THE MITES *RICCARDOELLA LIMACUM* (SCHRANK, 1776) AND *R. OUDEMANSI* THOR, 1932 (TROMBIDIFORMES: EREYNETIDAE) PARASITIC ON MOLLUSCS AT ST NICHOLAS FIELDS, YORK

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Abstract *We report on the recent finding of the mite* Riccardoella limacum *(Schrank, 1776) (Acari: Trombidiformes: Ereynetidae) parasitic on a garden snail* Cornu aspersum *(O. F. Müller, 1774) and* R. oudemansi *Thor, 1932 on numerous slug and snail species, and observations of the ecology of both species, at St Nicholas Fields, a small urban nature reserve in York, England. There has been much discussion historically about the identities of* R. limacum *and* R. oudemansi, *with many records of the former from slugs being misidentifications of* R. oudemansi. *We draw attention to accurate records of* R. limacum *from Menai Bridge, Cardiff and Devon made by Fiona Jane Graham during her PhD research (Graham, 1994).* R. limacum *is therefore clearly a good British species.*

Key words Riccardoella limacum, Riccardoella oudemansi, *new records, Mollusca, Gastropoda, Britain, Wales*

INTRODUCTION

There has historically been much discussion about whether the white snail mite *Riccardoella limacum* (Schrank, 1776) and the morphologically similar *R. oudemansi* Thor, 1932 are separate species or represent a single one. Morphological differences between the two were identified only quite recently by Fain & Van Goethem (1986); they, Graham *et al*. (1993) and Graham (1994) discuss the many erroneous records of *R. limacum* on slugs. Contrary to its species epithet, *R. limacum* appears to be restricted to snails, whereas *R. oudemansi* may be found on both slugs and snails (Fain & Van Goethem, 1986; Graham, 1994). Fain & Van Goethem (1986) gave confirmed records of *R. limacum* only from Roman snail *Helix pomatia*, garden snail *Cornu aspersum*, vineyard snail *Cernuella virgata* and copse snail *Arianta arbustorum*. They concluded that it had a rather narrow host range, and was probably restricted to the Helicoidea, although in this conclusion they overlooked a record of *R. limacum* by Reamur from the operculate round-mouthed snail *Pomatias elegans*.

R. limacum is absent from the United Kingdom Species Inventory (UKSI), whereas *R. oudemansi* is present (Raper, 2021). Although there are two recent British records of *R. limacum* on unidentified snails on iNaturalist, these are unverifiable as they were not microscopically checked, and have presumably been called this species simply because they were on snails; in fact, they may well be records of *R. oudemansi*. One of these records was classed as 'Research Grade' simply because two people identified it as *R. limacum*, illustrating the limitations of the iNaturalist verification system. This Research Grade record appears on the Global Biodiversity Information Facility (GBIF), making it appear as though *R. limacum* is a confirmed British species.

However, during her PhD research, Graham (1994) made accurate records of *R. limacum* from *C. aspersum* collected mainly from a private garden in Menai Bridge, Anglesey, Wales as well as some from unspecified locations in Cardiff, Wales and Devon, England. Graham *et al*. (1993) provided scanning electron microscope images to illustrate morphological differences between *R. oudemansi* and *R. limacum* found by Fain & Van Goethem (1986). To our knowledge, these are the only two *Riccardoella* species known in Britain. Below, we provide a further recent confirmation of *R. limacum* in Britain based on investigations into *Riccardoella* spp. at St Nicholas Fields in York, along with some general observations of *Riccardoella* ecology.

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Materials and Methods

Study site St Nicholas Fields Local Nature Reserve (St Nicks for short) is a 10ha (24-acre) site in the heart of York, England, with diverse habitats including meadows, scrub, woodland, and Osbaldwick and Tang Hall Becks (see Buckton, 2022 for details). Significantly for molluscs, many woodland areas are littered with boulders, stone slabs, bricks and other rubble as well as deadwood, underneath which an abundance of slugs and snails may be found. An impressive 18 slug species, 25 snail species and one semi-slug species are known from the reserve. *Riccardoella* mites are very common across the reserve, visible to the naked eye as white specks scurrying around over the surface of their host slugs and snails. We investigated what mite species were present, and on which hosts.

