RELATIONSHIPS BETWEEN HABITAT CHARACTERISTICS AND AQUATIC AND SEMIAQUATIC HETEROPTERA COMMUNITY STRUCTURE IN ROMANIAN MOUNTAINOUS REGIONS: A PRELIMINARY REPORT

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Aquatic and semiaquatic Heteroptera rarely find suitable habitats in high altitude regions of Romania. 14 sampling stations from different mountainous regions were chosen to express relations between habitat and community. The habitat conditions do influence the structure and composition of Heteroptera communities. Vegetation and anthropic impact seem to be the influential factors. *Gerris lacustris* Linnaeus, 1758 is the most common species, but its dominance and coinhabitants are dictated by the amount and density of the two factors mentioned above. Station size, water depth and flow velocity do not have any influence on community formation.

Key words: Aquatic and semiaquatic Heteroptera, community structure, vegetation density, anthropic impact.

INTRODUCTION

Aquatic and semiaquatic Heteroptera rarely find suitable habitats in high altitude regions of Romania. However, such habitats exist and are in conformity with normal conditions required by the group (Andersen, 1986; Davideanu, 1999): water surface, regardless of its dimension, presence of hygrophilous vegetation (especially for some species), and low current velocity, up to the absence of water movement. On this kind of habitat, the target group takes part in the formation of the nekton and epineuston.

Individuals belonging to the group were found in Romanian mountains by the authors (Olosutean & Ilie, 2008, 2010; Ilie & Olosutean, 2009) on different substrate types, on different densities of vegetation, on station with different amounts of anthropic impact, or with different dimensions. We will investigate the possible relation between these habitat characteristics and aquatic and semi aquatic Heteroptera community structure.

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MATERIAL AND METHODS

For our study, we selected 14 stations from five hydrographic basins: Arieşul Mare (Apuseni Mountains), Repede River (Rodna Mountains), Ruscova and Frumuşeaua (Maramureş Mountains) and Vişeu (Maramureş and Rodna Mountains). The stations were selected by their relative community similarity. Habitat characteristics for sampling stations are as follows:

Arieşul Mare River Basin (3 stations):

Ar 1 (Arieşul Mare River, 1 kilometer downstream its spring):

– altitude: 1042 meters;

– 46°28'59" northern latitude;

– 22°42'11" eastern longitude;

– a small slow flowing sector of the river and small swampy creek (left side affluent) at the confluence; muddy bottom; hygrophilous vegetation present;

– no signs anthropic impact;

– total size of sampling station: 7 meters long, 1 meter wide;

– water depth: around 40 centimeters.

Ar 2 (Arieşul Mic River, 1 kilometer upstream the confluence with Arieşul Mare):

– altitude: 575 meters;

– 46°22'06" northern latitude;

– 23°00'40" eastern longitude;

– a lateral slow flowing sector surrounding a small island; rocky bottom; small hygrophilous vegetation at shoreline;

– human impact present: wood scraps, garbage;

– total size of sampling station: 4 meters long, 4 meters wide;

– water depth: around 20 centimeters.

Ar 3 (Arieşul Mare River at the confluence with Arieşul Mic):

– altitude: 570 meters;

– 46°22'17" northern latitude;

– 23°01'03" eastern longitude;

– a large lake at the bottom of the dam; rocky bottom; uniform shores with wooden vegetation;

– human impact present: little amount of garbage, traces of petroleum products, turbid water with whitish colour;

– total size of sampling station: 5 meters long, 1 meter wide;

– water depth: 1-1.5 meters.

Repede Creek (3 stations):

Re 1 (Repede Creek, 3 kilometers upstream the confluence with Vişeu)

– altitude: 825 meters;

– 47°37’04” northern latitude;

– 24°41’49” eastern longitude;

– a river sector with slow stream flow; hygrophilous vegetation present in a small amount at the shore; muddy bottom;

– no signs of human impact;

– total size of sampling station: 10 meters long, 60-70 centimeters wide;

– water depth: 25-30 centimeters.

