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ORIGINAL RESEARCH

Species Composition and Diversity of the True Bugs (Hemiptera, Heteroptera) of a Raised Bog in Belarus

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Abstract Peat bogs in the temperate zone form isolated and discrete patches of "tundra" and so are azonal ecosystems relative to the surroundings. The aim of the current work is to investigate the species composition and diversity of the true bugs of pristine natural peat bog in Belarus. In total, 75 true bugs species belonging to 13 families in Belarusian peat bog were sampled by sweep net along transects. A specific complex of Heteroptera species were found. The results showed a low diversity and species richness of true bugs and a high abundance of a small number of species. Among these species, the primary peat bog specialist is *Stephanitis oberti* (Kolenati). Rare in Central Europe tyrphobiontic and tyrphophilous species were recorded. Abundance and species richness of Heteroptera were the highest in the shrub habitat. The modeling results (GLM) indicated that vegetation characteristics strong influenced true bugs abundances and species richness in peat bogs habitats, which I interpreted the as a measure of heterogeneity.

Keywords Assemblages · Heteroptera · Diversity · Peat bog · Belarus

Introduction

Boreal peatland ecosystems – bogs and fens – cover only about 3 % of the earth's land surface, but their overall ecological and societal importance is proportionately much greater than their area might suggest. Most of these ecosystems are located in the northern hemisphere in areas that were completely covered with ice 10,000–25,000 years ago. In the relatively short period of time since deglaciation, peatlands have become widely established in northern boreal regions (Wieder et al. 2006). Many bog inhabitants have specific habitat requirements, such as acidic and nutrient-poor conditions, specific cold-adapted or bog-restricted foodplants, and aquatic or aquatic-edge habitats (Spitzer and Danks 2006). Today, Central European peatlands play an important role in global and international species conservation. They harbour viable breeding populations and play a central role as migration and wintering sites for many bird species of global conservation concern. These areas have a special responsibility for the conservation of rare insect species (Bragg et al. 2003).

Raised bogs of Central Europe, including the Republic of Belarus, are island-like ecosystems with very specific environmental conditions and biota. Sphagnum moss with scattered or clumped ericaceous shrubs are predominating in these bogs, while the mineralization level is low and the peat activity is high. These specific conditions strongly influences the structure of invertebrate communities including insects inhabiting these habitats.

On the other hand, these ecosystems are among the most vulnerable ones in Europe and their area greatly diminished in the twentieth century. Peat bogs have almost completely disappeared from certain areas in western Europe (Joosten and Clarke 2002) and basic information on the fauna of bogs is often lacking. The first descriptions of the invertebrate fauna of European peatlands were compiled in the first decades of the twentieth century (Dampf 1924; Peus 1928; Skwarra 1929; Roubal 1934). A large number of invertebrate species have been reported almost exclusively from peatlands, at least in the southern part of the distribution area of these species (Peus 1928; Krogerus 1960; Spitzer and Jaroš 1993).

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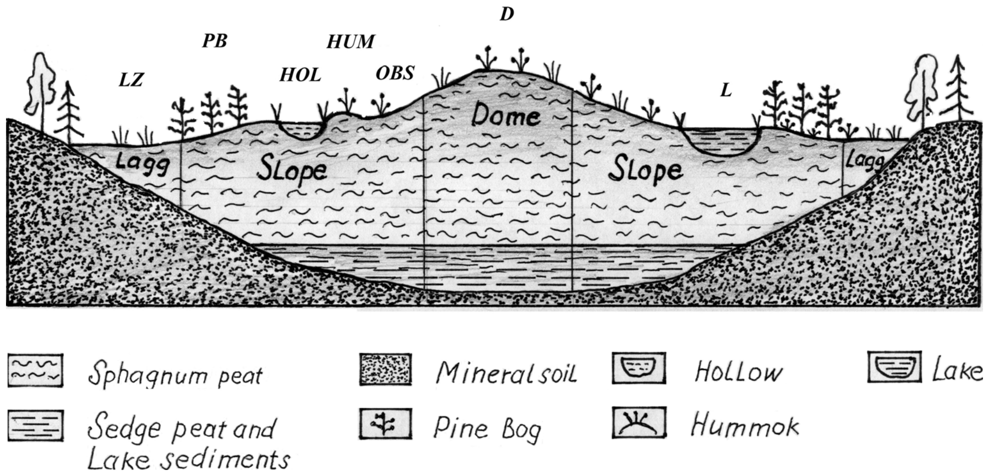

