

Two *Protracheoniscus* Species (Crustacea, Isopoda, Oniscidea) in Romanian Fauna: Morphology, Ecology and Distribution

Nicolae Tomescu^{1,✉}, Lucian Alexandru Teodor¹, Sára Ferentő²
and Severus-Daniel Covaciu-Marcov³

SUMMARY. Our study is dedicated to two *Protracheoniscus* species from Romania, *Protracheoniscus major* and *Protracheoniscus politus*. The specific morphological characters of *Protracheoniscus major* Dolfuss 1903 and *Protracheoniscus politus* C. L. Koch 1841 are redescribed. The morphology of the male pleopod 1 in *P. major* and *Protracheoniscus asiaticus* Uljanin 1875 are presented comparatively. At *Protracheoniscus politus* C.L. Koch 1841 the specific morphological characters, the intraspecific morphological variation of some taxonomical characters and some morphological anomalies are detailed. Also, we presented the changes of the male pleopod 1 endopods morphology after the post reproductive moult, the chitinous lobes of the endopods' tip being removed together with the exuvia. The taxonomic confusions emerging from the remove of the chitinous lobes are presented. The phenomenon of the chitinous lobes' remove in the post reproductive moult was not taken into account by them, new isopod subspecies for science being described. The ecology and the geographic distribution are presented in both species.

Keywords: distributions, ecology, isopods, morphology, *Protracheoniscus*.

Introduction

In the Romanian specialty literature (Radu, 1985), there are confusions and errors in the presentation of the genus *Protracheoniscus*. These confusions were determined by the incomplete description of the morphological characters with

¹"Babeș-Bolyai" University of Cluj-Napoca, Department of Taxonomy and Ecology, 5-7 Clinicilor Str., 400006, Cluj-Napoca, Romania.

²"Iosif Vulcan" National College, Jean Calvin str. 3, Oradea, Romania.

³University of Oradea, Faculty of Sciences, Department of Biology.

✉ **Corresponding author: Nicolae Tomescu**, "Babeș-Bolyai" University of Cluj-Napoca, Department of Taxonomy and Ecology, 5-7 Clinicilor Str., 400006, Cluj-Napoca, Romania, E-mail: nicolaetomescu36@gmail.com

taxonomical value, without many figures. The species *Protracheoniscus major* Dollfus 1903 was presented as *Protracheoniscus asiaticus* Uljanin 1875 (Radu, 1985). Only recently *P. major* was mentioned in western Romania (Ferenți, 2013, Ferenți *et al.*, 2015). The confusion between the two species is also found in the papers of other researchers (Strouhal, 1929, Wächtler, 1937, Frankenberger, 1959, Schmolzer, 1965). Gruner (1966) was the first one who compared morphologically the male pleopod 1 and 2 and showed the obvious differences between the two species, *P. asiaticus* and *P. major*. Based on the research of Gruner, other authors also identified the species *P. major* in different European countries, in Hungary (Csordás *et al.*, 2005), in Poland (Jedryzkowski, 1981), in Romania (Ferenți, 2013, Ferenți *et al.*, 2015). Schmalzfuss (2003) mentions the taxonomical confusion between *P. asiaticus* and *P. major* specimens from European countries.

Referring to *P. politus*, Radu (1985) mentions three subspecies in the Romanian fauna: *P. politus politus* C.L. Koch 1841, *P. politus carpathicus* Verhoeff 1928, *P. politus similis* Radu 1951, and a fourth one, *P. politus slovakius* Strouhal 1940, which is present in Czech. Tomescu (1972) has studied the post-embryonic ontogenetic development in *P. politus*. He described the progressive development of the secondary sexual characters in males and their morphological variation. He found that the male endopods tips' chitinous lobes are removed with the exuviae in the post reproductive moult, which usually takes place in May and June. The lobes re-grow progressively until the next year, when they reach the characteristic size for this species. Probably, the researchers who described the above mentioned subspecies were misled by the fact that they captured males after moult. This fact will be demonstrated in the present paper, where firstly we will present the complete morphology of *P. major*, than we will re-describe the morphological characters of *P. politus*, will present the changes of the male pleopod endopod 1 due to the moult, and the variability of some characters and morphological anomalies.

Material and methods

The *P. major* specimens were collected from two localities. Fifteen males and 42 females were collected from Simeria, Hunedoara County, near the walls of an old building with partly fallen plaster, from under the debris and stones. The specimens were collected in May 1995. Two males were collected from the soil at the entrance of a vine cellar in Sălacea, Bihor County, on April 03, 2012. From the collected material five males were dissected and microscopic slides were made. The *P. politus* specimens were collected between 1991 and 2015 from different habitats: spruce forests, deciduous forests, riverside coppices, mountain meadows. In 11 habitats the collecting was realized with pitfall traps monthly and bi-monthly. The habitats were situated in different geographical units: 23 habitats from mountain

areas, seven habitats from hills and one habitat from plain area. The collected specimens from both species were preserved separately in alcohol 70⁰. From *P. politus* 228 adult males and 117 females were collected. 93 males were dissected and microscopic slides were made using Canada balsam and Euparal. The preparations were studied at the stereomicroscope and microscope, the body of males and females and the appendages (antennae, pereopods 1-3 and 7, male pleopods 1 and 2) were photographed. From the specimens collected monthly and bi-monthly with the pitfall traps were dissected and studied males from the same habitat but collected on different dates, from May to October. Thus, we could overtake the changes of the male pleopod 1 endopods after the post reproductive moult.

The re-description of the species *Protracheoniscus major* Dollfus 1903

Protracheoniscus major (Dollfus, 1903) Gruner 1966

Literature consulted for the description of the species: Strouhal, 1929, Wachtler, 1937, Frankenberger, 1959, Gruner, 1966, Schmolzer, 1965, Radu, 1985. In other papers is also mentioned the presence of the species *P. major* in different European countries, without the description of the specific morphological characters (Cochard *et al.*, 2010, Csordas *et al.*, 2005, Jedryckowski, 1981, Vilisics and Hornung, 2009). In Romania, Radu (1985) mentions incorrect the presence of the species *P. asiaticus*. In the present paper we detail the morphology of *P. major*.

Size: males 12 x 5 – 18 x 6.5 mm, females 12 x 5 – 18 x 7 mm.

Body color: males are dark brown (Fig. 1.1.a) and females light brown (Fig. 1.1.b). Both sexes present yellowish oblong spots at the coxal plates` base. The pleon is colored uniformly in dark brown (Fig. 1.1.a,b).

Somatic characters:

Cephalon. The lateral cephalic lobes are relatively low developed, with triunghiular shape, slightly inclined. The median lobe is reduced. The eyes are compound of 22-23 ommatidia (Fig. 1.1.c).

Pereion. The noduli laterales have different position on the segments 3 and four, compared with the other pereional segments (Fig. 1.1.d).

Pleotelson is short at both sexes, the lateral edges forming an oblique angle (Fig. 1.1.e,f).

Appendages:

Antennae` last article length represents half of the penultimate one`s length (Fig. 1.2.a).

