

<i>Travaux du Muséum National d'Histoire Naturelle «Grigore Antipa»</i>	Vol. LIII	pp. 181–190	© Décembre 2010
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DOI: 10.2478/v10191-010-0014-7

FAUNISTIC AND ECOLOGICAL CHARACTERIZATION OF AQUATIC AND SEMIAQUATIC HETEROPTERA (INSECTA) COMMUNITIES IN PERMANENT SWAMPS SITUATED IN FĂGĂRAȘ DEPRESSION AND SIBIU DEPRESSION (ROMANIA)

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Abstract. This paper assesses the biodiversity of aquatic and semiaquatic Heteroptera in permanent swamps situated in two contact depressions between Făgăraș Mountains and the Transylvania Plateau, and performs a species association and a species monthly dynamics analysis. We have identified 30 species of Heteroptera, of which 18 species are aquatic (Infraorder Nepomorpha) and 12 are semiaquatic (Infraorder Gerromorpha). The α -biodiversity analysis reveals values between 0.379-3.475 for the investigated stations, which indicate a uniform distribution of individuals on species, both within stations and in each of the two depressions. The monthly sampling, in 2004, enabled us to analyze the species dynamics.

Résumé. Le travail a pour but l'évaluation de la biodiversité de communautés de Héteroptères aquatiques et semiaquatiques des mares permanentes situées dans deux dépressions de contact entre les Monts Făgăraș et le Plateau de Transylvanie, ainsi que la réalisation de l'analyse d'association des espèces et la surveillance de la dynamique mensuelle des espèces. On y a identifié 30 espèces de Héteroptères, dont 18 sont aquatiques (Infrasuborder Nepomorpha) et 12 semiaquatiques (Infrasuborder Gerromorpha). L'analyse de biodiversité α offre des valeurs comprises entre 0,379-3,475 pour les stations investiguées, et indique une distribution relativement uniforme des individus par espèces, tant dans le cadre des stations, que pour le niveau de chaque dépression. Les collectes périodiques, mensuelles, au cours de l'année 2004 ont permis la surveillance de la dynamique des espèces.

Key words: Nepomorpha, Gerromorpha, α -biodiversity, ecologic affinity, monthly dynamics, contact depressions between Făgăraș Mountains and the Transylvania Plateau, Romania.

INTRODUCTION

Făgăraș Depression and Sibiu Depression, situated between the Făgăraș Mountains and Cindrel Mountains at South, Târnava Plateau and Secaș Plateau at North and Perșani Mountains at East (South of Transylvania Plateau, Romania), are typical contact depressions that were formed by corrosion. There are morphologic units having an average height of 450 m, layered to the contact to the mountains (piedmont field). The relief was formed on a crystalline fundament, on which clay was deposited as well as gravels and sands bearing rich aquifer strata (Dobros, 1999).

The aquatic and semiaquatic Heteroptera populates a great variety of aquatic habitats (Andersen, 1982; Davideanu, 1999). Within these two depressions they were collected from different lakes, swamps and from the shore habitats of some brooks and rivers.

The swamp is a kind of still water, very much alike with the lake, but the difference consists in the surface and the quite small depth of the swamp which favorites the development of aquatic and swampy vegetation. Other factors were the great variability of the physical and chemical factors as well as the lack of the

thermic stratification (Pora & Oros, 1974). This notion of swamp is given to permanent or temporary aquatic basins.

MATERIAL AND METHODS

The aquatic and semiaquatic Heteroptera were studied within a complex study that took place during 2001 – 2002 and 2004 in the middle basin of the Olt River. In this paper data regarding the Heteroptera collected from permanent swamps situated in the Făgăraș Depression and Sibiu Depression are presented, in 8 stations, 4 being in the Făgăraș Depression (noted F1 – F4) and 4 being in the Sibiu Depression (noted S1 – S4) whose briefly characterization are presented as follows:

F1: Mândra (45°49'30"N, 25°02'20"E, altitude 440 m)

This is a small swamp (the surface round 3 m² and the depth of 50 cm). It is situated in the major riverbed of the Olt River in an area of ballast exploitation. In the middle of the swamp grows *Alisma plantago-aquatica*, and around it the vegetation is that one characteristic to the temporary wet soils (*Cyperus flavescens* etc.)

