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# Structural variation among species of *Leeuwenia* (Thysanoptera, Phlaeothripinae) with three new species from Australia

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## Abstract

The remarkable range of structural variation among the leaf-feeding thrips of the genus *Leeuwenia* is discussed and contrasted with the lack of intra-generic diversity exhibited by the leaf-feeding species of the related genus *Liothrips*. An identification key is provided to the eight species of *Leeuwenia* known from Australia, including three newly described species.

**Key words:** long-tailed thrips, prosternal basantra, male pore plate, leaf-galls

## Introduction

The genus considered here, *Leeuwenia*, comprises one of the groups of Phlaeothripidae in which the tenth abdominal segment, the tube, is often remarkably long, resulting in members of these groups sometimes being referred to as "long-tailed thrips" (Figs 1–3). In some species of Phlaeothripidae-Idolothripinae the tube has been observed to be raised over the body and projected forwards over the head (Mound 2004; Eow *et al*. 2014), in a position that suggests a defensive repellent might be extruded from the anus. And both sexes of *Idolothrips spectrum* have been observed raising the distal half of the abdomen in an apparently threatening gesture when disturbed (Alice Wells pers comm. ix.2020). Similar behaviour has not been recorded amongst the Australian species of leaf-feeding Phlaeothripinae considered here, but in Japan, Suzuki *et al*. (1988) noted that *Leeuwenia pasanii* turned the tube in the direction of marauding ants and sprayed them with a chemical repellent that caused the ants to disperse ("run about crazily"). In contrast, this chemical had little effect on an invading predatory Reduviid bug, nor on the inquiline thrips species, *Liothrips piperinus*, that was often found in the galls alongside the *Leeuwenia*. Similarly, in Australia the galls of *Leeuwenia tetrastigmae* are sometimes shared with a population of a leaf-feeding species of *Teuchothrips* (Fig. 5), and this also is presumably a true inquiline (Mound 2020).

Species of leaf-feeding and leaf-galling Thysanoptera are found mainly among genera of the *Liothrips*-lineage in the subfamily Phlaeothripinae (Mound 1994). The genus *Liothrips* is the second-most species-rich genus in this Order (ThripsWiki 2020), and the 270 included species are remarkably uniform in their body structure. This structural uniformity is so great that Priesner (1968), in describing 70 new species of *Liothrips* from Southeast Asia, commented to the first author (LAM) that no illustrations were needed for *Liothrips* species because they all look the same. *Leeuwenia* is classified together with *Liothrips* in this *Liothrips*-lineage of Phlaeothripinae (Mound 1994) but, in contrast to the members of that genus, the 30 included species exhibit a remarkable diversity in body structures. The objective here is to draw attention to this intra-generic structural diversity, to describe three new species from Queensland, Australia, and to provide a key to the eight species of *Leeuwenia* now known from Australia.

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**Acknowledgements, abbreviations and depositaries**

We are grateful to Alice Wells for help in field work, and for producing Figs 1–3, also to two *Zootaxa* reviewers for their valued criticisms and suggestions. Holotypes of the new species are deposited in the Australian National Insect Collection, CSIRO, Canberra (ANIC) with many paratypes in the Queensland Primary Industries Insect Collection, Brisbane (QDPC). Standard abbreviations are used for setae: S1 refers to a pair of setae closest to the body midline, and S2 refers to the pair lateral to S1; pronotal major setae: am—anteromarginal; aa—anterooangular; ml—midlateral; epim—empimeral; pa—posteroangular. Nomenclatural details of all Thysanoptera names mentioned here are available in ThripsWiki (2020).

## *Leeuwenia* Karny

*Leeuwenia* Karny, 1912: 161. Type species *Leeuwenia gladiatrix* Karny.

