

TERRESTRIAL ISOPODS (ISOPODA, ONSCIDEA) IN SEBIȘ TOWN, ARAD COUNTY (ROMANIA)

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Abstract. In the Sebiș town from Arad County, western Romania, we recorded 17 terrestrial isopod species. The study was made in the autumn of 2017, with the direct collecting method. The most common isopod in Sebiș is a species linked to open areas (*Trachelipus nodulosus*). The most favorable habitat type for terrestrial isopods in Sebiș town was the periurban area, presenting the highest species richness. This habitat type is less affected by human activities compared to the other habitat types, thus it shelters species both with restrictive and larger ecological demands. Unlike another town from the region, Sebiș town is bordered north by forests. Native, forest and wetland species are present especially in the periurban area, some of them being present exclusively here. However, some of these species are present occasionally in the industrial area, which is mostly abandoned and situated at the town's outskirts. The terrestrial isopod fauna from Sebiș underlines the importance of natural and forested areas close to the town, at least in the case of this group.

Keywords: localities, region, forests, surrounding areas, anthropogenic disturbance

Rezumat. Izopode terestre (Isopoda, Oniscidea) în orașul Sebiș, județul Arad (România). În orașul Sebiș din județul Arad, vestul României, am identificat 17 specii de izopode terestre. Studiul a fost realizat în toamna anului 2017, cu metoda de colectare directă. Specia de izopod cea mai comună în Sebiș a fost una de zone deschise (*Trachelipus nodulosus*). Cel mai favorabil tip de habitat pentru izopodele terestre din Sebiș a fost zona periurbană, prezentând cel mai mare număr de specii. Acest tip de habitat este mai puțin afectat de activitățile umane în comparație cu alte tipuri de habitate, adăpostind astfel atât specii cu cerințe ecologice mai restrictive cât și cu cerințe largi. Spre deosebire de un alt oraș din regiune, Sebiș se învecinează la nord cu păduri. Speciile native, de pădure și de zone umede, sunt prezente în special în zona periurbană, unele dintre acestea fiind prezente doar în aceasta. Totuși, anumite specii din această categorie ajung ocazional și în zona industrială, în mare parte abandonată și situată la periferia orașului. Fauna de izopode terestre din Sebiș demonstrează importanța existenței unor zone naturale, împădurite, la periferia orașelor, cel puțin pentru acest grup.

Cuvinte cheie: localități, regiune, păduri, zone învecinate, afectare antropică.

INTRODUCTION

Habitats which are partially affected by humans can be considered transition zones both for terrestrial isopods characteristic to natural zones and for species linked to affected areas (e.g. FERENȚI et al., 2013a,b). Thus, a higher diversity and abundance was observed in areas with an intermediate disturbance like suburban habitats, compared with more urbanized habitats or even natural ones (e.g. VILISICS et al., 2007). For terrestrial isopods, urban areas seem very diverse environments, which can offer optimal conditions both for non-native species, but also for natives linked to natural areas, and even for the endemic ones (GIURGINCA, 2006; GIURGINCA et al., 2017; VILISICS & HORNUNG, 2009; VILISICS et al., 2012). The isopod assemblages differ greatly between different regions of the same locality (e.g. JEĐRYCZKOWSKI, 1981; VILISICS & HORNUNG, 2009; LAZA et al., 2017), but also between localities situated in different regions (VILISICS et al., 2012; LAZA et al., 2017). The effect of urban areas and urbanization on fauna proved to be negative in numerous occasions (e.g. MCKINEY, 2008; FATTORINI, 2011; MARTINS et al., 2013; RAMÍREZ-RESTREPO & MACGREGOR-FORS, 2017). In Romania the studies upon terrestrial isopods in urban areas are limited to the capital (GIURGINCA, 2006; GIURGINCA et al., 2017) and some small towns from the western part of the country (BODIN et al., 2013; FERENȚI et al., 2015; HERLE et al., 2016; LAZA et al., 2017). The first three cited studies were made in Bihor County. In Arad County the only study was performed in the Pâncota town, where the isopod fauna was poor because of the past human impact, expressed mainly by deforestation (LAZA et al., 2017). Nevertheless, near the small stream from the town native forest species had survived, despite the lack of forests from surroundings (LAZA et al., 2017).