F2: Sâmbăta Abbey (45°41'31"N, 24°47'51"E, altitude 685 m)

This swamp is provided with water from superficial leaks and springs being placed on piedmont hills. There is no characteristic vegetation, the plants on its banks are those specific for the wood in which the swamp was formed.

F3: Sărata (45°44'10"N, 24°30'28"E, altitude 436 m)

This swamp is a result of the winding of the Nicula brook, provided with water from the brook to bigger waters as well as underground contribution. The swamp surface is around 35 m² and a depth of 30 cm and a mud deposit on the bottom. The immerse vegetation is represented by *Agrostietum stoloniferae* with *Juncus conglomeratus* and the vegetation within the swamp occupies approximately 20% of the water surface, being formed of algae.

F4: Porumbacu de Jos (45°45'30"N, 24°29'53"E, altitude 396 m)

This is a swamp within the area having a dam resulted from the hydro technical works that has been done. It is provided with water from the phreatic waters of the Olt River at high levels. The vegetal associations on the bank of the swamp are, as follows: *Salicetum albae - fragilis*, *Typhaetum latifoliae* with *Alisma plantago - aquatica*, *Lythrum salicaria*, *Glyceria plicata*, *Phragmites australis* and *Salix purpurea*. The vegetation within the water consists of *Potamogeton natans*, which occupies quite a lot of space. The underwater vegetation is represented by *Ceratophyllum demersum*, *C. submersum*, *Myriophyllum spicatum*, *Elodea canadensis* and *Potamogeton crispus*.

S1: Sadu (45°39'12"N, 24°09'21"E, altitude 487 m)

The swamp is formed by the water of the springs situated in the terminal area of the diluvia glacis as well as by rain. Its level varies, it is a degraded swamp due to the cattle which walk on it and as a result the vegetation which hardly develops.

S2: Tocile (45°40'50"N, 24°09'45"E, altitude 528 m)

The swamp basin is situated at the starting point of the Tocile Brook and it was formed by the waters of the springs at the base of the hill dejection cone and by the accumulation of rainy waters. The bottom with clay and the little salty water allows the development of some cenosis belonging to *Agrostio-Caricetum distantis* and of the bushes of *Deschampsia caespitosa* on the banks and on little islands.

S3: Sibiu (45°47'19"N, 24°07'44"E, altitude 429 m)

Being situated in the major meadow of the Cibin River the swamp is a result of the shallow underground interferences especially during the rainy periods of the year (floods of the big waters and maintaining them by underground support during the drought period). The immerse vegetation is made up of: *Typha latifolia*, *Phragmites australis*, *Butomus umbellatus*, *Alisma plantago-aquatica*, *Juncus articulatus*, *J. conglomeratus* etc., and the submerse vegetation by: *Ceratophyllum demersum*, *Myriophyllum spicatum*, *Lemna trisulca* etc.

S4: Tâlmăciu (45°39'23"N, 24°16'08"E, altitude 370 m)

This swamp is a result of the superficial leaks, not permanent ones, with the phreatic water situated very close to the major riverbed of the Cibin River. By clogging, this swamp having good conditions, it goes to a march full of reeds (*Phragmitetum australis*).

For the characterization of the thermic and pluvial regime of the researched area we used the data from two weather forecast stations in Sibiu and Făgăraș. Taking into consideration the data we had, we calculated the average temperature for many years that proved to be higher in Sibiu (8.9⁰ C) than in Făgăraș (8.2⁰ C). On the other hand the average of the rain for many years showed higher values in Făgăraș (691.0 mm) than in Sibiu (662.0 mm). In comparison with the average values for many years, in 2004, a yearly higher average value for temperature and less rains was registered; so we can draw to the conclusion that 2004 was a hot and dry year.

The data obtained as a result of the identification were analyzed from the biodiversity point of view, using the Margalef index (for general aspects, such as species and individual richness) and Lloyd – Ghelardi (for the heterogeneity evaluation). The dichotomic Jaccard index was used for the association analysis for the species (Sîrbu & Benedek, 2004).

During 2004 we collected periodically, monthly, from three stations in Făgăraș Depression and in Sibiu Depression. Therefore we could analyze the dynamic of the aquatic and semiaquatic Heteroptera in the researched area.

For each and every collecting station the Margalef and Lloyd-Ghelardi indexes were calculated as well as for each depression.

There was done the dendro graphic for ecologic affinity for the identified species in the swamp in Sibiu (Fig. 1).

