Acta Agrophysica, 2003, 1(1), 115-121

BEETLES (*COLEOPTERA*) OF SALINE WATERS FROM "BOGDANKA" STONE COAL MINE (SOUTH-EASTERN POLAND)

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Summary. During the period 1979-1989, 50 species of water beetles (*Coleoptera*) were collected in a sedimentation tank of saline waters, a drainage canal and three sampling sites in the Świnka River. Common freshwater species were dominant, *Enochrus bicolor* being the only halophile found. Although the numbers of the beetles were small, the qualitative and quantitative structure of their assemblages did not depend on the salinity of water. The most important environmental factors affecting this structure were: water flow, its temperature, spatial structure of habitat, and food resources.
Keywords: *Coleoptera*, beetles, stone coal-mine, saline waters

INTRODUCTION

The Lublin Coal Basin creates a serious environmental hazard in the Łęczna-Włodawa Lake District, and exerts its effect, among other things, on the quality of surface waters by the discharge of deep waters to the Świnka River. The aim of the study was analysis of assemblages of water *Coleoptera* colonizing water bodies alimented with these waters; the preliminary results were reported by Radwan *et al.* [14].

MATERIAL AND METHODS

The coal mine in Bogdanka is situated on the south-western border of the Łęczna-Włodawa Lake District, in the Lublin Region, 12 kilometres east of Łęczna (51°20'N, 23°01'E). Coal mining carried out to the depth of 920 m is hindered by numerous water-bearing layers. Water from these layers is discharged into the sedimentation tank, after that it flows via a canal into the Świnka River, in the amount of approx. 100 $dm^3 s^{-2}$ [12]. This water is characterised by an increased electrolytic conductivity, salinity and level of selected ions (Table 1) [10].

Table 1. Some properties of water at sampling sites I-IV in the years 1981-1984 (* only data from the year 1999 are available)

Factors	Sampling site			
	I	II	III	IV
pH	8.43	8.30	7.40	7.55
Conductivity * (μS cm^{-1})	3240-3420	2320-3140	532-644	1819-2160
– average	3333	2670	594	1948
Σ Na^+, Cl^- and SO_4^{2-} (mg dm^{-3})	1112.1-1488.4	521.8-1314.6	131.8-169.7	384.3-532.2
K^+ (mg dm^{-3})	17.3-26.6	10.0-23.9	1.8-5.7	8.8-9.2
Ca^{2+} (mg dm^{-3})	15.7-34.7	39.8-49.6	67.5-89.9	57.6-76.2
Salinity (‰)	1.15-1.55	0.57-1.38	0.20-0.26	0.45-0.62

5 sites were studied: (I) sedimentation tank in Bogdanka of an area of approx. 8 ha created in 1979; (II) drainage canal between Bogdanka and Puchaczów; (III) the Świnka River in Puchaczów above the canal-mouth; (IV) the Świnka River in Puchaczów below the canal-mouth; (V) the Świnka River in Łęczna (Fig. 1). The report by Kowalik [10] contains the description of the study sites. Selected physical and chemical properties of water are given in the Table 1.

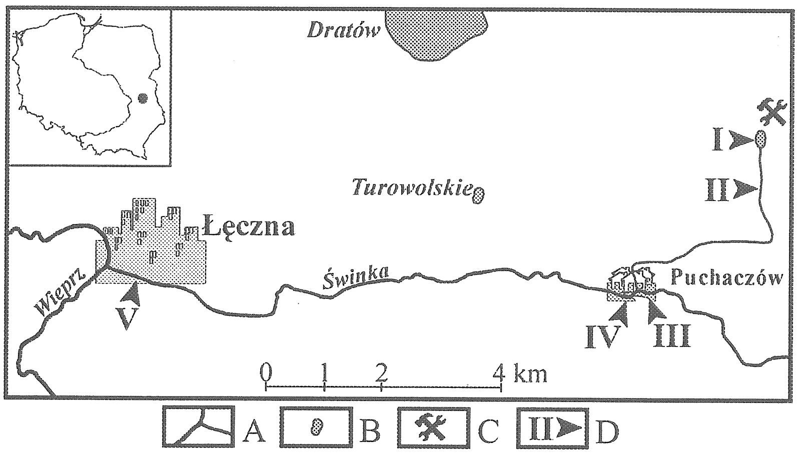

Fig. 1. Study area: A – rivers and channels, B – lakes, C – coal-mine, D – sampling sites

Studies were conducted in the years 1979-1989, mainly 1981 and 1983. The material was collected with a hydrobiological scoop, and sporadically by a benthos tube. A total number of 195 samples were collected (39 at each site). Imagines of *Coleoptera* were present in 55 samples – 396 individuals in general.

Species diversity was calculated according to Simpson's index [11].

RESULTS

50 species of beetles were stated. At individual sampling sites, 24-138 individuals, belonged to 11-24 species, were collected. Fauna at Site I occurred in the greatest numbers, followed by the assemblages of beetles at Sites III and IV, where they were less abundant; the number of species, however, was similar to that at Site I. The abundance of fauna at Site V was medium abundant, but composed of a small number of species. Fauna of the beetles at Site II was the least abundant. With respect to species diversity, the highest values were obtained at Sites III and II, followed by Site I, and Sites IV and V, where it was very low (Table 2).

