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AQUATIC AND SEMI AQUATIC HETEROPTERA COMMUNITIES FROM SOUTH-EAST TRANSYLVANIAN SMALL RIVERS

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Abstract. The paper presents the analysis of the relations between aquatic and semi aquatic Heteroptera from south-east Transylvanian small rivers and habitat characteristics of the sampling sites. Biological material was collected from 23 sampling sites from Hârtibaciu Plateau (8), and Făgaraş (12) and Sibiu (3) Depressions. A large number of species were identified, almost a third (22 out of 69) of the species sampled so far in Romania. *Gerris* (*Gerris*) *lacustris* (Linnaeus, 1758) has the highest relative abundance and frequency, seconded by *Nepa cinerea* Linnaeus, 1758 and *Sigara* (*Pseudovermicorixa*) *nigrolineata nigrolineata* Fieber, 1848. Community composition is influenced by habitat characteristics, the most important role being held by the presence of aquatic vegetation, favoring *G. lacustris* and *N. cinerea*, and the inconstancy of the hydrological regime, favoring *S. nigrolineata*. Habitat conditions are having a low influence on biodiversity values, although substrate and hydrological heterogeneity and aquatic vegetation seem to be responsible for higher species richness, while mild anthropic impact and a larger site size are resulting in higher species heterogeneity.

Résumé. Le travail présente l'analyse des relations entre les hétéroptères aquatique et semi-aquatique de petites rivières du sud-est de la Transylvanie et les caractéristiques des habitats des sites d'échantillonnage. Le matériel a été récolté dans 23 sites d'échantillonnage de Hârtibaciu Plateau (8), et Făgăraş (12) et Sibiu (3) dépressions. Un grand nombre d'espèces ont été identifiées représentant près d'un tiers de la faune de Roumanie (22 sur 69). *Gerris* (*Gerris*) *lacustris* (Linnaeus, 1758) a la plus grande abondance relative et fréquence, suivie par *Nepa cinerea* Linnaeus, 1758 et *Sigara* (*Pseudovermicorixa*) *nigrolineata nigrolineata* Fieber, 1848. La structure de la communauté est influencée par les caractéristiques des habitats, la présence de la végétation aquatique ayant le rôle le plus important pour *G. lacustris* et *N. cinerea* et l'inconstance du régime hydrologique pour *S. nigrolineata*. Les conditions de l'habitat ont une influence faible sur les indicateurs de biodiversité, bien que l'hétérogénéité du substrat et du régime hydrologique et la végétation aquatique semble être responsable pour une plus grande richesse en espèces, tandis que un impact anthropique modéré et une taille plus grande du habitat conduisent à une hétérogénéité plus élevé des espèces.

Key words: Heteroptera, Nepomorpha, Hârtibaciu Plateau, Făgăraş Depression, habitats.

INTRODUCTION

Small rivers play an important role for aquatic and semi aquatic fauna, offering a large variety of habitats for such species. Water level amplitudes, meanders, flow speed variation, different types of vegetation, both on the shores and on the water surface, changing conditions due to human impact are characteristic to those rivers, influencing the community composition.

According to the latest classification (Aukema, 2004), our target group, aquatic and semi aquatic Heteroptera, belong to infraorder Nepomorpha Popov, 1971, being insects associated, more or less, with water surfaces, forming a part of the nekton and epineuston, and inhabiting a large variety of micro-biotopes, from those lacking vegetation, to those completely covered (Andersen, 1982; Davideanu, 1999). The typical habitats of the group are ponds, lakes, slow flowing creeks or little bays formed at the banks of rivers. From that point of view, creeks and small rivers are favorable habitats.

Habitat conditions, such as the presence and type of vegetation, site size and its connectivity to large aquatic ecosystems, physico-chemical parameters of the water, substrate consistency etc., are known to influence the distribution and community structure of aquatic and semi aquatic Heteroptera (Savage, 1989; Nosek et al., 2007; Olosutean & Ilie, 2008, 2010 b; Skern et al., 2010).

