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Aquatic insects (*Odonata*, *Coleoptera*, *Trichoptera*) of the central part of the "Krowie Bagno" marsh: the state before restoration

Owady wodne (*Odonata*, *Coleoptera*, *Trichoptera*) centralnej części torfowiska „Krowie Bagno": stan przed renaturyzacją

SUMMARY

In 2003 the assemblages of selected aquatic insects (dragonflies, beetles, caddisflies) were studied within two lakes surrounded by a transitional peat bog, and a canal and ditches situated in the meliorated fen. The influence of melioration and peat bog degradation on entomofauna, its present status and the role of "Krowie Bagno" as a refugium of special care species were analysed. Thirty-seven dragonfly species, 75 beetle species, 21 caddisfly species were found. 12 special care and 8 indicatory species were recorded. The fauna of lakes was typical of polyhumic ones, however, the changes associated with drying out and early stage of eutrophization were clearly seen in case of caddisfly assemblages. Melioration ditches turned out to be a refuge for the species connected with completely vanished at the study area sedge bogs. Deep and rich in vegetation canal was the main habitat for lacustrine caddisfly species. Such fauna is the result of natural water recession, transformation of the remaining ones as well as creating anthropogenic waters. "Krowie Bagno" is still the refuge of many valuable species and assemblages typical of dystrophic waters. Nevertheless, they are still endangered, some of them are partially on the wane. The aim of the renaturalization activities like tree cutting, raising the level of impoundage conducted after 2003 is to prevent the fauna. In several years, the next planned inventory of entomofauna will discover whether such activities improve ecological relationships of the studied area or not.

STRESZCZENIE

W roku 2003 badano zgrupowania wybranych owadów wodnych (ważek, chrząszczy, chruścików) w dwóch jeziorach otoczonych torfowiskiem przejściowym oraz w kanale i rowach leżących na zmeliorowanym torfowisku niskim. Analizowano wpływ melioracji i degradacji torfowiska na entomofaunę, jej obecny stan oraz rolę „Krowiego Bagna" jako ostoi gatunków specjalnej troski. Stwierdzono 37 gatunków ważek, 75 chrząszczy, 21 chruścików. Odnotowano 12 gatunków specjalnej troski i 8 wskaźnikowych. Fauna jezior była typowa dla jezior polihumusowych, jednak widoczne były zmiany związane z osuszeniem i wczesną fazą eutrofizacji, zwłaszcza w zgrupowaniach chruścików. Rowy melioracyjne okazały się ostoją gatunków związanych z zanikłymi na terenie badań mokradłami turzycowymi. Głęboki i bogaty w roślinność kanał był głównym siedliskiem jeziornych gatunków chruścików. Taki obraz fauny jest skutkiem zaniku części wód naturalnych, odkształcenia innych i powstania wód antropogenicznych. „Krowie Bagno" wciąż jest ostoją szeregu cennych gatunków i zgrupowań, typowych dla wód dystroficznych. Jednak są one zagrożone, częściowo w zaniku. Mają temu zapobiec przeprowadzone po roku 2003 działania renaturalizacyjne (wycinanie drzew, podnoszenie poziomu wód gruntowych). Planowana za kilka lat, kolejna inwentaryzacja entomofauny wodnej odpowie na pytanie, na ile te działania poprawią stosunki ekologiczne terenu badań.

K e y w o r d s: *Odonata*, *Coleoptera*, *Trichoptera*, desiccation, restoration, fen, peat bog, lake

INTRODUCTION

Polesie, the vast region in south-eastern Poland, northern Ukraine and southern Belarus, covers the largest peat bog area in Middle-Eastern Europe. Nevertheless, since the 19th century, and especially in the second half of the 20th century, the significant part of peat bogs has been meliorated. In Poland, as a result of varied transformations of marshy areas, peat bogs have remained unaffected only in the area of 10% of all hydrogenic habitats (3). These transformations affected numerous areas which were particularly valuable in the respect of nature. "Krowie Bagno", the biggest and the most interesting regional peat bog, is the example of such area – it was drained 40 year ago, which resulted in degradation of major part of its area (23). Only northern fragments of this peat bog have remained in almost natural form. Their importance for nature protection was valued by proposing the part of "Krowie Bagno" to Nature 2000 network as Special Area of Conservation PLH060011 (18).

The aim of the authors was the analysis of qualitative and quantitative composition of the fauna of selected aquatic insect groups in order to value the ecological state of the studied area. Moreover, the valuation is going to be a starting point for tracking the changes within studied ecosystem after taking renaturalization activities. The studies of "Krowie Bagno" are also a good occasion for the observations of influence of environmental changes associated with meliorations on aquatic fauna. Moreover, in 2004, the partial renaturalization was started by removing forest communities with the dominance of *Betula pubescens* Ehrh. Next activities have been planned, first of all, the rise of water level in the examined area. Thus the comparison between faunas before and after renaturalization can be possible. This paper documents the state before these works.

MATERIAL AND METHODS

The study area is situated in Western Polesie, in the central part of the Łęczyńsko-Włodawska Plain (29). Researches covered the area of ca. 4 km^2 located south of the village Lubowież (51°25'N, 22°19'E, UTM: FB69), with four study sites (Fig. 1): I. Lake Lubowież; II. Lake Lubowieżek; III. the stretch of the "Więzienny Rów" canal of total length 2.2 km; IV. melioration ditches.

