



## Australian spore-feeding thrips of the genus *Phaulothrips* (Thysanoptera, Idolothripinae)

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### Abstract

Breeding by several of the spore-feeding species in the genus *Phaulothrips* is shown to be associated with abandoned tunnels of bees and scolytid beetles, as well as with the dead seed capsules of *Eucalyptus* species. The breeding sites for other species in the genus remain unknown, but 16 species are here recognised from Australia, of which the following six are newly described: *P. daguilaris*, *P. flindersi*, *P. kingae*, *P. kranzae*, *P. oakeyi*, *P. whyallae*.

**Key words:** Spore-feeding, new species, Idolothripinae, Phlaeothripidae, *Phaulothrips*

### Introduction

Information on aspects of the biology of fungus-feeding Thysanoptera is rarely available, particularly on factors that might have promoted the observed species richness, such as host and habitat specificity or lack of dispersive behavior. The genus *Phaulothrips* that is considered here, with a considerable number of apparently closely related species, is typical of this situation. The number of generic synonyms, indicated below, presumably reflects the fact that these large dark thrips are frequently encountered in general insect collecting—but almost always as single individuals. Acquisition of longer series, together with information on structural variation and habitat specificity, requires discovery of the breeding sites of each species. From the gut contents of adults and larvae it is evident that they feed by imbibing whole fungal spores. However, for none of these thrips has the species of fungus represented by spores in the body been identified, in contrast to the situation in *Mecynothrips hardyi*, another species of Idolothripinae (Tree *et al.* 2010). Considering habitat specificity, intensive field studies in recent years have revealed that some *Phaulothrips* species breed in specific situations, including the following: abandoned nesting tunnels of bees; abandoned beetle tunnels of the family Scolytidae; cavities within *Eucalyptus* dry seed capsules. Despite this, many of the species remain known only from few specimens collected by beating dead branches, with no information concerning biotic relationships.

In adult *Phaulothrips*, the anterior margin of the head is remarkable in being almost vertical. Moreover, it bears one or more pairs of prominent pre-ocellar setae that in some species arise from small, or even very large, tubercles (Figs 16–19). This head shape is presumably related in some way to colony protection within the small cavities within which these thrips breed. Moreover, the maxillary stylets are very long and deeply retracted into the head, and in the larger species the head is strongly elevated in the mid-line to accommodate the greater length of these stylets. Nothing is known of the mating behaviour of these thrips, but in contrast to many of the larger Idolothripinae, there is limited intra-specific variation in body size. Large males have the fore legs more-or-less expanded in contrast to small males and females, but sexual dimorphism is less evident than in many spore-feeding thrips in which it is associated with male/male competition (Eow *et al.* 2011).

An identification key was provided by Mound (1974) to the nine species of *Phaulothrips* then recognized, all from Australia. Six further species are here described from this continent, and the available samples suggest that more undescribed species exist. In addition, four species of *Phaulothrips* have been described from Asia or the

Pacific—one each from Samoa, Bali, and Sulawesi, and one from Taiwan and the Ryukyu Islands of southern Japan. Moreover, at least one undescribed species has been seen from New Guinea, and another from New Caledonia.

The objective of this paper is to provide an identification key to the 16 members of *Phaulothrips* now recognised from Australia, including six new species, in response to a Bush Blitz grant from the Australian Biological Resources Study, Canberra.

## Depositaries and Acknowledgements

Holotypes of the new species described here are in the Australian National Insect Collection, Canberra, with paratypes in ANIC and QDPC, Brisbane. Depositaries of type material of previously described species are indicated in the text: BMNH—the Natural History Museum, London; CAS—California Academy of Sciences, San Francisco; QM—Queensland Museum, Brisbane; SMNH—Swedish Museum of Natural History, Stockholm; USNM—U.S. National Museum, Washington. The authors are grateful to Dr Alice Wells and Dr Geoff Monteith for much help in field work.

## *Phaulothrips* Hood

*Phaulothrips* Hood, 1918: 146. Type species *P. vuilleti* Hood, by monotypy.

*Tetraceratothrips* Bagnall, 1924: 628. Type species *T. agrestis* Bagnall, by monotypy. Synonymised by Mound, 1974: 78.

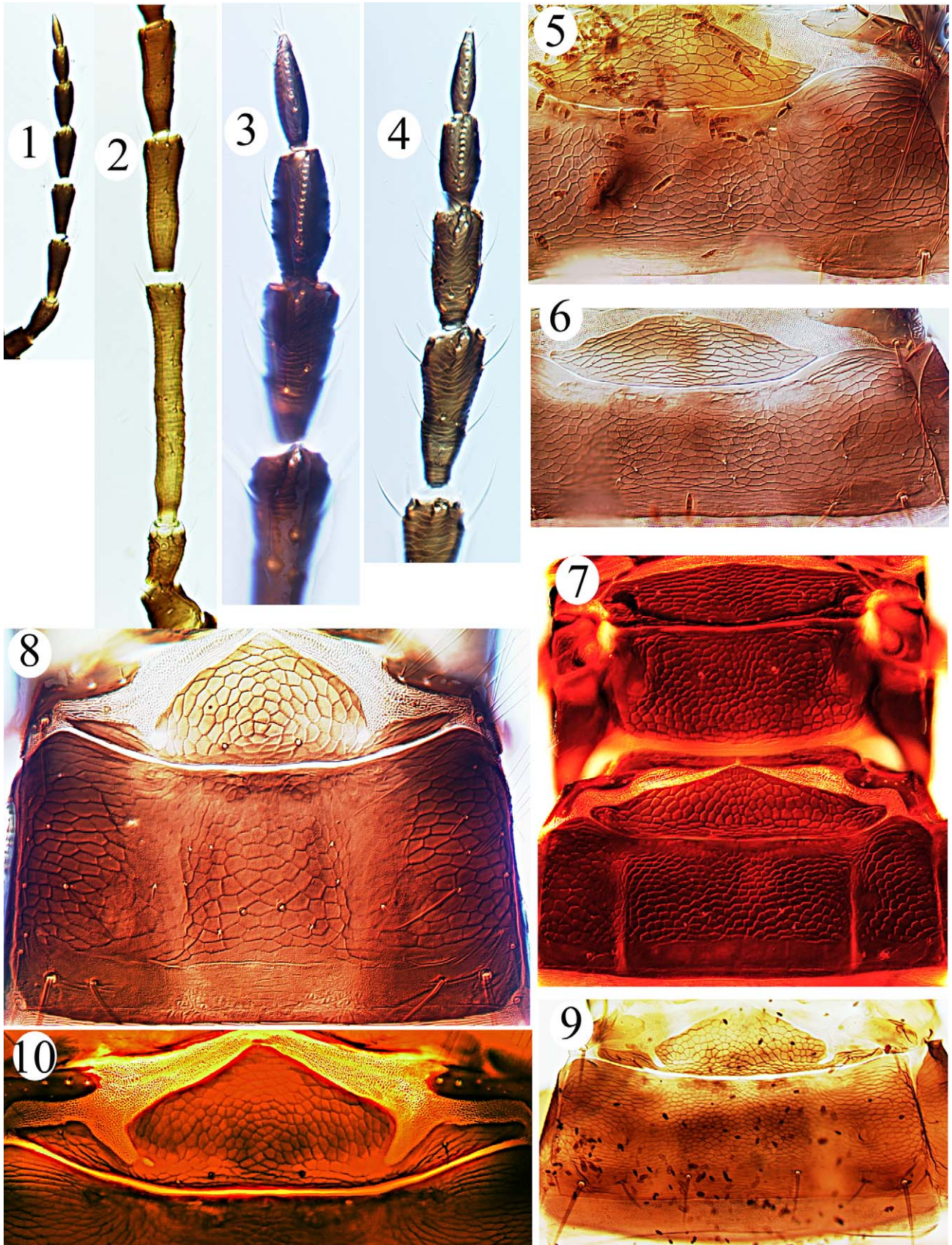
*Titanothrips* Karny, 1924: 38. Type species *T. portentosus* Karny, by monotypy. Synonymised by Mound, 1974: 78.

