

First record of two slug mite species of the genus *Riccardoella* Berlese (Acari: Ereyneidae) in Serbia

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Received: 21 December, 2016

Accepted: 30 December, 2016

SUMMARY

The paper presents the first data on slug mites *Riccardoella* (*Riccardoella*) *limacum* (Schrank) and *R. (Prorriccardoella) oudemansi* Thor (Acari: Ereyneidae) in Serbia. The two parasitic species were detected on seven species of snails and slugs (Gastropoda, Pulmonata) in Serbia. *Riccardoella limacum*, which is a specialized snail parasite, was found in *Helix pomatia* L. and *H. lucorum* L. species of the family Helicidae. *Riccardoella oudemansi* was found exclusively on slug species: *Arion lusitanicus* Mabilie (Arionidae), *Tandonia budapestensis* (Hazay) (Milacidae), *Limacus flavus* (L.), *Limax maximus* L. and *L. cinereoniger* Wolf (Limacidae).

Keywords: Snails; Slugs; Mites; Parasites

INTRODUCTION

Parasitic slug mites belong to the family Ereyneidae Oudemans 1931, subfamily Pseudotydeinae Baker 1974, which mostly consists of mite species free-living in detritus, moss, underneath tree bark, and similar sites, but includes also some parasitic species. Only several species of the genera *Riccardoella* Berlese 1923 and *Austreyneetes* Fain & Barker 2003 are obligate parasites in the pallial cavity of terrestrial snails and slugs (Fain, 2004).

The two best-studied species show a clear distinction regarding their hosts. *Riccardoella* (*Riccardoella*) *limacum* (Schrank 1776) parasitize snails, while *Riccardoella* (*Prorriccardoella*) *oudemansi* Thor 1932 is a slug parasite (Fain & van Goethem, 1986). The other biological and ecological characteristics are very similar - both species

move freely on the slimy host body surface, penetrate the pneumostome and settle inside the pallial cavity. They pierce the host's thin respiratory epithelium, feed on hemolymph, and then lay eggs (Baker, 1970). Heavy infestation weakens the host, inhibits its growth and development, ultimately leading to histopathological changes and shell softening. *R. limacum* has been reported to cause significant damage in edible snail farms (Flechtmann & Baggio, 1985; Graham et al., 1993; Segade et al., 2013). Besides, both of these cosmopolitan species evidently have a potential for playing a role in biological control of snail and slug pests (Cagan & Shoab, 2003; Ueckermann & Tiedt, 2003).

Seven species of the genus *Riccardoella* have been described so far, namely: *R. (R.) limacum* and *R. (P.) oudemansi* as cosmopolitan, while *R. (P.) reaumuri*

Fain & van Goethem 1986 has been detected in Belgium and France, *R. (P.) canadensis* Fain & van Goethem 1986 in Canada and Ukraine (Zabludovskaya, 1995), *R. (P.) triodopsis* Fain & Klompen 1990 in the US, *R. (P.) novaezealandiae* Fain & Barker 2004 in New Zealand, and *R. (P.) zadielensis* André, Ducarme & Lebrun 2004 in Slovakia and the Czech Republic (André et al., 2004; Fain & Barker, 2004; Zabludovskaya & Badanin, 2010).

No targeted research of parasitic slug mites has been organized in Serbia so far but they have been observed and collected sporadically as part of various applied malacology studies, so that a volume of data has accumulated and provided a core of the present report.

MATERIAL AND METHODS

All parasitic slug mites were collected from snails and slugs in anthropogenic habitats, i.e. the most frequent synanthropic species, from early June until early September. Mites were sampled from several species of land molluscs at different locations in Serbia, mostly within urban communities. Synanthropic snails and slugs are easy to find when their density is high, which results in wide infestation with parasitic mites in the later part of the vegetation season. The intensity of infestation within snail and slug populations was not measured.