South-eastern Transylvania (Făgăraş and Sibiu Depressions) is drained by Olt River and its tributaries, the largest one being Hârtibaciu, on the right, coming from the south of the Transylvanian Plateau. Both rivers are collecting a large number of small rivers and creeks, which represent the basis for our study.

MATERIAL AND METHODS

Data from 23 previously investigated habitats (Ilie, 2009) was taken into concern: eight from the Hârtibaciu Plateau, recoded H1 to H8, twelve from the Făgăraş Depression, recoded F1 to F12, and three from the Sibiu Depression, recoded S1 to S3. The habitats are mostly creeks and rivers of different sizes (from small springs, not more than 50 cm wide, to medium sized rivers), or, in some cases, drainage canals of the local dams or lateral arms of rivers (Figs 1, 2).

The biological material was collected during five sampling periods: September-October 2001, May-June 2002 and three ones between March and October 2004. Samplings were made by sweeping with an entomological net with a 60 cm^2 mesh-size, and were similar to all sites: one sample of 8 to 20 meters in length was taken from each site, covering the entire habitat (water surface and body, aquatic vegetation if present, bottom); twenty-five minutes constituted one sample for each of the sites.

Identification of species was made at a stereo binocular by the diagnostic of morphological characters or, where necessary, by analyzing their genitalia, using data by Jansson (1986) and Davideanu (1999).

Environmental conditions (presence and amount of vegetation, shade, presence of anthropic influence, water flow velocity and its yearly fluctuance, habitat size and the heterogeneity of the substrate) were recorded for each habitat as

Fig. 1 - Sampling stations: a) H2 - small spring; b) F1 - creek.

Fig. 2 - Sampling stations: a) F3 - river; b) S1 - drainage canal.

category variables, in order to point out their influence on aquatic and semiaquatic Heteroptera distribution and on community structure.

Similarity analysis was performed for both relative abundance and presence-absence data, in order to put out the relations between habitat characteristic and community composition. In that order, similarity cluster trees were constructed with Systat v.10.2, grouping being made by Euclidean distances, at average linkage.

Canonical Correspondence Analysis (CCA) was used to point out community/species-habitat relations, with the help of CANOCO v.4.5 (Ter Brack & Smilauer, 1998). Biodiversity values were also included in the CCA, namely species richness (Hill, 1973) and heterogeneity, expressed as the reversed values of the Simpson Index (Simpson, 1949).

RESULTS AND DISCUSSIONS

Twenty-two species out of the 69 living in Romania (Davideanu, 1999; Ilie, 2009; Berchi, 2011) were collected from the 23 sites: eleven semi aquatic ones: *Aquarius paludum* (Fabricius, 1794), *Gerris* (*Gerris*) *argentatus* Schummel, 1832, *G.* (*G.*) *costae* (Herrich-Schäffer, 1853), *G.* (*G.*) *lacustris* (Linnaeus, 1758), *G.* (*G.*) *odontogaster* (Zetterstedt, 1828), *G.* (*G.*) *thoracicus* Schummel, 1832, *Microvelia* (*Microvelia*) *reticulata* (Burmeister, 1835), *Velia* (*Velia*) *rivulorum* (Fabricius, 1775), *Hebrus* (*Hebrus*) *pussilus* (Fallen, 1807), *H.* (*Hebrusella*) *ruficeps* Thomson, 1871 and *Hydrometra stagnorum* Linnaeus, 1758, and eleven aquatic ones: *Notonecta* (*Notonecta*) *glauca* Linnaeus, 1758, *N.* (*N.*) *viridis* Delcourt, 1909, *Micronecta* (*Dichaetonecta*) *scholzi* (Fieber, 1860), *Ilyocoris cimicoides* (Linnaeus, 1758), *Ranatra* (*Ranatra*) *linearis* (Linnaeus, 1758), *Nepa cinerea* Linnaeus, 1758, *Sigara* (*Pseudovermicorixa*) *nigrolineata nigrolineata* Fieber, 1848, *S.* (*Sigara*) *striata* Linnaeus, 1758, *S.* (*Subsigara*) *iactans* Jansson, 1983, *S.* (*Vermicorixa*) *lateralis* Leach, 1817 and *Plea minutissima* Leach, 1817. Species distribution is presented in table 1. A total of 1765 adults were sampled and identified (Ilie, 2009).