Pereopods. The male pereiopod 7 ischium`s ventral side is slightly concave (Fig. 1.2.b). The male 1 pereiopod merus and carpus present numerous thin spines (Fig. 1.2.c). On the pereiopods 2 and 3 meros and carpus the spines are thicker and less in number (fig.1.2.d.e)

Pleopods. The male pleopod 1 exopods' exterior side is bended, forming an obtuse angle. The tip is slightly rounded. Both sides present short spines, more numerous in the internal side (Fig. 1.3.a). The endopods' basal half is slightly oblique (Fig. 1.3.b). The distal half's extremity is sharp, with fine hair in its internal side (Fig. 1.3.c). The pleopod 2 exopods are triangular with short spines at the external side (Fig. 1.3.d). The uropod exopods are long in males (Fig. 1.1.e), and short in females (Fig. 1.1.f). In figure 1.4. we present images with the pleopods 1 and 2 resulted in our research and drawings published by Grunner (1966) with the morphology of the pleopods 1 and 2 in *P. major* and *P. asiaticus*. The figures show obvious morphological differences between the two species.



Figure 1.1. *Protracheoniscus major* (Dolfus, 1903), male and female dorsal view:
a. ♂ 18 x 7 mm, **b.** ♀ 15 x 7.5 mm, **c.** cephalic lobes, **d.** noduli laterales,
e. ♂ pleotelson and uropods, **f.** ♀ pleotelson and uropods.

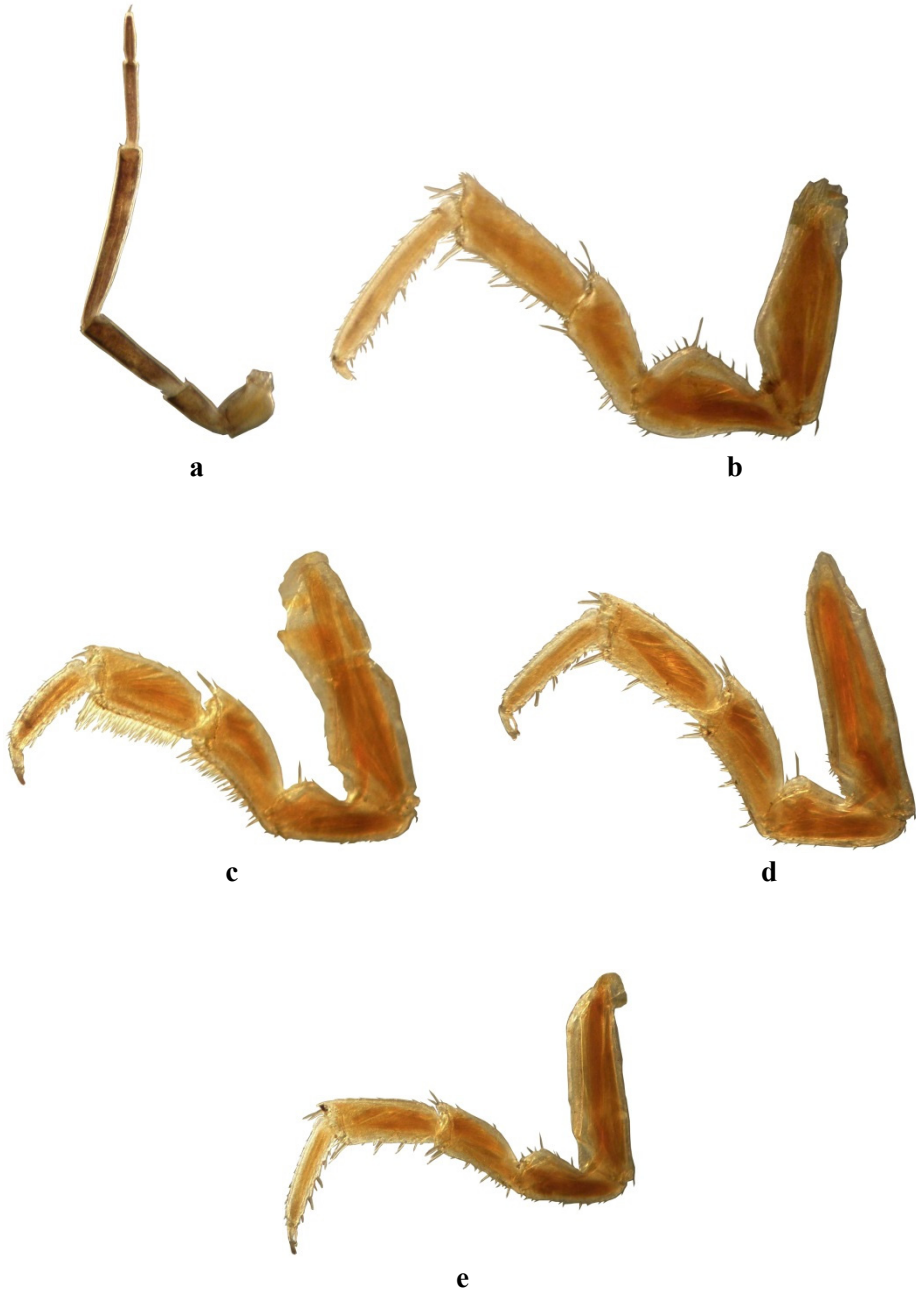


Figure 1.2. *Protracheoniscus major* (Dolfus, 1903), ♂ 16.5 x 6 mm, **a.** antenna, **b.** male pereopods 7, **c.** pereopods 1, **d.** pereopods 2, **e.** pereopods 3.



Figure 1.3. *Protracheoniscus major* (Dolfus, 1903), male pleopods 1 and 2: ♂ 16.5 x 6 mm, **a.** pleopods 1 exopods, **b.** pleopods 1 endopods, **c.** the apex of pleopods 1, **d.** pleopods 2.

Ecology. *P. major* is a synanthropic species in the European countries. It lives around buildings, preferring old houses with wet walls or cellars with vegetable and fruit deposits (Jedryckowski, 1981, Vilisics and Hornung, 2009, Ferenti, 2013, Ferenti *et al.*, 2015). Eshagi *et al.* (2015) affirms that in Iran *P. major* has numerous populations in agricultural areas.

Geographic distribution. *P. major* originates from Central Asia (Gruner, 1966). In Europe it is present in southern Russia, Romania, Hungary, Slovakia, Austria, Czech and Poland (Gruner 1966, Cochard *et al.*, 2010, Csordas *et al.*, 2005, Vilisics and Hornung, 2009, Jedryckowski, 1981, Ferenti, 2013, Ferenti *et al.*, 2015).