An electric magnifying glass (10x) was used for examining the foot integument and pneumostome edges in active and resting positions of snails and slugs at two minute intervals. An electronic scale and calipers were used for measuring all snails (g body weight / shell diameter) and slugs (g body weight only). Mites were sampled from the host integument by the sticky acarological pin dipped in Hoyer's medium, and then left to rest in a fixative. For fixation and transparency, a mixture of 70% ethanol and lactic acid was used at 5:1 ratio (Evans & Browing, 1955). Permanent microscopy specimens were mounted in Hoyer's medium (Baker & Wharton, 1964). Permanent specimens were examined under a phase-contrast light microscope, using the immersion oil system (Leica DM LS). Appropriate taxonomic literature was consulted, and keys for identification of mites of the genus *Riccardoella* (Fain & van Goethem, 1986; Fain & Klompen, 1990; André & Fain, 2000; Fain & Barker, 2003, 2004), as well as snail and slug hosts (Wiktor, 1982, 1989; Kozłowski, 2010).

The voucher specimens mounted in Hoyer's medium were deposited at the Department of Entomology and Agricultural Zoology of the Faculty of Agriculture, University of Belgrade.

RESULTS

Two species of slug mites were identified by microscopic examination: *Riccardoella (Riccardoella) limacum* (Schrank 1776) (Figures 1, 2, 3) and *Riccardoella (Proriccardoella) oudemansi* Thor 1932 (Figures 4, 5, 6). There is a significant taxonomic distinction between the two, primarily regarding their leg and pedipalp chaetotaxy, especially at subgenus level (Fain & van Goethem, 1986). Biological differences were also confirmed, i.e. the fact that the two mite species parasitize exclusively either snails or slugs, i.e. two ecologically and morphologically different groups of molluscs.



