TERRESTRIAL ISOPODS IN A SMALL TOWN IN WESTERN ROMANIA (PÂNCOTA, ARAD COUNTY): WITNESSES OF THE PAST HUMAN IMPACT OF THE REGION?

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Abstract. In Pâncota town from western Romania (Arad County) we identified 13 terrestrial isopod species, the most common being *Trachelipus nodulosus*. The species number registered in Pâncota was lower than in other towns which borders with forests, but was higher than in a previously studied town surrounded by agricultural areas in western Romania. Some species common in other towns from western Romania are not present in Pâncota. Most of the identified species are native, common and generalists. Nevertheless, the wet areas situated in the town and its surroundings are populated by species with narrow ecological demands, even forest species. They probably survived in the wet areas following the deforestations of the region. In Pâncota, there are less non-native species than in other towns from the Western Romanian Plain.

Keywords: plain, wet areas, forests, common species, urban area.

Rezumat. Izopodele terestre dintr-un oraş mic din vestul României (Pâncota, judeţul Arad): martorii impactului antropic al regiunii din trecut? În oraşul Pâncota din vestul României (judeţul Arad) am identificat 13 specii de izopode terestre, cea mai comună fiind *Trachelipus nodulosus*. Numărul de specii din Pâncota a fost mai mic decât în alte oraşe, care sunt înconjurate cu păduri, dar a fost mai mare decât într-un oraş înconjurat de terenuri agricole, studiat anterior în vestul României. Specii comune în alte oraşe din vestul României lipsesc din Pâncota. Majoritatea speciilor identificate sunt native, comune şi generaliste. Cu toate acestea, zonele umede situate în oraş şi în apropiere sunt populate de specii cu cerinţe ecologice înguste, chiar specii de pădure. Acestea probabil au supravieţuit în zonele umede după defrişările din regiune. În Pâncota sunt prezente mai puţine specii non-native decât în alte oraşe din Câmpia de Vest.

Cuvinte cheie: câmpie, zone umede, păduri, specii comune, zonă urbană.

INTRODUCTION

In Romania, over 80 terrestrial isopod species were confirmed to be present (e.g. RADU, 1983, 1985; TĂBĂCARU & GIURGINCA, 2013). Nevertheless, most of them populate natural areas, even restrictive habitats, having narrow habitat requirements, some being endemic or cave species (e.g. RADU 1983, 1985, TĂBĂCARU & GIURGINCA, 2013; TOMESCU et al., 2015). On the contrary, in human affected, and especially in urban areas, the species number is reduced (BODIN et al., 2013; FERENȚI et al., 2015; HERLE et al., 2016). Even more, there are obvious differences between towns surrounded by relatively natural habitats and towns surrounded by human affected, like agricultural, areas; until now, the smallest species number in the country was registered in a plain town surrounded by agricultural areas (FERENȚI et al., 2015). The species number and composition in urban areas seem to be influenced also by the geographic location (VILISICS et al., 2012). In the last years, in western Romania, some studies upon urban terrestrial isopods were performed with the direct collecting method (BODIN et al., 2013; FERENȚI et al., 2015; HERLE et al., 2016), and revealed the poverty of the isopod fauna once with the degradation of the areas surrounding the town (FERENȚI et al., 2015). Moreover, natural areas near towns, even in the industrialized ones, determined the isopod fauna recovery (HERLE et al., 2016). Taking into account this strong influence of the surroundings upon the urban fauna, we supposed that if a plain town is in contact with natural areas, the isopod fauna will be richer than in a town exclusively surrounded by flat plains exploited for agriculture. To test this hypothesis we chose Pâncota, a town that borders in three parts with flat agricultural plains, but in one side it is in contact with the lower limit of the first hills. As Pâncota is also situated in western Romania and we also used the direct collecting method, the results are comparable with the previous studies (BODIN et al., 2013; FERENȚI et al., 2015; HERLE et al., 2016). Our objectives were the following: **1.** to establish the terrestrial isopod species at Pâncota, **2.** to identify the differences between the isopod fauna from different habitat types in the town.

