included: *Aulonogyrus concinnus*, *Gyrinus substriatus*, *G. natator*, *Porhydrus lineatus*, *Helophorus granularis*, and *Laccophilus hyalinus*. Also 7 subdominants, 11 recedents, and 94 accessory species were distinguished.

The most widespread species was *Hydroporus palustris*, recorded in 63% of sites. In >50% of sites also the following species were collected: *Helophorus granularis*, *Anacaena limbata*, *A. lutescens*, and *Hydrobius fuscipes*. Quite common (> 25% sites) were also: *Haliplus fluviatilis*, *Hyphydrus ovatus*, *Noterus crassicornis*, *Porhydrus lineatus*, *Gyrinus substriatus*, *Hygrotus inaequalis*, *Haliplus ruficollis*, *Hydroporus striola*, *Orectochilus villosus*, *Aulonogyrus concinnus*, *Gyrinus aeratus*, *Helophorus minutus*, and *Hygrotus impressopunctatus*.

Six ecological elements were distinguished in the material collected: argilophiles, hylophiles, psammophiles, reophiles, tyrphophiles, and eurytopes. Eurytopes clearly dominated (63.1% of individuals collected). Reophiles (20.4%) and tyrphophiles (12.6%) were less numerous. The remaining elements were

[1] A record discussed in detail in the paper of Buczyński et al. (2011).

represented by few individuals: hylophiles – 2.9%, argilophiles and psammophiles – 0.5% each.

In individual environments, 18–85 species of beetles were recorded. The most rich fauna occurred in oxbow lakes (85 species). High species diversity was also determined in small water bodies (56 species), small rivers and streams (51 species), and the Bug River (44 species). The least number of species were collected in canals (19) and in the dam reservoir (18), although data for the latter is incomplete due to a small number of samples.

In the fauna of the River Bug, three eudominants (*Aulonogyrus concinnus* – 33.4%, *Laccophilus hyalinus* – 24.3%, *Helophorus granularis* – 10.1%) and one dominant (*Macronychus quadrituberculatus* – 6.7%) was distinguished. Moreover, three subdominants, three recedents, and 34 accessory species were determined. The beetle assemblage in the River Bug was highly specific in terms of habitat; reophiles constituted as much as 71.2% of the material collected (Fig. 2). Also eurytopes were quite numerous (26.1%). The remaining ecological elements determined (argilophiles, hylophiles, psammophiles, tyrphophiles) were represented by few individuals (0.5–2.9%). The value of the Hurlbert index for the River Bug amounted to 0.79 (Fig. 3).

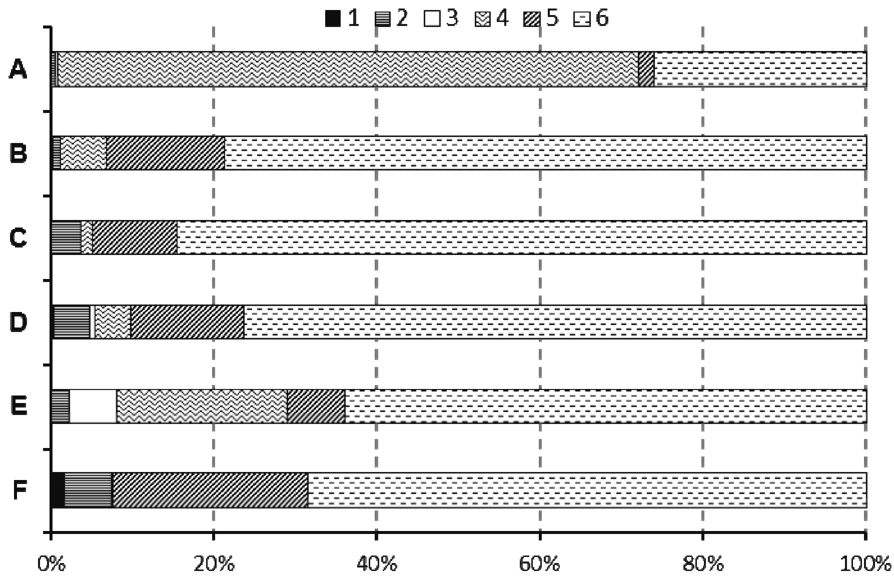

Fig. 2. Quantitative participation of individual ecological elements in material collected (%). A-E – environments (designations as in Table 1), 1-6 – ecological elements (1 – argilophiles, 2 – hylophiles, 3 – psammophiles, 4 – reophiles, 5 – tyrphophiles, 6 – eurytopes)

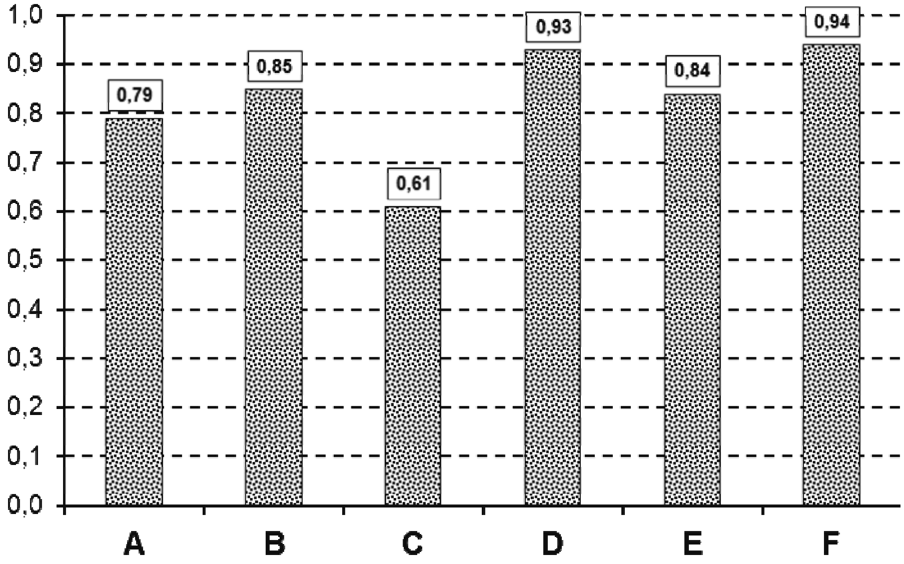

Fig. 3. Values of the beetle species diversity index (PIE) for the environments studied (designations as in Table 1)

In the fauna of streams and rivers, two eudominants (*Gyrinus substriatus* – 27.7% and *G. natator* – 19.4%), one dominant (*Gyrinus distinctus* – 7.5%), 7 subdominants, 7 recedents, and 34 accessory species were distinguished. Eurytopes predominated (78.7%), and the second numerous element were tyrphophiles (14.5%). Reophiles constituted only 5.6% of material collected. Hylophiles and psammophiles were represented by few individuals (0.2 and 1.0%) (Fig. 2). The Hurlbert index reached the value of 0.85 (Fig. 3).