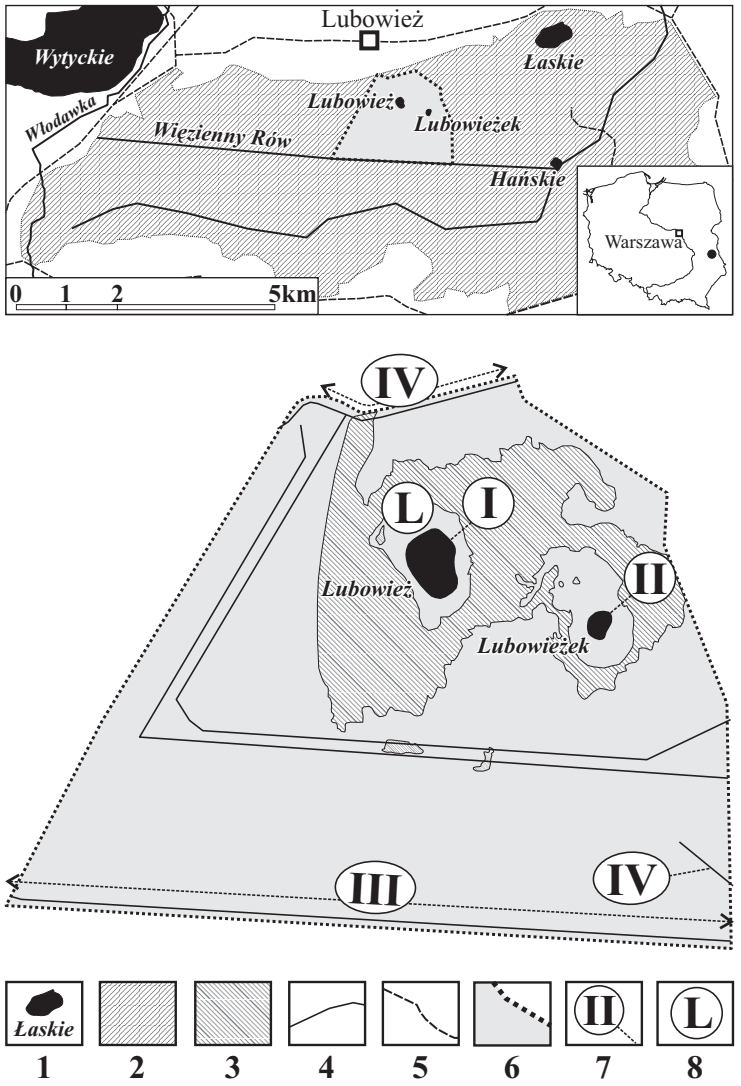

Fig. 1. The localization of the study area and study sites. 1 – lakes, 2 – the area of the "Krowie Bagno" marsh, 3 — forest, 4 – rivers and ditches, 5 – main roads, 6 – the study area, 7 – localities (see "Study area"), 8 – the localization of a light trap

Lakes are shallow and dystrophic. Lake Lubowież has the area of 2,7 ha and the value of its shoreline development index is 1.7 (50). There is no data about Lake Lubowieżek but its morphometry is very similar. Both lakes are surrounded by *Sphagnum* peat bogs though some traces of eutrophication can be observed, e.g. the lack of quaking mats of floating *Sphagnum* by shores (except for small fragments of Lake Lubowieżek), the configuration of higher vegetation and blooms of filiform in Lake Lubowież. Lake Lubowież is surrounded by compact ring of *Salix cinerea* L. thickets, Lake Lubowieżek – wide reed rushes of *Phragmites australis* (Cav.) Trin. ex Steud. Water column of Lake Lubowież is densely overgrown by *Myriophyllum spicatum* L. In littorals of both lakes the rushes of *Schoenoplectus lacustris* (L.) Palla and *Typha angustifolia* L. are present as well as patches of *Nymphaea* sp. (*N. candida* C. Presl.?) and *Batrachium aquatile* (L.) Dumort. The bottom is fragmentarily covered by *Chara* sp. (*Chara foetida* A.Br.?). Typical peat bog vegetation occurs on Lake Lubowieżek, of which the part of littoral and strongly soppy shore is covered by sedges (*Carex acutiformis* Ehrh., *C. lasiocarpa* Ehrh., *C. pseudocyperus* L.) with *Dryopteris thelypteris* (L.) A.Gray, *Schoenoplectus lacustris*, *Molinia caerulea* (L.) Moench and *Comarum palustre* L. Some places are also grown by homogeneous patches of *Heleocharis* sp. On Lake Lubowież only a few coves are taken by *Comarum palustre*.

The fluctuations of water level on peat bogs surrounding both lakes causes the fall of water table in summer and unveiling the large areas of the moisture bottom. This refers to Lake Lubowież mainly, which nearly completely dried out in 2003.

