Habitat features and associated terrestrial isopod species: a sampling scheme and conservation implications

3 authors:

Ferenc Vilisics
RolliPolli Tmi

Peter Solymos
University of Alberta

Hornung Elisabeth
University of Veterinary Medicine Budapest

A preliminary study on habitat features and associated terrestrial isopod species

FERENC VILISICS, PÉTER SÓLYMOS & ELISABETH HORNUNG

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We devised a sampling scheme that applies to Central-European landscapes. This consisted of (1) field inventory of isopod fauna (sampling methods and circumstances, collecting effort) and (2) habitat feature assessment (location, elevation, vegetation, moisture, disturbances, soil properties, micro-habitats). We aimed to analyse the association between occurrences of isopod species and certain habitat features.
We evaluated a total of 126 habitat data from field samples (n = 108) and published sources (n = 18). Out of 36 species, 21 (≥ 5 data/species) were included in the analyses. We applied binary logistic regression using species' occurrences as dependent and habitat features (elevation, canopy cover, moisture, disturbance) as independent categorical variables.
Out of the 21 species, nine showed significant ($p < 0.05$ or $p < 0.1$), non-random association with the analysed habitat features. Most of the significant associations support quantitatively our field experiences: e.g. *Armadillidium vulgare* appears in all kinds of habitats; *Haplophthalmus mengii* showed significant positive association with highlands and negative association with woodland habitats; *Hyloniscus riparius* needs moist or wet habitats; *Trachelipus rathkii* showed significant negative association with highland and urban habitats; and *Trachelipus nodulosus* showed significant negative association with woodlands and also with wet, and suburban and urban habitats. The absence of *Porcellio scaber* and *Porcellionides pruinosus* in rural habitats reflects their association with synathropic habitats.

Keywords: Woodlice, datasheet, database, key factors, habitat preference, biodiversity.

Ferenc Vilisics, Péter Sólymos and Elisabeth Hornung, Department of Ecology, Institute for Zoology, Faculty of Veterinary Science, Szent István University, H-1400 Budapest, P.O.Box 2, Hungary
E-mail: Vilisics.Ferenc@aotk.szie.hu

Introduction

Revealing biodiversity is a fundamental need for both biogeography and conservation biology (Wilson, 1988; Raven and Wilson, 1992; Williams et al., 2002). The criteria of good quality data are accurate and verifiable identifications and precise, detailed information on collection circumstances and habitats types.

The habitat and microhabitat preference and habitat spectra of soil invertebrate species are poorly quantified in the available publications, although they are important elements for understanding the species' ecological tolerance and for the selection of key landscape elements serving for biodiversity hot spots (Sutherland, 2001).

Soil dwelling macroinvertebrates are poorly represented in biodiversity estimations (Myers et al., 2000; Pressey, 2004), although they play a fundamental and diverse role in decomposing subsystems.

We aimed to collect information about the occurrence, distribution and the habitat/microhabitat preference of certain soil macroinvertebrate species/taxa (Gastropoda, Isopoda and Carabidae). For this purpose we compiled a field data sheet.

There are good examples of data sheets for field inventory assessments of invertebrates (e.g European Invertebrate Survey). Several publications dealing with species distribution and mapping of woodlice (Harding and Sutton, 1985) and of molluscs (André, 1984; Bába, 1988; Pintér et al., 1979; Pintér and Suara, 2004) provided valuable examples for our work, while Samu (1999) gave inspirations in creating a proper structure for our database.

We have chosen terrestrial isopods (Isopoda: Oniscidea) as a model taxon for testing our sampling scheme. The Hungarian isopod fauna is known to consist of 50 species (Kontschán, 2004). Besides the unquestionable biological importance of the taxon in decomposing subsystems, this number of species is suitable for testing a detailed but easily managed database.

During the last decade, 25 papers have been published which contain data on woodlice distribution

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in Hungary. The published data are restricted to certain geographical regions, covering less than 20 % of 10 km x 10 km UTM grids cells of Hungary (Forró and Farkas, 1998). Thus, reliable conclusions can not be drawn on country-wide isopod distributions or habitat diversity.

We aim to complete the present knowledge concerning the factors affecting isopods distribution, and create a sampling scheme that is suitable for observing other epigeic invertebrates from this aspect. The method is also appropriate for classical faunistic studies, such as the compilation of fauna lists and distribution maps. The present paper includes the main contents of our datasheet, and the results of our preliminary studies.