In the canals, *Gyrinus substriatus* (56.7%) and *G. natator* (17.9%) predominated. In addition to those eudominants, 5 subdominants and 12 accessory species were distinguished. The ecological structure of the assemblage was strongly dominated by eurytopes (84.4%), along with quite numerous tyrphophiles (10.4%). Hylophiles (3.7%) and reophiles (1.5%) occurred in low numbers (Fig. 2). The value of the Hurlbert index amounted to 0.61 (Fig. 3).

The eudominant in oxbow lakes was *Porhydrus lineatus* (18.7%), and the dominants were: *Noterus crassicornis* (7.5%), *Hyphydrus ovatus* (7.5%), and *Haliplus ruficollis* (5.2%). Moreover, 8 subdominants, 7 recedents, and 66 accessory species were recorded. The most numerously represented ecological elements were eurytopes (76.3%) and tyrphophiles (13.8%). Hylophiles and reophiles constituted 4.4% of material collected each, and the participation of argilophiles and psammophiles was at the level of < 1% (Fig. 2). The PIE index amounted to 0.93 (Fig. 3).

In the dam reservoir, eudominants were *Ilybius fenestratus* (22.2%) and *Laccophilus minutus* (18.5%), and dominants: *Haliplus fluviatilis* (8.6%), *Hygrotus impressopunctatus* (8.6%), *Noterus clavicornis* (7.4%), and *Laccophilus hyalinus* (7.4%). Also 5 subdominants and 7 recedents were distinguished (Fig. 2). The ecological structure of material collected was dominated by eurytopes (64.0%) and reophiles (20.9%). Tyrphophiles (7.0%), psammophiles (5.8%), and argilophiles (2.3%) were also found (Fig. 2). The value of the Hurlbert index amounted to 0.84 (Fig. 3).

The fauna of small water bodies included: one eudominant (*Helophorus granularis* – 11.1%), four dominants (*Helophorus minutus* – 9.3%, *Anacaena lutescens* – 7.5%, *Limnebius parvulus* – 6.5%, *Hydroporus striola* – 5.3%), 11 subdominants, 8 recedents, and 32 accessory species. Similarly as in oxbow lakes, ecological elements were dominated by eurytopes (68.5%) and tyrphophiles (23.9%). Also hylophiles (5.8%), argilophiles (1.6%), and reophiles (0.2%) were collected (Fig. 2). The value of the PIE index amounted to 0.94 (Fig. 3).

Qualitative and quantitative faunistic similarities between the environments studied were equivalent. Oxbow lakes and small water bodies were the most similar to each other, constituting a distinguishable group along with rivers and rivulets in terms of qualitative similarities. Canals corresponded to rivers and rivulets, and the River Bug – to oxbow lakes (Fig. 4). The dam reservoir was the most distinct, with the strongest correspondence to the Bug River. The data, however, is not fully reliable, because they are based on material from one site and a low number of samples. Fig. 4. Simplified Wrocław dendrite of faunistic similarities [%] between the environments studied. Upper diagram – qualitative similarities, lower diagram – quantitative similarities (designations as in Table 1).

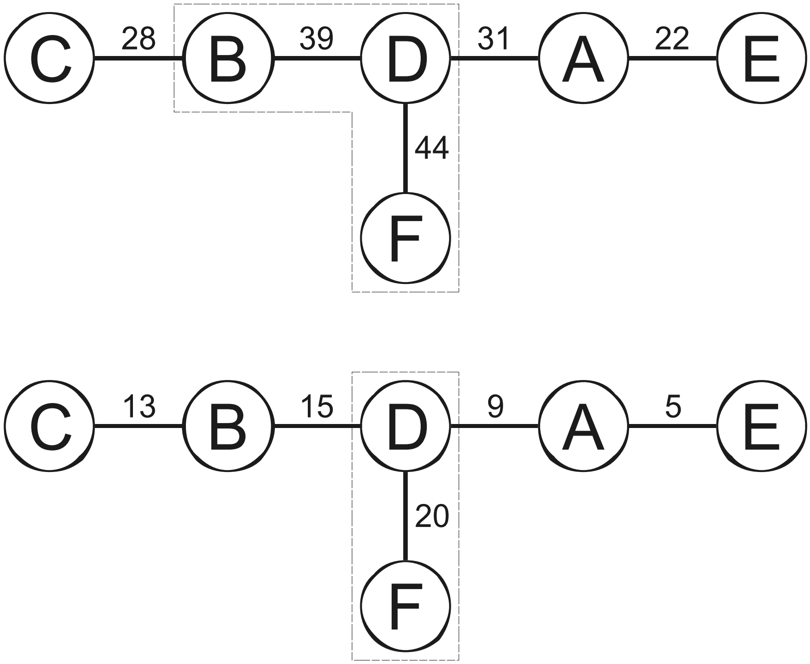

Fig. 4. Simplified Wrocław dendrite of faunistic similarities [%] between the environments studied. Upper diagram – qualitative similarities, lower diagram – quantitative similarities (designations as in Table 1)

The occurrence of the following was recorded: 10 species from the Polish Red List, 12 species from the regional List, one protected species, and two indicator species (Table 2). They occurred in 19 sites (63% of all sites) (Fig. 5). Sites No.: 9, 23, 21, 12, 20, 3, 11 were the most valuable. Among sites graded ≥ 9, the River Bug dominated: 5 sites, including four sites with the highest grade. Oxbow lakes follow in the classification (four sites) along with small rivers and small water bodies (one site each).