The only thorough diagnosis of this genus was provided by Okajima (2006). However, that diagnosis must now be interpreted in the light of the structural diversity among the included species that is indicated below. In particular, the presence of prosternal basantra is remarkable, not just for any members of this genus but for most members of the *Liothrips*-lineage (Mound & Marullo 1996). Members of the genus *Leeuwenia* are found widely in the tropical forests of Asia and Australia, with the most Western species being from Mauritius (Mound 2004). The galls known to be induced by these species range from irregularly distorted leaves (Fig. 4) to neatly rolled and even brightly coloured structures (Fig. 6). Host records are not available for many of the 30 species now listed in the genus, but 11 *Leeuwenia* species are recorded from trees in the family Myrtaceae, including two of the new species described below. In contrast, seven described *Leeuwenia* species are associated each with a tree in a different plant family (Mound 2004), including four of the species known only from Australia (*L. diospyrae*—Ebenaceae; *L. polyosmae*—Grossulariaceae; *L. scolopiae*—Flacourtiaceae; *L. tetrastigmae*—Vitaceae).

## Character variation in *Leeuwenia*

The most obviously variable characters among the species of *Leeuwenia* are the length of the tenth abdominal segment and the prominence of the lateral setae on the surface of the tube (see Figs 13–18 in Mound 2004). The type species of the genus, *L. gladiatrix* from Java, has the tube about 16 times as long as its basal width and bearing many prominent stout setae. Some of the species from Australia also have the tube long, 12 or 13 times as long as the basal width, however the surface setae are less prominent or even prostrate. Other species, including three from Australia, have the tube length little more than five times its basal width. One result of this variation between species is that several generic names have been proposed, and four of these are currently placed in synonymy (ThripsWiki 2020). The head shape also varies between species, from short, with the genae strongly convex (Fig. 8), to long with the genae parallel-sided (Fig. 9). Postocular setae are commonly not distinguished from the minor cephalic setae but are long and prominent in a few species. Similarly, the number of pronotal major setae varies, with one undescribed species from Vanuatu having none of the five major pairs longer than the discal setae, whereas *L. arbastoae* from The Philippines has all five pairs of major setae elongate. However, most species have the pronotal am setae small, and the ml and pa setae are also commonly not distinguished from the pronotal discal setae.

Among *Leeuwenia* species the prosternal ferna exhibit little variation between species (Fig. 20), but in two new species described here the two fernal sclerites are joined medially as a transverse band (Fig. 19). Prosternal basantra are usually absent in species of this genus, but they are well-developed in one Australian species (Fig. 20) and are weakly developed in two of the new species described here (Fig. 19). This presence of basantra in a few species within a genus in which species typically do not have these sclerites is reminiscent of a similar situation among Australian species of the genus *Hoplothrips* (Mound *et al*. 2020).

The tergal wing-retaining setae are slender and pointed in most species of *Leeuwenia* (Fig. 11), as is typical of most Phlaeothripinae, but two new species described below have these setae broadly flattened and leaf-like (Figs 13, 14). A similar condition is also found in *L. karnyi* from Indonesia, and more weakly developed in *L. karnyiana* from India. On tergite IX the major setae are short in all previously described species of this genus, but one new

species described below has setae S1 and particularly S2 unusually long (Fig. 12). In males, setae S2 on IX are usually slightly stouter than S1, but setae S2 are minute in two new species from Australia. Males are known for few species in this genus, but in the available males sternite VIII has a large pore plate.

