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A contribution to the knowledge of the enigmatic Tanaupodidae (Actinotrichida: Trombidiformes, Parasitengona)—description of a new species of *Lassenia* and a new host record

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Abstract

A new tanaupodid mite, *Lassenia newelli* **sp. nov.** is described based on a larva parasitising the aphid *Myzocallis coryli* (Goeze, 1778) (Aphididae) in Scotland, Great Britain. It is the ninth species of *Lassenia* known from the larval stage, the second host association for the genus and the first one for which the specific affiliation of both the parasite and its host is provided. The finding contributes to the taxonomy and biology of Tanaupodidae which have been considered to form one of the basal clades of Parasitengona. The discovery of elongate seta on the dorsal surface of tarsus III in *L. newelli*, a characteristic also shared by the monotypic *Amphotrombium*, supports the hypothesis of possible links between the tanaupodids and amphotrombiids as early derivative taxa of parasitengone mites.

Key words: *Lassenia*, larva, host, aphid, Hemiptera, Great Britain

Introduction

Tanaupodidae Thor, 1935 comprise nine genera: two fossil (*Atanaupodus* Judson *et* Mąkol, 2009, *Propolyssenia* Mąkol, Konikiewicz *et* Klug, 2018) and seven extant (*Eothrombium* Berlese, 1910, *Lassenia* Newell, 1957, *Neotanaupodus* Garman, 1925, *Polydiscia* Methlagl, 1928, *Rhinothrombium* Berlese, 1910, *Tanaupodus* Haller, 1882, and *Tignyia* Oudemans, 1937).

Only *Lassenia* is known from larvae and active postlarval stages, *Polydiscia* and *Propolyssenia* are described exclusively from the larvae and the knowledge of the remaining genera is limited to deutonymphs and/or adults.

Host associations of tanaupodids are scarce compared to many other terrestrial Parasitengona families. Of the ten extant and named species known from the larval stage, host affiliation has only been ascertained in two cases; larvae of the remaining species were collected off-host, including those collected from plants (Felska *et al*. 2018; Mąkol *et al*. 2018; Haitlinger *et al*. 2019). The Nearctic species, *Lassenia lasseni* Newell, 1957 was recorded from small flies (Drosophilidae) and the Palaearctic *Polydiscia deuterosminthurus* Baquero, Moraza *et* Jordana, 2003 was collected from springtails (*Deuterosminthurus bisetosus* Baquero, Moraza *et* Jordana, 2003) (Newell 1957, Baquero *et al.* 2003). Zhang (1998a) referred to Hemiptera (orig. "Homoptera") as hosts of Tanaupodidae, but did not provide further details concerning the taxonomic affiliation of larvae and their hosts.

Four species of Tanaupodidae, namely *Eothrombium echinatum* Berlese, 1910, *Rhinothrombium inopinum* Hull, 1918, *Rhinothrombium nemoricola* (Berlese, 1886) and *Tignyia* *sulcatus* (O.F. Müller, 1776), have been recorded from Great Britain to date (Hull 1918, Johnston 1849)—all from postlarval forms only. Of those, a final species, *T. sulcatus*, has been considered *nomen dubium* (Mąkol & Wohltmann, 2012).

Here we describe a new species of *Lassenia* from a larval specimen and we report the first known interaction between a tanaupodid and a hemipteran host. The finding also constitutes the first record of the genus *Lassenia* and of the larval stage of Tanaupodidae from Great Britain.

Material and methods

An adult alate aphid *Myzocallis coryli* with a larva attached to it was collected by AWF, directly from the aphid's host tree species *Corylus avellana* L. in the Glen Affric National Nature Reserve, Inverness-shire, Scotland on 7th July 2019. Photographs of the larva attached to the host were taken with a Canon 5D Mark IV camera and a 65 mm high magnification macro lens prior to preservation of the material in ethyl alcohol. The mite was mounted on a microscopic slide using Faure's fluid. Morphological analysis was carried out under a Nikon 80i compound light microscope coupled with differential interference contrast (DIC). Drawings were made using a camera lucida attached to the microscope, and converted into digital illustrations using Inkscape v. 1.0. Measurements are given in micrometers.

Results

Taxonomy

Order Trombidiformes Reuter, 1909
Suborder Prostigmata Kramer, 1877
Cohort Parasitengona Oudemans, 1909
Family Tanaupodidae Thor, 1935

For family diagnosis see Wohltmann *et al*. (2007).