Table 1. Aquatic beetles recorded in the study area. Habitats: A – the Bug River, B – streams and rivulets, C – canals, D – oxbow lakes, E – dam reservoir, F – small water bodies. Σ – total number of specimens, D – dominance

Species		**Distribution in localities**	**Specimens collected in particular habitats**						**Σ**	**D[%]**
			A	**B**	**C**	**D**	**E**	**F**		
1		2	3	4	5	6	7	8	9	10
Gyrinidae										
1.	*Aulonogyrus concinnus* (Klug)	3, 9, 12, 18, 20, 21, 23, 30	225	3	–	1	–	–	229	8.21
2.	*Gyrinus aeratus* Steph.	3, 11, 12, 14, 17,18, 20, 21	3	25	–	10	–	–	38	1.36
3.	*G. distinctus* Aubé	17, 18, 28	–	47	–	–	–	–	47	1.69
4.	*G. marinus* Gyll.	1, 11, 20, 29	–	–	–	22	3	–	25	0.90
5.	*G. natator* (L.)	3, 5, 11, 18, 25, 26, 28	3	122	76	1	–	–	202	7.25
6.	*G. paykulli* Ochs	1	–	–	–	–	1	–	1	0.04
7.	*G. substriatus* Steph.	5, 7-9, 11, 12, 14, 17, 18, 25, 28	3	174	24	7	–	4	213	7.64
8.	*Orectochilus villosus* (O.F. Müll.)	3, 9, 12, 18, 20, 21, 23, 26, 30	26	2	–	1	–	–	36	1.29
Haliplidae										
9.	*Peltodytes caesus* (Duftschm.)	21, 22	–	–	–	1	1	–	2	0.07
10.	*Haliplus confinis* Steph.	1	–	–	–	–	4	–	4	0.14
11.	*H. flavicollis* Sturm	1, 11, 22, 23	2	–	–	5	4	–	11	0.39
12.	*H. fluviatilis* Aubé	1, 3, 5-7, 9, 11, 14, 17, 20, 21, 23, 24	19	2	1	26	7	–	55	1.97
13.	*H. immaculatus* Gerh.	5, 28	–	1	1	–	–	–	2	0.07
14.	*H. lineatocollis* (Marsh.)	17	–	1	–	–	–	–	1	0.04
15.	*H. ruficollis* (De G.)	11, 15, 16, 20, 22-24, 27, 28	1	8	–	40	–	12	61	2.19
16.	*H. sibiricus* Motsch.	12, 13, 25	1	3	–	–	–	1	5	0.18
17.	*H. varius* Nic.	20	–	–	–	1	–	–	1	0.07
Noteridae										
18.	Noterus clavicornis (De G.)	1, 11, 20, 22, 29	–	–	–	7	6	–	13	0.47
19.	*N. crassicornis* (O.F. Müll.)	10, 11, 13-17, 20, 22, 24, 28, 29	–	4	–	58	–	15	77	2.77
–.	*Noterus* sp. larvae n.det.	9	1	–	–	–	–	–	1	0.04

1		2	3	4	5	6	7	8	9	10
Dytiscidae										
20.	*Agabus bipustulatus* (L.)	8	–	–	–	–	–	2	2	0.07
21.	*A. fuscipennis* (Payk.)	13, 24	–	–	–	4	–	1	5	0.18
22.	*A. sturmii* (Gyll.)	28	–	1	–	–	–	–	1	0.04
23.	*A. uliginosus* (L.)	14	–	–	–	1	–	–	1	0.04
24.	*A. undulatus* (Schrank)	11, 13, 14	–	–	–	4	–	2	6	0.22
–.	*Agabus* sp. larvae n.det.	8	–	–	–	–	–	1	1	0.04
25.	*Ilybius ater* (De G.)	12	1	–	–	–	–	–	1	0.04
26.	*I. fenestratus* (Fabr.)	1, 29	1	–	–	–	18	–	19	0.68
27.	*I. fuliginosus* (Fabr.)	5, 15, 28	–	8	1	–	–	1	10	0.36
28.	*I. neglectus* (Er.)	5, 14	–	–	1	1	–	–	2	0.07
29.	*I. quadriguttatus* (Lacord.)	28	–	1	–	–	–	–	1	0.04
30.	*I. subtilis* Thoms.	28	–	1	–	–	–	–	1	0.04
–.	*Ilybius* sp. larvae n.det.	13	–	–	–	–	–	3	3	0.11
31.	*Platambus maculatus* (L.)	1, 2, 18, 28	1	11	–	–	1	–	13	0.47
–.	*Agabinae* larvae n.det.	24	–	–	–	1	–	–	1	0.04
32.	*Colymbetes fuscus* (L.)	3, 8, 24, 27, 29	1	–	1	2	–	3	7	0.25
33.	*C. striatus* (L.)	5, 11, 18, 24, 29	–	1	4	8	–	–	13	0.47
–.	*Colymbetes* sp. larvae n.det.	4, 10, 13, 16, 17, 24	–	4	–	1	–	14	19	0.68
34.	*Rhantus bistriatus* (Bergstr.)	14, 24, 27	–	–	–	2	–	4	6	0.22
35.	*R. consputus* (Sturm)	14	–	–	–	1	–	–	1	0.04
36.	*R. exsoletus* (Forst.)	11, 13, 16, 29	–	–	–	5	–	2	7	0.25
37.	*R. frontalis* (Marsh.)	4, 5, 11, 18, 24	–	2	1	2	–	1	6	0.22
38.	*R. grapii* (Gyll.)	17, 18	–	2	–	–	–	–	2	0.07
39.	*R. incognitus* R.Scholz	1, 14, 28	–	1	–	2	–	–	3	0.11
40.	*R. latitans* Sharp	1, 17, 23, 25	2	3	–	4	–	–	7	0.25
41.	*R. notaticollis* (Aubé)	24	–	–	–	2	–	–	2	0.07
42.	*R. suturalis* (Mac L.)	8, 27	–	–	–	–	–	11	11	0.39
43.	*Liopterus haemorrhoidalis* (Fabr.)	11	–	–	–	2	–	–	2	0.07