The "Więzienny Rów" canal flows through the open area, covered mainly by blue moor grass meadows. Its width is 7–8 m, depth – ca. 1.5 m. The bottom is lined with concrete slabs with the layer of sludge in the middle part. Water carried by the canal is brown, slightly muddy, with very slow flow. The vegetation is rich in species, mainly consisting of: *Lemna gibba* L., *L. minor* L., *L. trisulca* L. and *Hydrocharis morsus-ranae* L. with water column grown by *Ceratrophyllum demersum* L. Some patches of *Iris pseudacorus* L., *Lysimachia thyrsiflora* L., *Phragmites australis* and submerged grasses are also present by its banks. In vegetation season filiform algae occur abundantly. The presence of *Spongilla lacustris* (L.) was also recorded.

Melioration ditches are temporary habitats, they dry out in summertime. Their width is ca. 2 m, the depth – 30–40 cm, the bottom is sludgy, water brown but transparent. Scarps of excavations are covered by willow thickets, sometimes growing under water. In water some patches of *Typha angustifolia*, *Carex* sp. and *Lysimachia thyrsiflora* occur, as well as submerged grasses by the banks.

The material was collected from May to September of 2003, five controls were made. Semi-quantitative samples were taken with a hydrobiological net. Larvae and pupae of *Trichoptera* were picked out from emerged plants, stones etc., imagines were caught with an entomological net. The observations of imaginal *Odonata* were conducted as follows: the numbers, the presence of juvenile individuals and development behaviour were put down. Exuviae were collected occasionally. *Coleoptera* and *Trichoptera* were collected twice to a light trap (31.05., 3.08.).

Evidence materials are: 180 larvae and 4 exuviae of *Odonata*; 541 imagines and 6 larvae of *Coleoptera*; 168 imagines, 3 pupae, 51 larvae and 59 cases of *Trichoptera*. They are in authors' collections.

Species diversity was calculated according to Probability of Interspecific Encounters (PIE) (30).

In sozological analysis the following groups of species were used: under protection ones (45), Annexes to the Habitats Directive and the Bern Convention (van Helsdingen et al., 1996), Red Lists of Animal in Poland (7, 25, 42, 47), Red List of dragonflies of the Lublin region (11), the list of critical species of IUCN (46) and the most useful species in evaluation of areas in Poland (5), the list of umbrella species (8, 22).

RESULTS

Thirty-seven dragonfly species, 75 beetle species and 21 caddisfly species were recorded in total (Table 1).

Table 1. Dragonflies, aquatic beetles and caddisflies recorded in the study area in the year 2003. I–IV – material collected using hydrobiological and entomological methods (in dragonflies larvae and exuviae only), L – material collected using a light trap, Σ – the total number of specimens, • – no larvae but the breeding behaviour was observed, 0 – no larvae and the breeding behaviour was not observed, * – fresh emerged imagines were observed

Species		Study site				L	Σ
		I	II	III	IV		
Odonata							
1.	*Calopteryx splendens* (Harr.)	–	0	•	–	–	–
2.	*C. virgo* (L.)	–	–	0	–	–	–
3.	*Sympecma fusca* (Vander L.)	0	–	–	0	–	–
4.	*S. paedisca* (Brau.)	–	–	–	0	–	–
5.	*Lestes sponsa* (Hansem.)	•	•	•	•*	–	–
6.	*Lestes virens* (Charp.)	–	•	–	–	–	–
7.	*Platycnemis pennipes* (Pall.)	–	–	•	–	–	–
8.	*Ischnura elegans* (Vander L.)	–	–	•	–	–	–
9.	*Enallagma cyathigerum* (Charp.)	2	1	•*	•*	–	3
10.	*Coenagrion hastulatum* (Charp.)	37	19	–	–	–	56
11.	*C. puella* (L.)	3	2	4	•*	–	9
12.	*C. pulchellum* (Vander L.)	2	6	12	0	–	20
13.	*Erythromma najas* (Hansem.)	4	1	15	–	–	20
14.	*E. viridulum* (Charp.)	–	–	•	–	–	–
15.	*Nehalennia speciosa* (Charp.)	–	2	–	–	–	2
16.	*Brachytron pratense* (O.F. Müll.)	1	•	–	–	–	1
17.	*Aeshna cyanea* (O.F. Müll.)	1	–	–	–	–	1
18.	*A. grandis* (L.)	11	10	9	–	–	30
19.	*A. isosceles* (O.F. Müll.)	•	1	•	–	–	1
20.	*A. juncea* (L.)	2	•	–	–	–	2
21.	*A. mixta* Latr.	3	2	•	0	–	5
22.	*A. viridis* Eversm.		7	–	–	–	7
23.	*Anax imperator* Leach	2	2	–	–	–	4
24.	*Cordulia aenea* (L.)	3	1	•	•	–	4