Genus *Lassenia* Newell, 1957
For a comparison of the genera of Tanaupodidae known from larvae see Mąkol *et al*. (2018).

Species: *Lassenia newelli* **sp. nov.**

Diagnosis

Larva. Anterior plate, encompassing the bases of ASens, well separated from the remaining part of scutum. fD = 20, fV = 6. fSt = 0-0. Anal sclerites with two setae, each. Two setae on palp femur. fCx = 2-2-1. Genu I with two solenidia. Lateral claws on tarsi simple.

Description. Figures 1–3. Metric data in Table 1.

Gnathosoma (Fig. 1). Palpal supracoxalae (*elcp*) thumb-like. Setae *as* acicular, smooth. Setae *bs* (tritorostrals, hypostomalae) with very short barbs, *cs* (adoral setae) nude, thread-like at termination (Fig. 1A). Palps five-segmented. Palp tibial claw only slightly curved, without signs of bifid termination (morphology uncertain due to position of odontus in slide-mounted specimen). Palp tarsus extending beyond the tip of odontus, almost parallel-sided at 2/3 of its length, then narrowing to form the base of long (37 µm) distal eupathidium. fPp = 0-BB-B-BBB-BBBBBBBζζω. Normal setae covered with minute barbs or more distinct setules (Fig. 1B).

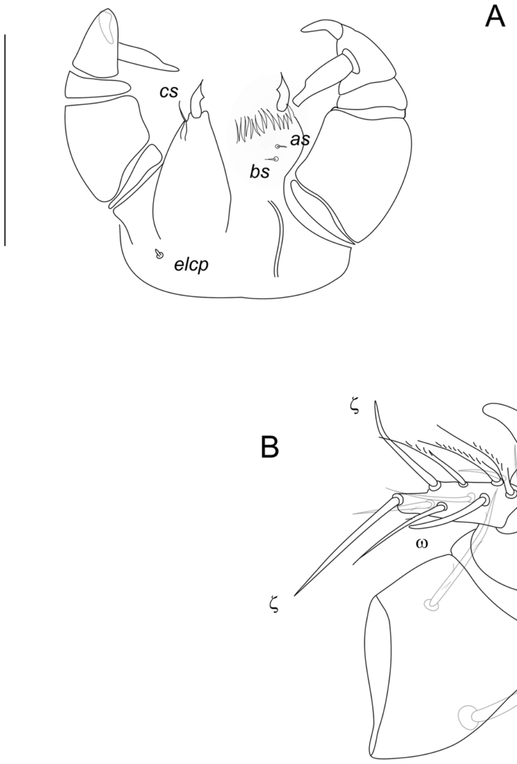

FIGURE 1. *Lassenia newelli* **sp. nov.**, larva. A. Gnathosoma: left – dorsal view, right - ventral view, chaetotaxy of palps omitted, scale bar: 100 µm. B. Details of palp (femur – tarsus), scale bar: 100 µm.

Idiosoma dorsum (Fig. 2A). A small, transversely oval sclerite (21x43), encompassing the bases of anterior sensilla (ASens), separated from the main section of the scutum (Figs. 2A, 2B). Scutum quadrangular, rounded at the corners and distinctly convex anteriorly. Lateral sides of the sclerite concave, the posterior margin only slightly convex. The sclerite accommodates the bases of posterior sensilla (PSens) and two pairs of non-sensillary setae (AL and PL). PSens shifted to anterior part of the sclerite, located medially, between the AL and PL. ASens < AL < PL < PSens, all covered with indistinct adnate barbs. Ocular plates oval, placed laterally to scutum, each plate accommodates two lenses of similar diameter. Dorsal setae behind the level of scutum arranged in rows: fD = c_{1-2}-d_{1-2}-e_{1-2}-f_{1-2}-h_{1-2}. All setae with short barbs along entire stem. Each seta located on distinct, roundish plate. Plate c_1: 60x45, d_1: 50x43, e_1: 48x42, f_1: 45x40, h_1: 45x38; lateral plates (c_2, d_2, e_2, f_2, h_2) similar in size to the medially located ones. Setae h_2 shifted to the ventral side of idiosoma. Integument on idiosoma, except for sclerites, but including the band between the small plate and main section of the scutum, folded in lines.