1		2	3	4	5	6	7	8	9	10
44.	*Acilius canaliculatus* (Nic.)	5, 11, 18, 20, 24, 28, 29	–	4	3	17	–	–	24	0.86
45.	*A. sulcatus* (L.)	11, 20	–	–	–	2	–	–	2	0.07
46.	*Graphoderus bilineatus* (De G.)	11, 13, 24	–	–	–	2	–	1	3	0.11
47.	*G. cinereus* (L.)	11	–	–	–	1	–	–	1	0.04
48.	*G. zonatus* (Hoppe)	13	–	–	–	–	–	1	1	0.04
49.	*Cybister lateralimarginalis* (De G.)	10, 20, 24	–	–	–	2	–	1	3	0.11
50.	*Dytiscus circumcinctus* (Ahr.)	4, 10, 11, 13, 14	–	–	–	3	–	13	16	0.57
51.	*D. circumflexus* Fabr.	14	–	–	–	1	–	–	1	0.04
52.	*D. dimidiatus* Bergstr.	5, 11, 14, 20, 23	1	–	1	4	–	–	6	0.22
53.	*D. marginalis* L.	4, 13, 18	–	1	–	–	–	7	8	0.29
–.	*Dytiscus* sp. larvae n.det.	4, 5, 10, 11, 13, 14, 17, 25, 28	–	8	1	6	–	7	22	0.79
54.	*Hydaticus continetalis* J.Balf.-Br.	4, 13, 14, 17, 27	–	1	–	1	–	3	5	0.18
55.	*H. seminiger* (De G.)	18, 28	–	2	–	–	–	–	2	0.07
56.	*H. transversalis* (Pontopp.)	11, 20, 23, 24, 28	1	1	–	8	–	–	10	0.36
57.	*Bidessus unistriatus* (Schrank)	11, 24	–	–	–	2	–	–	3	0.11
58.	*Hydroglyphus geminus* (Fabr.)	8, 10, 12, 15	1	–	–	–	–	4	5	0.18
59.	*Graptodytes granularis* (L.)	1	–	–	–	–	1	–	1	0.04
60.	*G. pictus* (Fabr.)	14, 17, 20, 28	–	2	–	5	–	–	7	0.25
61.	*Hydroporus angustatus* Sturm	5, 11, 17, 24	–	1	1	5	–	–	7	0.25
62.	*H. erytrocephalus* (L.)	11, 29	–	–	–	2	–	–	2	0.07
63.	*H. incognitus* Sharp	17, 24	–	25	–	1	–	–	26	0.93
64.	*H. palustris* (L.)	7-11, 13, 14, 16, 17, 22-25, 27-29	3	25	–	23	–	9	60	2.15
65.	*H. planus* (Fabr.)	10, 14, 15	–	–	–	3	–	4	7	0.25
66.	*H. striola* (Gyll.)	1, 5, 8, 11, 15, 16, 20, 23, 27,	1	–	1	10	2	27	41	1.47
67.	*H. tristis* (Payk.)	8, 17, 20, 25, 28	–	4	–	4	–	1	9	0.32
68.	*Hyphydrus ovatus* (L.)	1, 11-16, 20, 22-24, 28, 29	5	2	–	58	2	10	77	2.76
69.	*Porhydrus lineatus* (Fabr.	8, 11-16, 20, 22-24, 28	2	13	–	144	–	11	170	6.10
70.	*Scarodytes halensis* (Fabr.)	28	–	1	–	–	–	–	1	0.04
71.	*Suphrodytes dorsalis* (Fabr.)	8, 10, 11, 14, 17, 18	–	2	–	3	–	2	7	0.25

1		2	3	4	5	6	7	8	9	10
72.	*Hygrotus decoratus* (Gyll.)	11, 16, 20, 22, 24, 28	–	1	–	6	–	9	16	0.57
73.	*H. impressopunctatus* (Schall.)	1, 4, 11, 13, 14, 20, 21, 24	1	–	–	15	7	14	37	1.33
74.	*H. inaequalis* (Fabr.)	11, 16-18, 20, 22, 24, 27-29	–	20	–	32	–	12	64	2.30
75.	*H. versicolor* (Schall.)	1	–	–	–	–	1	–	1	0.04
76.	*Laccophilus hyalinus* (De G.)	1-3, 6, 7, 9, 12, 20, 21, 23, 26, 28-30	164	1	–	4	6	–	165	5.92
77.	*L. minutus* (L.)	1, 3, 8, 21, 23, 26	6	–	–	–	15	2	23	0.82
		Helophoridae								
78.	*Helophorus dorsalis* (Marsh.)	3	1	–	–	–	–	–	1	0.04
79.	*H. flavipes* Fabr.	4	–	–	–	–	–	2	2	0.07
80.	*H. granularis* (L.)	3-5, 8, 9, 11-14, 16, 18, 20, 21, 24, 25, 27-29	68	15	1	30	–	56	170	6.10
81.	*H. griseus* Herbst	4, 8, 10, 13, 23	1	–	–	–	–	22	23	0.82
82.	*H. minutus* Fabr.	4, 10, 11, 13, 14, 2, 23, 27	1	–	–	5	–	47	53	1.90
83.	*H. nanus* Sturm	14, 15, 16, 24	–	–	–	12	–	6	18	0.65
		Hydrochidae								
84.	*Hydrochrus brevis* (Herbst.)	11, 16, 24	–	–	–	4	–	1	5	0.18
85.	*H. crenatus* (Fabr.)	11, 14, 20	–	–	–	10	–	–	10	0.36
86.	*H. flavipennis* Küst.	27	–	–	–	–	–	1	1	0.04
87.	*H. megaphallus* Berge Henegouwen	20	–	–	–	1	–	–	1	0.04
		Spercheidae								
88.	*Spercheus emarginatus* (Schall.)	16	–	–	–	–	–	1	1	0.04
		Hydrophilidae								
89.	*Anacaena limbata* (Fabr.)	5, 9, 11, 12, 15-20, 22-24, 27-30	21	11	5	8	–	15	60	2.15
90.	*A. lutescens* (Steph.)	5, 7, 8, 11, 12, 14-20, 22, 23, 25, 27-29	7	26	6	16	–	38	93	3.34
91.	*Berosus luridus* (L.)	13, 14	–	–	–	1	–	3	4	0.14
92.	*B. signaticollis* (Charp.)	4, 13, 14	–	–	–	1	–	3	6	0.22
93.	*Cymbiodyta marginella* (Fabr.)	11, 15, 17	–	–	–	1	–	14	15	0.54
94.	*Enochrus affinis* (Thunb.)	4, 10, 11, 13, 25, 27	–	1	–	8	–	11	20	0.72
95.	*E. coarctatus* (Gredl.)	11, 13, 24, 27, 29	–	–	–	6	–	2	8	0.29

