



Fungus-feeding Thysanoptera: Phlaeothripinae of the *Idiothrips* genus-group in Australia, with nine new species

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Abstract

In a group of fungus-feeding Phlaeothripinae characterized by complex body sculpture, identification keys are provided to three genera and 15 species from Australia, including nine new species. In the genus *Azaleothrips* one new species is described, and one Asian species is newly recorded from Australia. The genus *Stictothrips* is recorded from Australia for the first time, with two new species. Within the genus *Strepterothrips* considerable structural diversity is recorded including three new species in which antennal segment III is greatly reduced and bears no sense cones. Some species in this genus exhibit the unusual condition of having several setae on the pelta, the first abdominal tergite. Problems in the production of generic diagnoses within the Phlaeothripinae are discussed.

Key words: *Azaleothrips*, *Stictothrips*, *Strepterothrips*, mycophagous, new species

Introduction

Classification of the large number of fungus-feeding Thysanoptera that comprise the *Phlaeothrips*-lineage (Mound & Marullo 1996) within the subfamily Phlaeothripinae remains difficult. This situation has been discussed recently by Dang *et al.* (2014), by Okajima and Masumoto (2014), and also by Cavalleri *et al.* (2015). The essential problem involved in producing functional classifications is that a taxon above the species-level, such as a genus, cannot be “defined” as a class possessing a complete set of essential characters (Zachos 2014). The members of a genus will share most of the characters listed in a generic diagnosis, but because a genus is an evolutionary lineage not all related species will exhibit every one of the listed characters. The alternative is the proliferation of monotypic genera surrounding a paraphyletic stem taxon - a situation that inadequately reflects evolutionary relationships. In each of the three genera considered here, one new species is described that has one or more character states differing from the other members of the genus. To treat such species each in a monotypic genus would fail to indicate any possible relationship between them. Similar problems occur throughout the Phlaeothripinae, in genera as widely different as *Holopothrips* in the Neotropics (Mound & Marullo 1996), *Dactylothrips* in Australia (Crespi *et al.* 2004), and *Hoplandrothrips* worldwide (Mound & Tree 2013).

Members of the *Phlaeothrips*-lineage are generally fungus feeders, and the group is structurally highly diverse with many species exhibiting complex polymorphisms (Mound *et al.* 2013). Okajima and Masumoto (2014) emphasized that within the *Phlaeothrips*-lineage there are too many species with character-states in an intermediate condition for any clear definition of genus-groups. Thus *Alerothrips* and *Neurothrips* resemble members of the *Amphibolothrips* genus-group in having a long tenth abdominal segment and long anal setae. However, these two genera also resemble members of *Azaleothrips* in having remarkably complex body sculpture. Moreover, *Azaleothrips* is also considered related to a few other genera with strongly sculptured species, including *Strepterothrips* and *Walkerthrips*. These latter genera have been referred to as the *Idiothrips* genus-group (Mound & Ward 1971), in which there is a tendency for the fusion of the distal antennal segments, and reduction in numbers of sense cones on antennal segments III and IV. The problems discussed above concerning the diagnosis of genera

are clearly even more acute when attempting to diagnose genus-groups. Therefore, no attempt is made here to diagnose the *Idiothrips* group, beyond mentioning the various genera that need to be considered. In an extensive discussion of the relationships of *Azaleothrips*, Okajima and Masumoto (2014) did not include the genus *Stictothrips*. However, these two genera share with other taxa in the *Idiothrips* group a complex body sculpture and fan-shaped major setae. *Stictothrips* is distinguished by the curiously constricted and twisted fore wings, but macropterae of *Strepterothrips* species such as *tuberculatus* also have the fore wings sharply bent beyond the basal third. In contrast to *Azaleothrips* species, the eighth antennal segment of *Stictothrips* species is elongate, and the third antennal segment bears only one sense cone. Species of both *Walkerthrips* from New Zealand, and *Stegothrips* from Ghana and Panama have 7-segmented antennae with two sense cones on the third segment, whereas *Idiothrips* species from Africa, Iran and India (Minaei 2013) have antennal segments VI–VII broadly joined (Fig. 1), and segment III lacks any sense cones.

The nine previously described species of *Strepterothrips* are all dark brown with 7-segmented antennae. The members of this genus were considered to have only one sense cone on the third antennal segment and two on the fourth. However, as discussed below, the number on segment III is now known to vary between species in that genus from zero to two, and the number on segment IV from two to three. The objective here is to contribute to the knowledge of the biological diversity of Australian Phlaeothripinae. We provide an introduction to the three genera of the *Idiothrips* group known from Australia, record *Stictothrips* from this continent for the first time with two new species, and describe one new species of *Azaleothrips* and six new species of *Strepterothrips*. The species involved are all fungus-feeding, have complex body sculpture, and the largest males, where known, have the fore tarsal hamus greatly elongate into a curved claw-like structure.

Abbreviations, depositaries and acknowledgments

Nomenclatural information on all Thysanoptera is available at ThripsWiki (2015). The following abbreviations for setal names are used: po - postocular setae on head; pronotal setae: am - anteromarginal, aa - anteroangular, ml - midlateral, epim - epimeral, pa - posteroangular; S1 refers to the setal pair closest to the midline of the body. Holotypes of the new species are deposited in the Australian National Insect Collection, CSIRO, Canberra, with some paratypes in the Queensland Primary Industries Insect Collection, Brisbane. This paper was produced as part of a programme studying the diversity of Australian fungus-feeding Thysanoptera, supported in part by a Bush Blitz Research Grant from Australian Biological Resources Study, Canberra.

Genera of the *Idiothrips* genus-group from Australia

1. Antennal segment III with two or three sense cones; antennae 8-segmented (Fig. 2) but with VIII broadly based and joined to VII to form one unit *Azaleothrips*
- Antennal segment III with one sense cone, or none at all; antennae either clearly 7- or 8-segmented 2
2. Antennae 8-segmented, VIII slender and constricted to base (Fig. 3); male sternites VII and VIII each with large pore plate area *Stictothrips*
- Antennae 7-segmented, VIII fused to VII with no suture (Fig. 4); male sternite VIII without pore plate *Strepterothrips*

Azaleothrips Ananthkrishnan

Azaleothrips Ananthkrishnan, 1964: 220. Type species: *A. amabilis* Ananthkrishnan, by monotypy.

This genus comprises 35 species, all from the tropical areas of eastern Asia, and a detailed and fully illustrated account of the genus has been made available by Okajima and Masumoto (2014). To this total of 35 should be added one new species from Australia described below, also a second species from Australia that was recently transferred to *Azaleothrips* (Mound & Tree 2014). In addition to the species considered below, a single female macroptera of an undescribed species has been studied from near Cairns with two sense cones on antennal segment III and three on IV, and with the third segment clear yellow. This species is similar in structure to *simulans* Okajima from Bali and Flores, Indonesia, but more specimens will be required before it can be considered further.

Azaleothrips species from Australia

1. Head without major postocular setae, head width slightly greater than length (Fig. 5) *lixinae* sp.n.
- Head with paired capitate postocular setae; head width less than length 2
2. Postocular setae with apex as wide as the setal length *perniger*
- Postocular setae 3 to 5 times longer than apical width 3
3. Antennal segments III and IV each with two sense cones *moundi*
- Antennal segment III with 3 sense cones, IV with 4 sense cones. *lepidus*

Azaleothrips lepidus Okajima

Azaleothrips lepidus Okajima, 1978: 386; Okajima & Masumoto, 2014: 327.

Described from Thailand, this species was subsequently recorded from Australia (Mound & Dang 2013). Specimens from Australia do not differ in any significant way from the available specimens from Thailand, neither in sculpture nor in colour pattern.