Idiosoma venter (Fig. 2C). Coxal plates well sclerotized, especially along their anterior margins. Supracoxalae of coxal fields I (*elcI*) acicular. For the chaetotaxy of coxae – see section Legs (below). Claparède's organ located laterally on podosoma, between coxae I and II. *Lassenia*-organ (45x35), at antero-lateral margins of coxae III, oval in shape, with a line ([?]fold) marked along the longer axis. Setae *3a* smooth, placed between coxae III. Posterior of coxae III three pairs of barbed setae (fV = 2-2-2) placed on distinct, but smaller than those on idiosoma dorsum, plates (1st pair: 23x18, 2nd pair: 30x21, 3rd pair: 32x25). Anus surrounded with paired sclerite, each part of which accommodates two acicular, indistinctly barbed setae.

TABLE 1. Standard measurements of *Lassenia newelli* **sp. nov.** collected from *Myzocallis coryli*.

character	value	character	value	character	value
PaTr (L)	[?]28	AW	83	Fe I	80
PaFe (L)	60	PL	80	Ge I	62
PaGe (L)	19	PW	75	Ti I	74
PaTi (L)	37	OL	48	Ta I	114
PaTa (L)	35	aO	19	leg I	457
odontus (L)	21	pO	18	Cx II	96
as	4	*c1*	68	Tr II	48
bs	12	*c2*	78	Fe II	64
cs	15	*d1*	63	Ge II	53
GL	101[1]	*d2*	71	Ti II	67
elcp	4	*e1*	63	Ta II	102
elcI	6	*e2*	68	leg II	430
IL	725	*f1*	66	Cx III	99
IW	519	*f2*	65	Tr III	58
scutum L	80	*h1*	58	Fe III	69
scutum W	98[2]	*h2*	49	Ge III	60
ASens	39	pVS	31–41	Ti III	97
SBa	13	An (L)	66	Ta III	126
PSens	81	An (W)	65	leg III	509
SBp	37	Cx I	83	IP	1396
AL	68	Tr I	44		

[1] measured to the tip of cheliceral blade
[2] measured at the level of sensilla

Legs (Figs 2C, 3). Segmentation formula 6-6-6. Coxa I with setae *1a*, *1b*, coxa II with setae *2a*, *2b*, coxa III with seta *3b* (Fig. 2C). All coxalae simple, acuminate, sparsely barbed. Leg chaetotaxy (Fig. 3) – leg I: Tr (1n) - Fe (6n) - Ge (4n, 2σ, 1κ) - Ti (8n, 4φ, 1Cp, 1κ) - Ta (26n, 2ζ, 2Cp, 1ω, 1ε); leg II: Tr (1n) - Fe (6n) - Ge (4n, 1σ, 1κ) - Ti (9n, 2φ) - Ta (24n, 2ζ, 1Cp, 1ω, 1ε); leg III: Tr (1n) - Fe (5n) - Ge (4n, 1σ) - Ti (9n, 1φ) - Ta (23n, 1ζ). Normal setae on legs with short setules or adnate barbs. Solenidia on genua and tibiae similar in structure, except for one solenidion on Ti I, which is much stouter and accompanied by seta Cp. Vestigialae on Ge I, Ti I, and Ge II obliquely truncated at termination. A distinctly elongate, whip-like seta (93), covered with minute barbs, present on tarsus III among other setae, at 0.34 length of the segment. Tarsi terminated with double claws and claw-like empodium (all covered with short onychotrichs).

Etymology

The specific epithet is given to commemorate Irwin M. Newell (1916–1979), Professor of Zoology, for his contribution to the taxonomy and ecology of mites.