Re 2 (Repede Creek, 3 kilometers upstream the confluence with Vişeu)

– altitude: 825 meters;

– 47°37’02” northern latitude;

– 24°41’49” eastern longitude;

– a river sector with almost still water; hygrophilous vegetation present in a small amount at the shore; muddy bottom;

– no signs of human impact;

– total size of sampling station: 10 meters long, 60-70 centimeters wide;

– water depth: 15-20 centimeters.

Re 3 (Repede Creek, 3.5 kilometers upstream the confluence with Vişeu)

– altitude: 831 meters;

– 47°36’55” northern latitude;

– 24°41’49” eastern longitude;

– a small puddle formed at the side of the road; hygrophilous vegetation heavily present; muddy bottom;

– no signs of human impact;

– total size of the sampling station: 5 meters long, 3 meters wide;

– water depth: 15-20 centimeters.

Frumuşeaua Creek (3 station):

Fr 1 (Tomnatec Creek, 200 meters upstream the confluence with Pop Ivan)

– altitude: 914 meters;

– 47°53”57’ northern latitude;

– 24°19’15” eastern longitude;

– a creek sector, affluent of Tomnatec, which flows slowly, before the confluence, on the river bed of the collector; sandy bottom, covered with small rocks; hygrophilous vegetation well represented;

– no signs of anthropic impact;

– total size of sampling station: 10 meters long, 40-50 centimeters wide;

– water depth: around 10 centimeters.

Fr 2 (Frumuşeaua Creek, 6 kilometers downstream the confluence of Tomnatec with Pop Ivan)

– altitude: 393 meters;

– 47°50”02’ northern latitude;

– 24°13’53” eastern longitude;

– temporary puddle, resulted from the construction of the road: a lower sector was dammed by the road, and filled with pluvial water; sandy and loamy bottom; hygrophilous vegetation present in small amount;

– no signs of anthropic impact;
– total size of sampling station: 3-4 meters long, 2 meters wide;
– water depth: around 1 meter.

Fr 3 (Frumuşeaua Creek, 500 meters upstream the confluence with Vişeu)
– altitude: 424 meters;
– 47°50”21’ northern latitude;
– 24°14’54” eastern longitude;
– a swamp sector resulted from the damming of a spring by the road; rocky bottom, with a thin lair of mud; hygrophilous vegetation well represented;
– anthropic impact present: logs, wood scraps;
– total size of sampling station: 5 meters long, less than 1 meter wide;
– water depth: 15-20 centimeters.

Ruscova River Basin (3 stations):

Ru 1 (Răchita Creek, 50 meters upstream the confluence with Socolău)
– altitude: 683 meters;
– 47°52”07’ northern latitude;
– 24°30’49” eastern longitude;
– a creek sector flowing along with the road; sandy bottom, with high quantity of organic detritus; hygrophilous vegetation poorly represented;
– anthropic impact present: wood logs in the water, prepared for future transportation;
– total size of sampling station: 5 meters long, less than 0.5 meters wide;
– water depth: around 10 centimeters.

Ru 2 (Bardi Creek, at the confluence with Ruscova)
– altitude: 569 meters;
– 47°49”50’ northern latitude;
– 24°28’20” eastern longitude;
– a stagnation sector of a Bardi affluent, caused by its damming from the road and by the level difference between the affluent and the canal from under the road; sandy bottom; hygrophilous vegetation abundant;
– anthropic impact present: wood parts on one side of the station, probably scrap from primary treatment;
– total size of sampling station: around 2 meters in both length and width;
– water depth: around 60 centimeters.

Ru 3 (Repedea River, 1 kilometer upstream the confluence with Ruscova)
– altitude: 540 meters;
– 47°50”57’ northern latitude;
– 24°24’25” eastern longitude;
– a chain of small temporary puddles, formed in tyre tracks from transportation vehicles, near a wood storage area; sandy and loamy bottom, no vegetation;

– anthropic impact present: substances from primary wood treatment (pieces of wood, sawdust, etc.);

– total size of sampling station: around 25 meters long, 2-3 meters wide;

– water depth: 10 centimeters.