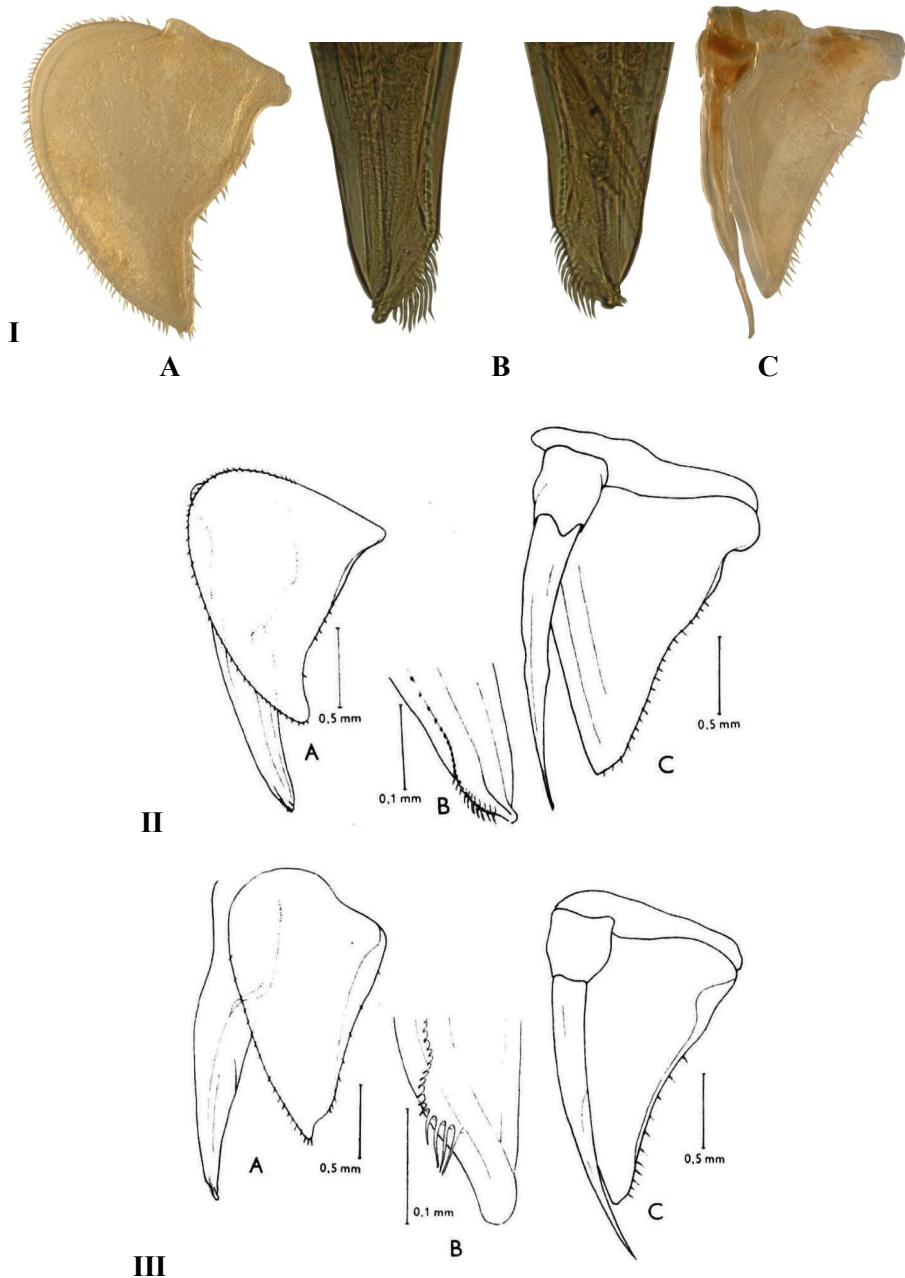


Figure 1.4. *Protracheoniscus major* (Dolfus, 1903), **I.** our research, **II.** after Grüner, 1966, **III.** *Protracheoniscus asiaticus* (Ulianin, 1875), after Grüner, 1966: **A.** pleopods 1 exopods, **B.** the apex of the pleopods 1 endopods, **C.** pleopods 2.

The re-description of the species *Protracheoniscus politus* C.L.Koch 1841

Protracheoniscus politus (C. L. Koch, 1841) Wachtler 1937

Protracheoniscus politus (C. L. Koch, 1841) Frankenberger 1959

Protracheoniscus politus (C. L. Koch, 1841) Schmolzer 1965

Protracheoniscus politus politus (C. L. Koch, 1841) Radu 1985

Protracheoniscus politus (C. L. Koch, 1841) Tomescu 1972

Literature consulted for the re-description of the species: Wachtler, 1937, Frankenberger, 1959, Schmolzer, 1965, Tomescu, 1972, Radu, 1985.

The re-description of the species *P. politus* is required because the main character with taxonomic value, the adult male pleopod 1 endopods changes after the post-reproductive moult, which usually takes place in May-June (Tomescu, 1972). In the biological material collected by us between the years 1990-2015 we have found some exceptions, like males collected in July-October with unmodified pleopod 1 endopods. The lack of data referring to the modifications of the morphology of *P. politus* male pleopod 1 endopods has contributed to taxonomic confusions, the males collected after the moult being described as new subspecies for science (*P. politus carpathicus* Verhoeff 1928, *P. politus slovakins* Strouhal, 1940 – cited by Radu, 1985).

Tomescu (1972) has studied and described the post-embryonic ontogenetic development in *P. politus*. He described the progressive show up of the male secondary sexual characters, as well the modification of the morphology of the endopods tip, the disappearance of the chitinous lobes after the post-reproductive moult. The rich and diverse samples, coming from a high number of habitats, situated in diverse geographical units has permitted a detailed study of adult *P. politus* males, with new results then was in the previous study (Tomescu, 1972), that was made on males collected from a single habitat.

Size: 93 males and 20 females were measured, the average size at males being 5 – 9 mm and at females 6 – 10 mm.

The body colour is dark brown; the median zone of the tergites is darker. Laterally of these zones there are fine yellowish marble shapes. At the base of the coxal plates there are yellow oblong spots (Fig. 2.1.a, b).

Somatic characters:

The cephalon have weak developed lobes, on the head there are numerous yellow-orange spots (Fig. 2.1.c).

The pleotelson has oblique angled lateral edges, the tip of the telson exceeding the tips of the last pleon segment (Fig. 2.1.d).

Appendages

Antennae: the penultimate antennary article's length is approximately equal with the half length of the last article (Fig. 2.2.a). The length ratio is a variable character.

The male 7 pereopods ischium's ventral side is slowly curved (Fig. 2.2.b). The 1-3 pereopods carpus' and meros' ventral sides present dense rows of thin spines (Fig. 2.2.c,d,e).

The male 1 pleopods: The exopods are approximately triangular, their external edge being curved at their distal third (Fig. 2.3.a). The endopods' edges on their basal half are curved (Fig. 2.3.b). At the extremity of the endopods there are chitinous lobes, with fine and short spines on the external edge (Fig. 2.3.c). The chitinous lobes are removed with the exuviae in the post-reproductive moult, a process that was described by Tomescu (1972). The moult takes place generally in May-June. The male pleopods 2 have no taxonomical value (Fig. 2.3.d).

At males collected monthly (from April to October) from an oak forest from Livada locality (Ferenți et al. 2012), in a hilly area (Satu-Mare County), we have noticed the development of these chitinous lobes before (Fig. 2.4.a,a') and after moult. In the first weeks after moult, the male pleopod 1 endopods resembles with the ones described by Strouhal in 1940 (cited by Radu, 1985), as being the subspecies named *P. politus slovakius* (Fig. 2.4.b,b',B). In males collected five months after the post-reproductive moult the newly formed chitinous lobes were very small, not having their initial size (Fig. 2.4.c,c'). They resemble with the chitinous lobes of the subspecies *P. politus carpathicus* (Fig. 2.4.c,c',C) described by Verhoeff in 1928 (cited by Radu, 1985). We consider that these two subspecies do not exist in reality, they being described on the basis of the morphological characters of *P. politus* males collected after the post-reproductive moult, after May-June. In males collected from mountain areas in July-October we have found males with normal sized chitinous lobes and males without these lobes, this fact proving that the moult process in a population does not take place in all males at the same time. In a sample collected on August 05, 2009 from the Călimani Mountains we also found males with and without chitinous lobes (Fig. 2.5.a,b). Thus, there is a possibility that not all males participate in the biological process of the reproduction.