Fig. 1 Location of the sampling sites in the "Moch" peat bog. Habitat symbols: lagg zone (*LZ*); pine forest (*PB*); hollow (*HOL*); hummock (*HUM*); open bog spaces (*OBS*), lakeshores (*L*); dome (*D*)

Heteroptera are among the most abundant animal groups in peatlands. Unfortunately, knowledge of their species composition is sparse. Very few papers so far have been dedicated to the true bugs of peat bogs (Peus 1928; Maavara 1957; Rampazzi and Dethier 1997; Montagna et al. 2008; Spungis 2008; Friess and Korn 2013; Frieß et al. 2013).

The aim of the current work is to investigate the species composition and diversity of the true bugs of pristine natural peat bog in Belarus.

Materials and Methods

Study Site

This research was carried out in the period of 2010–2015 in a 4602 ha peat bog "Moch" situated in Belarus (coordinates: 55°37′ N 28°06′ E). This is between the largest and anthropogenically least modified peat bog from this country and is currently protected as hydrological reserve. There is a slope, a peak, and a plateau, which is located at the edges of the border zone (lagg zone) and is periodically flooded due to a lower elevation (Fig. 1).

Vegetation

Vegetation surveys were conducted according to the method of Brown (1954) in 7 the most typical peat bogs habitats: 1) lagg zone (LZ) at the bog margin (plant association – *Eriophorum vaginatum – Sphagnum angustifolium*), 2) pine bog (PB) on the slope (plant association – *Pinus sylvestris – Eriophorum vaginatum – Ledum palustre – Sphagnum magellanicum*), 3) hollows (HOL) on the slope (plant association – *Rhynchospora alba – Sphagnum cuspidatum*), 4) hummocks (HUM) on the slope (plant association – *Eriophorum vaginatum – Oxycoccus palustris – Andromeda polifolia – Ledum palustre – Sphagnum magellanicum – S. angustifolium*), 5) open bog (OBS) on the slope (plant association – *Eriophorum vaginatum – Ledum palustre – Chamaedaphne calyculata – Empetrum nigrum – Calluna vulgaris – Oxycoccus palustris – Vaccinium uliginosum – Sphagnum magellanicum*), 6) lakeshores (L) on the slope (plant association – *Carex limosa – Sphagnum cuspidatum*), 7) dome (D) (plant association – *Eriophorum vaginatum – Calluna vulgaris – Sphagnum fuscum*) (Fig. 1).

Open and swampy lagg zone, hollows and lakeshores showed the higher percentage of herbs cover and low plants

Table 1 Site characteristics showing the means (±SE) of the vegetation structure

Environmental variable	Habitats						
	LZ	PB	HOL	HUM	OBS	L	D
presence of trees (−,+)	–	+	–	–	–	–	–
shrubs cover (%)	10.8 ± 2	57.9 ± 11	8.3 ± 6	54.3 ± 3	59.4 ± 16	0	56.1 ± 7
herbs cover (%)	68.8 ± 6	12.1 ± 4	43.3 ± 3	19.7 ± 2	28.5 ± 18	81.9 ± 1	24.7 ± 2
number of species of vascular plant	3	10	1	8	9	1	7
total number of sites per habitat type	3	3	3	3	3	3	3

Habitat symbols: lagg zone – LZ; pine bog – PB; hollow – HOL; hummock – HUM; open bog – OBS; lakeshores – L; dome – D