Vişeu River (2 stations):

Vi 1 (Vişeu River, 250 meters downstream the confluence with Ruscova)

– altitude: 401 meters;

– 47°46"54' northern latitude;

– 24°16'26" eastern longitude;

– a large temporary puddle, located in the flood plain of Vişeu, next to a wood industry scrap dump; sandy and loamy bottom, rich in organic detritus); hygrophilous vegetation poorly represented at shores;

– anthropic impact present: bottom of the station covered by a thick lair of sawdust;

– total size of sampling station: 7-8 meters long, 4 meters wide;

– water depth: 20 to 40 centimeters.

Vi 2 (Vişeu River 400 meters downstream the confluence with Frumuşeaua)

– altitude: 381 meters;

– 47°49"27' northern latitude;

– 24°14'10" eastern longitude;

– a river sector (a Vişeu affluent) partially dammed by a local road, in a way that in front of the dam, there is a low flow sector, with deeper water; rocky bottom, without a lair of mud; hygrophilous vegetation present at shores;

– anthropic impact present: garbage, plastics, wood scraps;

– total size of sampling station: 5 meters long, 4 meters wide;

– water depth: 40 to 60 centimeters.

Samplings were made in similar conditions for all campaigns, taking one sample from each station, of 8 to 15 meters in length, trying to cover the entire habitat (water surface and body, aquatic vegetation if present, bottom); the samples were collected in June or July in several years, with an entomological net with a 60 cm^2 mesh-size. Identification of species was made at a stereo binocular by the morphological features or, where necessary, by genitalia, using data from known specialists (Jansson, 1986; Davideanu, 1999). Species nomenclature is according to the system developed by Gaby Viskens (www.earthlife.net).

Nine species were collected from the 14 stations, six semiaquatic ones: *Gerris* (*Aquarius) paludum* Fabricius, 1794, *Gerris lacustris* Linnaeus, 1758, *Gerris costae* Herrich-Schäffer, 1853, *Gerris argentatus* Schummel, 1832, *Gerris gibbifer* Schummel, 1832 and *Gerris odontogaster* Zetterstedt, 1828 and three aquatic ones: *Notonecta glauca* Linnaeus, 1758, *Nepa cinerea* Linnaeus, 1758 and *Sigara (Pseudovermicorixa) nigrolineata* Jaczewski,1962. Species distribution is depicted in Table 1.

Table 1

Aquatic and semiaquatic Heteroptera collected (number of individuals)

Station / Species	Ar1	Ar2	Ar3	Re1	Re2	Re3	Fr1	Fr2	Fr3	Ru1	Ru2	Ru3	Vi1	Vi2
N. glauca	-	-	-	-	-	1	-	-	-	-	-	-	-	-
N. cinerea	-	-	-	-	-	-	3	1	-	-	-	-	-	-
S. nigrolineata	-	-	-	-	-	-	-	16	-	-	-	1	-	-
G. paludum	-	-	-	-	-	-	-	-	-	-	-	-	1	-
G. lacustris	-	4	5	4	1	-	2	10	4	13	21	1	6	4
G. costae	1	-	-	-	1	1	-	-	-	-	1	-	-	-
G. gibbifer	1	-	-	-	-	-	-	-	-	-	-	-	-	-
G. argentatus	-	1	-	-	-	-	-	-	-	-	-	-	-	-
G. odontogaster	-	1	-	-	-	-	-	-	-	-	-	-	-	-

RESULTS AND DISCUSSION

Similarity clusters for both relative abundance and presence-absence data are presented in Figure 1. They show the relations between the communities from our sampling stations, from two different points of view: community structure and species composition.

Table 2 is presenting habitat conditions from the 14 stations, coded as six variables: flow type, hygrophilous vegetation presence and quantity, substratum texture, presence of anthropic impact signs and their amount, station surface and water depth. In order to obtain a simpler approach, flow type was divided into only two categories – stagnant and flowing waters, habitats with the vegetation present were divided into those with vegetation only at shores and those more or less completely covered, and anthropic impact was categorized as present, if there were signs anywhere on the station, and heavy, if there were signs everywhere on the station. Size and depth were each classified into three conventional categories: under 5 square meters, between 5 and 15, and over 15 square meters, for station size, and under 0.5 meters, between 0.5 and 1 meter, and over 1 meter, for water depth.

