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Species diversity in the Palaeotropical leaf-litter genus *Apelaunothrips* (Thysanoptera, Phlaeothripinae)

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Abstract

Species of *Apelaunothrips* are fungus-feeders on dead leaves, particularly in leaf-litter, and they are recorded across the Old World tropics from Africa to northern Australia and southern Japan. All species in this genus have the maxillary stylets 4–6 microns in diameter, considerably broader than the 2–3 micron diameter that is typical among Phlaeothripinae. The species are largely uniform in structure, but in four species the larger males have fore femora enlarged with a conspicuous tubercle on the inner margin at the base. In one of these species, the males are dimorphic, with no intermediates between large and small individuals, in contrast to the continuous variation in structure found in many polymorphic Phlaeothripidae. A key is provided to the 37 recognised species of *Apelaunothrips*, including the following: *A. desleyae* **sp.n.** from northern Australia; *A. bogor* **sp.n.** from Java; *A. gombak* **sp.n.** from Peninsular Malaysia.

Introduction

Leaf-litter in some areas of the tropics and subtropics is known to support a high diversity of fungus-feeding Thysanoptera, but the only extensive sampling of such a habitat was carried out in southern Brazil. From those samples, a total of 50 species in eight genera of Phlaeothripinae were described (Mound 1977), with many of these apparently co-existing. A high diversity of similar Phlaeothripinae taxa also occurs in eastern U.S.A. (Mound 1976), but in other parts of the world the fauna of litter-living thrips has rarely been targeted, exceptions being in southern Queensland, Australia (Tree *et al.* 2012), and Japan (Okajima & Urushihara 1992). Moreover, thrips have been collected, and many taxa described, from leaf-litter and dead branches at several sites widely across Southeastern Asia (ThripsWiki 2013—Okajima publications list). Unfortunately, the collecting methods of taxonomists rarely generate data on taxon diversity at specific sites, such as one-metre quadrats, nor suitable data on species-turnover between sites. Despite this, it is clear that related species are sometimes collected together, and at least a few species have wide distributions across S.E.Asia (Table 1). However, it remains unclear why some genera of litter-thrips are so species-rich, with congeneric species apparently co-existing in the same habitat.

In the New World, the fauna of leaf-litter thrips is represented primarily by three genera, *Eurythrips*, *Terthrothrips* and *Tylothrips* (Mound 1977). In contrast, samples taken in the Old World rarely include these genera, whereas species of *Apelaunothrips* and *Adraneothrips* are often abundant, with species of *Psalidothrips* and *Zemiathrips* found commonly in the litter of sclerophyll forests in Australia (Mound 2002; Tree *et al.* 2012). A revision of *Apelaunothrips* was provided by Okajima (1979), with keys to the 19 species then known, all from the Palaeotropics between Africa and northern Australia. Subsequently, Okajima (1984) described a further seven species in this genus from the Philippines and, in two further papers, another five from the island of Borneo (Okajima 1987; Okajima & Reyes 1990). The present author and colleagues collected many specimens of *Apelaunothrips* from leaf-litter in Malaysia and Borneo, and in sorting these it became necessary to prepare the preliminary identification key below to the members of this genus. *This key is based almost entirely on original descriptions*, and thus cannot be considered more than a preliminary analysis. However, the detailed descriptions and excellent line drawings published by Okajima provide an unusually high level of security for identification ensuring the usefulness of this key as a tool. The sculpture on the vertex, whether transverse, reticulate, or completely absent, also the shape of the eighth antennal segment, suggest patterns of relationships amongst the

members of this genus. The purpose of the present paper is to discuss some of these relationships, to consider the variation in colour and structure exhibited by the most widespread species, and to describe three new species, one each from Peninsular Malaysia, Java, and northern Australia. The 37 species recognised in this genus are listed in Table 1, but the text includes only those species for which previously unreported material has been examined. Full bibliographic information on all taxa is available in ThripsWiki (2013).

TABLE 1. Distribution of known species of *Apelaunothrips*.

Species	Author	Date:page	Original genus	Distribution
<i>aokii</i>	Okajima	1987:290	<i>Apelaunothrips</i>	Indonesia–Kalimantan; Malaysia - Sabah
<i>armatus</i>	Okajima	1979:42	<i>Apelaunothrips</i>	Peninsular Malaysia
<i>bhowalii</i>	Ananthakrishnan	1972:183	<i>Stigmothrips</i>	India; Thailand
<i>bicolor</i>	Okajima	1979:44	<i>Apelaunothrips</i>	Thailand; China (Hainan, Yunnan)
<i>bogor</i>	sp.n.		<i>Apelaunothrips</i>	Indonesia–Java
<i>cephalicus</i>	Okajima	1984:719	<i>Apelaunothrips</i>	Philippines–Luzon
<i>consimilis</i>	Ananthakrishnan	1969:173	<i>Stigmothrips</i>	India; Peninsular Malaysia; Taiwan; Japan
<i>desleyae</i>	sp.n.		<i>Apelaunothrips</i>	Australia–Queensland
<i>fasciatus</i>	Okajima	1984:720	<i>Apelaunothrips</i>	Philippines–Luzon
<i>femoralis</i>	Okajima	1979:48	<i>Apelaunothrips</i>	Singapore
<i>flavicornis</i>	Okajima	1984:722	<i>Apelaunothrips</i>	Philippines–Mindanao
<i>gabonensis</i>	Bournier	1970:159	<i>Baphothrips</i>	Gabon; Angola
<i>gombak</i>	sp.n.		<i>Apelaunothrips</i>	Peninsular Malaysia
<i>hainanensis</i>	Zhang & Tong	1990:101	<i>Apelaunothrips</i>	China (Hainan)
<i>haradai</i>	Okajima	1987:291	<i>Apelaunothrips</i>	Indonesia–Kalimantan; Malaysia - Sabah
<i>indicus</i>	Ananthakrishnan	1968: 125	<i>Philothrips</i>	India
<i>japonicus</i>	Okajima	1979: 49	<i>Apelaunothrips</i>	Japan
<i>leios</i>	Mound	1970: 94	<i>Baphothrips</i>	Solomon Islands
<i>lieni</i>	Okajima	1979: 50	<i>Apelaunothrips</i>	Taiwan; China (Yunnan)
<i>limbatus</i>	Okajima & Reyes	1990: 437	<i>Apelaunothrips</i>	Malaysia–Sabah
<i>longidens</i>	Zhang & Tong	1990: 102	<i>Apelaunothrips</i>	China (Guangdong)
<i>lucidus</i>	Ananthakrishnan	1965: 56	<i>Malacothrips</i>	India
<i>luridus</i>	Okajima	1979: 52	<i>Apelaunothrips</i>	Peninsular Malaysia; China (Hainan, Yunnan)
<i>maculipennis</i>	Okajima	1976: 125	<i>Stigmothrips</i>	Japan–Okinawa
<i>madrasensis</i>	Ananthakrishnan	1964: 109	<i>Malacothrips</i>	India
<i>malayensis</i>	Okajima	1979: 54	<i>Apelaunothrips</i>	Peninsular Malaysia
<i>marginalis</i>	Okajima	1984: 723	<i>Apelaunothrips</i>	Philippines–Mindanao
<i>medioflavus</i>	Karny	1925: 50	<i>Ophidothrips</i>	Indonesia–Sumatra, Java; Taiwan; Philippines
<i>montanus</i>	Okajima	1979: 57	<i>Apelaunothrips</i>	Japan
<i>nigripennis</i>	Okajima	1979: 59	<i>Apelaunothrips</i>	Taiwan; China (Hainan, Yunnan); Japan
<i>ocularis</i>	Okajima	1979: 61	<i>Apelaunothrips</i>	Peninsular Malaysia
<i>philippinensis</i>	Okajima	1984: 724	<i>Apelaunothrips</i>	Philippines–Luzon
<i>rostratus</i>	Okajima	1984: 726	<i>Apelaunothrips</i>	Philippines–Mindanao
<i>simpliceps</i>	Okajima	1984: 727	<i>Apelaunothrips</i>	Philippines–Mindanao
<i>spinalis</i>	Okajima & Reyes	1990: 439	<i>Apelaunothrips</i>	Malaysia–Sabah
<i>tasmani</i>	Mound	1974: 18	<i>Apelaunothrips</i>	Australia–Queensland; New Guinea
<i>tricolor</i>	Priesner	1933: 70	<i>Baphothrips</i>	Indonesia–Java
<i>zonatus</i>	Okajima & Reyes	1990: 440	<i>Apelaunothrips</i>	Malaysia–Sabah