Material and methods

Sampling

Sampling sites were chosen according to the following main criteria: level of disturbance (rural vs. urban), geomorphology (hills *vs*. lowlands), type of bedrock (calcareous vs. silicate), canopy coverage (opened *vs.* closed), moisture (dry *vs.* moist/wet). In addition, various ecotones were sampled.

From the viewpoint of disturbance, samples were taken from rural (60), suburban (15), and urban habitats (33) in nine major geographic areas of Hungary (mountainous and lowland regions; small and large human settlements).

In addition to field samplings, we also used literature data. Out of 25 references only five contained data habitat characteristics (Farkas, 2004; Kontschán, 2002; Kontschán and Hornung, 2001; Vadkerti and Farkas, 2002; Vilisics and Farkas, 2004).

Field sampling was carried out by direct search (20 to 40 minutes per habitat) during the years 2003 and 2004.

Habitat feature assessment

For field data assessment we created a datasheet that is appropriate to build up a database on habitat features at different scales and also presenting methods and circumstances. The resultant field data are suitable to be converted into a computer database for statistical analyses.

This datasheet was designed for the Hungarian landscape and is suitable for further extension.

1. Database identifier: NNddmmyy-sample no. (NN: capital letters of collector's name initials; dd: day; mm: month; yy: year as for date of sampling).
2. Biotic data: Name of collector; Date and exact location of sampling; GPS coordinates and altitude of the sampling site.
3. Sampling circumstances: Sampling methods; Sampling effort; Weather conditions.
4. Habitat features: Disturbance/Perturbation: Protection status of the area; Urbanization (urban, suburban, rural); Human impact on the area (degraded or natural, semi natural); General habitat characteristics: geo-morphological character of site, vegetation formation (woodland vs. grassland); Moisture; Exposure; Vegetation: Á-NÉR code [=National Habitat Classification System, (Fekete et al., 1997]; Name of plant associations; Name of dominant or characteristic plants; Percentage coverage of herb layer, shrub and tree canopy; Bedrock: Type of bedrock; Surficial presence; Soil characteristics: Type of soil; Basic character (calcareaous vs. silicate); Soil moisture, and structure of soil; Leaf litter properties: Thickness, and structure of leaf litter; Substance of fallen leaves; Ecotones (e.g. forest edge, river-side); Microhabitats (e.g. rotten logs, stone, leaf litter).

There are also optional parts which require special equipment (e.g. soil pH). Besides field samplings, the structure of the datasheet enables the extension of a database with additional categories (e.g. microhabitat types) and also with published literature data. For better description of habitats we suggest to add photographs, and to indicate the localities on maps.

Data analysis

Our field sampling resulted data for 35 species. Data for an additional species (*Armadillidium opacum*) originates from the literature (Farkas, 2004; Vilisics and Farkas, 2004). 15 species with less than five occurrences were excluded from further analyses. One species, *Trichoniscus* cf. *pusillus* needs taxonomical revision. We used binary logistic regression for the analysis of the relationship between the species' occurrences and the selected environmental variables using the software SPSS 11.

Based on the datasheets, we used elevation (highland [n=78], lowland [n=49]), canopy coverage (open [n=51], closed [n=76]), moisture (wet [n=25], moist [n=64], dry [n=38) and urbanisation (urban [n=34], suburban [n=20], rural [n=73]) as independent variables. When an independent variable has two or more categories, one of them should be used as reference categories against the other(s).

Occurrence (present = 1, absent = 0) of the species was used as dependent (response) variable. We give the results as odds ratio, which is a summary measure of the relationship (effect size) between two variables. The relationship is negative if the odds ratio falls between 0 and 1, and is positive if the odds ratio exceeds 1. The larger/smaller the odds ratio is, the stronger is the relationship.

Results

The 36 isopod species involved in the evaluation cover > 70 % of the known Hungarian fauna. Five species proved to be new: *Agabiformius lentus*, *Chaetophiloscia cellaria*, *Paraschizidium coeculum*, *Trichoniscus bosniensis*, *Trichoniscus steinboecki*; all leg. by the first author (Vilisics, 2005).

Table 1. Distribution of the studied isopod species among habitat categories.