There were done graphics for the species of aquatic and semiaquatic Heteroptera that were present in our samples in every month during 2004 (Figs 2, 3).

RESULTS AND DISCUSSIONS

Totally, there were identified 30 species (Tab. 1) of aquatic and semiaquatic Heteroptera, 18 of them belonging to Nepomorpha and 12 to Gerromorpha, falling into 10 families, meaning that within this kind of habitat there are representatives from all the Heteroptera families present in the middle basin of the Olt River (Ilie, 2009). Systematic order, used in table 1, is according to the catalogue published by Aukema & Rieger (1995). From Corixidae family there were identified 12 species (from 13 species identified in the basin), from Gerridae family, 5 species (from 7 species identified in the basin), from Velidae family, 1 species (from 2 identified in the basin), and from other families there were identified all the representatives that were recorded at the level of the middle basin of the Olt River. We want to draw attention to the fact that many species considered rare, according to the reports in Romania (Davideanu, 1999), occur in this kind of habitat: *Gerris asper*, *Hebrus*

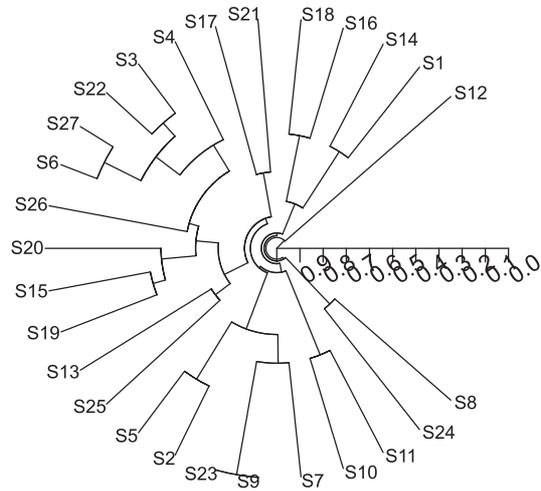


Fig. 1 - The cenotic affinity of the species identified in S3.

- S1 - *Gerris asper*; S2 - *Gerris thoracicus*; S3 - *Gerris argentatus*;
 S4 - *Gerris odontogaster*; S5 - *Gerris lacustris*; S6 - *Microvelia reticulata*;
 S7 - *Hebrus pussilus*; S8 - *Hebrus ruficeps*; S9 - *Hydrometra gracilentia*;
 S10 - *Mesovelia furcata*; S11 - *Mesovelia vittigera*; S12 - *Micronecta scholtzi*;
 S13 - *Cymatia coleoprata*; S14 - *Corixa punctata*; S15 - *Hesperocorixa linnaei*;
 S16 - *Hesperocorixa sahlbergi*; S17 - *Sigara nigrolineata*; S18 - *Sigara limitata*;
 S19 - *Sigara striata*; S20 - *Sigara iactans*; S21 - *Sigara lateralis*;
 S22 - *Ilyocoris cimicoides*; S23 - *Nepa cinerea*; S24 - *Ranatra linearis*;
 S25 - *Notonecta viridis*; S26 - *Notonecta glauca*; S27 - *Plea minutissima*.

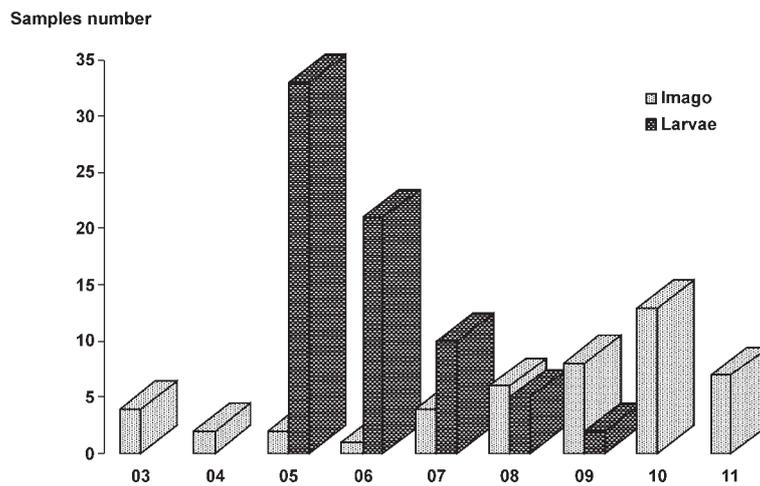


Fig. 2 - The dynamics of the species *Notonecta glauca* in the year 2004, in the station F3 (on the base of the number of imago and collected larvae).