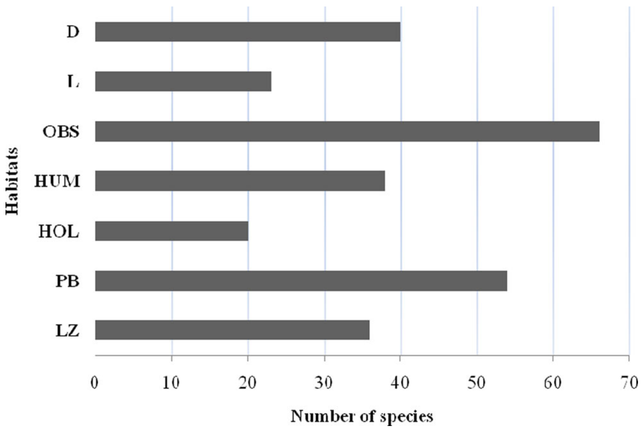

Fig. 2 Differences in the species richness in Heteroptera assemblages. Habitat symbols: lagg zone (*LZ*); pine forest (*PB*); hollow (*HOL*); hummock (*HUM*); open bog spaces (*OBS*), lakeshores (*L*); dome (*D*)

species richness (Table 1). The most common vascular plants species of these sites are *Eriophorum vaginatum, Carex limosa,* and *Rhynchospora alba.* Vegetation characteristics of a pine bogs, a hummocks and an open bog were similar. These sites showed the higher percentage of ericaceous dwarf shrubs cover and high plants species richness. The hummocks, which may vary in diameter from a 20–30 cm to several metres, are mainly composed cotton grass, cranberry, northern bilberry, Labrador tea, bog rosemary and common sundew. These plants are typical for pine bogs and open bogs, while the dome showed the higher percentage of heather in dwarf shrubs cover and a slight decrease of plants species richness.

In each habitat 3 sites with a homogeneous vegetation and a size of 250 m^2 were selected (in total, 21 sites).

Vegetation was sampled during July 2010 in all sites. Four vegetation parameters were recorded in each site: cover (%) of shrubs, herbs, the number of species of vascular plants and the presence of trees (Table 1). Sites had a minimum distance of 50 m from each other.

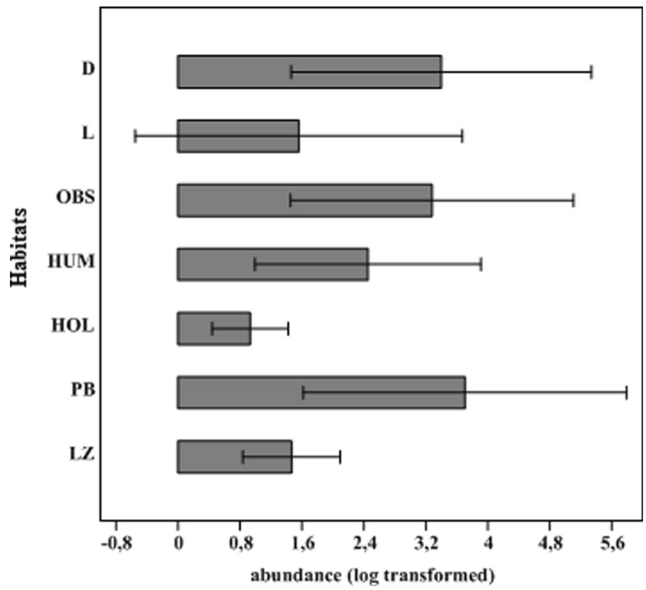

Fig. 3 Differences in the total Heteroptera assemblages abundance, with log-transformed. Habitat symbols: lagg zone (*LZ*); pine forest (*PB*); hollow (*HOL*); hummock (*HUM*); open bog spaces (*OBS*), lakeshores (*L*); dome (*D*)

Heteroptera Survey

Heteroptera were estimated by using a transect method. For the collection of true bugs entomogical sweep-net (diameter 30 cm) was used. Transects had a standardized length of 50 m and were 5 m width (= 250 m^2 per site). Each transect was done exactly 50 sweep-netting twice a month. For statistical analysis, data of the samplings in each site were summed up to obtain one dataset per habitat. Surveys were conducted during the main activity period of adult true bugs between May and the end of September.