1		2	3	4	5	6	7	8	9	10
96.	*E. melanocephalus* (Ol.)	20	–	–	–	1	–	–	1	0.04
97.	*E. ochropterus* (Marsh.)	20, 22	–	–	–	2	–	–	2	0.07
98.	*E. quadripunctatus* (Herbst)	4, 10, 13, 14	–	–	–	4	–	6	10	0.36
99.	*E. testaceus* (Fabr.)	11, 17, 27	–	1	–	2	–	1	4	0.14
100.	*Helochares obscurus* (O.F. Müll.)	3, 11, 13, 14, 20, 24, 27	2	–	–	27	–	10	39	1.40
101.	*Hydrobius fuscipes* (L.)	3, 4, 5, 8, 10-14, 17, 19, 20, 22-24, 28	9	3	1	10	–	10	33	1.18
102.	*Hydrochara caraboides* (L.)	11, 14, 16, 27	–	–	–	4	–	2	6	0.22
–.	*Hydrochara* sp. larvae n.det.	14	–	–	–	1	–	–	1	0.04
103.	*Hydrophilus aterrimus* (Eschscholz)	13, 24	–	–	–	1	–	2	3	0.11
104.	*Laccobius bipunctatus* (Fabr.)	1, 21, 23, 26	4	–	–	–	1	–	5	0.18
105.	*L. minutus* (L.)	1, 2, 3, 20, 21, 23, 24	12	–	–	5	1	–	18	0.65
106.	*Cercyon conveciusculus* Steph.	11, 24, 30	1	–	–	10	–	–	11	0.39
107.	*C. tristis* (Ill.)	21	1	–	–	–	–	–	1	0.04
		Hydraenidae								
108.	*Hydraena palustris* Er.	3, 11, 18, 20, 25, 28	4	7	–	3	–	–	14	0.50
109.	*H. riparia* Kug.	5, 9, 18, 20, 28	1	9	3	1	–	–	14	0.50
110.	*Limnebius atomus* Duftschmid	11, 12, 20	1	–	–	2	–	–	3	0.11
111.	*L. papposus* Muls.	27	–	–	–	–	–	1	1	0.04
112.	*L. parvulus* (Herbst)	4, 5, 13, 17, 18, 24, 27	–	3	1	1	–	33	37	1.33
113.	*Ochthebius flavipes* Dalla Tore	9, 11, 12, 18	12	2	–	2	–	–	16	0.57
114.	*O. minimus* (Fabr.)	4, 9, 12, 24, 25	6	2	–	1	–	2	12	0.43
		Elmidae								
115.	*Potamophilus acuminatus* (Ph. Müll.)	9	1	–	–	–	–	–	1	0.04
116.	*Oulimnius tuberculatus* (Ph. Müll.)	18	–	7	–	–	–	–	7	0.25
117.	*Macronychus quadrituberculatus* Ph. Müll.	9, 12, 21, 23, 26, 30	45	–	–	–	–	–	45	1.61
		Dryopidae								
118.	*Dryops auriculatus* (Fourcr.)	11, 14, 15	–	–	–	2	–	1	3	0.11

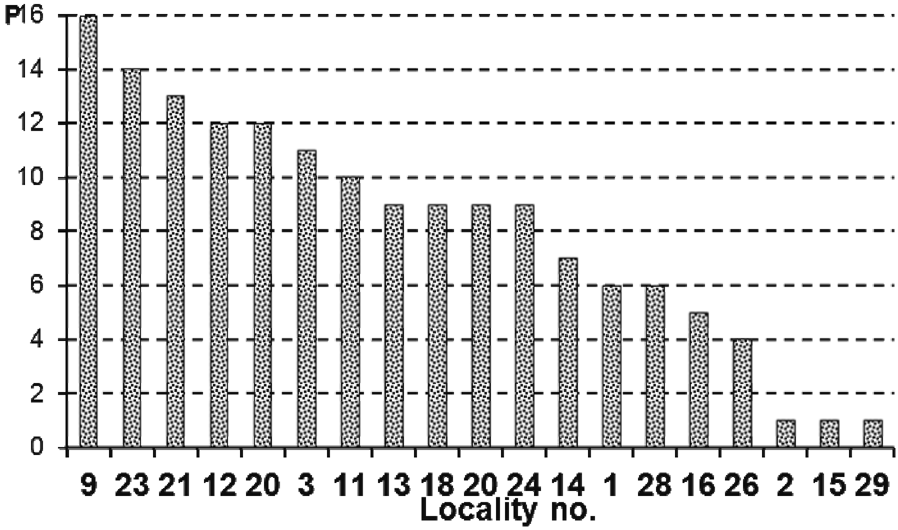

Fig. 5. Sozological significance of individual sites. P – points

Table 2. Special care species and indicator species of aquatic beetles collected in the study area in the years 2004-2007. RL-PL – Red List of Poland, RL-LD – Red List of the Lublin District, SP – protection by law, IND – indicator species, P – number of points in the sozological assessment

Species		RL-PL	RL-LD	LP	IND	P
1.	*Aulonogyrus concinnus*	VU	NT	–	–	5
2.	*Gyrinus paykulli*	NT	–	–	–	2
3.	*Haliplus confinis*	NT	–	–	–	2
4.	*Haliplus varius*	EN	VU	–	–	5
5.	*Agabus fuscipennis*	–	NT	–	–	2
6.	*Ilybius fenestratus*	–	–	–	x	1
7.	*Platambus maculatus*	–	–	–	x	1
8.	*Rhantus incognitus*	EN	VU	–	–	5
9.	*Graphoderus bilineatus*	–	NT	–	–	2
10.	*Dytiscus circumflexus*	–	NT	–	–	2
11.	*Helophorus dorsalis*	–	NT	–	–	2
12.	*Hydrochus megaphallus*	–	DD	–	–	2
13.	*Spercheus emarginatus*	CR	–	–	–	5
14.	*Hydrophilus aterrimus*	VU	NT	x	–	5
15.	*Cercyon tristis*	LC	–	–	–	4
16.	*Ochthebius flavipes*	–	VU	–	–	3
17.	*Potamophilus acuminatus*	DD	DD	–	–	4
18.	*Macronychus quadrituberculatus*	NT	NT	–	–	4

The highest average grade per site was obtained for the River Bug (8.2). The following were also valuable for the protection of beetles: retention reservoir (6.0), oxbow lakes (5.6), rivulets and rivers (3.0), and small water bodies (2.1). No such values were determined for canals (Fig. 6).