Species	**Source**[a]	**Analysis**[b]	**Elevation**		**Canopy cover**		**Moisture**			**Urbanisation**			**No. of locations**
			Highland	Lowland	Closed	Opened	Wet	Moist	Dry	Urban	Suburban	Rural	
Agabiformius lentus (Budde-Lund, 1885)	F	E	1	0	-	1	-	1	-	1	-	-	1
Androniscus roseus (C. Koch, 1838)	F,	ns	6	3	5	4	-	8	1	1	3	5	9
Armadillidium opacum (C. Koch, 1841)	L	E	3	0	3	-	-	3	-	-	-	3	3
Armadillidium versicolor Stein, 1859	F	E	0	3	3	-	-	2	1	2	-	1	3
Armadillidium vulgare (Latreille, 1804)	F,	*	26	22	23	25	3	26	19	16	8	24	48
Buddelundiella cataractae Verhoeff, 1930	F	E	0	2	-	2	2	-	-	2	-	-	2
Chaetophiloscia cellaria (Dollfus, 1884)	F	E	0	1	-	1	1	-	-	1	-	-	1
Cylisticus convexus (De Geer, 1778)	F,	ns	13	11	13	11	4	16	4	9	6	9	24
Haplophthalmus danicus (Budde-Lund, 1880)	F,	ns	4	9	4	9	3	10	-	8	2	3	13
Haplophthalmus mengii (Zaddach, 1844)	F,	*	11	3	6	8	2	9	3	4	4	6	14
Haplophthalmus montivagus (Budde-Lund, 1880)	F	E	1	0	1	-	1	-	-	-	-	1	1
Hyloniscus riparius (C. Koch, 1938)	F,	*	24	14	25	13	13	22	3	8	4	26	38
Hyloniscus vividus (C. Koch, 1941)	F	ns	5	1	5	1	2	4	-	1	-	5	6
Lepidoniscus minutus (C. Koch, 1838)	F	ns	17	0	17	-	3	9	5	-	-	17	17
Ligidium germanicum Verhoeff, 1901	F,	ns	14	0	14	-	4	10	-	-	-	14	14
Ligidium hypnorum (Cuvier, 1792)	F,	ns	9	1	9	1	3	6	1	-	-	10	10
Oniscus asellus Linnaeus, 1752	F	E	1	0	1	-	-	1	-	1	-	-	1
Orthometopon planum (Budde-Lund, 1885)	F	ns	7	0	6	1	2	3	2	-	-	7	7
Paraschizidium coeculum (Silvestri, 1897)	F	E	1	0	1	-	-	1	-	1	-	-	1
Platyarthrus hoffmansseggii Brandt, 1833	F,	*	7	13	9	11	-	16	4	12	4	4	20
Platyarthrus schoblii Budde-Lund, 1885	F	E	0	2	1	1	1	1	-	1	1	-	2
Porcellio scaber Latreille, 1804	F,	ns	3	18	9	11	1	12	8	18	3	-	21
Porcellio spinicornis Say, 1818	F	E	1	0	1	-	-	-	1	-	1	-	1
Porcellionides pruinosus (Brandt, 1833)	F,	*	4	10	2	12	1	7	6	11	3	-	14
Porcellium collicola (Verhoeff, 1907)	F,	*	16	10	17	9	-	21	5	10	4	12	26
Proporcellio vulcanius Verhoeff, 1908	F,	E	1	2	1	2	-	2	1	1	2	-	3
Protracheoniscus major (Dollfus, 1903)	F	E	0	2	-	2	-	-	2	1	1	-	2
Protracheoniscus politus (C. Koch, 1841)	F,	ns	31	0	27	4	5	17	9	-	-	31	31
Tachysoniscus austriacus (Verhoeff, 1908)	F	E	1	0	1	-	1	-	-	-	-	1	1
Trachelipus nodulosus (C. Koch, 1838)	F,	*	8	8	3	13	1	5	10	2	3	11	16
Trachelipus rathkii (Brandt, 1833)	F,	*	11	15	8	18	2	16	8	5	4	17	26
Trachelipus ratzeburgii (Brandt, 1833)	F,	ns	13	2	15	-	3	10	2	1	1	13	15
Trichoniscus bosniensis Verhoeff, 1901	F	E	3	0	3	-	1	2	-	-	-	3	3
Trichoniscus noricus Verhoeff, 1917	F,	E	1	1	1	1	-	2	-	1	-	1	2
Trichoniscus cf. *pusillus* Brandt, 1833	F,	*	7	1	6	2	3	5	-	2	1	5	8
Trichoniscus steinboecki Verhoeff, 1931	F	+	5	0	5	-	2	3	-	-	-	5	5

[a]F: field sampling, L: literature data.
[b]Overall model fit is based on likelihood ratio test (n = 126, df = 6), +: $p < 0.1$, *: $p < 0.05$, ns: not significant. E: species excluded from analyses.