The nomenclature of Heteroptera follows Aukema and Rieger (1995, 1996, 1999, 2001, 2006). The ecological

Table 2 The main parameters of true bug assemblages

Parameters	Habitats						
	LZ	PB	HOL	HUM	OBS	L	D
Number of families	10	10	7	9	11	8	9
Number of species	36	54	20	38	66	23	40
Number of specimens	110	278	70	184	246	117	255
Number of species represented by 1–2 specimens	23	31	11	24	46	21	18
% of species represented by 1–2 specimens	63.88	57.40	55.00	63.15	69.69	91.30	45.00
Number of species with abundance >5 %	4	4	8	4	3	2	4
% of specimens of species with abundance >5 %	40.00	53.23	75.71	54.89	45.53	80.34	54.90
Shannon-Wiener index (H′)	1.382	1.329	1.161	1.236	1.421	0.619	1.26
Simpson index (D)	0.052	0.092	0.071	0.099	0.089	0.479	0.093
Pielou index (J)	0.888	0.767	0.893	0.782	0.781	0.455	0.787

Habitat symbols: lagg zone (LZ); pine bog (PB); hollow (HOL); hummock (HUM); open bog spaces (OBS), lakeshores (L); dome (D)

Table 3 Composition of true bugs assemblages of different habitats in the peat bog

Family/Species	Abbrevi-ations	Habitats						
		LZ relative abundance, %	PB	HOL	HUM	OBS	L	D
Tingidae								
Agramma femorale (Thomson 1871)	Agr fem	4.55	1.08	14.29	2.72	0.81	0.85	1.96
Stephanitis oberti (Kolenati 1857) *	Ste obe	0.00	24.10	0.00	23.91	25.61	0.00	20.78
Miridae								
Lygus pratensis (L. 1758)	Lyg pra	15.45	11.87	4.29	15.22	10.98	1.71	17.65
L. rugulipennis (Poppius 1911)	Lyg rug	9.09	1.08	2.86	0.54	0.41	0.85	3.53
Stenodema calcarata (Fallén 1807)	Ste cal	2.73	0.36	12.86	0.54	0.81	0.85	0.39
Stethoconus cyrtopeltis (Flor, 1860)*	Ste cyr	1.82	0.36	0.00	0.54	0.41	0.00	1.18
Globiceps salicicola (Reuter 1880) **	Glo sal	0.00	1.80	0.00	2.17	1.22	0.00	0.00
Orthotylus ericetorum (Fallén 1807)	Ort eri	0.00	2.16	0.00	2.17	1.63	0.00	2.35
Nabidae								
Nabis brevis (Scholz 1847)	Nab bre	2.73	0.00	0.00	0.00	0.41	0.00	0.00
N. ericetorum (Scholtz 1847) *	Nab eri	0.91	0.36	1.43	1.09	0.41	0.85	1.57
N. ferus (L.1758)	Nab fer	4.55	3.60	2.86	4.35	2.85	0.00	7.06
Reduviidae								
Coranus woodroffei (P.V. Putshkov 1982) **	Phy cra	2.73	1.08	0.00	0.00	0.41	0.85	0.00
Lygaeidae								
Nysius helveticus (Herrich-Schaffer 1850) *	Nys hel	0.00	1.44	0.00	1.09	0.81	0.00	1.57
Kleidocerys resedae (Panzer 1797)	Kle res	10.00	8.99	10.00	5.43	3.66	11.97	3.14
Cymus grandicolor (Hahn 1832)	Cym gra	0.00	3.96	11.43	4.89	2.03	68.38	1.96
Scolopostethus decoratus (Hahn 1833)	Sco dec	0.00	1.44	0.00	1.09	0.81	0.85	1.57
Macrodema microptera (Curtis 1836)	Mac mic	0.00	1.08	0.00	1.09	0.81	0.85	1.57
Pterotmetus staphyliniformis (Schilling 1829)	Pte sta	0.00	1.08	0.00	0.00	0.81	0.00	0.00
Pachybrachius luridus (Hahn 1826)	Pac lur	0.00	0.36	7.14	0.00	0.41	0.00	0.39
Rhyparochromus pini (L. 1758)	Rhy pin	0.00	1.44	7.14	2.17	2.03	0.00	2.75
Stygnocoris sabulosus (Schilling 1829)	Sty sab	0.00	1.44	0.00	0.00	0.00	0.00	0.39
Ligyrocoris sylvestris (L. 1758)	Lig syl	0.91	0.36	0.00	1.09	0.81	0.00	0.00
Rhopalidae								
Rhopalus maculatus (Fieber 1837)	Rho mac	1.82	0.72	0.00	1.09	1.22	0.85	0.78
R. parumpunctatus (Schilling 1829)	Rho par	4.55	1.08	5.71	0.54	1.63	1.71	0.78
Stictopleurus abutilon (Rossi 1790)	Sti abu	2.73	0.72	0.00	1.09	0.81	0.00	0.78
S. crassicornis (L. 1758)	Sti cra	5.45	8.27	7.14	10.33	8.94	0.85	9.41
S. punctatonervosus (Goeze 1778)	Sti pun	1.82	0.36	0.00	0.00	1.22	0.85	0.39
Acanthasomatidae								
Elasmucha grisea (L. 1758)	Ela gri	1.82	0.36	0.00	0.54	1.22	0.00	0.39
Scutelleridae								
Eurygaster testudinarius (Geoffroy 1785)	Eur tes	1.82	0.00	1.43	0.00	0.41	0.85	0.00
Pentatomidae								
Jalla dumosa (L. 1758) *	Jal dum	0.91	0.36	2.86	0.00	0.41	0.00	0.39
Picromerus bidens (L. 1758)	Pic bid	0.00	1.08	0.00	2.17	1.22	0.00	1.96
Rhacognatus punctatus (L. 1758)	Rha pun	0.00	2.16	0.00	1.63	1.22	0.00	3.14
Aelia acuminata (L. 1758)	Ael acu	0.00	2.52	1.43	2.72	1.63	0.85	1.96
Neottiglossa pusilla (Gmelin 1789)	Neo pus	1.82	0.00	0.00	0.00	0.41	0.85	0.00
Antheminia aliena (Reuter 1891) *	Ant ali	1.82	0.00	0.00	0.00	0.41	0.00	0.00
Carpocoris fuscispinus (Boheman 1849)	Car fus	0.91	0.36	0.00	0.54	1.63	0.00	1.57
C. purpureipennis (De Geer 1773)	Car pur	2.73	0.36	0.00	0.54	0.41	0.00	0.39

