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Aquatic Insects (Insecta: Plecoptera, Ephemeroptera, Odonata, and Trichoptera) of the Rivers in the Berezinskii Biosphere Reserve

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Abstract—The fauna of aquatic insects was studied in the rivers of the Berezinskii Biosphere Reserve. A total of 108 species of 4 orders were found: Plecoptera (10 species), Ephemeroptera (24), Odonata (25), and Trichoptera (49). The aquatic fauna is abundant and includes some species rare in Belarus and Europe.

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The aquatic insects of the orders Plecoptera, Ephemeroptera, Odonata, and Trichoptera are one of the most abundant and widespread groups of aquatic invertebrates living in various running and stagnant continental water bodies. However, these taxonomic groups have been poorly studied in the river ecosystems of the Berezinskii Reserve up to now (Tishchikov and Tishchikov, 2000; Moroz et al., 2001), which determined the subject of our studies.

The Berezinskii Biosphere Reserve, whose area is more than 80 thousand hectares, occupies the central part of the Verkhneberezinskaya Lowland in the Belorusskoe Lakeland. The recent relief was formed in the Quaternary by glaciers and their melt waters. The main part of the Reserve (more than 95%) is situated in the basin of the Berezina River (one of the largest tributaries of the Dnepr) and, partly, in the basin of the river Essa (flowing into the Western Dvina). The watershed between the basins of the Baltic and the Black Seas is situated in the north-eastern part of the Reserve, near Lake Plavno and Domzheritzkoe Marsh. The total length of streams in the territory of the Reserve is about 315 km.

Berezina is a typical plane river with corresponding natural hydrochemical characteristics. The water is of the hydrocarbonate calcium type. The mineralization of water varies between 240 and 330 mg/l. in the low-water and decreases down to 64–163 mg/l. in the high water seasons with characteristic high content of iron (1.08 mg/l). The Berezina River is 613 km long, with 110 km running through the Reserve territory; its flood plain is 200 m to 2 km wide. The river-bed is strongly winding and freely meandering. The width of the river-bed is 10–15 m upstream and 15–20 m downstream of the Serguchskii Canal. The flow velocity is 0.22 to 0.59 m/s.

MATERIALS AND METHODS

The collecting of material and observations for this study were carried out in October of 2000 and February, April, and June of 2002. Most of the samples were taken in the ripal of streams at a depth of down to 1 m with the help of a hydrobiological net sweep (with input opening of 0.031 m^2 in area; made of gauze with mesh apertures of 25 μm). Usually, 2–3 samples were taken from sites differing in ground characteristics.

The following water bodies were examined:

I. Berezina River (near Berezino Vill.), 554 km from the river mouth, up to 10–15 m wide. The river-bed in natural state winding and unbranching. Banks low, mainly swamped. Bottom sandy, in places peaty.

II. Berezina River (near Brody Vill.). The collecting site is situated in the central part of the Berezinskii Reserve, 508 km from the river mouth; the river is up to 15–20 m wide. The hydrologic and landscape characteristics roughly the same as in the previous collecting site.

III. Berezina River (1 km upstream of Lake Palik), 476 km from the mouth, about 30 m wide. Owing to the influence of the lake, the flow considerably decelerates, and the ecosystem becomes transient from the

typical of rivers to the typical of lakes. Bottom sediments silty.

IV. Berezina River (1 km downstream of Lake Palik), 468 km from the mouth, more than 30 m wide. Banks low, strongly swamped. Bottom sandy, in places silty, with numerous residues of mollusk shells.

V. Moskovitsa River, left tributary of Berezina, 7.4 km long, flowing from the lake with the same name, and running through a swamp forest along its whole length. Banks low; bottom silty; the river-bed overgrowing with higher aquatic plants.

VI. Deryazhina River, right tributary of Berezina, 17.6 km long (with 4.6 km running through the Biosphere Reserve), 3–5 m wide, up to 0.7 m deep. Banks low; bottom silty and sandy.

VII. Krasnogubka River, left tributary of Berezina, forest brook (from source to mouth); bottom sandy in the collecting site. As distinct from other rivers studied, the Krasnogubka drains a moraine landscape rather than swamped areas.

VIII. Serguchskii Canal, about 10 km long, 0.4–0.5 m deep; collecting site near its inflow into Berezina. Banks low, swamped. Bottom sandy and silty. The canal connects water basins of Black and Baltic Seas in the Reserve.

IX. Smolyanka River, left tributary of Berezina, formed in the territory of Domzheritzkii marsh, one of the largest in Europe. The water of the Smolyanka River is characterized by a high content of humic substances; pH: 5.85–6.62. Banks low, swamped. Bottom sediments: peat, silt, and small sandbanks. The river-bed overgrowing with higher aquatic plants.