21 species – with ≥ 5 occurrences– were used for the analyses and ten showed significant ($p < 0.05$) or marginally significant ($p < 0.1$) fit of the logistic regression (Table 1). Out of these, *T. steinboecki* although fitted to the model, did not show significant association with the independent variables. The association between the independent variables and the occurrence of the remaining nine species was significant (Table 2).

All the nine species that showed significant associations with the analysed habitat features (Table 2) are either cosmopolitan (*Armadillidium vulgare*, *Porcellionides pruinosus*), or considered to be widely distributed in Europe (Schmalfuss, 2003), as well as is Hungary (Forró and Farkas, 1998; Farkas, 2004).

36 % of all species *(A. opacum, Haplophthalmus montivagus, Lepidoniscus minutus, Ligidium germanicum,*

Table 2. Results of the binary logistic regression. Results are shown as odds ratio, only significant and marginally significant associations are indicated based on the Wald statistic.

Species	Independent variables and categories[b]							
	Elevation	Canopy	Moisture			Urbanisation		
	Highland	Closed	All	Wet	Moist	All	Urban	Suburban
Armadillidium vulgare			*	0.14*				
Haplophthalmus mengii	8.99*	0.24+						
Hyloniscus riparius			*	16.09*	7.49*			
Platyarthrus hoffmansseggii					3.43+	*	21.31*	15.99*
Porcellionides pruinosus		0.17*					7.20*	
Porcellium collicola						*	7.86*	
Trachelipus nodulosus		0.08*		0.08*		*	0.04*	0.10+
Trachelipus rathkii	0.17*					+	0.23+	
Trichoniscus cf.*pusillus*							10.164*	

[b]Independent variables were coded as binary categorical variables. Dry and rural categories were used as reference category, thus not presented in this table but involved in "All" category.

L. hypnorum, Orthomethopon planum, Protracheoniscus politus, Tachysoniscus austriacus, T. bosniensis, T. steinboecki) occurred exclusively in rural and predominantly in woody habitats (Table 1).

Nine species (*Androniscus roseus, A. vulgare, Cylisticus convexus, Haplophthalmus danicus, H. mengii*, *Hyloniscus riparius*, *Platyarthrus hoffmannseggii*, *Porcellium collicola*, *Trachelipus nodulosus, T. rathkii, T.ratzeburgi* and *T.* cf. *pusillus*) were sampled in rural, suburban and urban sites (Table 1).

Discussion

Our results partly prove statistically previous field impressions concerning species' habitat preference. Nearly half of the analysed species are significantly associated with any of the habitat features.

Some results given in Table 2 are questionable. For example, *P. collicola* seems to be a dominant species in urban sites although it is also known to be one of the most widely distributed species in rural habitats of Transdanubia (Farkas, 2004).

The *Platyarthrus* spp. co-occur with certain ant species. The habitat preferences of the ants determine the occurrence of isopods. *P. hoffmannseggii* is a widespread species in Hungary and in Europe as far north as Finland (Forró and Farkas, 1998; Schmalfuss, 2003), while the Hungarian occurrence of *P. schoblii* was first reported in 2004 (Tartally et al., 2004; Hornung et al., 2005). It was probably introduced with the invasive ant species *Lasius neglectus*.

Minute species and soft bodied ones (e.g. *Androniscus roseus*, *Buddelundiella cataractae*, *Haplophthalmus* spp., *T. austriacus*, *Trichoniscus* spp.) should be considered on a much finer scale than that used in this investigation. Their microhabitat preference may be fulfilled by small shelter sites, such as underneath stones or barks, quite independent of the rural or urban nature of the habitat.

Species occurring in only one habitat type could be expected to show high correlation with characteristic features. A reason for the lack of any correlation might lie in the low number of data. In the present study, species that fit into this category are: *Ligidium* spp., *T. bosniensis* and *T. steinboecki*, which were collected in woodland ravines and streamside, while *L. minutus* and *Orthometopon planum* were found in quasi-natural deciduous forests in West- and/or North – Transdanubia. These areas are under-represented in our analyses. With future extension of sampling effort we expect to gain significant correlation with typical background factors.

A better knowledge on species preference may give useful information for habitat ranking in conservation biology. Both "rare" species with narrow tolerance – occuring mainly in rural-woody habitats- and the introduced and/or invasive ones can be of importance in habitat qualification.

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