Figure 1. *Riccardoella (Riccardoella) limacum*, habitus of a female



Figure 2. *R. limacum*, female with egg

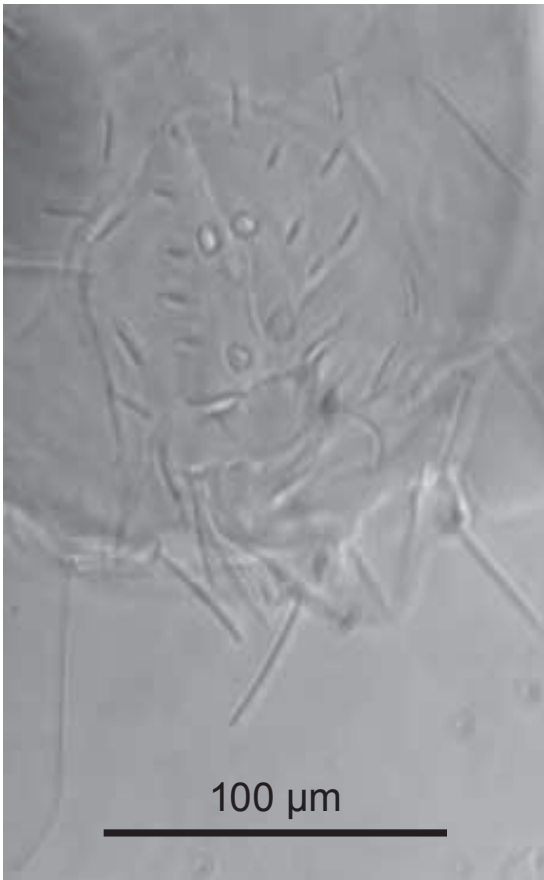


Figure 3. *R. limacum*, ano-genital region of a female



Figure 5. *R. oudemansi*, tarsi and tibia, legs I and II of a female

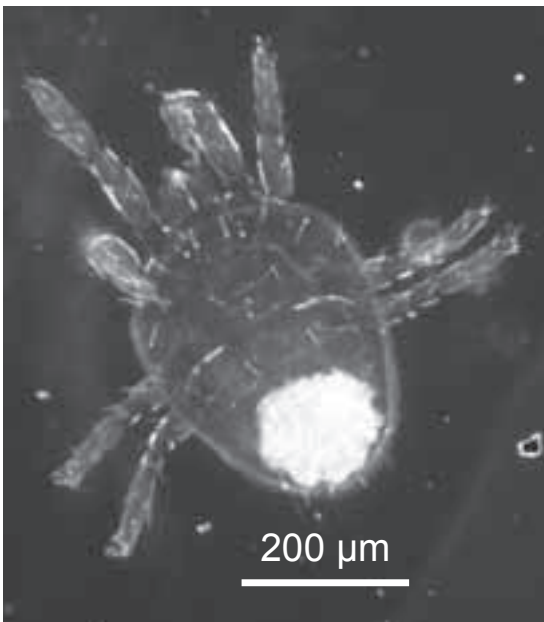


Figure 4. *Riccardoella (Proviccardoella) oudemansi*, habitus of a female

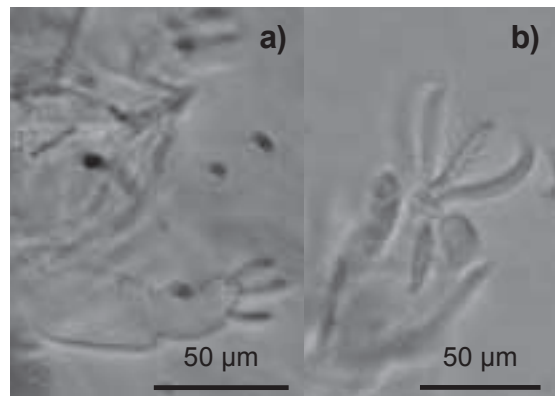


Figure 6. *R. oudemansi*, palptarsus of a female (a), I tarsus of a female (b)

The species *R. limacum* was detected on the two largest snail species, *Helix pomatia* L. and *H. lucorum* L., while inspection for the smaller *Cepea* spp. in the same locations led to no confirming data. *R. limacum* was found:

- on *H. pomatia*: Zemun, Bežanijska kosa, 25.06.2011, snail size 21.13 g / 37.03 mm (female and nymph); same location, 30.06.2011, snail size 26.30 g / 40.89 mm (2 females); Zemun – Central park, 28.06.2011, 2 snails, size 19.02 g / 34.36 mm and 14.81 g / 31.63 mm (2 females); Zvezdara, 10.07.2011, snail size 10.90 g / 28.01 mm (nymph); Novi Bečej, Center, 27.09.2014, snail size 16.83 g / 30.07 mm (female); Zrenjanin, Bagljaš, 28.09.2014, 2 snails, size 25.59 g / 34.08 mm and 20.33g / 35.72 mm (female and nymph); Lazarevac, Vis, Bazen 7.09.2015, snail size 19.80 g / 34.46 mm (female). (Figure 7).
- on *H. lucorum*: Plandište, 24.09.2005, a poorly tended farm of *H. pomatia* snails, size 20.34 g / 35.81 mm, (2 females).

The species *R. oudemansi* (Figure 8) was found on several slug species, *Arion lusitanicus* Mabilie (Arionidae) and *Tandonia budapestensis* (Hazay) (Milacidae), as well as *Limacus flavus* (L.), *Limax maximus* L. and *L. cinereoniger* Wolf (Limacidae). *R. oudemansi* was found:

- on *A. lusitanicus*: Ivanjica, 25. 07.2004, 2 slugs, size 10.75 g and 9.31 g, (4 females); Krnjača, 4.07.2008, 2 slugs, size 4.42 g and 7.90 g (2 females, nymph); Zenjanin, Bagljaš, 28.06.2009, slug size 3.77 g (female); Zemun, Bežanijska kosa, 15.07.2011, slug size 6.29 g (4 females); Lazarevac, Vis, 7.09.2015, slug size 11.34 g, (female). (Figure 9)
- on *L. flavus*: Ivanjica, 25. 07.2004, slug size 4.99 g (2 females); Krnjača, 07.08.2008, slug size 4.86 g (female); Zrenjanin, Bagljaš, 28.09.2009, slug size 2.18 g (2 females); Zemun, Bežanijska kosa 15.07.2011, 2 slugs, size 4.06 g and 2.82 g (4 females); Lazarevac, Vis, 7.09.2015, slug size 7.48 g (2 females); Sombor, 12.07.2011, 2 slugs, size 3.99 g and 5.30 g (3 females, nymph); Novi Bečej, Provala, 26.09.2014, slug size 3.47 g (3 females).
- on *L. maximus*: Bačka Palanka, 22.06.2011, slug size 5.31 (1 female); Sombor, 29.07.2012, 2 slugs, size 6.37 g and 5.80 g (4 females); Čačak, 13.06.2013, slug size 10.78 g, (3 females); Novi Bečej, Center, 26.09.2014, 2 slugs, size 8.95 g and 22.85 g (3 females, nymph).
- na *L. cinereoniger*: Novi Bečej, Center, 26.09.2014, slug size 5.38 g (2 females); Lazarevac, Vis, 7.09.2015, slug size 13.62 g (3 females).
- na *T. budapestensis*: Jakovo, 17.06.2011, slug size 1.13g (female); Kovin, Pločica, 29.07.2012, slug size