Hence, a total of observational and collecting localities embrace the main streams of the Berezinskii Reserve, thus reflecting the structural and functional organization of these aquatic ecosystems characteristic of this territory.

RESULTS AND DISCUSSION

A total of 6088 specimens of aquatic insects were collected belonging to 108 species of 4 orders: Plecoptera, 10 species, Ephemeroptera, 24, Odonata, 25, and Trichoptera, 49 species (see the Table).

Among the hydrobionts found, *Perlodes dispar* (Ramb.), *Isoperla diffornis* Klap., *Nemoura cambrica* Steph., *Baetis buceratus* Eaton, *B. scambus* Eaton, *B. tricolor* Tschern., *Caenis luctuosa* (Burm.), *Polycentropus irroratus* (Curt.), *Hydropsyche bulgaromanorum* Malicky, *Athripsodes bilineatus* (L.), and *Ylodes simulans* (Tjeder) are of certain interest as recorded from Belarus for the first time.

Perlodes dispar (Rambur, 1842) is recorded from central Europe, northwestern and western parts of European Russia and is absent in Great Britain (Zhiltzova, 1977; Lillehammer, 1988). Larvae are found in rivers and large brooks; imagines emerge in spring. Among the adjacent countries, the species is evidently distributed throughout Poland, but not abundant there (Fialkowski and Kittel, 2002). Material: 23.04.2001 (3 ♀, 1 larva), in Berezina River (Berezino Vill.).

Isoperla difformis (Klapálek, 1909) is distributed in northern and central Europe (Lillehammer, 1988). Larvae are found in rivers and large brooks; imagines emerge in spring. Among the adjacent countries, the species was recorded from Baltic States, northern part of European Russia, and Poland (Zhiltzova, 1977; Fialkowski and Kittel, 2002). Material: 19.10 2001 (1 larva) and 23.04.2002 (3 ♂, 3 ♀, 7 larvae), in Berezina River (Berezino Vill.).

Nemoura cambrica Stephens, 1836 is distributed in southern and central Europe. Larvae are found in brooks with rapid current; imagines emerge in spring and summer. Out of the adjacent countries, the species is distributed in Poland, in the springs of Mazurian Lakeland and the Carpathians (Fialkowski and Kittel, 2002). Material: 19.02.2002 (4 larvae), in Krasnogubka River.

Baetis buceratus Eaton, 1870 is distributed in Europe, Caucasus, southern Urals, and Middle Asia (Kluge, 1997), relatively rare (Landa, 1969). Material: 19.02.2002 (2 larvae) and 20.06.2002 (2 larvae), in the Berezina River (Berezino Vill.).

Baetis scambus Eaton, 1870 is recorded from northern and central Europe (Landa, 1969; Kluge, 1997). Material: 18.06.2002 (2 larvae), in Berezina (near its inflow into Lake Palik); 12.07.2002 (7 larvae), in Deryazhina River.

Baetis tricolor Tshernova, 1928, Transpalearctic species (Kluge, 1997). Material: 20.06.2002 (3 larvae), in the Berezina River (Brody Vill.).

Caenis luctuosa (Burmeister, 1839) is distributed in Europe and eastern Kazakhstan, rare (Kluge, 1997). Larvae dwell in rivers on silty ground (Kazlauskas, 1977). Material: 20.06.2002 (2 larvae), in the Berezina River (Brody Vill.).

Species composition and distribution of aquatic insects in the rivers of the Berezinskii Biosphere Reserve