### Key to *Leeuwenia* species from Australia

1. Tube no more than 1.5 times as long as head . . . 2
-. Tube at least 2.0 times as long as head . . . 4
2. Tergite IX with setae S1 and S2 unusually elongate, between 2.0 and 3.0 times as long as basal width of tube (Fig. 12) . . . *aliceae* **sp.n.**
-. Tergite IX setae S1 and S2 shorter, less than 1.5 times as long as basal width of tube . . . 3
3. Fore tarsus with prominent lateral tooth in both sexes . . . *polyosmae*
-. Fore tarsus without a prominent lateral tooth . . . *diospyri*
4. Antennal segment III at least 3.5 times as long as maximum width; prosternal basantra absent . . . 5
-. Antennal segment III less than 3.0 times as long as maximum width (Fig. 16); prosternal basantra present (Fig. 20) but sometimes weakly sclerotised (Fig. 19) . . . 6
5. All femora and tibiae clear yellow; head about 1.6 times as long as width across eyes; antennal segment III less than 4.0 times as long as maximum width; tube less than 9 times as long as basal width . . . *tetrastigmae*
-. Mid and hind femora as brown as body, mid and hind tibiae yellow but brown at base; head 2.0 times as long as width across eyes; antennal segment III at least 5.0 times as long as maximum width; tube at least 13 times as long as basal width . . . *convergens*
6. Pelta wider than long (Fig. 21); prosternal basantra well developed with several setae (Fig. 20); metanotum with several pairs of setae anterior to median pair; tergal wing-retaining setae slender and pointed . . . *scolopiae*
-. Pelta longer than basal width (Figs 17, 18); prosternal basantra weak and without setae (Fig. 19); metanotum without scattered setae anterior to major median setae; tergal wing-retaining setae broadly flattened . . . 7
7. Bicoloured (Fig. 2), head yellow medially, pronotum and abdominal segments II–VII largely yellow; mid and hind legs with femora brown but tibiae yellow; pronotum posterior fifth weakly reticulate (Fig. 7); male with large circular pore plate on sternite VIII. . . . *cameroni* **sp.n.**
-. Head, thorax and abdomen uniformly light brown, head with small pale area antero-medially (Fig. 3); mid and hind legs with femora and tibiae brown; pronotum posterior fifth finely tuberculate (Fig. 8); male with pore plate extending almost fully across sternite VIII. . . . *irukandji* **sp.n.**

### *Leeuwenia aliceae* sp.n.

[Figs 1, 9–12, 15]

*Female macroptera*. Body dark brown with yellow longitudinal stripe medially between compound eyes (Figs 1, 9); coxae and femora brown, tibiae yellow but washed with brown basally, tarsi yellow; fore wings pale with median longitudinal brown stripe; antennal segments I–II brown, III–VIII yellow. Head with genae parallel-sided; vertex with narrow transverse reticulation; postocular setae weakly capitate, small but distinct from minor setae, post ocellar setae slender and acute; maxillary stylets one third of head width apart, not deeply retracted into head (Fig. 9). Antennal segment III slender, almost 4.0 times as long as maximum width; III with one sense cone, IV with two, these sense cones slightly longer than apical width of their segment. Pronotum reticulate (Fig. 10), reticles with internal markings; am setae pointed and longer than discal setae, the other major setae capitate; notopleural sutures not fully complete. Mesonotal lateral setae small. Metanotum reticulate (Fig. 11), reticles with internal markings, with one pair of pointed setae medially and one pair of smaller setae near anterior margin. Prosternal basantra not developed, ferna transverse, mesopresternum complete; sternopleural sutures not present. Fore tarsi without tooth. Pelta wider than long (Fig. 11); tergites II–VII each with two pairs of slender wing-retaining setae; tergite IX setae S1 slender with bluntly pointed apices, S2 longer and finely acute (Fig. 12); tube about 5.3 times as long as basal width.

**Measurements** (holotype female in microns). Body length 2900. Head, length 325; width across genae 220; postocular setae 25. Pronotum, length 175; width 325; major setae am 25, aa 50, ml 40, epim 65, pa 35. Fore wing length 1100; sub-basal setae S1–S3 35, 50, 50. Tergite IX setae S1 210, S2 275. Tube 480. Antennal segments III–VIII length, 95, 80, 80, 75, 55, 45.

**Material studied**. Holotype female, **Australia, Queensland**, Fishery Falls [17°11'S; 145°53'E], 30km south of Cairns, from ?*Myrsine* leaves, 10.xi.2007 (Alice Wells).

Paratypes: 8 females collected with holotype.

**Comments**. This species is remarkable for the elongate, pointed major setae on the ninth abdominal tergite, but it shares a relatively short tube with both *L. dyospyri* and *L. polyosmae*.