25.	*Somatochlora flavomaculata* (Vander L.)	•	1	0	•	–	1
26.	*Epitheca bimaculata* (Charp.)	–	0	–	–	–	–
27.	*Libellula depressa* L.	0	–	–	–	–	–
28.	*L. fulva* (O.F. Müll.)	–	1	1	–	–	2
29.	*L. quadrimaculata* L.	1	1	1	•	–	3
30.	*Orthetrum cancellatum* (L.)	0	0	•	0	–	–
31.	*Sympetrum danae* (Sulz.)	–	0	–	•	–	–
32.	*S. flaveolum* (L.)	–	0	–	0	–	–
33.	*S. sanguineum* (O.F. Müll.)	•	•	•*	2	–	2
34.	*S. vulgatum* (L.)	0	4	1	3	–	8
35.	*Leucorrhinia albifrons* (Burm.)	1	–	–	0	–	1
36.	*L. caudalis* (Charp.)	•	•	–	0	–	–
37.	*L. pectoralis* (Charp.)	1	•	–	–	–	1
	Coleoptera						
1.	*Gyrinus aeratus* Steph.	–	–	1	–	–	1
2.	*G. marinus* Gyll.	–	–	2	–	–	2
3.	*G. natator* Fabr.	–	–	–	–	2	2
4.	*Haliplus flavicollis* Sturm	–	–	1	–	–	1
5.	*H. fluviatilis* Aubé	2	1	31	13	–	47
6.	*H. immaculatus* Gerh.	–	–	1	–	–	1
7.	*H. obliquus* (Fabr.)	–	–	1	–	–	1
8.	*H. ruficollis* (De G.)	–	–	4	–	–	4
9.	*Noterus crassicornis* (O.F. Müll.)	7	33	1	1	–	42
10.	*Copelatus ruficollis* (Schall.)	–	1	–	–	–	1
11.	*Laccornis oblongus* (Steph.)	–	1	–	–	–	1
12.	*Hydroglyphus pusillus* (Fabr.)	–	–	–	–	1	1
13.	*Hygrotus decoratus* (Gyll.)	–	–	–	2	–	2
14.	*H. inaequalis* (Fabr.)	–	1	–	–	–	1
15.	*H. impressopunctatus* (Schall.)	2	7	6	4	–	19
16.	*H. versicolor* (Schall.)	–	2	8	–	–	10
17.	*Hyphydrus ovatus* (L.)	–	1	28	3	–	32
18.	*Hydroporus angustatus* Sturm	1	20	2	–	–	23
19.	*H. erythrocephalus* (L.)	1	1	–	–	–	2
20.	*H. fuscipennis* Schaum	–	–	–	–	1	1
21.	*H. incognitus* Sharp	1	–	–	3	–	1

22.	*H. palustris* (L.)	–	1	–	2	–	3
23.	*H. striola* (Gyll.)	–	4	–	–	–	4
24.	*H. tristis* (Payk.)	–	2	–	1	–	3
25.	*Porhydrus lineatus* (Fabr.)	1	3	10	–		14
26.	*Graptodytes bilineatus* (Sturm)	1	4	2	–	–	7
27.	*G. granularis* (L.)	–	–	1	–	–	1
28.	*G. pictus* (Fabr.)	–	–	4	2	–	6
29.	*Suphrodytes dorsalis* (Fabr.)	1	1	–	1	–	3
30.	*Agabus fuscipennis* (Payk.)	–	–	–	–	1	1
31.	*Ilybius ater* (De G.)	–	2	–	–	–	2
32.	*I. fenestratus* (Fabr.)	–	–	17	–	–	17
33.	*I. quadriguttatus* (Lacord.)	–	1	–	–	–	1
34.	*I. similis* Thoms.	–	1	1	–	–	2
35.	*Rhantus grapii* (Gyll.)	–	1	–	1	–	1
36.	*Colymbetes fuscus* (L.)	–	1	–	–	–	1
37.	*Laccophilus hyalinus* (De G.)	–	1	–	–	–	1
38.	*L. minutus* (L.)	–	–	2	–	–	2
39.	*L. poecilus* Klug, 1834	–	2	5	–	–	7
40.	*Hydaticus seminiger* (De G.)	–	2	–	–	–	2
41.	*H. transversalis* (Pontopp.)	–	5	–	–	–	5
42.	*Graphoderus austriacus* (Sturm)	–	2	–	–	–	2
43.	*G. cinereus* (L.)	–	1	–	–	–	1
44.	*Acilius canaliculatus* (Nic.)	–	3	6	–	–	9
45.	*A. sulcatus* (L.)	–	–	1	–	–	1
46.	*Dytiscus dimidiatus* (Bergstr.)	–	–	–	1	–	1
47.	*Cybister lateralimarginalis* (De G.)	3	2	–	–	–	5
48.	*Helophorus aquaticus* (L.)	–	–	–	–	1	1
49.	*H. granularis* (L.)	–	–	–	1	10	11
50.	*Hydrochus carinatus* Germ.	–	1	1	–	–	2
51.	*Anacaena limbata* (Fabr.)	–	–	–	–	2	2
52.	*A. lutescens* (Steph.)	4	10	3	10	–	27
53.	*Laccobius minutus* (L.)	–	–	7	1	–	8
54.	*Helochares obscurus* (O.F. Müll.)	1	12	24	8	8	53
55.	*Enochrus affinis* (Thunb.)	1	6	1	–	3	11
56.	*E. coarctatus* (Gredl.)	–	13	1	–	1	15