*Kaleidothrips* Kelly, in Kelly & Mayne, 1934: 73. Type species *K. inquilinus* Kelly, by monotypy. Synonymised by Mound & Palmer, 1983: 27.

*Generic definition.* Large dark species, macropterous or micropterous. Head elongate, elevated dorsally, truncate at anterior with antennae arising a little ventrally; frons with, or without, prominent tubercles and commonly with one or more pairs of enlarged pre-ocellar setae; postocular setae behind inner margin of eyes, one pair of postocular cheek setae; maxillary stylets close together in middle of head, retracted to postocular setae; mouth cone broadly rounded. Antennae 8-segmented, III longest, VIII as long as VII; III and IV each with two sensoria; ventral apices of V and VI prolonged ventrally in some species; I–III sometimes with dorsal setae weakly capitate. Pronotum anterior margin excavate in large specimens, epimeral sutures complete; prosternal ferna large, usually with median margins parallel; basantra small, triangular, lateral to mouth cone; mesopraesternum transverse; metathoracic sternopleural sutures present. Fore tarsi with a tooth in both sexes; fore femora usually not greatly enlarged even in large males. Fore wing broad, slightly expanded distally, with 15–50 duplicated cilia (absent in *sibylla*). Metanotal median setae small. Pelta wide, usually with large median area and slender lateral wings. Tergites II–VI (or VII) usually with only one pair of wing-retaining setae, a few species with more than one pair; tergites II–VI frequently with a pair of longitudinal pale or weakly sclerotised areas mesad of wing-retaining setae; lateral abdominal setae acute, moderately long; tube variable in length and shape, with margins straight but constricted at apex to margins strongly convex.

This genus is placed in the subtribe Pygothripina (Mound & Palmer 1983), in which most of the taxa are from Australia and New Zealand. It shares with *Pygothrips* the presence of elongate maxillary stylets that are close together medially in the head, and the presence of a pair of stout ocellar setae, and is possibly closely related to two genera known only from Australia, *Emprosthiothrips* and *Pelinothrips*.

The non-Australian species of *Phaulothrips* are easily distinguished from those presented here. The species described by Bianchi (1953) from Samoa, *P. magnificus*, has the mid-dorsal setae on the head arising close to the postocular setae, and both pairs are more than 0.7 as long as the head width (see Mound & Palmer, 1983: 113). No other member of the genus has this setal arrangement. Three further species were described by Okajima (1989) *P. melanosomus* from Sulawesi has a long head with a pair of small mid-dorsal setae, and is unique in the genus in having the lateral lobes of the pelta broadly joined to the median area. *P. orientalis* from Bali has a similarly long head but lacks mid-dorsal setae, and the lateral lobes of the pelta are separated from the median area—a condition not found in any other member of the genus. *P. solifer* from the Ryukyu Islands and Taiwan has the tube slightly longer than the head, but in contrast to *P. daguilaris* described below it does not have a pair of setae on the lateral lobes of the pelta.



**FIGURES 1–10.** Australian species of *Phaulothrips*. (1) *barretti*, antenna; (2) *whyallae*, antennal segments I–V; (3) *daguilaris*, antennal segments V–VIII; (4) *flindersi*, antennal segments V–VIII; (5) *anici*, pelta of macroptera; (6) *anici*, pelta of microptera; (7) *kranzae*, meso & metanotum, pelta & tergite II; (8) *agrestis*, pelta & tergite II; (9) *whyallae*, pelta & tergite II; (10) *daguilaris*, pelta.

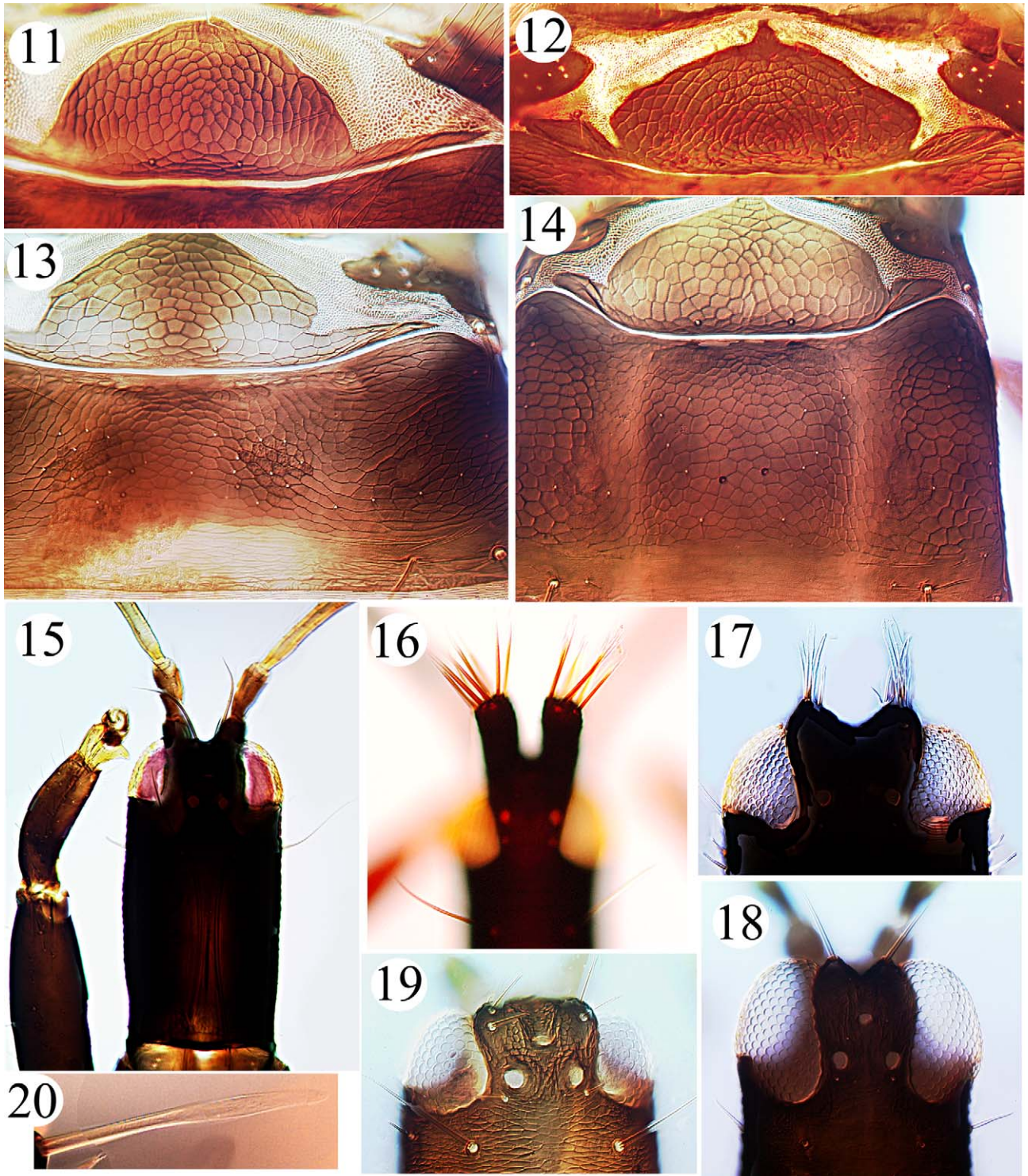
## Key to Australian species of *Phaulothrips*