Sebiș is a town localized in Arad County, close to Pâncota, having approximately the same size, and located at the same altitude. The only major difference is the fact that Sebiș is presently bordered north with a forest. We supposed that this fact will make a difference, determining a richer urban terrestrial isopod fauna. Thus, we investigated the terrestrial isopods from Sebiș, having two main objectives: 1. comparing the terrestrial isopods composition from Sebiș with the isopods previously identified in Pâncota, and 2. identifying the habitats, which shelter the richest isopod fauna in Sebiș.

MATERIAL AND METHODS

The Sebiș town is situated in Arad County, western Romania, at an altitude of approximately 150 m, being an important urban center for the Crișul Alb valley (VELCEA et al., 1979). Its population was, according to the last population census from 2011, 5831 inhabitants (<http://www.recensamanromania.ro/rezultate-2>). The town is located in

the Zărand Depression, on the southern flank of the Codru-Moma Mountains (MÂNDRUȚ, 2006). The region looks like a bay of the Crișuri Plain insinuated along the Crișul Alb River (MÂNDRUȚ, 2006), with a plain relief in the southern part of the locality. The north-eastern region of the town is bordered by a, mainly oak, forest, but some black locust plantations are also present here. There are also agricultural fields and grasslands, which surround the locality especially at its southern part. In the northern part of the town there are two artificial ponds. The town is crossed from east to west by the Moneasa River, which is a tributary of the Crișul Alb River (UJVÁRI, 1972). In the northern part of the town there are some small streams, surrounded by willows.

Sebiș hosts numerous traditional old buildings with green spaces and wide streets with trees. The downtown contains zones with crowded, multistory new blocks, without green spaces, but with wood storages. The town is crossed by numerous asphalted roads. Two small parks are located in the downtown. A cemetery and also some, mostly abandoned, industrial areas are situated in the northern and western parts of the town.

The samples were taken on October 7, 2017. We collected samples from 39 sampling points. They were classified in five habitat types: old buildings, parks, industrial zones, new buildings and periurban area. Isopods were collected directly by hand as well as in other urban studies (FERENȚI et al., 2015; LAZA et al., 2017), from under different shelters, debris, from the humid soil near wet areas. At each location we spent approximately 20 minutes. The isopods were conserved in test tubes with alcohol, separating in different test tubes the smaller fragile species from the larger ones. The species were identified in the laboratory, using the scientific literature (e.g. RADU, 1983, 1985). The data was analyzed both for the total and for the five habitat types. We calculated the percentage abundance and frequency of occurrence for each species. The other parameters were calculated using PAST (HAMMER et al., 2001). The species affinity to different habitat types taking into account their abundance was estimated by the correspondence analysis. The similarity between the assemblages from different habitat types was estimated by the Jaccard index, and the species diversity with the Shannon-Wiener index (SHANNON & WIEVER, 1949). With the Mann-Whitney test we estimated the significance of the differences between the terrestrial isopod assemblages from different habitat types.