G. lacustris is the dominant species (30.65% total relative abundance AR and 82.60% frequency F), the most eurivalent species of the group, found throughout Romania from the Danube Delta (Olosutean & Ilie, 2010 a, b) to altitudes over 1000 m (Olosutean & Ilie, 2008), in habitats from small puddles to large lakes and rivers (Davideanu, 1999; Ilie, 2009; Ilie & Olosutean, 2009). *G. lacustris* is seconded by *N. cinerea* (AR = 25.78%; F = 56.52%) and *S. nigrolineata* (AR = 15.98%; F = 39.13%) (Fig. 3).

Table 1

Presence of species (expressed in number of sampled individuals) from individual sites of the target area (adapted after Ilie, 2009).

Species / Site	H1	H2	H3	H4	H5	H6	H7	H8	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12	S1	S2	S3
A. paludum	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
G. argentatus	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
G. thoracicus	2	-	-	-	-	-	-	-	1	-	-	-	-	-	56	20	1	-	-	-	-	3	-
G. costae	8	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
G. odontogaster	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-	-	-	-
G. lacustris	55	6	-	3	-	5	45	5	14	-	-	23	47	3	128	44	68	9	56	18	8	2	2
M. reticulata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	1	25	-	-	-
V. rivulorum	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	22	-	-	-	-	-	-
H. pussilus	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	2	-	-	-	-	-	-	-
H. ruficeps	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-
H. stagnorum	-	-	-	-	-	-	13	-	3	2	-	1	1	3	183	-	-	-	2	-	2	-	-
S. nigrolineata	5	-	15	2	1	-	-	-	-	-	-	-	-	-	38	22	1	-	-	23	-	175	-
S. striata	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	2
S. iactans	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	6	-	-
S. lateralis	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	12	-
N. cinerea	2	-	-	3	-	1	69	-	76	6	1	4	1	-	260	4	-	1	-	-	-	27	-
R. linearis	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
N. viridis	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	7	-
N. glauca	-	-	-	-	-	-	-	-	-	-	2	6	-	-	7	4	1	-	-	4	-	1	-
M. scholzi	-	-	-	-	2	-	-	-	-	-	-	-	-	-	27	-	-	-	12	-	1	16	-
I. cimicoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-
P. minutissima	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-