1. Antennal segment III less than 200 microns long (Fig. 1) ..... 2
- Antennal segment III more than 220 microns long (Fig. 2) ..... 3
2. Antennal segment III length 120–140 microns (Fig. 1); tube shorter than head, tube/head ratio about 0.9 ..... *barretti*
- Antennal segment III length about 180 microns; tube longer than head, tube/head ratio about 1.3 ..... *caudatus*
3. Pelta with no lateral lobes (Figs 5–7) ..... 4
- Pelta with distinct, but sometimes small, lateral lobes (Figs 11–14) ..... 5
4. Pelta occupying no more than two-thirds of anterior margin of tergite II, maximum width less than four times median length (Figs 5–6) ..... *anici*
- Pelta occupying almost the entire anterior margin of tergite II, maximum width more than four times median length (Fig. 7) ..... *kranzae* **sp. n.**
5. Body bicoloured, thorax, abdominal segment I, antennal segments III–IV, and tarsi yellow (Fig. 26); tergites each with two pairs of wing-retaining setae (cf Fig. 8) ..... *uptoni*
- Body and legs dark brown; tergites usually with anterior pair of sigmoid wing-retaining setae vestigial ..... 6
6. Lateral lobes of pelta very short, one-eighth of width of this sclerite (Fig. 14); fore wing, when present, with no duplicated cilia ..... *sibylla*
- Lateral lobes of pelta long, one fifth of width of sclerite (Figs 8–10); fore wing, when present, with duplicated cilia present ..... 7
7. Anterior margin of head with pair of prominent rounded tubercles, each bearing about 10 dark setae with translucent apices (Fig. 16) ..... *inquilinus*
- Anterior margin of head sometimes with small tubercles, but these bear no more than three pairs of setae (Figs 17–19) ..... 8
8. Anterior margin of head with pair of small pointed tubercles each bearing three stout translucent setae about as long as antennal segment I (Fig. 17); pelta lateral lobes bearing one pair of setae ..... *kingae* **sp. n.**
- Anterior margin of head with no more than two pairs of pre-ocellar setae (Figs 18–19); pelta lateral lobes with or without setae ..... 9
9. Head with two pairs of short pre-ocellar setae (Fig. 19), neither setal pair longer than antennal segment I; pelta with pair of prominent setae on lateral lobes; tergites II–VII with median setae at least 0.5 as long as each tergite (Fig. 9) ..... *whyallae* **sp. n.**
- Head with one pair of prominent pre-ocellar setae (Figs 15, 18), if more than one pair then one pair is longer than antennal segment I; pelta lobes usually without setae; median pair of tergal setae not elongate ..... 10
10. Head with mid-dorsal pair of setae present; prosternal ferna bluntly pointed medially in females (Fig. 32) ..... *oakeyi* **sp. n.**
- Head without a pair of major mid-dorsal setae; prosternal ferna usually with median margins parallel (Figs 30, 31, 33) ..... 11
11. Tube of female with margins convex, no longer than 0.75 as long as head (Figs 27–28); pre-ocellar setae on head colourless, apical half broad and flat (Fig. 20) ..... *vuilleti*
- Tube of female with margins straight, but constricted at apex (Fig. 29), at least 0.8 as long as head; pre-ocellar setae pale or shaded, never colourless with flattened apices ..... 12
12. Tube at least 1.1 times as long as the head ..... 13
- Tube less than 0.9 as long as the head ..... 15
13. Tergites with more than one pair of wing-retaining setae; all 3 pairs of major setae on head dark, long, slender and sharply acute (Fig. 8) ..... *agrestis*
- Tergites with only one pair of wing-retaining setae; major setae on head pale or weakly shaded ..... 14
14. Pelta with pair of setae on lateral lobes (Fig. 10); tube 1.3–1.5 as long as head; pre-ocellar setae extend to apex of antennal segment II ..... *daguilari* **sp. n.**
- Pelta without setae on lateral lobes (Fig. 11); tube no more than 1.2 as long as the head; pre-ocellar setae extend to apex of antennal segment I ..... *flindersi* **sp. n.**
15. Pre-ocellar setae weakly shaded and slender; tube of female at least 0.85 of head length ..... *longitubus*
- Pre-ocellar setae colourless and stouter; tube of female no more than 0.8 of head ..... *fuscus*

### *Phaulothrips agrestis* (Bagnall)

*Tetraceratothrips agrestis* Bagnall, 1924: 628

This species was described from a single male (in BMNH), taken in April 1914 at “Austinmer”, a locality that is presumed to be just South of Sydney. No single population of this species has yet been located, but three females and one male have been identified from four different localities in southeastern Queensland. The post-ocular cheek setae of *agrestis* are particularly long and slender (Fig. 15) and, as in *uptoni*, the compound eyes are elongate dorsally around the ocellar region, and the abdominal tergites bear more than one pair of wing-retaining setae. However, the tube is slightly longer, about 1.1 times as long as the head in females.



**FIGURES 11–20.** Australian species of *Phaulothrips*. (11) *flindersi*, pelta; (12) *inquilinus*, pelta; (13) *oakeyi*, pelta; (14) *sibylla*, pelta; (15) *agrestis*, head; (16) *inquilinus*, pre-ocellar tubercles; (17) *kingae*, pre-ocellar tubercles; (18) *kranzae*, pre-ocellar tubercles; (19) *whyallae*, pre-ocellar tubercles; (20) *vuilleti*, pre-ocellar seta;

***Phaulothrips anici* Mound**

*Phaulothrips anici* Mound, 1974: 82

This is one of only two species in the genus with the pelta lacking lateral wings, and this structure differs in shape

between the macropterous female and micropterous male (Figs 5–6). It remains known from one specimen of each of these two morphs, collected together with larvae at Canberra in 1937. Antennal segment III is dark brown, and the postocular and pre-ocellar setae are long and weakly capitate, the latter extending just to the apex of antennal segment II. The postocular cheek setae are also weakly capitate.

### ***Phaulothrips barretti* Mound**

*Phaulothrips barretti* Mound, 1974: 83

The holotype, a male that was collected in S.E. Queensland, Mt Tamborine, is by far the smallest member of the genus and with short antennae (Fig. 1). The pelta is typical of *Phaulothrips*, with slender lateral wings, but the pre-ocellar setae are short, not extending to the apex of the first antennal segment. A considerably larger female has also been studied that apparently represents this species, taken in a trap at Indooroopilly, Brisbane, on 10.iv.2009. The sensoria on antennal segments III and IV in this species are slightly longer than in the other members of the genus, but are no longer than the apical width of their segment.