Thysanoptera taxa named by TN Ananthakrishnan

According to an extensive review by Bhatti (2004), TN Ananthakrishnan was responsible, between 1950 and 1980, for publishing 320 species-level names, of which 6 were at subspecies level. Unfortunately, as indicated by Dang *et*

al. (2013), the collections in which the holotypes of these species have been deposited remain far from clear. Although Ananthkrishnan sold most of his slide-collection to the University of Minnesota, the curators at that museum have not found any slides labeled as holotype. However, during September 2013, Dr V. Ramamurthy of the Indian Institute of Agricultural Research very kindly produced an Excel spread sheet listing thrips taxa that are held in the major insect collection for which he is responsible, the National Pusa Collection, and from this it appears that holotypes of 101 Ananthkrishnan species are deposited in IARI, Delhi. Moreover, Dr Vikas Kumar kindly produced a list of 10 Ananthkrishnan species that are represented by holotypes in the Zoological Survey of India collection in Kolkata. Currently there is no information where the holotypes of the remaining 209 species might be deposited. Type specimens have not been traced of three of the four Ananthkrishnan species considered in this paper, *Malacothrips lucidus*, *Stigmothrips bhowalii*, and *Philothrips indicus*, although the holotype of *Stigmothrips consimilis* is in the IARI collection.

The following abbreviations are used: po—postocular seta; am—pronotal anteromarginal seta; aa—pronotal anteroangular seta; ml—pronotal midlateral seta; pa—pronotal posteroangular seta; epim—pronotal epimeral setae; S1—seta pair I on abdominal tergite IX (the setal pair nearest the mid-line); S2—seta pair II on abdominal tergite IX; S3—seta pair III on abdominal tergite IX.

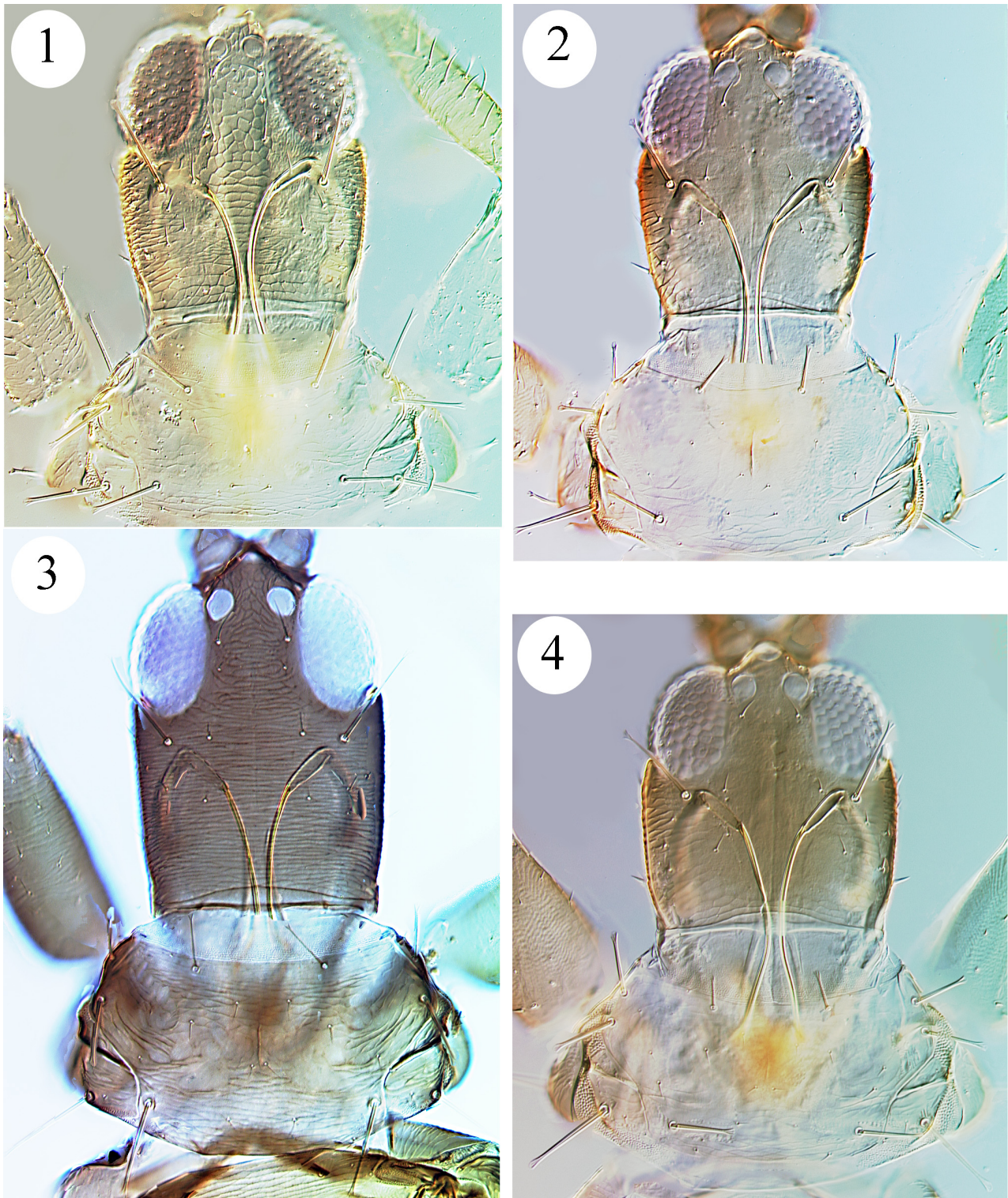
***Apelaunothrips* generic relationships**