57.	*E. ochropterus* (Marsh.)	1	1	1	–	–	3
58.	*Cymbiodyta marginella* (Fabr.)	–	4	–	–	–	4
59.	*Hydrobius fuscipes* (L.)	2	7	1	–	1	11
60.	*Hydrochara caraboides* (L.)	1	6	–	3	–	10
61.	*Hydrophilus aterrimus* Eschch.	–	1	–	–	1	2
62.	*Coelostoma orbiculare* (Fabr.)	–	–	1	–	–	1
63.	*Cercyon analis* (Payk.)	–	1	–	–	–	1
64.	*C. bifenestratus* Küst.	–	–	–	–	9	9
65.	*C. convexiusculus* Steph.	–	1	–	–	2	3
66.	*C. marinus* Thoms.	–	–	–	–	3	3
67.	*C. unipunctatus* (L.)	–	–	–	–	1	1
68.	*Ochthebius minimus* (Fabr.)	–	–	–	6	–	6
69.	*Hydraena palustris* Er.	–	1	–	–	–	1
70.	*Limnebius atomus* (Duftschm.)	1	22	4	–	–	27
71.	*L. parvulus* (Herbst)	–	24	3	4	–	31
72.	*Dryops ernesti* Gozis	–	2	–	1	–	3
73.	*D. griseus* (Er.)	–	–	1	–	–	1
74.	*Macronychus quadrituberculatus* (Ph. Müll.)	–	–	–	–	2	2
75.	*Tanysphyrus lemnae* (Payk.)	–	–	1	–	–	1
	Trichoptera						
1.	*Hydroptila sparsa* Curtis, 1834	–	–	–	–	2	2
2.	*Orthotrichia costalis* (Curtis, 1834)	–	–	–	–	1	1
3.	*O. tragetti* Mosely, 1930	–	–	–	–	14	14
4.	*Ecnomus tenellus* Rambur, 1842	–	–	–	–	10	10
5.	*Holocentropus picicornis* (Stephens, 1836)	–	2	6	–	–	8
6.	*Hydropsyche ornatula* McLachlan, 1878	–	–	–	–	1	1
-.	*Hydropsyche* sp. (females)	–	–	–	–	82	82
-.	*Agrypnia* sp.	1	–	–	–	–	1
7.	*Phryganea grandis* Linnaeus, 1761	–	1	–	–	5	6
8.	*Limnephilus flavicornis* (Fabricius, 1787)	3	8	6	2	3	22
9.	*L. nigriceps* (Zetterstet, 1840)	–	–	1	–	–	1
10.	*L. politus* McLachlan, 1865	–	–	1	–	–	1
11.	*L. rhombicus* (Linnaeus, 1758)	1	–	15	4	–	20
12.	*L. stigma* Curtis, 1834	–	–	1	–	–	1
13.	*Triaenoes bicolor* (Curtis, 1834)	6	–	3	–	1	10

14.	*Mystacies longicornis* (Linnaeus, 1758)	–	–	–	–	14	14
15.	*Athripsodes aterrimus* (Stephens, 1836)	–	–	61	–	–	61
16.	*Ceraclea dissimilis* (Stephens, 1836)	–	–	–	–	1	1
17.	*Leptocerus tineiformis* Curtis, 1834	–	–	–	–	6	6
18.	*Oecetis furva* (Rambur, 1842)	4	–	–	–	6	10
19.	*O. lacustris* (Pictet, 1834)	–	–	–	–	2	2
20.	*O. ochracea* (Curtis, 1825)	–	–	–	–	1	1
21.	*O. tripunctata* (Fabricius, 1793) (?)	–	–	–	–	1	1

The highest number of species were found at study sites II and III, the faunas of sites I and IV were clearly poorer in species. The highest numbers of individuals were collected at study sites III and II, clearly less at study site I, very little at site IV. Material from a light trap was the qualitatively poorest one but moderately rich in species (Fig. 2).

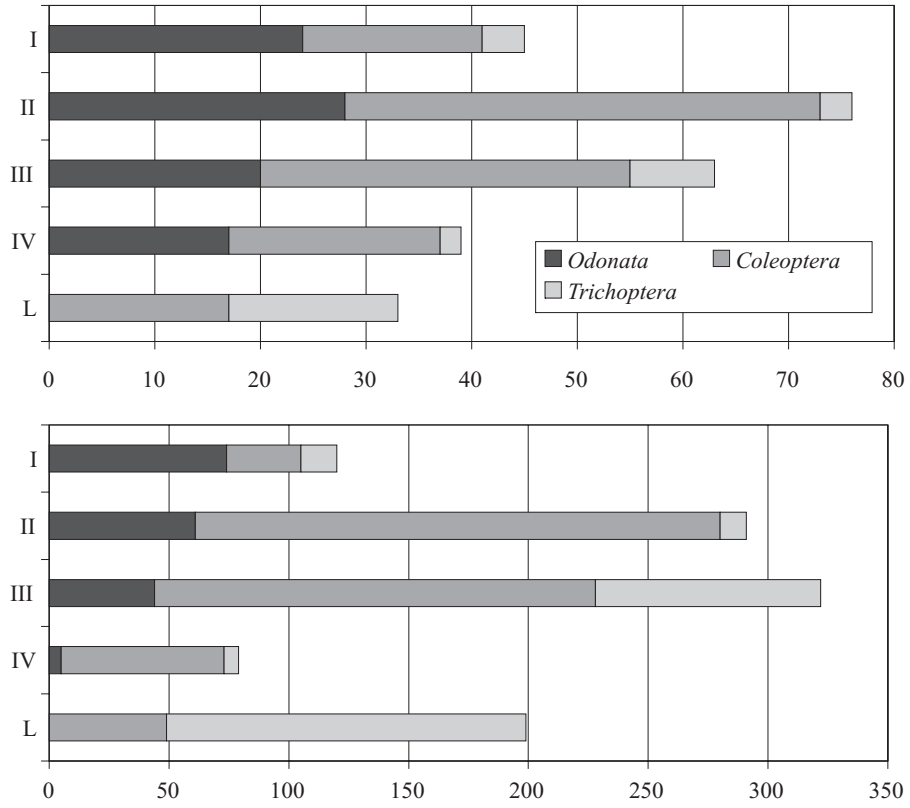

Fig. 2. The number of species (upper diagram) and collected specimens (lower diagram) collected in the study sites. I–IV – localities (see "Study area")