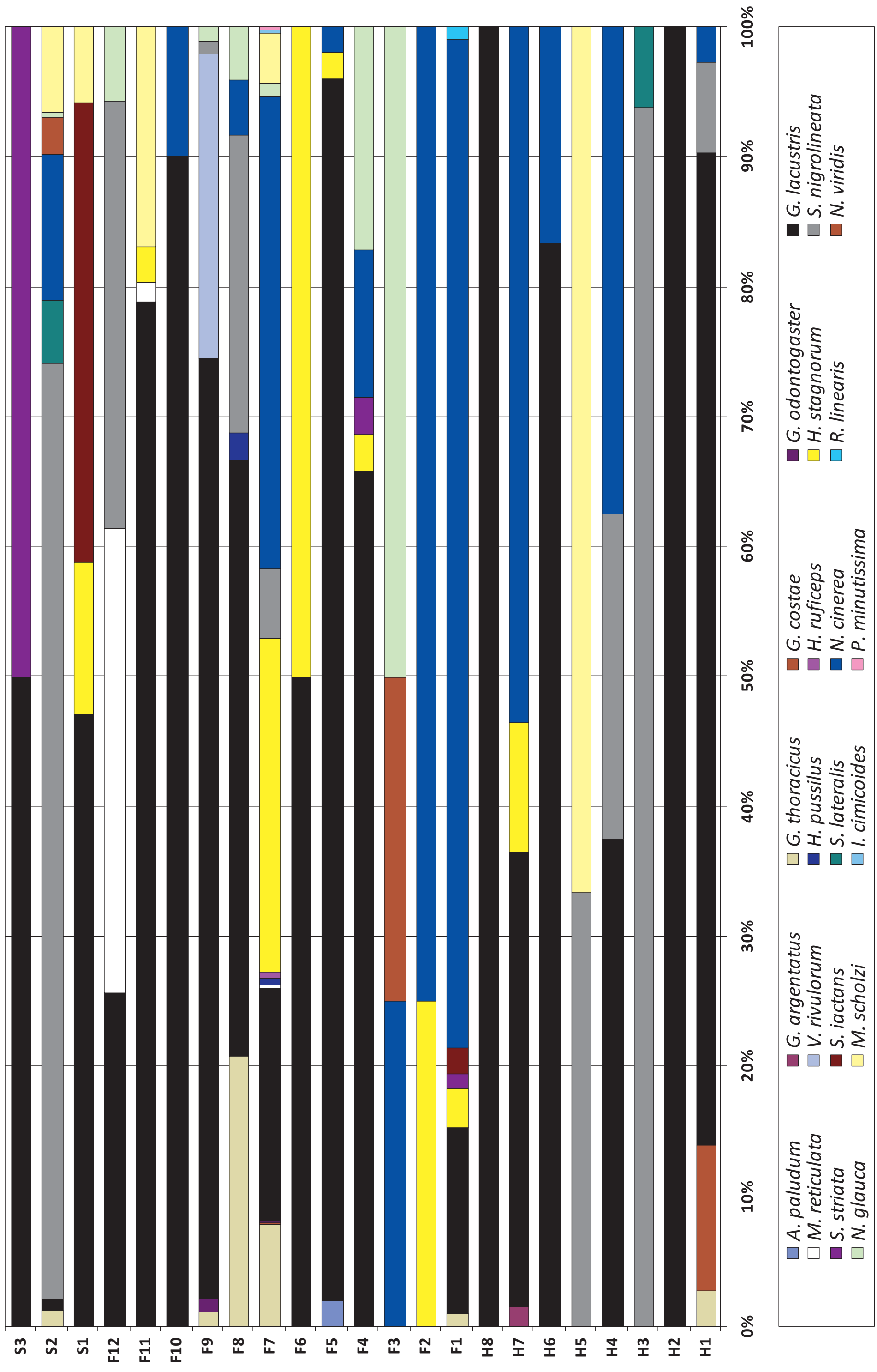

Fig. 3 - Community structures of the investigated habitats.

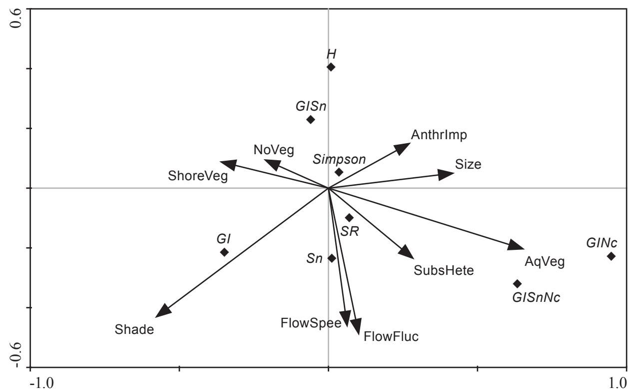

Fig. 4 - CCA biplot for community/diversity - habitat relations.
(NoVeg: no vegetation; ShoreVeg: vegetation at shores; AqVeg: aquatic vegetation presence; FlowSpee: flow velocity; FlowFluc: fluctuations of the hydrological regime; SubsHete: substrate heterogeneity; AnthrImp: anthropic impact intensity; Shade: degree of shading; Size: dimensions of the sampling sites; *H*: heterogeneous communities; *Gl*: *G. lacustris* dominated communities; *Sn*: *S. nigrolineata* dominated communities; *GlSn*: *G. lacustris – S. nigrolineata* communities; *GlNc*: *G. lacustris - N. cinerea* communities; *GlSnNc*: *G. lacustris - S. nigrolineata - N. cinerea* communities; *SR*: species richness; *Simpson*: heterogeneity as Simpson Index).