The character state by which membership of *Apelaunothrips* is recognized involves the width of the maxillary stylets (Okajima 1979). Species of the subfamily Idolothripinae apparently feed on large fungal spores, and the width of the maxillary stylets in such thrips varies from 5 to 10 microns between species. In contrast, the species of Phlaeothripinae have stylets that are scarcely 3 microns in diameter. Within this subfamily, the members of *Apelaunothrips* are unusual because the stylets are about 4 to 6 microns in diameter, and Okajima (1984), in discussing the systematic position of the genus, pointed out that the species apparently feed on small spores. Many of the character states of *Apelaunothrips* are shared with the hyphal-feeding species of *Hoplandrothrips*, as defined by Mound & Tree (2013). In particular, the “intermediate setae” (iS) that arise on the ninth tergite between setal pairs S1 and S2 are unusually long, and this occurs in several species of *Hoplandrothrips* as well as the species of the related genus *Adraneothrips* (Dang *et al.* 2013). Males of *Apelaunothrips* do not have a pore plate on the eighth sternite, and although this is true for some species in both *Adraneothrips* and *Hoplandrothrips* other species in these two genera have well-developed pore plates. Mound & Palmer (1983), in recognizing a distinct Tribe Apelaunothripini, implied that *Apelaunothrips* is only distantly related to these two genera. However, a more likely possibility is that the stylet condition among *Apelaunothrips* species is associated with a secondary reversal to spore-feeding amongst a lineage derived from within, or from a shared ancestor of, *Hoplandrothrips*.

Species-groups within *Apelaunothrips*

One group of species, the *consimilis* group, shares the presence on the vertex of transverse striae or narrow transverse reticulation (Fig. 3), and most of these also have the eighth antennal segment not constricted into a basal neck (Figs 17, 19). These species include: *armatus*; *bhowalii*; *consimilis*; *fasciatus*; *femoralis*; *flavicornis*; *malayensis*; *philippinensis*. In addition, *nigripennis* lacks a basal neck on antennal segment VIII, but has almost no sculpture medially on the vertex. However, loss of sculpture on the vertex is a character state that could be polyphyletic, and *nigripennis* is possibly related to the *consimilis* group. Another group of species has the vertex with equiangular reticulation (Fig. 1), and amongst these *aokii*, *haradai* and *zonatus* are particularly closely related, although *zonatus* has the reticulation reduced on at least the posterior part of the vertex. Males of *haradai* and *zonatus* are remarkable in having on the fore femora a large, curved basal tubercle (Fig. 15), but the available samples are insufficient to tell if small males of these species will lack this structure, as discussed below concerning variation in the fore femur of *bogor* (Fig. 14). Males of the latter species are particularly unusual because they are dimorphic, either large or small with no intermediates, in contrast to the normal situation amongst Phlaeothripidae in which structural variation related to body size is continuous within any given species. Three further species have the vertex fully reticulate; *marginalis* and *rostratus* appear to be closely related, but *tricolor* remains known only from a single specimen that is difficult to assess. All six of these species with the vertex

reticulate also have antennal segment VIII with a basal neck, and a similar constricted neck to this segment (Figs 20–22) occurs in the remaining species of this genus that lack sculpture medially on the vertex. A further group of closely related species is evident at couplets 26 and 27 in the key below; *spinalis* differs in having a rather longer head, but there are only weak differences recorded between *bogor*, *limbatus* and *longidens*. The last of these, *longidens*, was described as having five sensoria on the fourth antennal segment, with an extra sensorium on the external margin about one third of the length of the segment from the apex, but this requires further confirmation. Similarly, variation in the number of sensoria on the third antennal segment is discussed below in *medioflavus*, the type species of the genus.



FIGURES 1–4. *Apelaunothrips* species, head & pronotum. (1) *aokii*; (2) *bogor* sp.n.; (3) *consimilis*; (4) *gombak* sp.n.

Apelaunothrips Karny

Apelaunothrips Karny, 1925: 82. Type species *Ophidothrips medioflavus* Karny.

Diagnosis: Phlaeothripinae with maxillary stylets unusually broad, 4–6 microns wide; antennae 8-segmented, III with 2 or 3 sensoria, IV with 2, 3 or 4 sensoria; head usually constricted behind eyes; postocular setae long and capitate. Pronotum with 5 pairs of major capitate setae (4 in *desleyae*); notopleural sutures complete (incomplete in *desleyae*); basantra absent; mesopraesternum transverse; fore tarsal tooth usually absent in both sexes; fore wing with duplicated cilia (none in *desleyae*). Pelta variably bell-shaped to triangular, with lateral area unsculptured; campaniform sensilla present or absent; wing-retaining setae on tergites II and III commonly with apices uncinata (Figs 11, 12); tergite IX setae long, intermediate pair (iS) almost as long as setal pair S1; tube shorter than head; male without sternal pore plates.