### ***Phaulothrips caudatus* Bagnall**

*Phaulothrips caudatus* Bagnall, 1932: 510

This species remains known only from a single rather small female (in BMNH), taken on a *Casuarina* branch at Mornington, Victoria, 21.x.1928. This is mounted ventral side uppermost, the head is crushed and distorted, and the body contains a large quantity of opaque white pigment such that most details of the integument are not visible. Antennal segment III is shorter on this specimen than in any other available specimen of this genus, apart from the holotype of *barretti*. The body length is about 3100 microns; head length 450; tube length 670; antennal segments III–IV length 180, 110. The ratio of tube to head is thus 1.5. Without a sample from one population exhibiting a range of body sizes the identity of *caudatus* will remain in doubt.

### ***Phaulothrips daguilaris* sp.n.**

(Figs 3, 10, 21, 29, 30)

*Macropterous female.* Body (Fig. 21), legs, antennal segments I, II, VI–VIII dark brown, segments III–V light brown with darker apices; major setae mainly pale but shaded at base, postocular cheek setae dark; fore wing weakly shaded with darker area medially.

Head with cheeks straight; anterior margin with pair of pale pre-ocellar setae with shaded bases, extending to apex of antennal II; postocular setae longer than dorsal eye length, arising posterior to inner margins of eyes; maxillary stylets retracted to postocular setae, about one fifth of head width apart. Antennal segments IV–VI very weakly prolonged at ventral apex, VII with longitudinal row of sensoria (Fig. 3); VIII constricted at base.

Pronotum transverse, reticulate particularly laterally. Fore tarsal tooth recurved, length about half tarsal width. Metanotum reticulate, median setae well-developed. Prosternal basantra small, triangular, lateral to mouth cone; ferna large with median borders almost parallel (Fig. 30); mesopraesternum transverse.

Pelta with long lateral lobes (Fig. 10), bearing one pair of setae (in some specimens the setae arise anterior to lobe, or on a separate small sclerite); tergites with reticulate sculpture; III–VI each with one pair of sigmoid wing-retaining setae, lateral setal pairs long and blunt; tergite IX setae finely acute, shorter than tube; tube with straight margins weakly constricted near apex (Fig. 29).

Measurements (holotype female in microns). Body length 7100. Head, length 730; median width 390; pre-ocellar setae 230; postocular setae 260; postocular cheek setae 90. Pronotum, length 280; width 720; major setae—am 35, aa 30, ml 30, epim 310 (260), pa 165. Metanotal median setae 100. Fore wing, length 2380; number of duplicated cilia 20–25. Pelta, length 180; width 730. Tergite IV pair I lateral setae 310. Tergite IX setae S1 720, S2 730. Tube length 1070. Antennal segments III–VIII length 390, 240, 200, 150, 110, 90.

*Macropterosus male*. Similar in colour and structure to female; pronotum and fore femora more robust, fore tarsal tooth twice as long as tarsal width.

Measurements (paratype male in microns). Body length 6900. Head, length 720. Pronotum, length 380; width 820; major setae—am 20, aa 20, epim 280, pa 240. Metascutum, length 330; width 650. Fore wing, length 2300. Tergite IX setae S1 280, S2 300. Tube length 950.

**Specimens examined.** Holotype female, **Queensland**, Mt Glorious, from dead branches, 1.xi.2007 (DJT 548). Paratypes; 2 females taken with holotype; Mt Coot-tha, 1 female from dead wood, 17.iv.2011; Yarraman, 1 female from bark sprayed trees, 27.iv.2010; Upper Brookfield, 4 females, 3 males and 1 larva from bark sprayed *Eucalyptus*, 22.i.2011; Gap Creek Reserve, 1 male from dead wood, 22.iv.2011.

**Comments.** The tube of this species is longer than in any other member of the genus, the tube/head ratio in females being 1.46–1.67, and in males 1.23–1.31. The pre-ocellar setae are also elongate, and the pelta usually bears a pair of setae. Although apparently associated with *Eucalyptus*, the actual breeding site of this species is not known.

### *Phaulothrips flindersi* sp.n.

(Figs 4, 11, 31)

*Macropterosus female*. Body and legs brown to dark brown, fore tibiae and tarsi paler, also antennal segments III–V; major setae mainly pale, pre-ocellar and postocular cheek setae shaded; fore wing weakly shaded with darker area medially.

Head with cheeks straight to weakly concave; anterior margin with pair of pale pre-ocellar setae with shaded bases, extending to apex of antennal I; postocular setae shorter than dorsal eye length, arising slightly lateral to inner margins of eyes; maxillary stylets retracted to posterior margin of eyes, close together medially in head. Antennal segments II–III with dorso-apical setae weakly capitate; IV–VI ventral apex slightly prolonged with pair of prominent setae, VII prominent longitudinal row of sensoria (Fig. 4); VIII constricted at base.

Pronotum transverse with anterior margin concave; weakly reticulate only around margins; epimeral sutures complete. Fore tarsal tooth recurved, length about half tarsal width. Metanotum reticulate, median setae small. Prosternal basantra small, triangular, lateral to mouth cone; ferna large, median margins rounded and sub-parallel (Fig. 31); mesopraesternum transverse. Fore wings with about 50 duplicated cilia; sub-basal setae S3 longer than S1 and S2.

Pelta with long slender lateral lobes (Fig. 11); tergites reticulate III–VI each with one pair of long but weakly sigmoid wing-retaining setae; tergites II–IV and VIII postero-angular setae much shorter than on V–VII; tergite IX setae finely acute, shorter than tube; tube with tapering margins, apex weakly constricted.

Measurements (holotype female in microns). Body length 5900. Head, length 620; median width 370; pre-ocellar setae 100; postocular setae 120; postocular cheek setae 70. Pronotum, length 300; width 650; major setae—am 50, aa 80, ml 90, epim 230, pa 130. Metanotal median setae 60. Fore wing, length 2250. Pelta, length 180; width 700. Tergite IV lateral setae 220. Tergite IX setae S1 440, S2 450. Tube length 650. Antennal segments III–VIII length 270, 180, 150, 120, 100, 90.

*Macropterosus male*. Similar in colour and structure to female; pronotum and fore femora more robust, fore tarsal tooth as long as tarsal width.