RESULTS

In the Sebiș town we collected 318 individuals belonging to 17 terrestrial isopod species: *Trichoniscus steinboeckii* Verhoeff, 1931, *T. crassipes* Verhoeff, 1908, *Hyloniscus riparius* (C. Koch, 1838), *Haplophthalmus danicus* Budde-Lund, 1880, *H. mengii* (Zaddach, 1844), *Platyarthrus hoffmannseggii* Brandt, 1833, *Cylisticus convexus* (De Geer, 1778), *Porcellionides pruinosus* (Brandt, 1833), *Protracheoniscus politus* (C. Koch, 1841), *Trachelipus arcuatus* (Budde-Lund, 1885), *T. nodulosus* (C. Koch, 1838), *T. rathkii* (Brandt, 1833), *Porcellium collicola* (Verhoeff, 1907), *Porcellio scaber* Latreille, 1804, *P. spinicornis* Say 1818, *Armadillidium vulgare* (Latreille, 1804) and *A. versicolor* Stein, 1859. The most commonly encountered species was *T. nodulosus*, which was identified in 76.90 % of the sampling points, being also the most abundant species (125 individuals). This was followed by *A. versicolor*, both by percentage abundance and frequency of occurrence (Table 1). The third place, by both parameters, was occupied by *H. riparius*. *T. steinboeckii*, *T. crassipes* and *P. collicola* were represented by the lowest number of individuals (one individual each). The highest number of species / sample was six, registered twice. In seven sampling points we found only one species.

Table 1. The percentage abundance (P%), frequency of occurrence (f%), species richness (S) and diversity (H) from Sebiș town.

Species	Total		Old buildings		Parks		Industrial area		New buildings		Periurban area	
	P%	f%	P%	f%	P%	f%	P%	f%	P%	f%	P%	f%
1. <i>Trichoniscus steinboeckii</i>	0.31	2.56	-	-	-	-	-	-	-	-	0.96	10.00
2. <i>Trichoniscus crassipes</i>	0.31	2.56	-	-	-	-	-	-	-	-	0.96	10.00
3. <i>Hyloniscus riparius</i>	8.81	17.90	-	-	-	-	14.28	25.00	6.66	16.66	15.38	40.00
4. <i>Haplophthalmus danicus</i>	4.09	10.30	2.29	8.33	-	-	-	-	17.77	33.33	2.88	10.00
5. <i>Haplophthalmus mengii</i>	1.26	2.56	-	-	-	-	-	-	-	-	3.84	10.00
6. <i>Platyarthrus hoffmannseggii</i>	1.89	7.69	-	-	21.05	33.33	-	-	2.22	16.66	0.96	10.00
7. <i>Cylisticus convexus</i>	6.60	20.50	-	-	-	-	9.52	37.50	33.33	83.33	-	-
8. <i>Porcellionides pruinosus</i>	0.94	7.69	1.14	8.33	-	-	1.58	12.50	2.22	16.66	-	-
9. <i>Protracheoniscus politus</i>	4.40	7.69	-	-	-	-	1.58	12.50	-	-	12.50	20.00
10. <i>Trachelipus arcuatus</i>	0.63	5.13	-	-	-	-	1.58	12.50	-	-	0.96	10.00
11. <i>Trachelipus nodulosus</i>	39.30	76.90	56.32	91.66	47.36	100	52.38	87.50	26.66	66.66	21.15	50.00
12. <i>Trachelipus rathkii</i>	3.14	15.40	5.74	25.00	-	-	-	-	-	-	4.80	30.00
13. <i>Porcellium collicola</i>	0.31	2.56	-	-	-	-	-	-	2.22	16.66	-	-
14. <i>Porcellio scaber</i>	3.46	17.90	6.89	16.66	10.52	66.66	1.58	12.50	4.44	33.33	-	-
15. <i>Porcellio spinicornis</i>	0.63	2.56	-	-	10.52	33.33	-	-	-	-	-	-
16. <i>Armadillidium vulgare</i>	4.40	23.10	3.44	16.66	10.52	33.33	6.34	37.50	2.22	16.66	3.84	20.00
17. <i>Armadillidium versicolor</i>	19.50	41.00	24.13	50.00	-	-	11.11	50.00	2.22	16.66	31.73	50.00
S	17		7		5		9		10		12	
H	2.00		1.26		1.39		1.52		1.76		1.91	