Sampling technique Mites were collected in the field weekly in December 2020 and October-November 2021 in sample bottles half-filled with water. A small paintbrush dipped in the water was used to pick up mites from the slug or snail, and was then shaken vigorously in the water to dislodge the mites. Successful collection was evident by mites floating on the water surface, easily visible with a 10× magnification hand lens. At home, the water was poured out into a small petri dish on a black surface under a stereo microscope. A magnification of 20× allows the mites to be seen clearly. A very fine paintbrush (size 00 or 000, or a coarser brush with most of the bristles removed) was used to transfer mites to a container of 100% industrial methylated spirit, or denatured alcohol. Once in the spirit, the mites are stable and can be processed at a later date.

Preparation of mites for identification The preserved mites were cleared before identification. Relatively aggressive clearing agents such as 1% w/v potassium hydroxide or 60% lactic acid solutions were found to cause the mites to burst very easily. Although the images here were made from mites mounted in a drop of 70% alcohol hand gel with a drop of 40% lactic acid solution added, we have found subsequently that 40% lactic acid solution by itself also gives good results and is easier to work with. A small drop of the solution was placed on a microscope slide and a mite or mites transferred to it using a fine paintbrush, taking care not to let the mites dry out (this causes them to collapse). Mites may become stuck in the paintbrush bristles during this process, in which case they can be gently scraped out using a micro pin tool. A small coverslip was placed on top and the slide left for a few minutes to clear before observations were made. The weight of the coverslip can burst the mites, but as long as the dorsal setae and leg features are visible, identification should be possible (see below). Photographs were taken using a Fuji AX-5 camera attached to the microscope's photo eyetube, and the images stacked and processed using Affinity Photo software.

Mite identification Cleared adult mites were observed using a Brunel SP30 LED compound microscope and identified by reference to Fain & Van Goethem (1986), Graham *et al*. (1993) and Ueckermann & Tiedt (2003). 200× magnification is the most useful for obtaining an overview of the dorsal body setae and 400× or 1000× oil immersion is needed to see setal details on the tarsi and tibiae. Although we describe the identification below as a comparison between *R. oudemansi* and *R. limacum*, we made sure to rule out other named species in Fain & Van Goethem (1986), namely *R. reaumuri* Fain & van Goethem, 1986 and *R. canadensis* Fain & Van Goethem, 1986.

R. limacum could be distinguished from *R. oudemansi* by comparing the six pairs of setae arranged longitudinally in the dorsocentral part of the dorsum. In *R. limacum*, the anterior pair (designated *vi* in mite terminology) is shorter and thicker than the longer and thin remaining pairs (Fig. 1a & c). In *R. oudemansi*, these setae are all similar in appearance, being short and thick, but pair *vi* is longer than the other five pairs (Fig. 2a & c). Other obvious differences between the species can be seen on the tibia of leg I. The tibia of leg I bears a seta with a forked tip (the famulus). The length of the famulus relative to the seta next to it (hair *t*) is also diagnostic: in *R. oudemansi* , the famulus is about two-thirds the length of hair *t* (Fig. 2b), whereas in *R. limacum*, the famulus is about one-third of the length of hair *t* (Fig. 1b). Examining the dorsal setae and famulus is sufficient to distinguish *R. oudemansi*, *R. limacum* and other known *Riccardoella* species in Fain & Van Goethem (1986); our records have been verified by Matthew Shepherd as correct based on these characters, and we feel reasonably confident of their accuracy. However, examination of other