### *Leeuwenia cameroni* sp.n.

[Figs 2, 7, 13, 16, 17]

*Female macroptera*. Body bicoloured (Fig. 2), pterothorax and all coxae and femora brown, tibiae and tarsi yellow; head and pronotum yellow with brown lateral margins; abdominal segments II-VII largely yellow with variable brown markings medially, VIII light brown, IX and tube uniformly darker; fore wing pale without basal shading but with faint median longitudinal shaded line; antennal segments I–II brown, III–VIII yellow. Head with genae convex, sharply constricted behind compound eyes (Fig. 7); vertex with numerous small tubercles on lines of reticulation; postocular setae not distinguished from minor setae, post ocellar setae small; maxillary stylets about one fifth of head width apart, retracted to postocular region (Fig. 7). Antennal segment III less than 3.0 times as long as maximum width (Fig. 16); III with one sense cone equal in length to segment width, IV with two sense cones about 1.5 times as long as segment apical width. Pronotum reticulate, with median longitudinal band of reticles; setae am, ml and pa not distinguished from discal setae, aa and epim broadly capitate; notopleural sutures not complete. Mesonotal lateral setae minute. Metanotum (Fig. 17) reticulate, reticles with internal markings, sometimes with one or more pairs of small setae lateral to the median pair. Prosternal basantra weakly developed, ferna transverse and complete medially, mesopresternum complete; sternopleural sutures not present, meta-epimera swollen. Fore tarsi without tooth. Pelta rectangular, longer than wide with lateral margins constricted (Fig. 17); tergites II–VII each with two pairs of broadly flattened wing-retaining setae (Fig. 13); tergite IX setae S1 and S2 short and blunt to weakly capitate; tube at least 12 times as long as basal width.

**Measurements** (holotype female in microns). Body length 2500. Head, length 250; width across genae 185; postocular setae 10. Pronotum, length 150; width 250; major setae am 10, aa 25, ml 10, epim 55, pa 10. Fore wing length 700; sub-basal setae S1–S3 10, 10, 10. Tergite IX setae S1 15, S2 40. Tube 600. Antennal segments III–VIII length, 60, 50, 55, 50, 45, 40.

*Male macroptera*. Closely similar to female in colour and structure but smaller; tergite IX setae S2 shorter than S1; sternite VIII with large circular pore plate medially.

**Material studied**. Holotype female, **Australia, Queensland**, Mt Lewis [16°35'S; 145°18'E], 60km northwest of Cairns, from leaf galls on *Syzygium* sp., 1.x.2015 (LAM 6171) [on slide with paratype male].

Paratypes: 16 females, 10 males collected with holotype; same locality, 5 females, 4 males from leaf galls on *Syzygium alatoramulum*, 18.ix.2013 (DJT 1652).