Table 3 (continued)

Family/Species	Abbrevi-ations	Habitats						
		LZ relative abundance, %	PB	HOL	HUM	OBS	L	D
Dolycoris baccarum (L. 1758)	Dol bac	3.64	2.16	1.43	2.72	2.03	0.00	1.96
Holcostethus vernalis (Wolff 1804)	Hol ver	1.82	0.36	0.00	0.00	0.41	0.00	0.00
Palomena prasina (L. 1761)	Pal pra	0.91	0.72	0.00	0.00	2.03	0.00	0.00
Piezodorus lituratus (F. 1794)	Pie lit	1.82	0.00	0.00	0.54	0.41	0.00	0.39
Eurydema oleracea (L. 1758)	Eur ole	0.00	0.36	0.00	0.54	1.22	0.85	0.39

Habitat symbols: lagg zone (LZ); pine bog (PB); hollow (HOL); hummock (HUM); open bog spaces (OBS), lakeshores (L); dome (D); *Tyrphophilous species, **Tyrphobiontic species

terminology is that of Spitzer and Danks (2006): tyrphobiontic species are stenotopic and obligatory associated with peat bogs in the temperate zone, tyrphophilous taxa are more abundant on bogs than in adjacent habitats, and tyrphoneutral species are eurytopic and widely distributed in various habitats.

Data Analysis

Simpson (D) and Shannon-Wiener indices (H′) were used for the calculate of diversity of the Heteroptera assemblages. Evenness was estimated using Pielou's evenness (J). Hierarchical cluster analysis (UPGMA linking method) was employed in the analysis of habitats similarity. Calculations were performed using the Past® software (Hammer et al. 2001).

Principal component analysis (PCA) was used to ordinate the relationship among species and their habitats (Jongman et al. 1995). The data were $\log_2$ transformed. The acronyms of scientific species names in the ordination represent the first three letters of both the genus- and the species (Table 3). Species occurring as singletons (represented by 1–2 specimens) were omitted from ordination analysis as well as sites where only one individual was detected. Post hoc Tukey HSD tests were used to examine pairwise differences between axis 1 and 2 of the PCA ordinations (MVSP 2002).