Material studied. **Thailand**, Chiang Mai, 1 female, 1 male from dead leaves and branches, 1.ix.1991. **Australia, Northern Territory**, Coburg Peninsular, 1 female from dead twigs, 14.v.1999; Darwin, Holmes Jungle, 9 females, 5 males from dead branches, 8.v.2014; same locality, 1 female, 29.v.2011.

Azaleothrips lixinae sp.n.

(Figs 2, 5–8)

Female macroptera. Head and body, in life, with much red pigment; surface of body and legs light brown, head submarginally with longitudinal paler areas; tube and antennae darkest, tarsi yellow; fore wing and all major setae pale.

Head as wide as or wider than long, cheeks strongly rounded (Fig. 5); vertex with delicate, complex reticulate sculpture, without major setae; fore ocellus in small depression, directed forwards; eyes slightly larger dorsally than ventrally; maxillary stylets retracted to eyes, close together medially. Antennae 8-segmented, VII and VIII forming single unit but with complete suture, and ventral row of small sensoria on VIII extending onto distal half of VII; segment III with 3 stout sense cones, IV with 4. Pronotum with similar sculpture to head (Fig. 8), with 5 pairs of broadly capitate major setae; notopleural sutures complete. Mesonotum with narrow transverse reticulation, lateral setae small and capitate. Metanotum with bold longitudinal, narrow reticulation (Fig. 8), median setae small and finely pointed, anterior third with one or two pairs of small setae. Prosternal basantra absent; ferna transverse, almost continuous medially; mesopresternum complete but narrow medially; metathoracic sternopleural sutures long and slender. Fore tarsus with small acute tooth, shorter than half tarsal width. Fore wing almost parallel-sided, with about 8 duplicated cilia; sub-basal setae S1 and S2 short and broadly capitate, S3 longer and pointed. Pelta bell-shaped, reticulate, with campaniform sensilla (Fig. 6); tergites II–VII each with 2 pairs of sigmoid setae but anterior pair on each tergite smaller than posterior pair; posteromarginal paired setae arise close to posterior sigmoid setae, broadly and asymmetrically capitate; tergites II–VII lateral thirds with dentate microtrichia on sculpture lines; VIII with about 8 small discal setae medially; tergite IX setae S1 and S2 capitate, shorter than basal width of tube (Fig. 7); tube rather short, anal setae no longer than tube. Sternites with marginal setae short, little longer than discal setae.

Measurements (holotype female in microns). Body length 1750. Head, length 195; width 205. Pronotum, length 120; width 225; major setae, am 15, aa 20, ml 15, epim 25, pa 20. Fore wing length 620. Tergite IX setae, S1 35; S2 45. Tube length 100. Antennal segments III–VII+VIII length, 60, 55, 55, 40, 65.

Male macroptera. Very similar to female but smaller, tarsal tooth slightly larger; tergite IX setae S2 with apex blunt not capitate; sternite VIII with small circular pore plate centrally.

Material studied. Holotype female, **South Australia**, Meningie, dead *Eucalyptus* branch, 3.x.2013 (LiXin Eow 248).

Paratypes: **South Australia**, Salt Creek, 15km South of Coorong, 2 females from dead *Eucalyptus* branches, 11.iii.2011; Ngarcat National Park, 1 female, 1 male from dead *Eucalyptus* leaves, 4.x.2013. **Queensland**, Carnarvon Station, 1 male from *Rosa banksiae* fls, 9.x.2014 (DJT1871).

Comments. From the other species of *Azaleothrips* this species differs in having no postocular setae in either sex, and in having a small circular pore plate on sternite VIII of the male instead of the usual broad pore plate. No differences could be found between the male from Queensland and the male from South Australia.



FIGURES 1–8. *Idiothrips* genus-group from Australia. Antennae 1–4: (1) *Idiothrips bellus* from Iran; (2) *Azaleothrips lixinae*; (3) *Stictothrips namadji*; (4) *Strepterothrips verruculus*. *Azaleothrips lixinae* 5–8: (5) head; (6) pelta and tergites; (7) tergites VII–IX and tube; (8) pronotum and metanotum.

Azaleothrips moundi Okajima

Azaleothrips moundi Okajima, 1976: 19; Okajima & Masumoto, 2014: 332.

The two males listed below are identified as this species with some hesitation. They are both hemimacropterous, with wings 200 microns long and almost as long as the pterothorax width, also the pelta is bell-shaped and thus more typical of macropterae. In contrast, the micropterae of *moundi* from its previously known distribution in southern Japan and Taiwan have wings that are 100 microns long and the pelta broadly oval. There are slight differences in the body sculpture between the two specimens from Australia and those from Asia, but the observed wing morph differences suggest that it is not sensible to describe these two males as a distinct species. Among the 37 species of *Azaleothrips* now known, only *moundi* and *perniger* have only two sense cones on both antennal segments III and IV, and segments VII and VIII are particularly closely joined.

Material studied. Australia, Queensland, Redlynch, Crystal Creek, 2 males from *Macaranga* lvs, 5.xi.2008 (LAM5191).

Azaleothrips perniger (Girault)

Glyptothrips perniger Girault, 1929: 2

This species was transferred to *Azaleothrips* despite the fact that it remains known from a single female on which few structural details can be seen (Mound & Tree 2014). However, the maxillary stylets are long and close together medially, the postocular setae are very short and more widely expanded than in any other known member of this genus, and antennal segments VII and VIII are completely fused. The single female was collected in January 1929 at Brisbane, Queensland.

Stictothrips Hood

Stictothrips Hood, 1925: 295. Type species *Phloeothrips maculatus* Hood, by monotypy.

Four species are listed in this genus (ThripsWiki 2015); the type species from Northeastern USA; *faurei* from South Africa and also Iran; *leopardinus* from northern Egypt; and *fimbriata* from southern India. To these are added here two new species from Australia, with an expanded generic diagnosis based on that of Mound and Marullo (1996). However, one of these new species, although sharing many character states differs in several others, and it is not strictly congeneric. The species is described here in this genus to draw attention to the structural diversity, but when the male and macropterous female are discovered a further new genus may be required.

Generic diagnosis: Body bicoloured, surface with complex reticulate sculpture. Antennae 8-segmented, III with 1 sense cone, IV with 2 major sense cones, VIII lanceolate. Head about as long as wide, eyes much longer on dorsal than ventral surface, postocular setae not developed; mouth cone short. Pronotum transverse, with 5 pairs of short, broadly capitate major setae; notopleural sutures incomplete. Metanotum with about 6 pairs of minor setae in two longitudinal rows. Fore tarsus usually with small tooth. Fore wing sub-medially sharply constricted or twisted, without duplicated cilia; sub-basal setae short and capitate. Prosternal basantra weak, ferna transverse; mesopresternum transverse but eroded posteromedially opposite to an eroded area on the anterior margin of the mesoeusternum. Pelta with lateral thirds unsculptured, paired campaniform sensilla present; tergites II–VII each with 2 pairs of wing-retaining setae, posteromarginal setal pair with asymmetric broadly capitate apex, arising close to second wing-retaining seta; VII–VIII with irregular group of discal setae; tergite IX setae S1 and S2 capitate, shorter than basal width of tube in both sexes; tube shorter than head length, anal setae shorter than tube; male with large poorly defined pore plate area on sternites VII and VIII.

Key to species from Australia

1. Body brown; antennal segment VIII broad at base (Fig. 13); head with prominent cheek setae (Fig. 15); notopleural sutures complete; prosternal basantra absent; mesoeusternum not eroded medially; female with fore tarsal tooth *aoristus* sp.n.
- Body bicoloured; antennal segment VIII lanceolate (Fig. 3); head without stout cheek setae (Fig. 9); notopleural sutures incomplete; prosternal basantra present but weak; mesoeusternum eroded medially; female fore tarsus with no tooth
..... *namadji* sp.n.