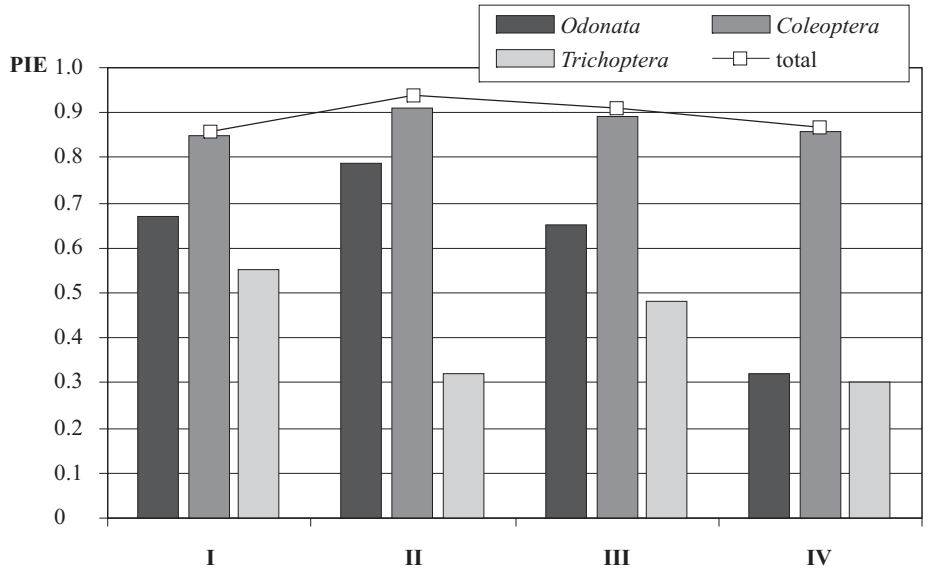

Fig. 3. Species diversity by PIE factor in the study sites (in dragonflies – basing on larvae and exuviae only). I–IV – localities (see "Study area")

The values of Hurlbert's Index (Fig. 3) were similar, but with relatively lower variations and high range of 0.86–0.94. However, the values were very varied for particular groups. As for *Coleoptera* they were very high at every study site. As for *Odonata*: they reached high level at study site II, moderately high at sites I and III, very low at site IV. The index for *Trichoptera* was the highest at study sites I and III, very low at sites II and IV.

In the collected material to dominants belonged eurytopic and tyrphophilous species. Less numerous were lacustrine and rheophilous species. Other gropus (psammophiles, hylophiles, hypohalophyles) were represented by single individuals (Fig. 4). The most numerous species were: *Athripsodes aterrimus* – limnobiont associates with helophyte rushes, *Coenagrion hastulatum* – a tyrphophilous species, *Haliplus fluviatilis* – a rheophilous one, and eurytopic *Helochares obscurus* and *Noterus crassicornis*. Females of *Hydropsyche* genera which were caught in the largest numbers to a light trap are not reliably determined, thus they were not taken into account in data analysis.

Ecological composition of fauna of particular habitats was very diversified. Eurytopes and tyrphophiles were present very numerously at every study site, nevertheless, the biggest share of eurytopes was typical of a study site III. Lacustrine species were the most numerous at study site III, relatively numerous were also at site I. Their numbers at study site II were low. Rheophilous species were