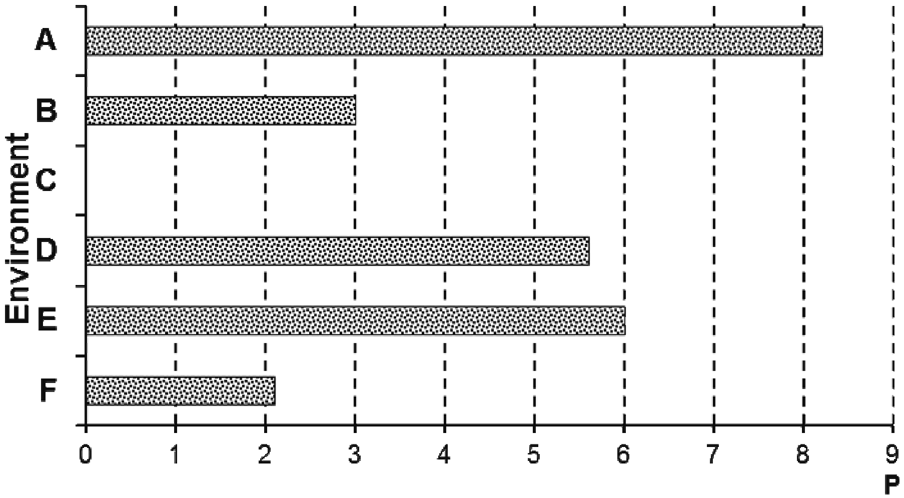

Fig. 6. Sozological significance of individual environments. P – points

Discussion

The presented data is interesting, because it extends the knowledge on the geographical distribution of a number of beetles in Poland and Middle Europe. In the case of some of the species, it is also significant for the determination of boundaries of their distribution areas.

Seven species were collected for the first time in Podlasie as one of faunistic regions of Poland according to the Catalogue of the Fauna of Poland (Burakowski et al. 1976). Those are: *Haliplus ruficollis*, *Agabus sturmii*, *Helophorus dorsalis*, *Hydrochus flavipennis*, *Hydraena riparia*, *Potamophilus acuminatus*, and *Dryops auriculatus* (Buczyński & Przewoźny 2006). Some of them are widespread or common in Poland, therefore the failure to record them so far suggests the incompleteness of knowledge on the fauna of the Podlasie region. *Hydrochus flavipennis* and *Potamophilus acuminatus*, however, occur very rarely (Anonymus 2004; Przewoźny 2004a, 2004b).

Potamophilus acuminatus is a rare species of potamal, endangered in almost entire Middle Europe. Poland is located at the fringe of the area of its distribution. It has been recorded at 18 sites so far (including new data), including 10 sites in modern times. It inhabits a major part of Poland, except for the north-eastern regions. The site in the Bug River Valley, typical of the species in terms of habitat, is located close to the northern boundary of its distribution (Buczyński et al. 2011).

Hydrochus flavipennis was recorded only once in Poland, at a site similar to that in the Bug River Valley: in an astatic water body on a meadow in the valley of the River Bystrzyca (Przewoźny & Buczyński 2003). It is a tyrphophile occurring in the area from Northern Africa and Southern Europe to Asia Minor and Eastern Siberia. The new site determines the northern boundary of its distribution, in the Polish section of the river's course (Alonzo-Zarazaga et al. 2010; Angus 1977).

The taxonomic status of *H. flavipennis* is uncertain, however, due to controversies related to the decision by Angus (1977) to synonymise a few species with it. Shatrovskiy (1993) suggests to distinguish a few of them again, including *Hydrochus kirgisicus* (Motschulsky, 1860). Should such a solution be adopted, the individual from the Bug River Valley would belong to the species. It would be the first known site in Poland, and the westernmost site in the entire distribution: so far, in Europe, *H. kirgisicus* was recorded only in a few regions of western Russia and central part of Belarus (Alexandrovich et al. 1996; Brekhov 2008; Löbl & Smetana 2004; Petrov 2005). Also Hidalgo-Galiana & Ribeira (pres. comm.) evidenced, by means of molecular methods, that *H. flavipennis* is a complex of species, at least two of which occur in Western Europe alone. Therefore, full revision of the genus with the application of molecular methods, based on specimens from Eastern Europe and even Asia, is anticipated. It can result not only in the recognition of formerly identified species, but also in distinguishing new ones. Until then, the solution by Angus (1977) needs to suffice.

At least 13 other species are valuable for zoogeographical and faunistic reasons. Eight of them are widely distributed in Poland, but recorded very rarely – either throughout the history of research, or they were identified more often in the past, and today are in regress. Those are: *Gyrinus distinctus*, *Agabus fuscipennis*, *Rhantus consputus*, *R. notaticollis*, *Graphoderus zonatus*, *Dytiscus circumflexus*, *Hydrophilus aterrimus*, and *Limnebius papposus* (Buczyński 2003; Buczyński & Przewoźny 2005; Burakowski et al. 1976; Przewoźny et al. 2006;

Przewoźny & Lubecki 2006a; Jaskuła et al. 2010). Five further species have a narrower distribution, and require a more thorough discussion.

Reophilous *Aulonogyrus concinnus* occurs in astonishing numbers and number of sites in the study area. New data confirms its occurrence in Eastern Poland, in the valleys of Bug and Wieprz River (Buczyński 1998, unpubl. data; Buczyński & Przewoźny 2005; Przewoźny & Buczyński 2006; data included herein) – those are the only known sites of their occurrence in Poland. In the case of other areas in which it was recorded (Baltic Coast, Pomorskie Lake District, and East Beskidy Mts – only five sites in total) (Burakowski et al. 1976), no data have been provided for the last few tens or over 100 years. In the River Bug Valley alone, the species has been so far determined in the area from Gołębie to Kodeń – at 13 sites located along almost 250 km of its course (Przewoźny et al. 2006; data included herein).

According to Audisio & Mazzoldi (2010), sites of *A. concinnus* in the Bug River are located at the eastern border of the compact part of the species' distribution, situated in West and Middle Europe. Farther, it should occur only in the centre of European Russia. The authors failed to take account of data from the south and north of Ukraine, however (Dyadichko 2009; Melnichuk 1994; Mikhina & Mulenko 2006). Data included in Przewoźny et al. (2006) suggest its occurrence at least in the west of Ukraine, and data included in this paper – also in western Belarus (it is difficult to assume that *A. concinnus* inhabits only the Polish bank of the River Bug). Therefore, the gap in the distribution map (Audisio & Mazzoldi 2010) results among others from the failure to access all relevant literature. Unfortunately, it is quite typical. Papers from East and Middle Europe are often ignored in general studies created in West Europe, not only those on beetles (Buczyński & Tończyk 2005). Their authors rarely know the languages of the region, and do not always research the literature with due diligence.