Table 2. Quantitative composition of material collected at sampling sites (%)

Species	Sampling site				
	I	II	III	IV	V
1. *Orectochilus villosus* (O. F. Müller, 1776)		20.8			
2. *Gyrinus distinctus* Aubé, 1836			1.1	1.5	
3. *G. mergus* Ahrens, 1812		4.2	3.4		
4. *G. minutus* Fabricius, 1798				3.0	
5. *G. natator* (Linnaeus, 1758)	0.7	8.3	12.5	1.5	1.3
6. *Peltodytes caesus* (Duftschmidt, 1805)				3.0	
7. *Haliplus confinis* Stephens, 1829	0.7				
8. *H. fluviatilis* Aubé, 1836	5.1	12.5	35.2	59.1	67.5
9. *Haliplus immaculatus* Gerhardt, 1877		4.2			
10. *Haliplus ruficollis* (De Geer, 1774)	0.7		1.1	1.5	
11. *H. wehnckei* Gerhardt, 1877		4.2			
12. *Noterus clavicornis* (De Geer, 1774)	1.4				
13. *N. crassicornis* (O.F. Müller, 177)			2.3		
14. *Copelatus haemorrhoidalis* (Fabricius, 1835)	1.4				
15. *Hydroglyphus pusillus* (Fabricius, 1781)		4.2	1.1	3.0	1.3
16. *Hygrotus impressopunctatus* (Schaller, 1783)	0.7				
17. *H. inaequalis* (Fabricius, 1777)	1.4		3.4	1.5	
18. *Hyphydrus ovatus* (Linnaeus, 1758)				1.5	
19. *Hydroporus nigrita* (Fabricius, 1792)				1.5	
20. *Porhydrus lineatus* (Fabricius, 1775)	1.4		8.0	4.5	1.3
21. *Graptodytes pictus* (Fabricius, 1787)	2.9			1.5	
22. *Nebrioporus airumlus* (Kolenati, 1845)	32.6				
23. *N. depressus* (Fabricius, 1775)	32.6		6.8	1.5	
24. *Platambus maculatus* (Linnaeus, 1758)			1.1		1.3

25. *Agabus didymus* (Olivier, 1795)			1.1		
26. *A. undulatus* (Schrank, 1776)			1.1	1.5	
27. *Ilybius quadriguttatus* (Lacordaire, 1835)					1.3
28. *I. similis* Thomson, 1856	3.6				
29. *I. subaeneus* Erichson, 1837					1.3
30. *Rhantus suturalis* (Mac Leay, 1825)	0.7				
31. *Laccophilus hyalinus* (De Geer, 1774)	1.4		12.5	1.5	7.5
32. *L. minutus* (Linnaeus, 1758)	0.7		1.1	6.1	6.3
33. *L. ponticus* (Sharp, 1882)	0.7				
34. *Acilius canaliculatus* (Nicolai, 1822)			1.1		
35. *Graphoderus cinereus* (Linnaeus, 1758)	0.7				
36. *Dytiscus circumcinctus* (Ahrens, 1811)	0.7				
37. *D. marginalis* Linnaeus, 1758	0.7				1.3
38. *Helophorus flavipes* Fabricius, 1792			1.1		2.5
39. *Berosus luridus* (Linnaeus, 1761)	0.7				
40. *Anacaena lutescens* (Stephens, 1829)		4.2			
41. *Laccobius bipunctatus* (Fabricius, 1775)	2.2	4.2			
42. *Laccobius minutus* (Linnaeus, 1758)	5.1	29.2		1.5	5.0
43. *Enochrus affinis* (Thunberg, 1794)			1.1		2.5
44. *E. bicolor* (Fabricius, 179)			1.1		
45. *E. coarctatus* (Gredler, 1863)			1.1		
46. *E. melanocephalus* (Olivier, 1792)		4.2			
47. *E. quadripunctatus* (Herbst, 1797)				1.5	
48. *Hydrobius fuscipes* (Linnaeus, 1758)				1.5	
49. *Coelostoma orbiculare* (Fabricius, 1775)	0.7		1.1		
50. *Oulimnius tuberculatus* (Müller, 1817)			1.1	1.5	
N =	138	24	88	66	80
Number of species:	24	11	22	20	13
Species diversity (Simpson's index):	0.78	0.84	0.83	0.65	0.53

At all sites, freshwater species with a high tolerance to salinity and haloxenes were stated. Taxa associated with saline waters were noted sporadically and individually (Fig. 2.) Considering habitat preferences, the following species were