At the 93 dissected males, of which microscopic slides were made, we have studied the variation of the pleotelson and the appendages morphology with taxonomical value, as well as the morphological anomaly cases. The length and the width of the pleotelson's distal half vary (Fig. 2.6.a,b,c). The male pereopod 7 ischiums ventral edge's curve also vary, which can be more accentuated (Fig. 2.6.d), reduced (Fig. 2.6.e) or absent (Fig. 2.6.f). There is a high morphological variation in male pleopod 1 exopods (Fig. 2.7.a-f).

Morphological anomalies at the pleon segments were observed in three males, in which the segments 1 and 2 were longer. Between the coxal plates of the last pereion segment and the epimeres of the 3rd pleon segment there is a bigger distance than normal (Fig. 2.7.g). In two males anomalies were observed at the antennae, one of the antennae being smaller and depigmented compared with the pair, at antenna (Fig. 2.7.h). In a single case of the 93 dissected males we found the

anomaly of the pleopod 1 endopod, which was smaller and probably nonfunctional (Fig. 2.7.i). In the case of 12 *Trachelipus* species this kind of anomaly was not noticed (Tomescu *et al.*, 2015a).



Figure 2.1. *Protracheoniscus politus* C. L. Koch 1841, male and female dorsal view: **a.** ♂ 6.5 x 2.8 mm, **b.** ♀ 7 x 2.8 mm, **c.** cephalic lobes, **d.** pleotelson and uropods.

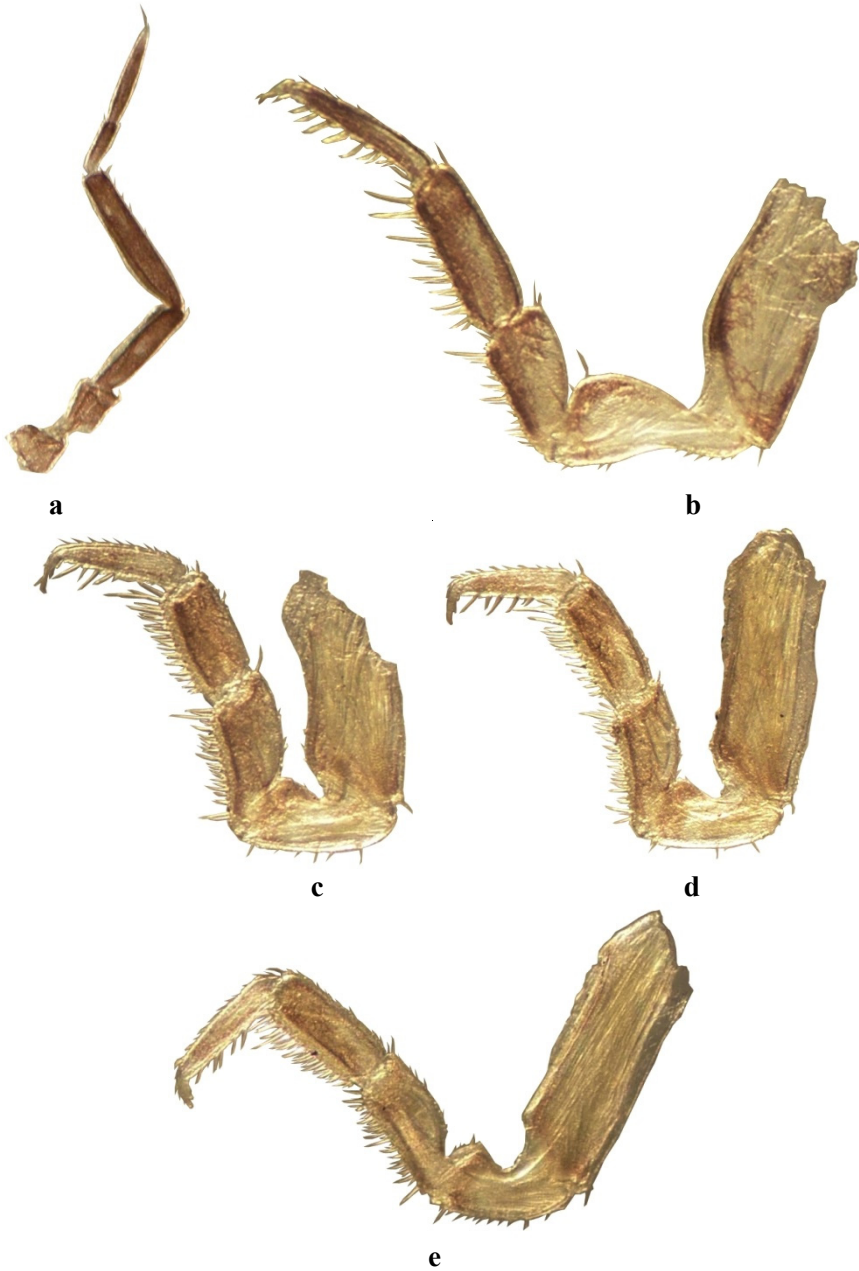


Figure 2.2. *Protracheoniscus politus* C. L. Koch 1841, ♂ 6.5 x 2.8 mm, **a.** antenna, **b.** male pereopods 7, **c.** pereopods 1, **d.** pereopods 2, **e.** pereopods 3.