Stictothrips aoristus sp.n.

(Figs 13–15)

Female microptera. With the characters given in the generic diagnosis, except: body, legs and antennae light brown, tarsi paler, major setae all pale.

Antennal segment VIII broadly joined to VII (Fig. 13); head with po setae scarcely different from minor setae; cheek setae prominent (Fig. 15); notopleural sutures complete; metanotum reticulate, median setal pair weakly capitate, with 2 or 3 minor setae on anterior half; prosternal basantra not developed; mesoeusternal anterior margin entire; pelta transverse; tergites II–VII with 2 pairs of setae medially (Fig. 14).

Measurements (holotype female in microns). Body length 1650. Head, length 200; width 180. Pronotum, length 130; width 215; major setae, am 15, aa 15, ml 15, epim 40, pa 20. Fore wing lobe 90. Tergite IX setae S1 50; S2 65. Tube length 110. Antennal segments III–VIII length, 50, 48, 50, 45, 45, 30.

Material studied. Holotype female microptera, **Queensland**, Carnarvon Station, Fig Tree Gully, from *Ficus coronata* leaves and branches, 14.x.2014 (DJT1963) (in ANIC).

Paratypes: 2 female micropterae taken with holotype.

Comments. As discussed above, and indicated in the key, this species is not strictly congeneric with the other *Stictothrips*, but is placed here pending further field studies.

Stictothrips namadji sp.n.

(Figs 3, 9–12)

Female macroptera. Body and legs yellow with light brown markings: head with paired sub-lateral longitudinal brown stripes (Fig. 9); pronotum and mesonotum with three similar longitudinal brown areas (Fig. 10); metanotum with 2 longitudinal brown areas, lateral part of metathorax brown; tergites II–VIII with brown markings laterally (Fig. 11), IX almost yellow; tube brown; tarsi yellow; femora and tibiae yellow with brown marking medially; antennal segment I yellow with brown external margin, II light brown, III yellow with apex shaded, IV and V brown with pedicel yellow, VI largely yellow, VII–VIII brown; fore wings largely pale with darker marking near sub-median constriction.

With the character states indicated in the generic diagnosis; body surface sculpture complex but delicate (Figs 9–12); head with maxillary stylets about 50% of head width apart, retracted almost to posterior dorsal margin of eyes, maxillary bridge stout; two longitudinal rows of metanotal setae finely acute (Fig. 12); mesoeusternum anterior margin eroded medially; fore tarsus without tooth; tergal wing-retaining setae sigmoid and slender.

Measurements (holotype female in microns). Body length 1650. Head, length 190; width 175. Pronotum, length 100; width 190; major setae, am 15, aa 15, ml 15, epim 25, pa 20. Fore wing length 600. Tergite IX setae S1 25; S2 30. Tube length 130. Antennal segments III–VIII length, 43, 43, 43, 40, 35, 35.

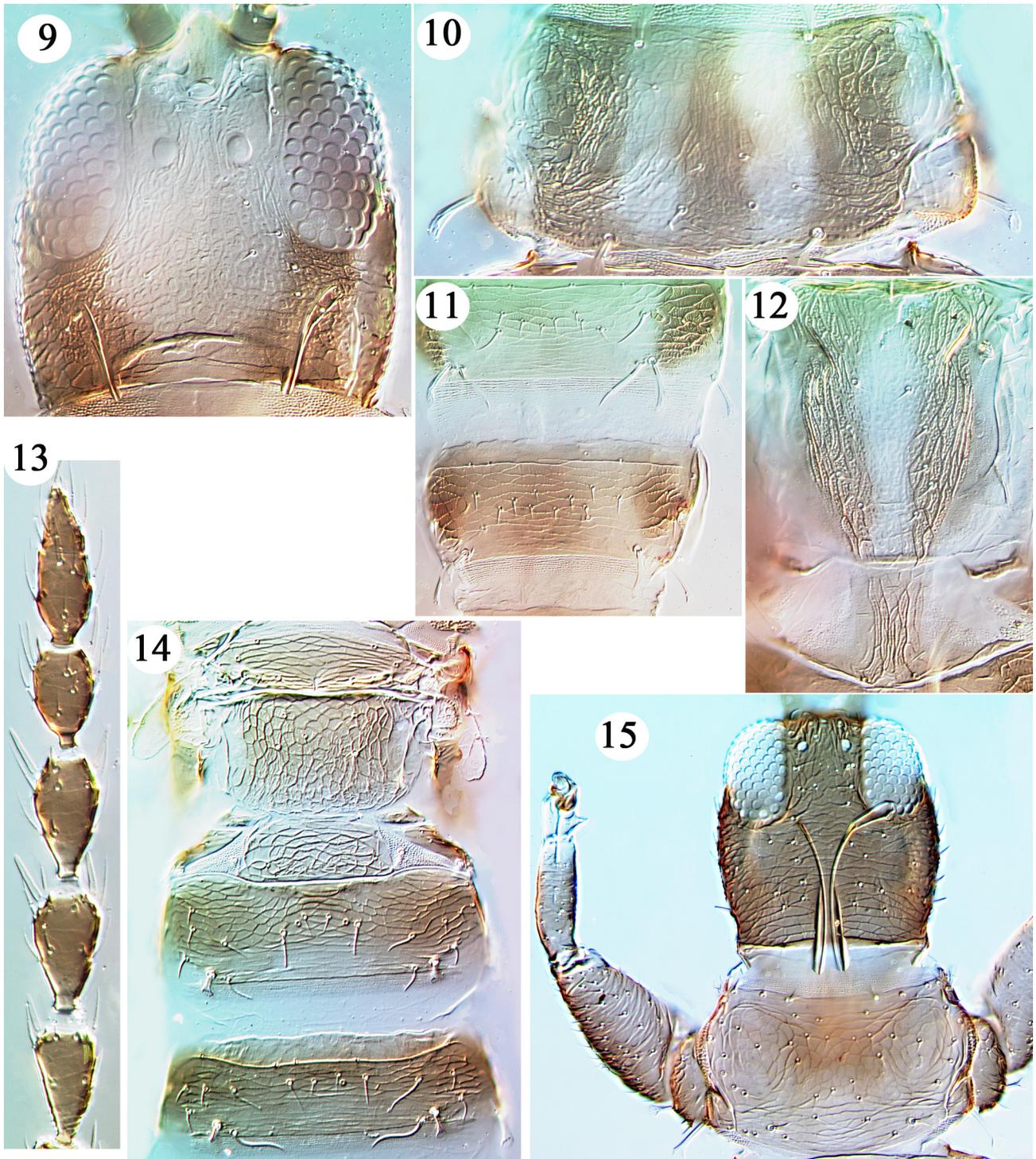
Male macroptera. Similar to female in colour and chaetotaxy but slightly smaller; fore tarsus with minute tooth at inner apex; sternites VII and VIII with surface porose (similar in appearance to pore plates of many Phlaeothripinae).

Material studied. Holotype female, **Australian Capital Territory**, Casuarina Sands, beaten from Epacridaceae species bearing lichen, 13.viii.1995 (LAM2791).

Paratypes: 5 females, 4 males taken with holotype; **Australian Capital Territory**, Namadji, 2 females beaten from *Monotoca* sp. (Epacridaceae), 1.xii.2002.

