

Spatial distribution of semiaquatic bugs (Heteroptera: Gerromorpha) and their wing morphs in a small scale of the Pohořský Potok stream spring area (Novohradské Hory Mts.)

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Abstract

A survey of semiaquatic bugs (Heteroptera: Gerromorpha) was managed in a small scale area (72 ha; spring area of Pohořský Potok stream, Novohradské Hory Mts., Czech Republic, Central Europe). Species composition of assemblages and rates of their pteromorphs were observed in the relation to selected environmental characteristics – stream velocity, site permanence, water surface coverage and site shading. *Gerris gibbifer* Schummel, 1832, *Gerris lateralis* Schummel, 1832 and *Velia caprai* Tamanini, 1947 are dominant gerromorphan species in the study area. *Gerris* species are univoltine; bivoltinism of Veliidae species cannot be excluded in this area. A redundancy analysis showed significant effect of stream velocity, site shading and site permanence on species and wing morphs composition of assemblages. *Velia caprai* mostly occur in shaded habitats with flowing water, whereas other species prefer still water bodies. *Gerris lateralis* prefers shaded sites as the only Gerrid. Occurrence of wing morphs of the only notably wing dimorphic species *G. lateralis* in the study area depends on site permanence. Permanent water bodies are occupied by both macropterous and apterous specimens, temporary sites are almost exclusively colonized by macropterous individuals. Ecological consequences are discussed.

Key words: Gerridae, Veliidae, habitat preferences, wing dimorphism, migration

INTRODUCTION

The semiaquatic bugs (Heteroptera: Gerromorpha) live on the water surface of both lentic and lotic habitats. They actively forage and suck up prey, usually soft bodied arthropods, on the surface. Both temporary and permanent habitats are often populated by several species of gerromorphan bugs creating various assemblages. A structure of these assemblages and distribution of semiaquatic bugs related to environmental conditions in large areas has been studied by several authors (e.g., PETR 2000, BÍRÓ 2003, KARAOUZAS & GRITZALIS 2006, TAYLOR & MCPHERSON 2007).

Most of the species occur in macropterous (long-winged – LW) and brachypterous (short-winged – SW) or fully apterous morph. Neither brachypterous nor apterous individuals are able to fly, thus both these morphs can be considered more or less arbitrarily to be SW for ecological purposes (SPENCE & ANDERSEN 1994). The wing morph is partly genetically determined in some species (SPENCE & ANDERSEN 1994), however, it usually depends on environmental conditions. Overwintering adults of polyvoltine populations, migrating to and from

overwintering sites, are usually macropterous, the same as species and individuals from temporary and unpredictable habitats (ANDERSEN 1993). Thus, in wing dimorphic species, brachypterous and apterous morphs are usually present more frequently in summer generation. A distribution of species and their wing morphs has never been investigated together in a small area, within not-separated populations of several semiaquatic bug species. Broken topography of the spring area of the Pohořský Potok stream in the Novohradské Hory Mts. offers the possibility for such a study that should answer the following two main questions:

(i) What is a habitat preference of semiaquatic bugs in a small scale area?

(ii) Does the distribution of wing morphs in semiaquatic bugs, living in non-separated populations and thus genetically homogenous, share the same pattern as distribution of wing polymorphic species within large areas?

MATERIALS AND METHODS

This study was carried out during summer 2007 in the spring area of Pohořský Potok stream in the Novohradské Hory Mts., one km south from the Pohoří na Šumavě village. This area (72 ha; center: 48°35'53" N, 14°41'23" E; mapping squares 7354 and 7454) is rich on numerous small pools and streams, both ephemeral and permanent, usually partly connected during heavy rains. Most of the water bodies are colonized by gerromorphan assemblages, consisting of various species. All localities with semiaquatic bugs were included into the survey. The sampling of bugs was realized by standard semiquantitative methods using a hand net (30 cm diameter, 1.5 mm mesh size). For ascertaining the state of a wing morph, only adults were included into the results. Beside species composition of samples, selected habitat characteristics were recorded: (I) stream velocity: according to stream velocity the sites were classified as (a) lentic – still water, (b) transitional – apparently still, but with inflow and outflow, and (c) lotic – visibly flowing water; fuzzy coding used for the analysis; (II) site shading: a proportion of the shaggy shore vegetation shading a site was measured and the site was classified as (a) completely sunny: 0–10% of the shore shaggy, (b) sunny: 10–30%, (c) half-shady: 30–70%, (d) shady: 70–90%, and (e) completely shady: 90–100%; (III) site permanence: the site was classified as (a) temporary if it dried-up during a survey or if a minimal recorded depth of lentic water body (measured in the deepest point) decreased below 3 cm, else it was classified as (b) permanent; (IV) vegetation coverage: a site was classified as (a) free of coverage when 0–10% of water surface was covered by macrophytes, (b) partly covered when 10–50%, and (c) covered when more than 50% of the water surface was covered by macrophytes. Size of the site was not recorded because all sites were similarly small (max. 3 m in diameter). Obtained data were analyzed by Redundancy analysis (RDA, software Canoco for Windows 4.5). Species counts were transformed by square-root transformation. In the first run, only counts of species were used. In the second run, wing morphs of dimorphic species (SW and LW) were used. Monte-Carlo permutation tests (499 permutations) were run for finding out the influence of the habitat characteristics.