No.	Order, species	Habitats									Total, ind.
	Order PLECOPTERA	I	II	III	IV	V	VI	VII	VIII	IX	
1	*Taeniopteryx nebulosa* (L.)							14			14
2	**Perlodes dispar* (Ramb.)	4									4
3	**Isoperla difformis* (Klap.)	10	4								14
4	*I. grammatica* (Poda)	1									1
5	*Amphinemura standfussi* (Ris)					1					1
6	**Nemoura cambrica* Steph.							4			4
7	*N. cinerea* (Retz.)	4	6			41		689	4	39	783
8	*N. dubitans* Mort.	1	4					211			216
9	*N. flexuosa* Aubert					47					47
10	*Leuctra fusca* (L.)		1					3			4
	Order EPHEMEROPTERA										
1	*Siphlonurus aestivalis* Eaton		51								51
2	*S. alternatus* Say		2								2
3	*Cloeon dipterum* (L.)	27	11	54	247	11			9	36	395
4	*Procloeon bifidum* (Bengts.)	4	20				1		3		28
5	*Centroptilum luteolum* (Müll.)	5					3	1			9
6	**Baetis buceratus* Eaton	4									4
7	*B. fuscatus* (L.)	4	3					1			8
8	*B. niger* (L.)		1				1	183			185
9	*B. rhodani* (Pict.)						15				15
10	**B. scambus* Eaton			1			7				8
11	*B. tricolor* Tshern.		3								3
12	*B. vernus* Curt.	2	7				25	192	25		215
13	*Heptagenia flava* (Rost.)	2							3		5
14	*H. fuscogrisea* (Retz.)	307	191	184	1		2		102		787
15	*Habrophlebia fusca* (Curt.)							4			4
16	*Leptophlebia marginata* (L.)	184	70	32		41		331	191	102	951
17	*Paraleptophlebia submarginata* (Steph.)	15	50				1			143	209
18	*Ephemera danica* Müll.		1				7	35			43
19	*E. vulgata* L.		1								1
20	*Ephemerella ignita* (Poda)		3				25				28
21	*Brachycercus harisellus* Curt.	2	9				7		2		20
22	*Caenis horaria* (L.)				4						4
23	**C. luctuosa* (Burm.)		2								2
24	*C. robusta* Eaton			1	1						2
	Order ODONATA										
1	*Calopteryx splendens* (Harr.)	11	32			1					44
2	*C. virgo* (L.)	4	18								22
3	*Lestes sponsa* (Hansem.)	6									6

Table (Contd.)

No.	Order, species	Habitats									Total, ind.
4	*Platycnemis pennipes* (Pall.)	6	12								18
5	*Ischnura elegans* (Vander L.)			1	2						3
6	*Enallagma cyathigerum* (Charp.)				3						3
7	*Pyrrhosoma nymphula* (Sulz.)							1			1
8	*Coenagrion hastulatum* (Charp.)	7				24					31
9	*C. puellum* (L.)	20	4	3	2	19		3	4		55
10	*C. pulchellum* (Vander L.)			26	14						40
11	*Erythromma najas* (Hansem.)	5		27	9						41
12	*Gomphus flavipes* (Charp.)		3								3
13	*G. vulgatissimus* (L.)	24	42					2	3		71
14	*Ophiogomphus cecillia* (Geoffr.)									1	1
15	*Aeschna cyanea* (O.F. Müll.)							5			5
16	*Ae. grandis* (L.)			2							2
17	*Cordulegaster boltonii* (Donov.)	2						25			27
18	*Cordulia aenea* (L.)			1						1	2
19	*Somatochlora flavomaculata* (Vander L.)					1				25	26
20	*S. metallica* (Vander L.)	1									1
21	*Libellula quadrimaculata* L.								1		1
22	*Sympetrum flaveolum* (L.)	2									2
23	*S. pedemontanum* (All.)			2							2
24	*S. sanguineum* (O.F. Müll.)			1	2						3
25	*S. vulgatum* (L.)	3									3
	Order TRICHOPTERA										
1	*Hydroptila* sp.		2				2				4
2	*Oxyethira* sp.				1						1
3	*Holocentropus dubius* (Ramb.)					1					1
4	*Cyrnus flavidus* McLach.				7						7
5	*Polycentropus flavomaculatus* Pictet		1				4	55	1	7	68
6	**Polycentropus irroratus* (Charp.)	1									1
7	*Neureclipsis bimaculata* (L.)	1	7	1					1		10
8	*Plectrocnemia conspersa* (Charp.)							44			44
9	*Lype reducta* (Hagen)						1	3			4
10	*Hydropsyche angustipennis* (Charp.)							32		3	35
11	**H. bulgaromanorum* Malicky			1							1
12	*H. pellucidula* (Charp.)	1									1
13	*Agrypnia pagetania* Charp.						1				1
14	*Oligostomis reticulata* (L.)							2			2
15	*Oligotricha striata* (L.)					1				4	5
16	*Phryganea bipunctata* Retz.			1							1

Table (Contd.)