Comments. From the four species currently placed in this genus, *S. namadji* differs in having the body surface

sculpture considerably more delicate. Also, the position of the maxillary stylets is very different, about 50% of head width apart with a long maxillary bridge, whereas in the other four species they are close together medially in the head. Moreover, females of the other species have a fore tarsal tooth, and their tergal wing-retaining setae are broadly flattened. *S. namadji* is superficially similar in appearance to some species of *Azaleothrips*, but species in that genus all have antennal segments VII and VIII broadly joined, and the maxillary stylets close together medially in the head. The porose sternites VII and VIII of the male of *namadji* are essentially similar to those of *fimbriata* Ananthkrishnan from India. However, the condition in the other three species of this genus is not known, although Mound and Marullo (1996) considered the males as “without glandular area”.



FIGURES 9–15. *Stictothrips* species from Australia. *S. namadji* 9–12: (9) head; (10) pronotum; (11) tergites VII–VIII; (12) metanotum and pelta. *S. aoristus* 13–15: (13) antenna; (14) metanotum, pelta and tergites; (15) head and pronotum.

***Strepterothrips* Hood**

Strepterothrips Hood, 1934: 431. Type species *Strepterothrips conradi* Hood, by monotypy.

An identification key was provided by Mound and Ward (1971) to the six species of this genus then known. Those species are recorded from the following areas: one from southern Brazil, one from Panama, one from territories around the Caribbean, one from East Africa, one from India but also known from Thailand and northern Australia, and one from southern Australia and New Zealand. Since that date three further species have been described: *bicomus* zur Strassen from Cape Verde Islands was described as unique in the genus because antennal segment III bears two sense cones (instead of one); *uenoi* Okajima from Thailand and West Malaysia shares with *orientalis* the presence on antennal segment IV of three sense cones (instead of two as in other members of the genus); and *apterus* Okajima from Australia was described as having an exceptionally short third antennal segment. Described below from Australia are the following: one new species that shares an antennal sense cone formula with *orientalis* and *uenoi*, one new species that shares a sense cone formula with *apterus*, and three new species in which antennal segment III is unusually short and lacks sense cones. A sixth new species, found only on Norfolk Island, shares with *tuberculatus* the presence of a complete anterior margin to the mesoeusternum, in contrast to the other members of this genus.

In addition to the material indicated below, the following apterous females of *Strepterothrips* have been studied: 1 from Kenya identified as *africanus*; 1 from Panama identified as *conradi*; 1 from Trinidad identified as *floridanus*; 3 from Singapore identified as *uenoi*. In each of these the mesoeusternum is longitudinally divided medially. In the *uenoi* specimens this division is weak and variable, and in the *africanus* female it is exceptionally broad.

***Strepterothrips* species (apterae) from Australia**

1. Mesoeusternum anterior margin entire (Fig. 16); antennal segment III at least 1.5 times as long as wide (Fig. 26); pelta without discal setae. 2
- Mesoeusternum divided longitudinally (Figs 17–19); antennal segment III shorter and broader, no more than 1.3 times as long as wide (Figs 20–25); pelta often with discal setae. 3
2. Metanotum with 20–50 short pale setae distributed evenly across sclerite (Fig. 41); pronotum with discal setae distributed almost evenly (Fig. 41), postero-median third with 8–10 setae; meso and metanota coarsely tuberculate (Fig. 41). *tuberculatus*
- Metanotum with less than 10 setae on anterior two-thirds, posterior third with narrow transverse band of 20–30 setae (Fig. 40); pronotum medially and posteriorly with 4–6 setae, anterolaterally with dense groups of 25–30 setae (Fig. 39); meso and metanota finely and densely tuberculate (Fig. 40) *verruculus* sp.n.
3. Antennal segment III clear yellow, or brownish-yellow, in contrast to dark brown IV (Figs 23–24); antennal segment IV with three sense cones 4
- Antennal segment III as dark brown as IV (Figs 20–22); antennal segment IV with two sense cones 5
4. Antennal segment II as yellow as III (Fig. 24), segment III short, 1.1 times as long as wide; postocular setae less than 0.5 as long as fore tarsal width; apterae with posteromarginal setae on tergites II–V scarcely longer than apical width; tube less than 2.8 times as long as basal width (Fig. 45). *orientalis*
- Antennal segment II brown (Fig. 23); segment III 1.2–1.3 times as long as wide; postocular setae as long as fore tarsal width (Fig. 30); apterae with posteromarginal setae on tergites II–V at least twice as long as apical width; tube at least 3 times as long as basal width (Fig. 44). *okajimai* sp.n.
5. Antennal segment III with one small fine sense cone. 6
- Antennal segment III small, without any sense cones 7
6. Metanotum with no more than 12 small, fine setae (Fig. 36); pelta without discal setae; pronotum weakly sculptured with no more than 16 fine setae *apterus*
- Metanotum with about 30 short, blunt setae (Fig. 37); pelta with discal setae; pronotum strongly reticulate with more than 24 small stout discal setae (Fig. 38). *barbatus* sp.n.
7. Pelta with no discal setae (Fig. 42); tube of female more than 2.2 times longer than basal width; antennal segments IV–V with distinct sculpture lines. *moffati* sp.n.
- Pelta with 2 or more discal setae (Fig. 34); tube of female less than 2.0 times as long as basal width; antennal segments IV–V with no sculpture lines. 8
8. Antennal segment III goblet-shaped, maximum width no more than 1.1 times apical width (Fig. 20); pronotal midlateral setal pair not developed; tergites III–IV with discal setae pointed *arake* sp.n.
- Antennal segment III maximum width 1.4 times apical width (Fig. 25); pronotal midlateral setal pair capitate; tergites III–IV with discal setae bluntly pointed *parvulus* sp.n.

***Strepterothrips apterus* Okajima**

(Fig. 36)

Strepterothrips apterus Okajima, 1976: 14.

Described from four females and three males, all apterae, this species is distinguished by the short, dark brown third antennal segment that bears one small, slender sense cone, but with two sense cones on the fourth segment. It is closely related to the new species *barbatus* described below, from which it differs as indicated in the key above. Three other new species described below from Australia have no sense cones on segment III but have two on segment IV, whereas *orientalis* has one sense cone on segment III and three on segment IV.

Material studied. **Australia: New South Wales**, near Walgett, holotype female, paratype male from *Eucalyptus* leaf litter, 5.vi.1968 (ANIC).

***Strepterothrips arake* sp.n.**

(Figs 17, 20, 32, 34, 43)

Female aptera: Body, legs and antennae brown, with antennal segment I light brown and II almost yellow; tarsi and apex of tibiae yellow; major setae all pale.

Head longer than wide (Fig. 32); cheeks almost parallel, dorsal surface weakly reticulate particularly in midline, mid-dorsal setae not elongate; eyes with 3 facets dorsally and 2 anteroventrally; postocular setae short, broadly capitate. Antennae 7-segmented (Fig. 20), III goblet-shaped with narrow pedicel and no sense cone, IV with 2 sense cones; segments IV–VI with no sculpture lines, VII unusually elongate. Pronotum weakly reticulate (Fig. 32), with irregular rows of small tubercles near posterior margin; with 4 pairs of short, broadly capitate setae, ml setae not developed; notopleural sutures incomplete. Mesonotum transversely reticulate, with one pair of capitate lateral setae. Metanotum weakly reticulate, with about 40 finely pointed discal setae. Prosternal basantra not developed; ferna transverse, not meeting medially; mesopresternum reduced to pair of very small lateral triangles, mesoeusternum anterior margin strongly eroded. Pelta broadly D-shaped, reticulate with transverse row of up to 8 pointed setae (Fig. 34); tergites weakly reticulate with rows of small tubercles near posterior margins, with transverse row of finely pointed discal setae; II–VII with pair of asymmetrically capitate posteromarginal setae (Fig. 34), these setae longer on VIII; setae S1 on IX capitate, longer than basal width of tube (Fig. 43); S2 longer and finely acute.