FIGURES 5–8. *Apelaunothrips* species, head & pronotum. (5) *madrasensis*; (6) *medioflavus* from East Timor; (7) *desleyae* sp.n.; (8) *ocularis* ventral surface of head.

Key to species of *Apelaunothrips*

[developed largely from published descriptions]

1. Body and head almost entirely yellow, only tube brown 2
- Body either brown or bicoloured yellow and brown, if largely yellow then at least tergite IX brown 3
2. Antennal segments IV–VIII uniformly dark brown (Fig. 18); pronotal am setae acute, less than 20 microns long [pronotal notopleural sutures not fully complete; fore wing with no duplicated cilia] *desleyae* sp.n.
- Antennal segments IV–VII brown with base yellow; pronotal am setae capitate, more than 40 microns long *lucidus*
3. Antennal segment IV with 2 sensoria 4
- Antennal segment IV with 3 or 4 (5?) sensoria 5
4. Interocellar setae acute; mesonotum with 12–14 setae *lienii*
- Interocellar setae weakly capitate; mesonotum with 2–4 setae *indicus*
5. Antennal segment IV with 3 sensoria 6
- Antennal segment IV with 4 (5?) sensoria 16
6. Antennal segment III with 2 sensoria 7
- Antennal segment III with 3 sensoria 10
7. Eyes prolonged ventrally *cephalicus*
- Ventral length of eyes no longer than dorsal length 8
8. Pronotum and abdominal segments II–III yellow *medioflavus* [in part]
- Pronotum and abdominal segments II–III brown 9
9. Antennae slender, IV at least 2.5 times as long as wide; pelta bell-shaped with campaniform sensilla *tasmani*
- Antennae less slender, IV less than 2.3 times as long as wide; pelta trapezoidal without campaniform sensilla *hainanensis*
10. Abdominal segments III–IV yellow 11
- Abdominal segments III–IV brown 12
11. Abdominal segments I–VII yellow, III–VI with small brown anterior marking *luridus*
- Abdominal segment II and VI–IX brown *medioflavus* [in part]
12. Abdomen bicoloured 13
- Abdomen uniformly brown 15
13. Abdominal segments I and IX yellow, II–VIII brown *zonatus*
- Abdominal segment IX brown, either or both V and VI yellow 14
14. Abdominal segments I and V yellow, VI brown *madrasensis*
- Abdominal segment I brown, V and VI yellow *leios*
15. Head 1.4 times as long as width *haradai*
- Head 1.2 times as long as width *aokii*
16. Body not uniformly brown, often bicoloured 17
- Body uniformly brown 28
17. Head uniformly brown 18
- Head yellow at least in part 22
18. Eyes prolonged posteriorly on ventral surface of head (Fig. 8) *ocularis*
- Eyes not longer ventrally than dorsally 19
19. Antennal segment VIII not constricted at base *fasciatus*
- Antennal segment VIII constricted to short basal neck (Fig. 20) 20
20. Eyes about as long as postocular length of vertex *japonicus*
- Dorsal eye length less than postocular length of vertex 21
21. Legs, pronotum, and abdomen yellow *bicolor*
- Femora dark brown, pronotum and abdominal segments II and IX brown, III–VIII brown laterally *gombak* sp.n.
22. Vertex fully reticulate medially; antennal segment VIII strongly constricted at base 23
- Median area of vertex without sculpture; antennal segment VIII base variable 25
23. Abdominal segment III brown; tube brown with basal fifth yellow *tricolor*
- Abdominal segment III yellow; tube brown with only extreme base yellow 24
24. Femora yellow; pointed mouth cone extends to posterior margin of prothorax *rostratus*
- Femora brown or shaded with brown; mouth cone not extending across prosternum *marginalis*
25. Abdominal segment II brown, clearly darker than segments III–V 26
- Abdominal segment II equally yellow as segments III–V 27
26. Head less than 1.2 times as long as wide (Fig. 2); cheeks with one pair of prominent setae; antennal segment VIII with distinct basal neck (Fig. 16) *bogor* sp.n.
- Head more than 1.3 times as long as wide; cheeks with several prominent setae; antennal segment VIII weakly constricted at base *spinalis*
27. Antennal segment VIII weakly constricted at base *limbatus*
- Antennal segment VIII strongly constricted at base *longidens*
28. Head 1.1 times as long as wide or less 29
- Head more than 1.1 times as long as wide 32
29. Vertex with transverse lines of sculpture medially 30

-.	Vertex with no sculpture medially	31
30.	Fore wings colourless	<i>bhowalii</i>
-.	Fore wings shaded pale brown	<i>philippinensis</i>
31.	Mid and hind tibiae dark brown with paler apices	<i>nigripennis</i>
-.	Mid and hind tibiae yellow	<i>simpliceps</i>
32.	Fore wing sub-basal setae S3 capitate	33
-.	Fore wing sub-basal setae S3 acute or softly pointed	35
33.	Vertex finely sculptured medially	<i>gabonensis</i>
-.	Vertex with no sculpture medially	34
34.	Head 1.2 times as long as wide; hind tibiae brown	<i>maculipennis</i>
-.	Head about 1.5 times as long as wide; hind tibiae yellow	<i>montanus</i>
35.	Fore tarsus with small tooth on inner margin; fore femora with basal tubercle in both sexes	<i>armatus</i>
-.	Fore tarsus with no tooth; fore femora without basal tubercle on inner margin	36
36.	Tergite IX setae S1 and S2 with apices sharply pointed	37
-.	Tergite IX setae S1 and S2 with apices weakly expanded or softly pointed	38
37.	Postocellar setae about as long as longitudinal diameter of an ocellus	<i>flavicornis</i>
-.	Postocellar setae much longer than longitudinal diameter of an ocellus	<i>malayensis</i>
38.	Postocellar setae minute; pelta bell-shaped	<i>femoralis</i>
-.	Postocellar setae longer than longitudinal diameter of an ocellus (Fig. 3); pelta subtriangular	<i>consimilis</i>

***Apelaunothrips aokii* Okajima**

(Figs 1, 9)

Described from two females collected in S.E Kalimantan [Borneo], Indonesia, this species is closely related to *haradai*. These two are distinguished by differences in the head length, but the specimens listed below, identified from the original description, vary in this length. The original description of *aokii* referred to the legs as “yellowish”, but Okajima & Reyes (1990) reported the legs as varying considerably in colour, to dark brown, in a series of specimens from Sabah, in N.E. Borneo. Some of the specimens listed below have the fore tibiae dark brown with the fore femora distinctly paler, and they have campaniform sensilla on the pelta, in contrast to the two type specimens. The male of *haradai* has the fore femora similar to that illustrated for *zonatus*, with a large curved basal tooth (Fig. 15), but none of the known males of *aokii* have such a process.