The relationship between species diversity and total Heteroptera abundance to environmental variables were tested with generalized linear models (GLM) to meet model assumptions (Zuur et al. 2009; Zuur et al. 2010). The statistical analyses were done in R 2.12.2 (R Development Core Team 2011).

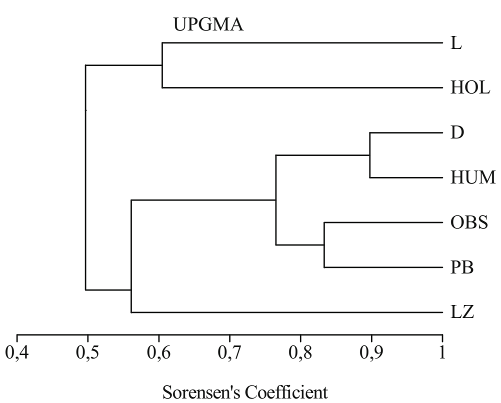

Fig. 4 Comparison of species compositions of true bugs recorded in different habitats in the peat bog, with Sørensen coefficient of similarity, UPGMA linking method. Habitat symbols: lagg zone (*LZ*); pine forest (*PB*); hollow (*HOL*); hummock (*HUM*); open bog spaces (*OBS*), lakeshores (*L*); dome (*D*)

Results

Heteroptera Species Richness, Abundance and Diversity

In total, 75 true bugs species belonging to 13 families (Saldidae, Tingidae, Miridae, Nabidae, Reduviidae, Aradidae, Lygaeidae, Berytidae, Rhopalidae, Coreidae, Acanthasomatidae, Scutelleridae, and Pentatomidae) were found. Miridae family represented by 16 species, while 18 Pentatomidae and 15 Lygaeidae species were recorded. Other families was represented by less than 6 species.

The assemblages of true bugs comprised from 20 to 66 species. The lowest number of species was recorded in the hollow (20). The highest species richness was captured in the open bog sites (66) (Fig. 2, Table 2). Heteroptera abundance was the highest in a pine bog, open bog spaces and dome and lowest in the hollow (Fig. 3).

Stephanitis oberti (20.78 %–25.61 %), *Lygus pratensis* (4.29 %–17.65 %), *Kleidocerys resedae* (3.14 %–11.97 %) and *Stictopleurus crassicornis* (0.85 %–10.33 %) were the most abundant species (Table 3). More than half of the species (55.00–91.30 %) caught in the six of the seven habitats were represented by 1–2 individuals. Only 12 species were recorded with abundance higher than 5 %. Among the specialized peat bog species, only *Stephanitis oberti* was recorded in greater number. The abundance of others peat bog dwellers was lower. They are such species as *Globiceps salicicola,* *Coranus woodroffei* (tyrphobiontic), *Agramma tropidopterum, Stethoconus cyrtopeltis, Orthotylus ericetorum, Nysius helveticus, Jalla dumosa* and *Antheminia aliena* (tyrphophilous). Nine species of true bugs (*Agramma femorale, Lygus pratensis, L. rugulipennis, Stenodema calcarata, Nabis ericetorum, N. ferus, Kleidocerys resedae, Rhopalus parumpunctatus* and *Stictopleurus crassicornis*) occurred in all habitats.

The open bog sites showed the highest average Shannon-Wiener index value (H′ = 1.421), whereas the lowest value was recorded from the lakeshores (H′ = 0.619). In other assemblages the diversity index slightly decreased (H′ = 1.161–1.382). The Pielou evenness index (J = 0.170) was minimum in the lakeshores also. On the contrary, dominance peaked (D = 0.479). The lowest dominance was in the lagg zone (D = 0.052).

The cluster analysis showed a similarity among true bugs assemblages of dome (D) and hummock (HUM) and assemblages of open bog spaces (OBS) and pine bogs (PB). Assemblages of the hollow (HOL) and lakeshores (L) were similar also. On the other hand the assemblages of lagg zone and other habitats were the least similar (Fig. 4).

