FAUNISTIC DATA UPON THE TERRESTRIAL ISOPODS (CRUSTACEA, ISOPODA, ONISCIDEA) FROM CRASNA HILLS, NORTH-WESTERN ROMANIA

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Abstract. Using the direct collecting method, we identified 21 terrestrial isopod species from Crasna Hills, three times more than it was previously collected in the region with pitfall traps. This difference confirms the fact that for faunistic studies upon terrestrial isopods, the direct method is the most suitable. The highest number of species populated especially natural, but also human modified wet areas. Many species were exclusively identified in natural habitats, under natural shelters, thus being vulnerable to anthropogenic activities. In some altered habitats, situated near natural areas and crossed by watercourses, isopod species linked to natural unaffected habitats may be present, alongside synanthropic species.

Keywords: collecting methods, diversity, habitats, wet areas, altitude.

Rezumat. Date faunistice asupra izopodelor terestre (Crustacea, Isopoda, Oniscidea) din zona Dealurilor Crasnei, nord-vestul României. Cu ajutorul metodei directe am colectat din zona Dealurilor Crasnei, 21 de specii de izopode terestre, de trei ori mai multe decât au fost identificate anterior în regiune cu capcane Barber. Aceasta diferenţă confirmă faptul că, pentru izopodele terestre, cea mai potrivită, în cazul studiilor faunistice, este metoda directă. Cel mai mare număr de specii au populat zone umede, în special naturale, dar şi modificate antropic. Multe specii au fost identificate exclusiv în habitate naturale şi sub adăposturi naturale, fiind astfel vulnerabile la activităţile antropice. În anumite habitate modificate antropic, situate in vecinatatea unor zone naturale şi străbătute de cursuri de apă, pot fi prezente şi specii de izopode legate de habitate naturale, neafectate, alături de specii sinantrope.

Cuvinte cheie: metode de colectare, diversitate, habitate, zone umede, altitudine.

INTRODUCTION

Data upon the terrestrial isopods from Crasna Hills, to our knowledge, are brief. Thus, there is information upon isopods from two localities in the region, where sampling was made quantitatively, with pitfall traps (FERENŢI et al., 2012a). Also, in another study, a single species was mentioned in a locality from the region (TOMESCU et al., 2015). Contrary to Crasna Hills, terrestrial isopods from other north-western Romanian zones, like Oaş area, were intensely studied (see in: FERENŢI et al., 2013a). In the case of terrestrial isopods, quantitative studies seem to underestimate the number of the species, which was higher when the direct collecting method was used (e.g. FERENŢI et al., 2012b; IANC & FERENŢI, 2014). For example, in Carei Plain from north-western Romania, only 6 species were collected with pitfall traps (TOMESCU et al., 2008), compared with the 15 species observed by the direct method (FERENŢI et al., 2012b). Considering the fact that in Crasna Hills only one study was made with pitfall traps, in the region a more diverse isopod fauna than it is known until now, was expected. Thus, we proposed to analyze the terrestrial isopod fauna from Crasna Hills using the direct method, trying to establish its real composition.

MATERIAL AND METHODS

The field study was made in the years 2011 and 2012, 2-3 years after the previous study realized in the region with pitfall traps (FERENŢI et al., 2012a). Terrestrial isopods were collected directly with the hand or with tweezers under different shelters from the region (natural or artificial shelters). For each collecting point we tried to allocate the same interval (20-30 minutes). We did not collect the same sample number from each locality, depending on possibilities. Thus, from some localities we managed to collect only one sample, but from other localities we collected more than 10 samples. Even if we mainly tried to observe the terrestrial isopod fauna from natural areas in Crasna Hills, in two cases we collected samples inside localities. In those localities we had known local peoples, thus having access to some artificial habitats. Totally, we collected 30 samples from 17 localities in Crasna Hills region. The majority of these localities are situated in Satu Mare County, only two being in Bihor County. In the case of each sample, we noticed the habitat characteristics, but also the type of shelters under which we collected the isopods. Crasna Hills are situated in north-western Romania, belonging to Crişanei Hills, hills situated in the north-western part of the Apuseni Mountains (POSEA & BADEA, 1984). The region altitude is low, reaching a maximum of 334 m (TUFESCU, 1986), but many time it descends below 200 m. The hills are crossed by wide and flat valleys, with wet areas. Crasna Hills border in the north with Tăşnad Plain (POSEA & BADEA, 1984), their limit being clear, despite their little altitudinal difference. The collected terrestrial isopods were conserved in alcohol and identified in the laboratory according to the literature (e.g. RADU, 1983, 1985; SCHMIDT, 1997; FARKAS & VILISICS, 2013). After the species were determined, we calculated their percentage abundance and frequency of occurrence. The diversity (SHANNON & WIEVER, 1949) was calculated both totally and also in the case of each habitat type. For the similarity we used Jaccard index, calculated with the software Past. 3 (HAMMER et al., 2001).