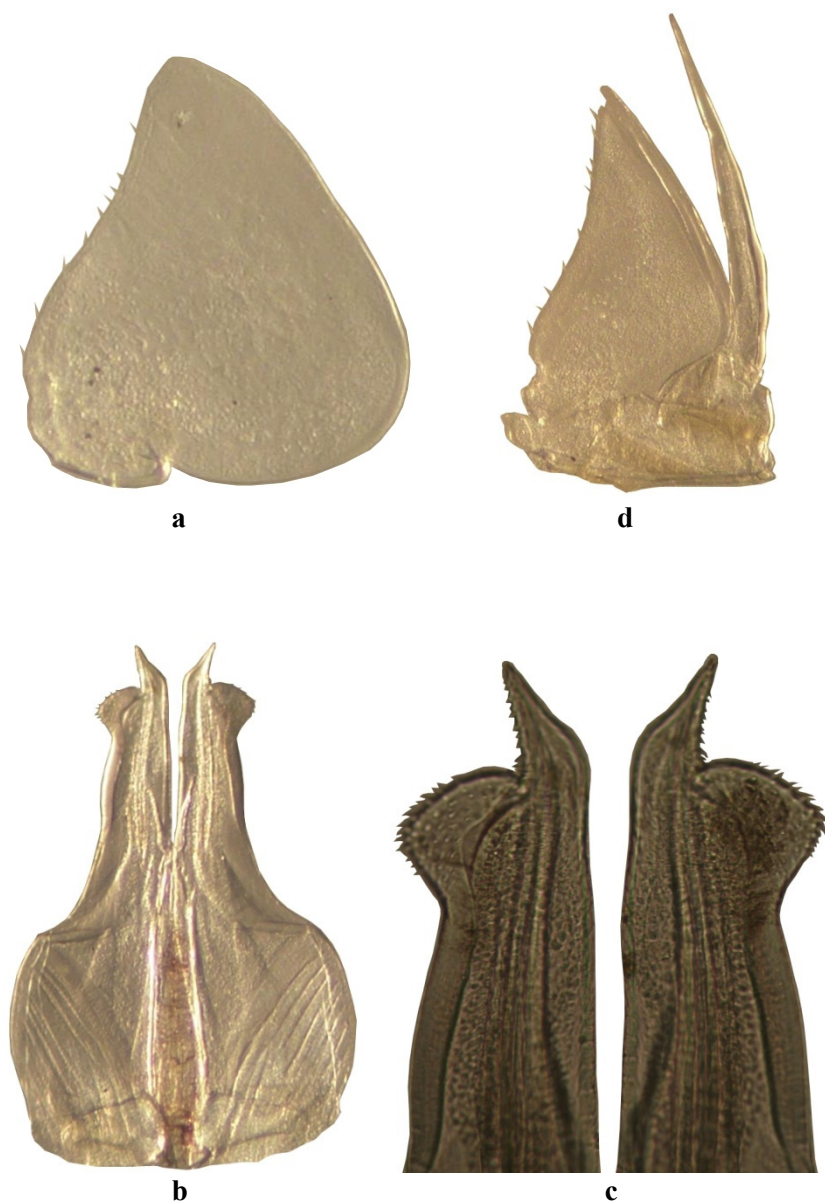


Figure 2.3. *Protracheoniscus politus* C. L. Koch 1841, male pleopods 1 and 2: ♂ 6.5 x 2.8 mm, **a.** pleopod 1 exopods, **b.** pleopod 1 endopods, **c.** the apex of the pelopod 1 endopods, **d.** pleopods 2.

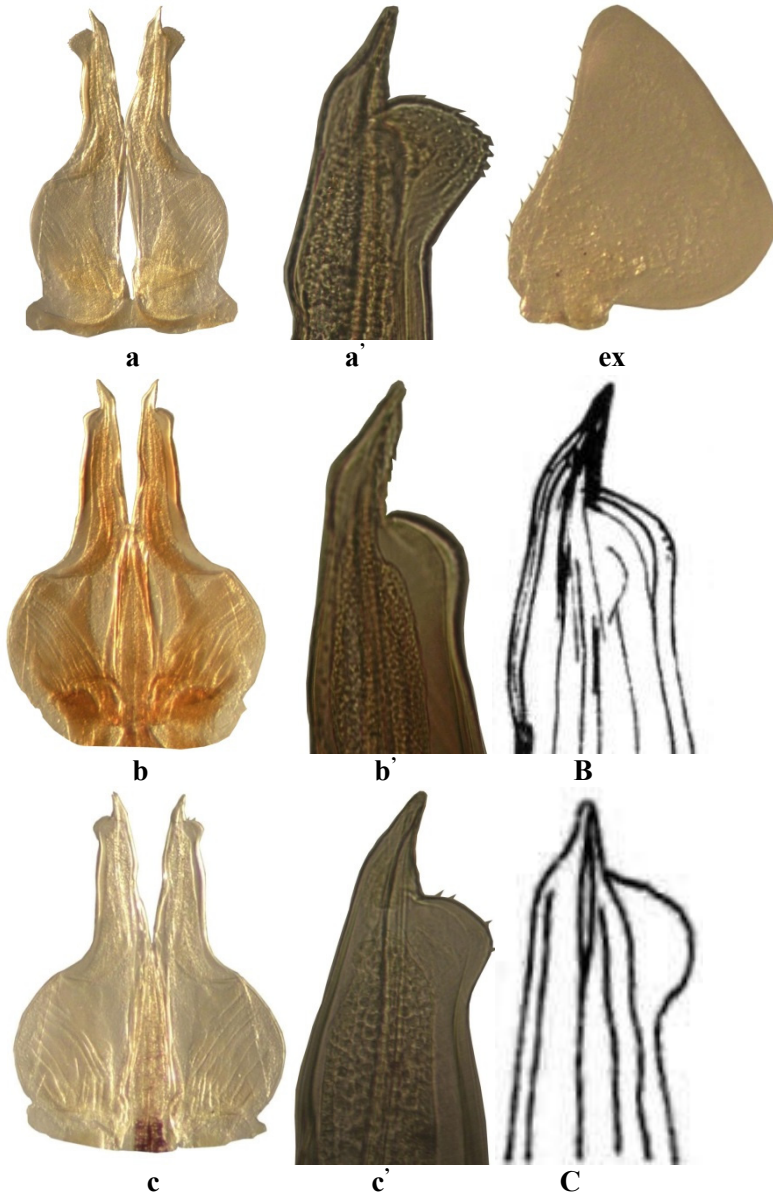


Figure 2.4. *Protracheoniscus politus* C. L. Koch 1841, male pleopods 1: **a, a'**. endopods of male 7.2 x 2.1 mm, collected in 11.May.2008 before molt, **ex.** exopods; **b, b'**. endopods of male 7.5 x 3 mm, collected in 06.July.2008, two months after molt; **B.** *P. politus slovakius* described by Strouhal, 1940 (cited by Radu, 1985); **c, c'**. endopods of male 6 x 2 mm, colectat in 03.October.2008, five months after moult; **C.** *P. politus carpathicus* described by Verhoeff 1928 (cited by Radu, 1985).

Ecology. *P. politus* is a typically sylvan species, living in the litter of regular and floodplain forests from all geographical units (mountains, hills, plains) (Hotea *et al.*, 2003, Mureșan *et al.*, 2003, Radu and Tomescu, 1972, 1976, 1980/1981, Tomescu, 2010, Tomescu *et al.*, 1979a,b, 2008, 2010, 2011a,b). In the research performed with pitfall traps in mountain pastures, we captured a high number of *P. politus* specimens, which proves that the ecological conditions of these pastures are optimal for this typically sylvan species (Tomescu *et al.*, 2001, 2002, 2005). The species was absent in the pastures situated in hilly and lowland areas (Tomescu *et al.*, 1979b, 1995, 2011b). *P. politus* ecological valences are wide, this particularity being constant both in experimental studies and natural habitats. In laboratory we studied the superior lethal temperatures and found that all specimens died at temperatures over 30°C (Tomescu and Radu, 1971a).