Heteroptera Species Composition and Response to Environmental Variables

PCA analysis revealed the groups of species associated with particular habitats (Fig. 5). The first two axes of the PCA ordination explained 60.04 % and 18.60 % of the variation. The cumulative percentage of variance explained by the two first axes was 78.65 %. Association for the lagg zone was shown by *Kleidocerys resedae* and *Eurygaster testudinarius*. *Rhyparochromus pini*, *Dolycoris baccarum, Stephanitis oberti, Globiceps salicicola* seemed to be associated with open treeless bog spaces on the slope. *Lygus pratensis, Stictopleurus crassicornis, Nabis ferus, Rhacognatus punctatus* correlated with hummock. *Agramma femorale* and *Cymus grandicolor* seemed to be more associated with hollows. *Stenodema calcarata*, *Rhopalus parumpunctatus* and *Pachybrachius luridus* associated with lakeshores. The coordinates of the remaining species are close to the ordination biplot center, which showed their lack of association for certain habitats.

The significant predictors variable in the GLM model for Heteroptera species richness were herbaceous cover and number of plants species. The significant predictors variable for true bugs abundance were shrubs cover and number of plants species (Table 4).

Discussion

The results showed a low species richness and diversity of true bugs and a high dominance of a small number of species in different habitats of the peat bog. That is typical for peat bogs in other European countries as well (Peus 1928; Maavara 1955; Rampazzi and Dethier 1997; Montagna et al. 2008; Spungis 2008; Friess and Korn 2013). Among them were the most abundant species such as *Lygus pratensis, Stictopleurus crassicornis, Kleidocerys resedae* and *Stephanitis oberti*.