RESULTS

In Crasna Hills region we collected 350 individuals, belonging to 21 terrestrial isopods species: *Ligidium hypnorum* (Cuvier, 1792), *L. germanicum* Verhoeff, 1901, *Hyloniscus transsilvanicus* (Verhoeff, 1901), *H. riparius* (C. Koch, 1838), *Trichoniscus carpaticus* Tăbăcaru, 1974, *Androniscus roseus* (C. Koch, 1838), *Haplophthalmus danicus* Budde-Lund, 1880, *H. mengii* (Zaddach, 1844), *Cylisticus convexus* (De Geer, 1778), *Porcellium collicola* (Verhoeff, 1907), *Protracheoniscus politus* (C. Koch, 1841), *Trachelipus difficilis* (Radu, 1950), *T. arcuatus* (Budde-Lund, 1885), *T. rathkii* (Brandt, 1833), *T. nodulosus* (C. Koch, 1838), *T. ratzeburgii* (Brandt, 1833), *Porcellionides pruinosus* (Brandt, 1833), *Porcellio scaber* Latreille, 1804, *P. spinicornis* Say, 1818, *Armadillidium vulgare* (Latreille, 1804), *A. versicolor* Stein, 1859. The highest percentage abundance was registered by *H. riparius*, followed by *H. transsilvanicus* and *A. vulgare* (Table 1). The most frequent species in the region was *A. vulgare*, followed by *H. riparius*, *T. nodulosus*, *T. arcuatus* and then *H. transsilvanicus*. The highest number of species / locality was 15, but it was registered only in one locality. In 8 from the 17 investigated localities we collected only 3 terrestrial isopod species. In one locality we found only one species. A number of 6 species was registered in only one locality. The highest species number (13 species) was registered in the moist areas neighbouring the natural streams from the region (Table 2). On the second place considering the species number are found the swampy areas and wetland shores. Forest edges are on the last place, with only one species.

Table 1. Terrestrial isopod species from Crasna Hills (Bh – Bihor County, Sm – Satu Mare County, Lh – *L. hypnorum*, Lh - *L. germanicum*, Ht - *H. transsilvanicus*, Hr - *H. riparius*, Tc - *T. carpaticus*, Ar - *A. roseus*, Hd - *H. danicus*, Hm - *H. mengii*, Cc - *C. convexus*, Pcol - *P. collicola*, Ppo - *P. politus*, Tdif - *T. difficilis*, Tarc - *T. arcuatus*, Trth - *T. rathkii*, Tn - *T. nodulosus*, Tratz - *T. ratzeburgii*, Ppr - *P. pruinosus*, Psc. - *P. scaber*, Psp - *P. spinicornis*, Avu - *A. vulgare*, Ave - *A. versicolor*, N sp – number of species).

