TERRESTRIAL ISOPOD ASSEMBLAGES FROM FOUR HABITATS FROM CRASNA HILLS, NORTH-WESTERN ROMANIA

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Abstract. We studied the terrestrial isopods from four habitats (natural woodland and forest edge on one hand, and an edge and a cleared area, resulted from woodcutting on the other) from north-western Romania, during 2009. The samples were taken monthly, from April to September, using pitfall traps. We identified seven terrestrial isopods species: *Hyloniscus riparius*, *H. transsilvanicus*, *Androniscus roseus*, *Protracheoniscus politus*, *Porcellium collicola*, *Trachelipus nodulosus*, *T. ratzeburgii*. In the natural habitats, the richness and diversity of species was higher than in anthropogenically affected ones. The very small evenness value and the mono-dominance of the *T. nodulosus* in the cleared grassland are explained by the habitat being affected by the woodcutting in the past. The very little species overlap between natural and affected habitats underlines the importance of the heterogeneity of habitats for the terrestrial isopod diversity of fauna on a larger area.

Keywords: terrestrial isopod assemblages, species diversity, clear-cut forest.

Rezumat. Comunităţi de izopode terestre din patru habitate din Dealurile Crasnei, nord-vestul României. Am studiat izopodele terestre din patru habitate (o pădure şi lizieră naturală, respectiv o lizieră şi o zonă deschisă rezultată în urma defrişării pădurii) din nord-vestul României, în anul 2009. Probele au fost prelevate lunar, din aprilie până în septembrie, folosind capcane de sol. Am identificat şapte specii de izopode terestre: *Hyloniscus riparius*, *H. transsilvanicus*, *Androniscus roseus*, *Protracheoniscus politus*, *Porcellium collicola*, *Trachelipus nodulosus*, *T. ratzeburgii*. În habitatele naturale, bogăţia şi diversitatea speciilor este mai mare decât în cele afectate antropic. Valoarea foarte redusă a echitabilităţii, respectiv mono-dominanţa speciei *T. nodulosus* în pajistea defrişată, se explică prin afectarea habitatului în trecut, datorită defrişărilor. Suprapunerea foarte mică a speciilor între habitatele naturale şi artificiale subliniază importanţa heterogenităţii habitatelor pentru diversitatea faunei de izopode terestre de pe o suprafaţă mai mare.

Cuvinte cheie: comunităţi de izopode terestre, diversitatea speciilor, defrişare.

INTRODUCTION

Terrestrial isopods are considered one of the most successful colonizers of a wide diversity of terrestrial habitats, by adapting morphologically, physiologically and behaviourally (see in: HORNUNG, 2011). They can be classified in various ecological categories in terms of their preferences towards the environment (RADU, 1983, 1985) or in terms of their adaptability to the extremes of the occupied habitat (TUF & TUFOVA, 2008). Knowing the ecological "affiliation" of different terrestrial isopod species allowed the possibility to evaluate the quality of the habitats (HORNUNG *et al*., 2009), because terrestrial isopods occupy a large variety of habitats even if those are affected by human activities (e.g. MAGURA *et al*., 2008). A human activity with negative consequences on biodiversity is clearing of forests (see in: ROZYLOWICZ *et al*., 2011). Exposure to the sun determines certain modification to the microclimate (TOMESCU *et al*., 1971), which in turn determines a lower abundance of micro-arthropods in clear-cut areas, especially in the xeric ones (ABBOTT & CROSSLEY, 1982). The variation of the composition of terrestrial isopod assemblages from different forest types and open areas was previously studied in Romania (e.g. TOMESCU, 2010; TOMESCU *et al*., 1995, 2000, 2001, 2002, 2005, 2011; IVANOV, 2011). However, these studies cover only a small part of the country, the problem of terrestrial isopod communities being very important, especially in the context of the massive clearings from Romania (ROZYLOWICZ *et al*., 2011). Thus, we set out to study the terrestrial isopods from woodland and clear-cut areas from north-western Romania in order to establish the differences between them.