Specimens studied. Malaysia, Sarawak, Mulu National Park, 5 females, 5 males in leaf litter, 24.ix–18.x.1977 (B. Bolton) (in The Natural History Museum, London).

***Apelaunothrips bogor* sp.n.**

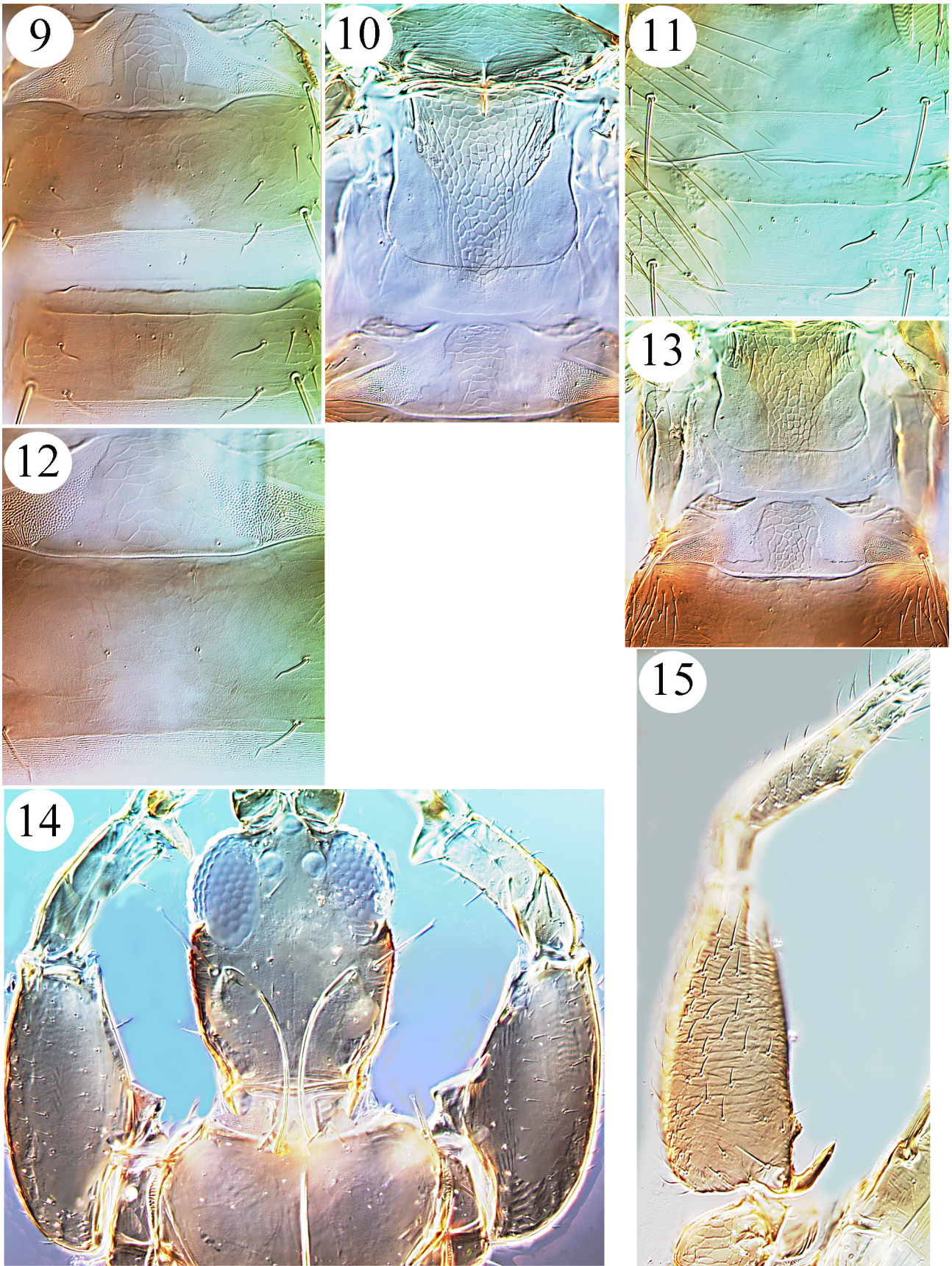
(Figs 2, 10, 11, 14, 16)

Female macroptera. Body largely brownish yellow with red internal pigment; head with lateral margins darker, mesonotum brown, tergite II brown laterally, tube brown; abdominal segments brownish yellow; femora all brown, tibiae yellow washed with brown; fore wing shaded distal to sub-basal setae, but pale medially then with dark line medially on distal third; antennal segments I–II dark brown and darker than head, III mainly yellow, IV–VI brown with base yellow, VII–VIII brown; major setae weakly shaded.

Head about 1.2 times as long as wide, cheeks with prominent pair of setae on basal third (Fig. 2); vertex with no sculpture medially, weak lines of sculpture present on about lateral fifths of head; stylets retracted anterior to postocular setae, close together medially on posterior third of head; postocellar setae about as long as an ocellus; postocular setae long and capitate. Antennal sensoria long, 3 on III, 4 on IV, the ventral sensorium on III strongly curved; VIII constricted to basal neck (Fig. 16).

Pronotum with almost no sculpture, chaetotaxy typical of genus. Mesonotum with lateral setae small; metanotum reticulate, median setae pointed. Prosternal ferna large, anterior margin with three small setae; mesopraesternum complete. Fore wing with 7–8 duplicated cilia; sub-basal setae all capitate.

Pelta almost hat-shaped with lateral wings (Fig. 10), median area reticulate, with paired campaniform sensilla; wing retaining setae on tergites II–III usually with apices uncinata (Fig. 11); tergite IX setae apices blunt but not expanded, shorter than tube, intermediate setal pair long.



FIGURES 9–15. *Apelaunothrips* species. (9) *aokii* pelta & tergites II–III; (10) *bogor* sp.n. metanotum & pelta; (11) *bogor* sp.n. tergites II–III; (12) *gombak* sp.n. pelta & tergite II; (13) *zonatus* metanotum & pelta; (14) *bogor* sp.n. male head & fore legs; (15) *zonatus* male fore leg.