The communities are dividable into six categories: *G. lacustris* dominated (AR > 60%) communities, such as H1, H2, H6, H8, F4, F5, F9, F10 and F11; *S. nigrolineata* dominated (AR > 70%) communities, like H3 and S2; *G. lacustris* and *S. nigrolineata* communities (combined AR > 55%), such as F8 and F12; *G. lacustris* and *N. cinerea* communities (combined AR > 85%), such as F1; *G. lacustris*, *S. nigrolineata* and *N. cinerea* communities (combined AR > 80%), such as H7 and F7; and heterogeneous communities, usually with low number of individuals and balanced species distributions, like H4, H5, F2, F3, F6, S1 and S3.

The influence of environmental factors on community composition is presented in figure 4. Although, as discussed before, *G. lacustris* is the most frequent species in the investigate habitats, the way it associates with other species is clearly determined by the characteristics of the habitats. In that order, sites where the named species is sole dominant are rather small, shaded habitats, with no anthropic impact.

The presence of aquatic vegetation and larger habitats sizes are favoring *G. lacustris'* codominance with *N. cinerea*, species finding shelter inside aquatic vegetation patches, while the Gerrids are occupying the open water. If substrate has a heterogeneous composition, the two species share habitats with *S. nigrolineata*, favored by muddy areas with organic debris.

A higher water velocity and important changes in yearly hydrological regime are leading to high quantities of sediments and organic debris on the river bed, favoring *S. nigrolineata*, which is dominating such habitats. In habitats with still water and stable hydrological regimes, the amount of organic sediments is much lower, therefore *S. nigrolineata's* weight is decreasing, the species being either seconded by *G. lacustris*, or the two species becoming part of more heterogeneous communities.

Biodiversity values are only slightly influenced by environmental habitats. Species richness is higher when the substrate is more heterogeneous, because different substratum types offer different micro-niches for the very specialized

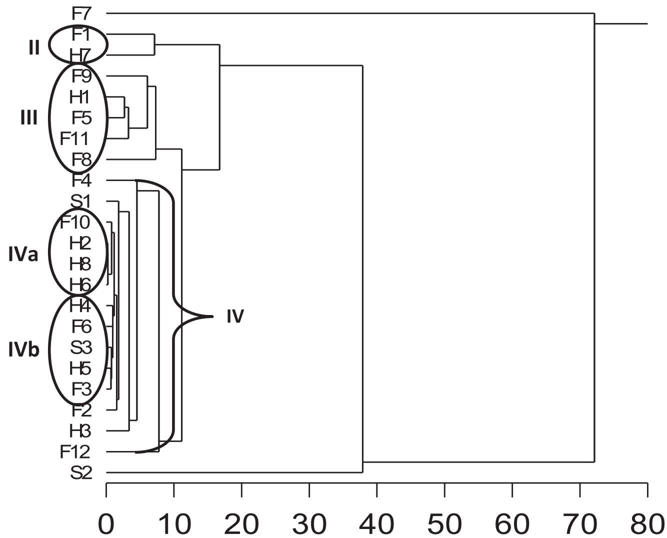

Fig. 5 - Sampling sites' similarity – AR% data (average linkage, Euclidean distances).

members of the group; a fluctuant hydrological regime also favors higher species richness, probably because of higher amounts of sediments and organic debris found in such site. The decrease of vegetation coverage is causing the increase of *G. lacustris'* dominance, and lower values of species richness.

Species heterogeneity is positively influenced by anthropic impact (cattle watering sites, small rock dams, sheep crossing paths), which creates microhabitats with favorable conditions for a larger number of species (still water, turbidity, organic matter surplus). Substrate heterogeneity and sampling site's size are also favoring higher Simpson Index values, offering different microhabitats, as discussed before, while shade is having a negative influence on species heterogeneity. Shade itself is not an inhibiting parameter, but shaded sites are usually smaller, homogenous ones, where *G. lacustris* is usually dominant.