MATERIAL AND METHODS

The study took place in 2009, in two localities (Săcăşeni and Sărăuad) from north-western Romania. They are situated in the southern part of Satu-Mare County, at the border between Crasna Hills and Tăşnad Plain (POSEA & BADEA, 1984). We studied the terrestrial isopod assemblages from four habitats, two in each locality. The first habitat at Săcăşeni (47º27`48.09``N/22º42`44.26``E, 228 m a.s.l.) is a dry grassland, with dense vegetation that has almost 100% coverage. The second habitat is an edge of an oak forest, with moderate humidity, and variable grassy vegetation, poorer than in the previous habitat. At Sărăuad (47º29`01.60``N/22º38`32.36``E, 152 m a.s.l.) the first habitat is again an edge of an oak forest, but with an even high humidity due to a stream that crosses by. The oak forest from Sărăuad is a wet woodland, with very little grassy vegetation, but with a very thick leaf litter covering the ground. The investigated habitats from Săcăşeni are areas where the forest was cut, so they present an indirect anthropogenic impact, while the habitats from Sărăuad are natural. The isopods were collected using pitfall traps. We analysed a total of 61 traps all along our study. The study period lasted from April to September, with the traps being emptied monthly, their content revealing the activity of terrestrial isopods from the previous month. At Sărăuad, the traps were disturbed in the last two months, probably by the people working the nearby agricultural fields. The species were determined using the

nowadays accepted nomenclature (SCHMALLFUSS, 2003) and scientific literature (e.g. RADU, 1983, 1985). We calculated various parameters in order to compare the influence of different habitats on terrestrial isopod assemblages. The quantitative parameters were the relative and numeric abundance. Among the qualitative parameters we can mention the frequency of some species in the traps during the whole study period, the diversity of the species (the Shannon-Wiever index) (SHANNON & WIEVER, 1949) and the similarity between the studied assemblages (the Jaccard index) (ZAR, 1999). We also analysed aspects of the biology of the species, like sex-ratio and the breeding period.

RESULTS

Totally we determined seven terrestrial isopod species belonging to different ecological categories, corresponding to the habitats they were found in. Thus, we identified: *Hyloniscus riparius* (KOCH, 1838) (paludicolous), *Hyloniscus transsilvanicus* (VERHOEFF, 1901) (paludicolous), *Androniscus roseus* (KOCH, 1838) (endogeic), *Protracheoniscus politus* (KOCH, 1841) (sylvan), *Porcellium collicola* (VERHOEFF, 1907) (praticolous), *Trachelipus nodulosus* (KOCH, 1838) (euritopic), *Trachelipus ratzeburgii* (BRANDT, 1833) (sylvan) (RADU, 1983, 1985). The species richness was different from one habitat to another, with no species being identified in all four habitats (Table 1). We identified a total number of 468 individuals. The average number of individuals captured per trap was 12.61 at Săcăşeni grassland and 6.65 at the forest edge, 5.8 at Sărăuad forest edge and 3.93 in the woodland respectively.

Table 1. Numeric abundance (a), relative abundance (A%) and the frequency (f%) of the species during the study period (H. rip-*H. riparius*, H. trans.-*H. transsilvanicus*, A. ros.-*A. roseus,* P. pol.-*P. politus*, P. coll.-*P. collicola*, T. nod.-*T. nodulosus*, T. ratz.-*T. ratzeburgii*).
Tabel 1. Abundenţa numerică (a), relativă (A%) şi frecvenţa (f%) speciilor de-a lungul studiului (H. rip – *H. riparius*, H. trans. – *H. transsilvanicus*, A. ros. – *A. roseus,* P. pol. – *P. politus*, P. coll. – *P. collicola*, T. nod. – *T. nodulosus*, T. ratz. – *T. ratzeburgii*).