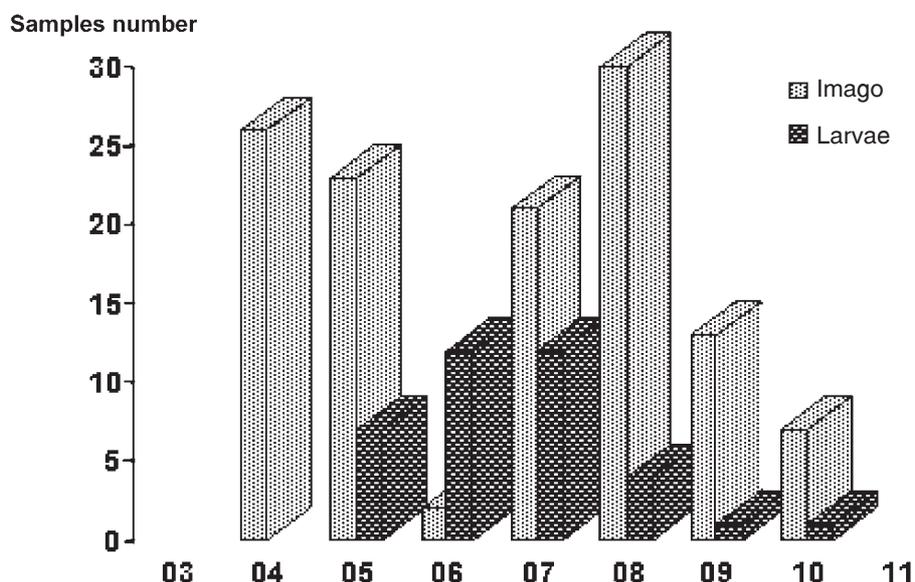


Fig. 3 - The dynamics of the species *Microvelia reticulata* in the year 2004, in the station F4 (on the base of the number of imago and collected larvae).

pussilus, *H. ruficeps*, *Hydrometra gracilentata*, *Micronecta scholtzi*, *Cymatia coleoptrata*, *Callicorixa praeusta*, *Hesperocorixa sahlbergi* and *Sigara semistriata*.

In Mândra (F1), we collected 170 samples, belonging to 11 species, the majority being Corixidae (9 species). We noticed the low presence of Gerridae (1 species with one sample), this being the consequence of the small surface of the swamp. We identified the species *Callicorixa praeusta* that is considered rare in Romania (Davideanu, 1999), this being the only recording in Transylvania. Having large population we can notice the species *Sigara lateralis* followed by *S. striata*, *S. limitata* and *S. nigrolineata* at a great distance. The other species were collected in very small number of samples leading to the conclusion that they had small population.

In the swamp in Sâmbăta (F2) there were identified two species of semiaquatic Heteroptera, being collected 14 samples. The lack of a characteristic vegetation (the plants on the banks of the swamp belong to the wood where the swamp was formed, and inside the swamp there is a lot of litter) explains the low number of Heteroptera species. In the same time the station was placed on the piedmont hills, with a lower average temperature, this being another restrictive factor for the aquatic and semiaquatic Heteroptera.

In Sărata (F3), we collected 1051 samples belonging to 20 species. The Corixidae family was represented by 8 species and the Gerridae family by 4 species. In this station we identified the species *Sigara semistriata* that is rare in Romania. *Plea minutissima* and *Microvelia reticulata* are noticed having a high number of samples. The development of these populations was encouraged, among other factors by the presence of algae that created a favorable micro habitat for these species.

Table 1

Species of aquatic and semiaquatic Heteroptera identified in permanent swamps situated in Făgăraș Depression and Sibiu Depression.