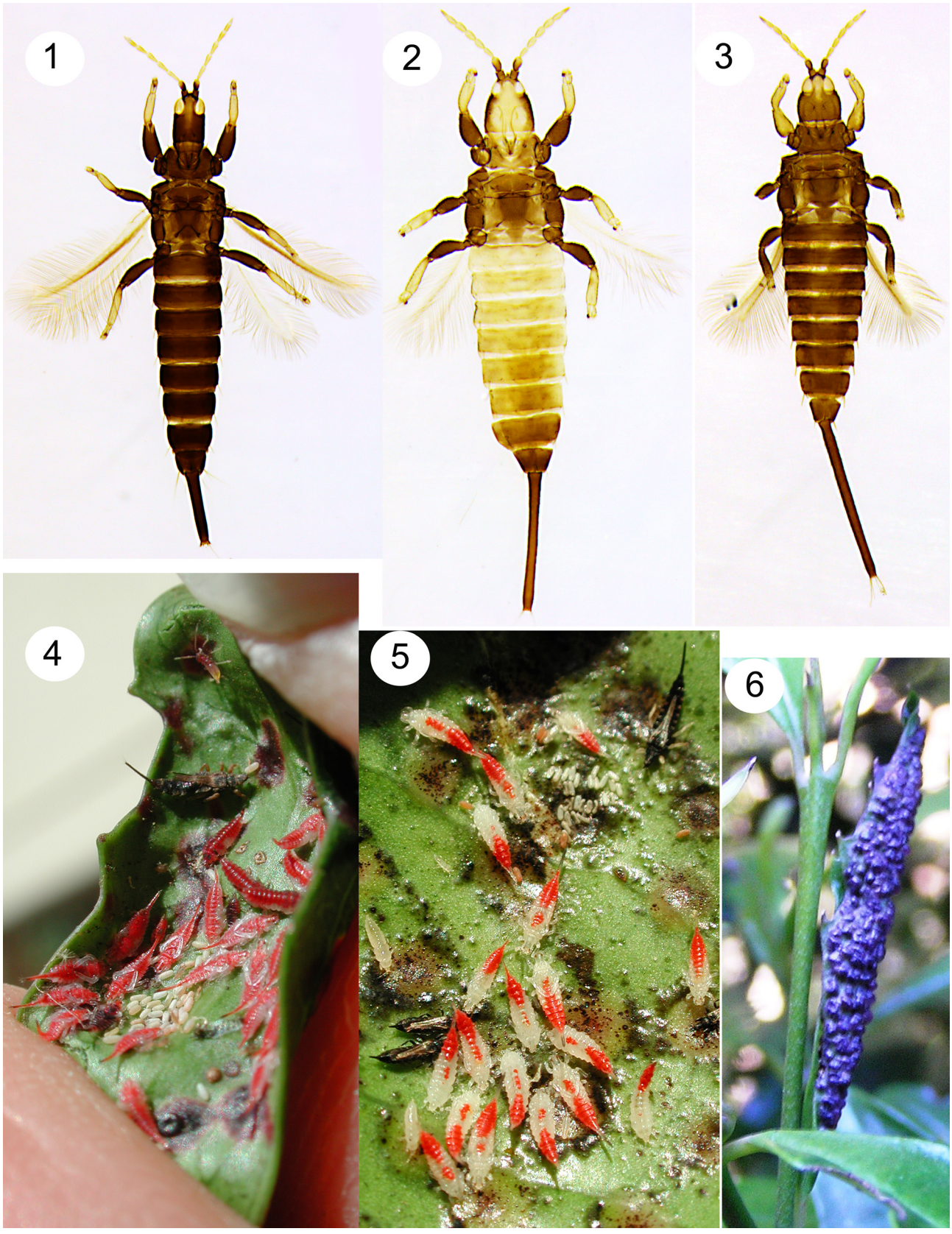
**Comments**. As indicated, this species is very similar in many structural details to *L. irukandji* but is noticeably different in colour. It is named in recognition of the extensive support provided to thrips studies in Queensland by Cameron Tree.