Locality	Habitat type		H. rip.	H. trans.	A. ros.	P. pol.	P. coll.	T. nod.	T. ratz.
Săcăşeni	Grassland	a	-	-	-	-	-	227	-
		A%	-	-	-	-	-	100	-
		f%	-	-	-	-	-	100	-
	Forest edge	a	-	-	-	-	16	135	2
		A%	-	-	-	-	10.46	88.24	1.307
		f%	-	-	-	-	34.78	95.65	8.696
Sărăuad	Forest edge	a	-	24	3	-	2	-	-
		A%	-	82.76	10.34	-	6.897	-	-
		f%	-	75	50	-	25	-	-
	Oak forest	a	1	14	-	37	-	2	5
		A%	1.695	23.73	-	62.71	-	3.39	8.475
		f%	6.667	40	-	80	-	6.667	20

Differences can be observed, depending on the study period, among the numbers of identified individuals (Table 2). At Săcăşeni, the greatest abundance of individuals is in June and July, while at Sărăuad the maximum abundance was in the beginning of the study period for the forest edge, while for the oak woodland is distributed evenly among the first four study months (Table 2). The maximum richness and diversity of species is recorded in the oak forest (Table 2). The greatest differences in the composition of species are found between the Săcăşeni grassland and the Sărăuad forest edge, the Jaccard index being 0. They are followed by the forest edge and the woodland from Sărăuad (J=0.14), the grassland and the oak forest and the two forest edges, both with J=0.2. The most similar terrestrial isopod assemblages are found between the grassland and the forest edge from Săcăşeni and also between the Săcăşeni forest edge and the Sărăuad oak forest (J=0.33). The sex-ratio is female biased. Thus the males: females ratio is 1:1.58 at the Săcăşeni grassland, 1:1.85 at the Săcăşeni forest edge, 1.23:1 at the Sărăuad forest edge and 1:1.56 in the oak forest, respectively. The sex-ratio was only calculated for species with high relative abundance, being different in terms of each species. Male predominance was noted for *H. trassilvanicus* (1.23:1). Female predominance was obvious for *P. politus* (1:2.08) and *T. nodulosus* (1:1.67). Regarding the breeding period, females with marsupium appear in April-May-June for *H. transsilvanicus* and in June-July for *T. nodulosus* and *P. politus*.

Table 2. Numeric abundance (a) and relative abundance (A%) depending on the study period, the species richness (No. – number of species), evenness (H`) and diversity (H) in the four habitats.
Tabel 2. Abundenţa numerică (a) şi abundenţa relativă (A%) în funcţie de perioada studiului, bogăţia de specii (Nr. – numărul speciilor), echitabilitatea (H`) şi diversitatea (H) în cele patru habitate.

Locality	Habitat type		V	VI	VII	VIII	IX	X	No.	H`	H
Săcăşeni	Grassland	a	4	10	116	68	14	15	1	0	0.00
		A%	1.76	4.40	51.10	29.96	6.16	6.60			
	Forest edge	a	14	17	60	35	17	10	3	0.36	0.40
		A%	9.15	11.11	39.22	22.88	11.11	6.53			
Sărăuad	Forest edge	a	14	12	1	2	-	-	3	0.52	0.58
		A%	48.28	41.38	3.44	6.89	-	-			
	Oak forest	a	14	9	12	16	7	1	5	0.64	1.03
		A%	23.73	15.25	20.34	27.12	11.86	1.69			

DISCUSSIONS

The composition of terrestrial isopod assemblages from Crasna Hills reflects the main characteristics of their habitat. The fact that no species appears in all four habitats proves their heterogeneity in terms of environment conditions. The habitats can be separated in two categories: dry (the grassland and the forest edge from Săcăşeni) and with high humidity (the forest edge and oak woodland from Sărăuad). The overlap in species of the terrestrial isopod assemblages between the habitats is very small, the driest habitat and the wettest habitat having no species in common. Furthermore, the composition of species from open and afforested areas is very different.