Measurements (holotype female in microns). Body length 1450. Head, length 195; width 160; po setae 20. Pronotum, length 110; width 200; major setae, am 17, aa 17, ml ?, epim 25, pa 25. Tergite IX setae S1 60; S2 75. Tube length 95; basal width 60; anal setae 85. Antennal segments III–VII length, 22, 35, 35, 45, 75.

Material studied. Holotype female aptera. **Australia, Queensland**, Carnarvon Station, nr Kaka Mundi Rd., *Callitris* barkspray, 10.x.2014 (DJ Tree 1913) (ANIC).

Paratypes: 3 female apterae taken with holotype;

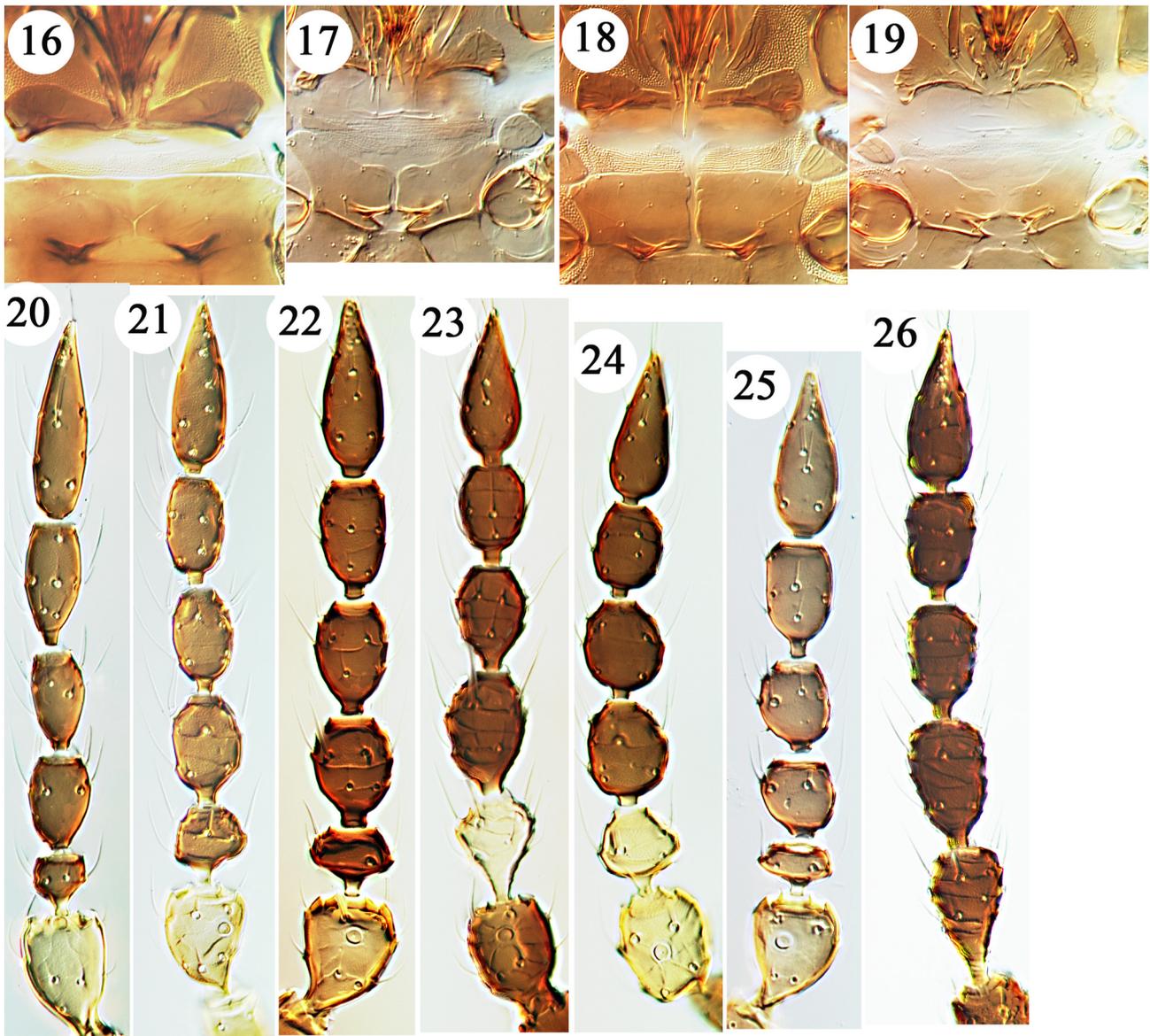
Non-paratypes. **Queensland**, Carnarvon Station, 2 female 2 male apterae from *Acacia harpophylla* barkspray, 13.x.2014.

Comments. The type specimens of this species have an almost symmetrical goblet-shaped third antennal segment (Fig. 20), and the species is unusual in lacking the pronotal midlateral pair of setae. The non-paratypes also lack this pair of pronotal setae, but the third antennal segment is less symmetrical, and the tergal discal setae are blunt not pointed. This species is very similar to *parvulus*, but has a shorter tube and longer terminal antennal segment.

***Strepterothrips barbatus* sp.n.**

(Figs 21, 37, 38)

Female aptera: Body, legs and antennae brown, with antennal segments I–II light brown; major setae all pale.



FIGURES 16–26. *Strepterothrips* species from Australia. Mesoeusternal anterior margin 16–19: (16) *verruculus*; (17) *arake*; (18) *orientalis*; (19) *parvulus*. Antennae 20–26: (20) *arake*; (21) *barbatus*; (22) *moffati*; (23) *okajimai*; (24) *orientalis*; (25) *parvulus*; (26) *tuberculatus*.

Head longer than wide; cheeks narrowed to base, dorsal surface reticulate but weakly so in midline, mid-dorsal setae capitate but shorter than broadly capitate po setae; eyes with about 5 facets dorsally and 2 anteroventrally. Antennae 7-segmented (Fig. 21), III sub-circular with narrow pedicel and one small fine sense cone; IV with 2 sense cones; segments III–V with transverse sculpture lines. Pronotum reticulate (Fig. 38), with a few small tubercles near posterior margin; with 5 pairs of short, broadly capitate major setae, and at least 25 short stout discal setae; notopleural sutures incomplete. Mesonotum transversely reticulate, with one pair of capitate lateral setae. Metanotum strongly sculptured, with about 30 stout, blunt discal setae (Fig. 37). Prosternal basantra not developed; ferna transverse, not meeting medially; mesopresternum reduced to pair of very small lateral triangles, mesoeusternum anterior margin strongly eroded. Pelta broad, reticulate with at least one discal setae (Fig. 37); tergites reticulate with rows of small tubercles near posterior margins, with transverse row of bluntly pointed discal setae; II–VII with pair of asymmetrically capitate posteromarginal setae, these setae longer on VIII; setae S1 on IX capitate, longer than basal width of tube; S2 longer and finely acute.

Measurements (holotype female in microns). Body length 1500. Head, length 200; width 160; po setae 18. Pronotum, length 125; width 200; major setae, am 18, aa 18, ml 18, epim 25, pa 20. Tergite IX setae S1 50; S2 100. Tube length 120; basal width 50; anal setae 125. Antennal segments III–VII length, 30, 37, 35, 37, 65.

Male aptera: Similar to female in colour and structure; large male with sub-apical tubercle on inner margin of fore tibia, tarsal hamus greatly enlarged and curved; tergite IX setae S2 slender and finely pointed.