No.	Order, species	Habitats									Total, ind.
17	*Semblis phalenoides* (L.)	3					2				5
18	*Brachycentrus subnubilus* Curt.	11					4		2		17
19	*Anabolia* sp.	3	41	2			2		1		49
20	*Halesus digitatus* (Schr.)	50	70			1		102	80		303
21	*H. radiatus* (Curt.)						2	8		1	11
22	*Chaetopteryx villosa* (F.)							8			8
23	*Glyphotaelius pellucidus* (Retz.)	12	54	16	8	15		9	18	54	186
24	*Grammotaulius nitidus* Müll.	2	7	2	40	18		1	5	3	78
25	*Limnephilus auriculus* Curt.								6		6
26	*L. binotatus* Curt.		1								1
27	*L. decipiens* Kolenati				2						2
28	*L. extricatus* McLach.	2	9			5		13	5		34
29	*L. flavicornis* (F.)	10	1	30		7			10	22	80
30	*L. fuscicornis* Ramb.	56	160		1				62		279
31	*L. fuscinervis* (Zett.)			6			2		8	1	17
32	*L. griseus* (L.)		1								1
33	*L. lunatus* Curt.	4									4
34	*L. nigriceps* (Zett.)									2	2
35	*L. politus* McLach.				21						21
36	*L. rhombicus* (L.)		1			29		45			75
37	*L. stigma* Curt.		4			6			20	26	56
38	*L. subcentralis* Brauer		1								1
39	*Potamophylax cingulatus* (Steph.)						1				1
40	*P. latipennis* (Curt.)							53			53
41	*P. rotundipennis* (Brauer)	1					2	19	40		62
42	*Sericostoma personatum* (Spence)		1					12			13
43	*Molanna angustata* Curt.				1						1
44	*Beraeodes minutus* (L.)							2			2
45	**Athripsodes bilineatus* (L.)	1									1
46	*Ceraclea dissimilis* (Steph.)		1								1
47	*Mystacides azurea* (L.)		8								8
48	*Triaenodes bicolor* (Curt.)			4						2	6
49	**Ylodes simulans* (Tjeder)	2									2
	Total number of species	44	44	22	18	18	22	33	26	17	108
	Total number of specimens	827	921	398	366	269	117	2112	607	417	6088

Notes: I, Berezina River (Berezino Vill.); II, Berezina River (Brody Vill.); III, Berezina River (upstream of Lake Palik); IV, Berezina River (downstream of Lake Palik); V, Moskovitsa River; VI, Deryazhina River; VII, Krasnogubka River; VIII, Serguchskii Canal; IX, Smolyanka River. Species recorded from Belarus for the first time are marked with asterisks (*).

Polycentropus irroratus (Curtis, 1834) is distributed in Europe; larvae are psychrophilic, prefer small rivers with rapid current (Ivanov et al., 2001; Czachorowski, 1998). Material: 20.06.2002 (1 larvae), in Berezina River (Berezino Vill.).

Hydropsyche bulgaromanorum Malicky, 1977 is distributed in Europe; larvae inhabit large rivers and canals (Ivanov et al., 2001); rare. Material: 24.04.2002 (1 larva), in the Berezina River (1 km upstream of Lake Palik).

Athripsodes bilineatus (Linnaeus, 1758) is distributed in Europe, except for Scandinavia and Iceland (Czachorowski, 1998); it is rare in European Russia (Ivanov et al., 2001). Larvae inhabit large brooks and rivers, prefer water bodies with rocky bottom (Wallace, 1990). Material: 20.06.2002 (1 larva) in Berezina River (Berezino Vill.).

Ylodes simulans (Tjeder, 1929) is distributed in northern and central Europe and rare in the northwestern part of European Russia (Ivanov et al., 2001). Larvae dwell in rivers amongst aquatic plants (Wallace, 1990; Czachorowski, 1998). Material: 20.06.2002(1 larva), in the Berezina River (Berezino Vill.).

In the river ecosystems of the Reserve, some species protected and included in the Red books and Red lists of Belarus and adjacent countries are found. Such are *Calopteryx splendens* (Harr.) and *Sympetrum pedemontanum* (All.), dragonflies placed into the Red book of Belarus. The Red list of Poland includes: *Taeniopteryx nebulosa* (L.), *Perlodes dispar* (Ramb.), *Isoperla difformis* (Klap.), *I. grammatica* (Poda), *Nemoura dubitans* Mort., *Heptagenia fuscogrisea* (Retz.), *Brachycercus harisellus* Curt., *Cordulegaster boltonii* (Donov.), *Hydropsyche bulgaromanorum* Malicky, *Semblis phalenoides* (L.), *Limnephilus fuscinervis* (Zett.), *Beraeodes minutus* (L.), and *Ylodes simulans* (Tjeder) (Fialkowski and Sowa, 2002; Klonowska-Olejnik, 2002; Bernard et al., 2002; Szczesny, 2002). *Calopteryx virgo* (L.) and *C. splendens* (Harris) are placed into the Red book of Ukraine (Red Book of the Ukraine, 1994). The European Red list includes *Gomphus flavipes* (Charp.) and *Ophiogomphus cecilia* (Geoffr.) (Supplement 2 to Bern Convention).