The terrestrial isopod species` diversity from Sebiș was $H=2.00$. In terms of habitat types, the highest species diversity was registered in the periurban area, followed by new buildings, industrial area, parks and old buildings (Table 1). The differences between the assemblages of terrestrial isopod species from different habitat types, according to the Mann-Whitney index, were not significant ($p>0.05$). According to the correspondence analysis, *P. spinicornis* and *P. hoffmannseggii* showed affinity for parks, but *P. collicola*, *C. convexus*, *H. danicus* and *P. pruinosus* for new buildings (Fig. 1a). According to the Jaccard index, the most accentuated overlap is registered between the assemblages from new buildings and industrial areas, the most distinct assemblage being found in parks (Fig. 1b).

The differences between the five habitat types from Sebiș town were obvious. The highest species number (12) was registered in the periurban area, the lowest number (5) being present in public parks. Also, there was a variation of the species richness, diversity, percentage abundance and frequency of occurrence of the species from different habitat types (Table 1). The two *Trichoniscus* species were present only in the periurban zone, while *P. spinicornis* was found exclusively in parks. *T. nodulosus* was the best represented species in almost all habitat types, with the exception of the periurban area (where *A. versicolor* had higher percentage abundance) and new buildings (where *C. convexus* was on the top).

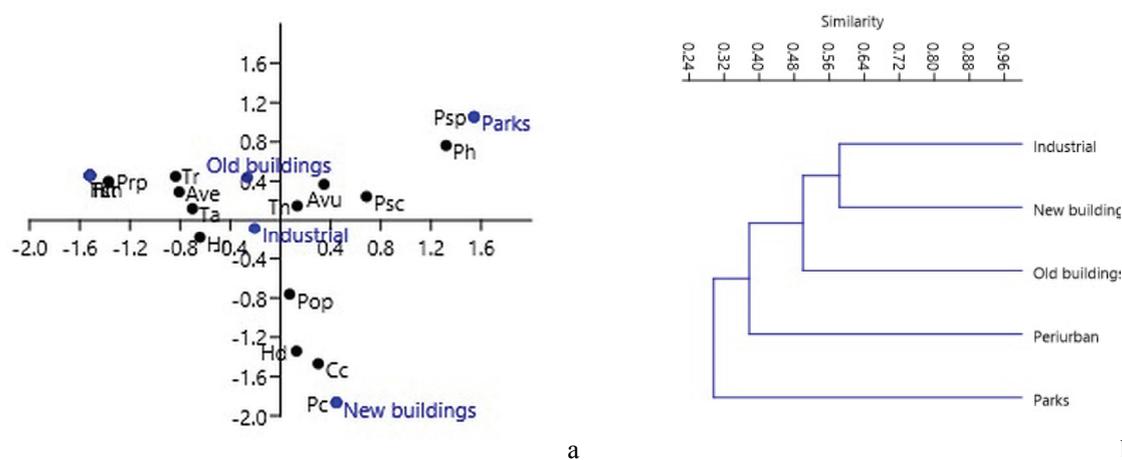


Figure 1. (a) Correspondence analysis between isopod species and habitat types and (b) the Jaccard similarity between the isopod assemblages found in different habitat types.

DISCUSSIONS

The 17 terrestrial isopod species identified in Sebiș town confirmed the hypothesis of this study, Sebiș having a richer fauna than Pâncota town from the same region (LAZA et al., 2017). Moreover, in Sebiș town the species number is higher than in other towns from north-western Romania (BODIN et al., 2013; FERENȚI et al., 2015; HERLE et al., 2016). Also, the species richness from this small town is equal with the one present in the parks of Bucharest, the capital of Romania (GIURGINCA et al., 2017). This species richness is mainly caused by the periurban areas, where the highest species number and diversity was registered. This confirms the importance of some natural zones in the town's vicinity for the isopod assemblages from the town (HERLE et al., 2016). The more natural the zones close to the town are, the richer the terrestrial isopod assemblages will be. Thus, urbanization will reduce a fauna which was richer from the beginning. The existence of natural forested zones near towns and the management of the green spaces as natural as possible proved to be beneficial for the biodiversity (MÜLLER et al., 2018).