Measurements (holotype female in microns). Body length 2450. Head, length 270; width 210; postocular setae 65. Pronotum, length 150; width 275; major setae—am 30, aa 50, ml 40, epim 80, pa 70. Mesonotum lateral seta 25. Fore wing, length 1000; sub-basal setae 50, 50, 75. Tergite IX, setae S1 110; iS 75; S2 100; S3 125. Tube length 160. Antennal segments III–VIII length, 85, 90, 95, 75, 60, 45.

Male macroptera. Dimorphic, small males very similar to female but paler and more slender; large males with fore femora enlarged and bearing a prominent irregular tubercle on inner margin near base (Fig. 14); fore tarsus with no tooth in small males, with large tooth in large males; pronotum of large males with anterolateral angles thickened and prominent; tergite IX setae S2 short and stout, shorter than intermediate setal pair (iS).

Measurements (small and large paratype males in microns). Body length 1750 (2000). Head, length 230 (270); width 170 (180); postocular setae 65 (75). Pronotum, length 110 (160); width 225 (250). Tergite IX setae, S1 100 (110); iS 80 (75); S2 35 (35). Tube length 130 (135).

Specimens studied. Holotype female, **Indonesia, Java**, Bogor Botanic Gardens, from large dead leaves on tree, 26.x.1973 (LAM 1177), in The Natural History Museum, London.

Paratypes: 22 females, 15 small males, 7 large males, all from same site as holotype.

Comments. The variation indicated above in the males is strictly dimorphic—there are no intermediates between the large and small males. In structure, this species is similar to *gombak* described below, but that has the head uniformly brown. The head colour of *bogor*, with darker cheeks and paler vertex, is similar to that described for *tricolor*, but that species has a strongly reticulate vertex. Two species from the Philippines, *limbatus* and *spinalis*, are similar to *bogor*, but have sculpture occupying the lateral thirds of the head, and antennal segment VIII weakly constricted at base. The fore femur of the male of *spinalis* has a similarly shaped basal tubercle to that of large males of *bogor* (Fig. 14). Also similar, is *longidens* from Guangdong, China, but that was described as having the body more extensively yellow.

***Apelaunothrips consimilis* (Ananthakrishnan)**

(Figs 3, 17)

Described from India, this species was redescribed and recorded by Okajima (1979) from Peninsular Malaysia, Indonesia (Obi Is.), Taiwan, and southern Japan (Ishigaki and Iriomote Is.). However, Okajima pointed out that there was variation between these samples in colour of the tibiae and shape of the pelta. This is one of a group of species in which the sculpture on the vertex is essentially of transverse lines or narrow reticulations (Fig. 3). Females in the series from Tjibodas listed below have the mid and hind tibiae largely dark brown, whereas most of the females listed from Bogor have the mid and hind tibiae yellow, and the females from sites in Malaysia have the mid-tibiae bicoloured but the hind tibiae yellow. All available males have yellow tibiae, regardless of the tibial colour of associated females. Specimens in the sample from Tjibodas lack campaniform sensilla on the pelta, but these sensilla are present in the specimens from Bogor and also from sites in Malaysia. Okajima (1984) referred to two un-named species from several sites on Luzon and Mindanao, the Philippines, that are clearly part of the *consimilis* complex. Currently there is no way of deciding how many species might be represented within this complex. The mesonotal lateral setae of *consimilis* are very short, and this character state is shared with several other species, whereas in *aokii*, *medioflavus*, *tasmani* and *zonatus* the mesonotal lateral setae are elongate and capitate.

Specimens studied. **Indonesia, Java**, Tjibodas Botanic Gardens, 14 females, 5 males from dead leafy branch, 23.x.1973; Bogor Botanic Gardens, 24 females, 10 males, 26.x.1973 (LAM). **Peninsular Malaysia**, Ringlelet, 1 female, 2 males from dead branch, 12.x.1973; Gombak, 2 females from dead branch, 5.x.1973; Genting Highlands, 1 female from dead leaves, 14.x.1973; Damansara Reserve, 1 female from dead leaves, 3.x.1973 (in The Natural History Museum, London).

***Apelaunothrips desleyae* sp.n.**

(Figs 7, 18)

Female macroptera. Body and legs almost entirely yellow with tube brown; lateral margins of pterothorax faintly brown; antennal segments I–II yellow, III yellow with apical half pale brown, IV–VIII uniformly dark brown; fore wing shaded distal to sub-basal setae, pale medially then with darker on distal third; major setae pale.

Head less than 1.2 times as long as wide, cheeks with no prominent setae (Fig. 7); vertex with no sculpture medially, weak lines of sculpture present on about lateral fifths of head; stylets retracted to postocular setae, about one fifth of head width apart medially; postocellar setae longer than an ocellus; postocular setae capitate. Antennal sensoria long, 3 on III, 4 on IV; VIII not constricted at base (Fig. 18).

Pronotum with reticulate sculpture only near posterior margin; notopleural sutures not fully complete; am setae minute and acute, remaining four pairs capitate. Mesonotum with lateral setae small; metanotum reticulate, median setae small and pointed. Prosternal ferna large, anterior margin with small setae; mesopraesternum complete. Fore wing without duplicated cilia; sub-basal setae S1 and S2 capitate, S3 acute.

Pelta broadly hat-shaped without lateral wings, median area reticulate, lateral area not sculptured, no campaniform sensilla; wing retaining setae on tergite II weakly developed, sigmoid on III–VII; tergite IX setae S1 shorter than tube with apices weakly expanded, intermediate setal pair long, S2 long and acute.

Measurements (holotype female in microns). Body length 1650. Head, length 175; width 150; postocellar setae 25; postocular setae 40. Pronotum, length 115; width 180; major setae—am 20, aa 30, ml 35, epim 50, pa 50. Mesonotum lateral seta 15. Fore wing, length 620; sub-basal setae 35, 40, 30. Tergite IX, setae S1 65; iS 50; S2 125; S3 50. Tube length 100. Antennal segments III–VIII length, 50, 55, 45, 40, 30, 25.

Male macroptera. Similar to female but smaller and more slender; sternite VIII without pore plate.