### *Leeuwenia convergens* Hood, 1918

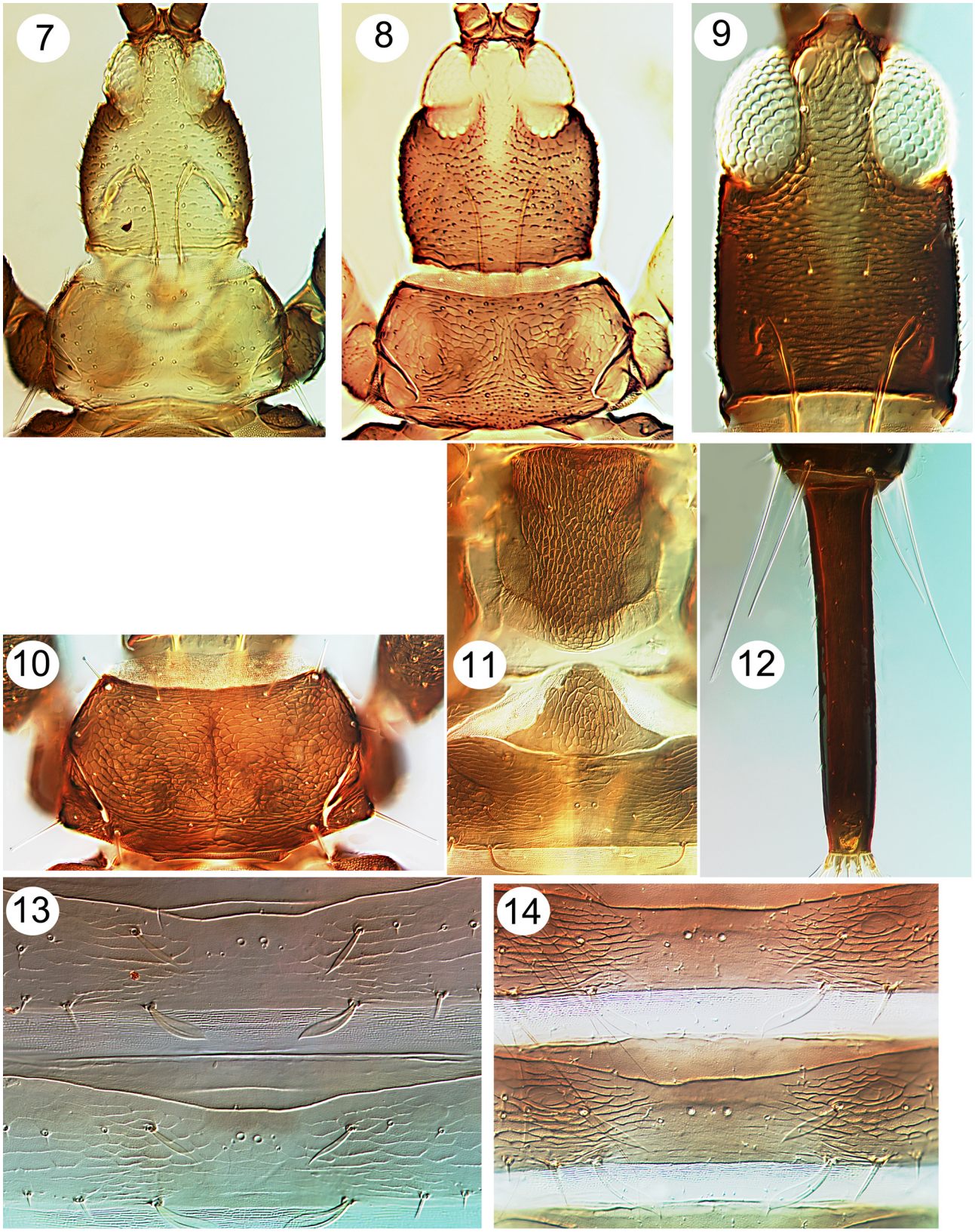
This species remains known only from two females collected in Queensland near Cairns from an unknown plant (Mound 2004). It has a distinctively elongate head with a transverse row of small setae across the vertex, and the tube is exceptionally long.

### *Leeuwenia diospyri* Mound, 2004

This species was described from a series of both sexes taken in curled leaf galls on *Diospyros pentamera* [Ebenaceae] in coastal rain forest at Taree, New South Wales. However, it was found subsequently in similar leaf-roll galls on the same plant species at Lamington in southeast Queensland. It is unusual amongst members of the genus in having the tube rather short, scarcely six times as long as the basal width.




**FIGURES 1–6**. *Leeuwenia* species. Females 1–3: **(1)** *aliceae* **sp.n.**; **(2)** *cameroni* **sp.n.**; **(3)** *irukandji* **sp.n.** Leaf galls 4–6: **(4)** colony of *scolopiae*; **(5)** colony of *tetrastigmae* with *Teuchothrips* sp. inquiline; **(6)** *polyosmae* gall.




**FIGURES 7–14**. *Leeuwenia* species. Head & pronotum 7–8: **(7)** *cameroni* **sp. n. (8)** *irukandji* **sp.n.** *L. aliceae* **sp.n.** 9–12: **(9)** head; **(10)** pronotum; **(11)** metanotum, pelta and tergite II; **(12)** tube. Tergites III–IV 13-14: **(13)** *cameroni* **sp. n.**; **(14)** *irukandji* **sp. n.**