Locality / species	Lh	Lg	Ht	Hr	Tc	Ar	Hd	Hm	Cc	Pcol	Ppo	Tdif	Tarc	Trth	Tn	Tratz	Ppr	Psc	Psp	Avu	Ave	N sp
Boianu Mare (Bh)	-	-	-	x	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	-	2
Viisoara (Bh)	x	-	x	x	-	-	-	-	x	x	-	x	x	-	x	-	x	x	x	x	x	13
Becheni (Sm)	-	-	-	-	x	-	x	-	-	x	-	-	-	-	-	-	-	-	-	-	-	3
Blaja (Sm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	1
Cean (Sm)	-	-	-	-	-	-	-	-	-	-	x	-	-	-	x	x	-	-	-	-	-	3
Cehalut (Sm)	-	-	-	x	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	-	2
Cheghea (Sm)	-	-	-	-	-	-	-	-	-	-	-	-	x	-	x	-	-	-	-	x	-	3
Orbau (Sm)	-	-	x	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	x	-	3
Pir (Sm)	x	x	x	x	-	-	x	x	x	x	x	-	x	-	x	x	x	x	-	x	-	15
Piru Nou (Sm)	-	-	-	-	-	-	-	-	-	x	-	-	x	-	-	-	-	-	-	-	x	3
Secheresa (Sm)	-	-	x	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	-	x	-	3
Sacaseni (Sm)	-	-	-	x	-	-	-	-	-	-	-	-	x	-	-	x	-	-	-	-	-	3
Sarauad (Sm)	-	-	x	x	-	x	-	-	-	x	-	-	-	-	x	-	-	-	-	-	-	5
Sauca (Sm)	-	-	x	x	-	-	-	-	-	-	-	-	x	-	x	-	-	x	-	x	x	7
Supuru de Jos (Sm)	-	-	x	-	-	-	-	-	-	-	-	-	-	-	x	-	-	-	-	-	x	3
Supuru de Sus (Sm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	x	x	2
Tasnad (Sm)	-	-	-	x	-	-	-	-	-	x	-	-	x	-	x	-	-	x	-	-	x	6
Percentage abundance (%)	1.14	1.14	10.86	18.86	4.00	2.00	6.00	0.28	2.00	9.14	0.85	0.28	6.00	1.71	8.28	4.00	2.00	5.71	0.57	10.57	4.57	
Frequency of occurrence (%)	11.70	5.88	41.18	47.06	5.88	5.88	11.76	5.88	11.76	35.29	11.76	5.88	47.06	11.76	47.06	17.65	11.76	23.53	5.88	52.94	35.29	

The highest species number (14 species), was collected under fallen tree trunks and their barks; the lowest (only one species) under agricultural residues (Table 3). Two species (*P. pruinosus* and *P. spiniconis*) were collected only under artificial shelters, like rubble or agricultural residues. Unlike those, 10 from the 21 species found in the region were collected only under natural shelters (Table 3). The diversity of terrestrial isopod fauna from Crasna Hills was H=2.63. The highest diversity was registered on the banks of natural streams and the lowest on forest edges (Figure 1). In the case of similarity between habitats (Fig. 2a), they group in different patterns. Thus, close to one another are the streams shores and the oak forests. On another side, close to one another are also the artificial habitats, like cellars, roads edges or poplar plantations. The terrestrial isopod fauna from swamps, road side ditches and distilleries are similar, as well as the one from pastures and forest edges. In the case of species similarity (Fig. 2b), very close are the species *L. germanicum* and *A. roseus*, but also *H. mengii*, *L. hypnorum* and *T. difficilis*. Close to one another are also the species *C. convexus*, *P. pruinosus* and *P. spincornis*.

DISCUSSION

With the help of the direct method, we managed to collect in Crasna Hills three times more terrestrial isopod species than it was previously collected with pitfall traps (FERENȚI et al., 2012a). Thus, the region terrestrial isopod species list has risen from 7 to 21. All species, captured previously with pitfall traps, (FERENȚI et al., 2012a) were also captured with the direct method, alongside other 14 species in the region. Thus, the fact that the direct method is the most efficient one in surprising the aspect and the diversity of terrestrial isopod fauna from a region is once again confirmed (e.g. VILISICS & HORNUNG, 2009; FERENȚI et al., 2012b; IANC & FERENȚI, 2014). Differences between the species collected with pitfall traps and with the direct method were observed in north-western Romania also in other invertebrates, like wolf spiders (SAS-KOVÁCS & SAS-KOVÁCS, 2014). Nevertheless, in the case of wolf spiders, even if the species captured with the two methods differ, the pitfall traps seem more efficient (SAS-KOVÁCS & SAS-KOVÁCS, 2014).

Table 2. Terrestrial isopod species distribution in the area habitat types (1-oak forest, 2-forest edge, 3-wetland, 4-stream, 5-pond, 6-pasture, 7-cellar, 8-abandoned buildings, 9-roadside, 10-poplar plantation, 11-roadside canals, 12-traditional distilleries).