Specimens studied. Holotype female, **Australia, Queensland**, Cape Tribulation, from dead leaves, 7.vii.1995 (LAM2725), in Australian National Insect Collection, Canberra. Paratypes from same locality as holotype, 2 females from dead *Calamus* leaves, 9.vii.1995 (LAM 2743); 20km south of Cape Tribulation, Lync Haven, 1 male by spraying tree bark, 5.x.2012 (DJ Tree 1475) (in Queensland Primary Industries Insect Collection, Brisbane).

Comments. This species is unusual within *Apelaunothrips* in having no duplicated wing cilia, reduced pronotal anteromarginal setae, and incomplete notopleural sutures. In these character states it is similar to species of another Southeast Asian genus, *Phylladothrips* Priesner, but the nine species in that genus have wing-retaining setae on tergite VIII. The maxillary stylets of *desleyae* are about 6 microns wide, as in other members of this genus, and the intermediate pair of setae on tergite IX is almost as long as setal pair S1. In body colour, it can be compared only to *lucidus* from India, but the un-illustrated description of that species includes few structural details and no specimens have been traced.

Apelaunothrips flavicornis Okajima

(Fig. 19)

The specimens listed below are identified from the original description that was based on over 60 specimens taken mostly from “half dead grass” on Mindanao, the Philippines. The sculpture on the vertex is essentially similar to that of *consimilis*, to which species *flavicornis* is presumably related judging from the key to species above. The base of antennal segment VIII does not have a constricted neck in this species (Fig. 19).

Specimens studied. **Malaysia**, Kuala Lumpur, 30 miles east, 5 females, 1 male with larvae from grass, 28.ix.1973 (LAM) (in The Natural History Museum, London).

Apelaunothrips gombak sp.n.

(Figs 4, 12, 20)

Female macroptera. Body largely brown with red internal pigment, but median area of metathorax and anterior area of tergite I yellow, tergites IV–VIII mainly yellowish but with a small brown spot medially and brown lateral margins; fore femora brown, mid and hind femora brown with yellow apex, tibiae yellow; fore wing shaded distal to sub-basal setae, but pale medially then with dark line medially on distal third; antennal segments I–II as dark as head, III mainly yellow, IV–VI light brown with base yellow, VII–VIII light brown; major setae weakly shaded.

Head about 1.2 times as long as wide, cheeks with prominent pair of setae on basal third (Fig. 4); vertex with no sculpture medially; stylets retracted anterior to postocular setae, close together medially on posterior third of head; postocellar setae shorter than length of an ocellus; postocular setae long and capitate. Antennal sensoria slender, 3 on III, 4 on IV; VIII constricted to basal neck (Fig. 20).

Pronotum with almost no sculpture, chaetotaxy typical of genus. Mesonotum with lateral setae very small; metanotum reticulate, median setae pointed. Prosternal ferna large, anterior margin with a few small setae; mesopraesternum complete. Fore wing with 8 duplicated cilia; sub-basal setae all capitate.

Pelta broadly triangular, median area reticulate but not lateral areas, with paired campaniform sensilla (Fig. 12); wing retaining setae with apices uncinata on tergites II–III (Fig. 12); tergite IX setae apices weakly expanded, shorter than tube, intermediate setal pair long.

Measurements (holotype female in microns). Body length 2250. Head, length 250; width 185; postocular setae 70. Pronotum, length 130; width 260; major setae—am 30, aa 35, ml 70, epim 75, pa 60. Mesonotum lateral seta 15. Fore wing, length 950; sub-basal setae 50, 45, 70. Tergite IX, setae S1 105; iS 75; S2 95; S3 110. Tube length 150. Antennal segments III–VIII length, 80, 80, 80, 65, 55, 35.

Male macroptera. Very similar to female, but paler and more slender. No teeth on fore tarsus or fore femora; tergite IX setae S2 short and stout, shorter than intermediate setal pair.

Measurements (paratype male in microns). Body length 1750. Head, length 210; width 170; postocular setae 70. Pronotum, length 120; width 240. Tergite IX setae, S1 95; iS 75; S2 30. Tube length 125.

Specimens studied. Holotype female, **Peninsular Malaysia**, Gombak, near Kuala Lumpur, from dead leaves on tree together with larvae, 29.ix.1973 (LAM 1030), in the Natural History Museum, London.

Paratypes. 10 females, 5 males taken with holotype.

Comments. The form of the head with a pair of prominent cheek setae is similar to that of *nigripennis*, but that was described as having the body uniformly brown, and the mid and hind tibiae also brown. Moreover, *bogor* and *limbatus* also have a similar pair of cheek setae, but they have the body bicoloured.

***Apelaunothrips madrasensis* (Ananthakrishnan) comb.rev.**

(Figs 5, 21)

Described in the genus *Malacothrips*, and transferred to *Apelaunothrips* by Mound (1974), this species was later transferred to *Dexiothrips* by Okajima (1979). It is here returned to *Apelaunothrips* in view of the long stylets that are less than one third of the head width apart medially (Fig. 5). In contrast, the only species in the genus *Dexiothrips*, from Africa, has the stylets at least 0.5 of the head width apart and low in the head. Antennal segment VIII of *madrasensis* has a distinct basal neck (Fig. 21), the mesonotal lateral setae are long and capitate, the pelta lacks campaniform sensilla, on tergite IX the major setae are longer than the tube and the iS setal pair is two-thirds as long as setae S1.