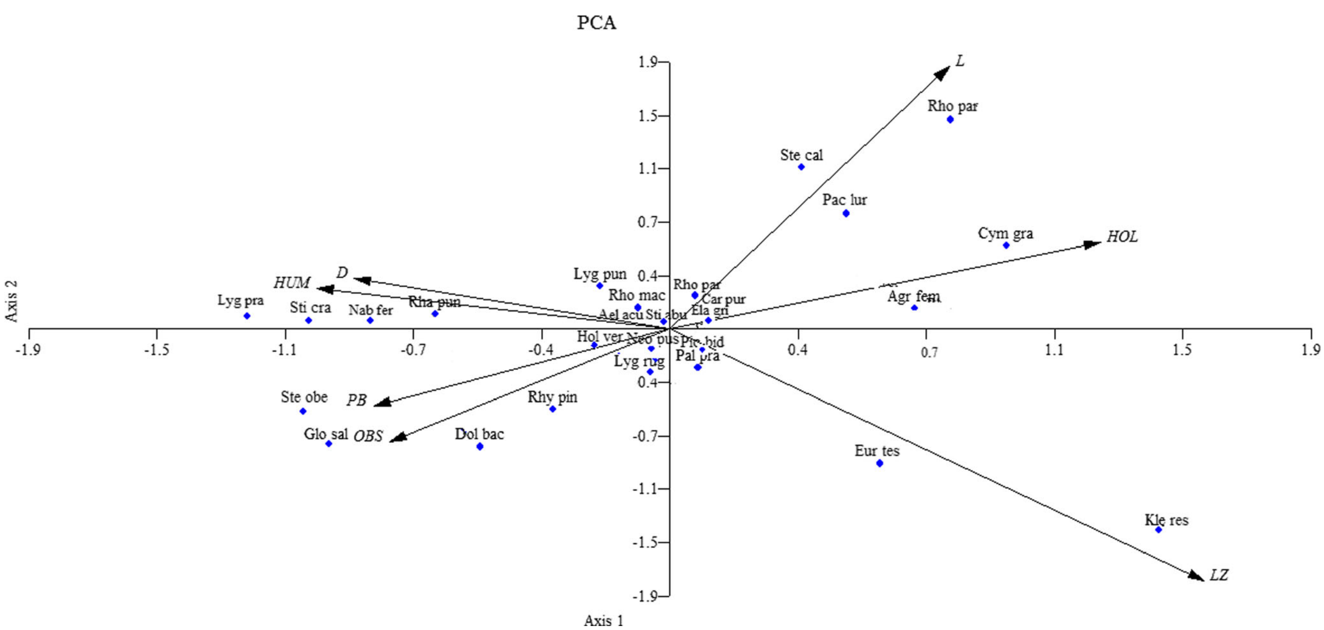

Fig. 5 The ordination diagram of the principal component analysis (PCA) for assemblages of Heteroptera in the analyzed habitats (Species abbreviations are given in Table 3); The first two axes of the PCA ordination explained 60.04 % and 18.60 % of the variation. The cumulative percentage of variance explained by the two first axes was 78.65 %

Table 4 Relationship of total Heteroptera species richness and abundance to environmental factors, with generalized linear model with log transformed data, multiple regression

Parameters	Estimate	SE	t	P
Species richness (R^2 = 0.762)				
shrubs cover	-0.97671	0.57875	-1.6876	0.15229
herbs cover	1.3566	0.44348	3.0589	**0.028138**
number of species of vascular plants	0.1985	0.051086	3.8856	**0.011577**
presence of trees	0.009134	0.009583	0.95311	0.3843
Abundance (R^2 = 0.889)				
shrubs cover	0.24009	0.094565	2.5389	**0.00519**
herbs cover	0.30442	0.05878	5.179	0.003528
number of species of vascular plants	0.03685	0.0117	3.1497	**0.00253**
presence of trees	0.002416	0.001749	1.3812	0.22575

The primary indicator of raised bog habitats is the complex of tyrphobiontic species *Coranus woodroffei, Globiceps salicicola* (Sushko and Lukashuk 2011; Friess and Korn 2013) and the tyrphophilous species *Stephanitis oberti, Nysius helveticus, Agramma tropidopterum*, *Stethoconus cyrtopeltis, Orthotylus ericetorum* and *Antheminia aliena* (Sushko and Lukashuk 2011). Most of these species are herbivorous and associated trophically with specialized peat bogs plants (mainly ericaceous shrubs), such as *Ledum palustre, Chamaedaphne calyculata, Calluna vulgaris, Oxycoccus palustris, Andromeda polyfolia, Vaccinium uliginosum.* Only *Agramma tropidopterum* feeds on cotton grass (Sushko and Lukashuk 2011). *Stethoconus cyrtopeltis* is interesting more than others predatory true bugs (Sushko and Lukashuk 2011). This species feeds on imagoes and larvae of another peat bogs inhabitant – *Stephanitis oberti*. Most of these species are established on peat bogs in the Baltic region and Central Europe (Maavara 1955; Spungis 2008; Friess and Korn 2013; Frieß et al. 2013).

The highest Heteroptera species richness, abundance and diversity were in the habitats covered with shrubs. On the other hand, in habitats, covered only with grasses, diversity measures decreased. Cluster analysis revealed a clear separation among the true bugs assemblages on shrub-covered sites and grass-covered sites. The modeling results (GLM) indicated that vegetation characteristics strongly influenced true bugs abundance and species richness in peat bog habitats.

The majority of species showed not clear correlation for certain habitats. Peat bog specialist *Stephanitis oberti*, feeding on dwarf shrubs, seemed to be associated with open treeless bog spaces on the slope and on the dome. On the other hand, separate peat bog habitats offer favorable conditions to some hygrophilous and eurytopic Heteroptera species.

Conclusions

To conclude, the results showed a low diversity and species richness of true bugs and a high abundance of a small number of species. Among these species, the primary peat bog specialist is *Stephanitis oberti*. Moreover such rare in Central Europe tyrphobiontic and tyrphophilous species as *Coranus woodroffei, Globiceps salicicola*, *Nysius helveticus, Agramma tropidopterum*, *Stethoconus cyrtopeltis, Orthotylus ericetorum* and *Antheminia aliena*, were also recorded. Abundance and species richness of Heteroptera were the highest in the habitats covered with shrubs. The modeling results (GLM) indicated that vegetation characteristics strongly influenced true bugs abundance and species richness in peat bogs habitats, which I interpreted the as a measure of heterogeneity.

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