Material studied. Holotype female aptera. **Australian Capital Territory**, Canberra, Black Mt., from dead twigs, 1.x.2006 (LAM4928) (ANIC).

Paratypes, all apterae: 1 female 2 males collected with holotype; 3 males, same site, on 13.iv.2006, 7.iv.2007, 30.iv.2011. **New South Wales**, 40km South of Coonabarabran, 1 female from grasses, 13.iii.2006.

Comments. Closely similar to *apterus*, this species differs in being strongly reticulate, and with many more setae on the pronotum and metanotum.

***Strepterothrips moffati* sp.n.**

(Figs 22, 27, 42)

Female aptera: Body, legs and antennae brown with antennal segments I–II almost yellow, tarsi and apex of tibiae scarcely paler than femora; major setae all pale.

Head longer than wide (Fig. 27); cheeks almost parallel, dorsal surface reticulate except in midline, mid-dorsal setae not elongate; eyes with about 3 facets dorsally and 2 ventrally; postocular setae short, broadly capitate. Antennae 7-segmented (Fig. 22), III short and broad with narrow pedicel and no sense cone, IV with 2 sense cones; segments IV–V dorsally with 2 transverse sculpture lines, VI with faint lines. Pronotum reticulate, with about three irregular rows of small tubercles along posterior margin; with 5 pairs of short, broadly capitate setae, notopleural sutures incomplete. Mesonotum reticulate, with one pair of small capitate lateral setae. Metanotum weakly reticulate, with about 30 bluntly pointed discal setae (Fig. 42). Prosternal basantra not developed; ferna transverse, not meeting medially; mesopresternum reduced to pair of very small lateral triangles, mesoeusternum anterior margin strongly eroded. Pelta sub-quadrangle, reticulate with pair of campaniform sensilla (Fig. 42); tergites weakly reticulate with rows of small tubercles near posterior margins, with transverse row of bluntly pointed discal setae; II–VI with pair of short, asymmetrically capitate posteromarginal setae (Fig. 42), these setae longer on VII–VIII; setae S1 on IX capitate, longer than basal width of tube; S2 longer and finely acute.

Measurements (holotype female in microns). Body length 1550. Head, length 240; width 200; po setae 25. Pronotum, length 130; width 250; major setae, am 22, aa 25, ml 25, epim 30, pa 25. Tergite IX setae S1 75; S2 100. Tube length 140; basal width 60; anal setae 125. Antennal segments III–VII length, 25, 40, 40, 43, 65.

Male aptera: Similar to female in colour and structure, tergite IX setae S2 short and stout.

Material studied. Holotype female aptera. **Australia, Queensland**, Mt Moffat, Carnarvon N.P., from barkspray in Mahogany Forest, 16.i.2013 (G.Monteith), in ANIC.

Paratypes, all apterae: 2 males taken with holotype; Carnarvon Station homestead, 1 female from barkspray of tree trunk, 14.x.2014.

Comments. This is one of a group of three species from Australia in which the third antennal segment is unusually small and lacks any sense cones. It is distinguished from the other two by the absence of setae on the pelta, the presence of sculpture lines on the antennal segments, and the longer tube.

***Strepterothrips okajimai* sp.n.**

(23, 30, 33, 44)

Female aptera: body, legs and antennae dark brown, except antennal segment III and bases of all tibiae bright yellow, metanotum brownish yellow, head slightly paler between eyes; postocular setae, major setae on pronotum and laterally on abdomen all pale, tergites II–VI with one pair of expanded shaded posteromarginal setae, posteroangular setae pale.

Head longer than wide (Fig. 30), dorsal surface reticulate, finely tuberculate medially between longitudinal rows of small setae, one pair of mid-dorsal setae about 0.8 as long as postocular setae; eyes with about 12 facets dorsally but none ventrally; capitate postocular setae well-developed, about as long as width of antennal segment II. Antennae 7-segmented (Fig. 23), III with one sense cone, IV with 3. Pronotum reticulate on anterior third, tuberculate on posterior third (Fig. 30); with 5 pairs of capitate setae, epim arising from small tubercle; notopleural sutures incomplete. Mesonotum with tuberculate sculpture, one pair of small capitate lateral setae (Fig. 33), closely

fused to metanotum. Metanotum coarsely tuberculate with about 26 small setae. Prosternal basantra not developed; ferna transverse, slender but not meeting medially; mesopresternum reduced to two lateral triangles, mesoeusternum divided medially. Pelta transversely oval, without discal setae (Fig. 33); tergites with tuberculate sculpture, particularly on posterior half of each tergite; II–VI with pair of large posteromarginal setae each with strongly asymmetric expanded apex; VI–VIII with median transverse row of discal setae; setae S1 on IX capitate, S2 long and finely acute.

Measurements (holotype female in microns). Body length 1520. Head, length 250; width 160; po setae 30; mid-dorsal setae 23. Pronotum, length 110; width 245; major setae, am 20, aa 25, ml 20, epim 40, pa 25. Tergite IX setae S1 55; S2 75. Tube length 165; basal width 50; anal setae 85. Antennal segments III–VII length, 35, 45, 37, 37, 62.

Material studied. Holotype female aptera. **Australia, Queensland**, Cairns, Lake Barrine, from dead branches, 10.x.2012 (LAM 5657).

Non-paratypes, all apterae. **Queensland**, Brisbane: Brookfield Smiths Scrub, 2 females from barkspray, 22.i.2011 (DJT1381); Cameron's Scrub, 1 female 1 male from barkspray rainforest, 30.iv.2012. Cooloola, 1 female from barkspray open forest, 16.vii.2013 (G. Monteith).

Comments. Amongst the species of this genus *okajimai* shares the antennal sense cone formula (1 on III; 3 on IV) only with *orientalis* and *uenoi*. It is closely related to the latter species that was described from Thailand, West Malaysia and Singapore. In contrast to *uenoi* the mid-dorsal setae on the head are shorter, the mesonotum bears only one seta laterally, the entire metanotum is pale (not just the posterior half), and tergite IX setae S1 are no longer than the basal width of the tube. The specimens listed as non-paratypes are from southeastern Queensland. These differ from the holotype in having the tube slightly longer, the tergal major setae with apices less asymmetric, the head not finely tuberculate medially but with a pair of indistinct longitudinal pale areas. However, there is variation amongst these specimens, and the female from Cooloola is particularly unusual in having four setae in a transverse row across the pelta.

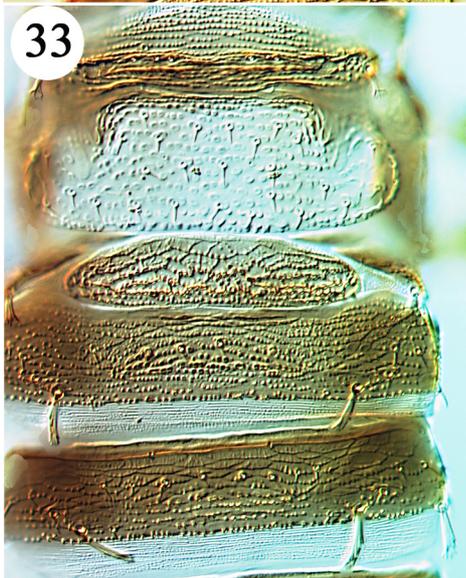
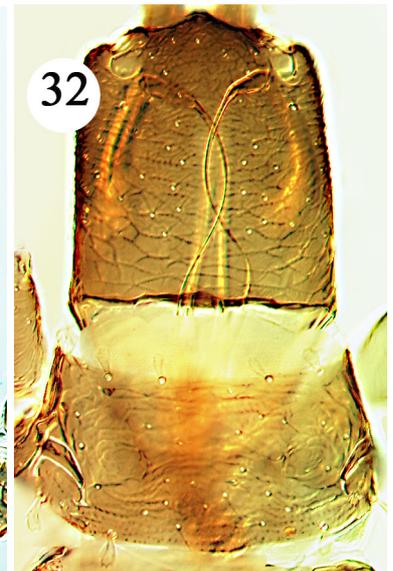
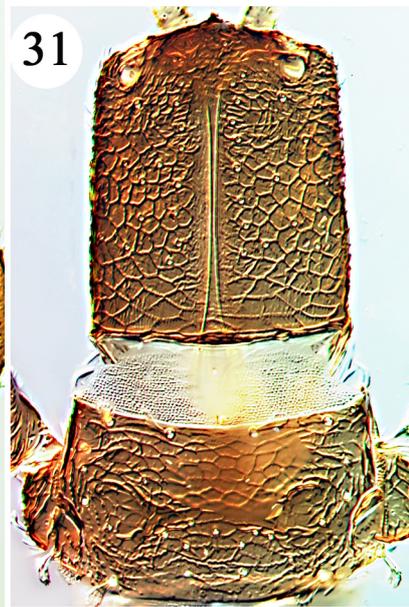
***Strepterothrips orientalis* Ananthkrishnan**