	Taxon	Station / Number of samples							
		F1	F2	F3	F4	S1	S2	S3	S4
Infraorder Nepomorpha Popov, 1971									
Fam. Nepidae Latreille, 1802									
1	<i>Nepa cinerea</i> (Linnaeus, 1758)			26	2			1	1
2	<i>Ranatra linearis</i> (Linnaeus, 1758)				3			10	
Fam. Corixidae Leach, 1815									
3	<i>Micronecta (Dichaetonecta) scholtzi</i> (Fieber, 1860)	2			88			11	
4	<i>Cymatia coleoptrata</i> (Fabricius, 1777)							32	
5	<i>Callicorixa praeusta praeusta</i> (Fieber, 1848)	1							
6	<i>Corixa punctata</i> (Illiger, 1807)	1		31	1			4	
7	<i>Hesperocorixa linnaei</i> (Fieber, 1848)	1		1				67	
8	<i>Hesperocorixa sahlbergi</i> (Fieber, 1848)			3				1	
9	<i>Sigara (Pseudovermicorixa) nigrolineata nigrolineata</i> (Fieber, 1848)	21		10	5	98	59	21	
10	<i>Sigara (Retrocorixa) limitata limitata</i> (Fieber, 1848)	29		17	1			2	
11	<i>Sigara (Retrocorixa) semistriata</i> (Fieber, 1848)			7					
12	<i>Sigara (Sigara) striata</i> (Linnaeus, 1758)	32		12	51			297	
13	<i>Sigara (Subsigara) iactans</i> Jansson, 1983	3		2	31			26	
14	<i>Sigara (Vermicorixa) lateralis</i> (Leach, 1817)	78			2		3	3	
Fam. Naucoridae Leach, 1815									
15	<i>Ilyocoris cimicoides cimicoides</i> (Linnaeus, 1758)			52	91			302	1
Fam. Notonectidae Latreille, 1802									
16	<i>Notonecta viridis</i> Delcourt, 1909			1				4	
17	<i>Notonecta glauca glauca</i> (Linnaeus, 1758)	1		51	2	1	2	19	
Fam. Pleidae Fieber, 1851									
18	<i>Plea minutissima minutissima</i> Leach, 1817			456	757			482	4
Infraorder Gerromorpha Popov, 1971									
Fam. Mesoveliidae Douglas & Scott, 1867									
19	<i>Mesovelia furcata</i> (Mulsant & Rey, 1852)				25			17	7
20	<i>Mesovelia vittigera</i> (Horváth, 1895)				25			24	21
Fam. Hebridae Amyot & Serville, 1843									
21	<i>Hebrus pusillus pusillus</i> (Fallén, 1807)			4				5	
22	<i>Hebrus (Hebrusella) ruficeps</i> (Thomson, 1871)							1	
Fam. Hydrometridae Billberg, 1820									
23	<i>Hydrometra stagnorum</i> (Linnaeus, 1758)		3	13	20				
24	<i>Hydrometra gracilentata</i> (Horváth, 1899)							1	
Fam. Veliidae Brullé, 1836									
25	<i>Microvelia reticulata</i> (Burmeister, 1835)			319	123			264	2
Fam. Gerridae Leach, 1815									
26	<i>Gerris (Gerriselloides) asper</i> Fieber, 1860							1	
27	<i>Gerris thoracicus</i> (Schummel, 1832)	1		17	21	1		10	
28	<i>Gerris argentatus</i> Schummel, 1832			1	101			120	
29	<i>Gerris odontogaster</i> (Zetterstedt, 1828)			5	5			43	
30	<i>Gerris lacustris</i> (Linnaeus, 1758)		11	23	48			6	1
	TOTAL	170	14	1051	1402	100	64	1774	37

In the swamp of Porumbacu de Jos (F4) 20 species of aquatic and semiaquatic Heteroptera were identified from which 7 are Corixidae and 4 are Gerridae. The number of collected samples was of 1402, the largest population belonging to: *Plea minutissima*, *Microvelia reticulata*, *Gerris argentatus*, *Ilyocoris cimicoides* and *Micronecta scholtzi*.

In the swamp at the springs of Tocile Brook (S2) only 3 species of aquatic Heteroptera were identified, but in a quite large number of samples (64 samples), and this fact is due to the population of *Sigara nigrolineata*, which is very well adapted to this kind of habitat.

Regarding the swamp of Sadu (S1) there was noticed a resemblance with the swamp of Tocile because there were identified 3 species having a great number of samples (100); the largest population belong to the species *Sigara nigrolineata*. This similarity is not at random, it is due to the ecologic conditions in these habitats (still waters, little depth and muddy).