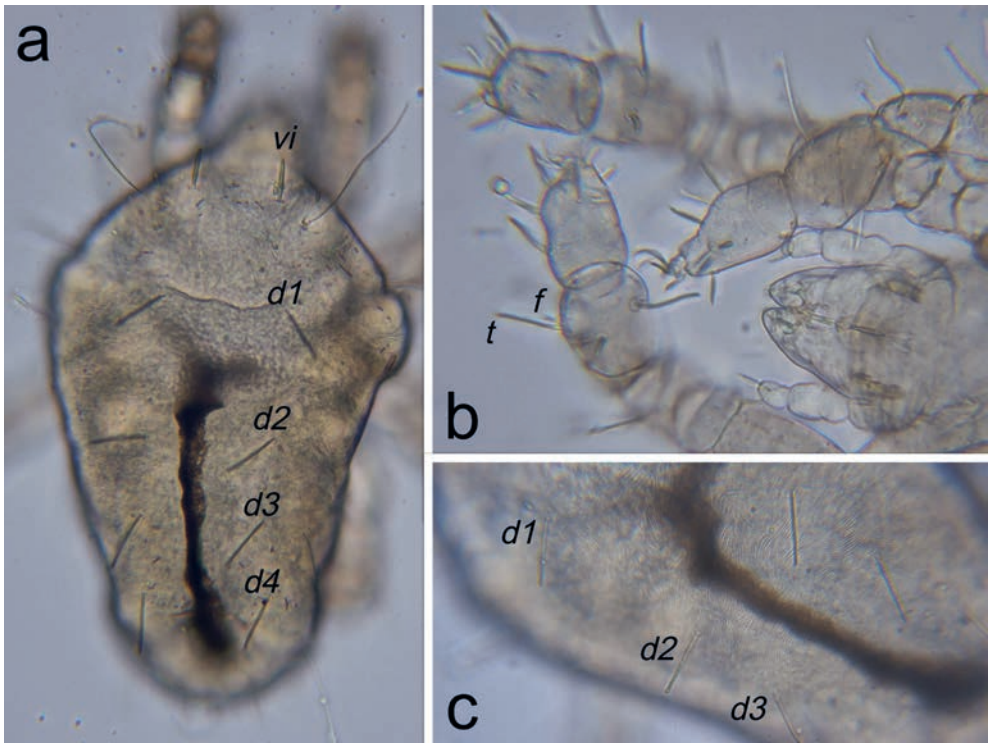

Figure 1 Identification features of *Riccardoella limacum* (the mite body is c. 0.4mm long): **a** dorsal view showing long thin dorsocentral setae *d*1-4 (pair *d*5 is not visible in this image, but is similar to the other setae) compared to shorter thicker anterior pair *vi*; **b** leg I showing detail of the famulus (*f*) relative to its paired seta (*t*) on the tibia; **c** detail of dorsocentral setae. Photos: Jane Thomas.