(18, 24, 45)

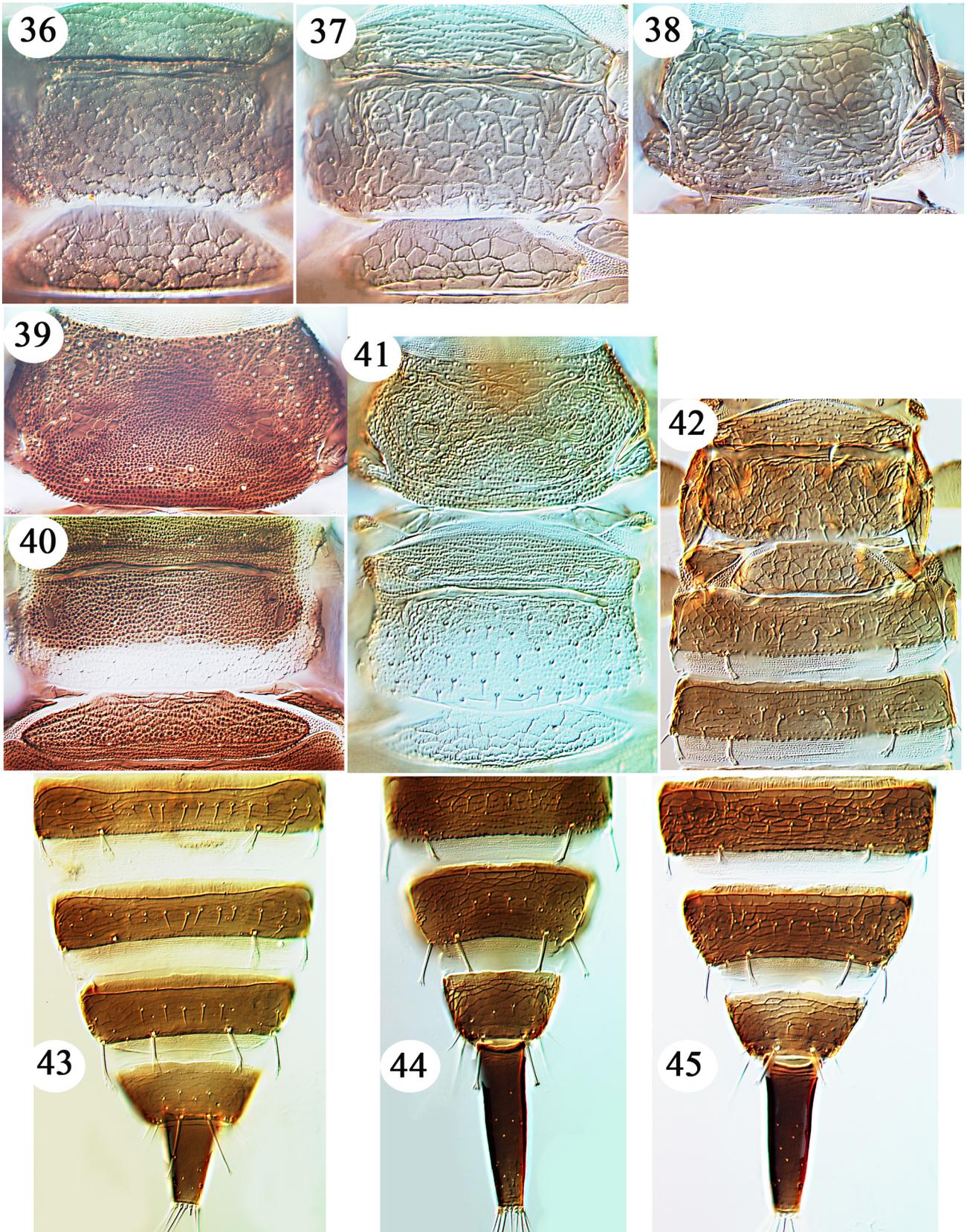
Strepterothrips orientalis Ananthkrishnan, 1964: 118.

Apart from the colour details and a large number of measurements, the original description of this species from southern India included few structural details. As indicated above *orientalis* is similar to *okajimai* and *uenoi* in the antennal sense cone arrangement, with one on segment III and three on segment IV. In macropterae, the prosternal basantra are faintly indicated although in apterae they are absent. The mesopresternum is not developed in any available specimen, and the mesoeusternum is longitudinally divided, even in macropterae. The tergal posteromarginal setae of apterae are short and broadly capitate, but in macropterae these setae are long with the apex asymmetric and arise close to the enlarged posterior pair of wing-retaining setae. This species has been found widely across the tropical northern areas of Australia, and most of these specimens bear one or more discal setae on the pelta.

Material studied, all apterae. **India**: Chennai, 1 female from *Borassus* dead lvs, x.2005; Kallar, 1 female macroptera from dead wood, x.2005. **Australia: Queensland**, Townsville, 1 female, 16.vii.1995, 2 females, 23.viii.2004; **Torres Strait Islands**, Boigu, 4 females, 1 male from dead wood, 16.xi.2009; Darnley, 2 females from dead wood, 17.xi.2009; Warraber, 2 males from dead leaves, 19.xi.2009. **Northern Territory**, Coburg Peninsular, Smith Point, 1 female from dead twigs, 14.v.1999. **Western Australia**, Kununurra, 3 females, 1 male, 23.ii.2005, 2 females, 1 male, 27.ix.2009; Broome, 20km east, 4 female apterae, 3 female macropterae, 1 male from dead mango branch, 1.iii.2005.



FIGURES 27–35. *Strepterothrips* species from Australia. Head 27–29: (27) *moffati*, (28) *tuberculatus*; (29) *verruculus*. Head and pronotum 30–32: (30) *okajimai*; (31) *parvulus*; (32) *arake*. Metanotum, pelta and tergites 33–34: (33) *okajimai*; (34) *akake*. (35) Male *verruculus*.



FIGURES 36–45. *Strepterothrips* species from Australia. Metanotum and pelta 36–37: (36) *apterus*; (37) *barbatus*. Pronotum 38–39: (38) *barbatus*; (39) *verruculus*. (40) *verruculus* metanotum and pelta. (41) *tuberculatus* thorax and pelta. (42) *moffati* metanotum, pelta and tergites. Apical abdominal segments 43–45: (43) *arake*; (44) *okajimai*; (45) *orientalis*.