In Sibiu (S3), we collected 1774 samples, belonging to 27 species of aquatic and semiaquatic Heteroptera. 10 species belong to the Corixidae family and 5 species belong to the Gerridae family. The other families had 1- 2 species present in this swamp. We noticed the fact that in this station the largest number of Gerridae species were present, being identified *Gerris asper*, rare species in Romania. At the same time there were other 6 species of aquatic and semiaquatic Heteroptera that are considered rare in Romanian fauna. There are more species represented by large populations: *Plea minutissima*, *Ilyocoris cimicoides*, *Sigara striata*, *Microvelia reticulata* but at the same time the number of species with low population was as numerous as those having large populations: *Gerris asper*, *Hebrus ruficeps*, *Hydrometra gracilenta*, *Hesperocorixa sahlbergi*, *Nepa cinerea*.

In the swamp in Tâlmăciu (S4) there were identified 7 species of aquatic and semiaquatic Heteroptera, being collected 37 samples. The population of the species *Mesovelia vittigera* was the biggest one.

None of the species was present in all stations. This is due to the different conditions from the researched habitats as well as to the preferences and the degree of adaptability of each and every species. From this point of view *Sigara nigrolineata*, *Notonecta glauca*, *Gerris thoracicus* and *G. lacustris* are to be remarked for a more ample ecologic valence.

The values of Margalef index (Tab. 2) are between 0.379 and 2.731 for the stations in the Făgăraș Depression. The lowest value of the biodiversity was registered in the station F2 where the ecologic conditions are not good for Heteroptera. The values for the stations F3 and F4 are the biggest ones (2.731, respectively 2.622) because the quality of the habitats is a better one (regarding the size of the aquatic basins, their location and the development of the vegetation); the number of the identified species is the same, the difference between the values of the index coming from the difference between the numbers of the collected samples. For the stations of Sibiu Depression the Margalef index of biodiversity varies between 0.434 and 3.475, reflecting in this way the quality of the habitats. Remarkable is the high value registered in station S3 in spite of men's activities that are quite frequent, suggesting once again the fact that the aquatic and semiaquatic Heteroptera are not disturbed by these activities. The comparison of the α biodiversity from two relief units neighboring each other shows a less high value for the Sibiu Depression (3.426 comparatively to 3.174) this being connected to the fact that this is characterized by higher temperatures.

Table 2

Biodiversity indexes values for the study area.

Index / Station	F1	F2	F3	F4	S1	S2	S3	S4	Făgăraş Depression	Sibiu Depression
Margalef	1.947	0.379	2.731	2.622	0.434	0.481	3.475	1.662	3.174	3.426
Lloyd-Ghelardi	0.628	0.750	0.571	0.590	0.102	0.297	0.657	0.682	0.627	0.691

The values of the index Lloyd – Ghelardi (Tab. 2) indicates a relatively uniform distribution of the individuals taking into account their species within the stations as well as for each depression (representing 57% - 75% from the ideal value). As an exception we quote the stations S1 and S2 where only 3 species were identified but having large populations.

From the analysis of the dendro graphic of ecologic affinity (Fig. 1) done for the identified species in the swamp of Sibiu, there was established that the species *Nepa cinerea* and *Hydrometra gracilena* had a maximum degree of affinity, as they were collected from the same micro habitats. The dendrogram indicated a powerful affinity between the Heteroptera species *Plea minutissima* and *Microvelia reticulata*, respectively between *Gerris argentatus* and *Ilyocoris cimicoides*, there being affinity also between the two groups of species. This situation is similar to that registered in the natural lake – Oltul Mic, as well as in the artificial lake of Sebeş Olt. In this station it was established that there were relatively powerful relations of cenotic affinity between the different species of aquatic Heteroptera (*Hesperocorixa sahlbergi* and *Sigara limitata*, *Hesperocorixa linnaei* and *Sigara striata*) but also between different species of semiaquatic Heteroptera (*Gerris lacustris* and *G. thoracicus*, *Mesovelia furcata* and *M. vittigera*), different from what was established in the case of the lakes Oltul Mic and Sebeş Olt (Ilie, 2009).