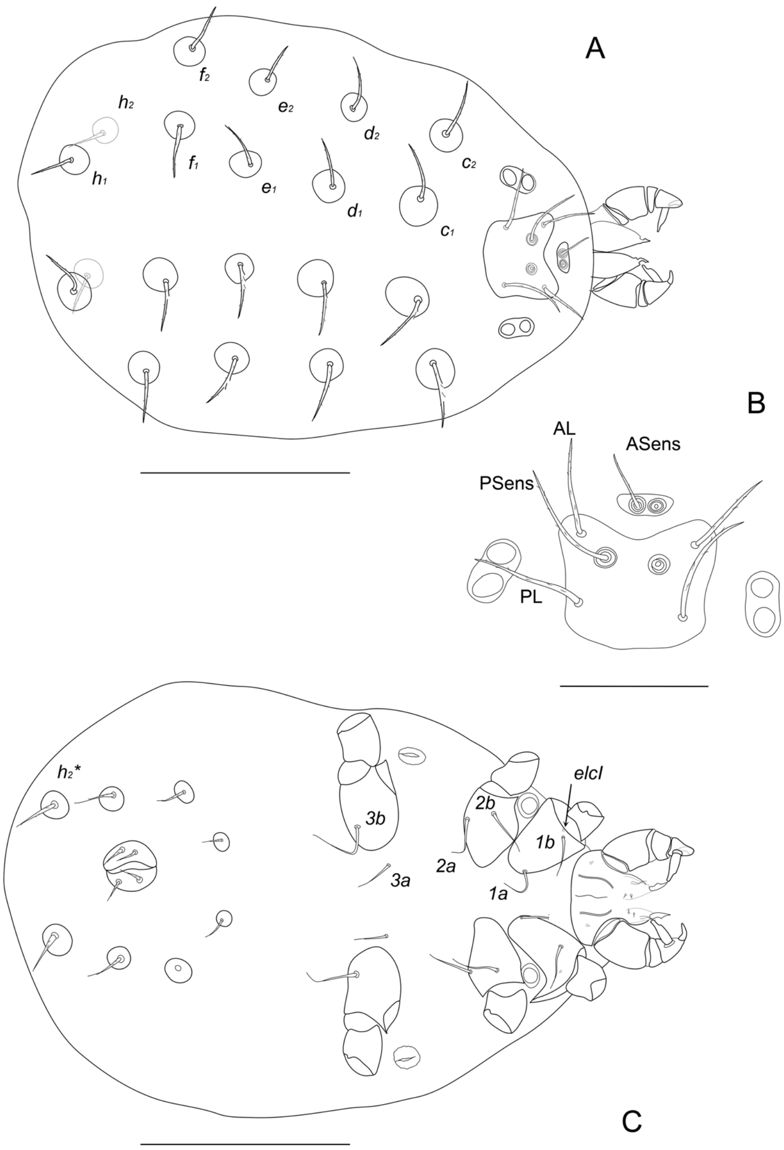

FIGURE 2. *Lassenia newelli* **sp. nov.**, larva. A. Body, dorsal aspect (legs omitted), scale bar: 250 μm. B. Scutum, scale bar: 100 μm. C. Body, ventral aspect (legs omitted beyond trochanter), scale bar: 250 μm.

Type material and type depository

Holotype: larva (ID: MNHW 1354 [H7190]), Glen Affric National Nature Reserve, Inverness-shire, Scotland, deposited at the collection of the Museum of Natural History, University of Wrocław.

Comparison

The presence of normally developed odontus, *Lassenia*-organ, leg segmentation formula 6-6-6, fCx = 2-2-1, vote for the assignment of the new species to *Lassenia* Newell, 1957. *Lassenia newelli* **sp. nov.** can be differentiated among other members of the genus by the following characters: the lowest number of setae in NDV formula (26), fCx (2-2-1) and the number of solenidia (σ) on genu I

(2). With respect to fCx, it is similar to *Lassenia xymenae* Haitlinger, 1995, from which it differs in the number of solenidia on genu I (2 vs 4 in *L. xymenae*). The presence of 2σ is shared also by *L. hemsinensis* Noei, Saboori & Çobanoğlu, 2018 (in Noei *et al.* 2018) and *L. japonica* Haitlinger, Negm et Šundić, 2019 (in Haitlinger *et al*. 2019). *Lassenia newelli* **sp. nov.** differs from *L. hemsinensis* and *L. japonica* in the fCx formula (2-2-1 vs 2-1-2 in *L. hemsinensis* and 1-1-2 in *L. japonica*). Moreover, in *Lassenia newelli* **sp. nov.** a distinctly elongate seta is present on tarsus III. It has not been referred to in the previous descriptions of *Lassenia*.