MATERIAL AND METHODS

Pâncota is a small town situated in the central-western part of Arad County, at the contact between the Lower Crișuri Plain and Zărand Hills (POSEA & BADEA, 1984). According to the last population census from 2011, the town has 6946 inhabitants (http://www.recensamantromania.ro/rezultate-2/), a decreasing population, like in Arad County generally (VERT & ANCUȚA, 2011). In its southern, northern and western parts, the town borders with flat pain areas, used for cereal cultivation, but also vegetables in the northern region (OKROS et al., 2015). Only in the eastern part the aspect is different, the town bordering with the first heights of Zărand Hills, which are mostly used as vineyards, characteristic for this region (e.g. GRECU, 2008; MĂLĂESCU et al., 2014). Even if the landscape is agriculturally modified, zones with shrubs or grasslands are still present. The town is crossed by a small stream which springs from the south-eastern high areas. In the town, the

stream is heavily polluted, mostly arranged and drained. At the western limit of the town, there are some larger ponds. The town is crossed by a main and some secondary driveways from north to south, with many perpendicular branches. Pâncota contains mostly traditional houses and streets with green spaces. There are only few residential blocks and some massive old official buildings. The industrial activity in the town is reduced. The fieldwork was conducted on March 8, 2017. We collected 33 samples from 24 collecting points, because the large and small sized isopods were separated in different tubes. Isopods were captured directly by hand from under different shelters, as well as in other studies in Romania (e.g. HERLE et al., 2016). As in the previous cases, at each sampling point, we spent approximately 20 minutes. Isopods were found generally under debris and more rarely in the humid soil near wetlands. The sampled individuals were conserved in test tubes with alcohol; the species were determined in the laboratory. By the sampling points we tried to cover relatively uniformly the entire surface of the town, collecting from its most representative zones (both downtown and outskirts). The 24 sampling points matched with 6 habitat types: grasslands, wetlands, abandoned buildings, houses from the centre, houses from the town edge, public zones. The obtained data were analyzed both for the total and for the habitat types. We calculated the percentage abundance and frequency of occurrence for each species. We also calculated the percentage abundance for the individuals from each collecting point. These two parameters were given for habitat types too. The similarity of species was estimated by Jaccard and Bray-Curtis indexes, the species diversity by the Shannon-Wiever index. The affinity of the species to different habitat types was estimated by the Principal Component Analysis (PCA). The significance of the differences between the species composition of different habitat types was tested by the Kruskal-Wallis (for all habitat types) and Mann-Whitney (for habitat type pairs) indexes. All calculations were realized with the PAST 3x software (HAMMER et al., 2001).

RESULTS

In Pâncota town, we found 233 individuals belonging to 13 terrestrial isopod species: *Trichoniscus sp*., *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), *Porcellium collicola* (Verhoeff, 1907), *Trachelipus arcuatus* (Budde-Lund, 1885), *T. nodulosus* (C. Koch, 1838), *Armadillidium versicolor* Stein, 1859 and *A. vulgare* (Latreille, 1804). *Trichoniscus* sp. could not be determined to species level, because we found only 9 females. *T. nodulosus* had the highest percentage abundance. It was followed by *H. riparius* and *A. vulgare* (Table 1). Regarding the frequency of occurrence, the top is occupied by *T. nodulosus*, identified in 91.66% of the collecting points from Pâncota. *T. nodulosus* was followed in frequency by *A. vulgare*, and then by *H. riparius* and *P. pruinosus* (Table 1). In three sampling points, we identified only one species. The maximum number of species / sampling point was seven, registered in only one collecting point. In 10 sampling points, we identified two terrestrial isopod species (Table 1). In Pâncota town, the diversity of terrestrial isopod assemblages was H=1.84.

Table 1. The distribution of the terrestrial isopod species in the sampling points in Pâncota town (N - number of species, P% - percentage abundance, f% - frequency of occurrence, Tri – *Trichoniscus* sp., Hr – *H. riparius*, Hd – *H. danicus*, Hm – *H. mengii*, Ph – *P. hoffmannseggii*, Cc – *C. convexus*, Ppr – *P. pruinosus*, Ppo – *P. politus*, Pco – *P. collicola*, Ta – *T. arcuatus*, Tn – *T. nodulosus*, Ave – *A. versicolor*, Avu – *A. vulgare*).