Species	1	2	3	4	5	6	7	8	9	10	11	12	No. of habitats
L. hypnorum	-	-	-	-	x	-	-	-	-	-	-	-	1
L. germanicum	-	-	-	x	-	-	-	-	-	-	-	-	1
H. transsilvanicus	x	-	x	x	x	-	x	-	-	x	x	x	8
H. riparius	x	-	x	x	-	-	x	-	-	-	x	-	5
T. carpaticus	-	-	x	-	-	-	-	-	-	-	-	-	1
A. roseus	-	-	-	x	-	-	-	-	-	-	-	-	1
H. danicus	-	-	x	x	-	-	-	-	-	x	-	x	4
H. mengii	-	-	-	-	x	-	-	-	-	-	-	-	1
C. convexus	-	-	-	-	-	-	x	-	x	x	-	-	3
P. collicola	x	-	x	x	x	-	-	-	-	x	x	-	6
P. politus	x	-	-	x	x	-	-	-	-	-	-	-	3
T. difficilis	-	-	-	-	x	-	-	-	-	-	-	-	1
T. arcuatus	x	x	x	x	x	x	-	-	-	-	-	-	6
T. rathkii	-	-	x	x	-	-	-	-	-	-	-	-	2
T. nodulosus	x	-	-	x	-	x	x	x	x	x	x	x	9
T. ratzeburgii	x	-	-	x	x	-	-	-	-	x	-	-	4
P. pruinosus	-	-	-	x	-	-	x	x	-	x	-	-	4
P. scaber	-	-	x	-	-	-	-	x	x	x	x	x	6
P. spinicornis	-	-	-	-	-	-	x	-	-	-	-	-	1
A. vulgare	x	-	x	x	x	x	x	-	x	x	x	-	9
A. versicolor	-	-	x	-	x	-	x	-	-	-	x	x	5
TOTAL	8	1	10	13	10	3	8	3	4	9	7	5	12

Although the investigated region is represented by low altitude hills with a relatively uniform aspect, the number of terrestrial isopod species is identical with the one registered in Padurea Craiului mountain from the Apuseni Mountains, with higher altitudinal differences and more diverse habitats (IANC & FERENȚI, 2014). The resemblance of the terrestrial isopod fauna from these two areas, probably a consequence of their appurtenance to the same geographic unit, is also highlighted in the case of Trachelipus genus, represented in both areas by the same species.

The terrestrial isopod fauna from Crasna Hills resembles with the one from other regions from north-western Romania (FERENȚI et al., 2012b, 2013a, b). In this region, there stands out the presence of the species *L. germanicum*, *L. hypnorum* and H. *transsilvanicus*, considered mountain species (e.g. TOMESCU et al., 2011), at unusually low altitudes, even in typically plain habitats. This is probably a particularity of the terrestrial isopod fauna from the north-eastern sector of the Pannonic Plain, being observed both in north-western Romanian plains (FERENȚI et al., 2012b, 2013b), but also in Hungary (VILISICS & HORNUNG, 2010). These species are present even below 200 m altitude, at the limit between hills and plain, but also in the vicinity of watercourses, which cross the hills. The situation is identical with the previously mentioned one at the contact between Oas Mountains and the surrounding plains (FERENȚI et al., 2013b). The resemblances between the distribution of some terrestrial isopods and some reptile species with similar requirements (see in: FERENȚI et al., 2012b) is obvious also in Crasna Hills region. In this region there are also low altitude *Zootoca vivipara* populations (COVACIU-MARCOV et al., 2008).

Alongside the above mentioned species, in Crasna Hills region *T. carpaticus* is also present. This species is distributed only in Romania, in the Carpathian Mountains (e.g. RADU 1983; SCHMALFUSS, 2003), being encountered in different mountain sectors from the country (e.g. GIURGINCĂ et al., 2006, 2014; IANC & FERENȚI, 2014). Recently, it was encountered in north-western Romania at the limit between mountains and plains (FERENȚI et al., 2013b). In Crasna Hills area *T. carpaticus* is also present at low altitude, being found at 141 m in a wet area situated near a small stream at the lower limit of the hills. The species presence in this region is probably a consequence of the continuity between Crasna Hills and the Apuseni Mountains, where it is present (e.g. RADU, 1983).