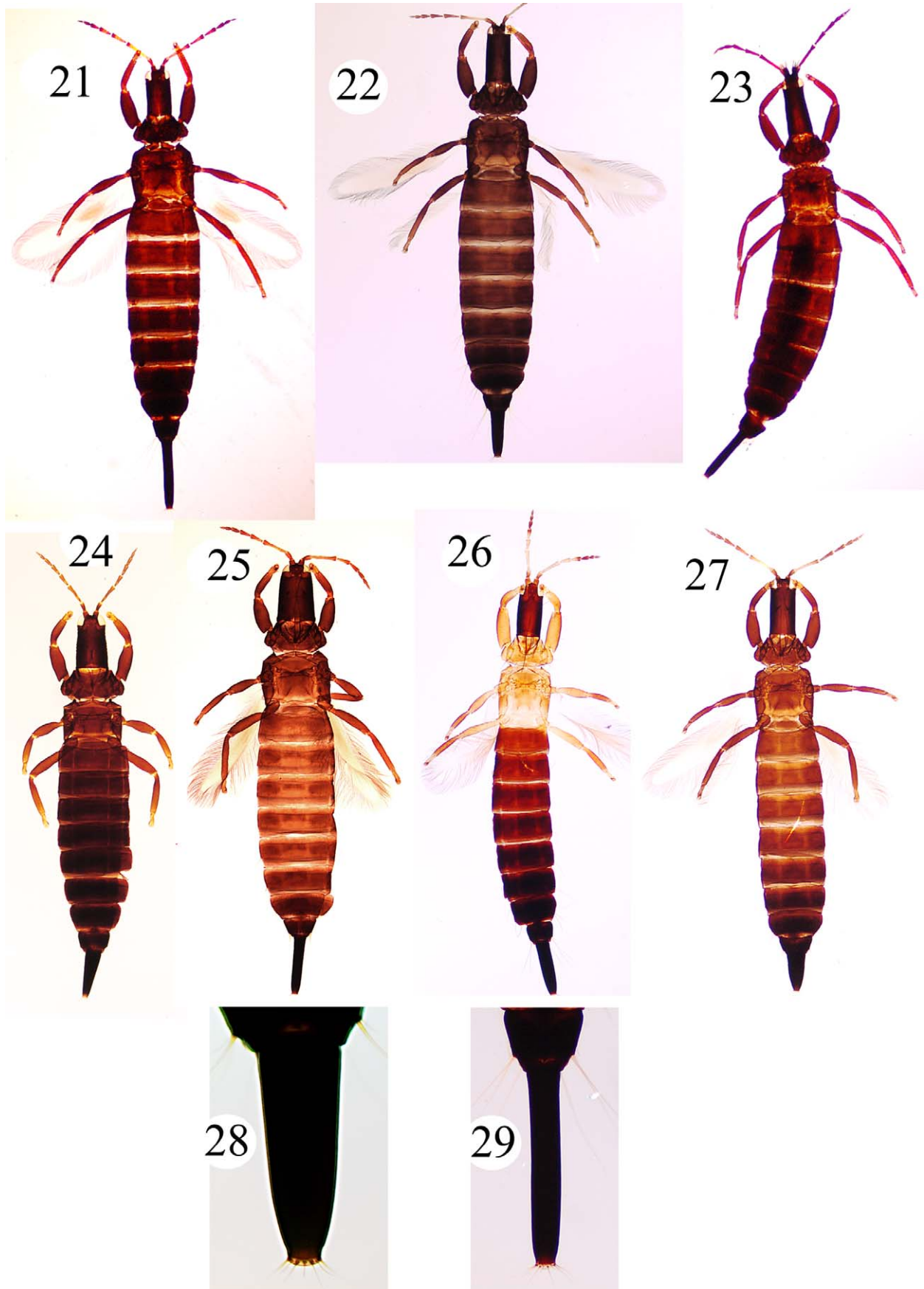
Measurements (paratype male in microns). Body length 5100. Head, length 570. Pronotum, length 340; width 650. Fore wing length 2100. Tergite IX setae S1 370, S2 320. Tube length 550.

**Specimens examined.** Holotype female, **Tasmania**, Flinders Island, from dead *Eucalyptus* twigs and nuts, 27.xi.2011 (LAM 5524).

Paratypes: 1 female 1 male taken with holotype.

Non-paratypic specimens: **New South Wales**, Bungonia 25km south, 2 females from dead *Casuarina* branches, 4.vi.2011; Barrington Tops, 1 female, 21.ii.2002. **Australian Capital Territory**, Namadgi, 1 female from dead twigs, 27.xii.2005.

**Comments.** This species is considerably smaller than *daguilaris*, with the tube, also the pre-ocellar setae, much shorter. The medial margins of the prosternal ferna are more rounded and less parallel sided. The specimens excluded from the type series are similar in structure, but the ones from New South Wales have longer pre-ocellar setae.



**FIGURES 21–29.** Australian species (females) of *Phaulothrips*. (21) *daguilaris*; (22) *fuscus*; (23) *inquilinus*; (24) *kranzae*; (25) *oakeyi*; (26) *uptoni*; (27) *vuilleti*; (28) *vuilleti*, tube; (29) *daguilaris*, tube.



## *Phaulothrips fuscus* Moulton

*Phaulothrips fuscus* Moulton, 1935: 100

*Cladothrips punctatus* Raymont, 1948: 257. Synonymised by Mound, 1971: 420

This species (Fig. 22) is similar in structure to *vuilleti*, but has the pre-ocellar setae more slender, and the tube relatively longer and almost parallel sided. Measurements of the head and tube are identical in the *fuscus* holotype and a syntype female of *punctatus*; 730 and 580 microns, with the ratio 0.8. In contrast, the male syntype of *punctatus* has these measurements 700 and 500 microns (ratio 0.71). In the series listed below from near Bungonia the ratio of tube length to head length ranges from 0.77 to 0.82. Based on these measurements, *fuscus* is here interpreted as a species that is widespread across Australia, although it may yet prove to be the same species as *longitubus* (qv). These are distinguished from each other only on rather weak character states, including rather more slender lateral wings to the pelta in *fuscus*.

**Specimens examined.** Holotype female, **Western Australia**, Bridgetown, 15.xi.1927 (in CAS); 60km northeast of Narrogin, 1 female by insecticide fogging of *Eucalyptus*, x.2006; Broome, 1 male from “pindan” (?*Acacia tumida*), 3.viii.1997. **New South Wales**, Sydney, Lane Cove, syntypes of *punctatus* (labeled maculosus) in *Hylaeus* sp. cells, 10.xi.1946; Bungonia 25km south, 7 females 2 males from dead *Eucalyptus*, 4 females 2 males from dead *Acacia* branches, 1 female from dead wood, 3 females from dead *Casuarina* branches, 4.vi.2011.

## *Phaulothrips inquilinus* (Kelly)

*Kaleidothrips inquilinus* Kelly, in Kelly & Mayne, 1934: 73

This is a particularly remarkable species (Fig. 23), although it is closely related to *kingae* described below from a single macropterous female. The head bears 10 or 12 pairs of pre-ocellar setae that arise on two elongate tubercles (Fig. 16). These setae are dark but with the apices sharply pale and blunt. In contrast to many other members of the genus, antennal segment III is uniformly dark brown. Winged and wingless adults have a single pair of wing-retaining setae on the tergites, and bear a seta on the lateral lobes of the pelta. The specimens taken from within bee tunnels are all micropterae.

**Specimens examined.** **New South Wales**, Marrickville, labeled “TYPE” without further data; Sydney, Normanhurst, 1 female from grasses, i.1959; Goulburn, 7 females, 2 males with larvae, from a bee tunnel in *Foeniculum vulgare* stem, iv.1955; Armidale, 1 female, 2 males from a bee tunnel in *F. vulgare* stem, iv.1955. **Queensland**, Mt Coot-tha, The Gap, 1 female from dead leaves, 31.xii.2006; Barakula forest, 1 female from Malaise trap, 23.i.-10.ii.2010. **South Australia**, Whyalla, 1 female macroptera, 1.viii.2000; Lake Gilles, 1 female macroptera, 1 male microptera, 10.iv.2000. **Australian Capital Territory**, Mt Ainslie, 1 female from dead branches, 19.ix.2008.