The differences between the two towns are expressed mainly by the higher abundance of the native fauna in the town surrounded with forest compared to the other without forest (LAZA et al., 2017), and do not necessarily imply the presence of some additional native species. Practically, the Sebiș town, having more natural forests in surroundings, preserves in many points species linked to natural forested areas, points, which are strictly localised in Pâncota (LAZA et al., 2017). Taking into account that the individuals from the *Trichoniscus* genus in Pâncota, being females, could not be determined (LAZA et al., 2017), it is hard to say whether the two species of this genus found in Sebiș are additional species or not. Anyway, *T. steinboecki* and *T. crassipes*, are novelty, they not being mentioned until now in the urban areas of western Romania (BODIN et al., 2013; HERLE et al., 2016; LAZA et al., 2017). Both species were collected from the periurban zone, fact which can indicate their native character in the region. *T. crassipes* was collected on humid soil near the pond from the quarry, while *T. steinboecki* was collected under debris from the humid soil on the bank of a small stream. *T. steinboecki* is a species considered characteristic to humid zones from deciduous forests (FARKAS & VILISICS, 2008). SCHMALFUSS (2003) had restricted the distribution of these two species to southeastern and eastern Austria, but afterwards they were found in Hungary (VILISICS, 2007). Both are considered to be rare species, which live in natural habitats, wet areas from mountain zones (HORNUNG et al., 2009), but VILISICS (2007) suggests that *T. steinboecki* could be a common species, since it was identified in numerous humid zones in Transdanubia. This species was also found in a forest from Croatia (FARKAS & VILISICS, 2008). In Sebiș, *T. steinboecki* was collected together with *H. riparius*, *H. danicus*, *H. mengii*, known for their

affinity with humidity (e.g. RADU, 1983; WIJNHOFEN, 2000; FERENȚI & COVACIU-MARCOV, 2016) and *P. hoffmannseggii*, a myrmecophilous species (RADU, 1985). *T. crassipes* was found in Sebiș in the same microhabitat as *H. riparius* and *A. versicolor*.

Another additional species in Sebiș compared to Pâncota (LAZA et al., 2017) is *T. rathkii*, which is a eurytopic species, being widespread in Romania (e.g. TOMESCU et al., 2015), and very common in other urban areas (e.g. VILISICS & HORNUNG, 2009; ȘATKAUSKIENĖ et al., 2015; HORNUNG et al., 2015). *P. scaber* and *P. spinicornis* are also well represented species in localities from Romania (e.g. BODIN et al., 2013; FERENȚI et al., 2015). *P. scaber*, while being frequently mentioned in towns (e.g. JEȚDRYCZKOWSKI, 1981; VILISICS & HORNUNG, 2009; VILISICS et al., 2012; ȘATKAUSKIENĖ et al., 2015), is missing from Pâncota (LAZA et al., 2017). Its identification in many samples from Sebiș confirms the fact that its absence from Pâncota was incidental. More precisely, the species was introduced by chance in town by urbanization, and sometimes, by the same chance, it was not introduced (LAZA et al., 2017). An additional confirmation of this fact is that in Sebiș this species was not found in the periurban area, being clearly linked to urbanization, confirming the affirmation that urban pressure increase leads to the increase of cosmopolitan species' abundance (JEȚDRYCZKOWSKI, 1981).