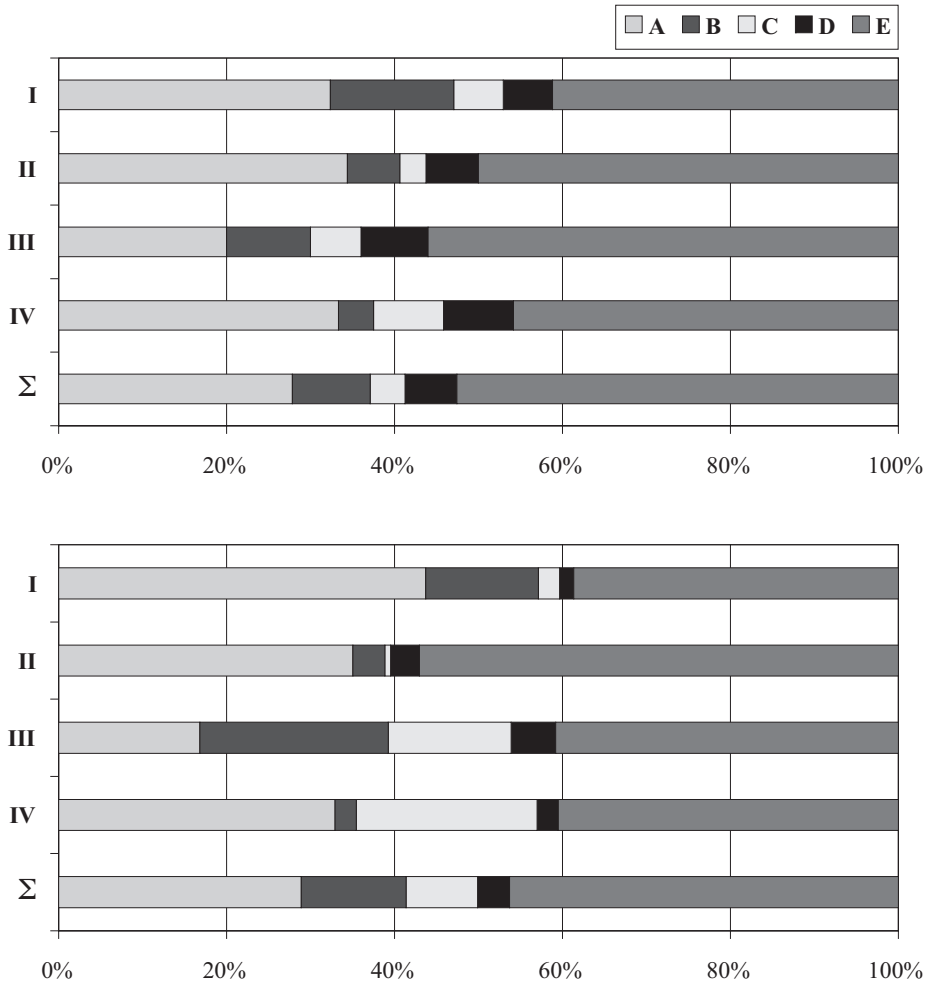

Fig. 4. Ecological composition of the collected material (in dragonflies – basing on larvae and exuviae only). I–IV – study sites (see "Study area"), Σ – the whole material, upper diagram – qualitative data, lower diagram – quantitative data, A – tyrphophiles, B – limnobionts and limnophiles, C – rheophiles, D – other stenobionts, E – eurybionts

present at study sites III and IV mainly, in the remaining sites they were sporadically collected.

Fourteen special care species or indicatory ones were recorded, which included: 6 protected species, 5 from Annexes to the Habitats Directive and the Bern Convention, 9 from national Red List, 4 from Regina Red List, 3 critical species of IUCN, 3 species of the highest value in an evaluation of areas, 8 umbrella species (Table 2). Particular attention should be paid to species with the highest threatened categories.

Table 2. The hydrobiont species of special care (1–5) and indicatory species (7, 8) collected in the year 2003 in the study area. 1 – species protection, 2 – annexes of international conventions and directives of the European Union, 3 – Polish red lists, 4 – regional red list, 5 – IUCN critical species, 6 – most useful dragonfly species in evaluation of areas in Poland, 7 – umbrella species for the studied habitats. The numbering of study sites – see "Study area"

Species		Criterion							Study site				
		1	2	3	4	5	6	7	I	II	III	IV	L
1.	*Sympecma paedisca*	•	•									•	
2.	*Nehalennia speciosa*	•		EN	E	•	•	•		•			
3.	*Aeshna juncea*			LC				•	•	•			
4.	*A. viridis*	•	•	LC						•			
5.	*Epitheca bimaculata*							•					
6.	*Libellula fulva*				R					•	•		
7.	*Leucorrhinia albifrons*	•	•	LC	R	•	•	•	•			•	
8.	*L. caudalis*	•	•	NT	V	•	•	•	•	•		•	
9.	*L. pectoralis*	•	•					•	•	•			
10.	*Ilybius fenestratus*							•			•		
11.	*Hydrophilus aterrimus*			VU						•			•
12.	*Macronychus quadrituberculatus*			NT									•
13.	*Hydropsyche ornatula*			DD				•					•
14.	*Oecetis tripunctata* (?)			EX									•
The sum of species		6	5	9	4	3	3	8	4	7	2	3	4

Nehalennia speciosa is an extincting relict of peat bog waters in the whole Europe (6). The population in Lake Lubowieżek is not numerous, it occurs in two places only:

• the cut off from the lake by floating mat of *Sphagnum* shallow cove in the northern part of strongly moisture transitional peat bog character with the area of ca. ok. 60 m^2. It is covered with dense rushes of *Caricetum acutiformis* with the addition of other plants, e.g. *Carex lasiocarpa* on the edges of this patch. Five-six breeding imagines (territorial ♂♂, tandem, in copula) were observed on June 14;

• the cove connected with the lake in the eastern part, with the area of 10 m^2, bottom of tyrphopel, with scarce rushes of *Carex lasiocarpa* in water and in the edges of floating mat (with *Dryopteris thelypteris* in this place). Two larvae were caught on May 31, four breeding imagines (territorial ♂♂, tandem, in copula) were observed on June 14.

Oecetis tripunctata inhabiting a helophyte zone in eutrophic lakes (20). Szczęsny (47) lists this species in "probably extinct" category despite current

data from Olsztyn Lakeland (20). One female of this species (doubtful identification) was attracted to a light trap by Lake Lubowieżek on May 31, 2003.