Rhantus incognitus is a reophile with the distribution area comprising Middle Europe. Buczyński (2001) determined its NS distribution from Latvia to Slovakia, and EW – from north-central Poland to western regions of Belarus and Ukraine. Later, however, *R. incognitus* was recorded in three districts of western Poland (Gawroński 2005; Przewoźny & Lubecki 2006b), in Mecklenburg-Vorpommern in eastern Germany (Hendrich et al. 2010), and in four districts in western Russia (Dyadichko & Chertoprud 2009). Part of those areas have been studied in terms of the occurrence of aquatic beetles regularly for a long time. Therefore, the cases of determination of the species indicate its expansion – at least in the western direction. Only in the case of Russia it results rather from the current lack of research on relevant habitats (Dyadichko pers. comm.). In Poland, 16 sites of *R. incognitus* have been recorded so far (Buczyński 2001; Buczyński & Kowalik 2005; Buczyński et al. 2009; Gawroński 2005; Hendrich et al. 2010; Pakulnicka & Bartnik 1999; Przewoźny & Lubecki 2006b), which constitutes a major part of data from Middle Europe. The centre of the distribution area is eastern Poland, with 13 sites (Buczyński 2001; Buczyński & Kowalik 2005; Buczyński et al. 2009; Hendrich et al. 2010; Pakulnicka & Bartnik 1999).

Tyrphophilous *Hydrochus megaphallus* has been recorded at few sites, and only in six faunistic regions in Poland (Przewoźny & Barłożek 2007). This, however, may partly result from the fact that it was described only 13 years ago, and its distribution is still studied to little extent. It has already been recorded in the Bug River Valley, in the "Magazyn" reserve near Sobibór (Przewoźny et al. 2006). According to the current knowledge, Polish and Belarusian sites (Moroz et al. 2004; Przewoźny et al. 2006; data included herein) determine the NE boundary of the species' distribution area (Löbl & Smetana 2004).

Ochthebius flavipes, inhabiting small water bodies, has been earlier determined at five sites in Poland, located: in Silesia (Burakowski et al. 1976 based on the collection by Letzner from the XIX century), the Masovian Plain (Majewski 1998), as well as in Lublin Upland and Podlasie (Przewoźny et al. 2006). Data from the two latter regions also come from the Bug River Valley; therefore 75% of currently known sites of the species in Poland are located here. It is significant that *O. flavipes* is collected here in the coastal zone of the River Bug with the same frequency as in its optimal habitat. Considering water temperature in that environment (data included herein), it is not surprising. Data from eastern Poland, along those from Latvia (Vorst et al. 2007), determine the eastern boundary of the area of occurrence of the species (Löbl & Smetana 2004).

Macronychus quadrituberculatus is a beetle of potamal, 20 years ago known in Poland from only three sites, one in the Masurian Lake District, one in the Krakowsko-Wieluńska Upland, and one in West Beskidy Mts (Burakowski et al. 1983). In the 1990's, further two sites were recorded (Babula 1991; Staniec 1997), and in the last decade, 19 sites (Buczyński & Pałka 2003; Jaskuła et al. 2005; Kalisiak et al. 2003; Przewoźny et al. 2006, 2009, 2011). Currently, the species is known to occur in nine regions (out of 25), although data from western and SW Poland are still missing. Perhaps the progress represents colonisation or recolonisation of Polish rivers by *M. quadrituberculatus*, related to the substantial improvement in the quality of water in rivers in the period after the political system transformation (GUS – Central Statistical Office 2008). The currently dominating pollutants related to eutrophication seem not to have significant impact on its occurrence (Przewoźny et al. 2006, 2009, 2011; Jaskuła et al. 2005; data included herein).

The second, particularly interesting aspect of our results is the species diversity of the aquatic fauna of the study area. In Poland, approximately 350 species of beetles related to aquatic environment occur, belonging to the studied families[2] (Anonymus 2004; Przewoźny 2004a, 2004b); therefore, 118 species are equivalent to 34% of national fauna. The large scale of the number is evidenced by its comparison with data from landscape and national parks of the lowland and upland parts of Poland (areas with similarly large surfaces). In landscape parks subject to complex research, 100–113 species were recorded (Biesiadka & Pakulnicka 2004a; Buczyński et al. 2007; Buczyński & Przewoźny 2002, 2009, 2010). In the Poleski National Park, constituting a refugium of endangered aquatic fauna and an area with its high taxonomic diversity, 123 species were recorded (Buczyński & Piotrowski 2002; Guz 2006).

Taking account of the data included in Przewoźny et al. (2006), in the part of the Middle Bug River Valley studied so far – between Gołębie and Kodeń, along approximately 250 km of the river course –166 species of aquatic beetles were recorded, which constitutes as much as 47% of national fauna. The fauna is equally rich in qualitative terms, and the case of Adephaga, it is even richer than in the Białowieża Forest (Mielewczyk 2001; Zięba & Buczyński 2007).

Aquatic beetles are good indicators of variously understood quality of environment, including river water quality (Iliopoulou-Georgudaki et al. 2003). Moreover, beetle species diversity suggests high biodiversity (Gutiérrez-Estrada & Bilton 2010). It is related to the diversification of habitats and their state. A number of beetles are habitat generalists – they constitute a core of aquatic coleopterofauna, repeating in various areas, including up to approximately 100 species. In order for the fauna to be richer, appropriate conditions for less numerous and much more demanding stenotopes must occur. Our results indicate high natural values of the Middle Bug River Valley, which confirms earlier analyses based on: vegetation (Urban & Wójciak 2002), Hemiptera (Lechowski

[2] Some representatives of Hydrophiloidea inhabit terrestrial environments, mainly excrements of animals.

& Buczyński 2006), Odonata (Buczyński 2007), various groups of Coleoptera (Gosik 2006; Przewoźny et al. 2006), or Trichoptera (Serafin 2004). Apart from habitat variation, the natural water dynamics in the valley of a large river hardly affected by regulation and melioration is significant in the study area. High connectivity of habitats is also important, particularly for the beetles of stagnant waters (Ribeira et al. 2003).