In the studied region, the humid habitats shelter the highest number of terrestrial isopod species. The most favourable for terrestrial isopods are the natural humid habitats, represented by small streams and swamps. Nevertheless, a high species number is also present in human modified humid habitats, like ponds. Less species, but still important numerically, are present

in the road side ditches. Those ditches are more frequent at the edge between the hills and the plain, where they largely replaced the natural wet areas, a fact also mentioned in other groups (COVACIU-MARCOV et al., 2008). Probably, in that area, roadside ditches are the only habitats available for terrestrial isopods related to wet areas. In these habitats, there are present even xerophilous species, like *T. nodulosus* (FARKAS, 2010), originating from open, affected areas, situated in their vicinity. The importance of wet areas from north-western Romania for terrestrial isopods was previously indicated, these being the region initial, natural habitats (FERENȚI et al., 2012b, 2013b).

Table 3. Distribution of the terrestrial isopod species in the area shelter types (1-fallen logs, 2-barks, 3-stones, 4-humid soil and vegetation near waters, 5-rubble, 6-paperboards, 7-clothes, 8-agricultural residues).

Species	1	2	3	4	5	6	7	8	No. of shelters
L. hypnorum	-	-	-	x	-	-	-	-	1
L. germanicum	x	-	-	-	-	-	-	-	1
H. transsilvanicus	x	-	x	x	x	-	-	-	4
H. riparius	x	x	x	x	x	x	x	-	7
T. carpaticus	-	-	-	x	-	-	-	-	1
A. roseus	-	-	x	-	-	-	-	-	1
H. danicus	x	-	-	x	-	-	-	-	2
H. mengii	x	-	-	-	-	-	-	-	1
C. convexus	x	-	-	-	x	-	-	-	2
P. collicola	x	-	x	x	-	x	x	-	5
P. politus	x	x	-	-	-	-	-	-	2
T. difficilis	-	-	-	x	-	-	-	-	1
T. arcuatus	x	-	-	x	x	-	x	-	4
T. rathkii	x	-	-	-	-	-	-	-	1
T. nodulosus	x	-	x	-	x	x	x	-	5
T. ratzeburgii	x	x	-	-	-	-	x	-	3
P. pruinosus	-	-	-	-	x	-	-	x	2
P. scaber	x	-	-	-	x	x	-	-	3
P. spinicornis	-	-	-	-	x	-	-	-	1
A. vulgare	x	x	x	x	x	-	-	-	5
A. versicolor	-	-	x	x	x	x	x	-	5
TOTAL	14	4	7	10	10	5	6	1	8

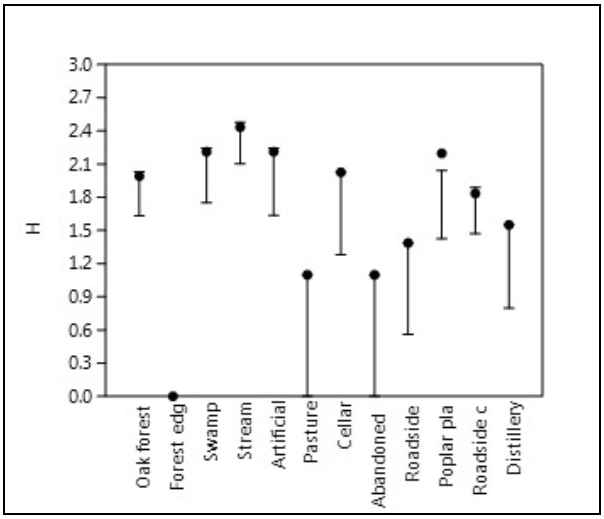
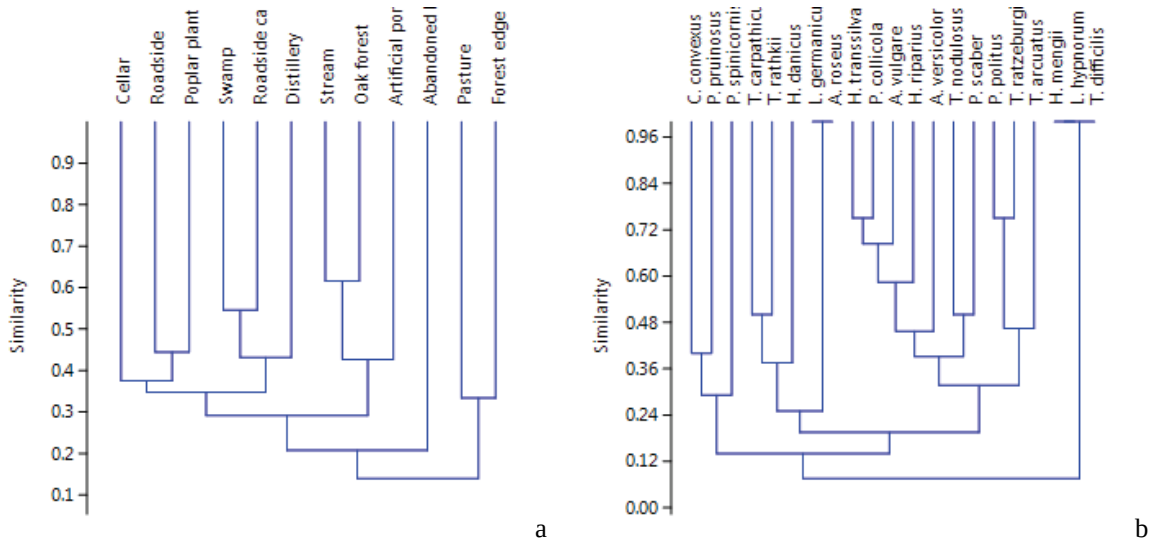