T. nodulosus, a xerophilous species (FARKAS, 2010), prevails in the dry habitats, while at the Săcăşeni forest edge, the species' composition is completed by *P. collicola*, a praticolous species, and *T. ratzeburgii*, a sylvan species. In the wettest habitat – the forest edge from Sărăuad - *H. transsilvanicus*, a paludicolous species, prevails, while in the woodland, the typical sylvan species, *P. politus* is dominant. The presence of a species with low mobility such as *A. roseus* in traps raises interest. Many authors consider that pitfall traps are ideal for capturing species with high mobility (ARNDT & MATTERN, 2005; TOMESCU *et al*., 2008; MAGRINI *et al*., 2011), while in order to capture species with low mobility, it is recommended to use the direct capturing method (TOMESCU *et al*., 2008). *A. roseus* is rare in Romania (RADU, 1983), this being to our best knowledge the first mention of the species in Crasna Hills. Probably their capture was a chance, due to the placing of the traps in the close vicinity of this species microhabitat. In the past, *A. roseus* was identified near affected areas, appearing only sporadically (HORNUNG *et al*., 2007).

T. ratzeburgii is found at the edge of the forest from Săcăşeni, which is unusual, since this species is known to prefer dense deciduous forests (FARKAS & VILISICS, 2006). This forest edge was formed by cutting what used to be a part of the forest. So, being characteristic to the initial forest, *T. ratzeburgii* survived at this edge as well. *T. nodulosus*' presence in the oak forest from Sărăuad is surprising, even more since it was not identified at its edge. Generally, this species was identified in open areas (see in: FARKAS, 2010), like the grassland from Săcăşeni. Its absence from the forest edge from Săcăşeni, which is situated near a stream, is therefore natural. *T. nodulosus*' mono-dominance from the grassland from Săcăşeni can be explained through the origin of this open area, which used to be a forest that was clear-cut, and it was the only species that could survive in this sunny, dry grassland, as opposed to *T. ratzeburgii* which is found only at the edge of the forest.

The high diversity of terrestrial isopod species in the woodland is also indicated by the high evenness of the individuals from each species. It was previously noted that, in the case of other invertebrates, the key of a stable functionality of an ecosystem is high evenness of the individuals from each species (WITTEBOLLE *et al*., 2009). The net predominance of a species indicates a lower resistance of the community to environment stress conditions (WITTEBOLLE *et al*., 2009). The low diversity from other habitats can be caused to the impact brought upon them (previous clearing of the forest), just like is the case at Săcăşeni. The presence of only one species in the grassland from Săcăşeni is a consequence of the habitat's artificial and unfavourable character. In the case of isopods, it was observed before that by affecting the habitat, there is an immediate drop in species diversity simultaneously with a raise in abundance for the most common species (MOSS & HASSALL, 2006).

The higher the diversity and species richness is, the smaller the number of individuals per trap is. Taking into account that the structure of terrestrial isopod assemblages can indicate the environmental status (HORNUNG *et al*., 2009), we can assume that the higher the terrestrial isopod diversity in a relatively natural area, without synanthropic species, is, the richer the soil's macrofauna has to be. It was noted before that, if species are limited by multiple factors, the coexistence of more species is possible, while the heterogeneity of habitats favours species diversity (ALLESINA & LEVINE, 2011). In areas with harsh environmental conditions like the dry and affected grassland, the number of species is lower. This fact probably determined an expansion for *T. nodulosus*, its populations having a gregarious way of life (see in: FARKAS, 2010).

The breeding period for the species with high abundance overlaps the period in which they are most active (like June-July in the habitats where *T. nodulosus* and *P. politus* prevail, and April-June in the habitat where *H. transsilvanicus* prevails). This fact is probably correlated with the behaviour of the females with marsupium that search for shelter (DANGERFIELD & HASSALL, 1994).

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