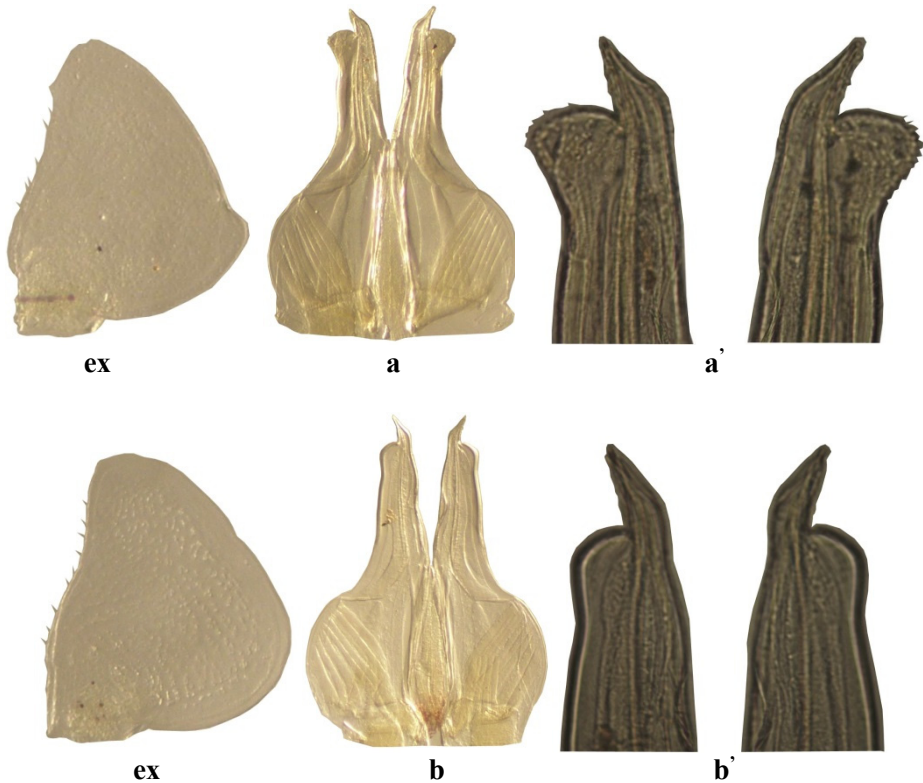


Figure 2.5. *Protracheoniscus politus* C. L. Koch 1841, males from the same sample collected in 05.August.2009, in Călimani Mountains, **a, a'**. male 6.5 x 2.5 mm, **b, b'**. male 7.2 x 3 mm, **ex.** pleopode 1 exopodites, ; **a, a'**, **b, b'**. pleopode 1 endopodites.

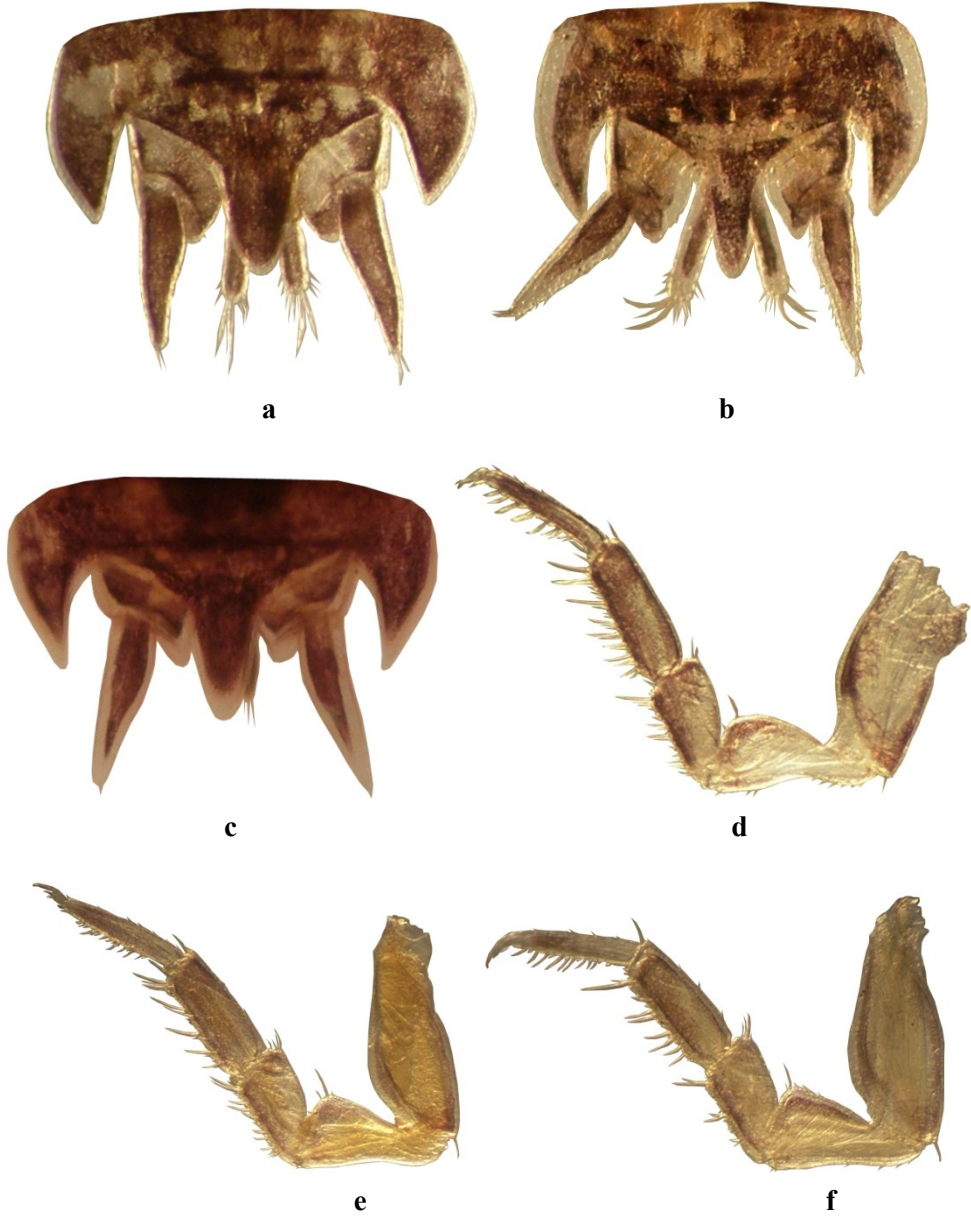


Figure 2.6. *Protracheoniscus politus* C. L. Koch 1841. Morphological variation in males pleotelson: **a.** ♂ 6.5 x 2.8 mm, **b.** ♂ 8 x 3 mm, **c.** ♂ 7 x 3 mm; Pereiopod 7 **d.** ♂ 6.5 x 2.8 mm, **e.** ♂ 7.8 x 3 mm, **f.** ♂ 6 x 5 mm.