	Tri	**Hr**	**Hd**	**Hm**	**Ph**	**Cc**	**Ppr**	**Ppo**	**Pco**	**Ta**	**Tn**	**Ave**	**Avu**	**N**	**P%**
1. Park, high school	-	-	-	-	-	-	-	-	-	-	X	-	-	1	2.57
2. Stream bank, northern town	X	X	-	-	-	X	-	X	-	-	X	-	X	6	6.43
3. Park, town hall	-	-	-	-	-	-	-	-	-	-	X	-	X	2	4.72
4. Stream bank, eastern town	X	X	X	X	-	-	-	-	-	-	-	-	-	4	5.15
5. Houses, near railway station	-	-	-	-	-	-	-	-	-	-	X	-	X	2	3.00
6. Stream bank, centre	-	-	-	-	-	-	-	-	-	X	X	X	-	3	3.43
7. Houses, eastern town	-	-	-	-	-	-	-	-	-	-	X	-	X	2	1.28
8. Houses/pasture, eastern town limit	-	-	-	-	X	-	-	-	-	-	X	-	-	2	1.71
9. Narrow gauge railway station	-	-	-	-	-	-	X	-	-	-	X	-	-	2	2.57
10. Abandoned storehouse, town centre	-	-	-	-	-	-	X	-	-	-	X	-	X	3	2.14
11. Houses/grassland, eastern town limit	-	-	-	-	-	X	-	-	-	-	X	-	-	2	3.00
12. Old abandoned house, northern town	-	X	-	-	-	X	X	-	-	-	X	-	X	5	3.43
13. Large street with old houses	-	-	-	-	-	-	-	-	-	-	X	-	-	1	1.28
14. Cellar entrance, eastern town	-	-	X	-	-	-	-	-	-	-	-	-	-	1	2.57
15. Houses, northern town	-	-	-	-	-	-	X	-	-	-	X	X	X	4	5.57
16. Houses, to the railway station	-	-	-	-	X	-	-	-	-	-	X	-	X	3	5.15
17. Pond, railway station	-	X	-	-	-	-	-	-	X	-	X	-	X	4	18.88
18. Green space, gas station	-	-		-	-	-	-	-	-	-	X	-	X	2	2.14
19. Graveyard, eastern town	-	-	-	-	X	-	-	-	-	-	X	-	X	3	3.86
20. Houses, northern town limit	X	X	-	X	-	X	X	-	-	-	X	-	X	7	6.00
21. New block residential area	-	-	-	-	-	-	-	-	-	-	X	-	X	2	7.29
22. Green space, centre	-	-	-	-	-	-	-	-	-	-	X	-	X	2	3.43
23. Abandoned factory, railway station	-	X	-	-	-	-	X	-	-	-	X	-	X	4	2.57
24. Abandoned railway station	-	-	-	-	-	-	-	-	-	-	X	-	X	2	1.71
P%	3.86	20.60	3.86	1.28	3.86	5.15	2.57	0.42	2.57	0.42	39.05	0.85	15.45		
f%	12.50	25.00	8.33	8.33	12.50	16.66	25.00	4.16	4.16	4.16	91.66	8.33	66.66		

Grasslands presented the lowest species number and the public zones the fewest individuals. Humid zones registered the highest species and individual number (Table 2). The most frequent species were *T. nodulosus* and *A. vulgare*, they being present in all 6 habitat types (Table 2). The species *P. politus*, *T. arcuatus* and *P. collicola* were present in only one habitat type, near wetlands (Table 2). According to the Jaccard index, the most resembling isopod assemblages were found in the central house areas and public zones (J=0.8), but grasslands and wetlands presented the most different species composition (J=0.18) (Fig. 1a). Likewise by the Bray-Curtis similarity, the most distinct assemblage was sheltered by wetlands and the closest by central house areas and grasslands (BC=0.06) (Fig. 1b). According to PCA analysis *H. riparius* showed affinity towards wetlands; *A. vulgare* and *T. nodulosus* seem to prefer the central houses area (Fig. 2).

According to Kruskal-Wallis index, there were significant differences between the isopods from different habitat types from Pâncota (p=0.020). Analyzing the differences between the habitat type pairs with the Mann-Whitney index, these were significant only in some cases. Thus, significant differences were registered between grasslands and wetlands (p=0.004), grasslands and houses from the town edge (p=0.025), and wetlands and public zones (p=0.011).

Table 2. Terrestrial isopod species distribution in different habitat types in Pâncota town (N - number of species, P% - percentage abundance, f% - frequency of occurrence, Tri – *Trichoniscus* sp., Hr – *H. riparius*, Hd – *H. danicus*, Hm – *H. mengii*, Ph – *P. hoffmannseggii*, Cc – *C. convexus*, Ppr – *P. pruinosus*, Ppo – *P. politus*, Pco – *P. collicola*, Ta – *T. arcuatus*, Tn – *T. nodulosus*, Ave – *A. versicolor*, Avu – *A. vulgare*).