In the case of beetles, the most valuable habitats include the River Bug, oxbow lakes, and small water bodies. It is consistent with the data from the River Bug Valley above Włodawa (Przewoźny et al. 2006).

The most valuable was definitely the River Bug. Its fauna, fairly rich in qualitative terms, is varied as for such a habitat – almost the same number of species (45) was recorded in the middle course of the River Neman (Biesiadka & Pakulnicka 2004b), considered as a gem of the nature of Eastern Europe (Czachorowski 2004). In Poland, in the middle course of the River Narew, 38 species were recorded (Biesiadka & Pakulnicka 2004a). The fauna is also more specific, and determines the natural character of the habitat. Only the River Bug was dominated by stenotopes relevant for a given environment instead of eurytopes. The most numerous and widely spread species was *Aulonogyrus concinnus* which is not only a reophile, but also a species endangered in Poland and certain neighbouring countries (Hájek 2005; Pawłowski et al. 2002).

In comparison to the River Bug, results for running waters were not impressive. They are in contrast to those obtained for Hydrachnidia – with poor and degraded fauna in the River Bug, and habitat-specific fauna in its tributaries (Stryjecki 2009). This may result from various degrees of sensitivity to individual types of pollutants, particularly mineralisation: water mites are the most sensitive to it, and beetles are the most resistant (Gerecke 1991). A number of features of the environment of the Bug River are favourable for organisms – e.g. the natural character of the river, values of oxygen and biological indices. However, water mineralisation and related eutrophication are considerable (Iwaniuk & Piebiak 2008; Miazga et al. 2006; Miazga & Parcheta 2007). Even in such conditions, beetles can establish valuable and natural assemblages. Other invertebrates in the Middle River Bug, in turn, responded in a manner between that of beetles and Hydrachnidia: their assemblages were deformed to various degrees, but retained a lot of valuable elements (Buczyński 2007; Lechowski & Buczyński 2006; Serafin 2004).

The highest value of the coleopterofauna of the Bug River is the co-occurrence of *Macronychus quadrituberculatus* and *Potamophilus acuminatus*, belonging to the assemblage of insects of potamocoen. They often occur along with another representative of family Elmidae: *Stenelmis consorbina* (not recorded by us). That group of species diminishes along with the degradation of the environment (Braasch 1995; Graf & Kovács 2002; Klausnitzer 1996). Along the studied section of the Bug River, it is developed better than above Włodawa – *P. acuminatus* was not collected there, and *M. quadrituberculatus* was very scarce (Przewoźny et al. 2006). This suggests that already the middle course of the River Bug is important for the fauna of potamocoen, and the lower course of the river, not studied so far in those terms, may be of even more significance. It urgently requires relevant research.

Stenelmis consobrina from the Bug River and its tributaries was recorded by Błachuta & Błachuta (2003). It was the first information on the occurrence of the species in Poland. Unfortunately, the site was not specified, and the study area stretched between Kryłowo and Popowo, including approximately 560 km of the course of the river. Moreover, the data is not certain – the material was not determined by a specialist, and the species was identified based on larvae (Błachuta pers. comm.). Therefore, the occurrence of the species in Poland requires confirmation. The nearest sites of *S. consorbina* are known to be located in the Czech Republic. Currently, however, the species is considered extinct (Boukal D.S. 2005c). It has never been recorded in Slovakia (Kodada et al. 2003), and the nearest modern site is known to be located in Hungary (Kálmán et al. 2009). In Poland, among representatives of genus *Stenelmis* Dufour, 1835, only *S. canaliculata* was found (Gyllenhal, 1808) – approximately 100 years ago, twice in southern Poland (Burakowski et al. 1983; Przewoźny 2004a).

To sum up the data presented in this paper and the data included in Przewoźny et al. (2006), the Middle Bug River Valley should be recognised as one of the most valuable regions of the lowland part of Poland in terms of preservation of aquatic beetles on three levels – protection of individual species, their assemblages (particularly potamocoen, dynamic waters of small water bodies of river valleys, natural oxbow lakes), and species diversity. The scale of the species diversity, and valuable beetle assemblages are discussed above. The significance of the Middle Bug River Valley for protection of endangered beetles is evidenced by the occurrence of often numerously collected 13 species from the Red List of beetles of Poland, including: one from category CR (critically endangered species), three from category EN (endangered), and 5 from category VU (vulnerable) (Przewoźny et al. 2006; data included herein). It constitutes 17% of aquatic species from the list, including 22% of species subject to high risk (Pawłowski et al. 2002). The species belong to various synecological groups, which suggests good preservation of a number of habitats.

The significance of the Middle River Bug Valley as a refugium of aquatic beetles is supranational. In our opinion, the region is important at least for Middle Europe. The determination of the following is significant: 43 species from the Red List of animals of Germany (including 34 from the high-risk zone), 35 from the Red List of animals of the Czech Republic (all from the high-risk zone), 13 from the Red List of animals of Slovakia (all from the high-risk zone as well) (Binot et al. 1998; Boukal D.S. 2005a, 2005b, 2005c; Boukal M. 2005; Hájek 2005; Hájek & Šťastný 2005; Holecová & Franc 2001; Trávniček et al. 2005)[3]. Moreover, *Graphoderus bilineatus* is included in the Red List of IUCN in category VU (Foster 2010).

A region as valuable as the Middle River Bug Valley should be protected in a relevant manner, which did not occur until recently. Its minor part was protected only within the scope of the Strzelecki Landscape Park, located to the South of Dubienka. Also one water-peat bog reserve – "Magazyn" near Włodawa, is adjacent to the flood plain (Walczak et al. 2001). Fortunately, the situation changed after the special protection area Nature 2000 – "Middle River Bug Valley" (PLB060003) was established, including the river valley from Gołębie to Terespol (GDOŚ – General Directorate for Environmental Protection 2011). An important rule binding within Nature 2000 areas is a ban on activities which could "materially impair the state of environmental habitats and habitats of plants and animals" (Symonides 2007). Therefore, it can be assumed that with relevant supervision, the natural values of the Bug River Valley will be retained. There is no need to establish any forms of strict protection here: human economic activity (e.g. management of meadows) constitutes one of important elements of the natural environment. The area should be protected against changes in the landscape and water relations. A potential threat is also intensification of agriculture, including related melioration, fertilisation, and increase in the use of crop protection chemicals.

[3] Unfortunately, no Red Lists of animals of Belarus or Ukraine exist.

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