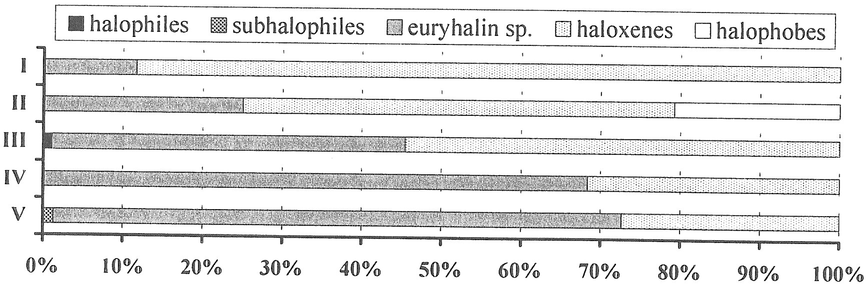

Fig. 2. Ecological composition of beetle assemblages in sampling sites according to salinity tolerance of the species collected

dominant: small water bodies species (often acidophilous), stagnophilous with a wide environmental spectrum and eurytopic species [6, 7, 8].

The collected material was characterized by a small number of eudominant and dominant species. The majority of species was collected rarely and at a small number of sites: 29 species only at one site, 11 – at two sites. Only *Haliplus fluviatilis* and *Gyrinus natator* occurred at all sampling sites, while *Hydroglyphus pusillus, Porhydrus lineatus, Laccophilus hyalinus, L. minutus* and *Laccobius minutus* – at four sites (Table 2).

DISCUSSION

The obtained results differ from what might have been expected. The numbers of beetles and their taxonomic diversity did not change according to the salinity gradient. The richest fauna was noted at the sampling site with the greatest environmental stress. The effect of the change of the chemistry of water in the Świnka River on water beetles was hardly observable. Apart from *Enochrus bicolor* (halophile) and *Ilybius subaeneus* (sub-halophile) [7, 8], the species associated with saline waters were not observed.

Therefore, it may be presumed, that there was no direct relationship between salinity and conductivity, and a qualitative and quantitative structure of assemblages of beetles. This, at least partly, results from the fact that the study covered three different types of water bodies: a water body of stagnant water (Site I), a swift water flow canal with poor vegetation (Site II), and a slow flowing river with well-developed vegetation (Sites III and IV). Differences in the environmental features – water flow, spatial structure, thermal conditions, development of vegetation and food resources associated with it – overlaps with changes in the chemical composition of water.

Beetles belong to freshwater arthropods showing the best tolerance to salinity [1, 4, 5, 6, 15]. The boundary value of electrolytic conductivity for the most resistant haloxenic species seems to be 10.000 $\mu S\ cm^{-1}$, and for the halobiontic species: 16.000 $\mu S\ cm^{-1}$ [5]. Therefore, salinity at the sampling sites examined was probably too low to exert a strong effect on the taxonomic diversity of the assemblages of the beetles, other environmental factors were more significant. In sensitive water mites (*Hydrachnidia*), the negative effect of salinity was clearly observed at these sites and belonged to the most important factors moulding these assemblages of mites [10].

Thus, low numbers of the beetles may be considered as the only clear effect of salinity. This, however, results more from the young age of the waters during studies – a considerable part of the material was collected during the first four years of the existence of these waters, i.e., in the first years of their colonization. Data concerning mid-dune water bodies indicate that the pace of colonization of newly-created saline waters by the beetles is considerably slower, compared to freshwater ones [13]. The fauna of the older water bodies is rich and more diverse [1]. Similar changes may be expected at the sites examined.

The above-mentioned statements are confirmed by a small number of saline water species. Apart from seaside areas, these species occur at few sites [3]. Thus, even in favourable conditions, the colonization of newly created saline waters is hindered by the dispersion of these species and their small population size. Therefore, during the period of the study, freshwater beetles were almost exclusively found, usually those commonly occurring in the Łęczna-Włodawa Lake District [2, 9]. Considering the great distance from the nearest salt pans, even after many years halophilous species may be not numerous at the sites in the study and occur sporadically.

CONCLUSION

In saline waters from "Bogdanka" stone coal mine common freshwater species were dominant, *Enochrus bicolor* being the only halophile found. Although the numbers of the beetles were small, the qualitative and quantitative structure of their assemblages did not depend on the salinity of water. The most important environmental factors affecting this structure were: water flow, its temperature, spatial structure of habitat, and food resources.

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CHRZĄSZCZE (*COLEOPTERA*) ZASOLONYCH WÓD Z KOPALNI WĘGLA KAMIENNEGO W BOGDANCE

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Streszczenie. W latach 1979-89 (głównie 1981 i 1983) w zbiorniku sedymentacyjnym wód zasolonych, kanale odpływowym i trzech stanowiskach na rzece Śwince, stwierdzono 50 gatunków chrząszczy. Dominowały pospolite gatunki słodkowodne, jedynym halofilem był *Enochrus bicolor*. Chrząszcze występowały nielicznie, jednak struktura jakościowa i ilościowa ich zgrupowań nie zależały od zasolenia wody. Decydowały o nich: przepływ wody, jej temperatura, struktura przestrzenna siedliska i baza pokarmowa.

Słowa kluczowe: *Coleoptera*, chrząszcze, wody zasolone, kopalnia węgla kamiennego