Site similarity for relative abundance data (Fig. 5) reveals the presence of four different groups.

Group I (F7 and S2) is characterized by a large number of species and individuals, and comprises the sites with the largest sizes and heterogeneous habitat conditions; it is not a group by definition, only two sites largely apart from the rest.

Group II (F1 and H7) is dominated by *G. lacustris*, *H. stagnorum* and *N. cinerea*; its sites are having faster water flow and clean water, vegetation present inside the water and at least one lenitic sector at shores.

Group III (H1, F5, F8, F9 and F11) is dominated by *G. lacustris*, comprising shaded sites with slower water flow and vegetation at shores.

Group IV (the rest of the stations) gathers the smallest sampling sites, characterized by a low number of species and individuals. Inside this large group two smaller ones can be identified: subgroup IVa (H2, H6, H8 and F10), occupied only by *G. lacustris* or heavily dominated by this species, formed by small sites where anthropic impact is present and with vegetation at least at shores, and subgroup IVb (H4, H5, F3, F6 and S3), with equilibrated distributions of two or three species,

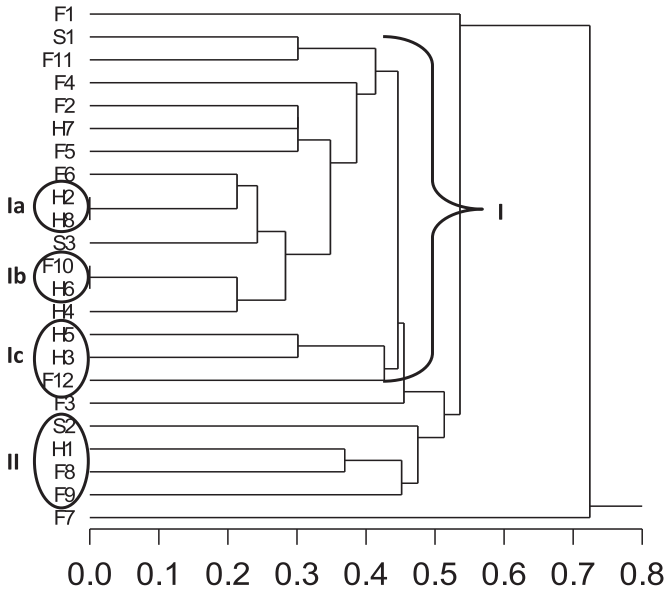

Fig. 6 - Sampling sites' similarity - presence-absence data (average linkage, Euclidean distances).

comprising sites with a bit larger sizes and heterogeneous conditions (parts with and without vegetation, localized or inconstant anthropic impact, etc.).

Presence-absence data (Fig. 6) shows a slightly different picture.

A large group of sites are at close distance (Group I), comprising of sites with a low number of species, mostly *G. lacustris*, alone or seconded by *N. cinerea* and *H. stagnorum*. Three subgroups are standing up: subgroup Ia (H2 and H8), with habitats occupied only by *G. lacustris*, characterized by fluctuant water flow, mild anthropic impact and vegetation at shores; subgroup Ib (F10 and H6), habitats with faster water flow and clean water, occupied by a *G. lacustris – N. cinerea* community; subgroup Ic (H3, H5 and F12), sites occupied by *S. nigrolineata*, favored by muddy substratum of anthropic or natural origin.

A second group (Group II) gathers sites with a higher number of species (H1, F8, F9 and S2), that offer a larger number of microhabitats, caused either by their larger size, or by particular habitat conditions (different substratum types, localized anthropic impact, patches of vegetation, etc.).

Three sampling sites are apart from the two groups: F3, a site where none of the three dominant species were found, with *Notonecta* individuals finding excellent conditions on the excavations made on the shores by a meandered course, F1 and F7, sites with a much larger number of species than the others, due to the same conditions as Group II, but at a larger scale.