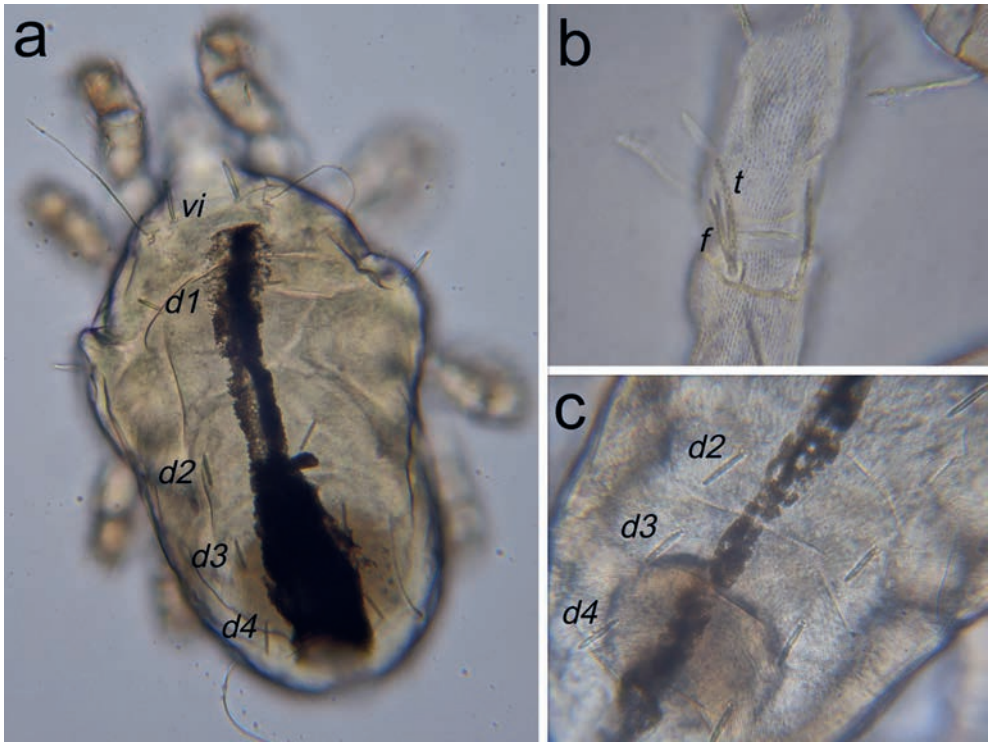

Figure 2 Identification features of *Riccardoella oudemansi* (the mite body is c. 0.4mm long): **a** dorsal view showing short thick dorsocentral setae *d*1-4 (pair *d*5 is not visible in this image, but is similar to the other setae) compared to the longer anterior pair *vi*; **b** tibia of leg I showing detail of the famulus (*f*) relative to its paired seta (*t*); **c** detail of dorsocentral setae. Photos: Jane Thomas.

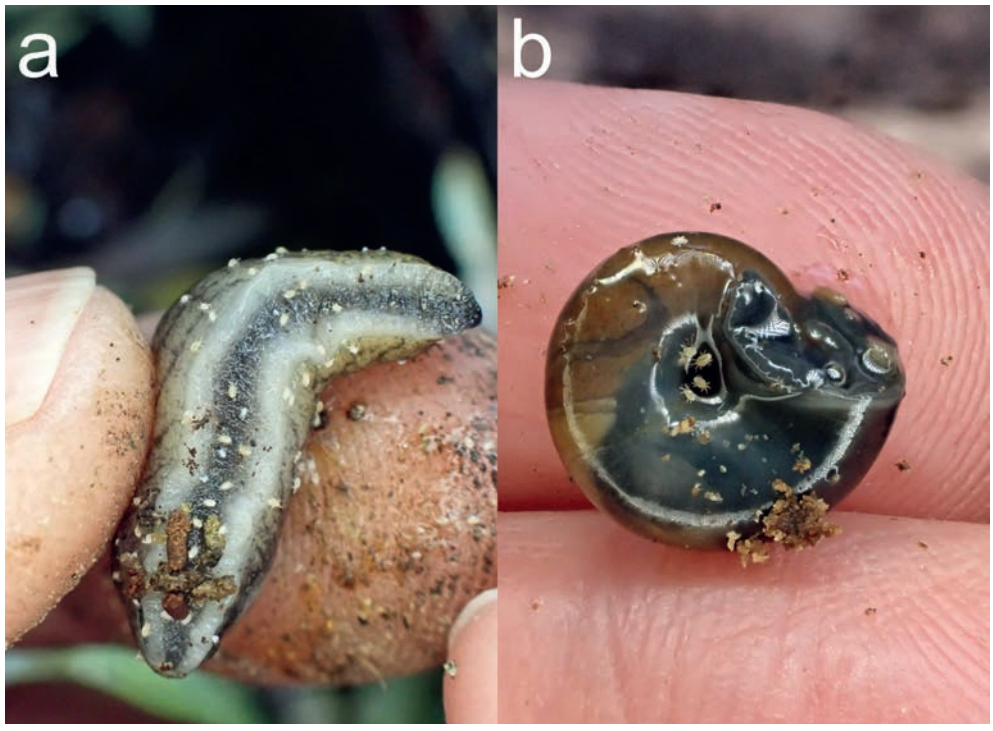

Figure 3 The ubiquitous *Riccardoella oudemansi* at St Nicks: **a** Budapest keeled slug *Tandonia budapestensis* covered in *R. oudemansi* (this slug species often suffers from a relatively high mite load); **b** *R. oudemansi* clustered in the umbilicus of an *Oxychilus* sp. Amongst snails, *Oxychilus* spp. seem to suffer a comparatively high mite load in relation to their size. Photos: Jane Thomas.

features (tarsus and tibia of leg I and tarsus of leg II) can further increase the confidence of identification and should ideally be carried out, particularly to rule out possible undescribed species, although these features are more challenging to find and view. See Fain & Van Goethem (1986) for details.