DISCUSSION AND CONCLUSIONS

Study sites represent natural habitats under anthropopression (lakes) and anthropogenic ones (the "Więzienny Rów" canal, melioration ditches). In the first case the fauna has natural continuance and relative naturality, though it may be transformed. However, the assemblages of the canal and ditches were originated *de novo* in the 60s and 70s of the 20th century.

The fauna of the examined lakes is typical of polyhumic lakes of Western Polesie (9, 12, 15, 21) and other regions in Poland (13, 20, 33, 34, 49). It can be well seen as exemplified by dragonfly fauna, in which worth mentioning is the occurrence of species sensitive to eutrophication from the genus *Leucorrhinia* Britt., especially *L. albifrons* and *L. caudalis* (7, 8), as well as the occurrence of stenotopic and very sensitive to environmental changes *Nehalennia speciosa* (6). The same refers to aquatic beetles though to a lower degree – their lowland assemblages are characterized by the dominance of eurytopes (43). The least typical was the fauna of caddisflies: tyrphophiles, limnobionts and limnophiles were more numerous in ditches than in lakes or were found in ditches only.

This different ecologic composition can be a good hint in the evaluation of the state of lakes. Caddisflies inhabiting varied microhabitats and depending on spatial structure of vegetation in different lake zones are the most sensitive indicators of water trophy. Basing on data of Czachorowski (20) it can be concluded that the assemblages of both investigated lakes are more typical of eutrophic waters than dystrophic ones. Dragonflies are associated with a littoral and there are no specific assemblages of other zones (35). Therefore, the fauna may be transformed to a lower degree though some changes can also be observed, e.g. the small numbers of many species. The good example can be *Nehalennia speciosa*, which is almost extinct. Finally, the least changed was beetle fauna – the least sensitive order of the examined insects.

The situation described above is a model example of early stage degradation of dystrophic lake by its eutrophication. This resulted from meliorations and the fall of groundwater level. The adjacent peat bog has become desiccated and biogens are released, therefore water parameters and the composition of vegetations in lakes have been changing. This stage is characterized by species-rich fauna despite the regress of stenobionts due to the appearance of eurytopic species (8). Negative influence on the fauna is also connected with high fluctuations of water table, especially in Lake Lubowież, which is clearly seen in caddisfly

fauna: all collected limnobionts and limnophiles were associated with an astatic littoral (20).

Apparently unattractive anthropogenic waters, especially the "Więzienny Rów" canal, seem to be quite interesting in the light of previous statements. The canal is much deeper than the lakes. It is also characterized by higher diversity of aquatic vegetation, which can be the result of extensive way of using meadows of "Krowie Bagno" – water of such habitats is more fertile (28). Obtained results indicate that the "Więzienny Rów" canal is a very important refugium of limnobionts and limnophiles.

However, the insect assemblages of melioration ditches can be regarded as a relict fauna of the old fen. Nevertheless, it is qualitatively and quantitatively impoverished, which is clearly seen in the groups rich in stagnant water species (e.g. dragonflies). Yet, some valuable beetle species were recorded in this habitat.

Particularly helpful aspect of the presented data is the fact that it makes it possible to follow the changes connected with active protection of the examined area. In Europe many analyses of the results of such works were studied. The results are incentive, but still very little is known about fens: most studied referred to running waters (1, 2, 27, 31, 32) and high peat bogs (4, 26, 44). Only single papers presents the faunas of dragonflies and aquatic beetles of fens (41). The Łęczyńsko-Włodawska Plain, and in wider aspect – Polesie, can be a model area for such works on fens. There are many fens with different stage of preservation, for many of them data on aquatic insects are available (e.g. 9, 10, 12, 14, 15, 36–40). In the last decade a planned and scientifically controlled renaturalization of aquatic and peat bog habitats was conducted (16), unfortunately, without consideration of aquatic insects.

Our data as well as literature on diurnal butterflies (18) indicate the high virtues of the investigated area but also its threats. Thus active protection is needed. The first stage was chosen properly. The removing of forest with birch should limit the fall of ground water on the peat bog and at the same time stop desiccation and mucking of peat bogs and eutrophication of lakes. These actions refer to the least transformed habitats so there is a chance for natural regeneration and re-establishing ecological relations (17). Nevertheless, the success in renaturalization project is short-term solution, usually the results do not lead to forming stable and typical biocenosis (24). The obtaining of satisfying results is associated with long-term monitoring of changes appearing in the examined area. Easy and good way of checking their effectiveness can be the faunal monitoring of the groups presented in the paper (especially the share of particular ecological elements) as well as the size of selected species populations. Due to well

known ecology and worked out methods, the best group would be dragonflies, especially *Nehalennia speciosa* and *Leucorrhinia* spp.

In the subsequent stage of renaturalization, provided that the part of the area is bought out from private owners, the rise of water level is planned by damming canals and ditches. So there would be a chance of re-establishing of sedge marshes, the natural habitats of fen aquatic fauna. However, Chmielewski (17) points out that on the areas which were degraded for a long time, other than primeval environments can develop. Despite this possibility, such test is worth conducting because there is a chance of reconstruction of threatened natural caddisfly assemblages (cf. 19).

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