## *Phaulothrips kingae* sp.n.

(Fig. 17)

*Female macroptera.* Body with much reticulation, dark brown to black with pale major setae; fore tarsi and extreme apex of antennal segment I slightly paler, antennal III uniformly dark; fore wing deeply shaded with extreme base and apex sharply pale; tergite II anterolaterally with paired small pale area.

Head long with cheeks almost straight, posterior margin slightly pointed medially, eyes small; three pairs of pre-ocellar setae arise from pair of prominent tubercles (Fig. 17), these setae dark at base but pale in distal half; one pair of long postocular setae with weakly capitate apices; two pairs of small stout postocular cheek setae; maxillary stylets close together medially and retracted to postocular setae. Antennae 8-segmented; III and IV each with two sensoria, their length less than 0.5 of apical width of the segment; IV–VII with apex slightly asymmetric; VII with ventral longitudinal row of small sensoria; VIII constricted at base.

Pronotum transverse; major setae pale, blunt or weakly capitate. Metanotum reticulate, with one pair of small, pale median setae. Fore tarsal tooth slightly recurved. Prosternal basantra small, triangular, lateral to mouth cone;

ferna large with median margins sub-parallel; mesopraesternum boat-shaped but slender; metathoracic sternopleural sutures long and recurved. Fore wing broad, with about 25 duplicated cilia; three sub-basal setae arise in a straight line, S3 longest.

Pelta reticulate, tri-lobed with pair of setae on lateral lobes; small campaniform sensilla medially; tergites with narrow transverse reticulation, II with minute discal setae anterolaterally; III–VII with 2 pairs of long pale setae laterally, on II–IV with apices broadly blunt, on V–VIII longer and acute, on VII twice as long as median length of tergite; setae on IX as long as tube.

*Measurements* (holotype female in microns). Body length 6100. Head, length 900; width across cheeks 390; longest pre-ocellar setae 120; postocular setae 220; postocular cheek setae 55. Pronotum, length 260; width 600; major setae length am 100, aa 70, ml 230, epim 270, pa 330. Fore wing length 2000. Tergite III lateral setae, pair I 250, pair II 220. Tergite IX setae, S1 700, S2 700. Tube length 760. Antennal segments III–VIII length 400, 220, 180, 130, 110, 100.

**Specimens examined.** Holotype female, **Queensland**, Stanthorpe, Passchendale, from *Pinus radiata* male cone, 14.i.1999 (Judy King).

**Comments.** This species is currently unique in the form of the anterior margin of the head and pre-ocellar setae (Fig. 17). It is an interesting intermediate species between the typical members of the genus and the extreme condition of the head exhibited by *inquilinus*.

### ***Phaulothrips kranzae* sp.n.**

(Figs 7, 18, 24, 34)

*Macropterous female.* Body, legs and antennae blackish brown (Fig. 24), major setae pale to very weakly shaded, fore wing weakly shaded; tergites with pair of paler longitudinal areas laterally.

Head with cheeks almost straight, anterior margin with pair of prominent tubercles each bearing a pale blunt seta (Fig. 18); postocular setae shorter than dorsal eye length, arising posterior to inner margins of eyes; maxillary stylets retracted almost to postocular setae, about one fifth of head width apart. Antennae 8-segmented; III and IV each with two sensoria, their length about 0.7 of apical width of the segment; V–VII with apex slightly prolonged ventrally; VII ventrally with short longitudinal row of small sensoria; VIII constricted at base.

Pronotum transverse, reticulate (Fig. 34). Fore tarsal tooth pointed, length less than half tarsal width. Metanotum transverse, reticulate, median setae small. Prosternal ferna placed laterally, basantra large with median borders parallel; mesopraesternum transverse; metathoracic sternopleural sutures strongly recurved.

Pelta transverse fully across anterior margin of tergite II (Fig. 7); III–V each with one pair of sigmoid wing-retaining setae; tergites strongly reticulate, lateral setal pairs bluntly rounded to weakly capitate; tergite IX setae almost acute, shorter than tube; tube with straight margins weakly constricted near apex.

*Measurements* (holotype female in microns). Body length 4400. Head, length 600; median width 330; ocellar setae 100; postocular setae 90; postocular cheek setae 75. Pronotum, length 280; width 600; major setae—am 50, aa 75, ml 60, epim 125, pa 80. Metanotal median setae 60. Fore wing, length 1700; number of duplicated cilia 20–25. Pelta, length 140; width 580. Tergite IV lateral setae pair I 110, pair II 65. Tergite IX setae S1 300, S2 350. Tube length 580. Antennal segments III–VIII length 250, 150, 140, 110, 70, 80.

*Micropterous female.* Similar in colour and structure to macropterous female; postocular setae shorter, metascutum strongly transverse.

*Measurements* (paratype female collected with holotype, in microns). Body length 4500. Head, length 650; median width 320; ocellar setae 115; postocular setae 80; postocular cheek setae 65. Pronotum, length 280; width 550; major setae—am 40, aa 55, ml 35, epim 110, pa 75. Metanotal median setae 55. Fore wing length 300. Pelta, length 130; width 600. Tergite IV lateral setae pair I 100, pair II 50. Tergite IX setae S1 350, S2 330. Tube length 580.

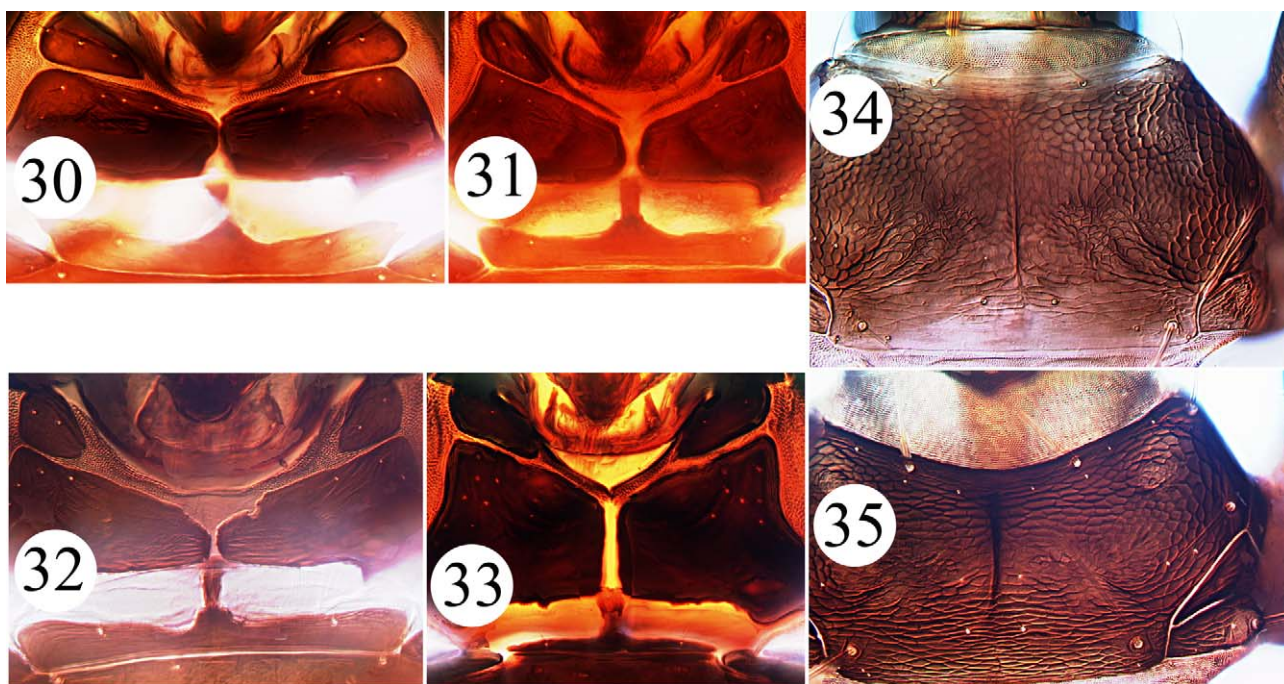
*Micropterous male.* Similar in colour and structure to micropterous female; pronotum and fore femora more robust, fore tarsal tooth as long as tarsal width.