***Strepterothrips parvulus* sp.n.**

(19, 25, 31)

Female aptera: Body, legs and antennae brown, but antennal segments I–II, tarsi and apex of tibiae almost yellow; major setae all pale.

Head longer than wide (Fig. 31); cheeks almost parallel, dorsal surface reticulate except in midline, mid-dorsal setae not elongate; postocular setae scarcely longer than broadly capitate apex; eyes with about 5 facets dorsally but one or none ventrally. Antennae 7-segmented (Fig. 25), III flattened, almost disc-shaped with no sense cone, IV with 2 sense cones; segments IV–VI with no sculpture lines. Pronotum reticulate (Fig. 31); with 5 pairs of short, broadly capitate setae, notopleural sutures incomplete. Mesonotum reticulate, with one pair of capitate lateral setae. Metanotum reticulate with about 25 bluntly pointed discal setae. Prosternal basantra not developed; ferna transverse, not meeting medially; mesopresternum not developed, mesoeusternum anterior margin strongly eroded (Fig. 19). Pelta sub-quadrangle to D-shaped, with irregular weakly reticulate sculpture and 4–5 bluntly pointed setae; tergites with narrow transverse reticulation, with transverse row of bluntly pointed discal setae; II–VI with pair of short, broadly capitate posteromarginal setae; setae S1 on IX capitate, longer than basal width of tube; S2 finely acute.

Measurements (holotype female in microns). Body length 1370. Head, length 210; width 160; po setae 20. Pronotum, length 110; width 210; major setae, am 23, aa 20, ml 20, epim 25, pa 25. Tergite IX setae S1 68; S2 70. Tube length 110; basal width 60; anal setae 55. Antennal segments III–VII length, 18, 32, 32, 43, 63.

Male aptera: Similar to female in colour and structure; pelta with only 2 setae; tergite IX S2 setae more than 0.5 as long as S1 setae.

Material studied. Holotype female aptera. **Australia, Queensland**, Brisbane, Mt Coot-tha, from barkspray on Ironbark *Eucalyptus*, 29.vi.2008 (DJT660), in ANIC.

Paratypes, all apterae: 1 male taken with holotype; **Queensland**, Brisbane Forest Park, Centre Road, 2 females from barkspray on *Eucalyptus siderophloia*, 22.i.2009 (DJT888) and 27.ii.2009 (DJT915); Redcliffe Tableland [100km west of Mackay], 1 female from barkspray on *Acacia harpophylla*, 18.iv.2012.

Non-paratypes, all apterae: **Queensland**, Carnarvon Station, 1 female 1 male from barkspray of tree trunk, 14.x.2014; **New South Wales**, Mt Kaputar NP, Dawson Springs, 1 female from barkspray on *Eucalyptus*, 21.i.2015.

Comments. This is one of two *Strepterothrips* from Australia in which the antennal segments bear no lines of sculpture, the other being *arake*. It is particularly remarkable for the very short, almost disc-shaped third antennal segment, and the reticulation over much of the head and body that is less robust than usually seen in this genus. The specimens listed as non-paratypes are essentially similar to the types, but have antennal segment III slightly longer, approaching the condition found in the non-paratypes of *arake*.

***Strepterothrips tuberculatus* (Girault)**

(Figs 26, 28, 41)

Rhopalothrips tuberculatus Girault, 1929: 2.

A full description of this species, indicating its wide distribution across Australia, was provided by Mound and Ward (1971). Males vary greatly in body size, head shape, and length of the claw-like fore tarsal hamus, and fully winged females occur in low numbers. Moreover, antennal segment III varies in colour, both within and between populations, from almost uniformly dark brown (Fig. 26) to pale brownish-yellow. This thrips is common on dead, often dry, twigs in eastern Australia, and has been studied from Kangaroo Island, South Australia, Tasmania, Victoria, New South Wales (including ACT and Lord Howe Island), Central and southeastern Queensland, and the southwest of Western Australia. The species is established in New Zealand, but despite extensive collecting activity, only one female, a macroptera, has been taken from the northern, tropical, areas of Australia. On Norfolk Island a similar species, *verruculus*, is common but this differs from *tuberculatus* in details of sculpture and thoracic chaetotaxy (Figs 39–41).

***Strepterothrips verruculus* sp.n.**

(Figs 4, 16, 29, 35, 39, 40)

Female aptera: body dark brown with much internal red pigment; legs and antennae brown, antennal segment III slightly paler at extreme base, head with paired longitudinal submedian paler areas, pterothorax sometimes paler laterally, metanotum sharply yellow on posterior third; major setae all pale.

Head longer than wide (Fig. 29); cheeks weakly convex with several weakly curved, broadly blunt setae; dorsal surface strongly reticulate particularly medially with small tubercles within each reticle, mid-dorsal setae not elongate; eyes with about 18 facets dorsally and 5 ventrally; postocular setae short, broadly capitate. Antennae 7-segmented (Fig. 4), III with one small sense cone, IV with 2 larger sense cones; segments with strong sculpture lines, II with 2 pairs of broadly blunt setae. Pronotum finely tuberculate (Fig. 39), anterolaterally with paired groups of about 25–30 small spatulate setae; major setae short, broadly capitate, but pa setae not developed; posteromedially with 2 pairs of short capitate setae; notopleural sutures incomplete. Mesonotum finely tuberculate, with one pair of capitate lateral setae. Metanotum finely tuberculate, with less than 10 setae on anterior two-thirds, but posterior third with narrow transverse band of 20–30 setae (Fig. 40). Prosternal basantra not developed; ferna transverse, not meeting medially; mesopresternum reduced to pair of small lateral triangles, mesoeusternum anterior margin complete (Fig. 16). Pelta transverse, with irregular reticulate sculpture of small tubercles but no discal setae (Fig. 40); tergites finely tuberculate, with transverse row of 4–6 small pointed discal setae; II–VII with pair of broadly capitate posteromarginal setae; setae S1 on IX capitate, S2 finely acute.

Measurements (holotype female in microns). Body length 1510. Head, length 200; width 175; po setae 15. Pronotum, length 125; width 250; major setae, am 20, aa 20, ml 20, epim 30, pa ?. Tergite IX setae S1 40; S2 80. Tube length 135; basal width 55; anal setae 100. Antennal segments III–VII length, 50, 43, 40, 38, 63.

Male aptera: similar in colour, sculpture and chaetotaxy to female, but highly variable in body size; small males similar to small females with normal small hamus on fore tarsus; largest males with head longer, projecting in front of eyes and narrowed to base (Fig. 35); fore femora swollen sub-basally on inner margin, fore tibia with small apical tubercle, fore tarsal hamus greatly enlarged and claw-like.

Material studied. Holotype female aptera. **Australia, Norfolk Island**, Prince Philip Drive, from dead *Lagunaria* branches, 26.xi.2014 (LAM 6084), in ANIC.

Paratypes, all apterae from Norfolk Island; 4 females, 5 males taken with holotype, also 4 females, 4 males at same site, 29.xi.2014; 21 females, 18 males from dead branches on various dates between 27.xii.2012 and 24.xi.2014, at many localities including, 100 Acre Reserve, Mt Bate, Highland Lodge, Palm Glen, Bird Rock Track, and Mission Road Forest.

Comments. This species, together with its bright red larvae, is common and widespread on dead branches across Norfolk Island where it is presumably endemic (Mound & Wells 2015). It is one of only two *Strepterothrips* in which the anterior margin of the mesoeusternum is known to be transverse and entire. In structure and colour, *verruculus* is closely similar to *tuberculatus* that is widespread across Australia, differing particularly in the sculpture and arrangement of setae on the pronotum and metanotum. In contrast to that species, no macropterae have been found, but the males show a similar diversity of form depending on the body size.

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