Habitats	**Tri**	**Hr**	**Hd**	**Hm**	**Ph**	**Cc**	**Ppr**	**Ppo**	**Pco**	**Ta**	**Tn**	**Ave**	**Avu**	**N**	**P%**
1. Grasslands											x		x	2	12.88
2. Wetlands	x	x	x	x		x		x	x	x	x	x	x	11	33.91
3. Abandoned buildings		x				x	x				x		x	5	8.15
4. Houses, town centre					x		x				x	x	x	5	21.03
5. Houses, town edge	x	x	x	x	x	x	x				x		x	9	15.88
6. Public zones					x		x				x		x	4	8.15
f%	33.33	50.00	33.33	33.33	50.00	50.00	66.67	16.67	16.67	16.67	100	33.33	100		

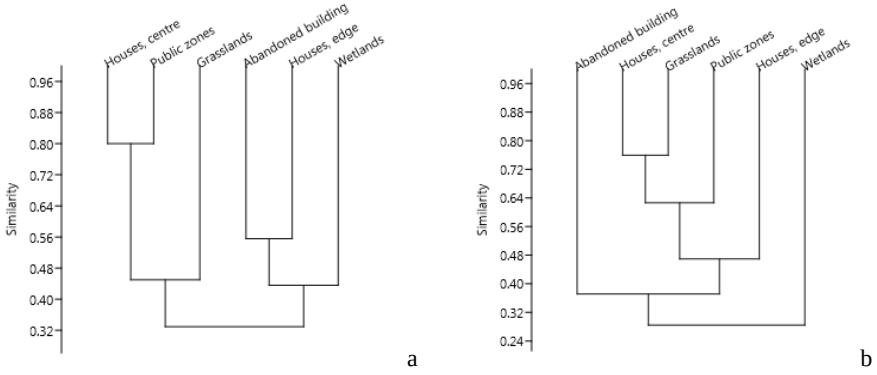

Figure 1. The Jaccard (a) and Bray-Curtis (b) similarity of the species from different habitat types.

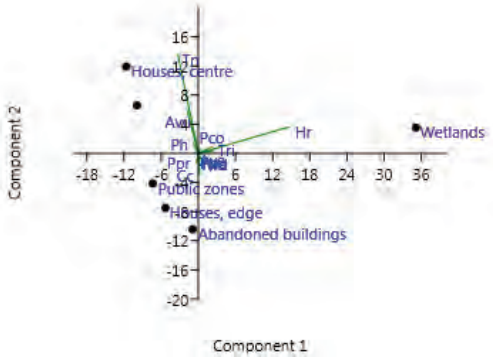

Figure 2. Principal component analysis (PCA) biplot between habitat types and species.

DISCUSSIONS

The presence of the 13 terrestrial isopod species identified in Pâncota is not surprising in the context of their ecological requirements and distribution pattern in Romania (RADU, 1983, 1985; TOMESCU et al., 2011). The number of the identified species in Pâncota is situated between the one registered in Romanian urban areas surrounded by

relatively natural, humid and forested habitats (BODIN et al., 2013; HERLE et al., 2016) and the one situated on plain (Salonta) surrounded by agricultural areas without forests, where only 11 terrestrial isopod species were identified (FERENȚI et al., 2015). Thus, the presence of the additional two species is a consequence of the fact that Pâncota is neighbored partially by a hilly area. Also, it can be attributed to the presence of some permanent wetlands, even if, as well as in Salonta (FERENȚI et al., 2015), the town is surrounded mostly by agricultural areas. Most of the sampling points presented only few species, the remaining species being added by the wetland areas sampling points, especially at the eastern limit of the town, situated in contact with the hilly area.

The isopods identified only in Pâncota, which were not previously found in Salonta, are native, generally linked to wetland and forested areas. The presence of *P. politus*, a typical sylvan species (RADU, 1985; TOMESCU et al., 2011, 2016), is unusual in a locality without forests. *P. politus* was previously identified in urban areas surrounded by forests, but only inside forests (e.g. VILISICS & HORNUNG, 2009; HERLE et al., 2016). However, the species was sometimes observed in disturbed sylvan habitats, like plantations (FARKAS et al., 2013; IANC & FERENȚI, 2014). At Pâncota, *P. politus* was identified on the bank of a small permanent stream, surrounded by willows and shrubs, situated at the eastern part of the town, with higher relief. Probably in the recent past, there were forests near Pâncota. Crişuri Plain was covered by forests in the past, which were clear cut (BERINDEI et al. 1977). The species survived these clearings in the immediate vicinity of the stream, a zone which is still surrounded by shrubbery, like in other cases (TOMESCU et al., 2010). The same explanation was given in the case of the presence of sylvan species in open wetland areas, in north-western Romania (TOMESCU et al., 2010; FERENȚI & DIMANCEA, 2012). This is the case of *T. arcuatus*, which is rare in urban habitats (BODIN et al., 2013; HERLE et al., 2016) and is considered a forest species (e.g. TOMESCU et al., 2015). At Pâncota, *T. arcuatus* was found on the bank of the same stream, the explanation of its presence being the same as in the case of *P. politus* or the other areas of northwestern Romania. Both species are survivors of the past forests, which were replaced by vineyards; at some kilometers distance from Pâncota, there are forests in the hilly area. Other isopods, considered characteristic for mountain forested habitats, were previously identified in humid zones without forests, where they were considered relict species (FERENȚI & COVACIU-MARCOV, 2014).