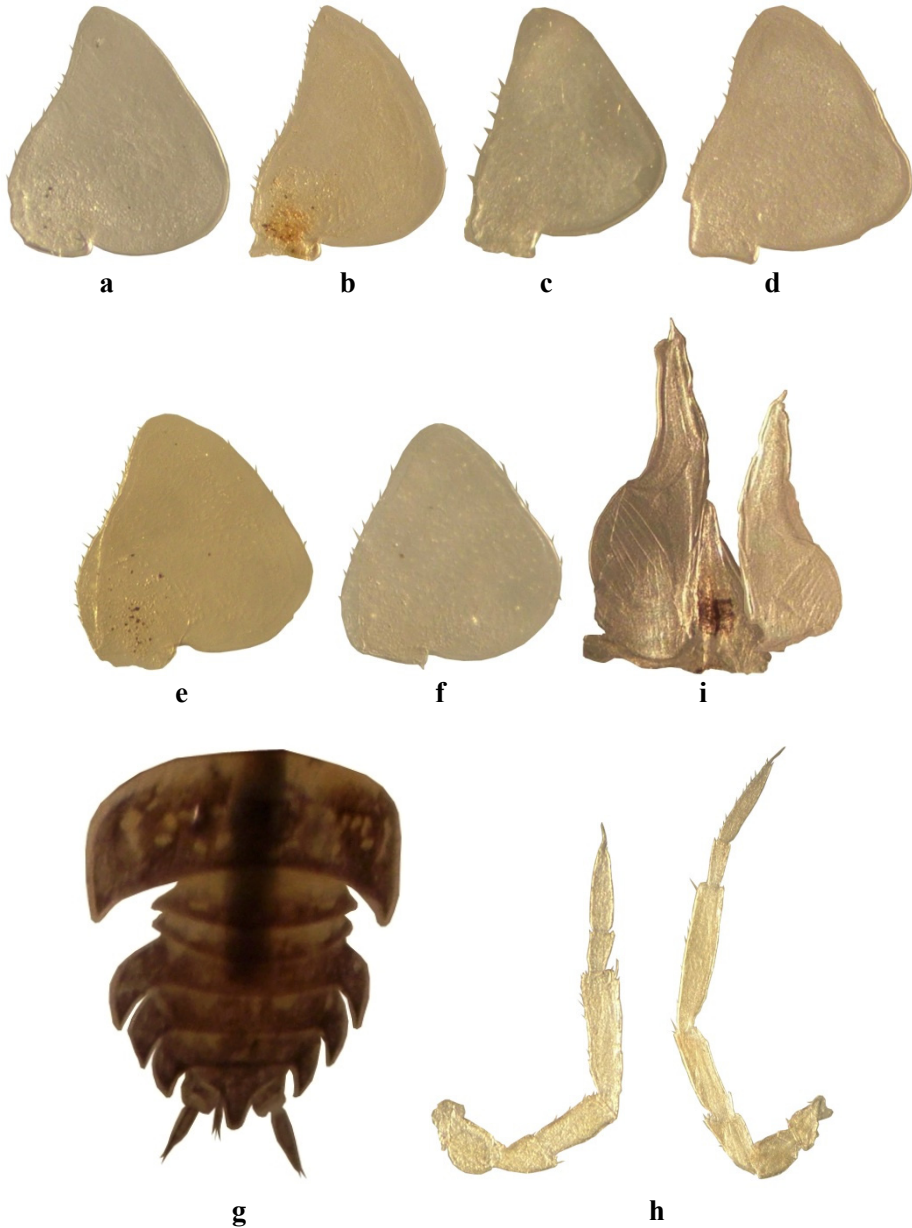


Figure 2.7. *Protracheoniscus politus* C. L. Koch 1841, the variation of the pleopod 1 exopods: **a.** ♂ 6.5 x 2.8 mm, **b.** ♂ 7.5 x 3 mm, **c.** ♂ 7 x 2.5 mm, **d.** ♂ 7 x 3 mm, **e.** ♂ 8 x 3 mm, **f.** ♂ 6 x 2.8 mm; **morphological anomalies:** **g.** ♂ 7 x 2.5 mm 1 and 2 pleonal segments, **h.** ♂ 6 x 2.5 mm antennae, **i.** ♂ 6 x 2.5 mm pleopod 1 endopod.

In field we studied the *P. politus* populations from two forested hills, with southern and northern exposition (Tomescu *et al.*, 1971b). The temperature under the litter and the humidity on the soil surface were measure. There were differences in temperature and humidity. At the southern exposure the temperature was 28⁰C and the humidity 40%, and 16⁰C and 65% at the northern exposure. The quantitative researches has shown the existence of some numerous populations of *P. politus* in forests of both hills (Tomescu *et al.*, 1971b), which proves the relatively high tolerance of the species to the temperature and the humidity of the soil of the habitats it lives in. *P. politus* also has numerous and stable populations in peat bogs, where the humidity of the soil surface is 100% (Tomescu *et al.*, 2015b).

Geographic distribution. The species *P. politus* is present in eastern Germany, Poland, Czech, Slovakia, Austria, Serbia, Montenegro, Hungary and Romania (Schmalfuss, 2003). In Romania we have found *P. politus* populations in all forest types from mountain, hilly and plain areas, as well in mountain pastures with moderate soil humidity.

Discussion

The taxonomical status of the species *P. major* was clarified by Grunner (1966), who studied comparatively the male 1st pleopods in five *Protracheoniscus* species. He described comparatively the shape of male 1st pleopods in *P. major* and *P. asiaticus*, showing the obvious morphological differences between the two species. In our research we described additionally other morphological characters, the male and female cephalon morphology, the cephalic lobes, antennae, the pereopods 1, 2, 3 and 7. In Romania, Radu (1985) mentions wrong *P. asiaticus* as being present in the country. *P. major* is present in many European countries, an exclusively synanthropic species, which lives near old houses and cellars (Jedryckowski, 1981, Vilisics and Hornung, 2009, Ferenti, 2013, Ferenti *et al.*, 2015). We have collected individuals from two Transylvanian localities (Simeria and Salacea), but we consider that it is also distributed in other parts of the country. Recently it was encountered in another small town (Salonta) from western Romania (Ferenti *et al.*, 2015). Further researches are necessary for know its exact distribution in Romania. Under the name of *P. asiaticus* it was recorded by Radu in different localities from Moldova, but without any precise indication and in Oradea (Radu, 1985).

In *P. politus* there are intraspecific morphological variations of the specific characters. At the pleotelson the length and the width of the distal half vary. Also, variations do exist at the length ratio of the last and the penultimate antennary articles. At male pereopod 7 ischium the concavity of the ventral edge varies. Significant variations also exist at male 1st pleopods. The exopods shape varies. At

endopods there are variations related to the post-reproductive moult. At adult males, before moult there are chitinous lobes at the endopods' tip. After the reproduction period the post-reproductive moult takes place, the lobes being removed together with the exuviae. The presence of the chitinous lobes represents the main specific character for *P. politus*. After the chitinous lobes loss the endopods' morphology is modified, fact which determined the confusions of some researchers, which did not know the phenomenon. They studied *P. politus* individuals captures in certain intervals after moult and had described the subspecies *P. politus carpathicus* and *P. politus slovakius* (cited by Radu, 1985). The present and the previous (Tomescu, 1972) research emphasized the modifications of the male pleopod 1 endopods' tips related to the post-reproductive moult. The described subspecies are not valid; they represent taxonomical mistakes of the specialty literature.

In the material collected by pitfall traps between April and October, in 11 habitats, we found males of which endopods without chitinous lobes, but also males in which these were present. We consider that the moult is influenced by the males' participation in the reproduction activity, which triggers the moult process. Analyzing the monthly collected males, we could observe the process of the chitinous lobes' regeneration. In males collected in July, after the moult, the endopods' tip without lobes resembles the ones described by Strouhal (1940) in *P. politus slovakius*. In males collected in October, the lobes were small; resembling the ones described by Verhoeff (1928) in *P. politus carpathicus*. Analyzing the males collected in the next year, in May, we observed that the chitinous lobes were developed at their normal dimensions, specific for all males. Anomalies were observed in a reduced number of males of the 93 dissected males in pleon, antennae and in a male at the pleopod 1 endopods.