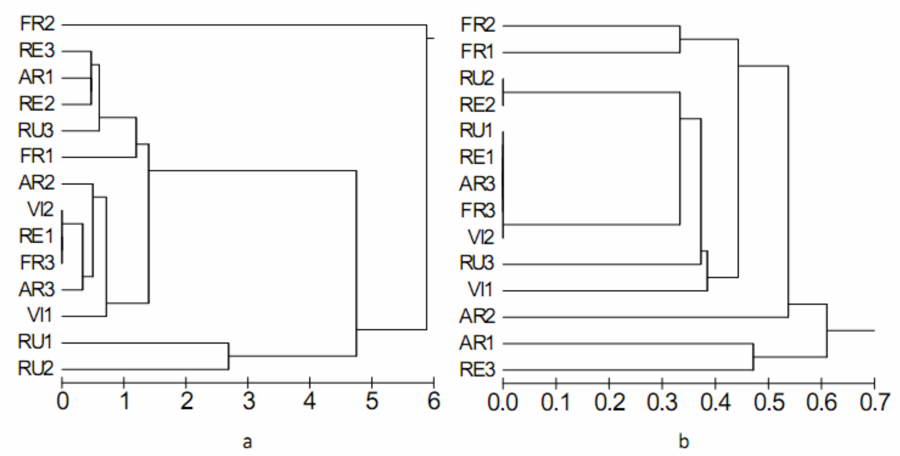

Fig. 1. Sampling stations' similarity (average linkage, Euclidean distances):
a – relative abundance data; b – presence-absence data.

Stations group according to relative abundance data into three different categories: the *G. lacustris* domination group (grey columns from Table 2), formed by stations Ar2, Ar3, Re1, Fr3, Vi1 and Vi2, stations with few individuals, mostly part of the mentioned species, named group 1; the high heterogeneity group (white columns from Table 2), formed by stations Ar1, Re2, Re3, Ru 3 and Fr1, again with few individuals, but equally divided between the species present, named group 2; the high number group (black columns from Table 2), formed by stations Ru1, Ru2 and Fr2, stations with the highest number of individuals, found at larger Euclidean distances from each other, named group 3.

Stations from group 1 are lotic and lentic habitats, on all three types of substrate, and are heterogeneous in both size and depth. As for the vegetation and anthropic impact, some relations seem to appear: all stations have some amount of vegetation, mostly in the shore area, and five out of six stations present heavy anthropic impacts.

Group 2 are again lotic and lentic habitats, of all kinds of sizes, with all types of vegetation coverage taken into concern present. Closer relations are between the community and substrate type (only friable types, sandy and muddy, are present) or anthropic impact (four out of five stations present no anthropic impact, and the fifth, Ru3, is affected by wood scraps and sawdust, which is an organic matter). Another similarity seems to be regarding the water depth, all stations presenting low depth, according to our categories.

Group 3 is the most heterogeneous one, as community structure and as habitat characteristics, but its stations share the same sandy substrate and the presence of vegetation.

Table 2

Habitat characteristics of sampling stations

Station / Habitat		Ar1	Ar2	Ar3	Re1	Re2	Re3	Fr1	Fr2	Fr3	Ru1	Ru2	Ru3	Vi1	Vi2
Flow type	lentic			x		x	x		x	x		x	x	x	
	lotic	x	x		x			x			x				x
Vegetation	absent												x		
	shores		x	x	x	x			x		x			x	x
	abundant	x					x	x		x		x			
Bottom	sandy							x	x		x	x	x	x	
	muddy	x			x	x	x								
	rocky		x	x						x					x
Anthropic impact	absent	x			x	x	x	x	x						
	present											x			
	heavy		x	x						x	x		x	x	x
Size (m^2)	small			5				4		5	2.5	4			
	medium	7			7	7			7						
	large		16				15						50	30	20
Depth (m)	low	0.4	0.2		0.3	0.2	0.2	0.1		0.2	0.1		0.1	0.3	
	medium											0.6			0.5
	high			1.5					1						

If we look at the presence-absence data, we see two very close groups: Ru2 and Re2, at first, and Ru1, Re1, Ar3, Fr3 and Vi2, at second.