Results

It is clear that *R. oudemansi* is ubiquitous at St Nicks on slugs and snails. Particularly heavy parasite burdens were often found on Budapest keeled slug *Tandonia budapestensis* (Hazay, 1880) (Fig. 3a) and green cellar slug *Limacus maculatus* (Kaleniczenko, 1851); although other slug species were infested, they seldom had so many mites. Snails appeared not to carry such high mite burdens as slugs, but this may be due to the mites having less exposed body surface to run around on, and thus being less visible. Mites were often found clustered in the umbilicus of *Oxychilus* species (Fig. 3b), which seemed to carry a relatively high number of mites for their size. We found *R. oudemansi* on a wide range of slug and snail species in various locations (Table 1).

R. limacum was found on only one occasion on 20/10/2021, from a group of *C. aspersum* under a wooden plank near a composting area at the edge of the reserve (SE616515). Four mites were obtained, two of which proved to be *R. limacum*, whilst the other two were *R. oudemansi*. Since the snails were not sampled individually, we are not able to confirm if both species were present on an individual snail, although the two mite species were clearly in close proximity.

Conclusions and future directions

R. limacum is clearly a good British species and should be added to the UKSI. If St Nicks is reflective of other British sites, *R. limacum* would be expected to be considerably rarer than *R. oudemansi*, although it is surely present at far more locations than current verifiable records – from Menai Bridge, Cardiff and Devon by Graham in the 1990s, and York in the 2020s (as shown in this present study) - would suggest, and may co-exist in close proximity to *R. oudemansi*. Our observations corroborate the notion of *R. oudemansi* as a generalist on slugs and snails and *R. limacum* as specialising on snails reported by Fain & Van

Table 1 Details of *Riccardoella oudemansi* records from St Nicholas Fields, York. All records were made by Jane Thomas.

Grid ref.	Date	Host
SE614519	17/11/2021	Smooth glass snail *Aegopinella nitidula* (Draparnaud, 1805)
SE617515	20/10/2021	White-lipped snail *Cepaea hortensis* (O. F. Müller, 1774)
SE616515	20/10/2021	Garden snail *Cornu aspersum* (O. F. Müller, 1774)
SE616517	03/11/2021	Cellar snail *Oxychilus cellarius* (O. F. Müller, 1774)
SE615516	13/10/2021	Draparnaud's glass snail *O. draparnaudi* (H. Beck, 1837)
SE616518	17/11/2021	Glossy glass snail *O. navarricus* (Bouguignat, 1870)
SE616519	30/12/2020	Hairy snail *Trochulus hispidus* (Linnaeus, 1758)
SE615516	30/12/2020	Iberian threeband slug *Ambigolimax valentianus* (Férussac, 1822)
SE616518	17/11/2021	Brown soil slug *Arion distinctus* J. Mabille, 1868
SE616516	30/12/2020	Tawny soil slug *A. owenii* Davies, 1979
SE616516	04/05/2022	Vulgar slug *A. vulgaris* Moquin-Tandon, 1855
SE616519	30/12/2020	Green cellar slug *Limacus maculatus* (Kaleniczenko, 1851)
SE615519	13/10/2021	Budapest keeled slug *Tandonia budapestensis* (Hazay, 1880)
SE614519	17/11/2021	Winter semi-slug *Vitrina pellucida* (O. F. Müller, 1774)

Goethem (1986). We remain on the lookout for more *R. limacum* at St Nicks, as well as other *Riccardoella* species both described (e.g. *R. reaumuri* and *R. canadensis* – see Fain & Van Goethem, 1986) and undescribed, which might be found in Britain. It is hoped that others are encouraged to look more closely at these highly under-recorded mites.

Acknowledgements

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