RESULTS

Semiaquatic bugs were found at 31 sites within the study area, 363 adults of five species were caught in total. Most abundant species in the area are water cricket *Velia caprai* Taminini, 1947 and water striders, *Gerris lateralis* Schummel, 1832 and *G. gibbifer* Schummel, 1832. Sparsely occurring species are *Microvelia reticulata* Burmeister, 1835 and *G. lacustris* L., 1758 (see Table 1). All *G. gibbifer* and *G. lacustris* were LW, only SW individuals of *M. reticulata* were caught, the same as males of *V. caprai*. One LW female of *V. caprai* was

Table 1. List of species of Gerromorpha found in the study area. N denotes number of adult individuals caught. Distribution was evaluated as a number of sites colonized by the species.

Family	Species	N	LW	SW	Distribution
Gerridae	<i>Gerris gibbifer</i>	74	74	0	14
	<i>Gerris lacustris</i>	23	23	0	4
	<i>Gerris lateralis</i>	114	42	72	18
Veliidae	<i>Microvelia reticulata</i>	4	0	4	1
	<i>Velia caprai</i>	148	1	147	20

found. The only distinctly pterypolymorphic species within the study area was *G. lateralis* with 37% LW and 63% SW morphs. Gerrid nymphs were found from June to August, some fourth and fifth instars occasionally till September. Phenological data show typical one waved occurrence of all gerrid species nymphs. *Gerris* species produce only one (spring) generation in the study area. *V. caprai* nymphs were found from the end of April (first instars) to November (fifth instars) with mass occurrence in July and beginning August. Nymphs of *M. reticulata* occurred from June to September, neither nymph nor adult was found after the end of September. Production of the second generation cannot be excluded in *V. caprai* and *M. reticulata* by phenological data.

A significant effect of shading and stream velocity on species composition of the assemblages was exhibited by RDA of the species data (pseudo-F = 7.03; p = 0.002; pseudo-F = 3.5; p = 0.012, respectively). An effect of site permanence was not significant (pseudo-F = 1.46; p = 0.246). Because most of the sites were free of the water coverage (only 3 sites were partly covered by macrophytes), water coverage was not included into the analysis. Thus, two selected constrained axes explained 23.8% (first axis) and 4.7% (second axis) of total species composition variability. Water cricket *V. caprai* usually occurs in shaded flowing habitats, whereas all water striders and *M. reticulata* were usually found in lentic habitats. *G. lateralis* often occur in shaded habitats as the only gerrid (see ordination diagram, Fig. 1).

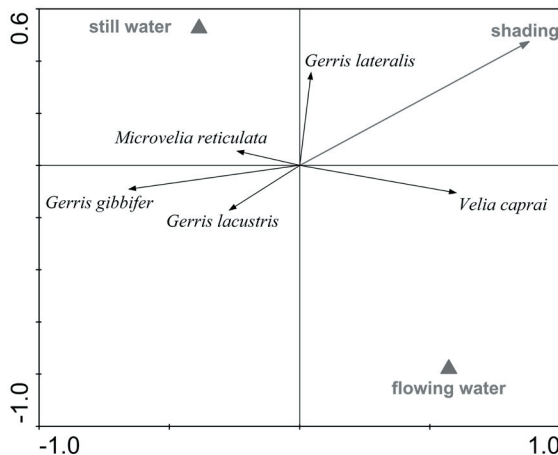


Fig. 1. Ordination diagram RDA of species habitat preference within the study area. *V. caprai* mostly occurs in shaded lotic habitats, *G. lateralis* in shaded lentic habitats and other species in sunny lentic habitats.

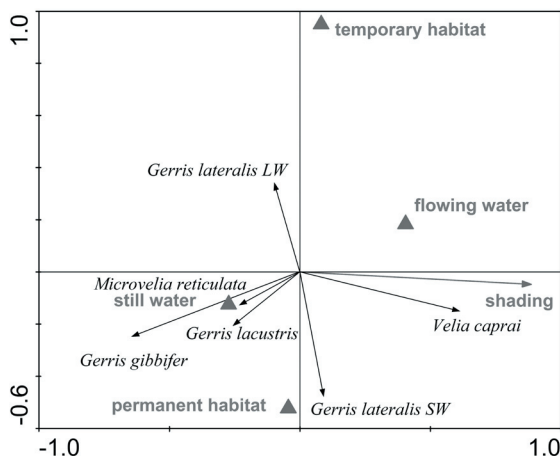


Fig. 2. Ordination diagram RDA of species and their wing morphs habitat preference within the study area. Metapopulation of *G. lateralis* split into cohorts of SW individuals occurring in permanent sites, and LW individuals occurring in both temporary and permanent sites. Other species distribution is similar to Fig. 1.