Figure 1. The diversity of the terrestrial isopod species in the region-habitat types.

The high number of species encountered only in natural habitats and under natural shelters, highlight the high percentage abundance of the species which are characteristic for natural areas of the region, which survive in Crasna Hills area. These species seem to be sensitive to disturbance, inhabiting exclusively natural zones. Probably, their territory occupied in the present is more reduced than the initial one. Even if they are well represented in the region yet, their surviving in Crasna Hills depends on natural habitats` conservation. Even if some species tied to natural zones can also use artificial shelters (FERENȚI et al., 2013a), this fact is not valid in all cases.



a b

Figure 2. Similarity between habitats (a) and terrestrial isopod species (b).

In north-western Romania forest plantations with allochthonous species shelter a very low number of terrestrial isopod species (TOMESCU et al., 2008; FERENŢI et al., 2012b; IANC & FERENŢI, 2014). Nevertheless, in other regions, in plantations, there was identified a relatively high number of terrestrial isopod species (e.g. FARKAS et al., 2013; OTARTICS et al., 2014). In Crasna Hills region, at Pir, we found a poplar plantation, which diverges of the northwestern country rule, presenting a high species richness. Alongside synanthropic species like *P. pruinosus* and *P. scaber* (RADU, 1985) in that plantation there are also native species tied to wetlands, like *H. transsilvanicus* and *P. collicola* (RADU, 1983, 1985) or sylvan species like *T. ratzeburgi* (e.g. TOMESCU et al., 2015). The presence of synanthropic species is a consequence of the anthropogenic activities from the locality, they being identified under agricultural wastes thrown in the plantation (corn stalks, rotting fruits). The species related to humid zones are a consequence of a permanent stream which crosses the plantation, springing from a natural forest situated 3 km from the plantation. In that forest the same species are present, which probably survived the clearcut and the plantation of poplars here due to the stream. From the banks of the stream they could subsequently recolonize the plantation. As terrestrial isopods from the region can survive in canals formed in the place of initial wetlands, just as they can use plantations instead of native forests crossed by waters.

The high species richness from the poplar plantation may be due to the particular conditions which have permitted the wetland species survive here, permitting in the same time the synanthropic species ingoing. Approximately in the same category can fit the wine cellars of the zone, which offer conditions both for wetland species, because of the coolness and moisture from them, but also synanthropic species, because of their lay in localities. Surprising is the presence of *P. spinicornis*, previously mentioned in north-western Romania in a calcareous gorge (IANC & FERENŢI, 2014), being tied to stony surfaces (VILISICS & HORNUNG, 2009). This habitat type lacks completely from Crasna Hills zone, where the species shows up exclusively near cellars. In this case, because of the lack of its habitat from the region, probably *P. spinicornis*, even if it is native in north-western Romania, was introduced in Crasna Hills with the stones used for the construction of the cellars.

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