From the species *Notonecta glauca* we collected adults starting in March till November, in the station F3 (permanent swamp in the locality Sărata). The largest number of adults was collected in October (Fig. 2). The graphic showed a decrease in number till June, due to the mortality of the adults from the previous year. After that it began to grow, due to the new generation of adults, reaching its top in October. In November, there was a smaller number of individuals due to the bad weather that would lead to the pause - in order to hibernate. The number of larvae was maximum in May and then decreasing successively, as larva became adults, till September, when the last larvae were collected. This figure draw to the conclusion that *Notonecta glauca* had only one generation in 2004, being in agreement with the theoretic possibility of multiplying this species in the climate condition of the area (Rabitsch, 2005). Another comment that has to be made is that there is a large number of larvae that are eaten by the predatory animals, belonging to different trophic chains (among others, in the respectively swamp there were amphibians and also storks that fed from there, being a well known fact that both category of predatory animals had this species of Heteroptera included in their diet).

The same kind of graphics (Fig. 3) was made for the species *Microvelia reticulata*, which was a constant presence in the collected samples from the station F4 (permanent swamp in Porumbacu de Jos) during 2004. From this habitat we collected adults beginning in April till October. In April there were a larger number of adults that passed through the winter, after that the population began to decrease; then there was an important raise in July reaching its maximum in August. The high

number of larvae in July, very much alike that in June, suggested the possibility of the development of two generations in that summer (at the beginning of July appeared the first generation of *Microvelia reticulata*, which had time, during the same month, to give birth to a new set of larvae, which in its turn to be the second generation till the end of August). The development of a second generation was possible under the specific conditions of 2004 and particularly in July (warmer and wetter than the average value taken in many years).

ACKNOWLEDGEMENTS

We want to thank to Prof. Ph. D. Constantin Drăgulescu for the identification of some species of plants. We also want to thank to Mr. Univ. Lecturer Mihai Buiuc for the climate data that he had put to our disposal and the discussions regarding the influence of the weather conditions upon the insects' biology; and also to Univ. Reader Ph. D. Ioan Sirbu for the help he gave us in processing on the computer of the statistic data. The authors owe gratitude and sincere regards to all those mentioned, as well as to the referees of this paper, namely Dr. Ljiljana Protić and Dr. Ana Davideanu.

CARACTERIZAREA FAUNISTICĂ ȘI ECOLOGICĂ A COMUNITĂȚILOR DE HETEROPTERE (INSECTA) ACVATICE ȘI SEMIACVATICE DIN BĂLȚI PERMANENTE SITUATE ÎN DEPRESIUNEA FĂGĂRAȘULUI ȘI DEPRESIUNEA SIBIULUI (ROMÂNIA)

REZUMAT

Lucrarea își propune evaluarea biodiversității comunităților de heteroptere acvatice și semiacvatice din bălți permanente situate în două depresiuni de contact între Munții Făgărașului și Podișul Transilvaniei, realizarea analizei de asociere a speciilor și urmărirea dinamicii lunare a speciilor. Pentru atingerea scopului au fost colectate probe din opt stații din bazinul hidrografic al râului Olt, patru localizate în Depresiunea Făgărașului și patru în Depresiunea Sibiului. Prelevarea probelor s-a desfășurat în perioada 2001-2002 și 2004. Au fost identificate 30 specii de heteroptere, dintre care 18 specii sunt acvatice (Infraordin Nepomorpha) iar 12 sunt semiacvatice (Infraordin Gerromorpha). Analiza de biodiversitate α oferă valori cuprinse între 0,379-3,475 pentru stațiile investigate, valori apropiate pentru cele două depresiuni (3,174 pentru Depresiunea Făgărașului, respectiv 3,426 pentru Depresiunea Sibiului) și indică o distribuție relativ uniformă a indivizilor pe specii, atât în cadrul stațiilor, cât și la nivelul fiecărei depresiuni. Analiza de asociere între speciile identificate în balta din lunca Cibinului, în localitatea Sibiu, relevă grad maxim de afinitate între *Nepa cinerea* și *Hydrometra stagnorum*, precum și o afinitate cenotică puternică între *Plea minutissima* și *Microvelia reticulata*, respectiv între *Gerris argentatus* și *Ilyocoris cimicoides*. Colectările periodice, lunare, în decursul anului 2004 au permis urmărirea dinamicii speciilor. *Notonecta glauca* a avut o perioadă de activitate extinsă în anul 2004 (martie-noiembrie) și a dezvoltat o singură generație. *Microvelia reticulata* a fost observată din aprilie până în octombrie, numărul larvelor sugerând posibilitatea dezvoltării a două generații.

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Received: February 12, 2010

Accepted: September 27, 2010

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