If the isopod species present in Pâncota were generally expectable, in our case the absence of some species is more curious. Firstly, this is the case of *Porcellio scaber* Latreille, 1804, a common species in other urban areas of Romania (e.g. BODIN et al., 2013; HERLE et al., 2016) or other countries (e.g. JĘDRYCZKOWSKI, 1981; VILISICS & HORNUNG, 2009; VILISICS et al., 2012; PRECIADO & MARTINEZ, 2014). *P. scaber* is a synanthropic species (RADU, 1985), which was introduced in many places over the world (e.g. SCHMALFUSS, 2003; PARKER & MINOR, 2015). For all that, in Pâncota we did not identify any individual of this species, even if it was mentioned in urban areas from the northernmost Europe (JĘDRYCZKOWSKI, 1981; VILISICS & TERHIVUO, 2009; ŠATKAUSKIENĖ et al., 2016), thus zones with harsher environmental conditions. Taking into account the fact that the collecting points covered relatively uniformly the town surface, targeting its representative habitats, probably the species is really missing from Pâncota. Also, in Pâncota we collected more individuals than previously in Ștei town, where 16 species were present and *P. scaber* was common (HERLE et al., 2016). The absence of the species is even more surprising, because in Romania *P. scaber* was frequently identified in rural areas and even in seminatural and natural habitats (e.g. FERENȚI & COVACIU-MARCOV, 2012, 2015; IANC & FERENȚI, 2014). *P. scaber* absence from Pâncota probably indicates that this species was truly introduced in other urban areas, not being native in this region, and by chance it was not introduced in Pâncota. This seems plausible, because another non native species in Europe like *Protracheoniscus major* (Dollfus, 1903) (COCHARD et al., 2010), were not identified in Pâncota, even if it was introduced in some localities from western Romania (e.g. TOMESCU et al., 2016). Unfortunately, data upon terrestrial isopods are very few in Arad County (TOMESCU et al., 2015); thus, we cannot know the status of *P. scaber* in the surrounding regions. Even more, this species is considered an indicator of metal urban pollution (e.g. HOPKIN, 1986; DALLINGER et al., 1992; UDOVIC et al., 2009), and the vegetables grown on soils from Arad region have a reduced concentration of heavy metals (MUNTEANU et al., 2011).

The terrestrial isopod fauna in Pâncota, although poor, contains mostly native species, characteristic to the region, but common and tolerant species, frequent in urban areas. The most common species, *T. nodulosus*, is native, considered typical for open and dry plain areas (FARKAS, 2010), being frequently mentioned in western Romania (TOMESCU et al., 2015). *T. nodulosus* was encountered also in other localities with high frequency and percentage abundance (e.g. BODIN et al., 2013; FERENȚI et al., 2015). The wet areas are the most important habitats for isopods in Pâncota, like in other towns (FERENȚI et al., 2015; HERLE et al., 2016) and also in natural areas (e.g. FERENȚI et al., 2012, 2013). The species mostly linked with wet areas was *H. riparius*, a species known to be related with such habitats (e.g. RADU, 1983). Related with wet and relatively natural habitats are also *P. collicola* and *T. arcuatus*, like in other regions from western Romania (e.g. FERENȚI et al., 2012). In the same time, the non-native species, frequent in other urban areas (e.g. VILISICS & HORNUNG, 2009; FERENȚI et al., 2015) generally lack from Pâncota. Nevertheless, *P. pruinosus* is present, a Mediterranean species (RADU, 1985), which was frequently mentioned in localities (JĘDRYCZKOWSKI, 1981; VILISICS & HORNUNG, 2009; BODIN et al., 2013), but also in natural xeric habitats (FERENȚI et al., 2012).

The majority of habitat types in Pâncota shelters a poor and uniform terrestrial isopod fauna, with few species on a collecting point. The town is populated by native tolerant species, related to open areas. The town small dimension generally protected it from the entrance of non-native species, as in the case of another small town from western

Romania (BODIN et al., 2013). The vicinity of this plain town with higher and wet areas increased the species richness compared to a plain town surrounded only by agricultural areas (FERENȚI et al., 2015). The vineyards from Pâncota vicinity do not seem to influence the isopod fauna. The few native species with narrow habitat requirements are very rare, being survivors of the region`s ancient natural habitats.

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