Ru2 and Re2 are lentic habitats, with vegetation present, friable substrate and relatively free of anthropic impact (although Ru2 is affected, the impact is only on one part of the station, most of it being clear). The species present are *G. lacustris* and *G. costae*.

The second group is characterised by the presence of vegetation, mostly at shores, and severe anthropic impact in four stations out of five (the fifth station, Re1, shows no obvious signs of impact, but it is a dammed sector, with almost no flow, in contrast with the normal conditions of the river). All sizes, water depths, flow types and bottom types are present. Only *G. lacustris* was collected.

Next to those very close related groups, we can identify another two, at larger distances: Fr1 and Fr2, with vegetation present, sandy bottom and no anthropic impact, but with different flow types, sizes and depths, where *G. lacustris* and *N. cinerea* dominate, and Ar1 and Re3, with abundant vegetation, muddy bottom and no anthropic impact, again with different flow types, sizes and depths, where *C. costae* was present, along another one species (those are the only two stations where *G. lacustris* was not found).

Possible relations between habitat characteristics and Heteroptera community structure are a new point of interest. So far, such relations were studied by research groups conducted by Nosek (2007) or Skern (2010) on different parts of the

Danube Basin (in Hungary, respectively Austria), on large areas with much better habitats for the group, and on data from multiple samplings. Both authors emphasized that macrophyte density, current velocity and connectivity to the main river are important factors in community structure formation, but all information refers to presence-absence data, not taking into concern relative abundance.

CONCLUSIONS

As for our informations, some facts easily emerge:

1. *Gerris lacustris* is the best adapted species for such areas, being present in 12 out of 14 stations considered (it is also the dominant species in many of the mountainous sampling stations researched in our previous studies); the species has wide ecological preferences, being found in both small and large stations, regardless of vegetation density, anthropic impact or substrate; although Andersen (1982) refers to the species as a shore vegetation one, we found it in our stations on open water, probably due to lack of competition from larger species such as *Gerris paludum* or *G. (Limnoporus) rufoscutellatus*, the ones who usually occupy this niche; this situation is more obvious where *G. lacustris* is sharing the habitat with high vegetation density specialists, such as *G. costae* or *G. argentatus*.

2. Presence of vegetation in some amount favours the group (only one station, Ru3, lacks vegetation and very few altogether from our previous campaigns).

3. Size and depth of the station seem to have no importance for community configuration (although group 2 in our analysis seem to be linked by low water depth, it is probably a coincidence, since 10 out of 14 stations are sharing this characteristic).

4. Current velocity is important up to a point, where it is too high; lotic and lentic habitats are having the same community structure.

5. *G. lacustris* tends to dominate habitats with vegetation at shores and heavy anthropic impact: group 1 from relative abundance cluster, and the five stations group from presence-absence cluster share the same characteristics; even more, two stations from group 3 of relative abundance, Ru1 and Ru2, are heavily affected by anthropic impact, and dominated by *G. lacustris*, but the large number of individuals influenced their linkage with the rest of the stations.

6. Rocky substrate also favours *G. lacustris*, the only species sampled in three out of four stations with such substrate, and the dominant one in the fourth.

7. The absence of anthropic intervention favours a much more heterogeneous community, from both points of view: group 2 from the relative abundance cluster, and station Fr3 (which belongs to group 3 due to the large number of individuals, but has a much more heterogeneous composition than the rest of group 3) are sharing the lack of human interference; presence-absence data show that all

combinations (*G. lacustris* – *N. cinerea*, *G. lacustris* – *G. costae*, *G. costae* – another species) are found in no impact stations; friable substrate (sandy or muddy) also seems to favour this kind of association.

8. *G. costae* prefers higher vegetation densities, regardless of its association with other species.

All this information is preliminary and needs to be confirmed by further research. Other habitat variables, such as water pH values, geological substratum, presence or absence of direct light, altitude, etc. could be as important and should be analyzed in the future.

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