REFERENCES

- Cochard, P.O., Vilisics, F., Sechet E. (2010) Alien terrestrial crustaceans (Isopods and Amphipods) Chapter 7. I., *BioRisc.*, 4(1)
- Csordás, B., Kontschán, J., Gábor, H. (2005) Két ritka ászkarák (*Oniscus asellus* Linnaeus, 1758 és *Protracheoniscus major* (Dolfus, 1903) újabb előfordulásai Magyarországon (Crustacea: Isopoda: Oniscidea), *Folia Historico Naturalia Musei Matraensis*, 29, 81-83
- Eshaghi, B., Kiabi, B.H., Kashani, G.M. (2015) The agnarid terrestrial isopods (Isopoda, Oniscidea, Agnaridae) of the province Qazvin, Iran, with a description of a new species, *ZooKeys.*, 515, 59-66
- Ferenți, S. (2013) Izopode terestre (Crustacea, Isopoda) din nord-vestul României: cercetări faunistice și ecologice, *Teză de doctorat, UBB Cluj-Napoca*

- Ferenți, S., Lucaciu, M., Mihuț, A. (2015) Terrestrial isopods from Salonta town, western Romania, *South Western Journal of Horticulture, Biology and Environment*, **6**(1), 21-31
- Ferenți, S., Sas-Kovacs, E. -H., Cupșa, D., Ianc, R. (2012) Some data on the terrestrial isopod assemblages from Livada Forest, northwestern Romania, *Entomologica Romanica*, **17**, 13-19
- Frankenberger, Z. (1959) Stejnonožci Suchzemští – Oniscoidea, Fauna ČSR, *Nakladatelství Československé Akademie Věd*, Praha, pp. 212
- Gruner, H.E. (1966) Über *Protracheoniscus asiaticus* (Uljanin, 1875) und die verwandten arten (Isopoda, Oniscoidea), *Mitt. Zool. Mus. Berlin.*, **42**, Heft 2
- Hotea, R., Tomescu, N., Mureșan, D., Hotea, M. (2003) Cercetări faunistice și ecologice asupra izopodelor terestre de pe versantul sudic al Munților Gutâi, *Analele Univ. Oradea, Biol.*, **10**, 33-37
- Jedryczkowski, W. (1981) Isopods (Isopoda) of Warsaw and Mazovia, *Memorabilia Zool.*, **34**, 79-86
- Mureșan, D., Tomescu, N., Olariu, L., Hotea, R. (2003) Cercetări faunistice și ecologice asupra izopodelor terestre din sectorul mijlociu al Bazinului Arieșului, *Anal. Univ. Oradea, Biol.*, **10**, 27-32
- Radu, V.G. (1985) Crustacea, Isopoda, Oniscoidea, Crinocheta, In *Fauna R.S.R.*, **IV**(14), pp. 155
- Radu, V.G., Tomescu, N. (1972) Studiul populației de *Protracheoniscus politus* (Crustacea, Isopoda) într-o pădure de foioase, *Studia UBB Biologia*, **1**, 75-82
- Radu, V.G., Tomescu, N. (1976) Quantitative ökologische Untersuchungen an Landisopoden, *Pedobiologia*, **16**, 36-43
- Radu, V. G., Tomescu, N. (1980-1981) Cercetări ecologice cantitative asupra unor populații de izopode terestre, *Nyphaea (Folia naturae Bihariae)*, **8-9**, 433-438
- Schmalzfuss, H. (2003) World catalog of terrestrial isopods (Isopoda: Oniscoidea), *Stuttgarter. Beitr. Naturk. Ser. A.*, **654**, pp. 341
- Schmölzer, K. (1965) Ordnung Isopoda (Landasseln), *Bestimmungsbücher zur Bodenfauna Europas*, **5**, 187-468
- Strouhal, H. (1929) Über einige Arten der Gattung *Protracheoniscus* Verh. (Isop. terr.), *Ann. Naturhist. Museums in Wien*, Bd. **43**
- Tomescu, N. (1972) Reproduction and ontogenetic development of *Protracheoniscus politus*, *Rev. Roum. Biol., Zool.*, **17**(1), 31-39
- Tomescu, N. (2010) Izopode terestre (Isopoda, Crustacea), In: *Situl Natura 2000 Cușma*, Proorocu, M., Beldean, P., Crișan, A. (eds.), Ed. Risoprint, Cluj-Napoca, pp. 126-139
- Tomescu, N., Radu, V.G. (1971a) Temperaturile letale superioare la câteva specii de izopode terestre, *Stud. Cercet. Biol., Zool.*, **23**(3), 263-267
- Tomescu, N., Radu, V.G., Tudoran, P., Fărcaș, I., Buz, V. (1971b) Influența microclimei asupra macrofaunei din frunzar, *St. Cercet. Biol., Zool.*, **23**(1), 53-59
- Tomescu, N., Ceuca, T., Matic, Z., Crișan, D. (1979a) Cercetări ecologice cantitative asupra unor grupe de artropode din litieră, *Studia UBB Biologia*, **1**, 41-46
- Tomescu, N., Schneider, E., Weiss, I. (1979b) Die Isopoden eines Südhagens in hügelnd Südsiebenbürgens, *Muz. Brukenthal Stud. Comun., Sti. nat.*, **23**, 275-286

- Tomescu, N., Accola, S., Pașca, C. (1995), Ecology of the populations of terrestrial isopods (Crustacea: Isopoda) in Cheile Turzii, *Studia UBB Biologia*, **40**(1-2), 78-94
- Tomescu, N., Mureșan, D., Popa, V. (2001) The terrestrial isopod fauna in the superior basin area of the Someșul Cald river, *Studia UBB Biologia*, **46**(2), 43-47
- Tomescu, N., Mureșan, D., Popa, V. (2002) Faunistic and ecological researches on the terrestrial isopods from the superior sector of the Arieș river basin, *Studia UBB Biologia*, **47**(1), 3-14
- Tomescu, N., Mureșan, D., Olaru, L., Hotea, R. (2005) Terrestrial Isopod communities (Crustacea, Isopoda) in riverside coppices and meadows of mountainous, hilly and depression areas, *Studia UBB Biologia*, **50**(2), 19-25
- Tomescu, N., Bogdan, H., Peter, V., Covaciu, S., Sas, I. (2008) Terrestrial Isopods from the Western and North-Western Romania, *Studia UBB Biologia*, **53**(2), 3-15
- Tomescu, N., Ferentți, S., Covaciu-Marcov, S.D., Sas, I., David, A. (2010) What do the terrestrial isopods eaten by some frogs from north-western Romania have to say?, *North-Western Journal of Zoology*, **6**(2), 268-274
- Tomescu, N., Ferentți, S., Teodor, L.A., Covaciu-Marcov, S.D., Cicort-Lucaciu, A.Ș., Sucea, F.N. (2011a) Terrestrial Isopods (Isopoda: Oniscoidea) from Jiului Gorge National Park, Romania, *North-Western Journal of Zoology*, **7**(2), 277-285
- Tomescu, N., Mureșan, D., Teodor, L.A. (2011b) Izopodele terestre din bazinul inferior al Arieșului: cercetări faunistice și ecologice, In: *Volum comemorativ – Bogdan Stugren*, Rákosy, L., Momeu, L. (eds.), Ed. Presa Univ. Clujeană, pp. 39 – 45
- Tomescu, N., Teodor, L.A., Ferentți, S., Covaciu-Marcov, S.D. (2015a) *Trachelipus* species (Crustacea, Isopoda, Oniscoidea) in Romanian fauna: morphology, ecology, and geographic distribution, *North-Western Journal of Zoology*, Oradea, **11**(Supplement 1), 1-106
- Tomescu, N., Urák, I., Teodor, L.A. (2015b) Terrestrial isopod (Crustacea, Isopoda) of peat bogs in Romania, *Studia UBB Biologia*, **60**(1), 89-94
- Vilisics, F., Hornung, E. (2009), Urban areas as hot-spots for introduced and shelters for native isopod species, *Urban Ecosyst.*, **12**, 333-245
- Wächtler, W. (1937) Ordnung: Isopoda, Asseln, *Die Tierwelt Mitteleuropas*