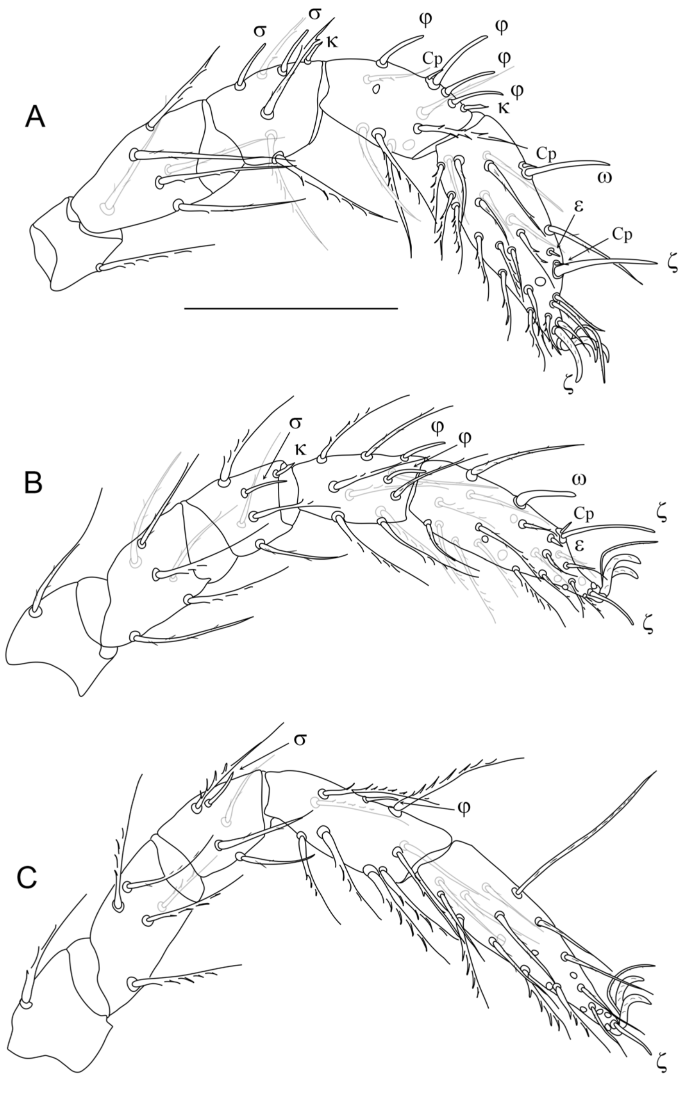

FIGURE 3. *Lassenia newelli* **sp. nov.**, larva. Legs (trochanter–tarsus), scale bar: 100 µm. A. leg I. B. leg II. C. leg III.

Data on host

One, moderately engorged larva was attached to an adult alate small hazel aphid, *Myzocallis coryli* (Fig. 4A–B). The aphid was feeding on the underside of a leaf of its host tree, *Corylus avellana*, and was collected on 7th July 2019.

FIGURE 4. Larva of *Lassenia newelli* **sp. nov.**, attached to adult alate small hazel aphid (*Myzocallis coryli*). A. dorsal aspect. B. lateral aspect. Not to scale.

Discussion

Tanaupodids have been traditionally placed among early derivative terrestrial Parasitengona (Feider 1959; Wohltmann 2000). The knowledge of the systematics and biology of the group is still fragmentary, and is caused mainly by the rarity of occurrence of these mites, and the consequent limited material that has been published about them. The lack of correlation between life stages (parasitic larvae and free-living postlarvae) greatly inhibits our understanding, including topics such as larval ecology, species diversity, and evolution.

Tanaupodidae are also among the least-studied families within terrestrial Parasitengona mites in terms of their host-parasite relationships (Felska *et al*. 2018). Hemiptera have frequently been recorded as hosts of Trombidiidae and Podothrombiidae. The single records on Hemipteran hosts apply to the members of Microtrombidiidae (2), Chyzeriidae (1), Amphotrombiidae (1), and Tanaupodidae (2, including the present study). This paucity precludes the identification of the host group most frequently exploited by tanaupodids. However, with two records now from Hemiptera, we may have an important clue for further searches of regular hosts for these mites.

The problem of unresolved relations between the tanaupodid genera, with special reference to those known from larvae, has been already summarised and discussed by Mąkol *et al*. (2018). The present finding confirms the necessity of critical re-appraisal of the characters that constituted the basis for distinguishing subfamilies and genera, and again raises the question of the boundaries between the genera and species.

The ancestral position of tanaupodid mites in the system of Parasitengona, as already suggested by Feider (1959), Vercammen-Grandjean (1972), Welbourn (1991), Wohltmann (2000), Zhang and Fan (2007), but also the relations with other early derivative parasitengone families, e.g. Amphotrombiidae Zhang, 1998 (Zhang 1998b), should nonetheless be a subject of extensive phylogenetic approach. Several characters shared by the larvae of Tanaupodidae and the monobasic Amphotrombiidae, and among them the presence of distinctly elongate seta in a dorsal position on tarsus III (confirmed to date in *Amphotrombium jenseni* Zhang, 1998 and in *Lassenia newelli* **sp. nov.**), should be considered in tracing the evolutionary history of both families.

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