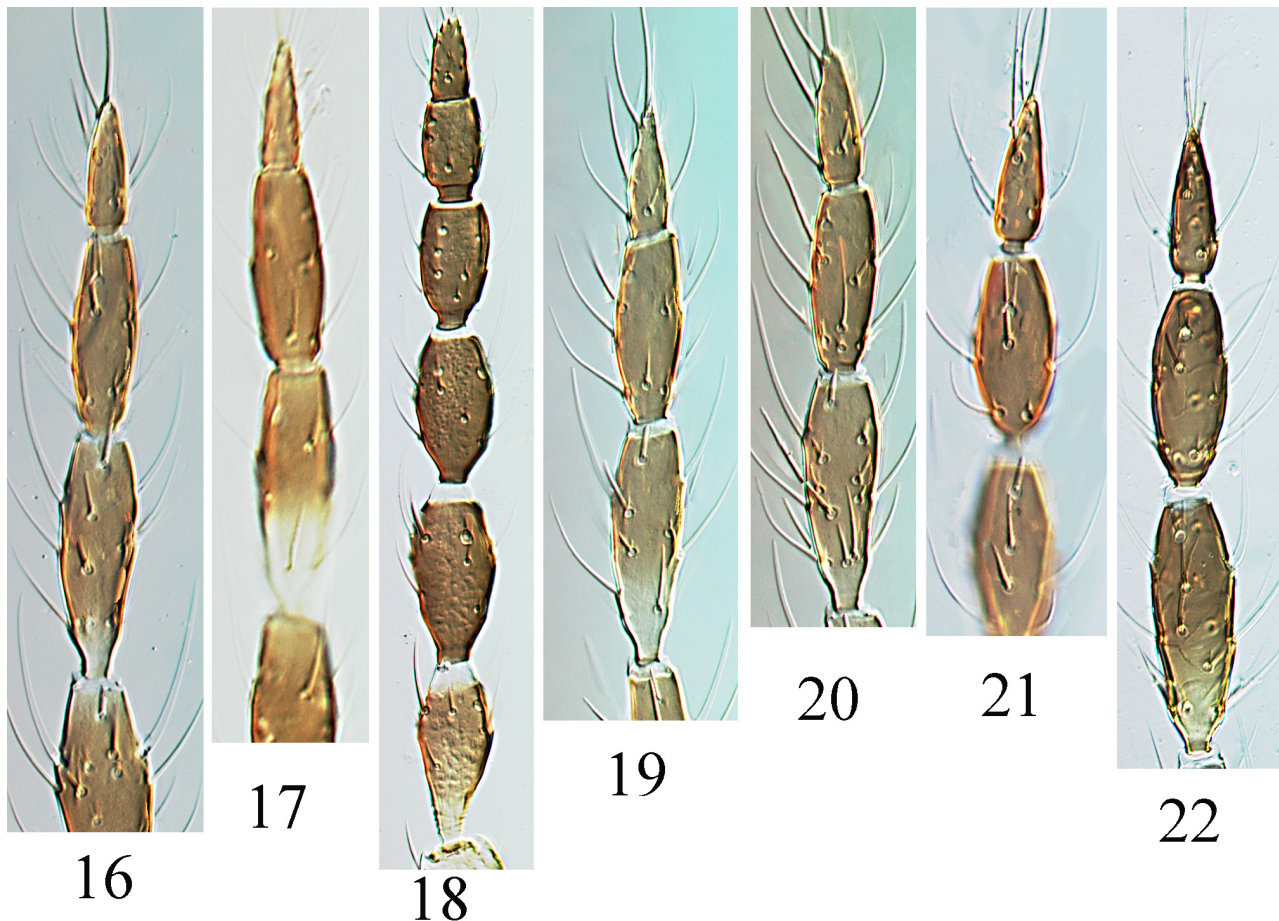
Specimen studied. **Indonesia**, Java, Tjibodas Gardens, 1 female from grass, 22.x.1973, in the Natural History Museum, London.

***Apelaunothrips medioflavus* (Karny)**

(Figs 6, 22)

The third antennal segment of this species is reported to have only two sensoria on the third antennal segment (Okajima 1979), but one female specimen listed below from Taiwan has a third slender sensorium ventrally on the right antenna, although the left antenna has only two sensoria on this segment. The male collected with this female also has only two sensoria on the third segment. In contrast, the single female listed below from Timor has a third slender ventral sensorium on the third segment of both antennae, and this is here interpreted as intraspecific variation. The head of *medioflavus* is elongate, and weakly reticulate medially, but the stylets are usually close together medially, in contrast to the illustrated individual from East Timor (Fig. 6). Antennal segment VIII has a distinct basal neck (Fig. 22). The specimen from Timor has a pair of campaniform sensilla on the pelta, but this is absent in the specimens from Taiwan.

Specimens studied. **Taiwan**, Pingdong County, Nanjenshan, 1 female, 1 male from dead leaves, 3.xi.2001, in the National Zoological Museum of China, Beijing. **East Timor**, Ainaro, 1 female from grass, 5.xii.2003 (A. Roach), in Australian National Insect Collection, Canberra.



FIGURES 16–22. *Apelaunothrips* species, antennae. (16) *bogor* sp.n.; (17) *consimilis*; (18) *desleyae* sp.n.; (19) *flavicornis*; (20) *gombak* sp.n.; (21) *madrasensis*; (22) *medioflavus*.

Apelaunothrips *ocularis* Okajima

(Fig. 8)

Described from 10 females and four males from the Cameron Highlands, Tanah Rata, Malaysia, the two specimens listed below are identified from that original description. The vertex lacks sculpture, antennal segment III is largely yellow but is distinctively shaded on the basal third, and antennal segment VIII has a short basal neck. The compound eyes are prolonged ventrally in females (Fig. 8) but less so in the male.

Specimens studied. **Malaysia**, Genting Highlands, 1 female, 1 male in leaf-litter, 29.ix.1973 (LAM) (in The Natural History Museum, London).

Apelaunothrips *tasmani* Mound

Described on two females from northern Queensland, Australia, and two females with three males from Papua New Guinea, the series listed below has now been studied from Central Queensland. These specimens are paler than the holotype, but the body colour is distinctive with the metathorax and first abdominal segment yellow, and abdominal segment VI clearly paler than the brown segments II–V and VII–IX. The legs are yellow, the mesonotal lateral setae are long and capitate, and the pelta bears a pair of campaniform sensilla.

Specimens studied. **Australia, Queensland:** Holotype female, 7 miles north of Atherton, 3.v.1967 (in Australian National Insect Collection, Canberra); near Bororen, 120km northwest of Bundaberg, 5 females, 3 males in pitfall trap, x.2007 (J.King) (in Queensland Primary Industries Insect Collection, Brisbane).

Apelaunothrips zonatus Okajima & Reyes

(Figs 13, 15)

Described from 11 females and three males taken in the region of Mt Kinabalu, Sabah, the specimens listed below from Mt Mulu in northern Sarawak are here identified from the original description. This species has a particularly elongate head, and both the head and metanotum (Fig. 13) bear a large number of setae. The male fore femur has a large, recurved tubercle at the base on the inner margin (Fig. 15).

Specimens studied. Malaysia, Sarawak, Mulu National Park, 2 females, 1 male in lowland rainforest leaf-litter, 18.ix.–18.x.1977 (B.Bolton) (in The Natural History Museum, London).

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