When the RDA was executed with species data split into wing morph data (*G. lateralis* only, single LW female *V. caprai* was omitted), a significant effect of shading (pseudo-F = 6.22; $p = 0.002$), stream velocity (pseudo-F = 3.12; $p = 0.018$), and site permanence (pseudo-F = 3.44; $p = 0.01$) on species and wing morphs composition was exhibited. Thus, three constrained axes explained 21.5% (first axis), 9.1% (second axis), and 3.7% (third axis) of total species and wing morphs composition variability. Occurrence of *G. lateralis* distinctly split according to wing morphs into cohorts of SW individuals of permanent sites and LW individuals of temporary sites (Fig. 2). SW individuals were found almost exclusively at permanent sites (96%).

DISCUSSION

Only species listed by PAPAČEK et al. (2002) for the Novohradské Hory Mts. were caught during this survey. All gerrid species were univoltine with absence of the summer generation in the study area, partly bivoltine or polyvoltine life cycle of *V. caprai* or *M. reticulata*, respectively, cannot be excluded.

According to the published data, *G. lacustris* is known to colonize open and semi-open still water, usually with moderate vegetation cover on the water surface (VEPSÄLÄINEN 1973), similar habitat as *M. reticulata* (ANDERSEN 1982). *G. lateralis* prefers both temporary and permanent shady sites, usually still, but sometimes slowly moving waters (KMENT & SMÉKAL 2002, VEPSÄLÄINEN 1973, WRÓBLEWSKI 1980) with dense water surface coverage (ANDERSEN 1982). This water strider is widespread in Northern Europe, even behind the Arctic Circle, where it avoids co-occurrence with other *Gerris* spp. *G. gibbifer* often occurs on small ephemeral ditches and pools (WRÓBLEWSKI 1980).

In this study, there is apparent effect of water stream and site shading on the species composition of gerromorphan assemblages, even in a small area. A preference of different habitats by different species (*V. caprai* – forest flowing waters, Gerridae – still waters) correspond to the preferences found by large-scale surveys (e.g., ANDERSEN 1982; KARAOUZAS & GRITZALIS 2006), although BÍRÓ (2003) found *G. lacustris* occurring in the streams and *V.*

caprai in the still water. Even though *G. lateralis* usually avoided competition with other gerriids, it often occurred together with *G. gibbifer* and sometimes with water cricket *V. caprai* in the study area. The coverage of water surface by macrophytes influences occurrence of some gerromorphan species (see PETR 2000, VEPSÄLÄINEN 1973). This effect cannot be confirmed by this study, probably because of pattern of sites at the study area where most of the sampled sites was free of coverage. When the RDA was run with wing morphs included beside the species data, there was apparent significant effect of the site permanence on wing morphs and species composition in the assemblages. SW individuals of *G. lateralis* were found almost exclusively in permanent sites, whereas LW specimens colonized both temporary and permanent habitats. Thus, in the case of drying out the habitat, macropterous individuals are able to migrate to sufficient sites. A wing dimorphism for this species is considered to be genetically based (see ANDERSEN 1993), but the present results indicate also possibility of environmental effect because of survey of metapopulation and absence of the second (summer) generation. *G. gibbifer*, known to be SW rarely (see ANDERSEN 1993), was found in common LW morph in all specimens. This species can thus migrate to sufficient sites during the season. Common water strider *G. lacustris*, known to be highly wing polymorphic (cf. ANDERSEN 1993), was found in permanent habitats only, all specimens represented LW morph. Absence of SW morphs is probably caused by possible absence of the second (summer) generation and by low abundance of this species within the relatively cold study area.

Water cricket *V. caprai* is almost exclusively apterous in South Bohemia (Czech Republic) (DITRICH 2005), but proportion of LW individuals is much higher in some regions (BRÖNMARK et al. 1985). Occurrence of wingless specimens in both temporary and permanent running waters and rarely in still waters (e.g., in isolated small puddles nearby streams, M. PAPÁČEK, unpubl. data) indicates possible terrestrial migration of this species. This hypothesis can be supported by the mode of locomotion in *Velia* species in terrestrial conditions. Contrary to *Gerris* species, water crickets move their legs in the same way as terrestrial insects when placed on the solid ground (ANDERSEN 1995).

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