*Measurements* (paratype male collected with holotype, in microns). Body length 4020. Head, length 550. Pronotum, length 370; width 630; major setae—am 50, aa 70, ml 50, epim 100, pa 80. Metascutum, length 170; width 600. Fore wing, length 230. Tergite IX setae S1 280, S2 300. Tube length 500.

**Specimens examined.** Holotype female macroptera, **South Australia**, Adelaide Hills, Scott Creek, from *Eucalyptus* seed capsules, 28.xi.2005 (Brenda Kranz 1195b).

Paratypes (micropterae unless stated otherwise): **South Australia**: 3 females 3 males taken with holotype (and larvae); same locality, 2 female macropterae, 1 male microptera, 2.ix.2005. Adelaide, Stirling, 5 females 5 males from *Eucalyptus* seed capsules, 8.iv.2004; Adelaide, Mt Lofty, 1 male from *Eucalyptus* dead leaves, 22.xii.2005; Adelaide, Mt George, 1 female from *Eucalyptus* dead leaves, 9.1.2006; Kingston 15km west, 1 female 1 male from *Eucalyptus* nuts, 10.iii.2011; 5 km south of Salt Creek, Coorong, 1 female from dead *Eucalyptus* nuts 11.iii.2011, 50km south of Salt Creek, Coorong, 1 male from dead *Eucalyptus* nuts 11.iii.2011, 15km north of Kingston, 2 females 1 male from dead *Eucalyptus* nuts 10.iii.2011, 50km south of Desert Camp Park, Keith, 4 female 3 male from dead *Eucalyptus* nuts 14.iii.2011, 15km south of Murray Bridge, 1 male from dead *Eucalyptus* branches 14.iii.2011. **Victoria**, Mallacoota, 6 females 5 male from *Eucalyptus* nuts, 1.iv.2011. **New South Wales**, Tallaganda, 6 females 7 males from *Eucalyptus* nuts and dead twigs, viii & xi. 2006, and ii.2011; Chichester Dam, 1 female from *Themeda*, 26.xii.2000. **Australian Capital Territory**, Lowden Forest Park, 1 female 1 male, 27.ii.2011; Black Mtn, 5 female 4 male from *Eucalyptus* litter, xii.1960 & i.1961; 3 females 1 male, 30.iv.2011. **Queensland**, Brisbane Forest Park, 1 female 9.iii.2006, 5 females 7 males 22.iv.2011, 1 male from dead leaves 27.v.2011, 5 females and 6 males from dead *Eucalyptus* nuts, 27.ii.2011; Mt Coot-tha, The Gap, 10.iii.2006, 1 male from dead leaves, 31.xii.2006; Girraween National Park, 1 female from dead leaves, 29.xii.2011. **Western Australia**, 60km northeast of Narrogin, 4 females 5 males by insecticide fogging of *Eucalyptus*, x.2006.

**Comments.** The micropterae that were provisionally identified as *sibylla* by Mound (1974: 85) are here recognized as this new species. This identification was not possible until both wing morphs of *kranzae* were found living together, and thus confirmed that micropterae and macropterae have a similar broad pelta. In contrast, the pelta of both morphs of *sibylla* are here reported as having unusually small lateral wings (Fig. 14). The fully winged morph of *kranzae* has been collected rarely, but the short winged morph is widespread across Australia in association with the seed capsules of various *Eucalyptus* species. The only other known member of the genus with the pelta un-lobed is *anici*. There is some variation among the available samples, such that the tube of the holotype is 0.96 as long as the head and that of paratypes from South Australia and New South Wales 0.95–1.0, whereas this ratio is 0.86–0.9 in specimens from Western Australia. Specimens from Queensland have the setae on tergite IX longer relative to the tube, and also have the epimeral setae shorter.



**FIGURES 30–35.** Australian species of *Phaulothrips*. Prosternal basantra, ferna and mesopraesternum 30–33: (30) *daguilaris*, (31) *flindersi*, (32) *oakeyi* - female, (33) *oakeyi* - large male. Pronotum 34–35: (34) *kranzae*, (35) *oakeyi*.

## *Phaulothrips longitubus* Girault

*Phaulothrips longitubus* Girault, 1928: 2

The original specimen on which this species was based (in QM) is a severely damaged macropterous female, with the head mounted laterally and lacking major setae and antennae. The tergites have only one pair of wing retaining setae, and the lateral lobes of the pelta do not bear a pair of setae. The head is 880 microns long, and the tube about 800 microns, thus the ratio of tube to head length is about 0.9. This specimen was collected at Mt Tamborine, in southeast Queensland. Several specimens from southeastern Queensland have been studied that possibly represent this species, but these have a head to tube ratio of 0.76–0.96 in females. In addition, the following are also considered to represent *longitubus*: one male from near Canberra, one female from Nelson, Victoria, and three females from Flinders Island (taken at same site as *flindersi*). On present evidence it is not possible to be sure if *longitubus* and *fuscus* are really distinct species, or indeed if they are members of a group of unrecognized sibling species.

## *Phaulothrips oakeyi* sp.n.

(Figs 13, 25, 32, 33, 35)

*Macropterous female*. Body legs and antennae dark brown to black (Fig. 25), tarsi and antennal segment III lighter; major setae colourless to weakly shaded; fore wing shaded on median half.

Head long with cheeks almost straight, posterior margin slightly pointed medially; dorsal surface strongly reticulate except medially; eyes longer dorsally than ventrally; one pair of pale pre-ocellar setae extending to mid-point of antennal segment II; anterior margin of head without tubercles; postocular setae short, scarcely reaching posterior margin of eyes; paired mid-dorsal setae equally long, arising mid-way between posterior margin of eyes and posterior margin of head; maxillary stylets close together medially, retracted to eyes. Antennae 8-segmented, VIII constricted at base; V–VII with apex slightly prolonged, VII with short longitudinal row of sensoria ventrally; I–III with dorsoapical setae weakly capitate; III and IV each with two short sensoria.

Pronotum reticulate (Fig. 35), transverse, anterior margin concave; major setae pale, blunt or weakly capitate. Metanotum reticulate, with one pair of small, pale median setae. Fore tarsal tooth small, recurved. Prosternal basantra small, oval, lateral to mouth cone; ferna large, median margins rounded not parallel (Fig. 32); mesopraesternum transverse; metathoracic sternopleural sutures long. Fore wing broad, with about 30 duplicated cilia; three long, pale sub-basal setae with blunt apices arise in a straight line, S1 longest.