***Leeuwenia irukandji* sp.n.**
[Figs 3, 8, 14, 18, 19]

*Female macroptera*. Body light brown with yellow longitudinal stripe medially between compound eyes (Figs 3, 8); tarsi yellow, but all coxae also mid and hind femora and tibiae brown, fore tibiae and most of fore femora yellow; fore wings pale, shaded at base and with weak median longitudinal darker stripe; antennal segments I–II brown, III–VIII yellow. Head with genae convex, constricted behind large compound eyes (Fig. 8); vertex with numerous small tubercles; postocular setae not distinguished from minor setae, post ocellar setae small; maxillary stylets less than one third of head width apart, retracted to postocular region (Fig. 8). Antennal segment III less than 3.0 times as long as maximum width; III with one sense cone, IV with two, these sense cones distinctly longer than apical width of their segment. Pronotum reticulate, posterior fifth with transverse band of minute tubercles (Fig. 8); setae am, ml and pa not distinguished from discal setae, aa and epim broadly capitate; notopleural sutures not complete. Mesonotal lateral setae minute. Metanotum reticulate, reticles with internal markings, with one pair of pointed setae medially. Prosternal basantra weakly developed, ferna transverse and complete medially (Fig. 19), mesopresternum complete; sternopleural sutures not present, meta-epimera swollen. Fore tarsi without tooth. Pelta rectangular, longer than wide with lateral margins slightly constricted (Fig. 18); tergites II–VII each with two pairs of broadly flattened wing-retaining setae (Fig. 14); tergite IX setae S1 and S2 short and blunt to weakly capitate; tube at least 12 times as long as basal width.

**Measurements** (holotype female in microns). Body length 2500. Head, length 250; width across genae 200; postocular setae 10. Pronotum, length 135; width 250; major setae am 10, aa 25, ml 10, epim 45, pa 10. Fore wing length 800; sub-basal setae S1–S3 10, 10, 20. Tergite IX setae S1 25, S2 70. Tube 760. Antennal segments III–VIII length, 60, 50, 55, 50, 45, 35.

*Male macroptera*. Closely similar to female but smaller; tergite IX setae S2 shorter than S1; sternite VIII fully occupied by pore plate.

**Material studied**. Holotype female, **Australia, Queensland**, Cairns, Stoney Creek Road [16°52'S; 145°40'E], from *Syzygium tierneyanum* leaves, 6.xi.2008 (LAM 5202).

Paratypes: 2 females, 6 males collected with holotype; 2 females, 1 male, same locality and tree, 4.x.2012.

**Comments**. This species is structurally very similar to *L. cameroni*, and it lives on the leaves of a tree in the same genus, *Syzygium*. The two species are strikingly different in colour (Figs 2, 3), but also differ in head shape and the character states indicated in the key above. The name refers to the language of the original people of northern Queensland.