F7 is a special situation, having by far the largest number of species and individuals. This high diversity might be explained, on one hand, by the highly meandered conformation of the sampling site, resulting in sectors with higher and lower flow velocities, and, on the other hand, by the relatively heterogeneous substratum of the site, with particles from fine mud to medium sized rocks; also, the shores are inhabited by several types of hygrophilous plants, some entering the water and providing shelter for some species; at last, mild anthropic impact is also present (cattle marks from a watering site), and may also favor some species by increasing water turbidity and providing supplemental organic matter.

Conclusions

Small rivers from Southern Transylvania are offering suitable habitats for aquatic and semiaquatic Heteroptera, around one third of the species known for Romania (22 out of 69) being sampled on a relatively small area.

G. lacustris is the most important species of the investigated communities, in both relative abundance and frequency, found in 19 out of the 23 habitats (sampling sites), and dominant or codominant species in 14 of those habitats, proving once more its wide ecological valences. The species is seconded by *N. cinerea* and *S. nigrolineata*, favored by specific habitat characteristics, such as the abundance of vegetation, for the first species, respectively by higher turbidity and the presence of organic sediments, for the second species.

Community composition is closely related to habitat specificity. One of the most influential variables is the amount of aquatic vegetation present inside the site or on its shores, acting as a shelter for species such as *N. cinerea*, *H. stagnorum* or for different *Gerris* species. Hydrological characteristics, such as current velocity or annual fluctuations of the water level, are also of great importance, influencing the amount of sediments, especially organic, which favors species like *S. nigrolineata* or *I. cimicoides* (Jansson, 1986; Ilie, 2009).

Homogenous habitats tend to have a lower number of species, because of specific habitat requirements of most species: presence and type of vegetation, substratum consistence and water flow speed (Andersen, 1982; Davideanu, 1999). Such sites are usually small ones, where *G. lacustris* is highly dominant despite specific conditions, due to its large ecological valences.

As opposed, larger sites tend to be more heterogeneous, offering a larger number of ecological niches, therefore hosting a larger number of species and individuals; this situation is more of a local trademark, not a general rule, since the size of the sampling site was found not to influence community structure (Olosutean & Ilie, 2010 b).

The influence of habitat characteristics on biodiversity values is very low, species richness being favored by water flow and substrate heterogeneity and by the presence of vegetation, while species heterogeneity is higher in larger sites with stable flow conditions and mild anthropic impact.

COMUNITĂȚI DE HETEROPTERE ACVATICE ȘI SEMIACVATICE DIN RÂURILE MICI DIN SUD-ESTUL TRANSILVANIEI

REZUMAT

Lucrarea prezintă rezultatele analizei relațiilor dintre heteropterele acvatice și semiacvatice din pâraiele sud-transilvănene și caracteristicile de habitat ale stațiilor investigate. Materialul biologic a fost colectat din 23 de stații de colectare din Podișul Hârtibaciului (8) și din depresiunile Făgăraș (12) și Sibiu (3). Un număr important de specii a fost colectat, circa o treime (22 din 69) dintre speciile cunoscute în România. *Gerris* (*Gerris*) *lacustris* (Linnaeus, 1758) are cea mai mare abundență relativă și frecvență, urmat de *Nepa cinerea* Linnaeus, 1758 și *Sigara* (*Pseudovermicorixa*) *nigrolineata nigrolineata* Fieber, 1848. Structura comunităților este influențată de caracteristicile de biotop, cel mai important rol avându-l prezența vegetației acvatice, care favorizează speciile *G. lacustris* și *N. cinerea*, și inconstanța regimului hidrologic, care favorizează specia *S. nigrolineata*. Condițiile de habitat au o influență redusă asupra valorilor biodiversității, deși eterogenitatea substratului și a regimului hidrologic și prezența vegetației acvatice par să fie responsabile de valori mai mari ale bogăției în specii, în timp ce un impact antropic moderat și o dimensiune mai mare a stației conduc la o eterogenitate specifică ridicată.

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