Pelta reticulate, lateral lobes slender (Fig. 13); tergites with narrow transverse reticulation, II with numerous minute discal setae; II–VII with one pair of sigmoid wing-retaining setae; III–VII with two pairs of long pale setae laterally; setae on IX shorter than tube with apices blunt; tube parallel sided with apex constricted.

Measurements (holotype female in microns). Body length 5100. Head, length 700; median width 350; pre-ocellar setae 120; postocular setae 80; postocular cheek setae 50. Pronotum, length 220; width 550; major setae—am 100, aa 40, ml 150, epim 190, pa 120. Metanotal median setae 70. Fore wing, length 1800. Pelta, length 150; width 550. Tergite IV lateral setae 180. Tergite IX setae S1 370, S2 370. Tube length 680. Antennal segments III–VIII length 310, 160, 140, 110, 70, 80.

*Macropterous male*. Small males similar in colour and structure to female; large males far more robust, pronotum and fore femora expanded, fore tarsal tooth longer than tarsal width, anterior half of metanotum with no reticulate sculpture, prosternal ferna massive with parallel median margins (Fig. 33).

Measurements (paratype large male in microns). Body length 4900. Head, length 680. Pronotum, length 400; width 700. Fore wing, length 1700. Tube length 600.

**Specimens examined.** Holotype female, **Australian Capital Territory**, Weston, Oakey Hill, from *Eucalyptus blakeleyi* dead branches with abandoned scolytid tunnels, 6.iii.2011 (LAM 5445).

Paratypes: 2 females, 3 males taken with holotype; **A.C.T.**, Black Mt., 9 females 2 males from dead *Eucalyptus* with scolytid tunnels, iv.2011, 1 female from dead *Eucalyptus*, 18.v.2009, 6 females and 1 male from dead wood, 26.ii.2011, 1 female from dead wood 19.ix.2011.

**Comments.** This species is unusual in having a pair of well-developed setae medially on the head. Females have the pronotal antero-marginal setae well-developed.

### ***Phaulothrips sibylla* Mound**

*Phaulothrips sibylla* Mound, 1974: 84

The original two specimens from which this species was described were macropterous females. These came from two sites in Queensland; the holotype from 120km south of Gladstone, and the paratype from Mt Tamborine. The micropterae mentioned with that original description are described here as a new species, *kranzae*. More recently, micropterae of both sexes of *sibylla* have been collected, as listed below, but no further macropterae have been seen. The micropterae are very similar to the holotype, with a large pelta bearing very small lateral lobes (Fig. 14). The pre-ocellar setae arise on tubercles, but these are smaller than those of *kranzae*. Micropterae of both sexes have been taken on several dates at Brisbane, The Gap, and also at Kuranda in northern Queensland.

### ***Phaulothrips uptoni* Mound**

*Phaulothrips uptoni* Mound, 1974: 85

This sharply bicoloured species (Fig. 26) was described from a single macropterous female, taken at Kanangra Walls in the Blue Mountains, New South Wales. More recently a male and female macropterae were collected from dead twigs at Pottsville, in northern New South Wales, June 2009, and five females have been studied from southeast Queensland, at Indooroopilly, Bribie Island, Barakula State Forest, and Bunya Mts. The anterior margin of the head is less vertical than in most species of the genus, the compound eyes are longer on the dorsal surface, and the tergites bear two pairs of wing-retaining setae, although the anterior pair is smaller than the posterior pair on each segment. In these three character states *uptoni* is similar to *agrestis*, despite the different body colour.

### ***Phaulothrips vuilleti* Hood**

(Figs 20, 27, 28)

*Phaulothrips vuilleti* Hood, 1918: 147

*Titanothrips portentosus* Karny, 1924: 40. Synonymised by Mound, 1974: 86

Although similar in structure to *fuscus*, this species seems to be well characterized by the shorter, broader, tube with convex margins (Figs 27–28), and the broadly expanded pale pre-ocellar setae (Fig. 20). The head and tube of the male holotype (in USNM) measure 590 and 400 microns, with a ratio of 0.69, and these measurements of the male of *portentosus* (in SMNH) are 680 and 360 microns with a ratio of 0.53. In a long series of specimens from Magnetic Island, Queensland, taken from a stem gall with an abandoned wasp nest, the ratio varied from 0.65 to 0.75. Most of the specimens studied are from northern Australia, but the species has been taken from Sandgate (Brisbane), also south of Sydney, and was recorded from Tanzania by Mound & Palmer (1983).

### ***Phaulothrips whyallae* sp.n.**

(Figs 9, 19)

*Macropterous female*. Body brown to dark brown, tibiae, tarsi and antennal segment III light brown to yellowish; major setae on head and pronotum shaded, setae on posterior tergites pale; fore wing shaded medially but mainly pale in basal and apical quarters.

Head with cheeks almost straight, not strongly elevated medially; two pairs of short pre-ocellar setae present (often dehiscent) (Fig. 19); postocular setae long, apices blunt; postocular cheek small; one pair of small mid-dorsal setae; maxillary stylets close together medially, retracted to postocular setae. Antennae 8-segmented, VIII constricted at base, IV–VII with apex slightly asymmetric, VII with longitudinal row of small sensoria; III and IV each with two short sensoria.

Pronotum transverse; major setae blunt to weakly capitate. Metanotum reticulate, with one pair of pale median

setae. Fore tarsal tooth slightly recurved, with small sub-terminal seta. Prosternal basantra small, triangular, lateral to mouth cone; ferna large, median margins rounded but sub-parallel; mesopraesternum boat-shaped but slender; metathoracic sternopleural sutures long. Fore wing broad, with about 25 duplicated cilia; three sub-basal setae arise in a straight line, seta S3 longest.

Pelta reticulate, tri-lobed with pair of setae on lateral lobes (Fig. 9); small campaniform sensilla medially; tergites with narrow transverse reticulation, II with minute discal setae anterolaterally; II–VII each with one pair of long setae medially (Fig. 9), and one pair of weakly sigmoidal wing-retaining setae; III–VII with 2 pairs of long pale setae laterally, on VII twice as long as median length of tergite; setae on IX weakly capitate, shorter than tube.

*Measurements*, holotype female in microns. Body length 5600. Head, length 750; width across cheeks 420; longest pre-ocellar setae 100; postocular setae 180. Pronotum, length 280; width 620; major setae length am 90, aa 50, ml 160, epim 180, pa 160. Fore wing length 1600. Tergite IX setae S1 380, S2 380. Tube length 670. Antennal segments III–VIII length 430, 240, 190, 120, 110, 100.

**Specimens examined.** Holotype female macroptera, **South Australia**, Whyalla, Middleback Station, in old bee nest in *Eremophila* stem, 16.x.1996 (David Morris 139).

Paratypes: 6 female macropterae, 8 female micropterae, 1 female hemimacroptera, all taken with holotype.

## Comments

This species is known from a single colony comprising females only. The arrangement of the pre-ocellar setae is characteristic of this species, as is the long pair of setae medially on tergites II–VII. The fore wings are relatively short for fully macropterous individuals of this genus.

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