The differences between the isopod assemblages from different town parts were determined by the surface of the habitats from them, by their link to periurban or natural zones and by the disturbance level. The lowest species number was registered in parks, habitats which also in other towns sheltered few species (e.g. FERENȚI et al., 2015). Unlike these, big cities have a high number of species in parks (e.g. JEȚDRYCZKOWSKI, 1981; VILISICS & HORNUNG, 2009; GIURGINCA et al., 2017). In the case of Sebiș, these two small parks have no humid zones and are completely isolated in the downtown, similar to other small towns (FERENȚI et al., 2015). Thus the few species present here are common and synanthropic. On the contrary, in big cities the parks are large, with diverse humid habitats, offering appropriate conditions for a high number of species (e.g. JEȚDRYCZKOWSKI, 1981; VILISICS & HORNUNG, 2009; GIURGINCA et al., 2017). The small parks from Sebiș are not remnants of the initial natural habitats, but they are recent arrangements situated in an already disturbed area. In Sebiș town even industrial zones shelter more species than parks.

In the Sebiș town, the identified isopods are mostly native, characteristic for the region and expected in the region. Unlike other cities (e.g. VILISICS & HORNUNG, 2009; VILISICS et al., 2012; FERENȚI et al., 2015), non-native, invasive or recently introduced species do not exist in Sebiș. This fact is probably a consequence of the reduced anthropogenic impact upon the region, many species being introduced passively by human (COCHARD et al., 2010), and their spreading is facilitated by anthropogenic activities, like highway networks (VONA-TÚRI et al., 2017). However, in Sebiș synanthropic species are also present, which are typical for towns, and were also reported in towns from northwestern Romania (FERENȚI et al., 2015; HERLE et al., 2016; LAZA et al., 2017). Terrestrial isopod species in Sebiș are distributed according to their previously known ecological demands (RADU, 1983, 1985; TOMESCU et al., 2011, 2015, 2016). Species linked to natural zones are present in the periurban zone and synanthropic ones are more numerous where the anthropogenic disturbance level is higher. Unlike Pâncota, species linked to natural forested areas are better represented; both *P. politus* and *T. arcuatus* are well represented in many sampling points, especially in the periurban area. However, both species were also present in the industrial zone, which is situated at the town's outskirts, and after some decades of functioning it is mostly abandoned now. In the past, they were also reported outside forests in wet areas (e.g. FERENȚI & DIMANCEA, 2012; LAZA et al., 2017), but in Sebiș they can survive in the former industrial zones situated near forests. However, some species linked to natural humid zones are present in the downtown, even in the newly constructed neighborhoods. For example, *H. danicus*, which was frequently observed in natural, humid zones (e.g. GIURGINCA, 2006; CICORT-LUCACIU & SUCEA, 2015; FERENȚI et al., 2015), is advantaged by these new buildings because of the wood storages, under which they were found. This species is considered to be adapted to decomposed logs (RADU, 1983). Probably, in the past *H. danicus* was present along the Moneasa River, which flows near this town part, nowadays it being regularized and dammed.

In Sebiș, *T. nodulosus* has the highest percentage abundance and frequency of occurrence, as well as in other towns surrounding Sebiș: Pâncota (LAZA et al., 2017) and Salonta (FERENȚI et al., 2015). All three towns are situated in or at the limit of plain areas, and *T. nodulosus* is considered characteristic for plain and xeric zones with herbaceous vegetation (e.g. FARKAS, 2010; TOMESCU et al., 2015). In the intermountain depression areas from western Romania, *T. nodulosus* is not the most common species, even if it is present in the town (HERLE et al., 2016). Also, *T. nodulosus* lacks from other towns, like some from Switzerland, Zurich, Lucerne, Lugano (VILISICS et al., 2012), which are probably situated outside the species' distribution range (SCHMALFUSS, 2003).

The terrestrial isopods from Sebiș confirm our suggestion based on the isopod assemblages from Pâncota town, from the same region (LAZA et al., 2017). Because of the more surrounding forests, the town shelters larger populations of native species, linked to forested or humid areas. In the same time, the lack of some synanthropic species from some towns is probably accidental. The more natural periurban zones near Sebiș permit the survival of a large number of species. Sebiș has a rich terrestrial isopod fauna because of the surrounding natural areas and the reduced anthropogenic pressure.

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