***Leeuwenia polyosmae* Mound, 2004**

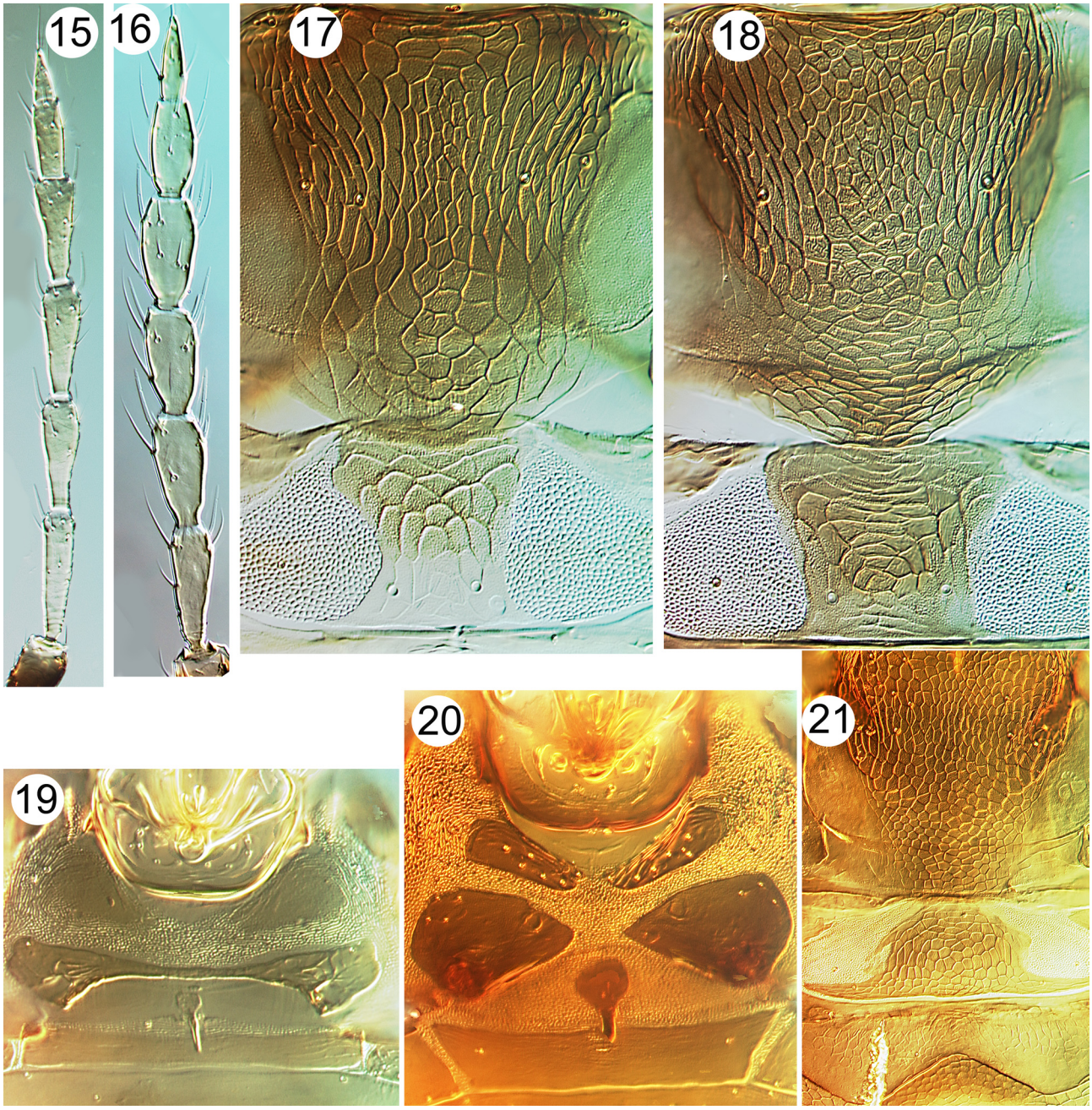
Described originally from two females taken in a leaf gall on *Polyosma cunninghamii* [Grossulariaceae] near Brisbane, Queensland, this thrips was found subsequently on the same plant species in rainforests at Lamington near the border with New South Wales. Some of the galls were a remarkable blue colour (Fig. 6), and the species is unusual within the genus in having a fore tarsal tooth, in both sexes.

***Leeuwenia scolopiae* Mound, 2004**

This species is known from Lamington and Mt Tambourine, two rainforest localities south of Brisbane, Queensland, breeding in curled leaf-galls on *Scolopia braunii* [Flacourtiaceae]. It is unusual within the genus in having the prosternal basantra well-developed, and in having a number of minor setae on the anterior half of the metanotum.

***Leeuwenia tetrastigmae* Mound, 2004**

The host plant of this thrips, *Tetrastigma nitens* [Vitaceae], is widespread in rainforest areas of the Australian East coast from Sydney northwards. However, populations of the thrips and the distorted leaf-galls it induces have a patchy distribution. Adults are smaller than those of *convergens*, with the head and the tube shorter, and the legs uniformly yellow.




**FIGURES 15–21**. *Leeuwenia* species. Antennal segments III–VIII 15–16: **(15)** *aliceae* **sp. n.**; **(16)** *cameroni* **sp. n.** Metanotum & pelta 17–18: **(17)** *cameroni* **sp. n.**; **(18)** *irukandji* **sp. n.** Prosternites 19–20: **(19)** *irukandji* **sp. n.**; **(20)** *scolopiae*. **(21)** *scolopiae* metanotum, pelta and tergite II.

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