Hence, the fauna of the studied groups of aquatic insects in streams of the Berezinskii Reserve is rich and includes not only rare species, but also animal species protected both in Belarus and several European countries. It may be suggested, that the rivers studied play the role of refugiums, especially for rheophilous and oxyphilous hydrobionts. The results obtained reflect the importance of the territory of the Berezinskii Reserve as an etalon of European plain landscapes; various non-transformed natural complexes are preserved in the Reserve due to the long-time sanctuary regime.

The analysis of the relative abundance of aquatic insects revealed dominating species. In Plecoptera, the most abundant species were *Nemoura cinerea* (Retz.) with 71.97% of all stonefly specimens and *N. dubitans* Mort., with 19.85%. Larvae of *N. cinerea* and *N. dubitans* inhabit various flowing water bodies, including those with marsh type of alimentation (Khmeleva et al., 1994; Moroz et al., 1999).

In Ephemeroptera, *Leptophlebia marginata* (L.) with 31.54% of the total number of mayflies and *Heptagenia fuscogrisea* (Retz.) with 26.10% are dominating. Larvae of these species prefer rivers with slow current and lakes with silty ground and live on aquatic plants (Kazlauskas, 1977).

In Odonata, *Gomphus vulgatissimus* (L.) with 17.19% of all dragonfly specimens and *Coenagrion puella* (L.) with 13.32% were the most abundant. Larvae of *G. vulgatissimus* are frequently found in flowing water bodies on sandy or silty ground; those of *C. puella*, in various stagnant and slowly flowing water bodies on aquatic plants (Popova, 1977).

In Trichoptera, *Halesus digitalis* (Schr.) with 19.28% of total number of caddisflies and *Limnephilus fuscicornis* Ramb. with 17.75% were the most abundant. Preferential habitats of larvae for *H. digitalis* are brooks and pure small rivers, for *L. fuscicornis*, rivers with sandy and rocky bottom (Wallace et al., 1990; Czachorowski, 1998; Ivanov et al., 2001).

The ecological structure of the aquatic insects of the orders Plecoptera, Ephemeroptera, Odonata, and Trichoptera in the streams of the Berezinskii Biosphere Reserve is characterized by the presence of species preferring plain flowing waters and those from water bodies with distinctive drainage areas of the Reserve, which include great forest and marsh massifs.

The analysis of the significance of each water body in maintenance of the species diversity in Berezinskii Reserve has shown that an important backbone role is played by the Berezina River in its section between the villages Berezino and Brody, where 64 species of aquatic insects (59.26% of all hydrobionts revealed) were collected. A considerable insect abundance

(28.71% of all collected animals) was also observed in this river section. The Krasnogubka River, which is a stream of the brook type, is also important for species diversity (33 species, i.e. 30.56% of all hydrobionts revealed). The maximum abundance of aquatic insects (34.69%) was also observed in this river. The role of the other streams was not such significant.

CONCLUSION

The fauna of aquatic insects of the studied groups in the rivers of the Berezinskii Reserve is species-rich and includes species, which are rare and protected both in Belarus and some European countries. A total of 108 species were found (10 species of Plecoptera, 24, of Ephemeroptera, 25, of Odonata, and 49 species of Trichoptera).

The following species are recorded from Belarus for the first time: *Perlodes dispar* (Ramb.), *Isoperla difformis* Klap., *Nemoura cambrica* Steph., *Baetis buceratus* Eaton, *B. scambus* Eaton, *B. tricolor* Tshern., *Caenis luctuosa* (Burm.), *Polycentropus irroratus* (Curt.), *Hydropsyche bulgaromanorum* Malicky, *Athripsodes bilineatus* (L.), and *Ylodes simulans* (Tjeder).

Hence, the rivers studied play the role of refugiums, especially for rheophilous and oxyphilous hydrobionts. The results obtained suggest that the territory of the Berezinskii Reserve is important as an etalon of European plain landscapes. Obviously, various flowing water bodies of the Reserve have been preserved due to the longtime sanctuary regime.

Quantitatively, the fauna of the aquatic insects studied is mainly formed by species preferring typical plain flowing waters and water bodies with distinctive drainage areas of the Reserve, which include great forest and marsh massifs.

The Berezina River plays an important system-constituting backbone role. Small rivers of the brook type are also important; this is exemplified by the Krasnogubka River. The Berezinskii Reserve is a reference territory for assessment of anthropogenic transformations in landscapes of Eastern Europe.

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