1.14g (female); Zemun, Gornji grad 26.09.2014, slug size 1.64g (female); Čačak, 13.06.2013, slug size 1.05g (female); Novi Bečej, Center, 26.09.2014, slug size 1.22g (female).



Figure 7. *R. limacum*, on *Helix pomatia*



Figure 8. *R. oudemansi*, slug mites in vivo



Figure 9. *R. oudemansi*, in the pneumostome of *Arion lusitanicus*

DISCUSSION

In the course of this research, we collected two most frequent species of parasitic mites from molluscs that are already known as the host species of these parasites. The revealed hosts in Serbia are consistent with an earlier conclusion (Fain & van Goethem, 1986) that *R. limacum*, which is a member of the more advanced subgenus *Riccardoella*, is a highly specific parasite of snails from several genera of the family Helicidae, while *R. oudemansi* belongs to the more primitive genus *Proriccardoella*, so that its feeding is limited to primitive molluscs, i.e. slugs of the families Arionidae, Limacidae and Milacidae.

Information about the distribution of *Riccardoella* mites in the region of Serbia is insufficient. Our findings are partly consistent with data reported from Slovakia (Shoaib & Cagaň, 2004), where *R. oudemansi* was also found on the species *L. flavus*, *L. maximus* and *A. lusitanicus*, but it was also detected on the species *Arion ater* L. and *Deroceras reticulatum* (O.F. Müller), which were not found in our present study. We found massive mite infestations within some populations of *A. lusitanicus* and in *H. pomatia*-growing farms because both species, the invasive slug and the reared snail, have a tendency of aggregation, which facilitates mite transfer by contact, and the resulting spread of infestation (Schüpbach & Baur, 2010). In Slovakia, the highest infestation was detected in the species *L. maximus*, i.e. 6-12 *R. oudemansi* mites per animal (Shoaib & Cagaň, 2004), even though the slug is not known as a species normally forming large aggregations, but the next most infested species was also *A. lusitanicus*.

ACKNOWLEDGEMENT

This study received a grant from the Serbian Ministry of Education, Science and Technological Development (Project No. III 46008).

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Prvi podaci o parazitskim grinjama roda *Riccardoella* Berlese (Acari: Ereyneidae) na puževima plućašima u Srbiji

REZIME

U radu su izloženi prvi podaci o nalazima plućnih grinja *Riccardoella* (*Riccardoella*) *limacum* (Schrank) i *R. (Proriccardoella) oudemansi* Thor (Acari: Ereyneidae), koje su zabeležene u Srbiji na sedam vrsta puževa i golača (Gastropoda, Pulmonata). *Riccardoella* (*R.*) *limacum*, koja je parazit puževa sa ljušturom, nađena je na vrstama familije Helicidae, *Helix pomatia* L. i *H. lucorum* L. Nasuprot tome, vrsta *R. (P.) oudemansi* nalazena je isključivo na golačima, na vrstama: *Arion lusitanicus* Mabilie (Arionidae), *Tandonia budapestensis* (Hazay) (Milacidae), *Limacus flavus* (L.), *Limax maximus* L. i *L. cinereoniger* Wolf (Limacidae).

Ključne reči: Puževi; Golači; Grinje; Paraziti