

Phylogenetic relationships within the genus Desmothrips (Thysanoptera, Aeolothripidae), an Australian genus of facultative flower-living predators

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Abstract. A phylogenetic analysis of the Australian Aeolothripidae genus *Desmothrips* Hood is presented. A data matrix with 27 species is analysed under parsimony criteria. The monophyly of *Desmothrips* is recovered. Continuous and discrete characters were analysed separately and in combination, and continuous characters were rescaled and analysed under equal weights. Three new species from the northwestern and one from the southeastern areas of Australia are described and illustrated. A key to the 18 species of *Desmothrips* is provided.

Introduction

Desmothrips is present only in Australia, where species are common in the flowers of many native plants. Until about 10 years ago, the genus comprised nine species from the southern part of Australia (Mound, 1996), with almost no specimens recorded north of the Tropic of Capricorn. This pattern changed with the description of one species that is widespread across the northern part of the arid zone (Marullo, 1995), followed by that of two species from near Darwin and another from a site close to the Gulf of Carpentaria, together with a fourth species from south of the Tropic of Capricorn at Geraldton in Western Australia (Mound & Marullo, 1998). The most recent revision of this genus therefore recognized 14 species. In the present paper three new species of Desmothrips are described, each from the tropical northwest of this continent, and one further species is recorded from that area although is based on specimens from the southeast, near Canberra. These new distribution records, together with the increase in recorded structural diversity within the genus, provide the opportunity to examine the patterns of radiation and systematic relationships within the genus.

In a previous analysis (Pereyra & Mound, 2009), continuous characters were used to reconstruct phylogenetic relationships between members of *Cranothrips* (Thysanoptera: Melanthripidae); the use of these characters helped to resolve relationships between members of that genus, measured by an increase of

group supports when the continuous characters were included in the analysis. The use of continuous characters in phylogeny is controversial, but they contain important and useful phylogenetic information (Goloboff et al., 2006). One of the objectives of this study is to evaluate the influence of these characters in Desmothrips phylogeny. The method implemented in TNT (Goloboff et al., 2006, 2008) was used to analyse continuous and discrete characters in order to study internal relationships between Desmothrips members. This method treats continuous characters as additive by applying standard algorithms for optimization of additive characters, which are defined in terms of intervals (Farris, 1970, Goloboff, 1993). It is then possible to assign ranges to the terminals, for example mean, plus or minus a standard deviation; in this way, two terminal taxa with ranges that overlap will produce a step count of 0 and vice versa. These ranges can be treated like polymorphisms and analysed in the usual way (Goloboff et al., 2006).

Another four undescribed species are represented in the Australian National Insect Collection, Canberra, each by a single female taken at widely separated localities across the southern part of the Australian continent. Full nomenclatural details of all thrips taxa mentioned in this paper are available at http://www.ento.csiro.au/thysanoptera/worldthrips.html.

Material and Methods

Taxon sampling

This analysis includes all 18 species of *Desmothrips* Hood, four of which are new (Table 1). Trees were rooted with

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Table 1.	Material	examined	for	the analysis	(number a	and sex),	depositary	, and	collection lo	ocalities.
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Species	Number/Sex	Depositary	Locality
Aeolothrips insularis	4♀ 4♂	SMF	Canary Islands
Aeolothrips intermedius	2♀ 3 ♂	SMF	Germany, Italy, Spain
Desmothrips australis	4♀ 3♂	ANIC	A.C.T., N.S.W., Qld, W.A.
Desmothrips aliceae.	3♀ 3♂	ANIC	N.S.W., W.A.
Desmothrips bagnalli	3♀ 3♂	ANIC/UCR	Qld,
Desmothrips barrowi	1º 1♂	ANIC	Barrow Island (WA).
Desmothrips broomei	2♀ 2♂	ANIC	W.A.
Desmothrips chirus	19	ANIC	N.T.
Desmothrips crespii	2♀ 2♂	ANIC	N.T., Qld,
Desmothrips darwini	2♀ 2♂	ANIC	N.T.
Desmothrips marilynae	5♀ 3♂	ANIC	W.A.
Desmothrips mendozai	19	QM	W.A.
Desmothrips obsoletus	4♀ 3♂	ANIC/UCR	A.C.T., Qld,
Desmothrips postlei	19	ANIC	W.A.
Desmothrips propinguus	5♀ 5♂	ANIC	N.S.W., Qld, S.A. W.A.
Desmothrips reedi	5♀ 4♂	ANIC	A.C.T., Lord Howe Is. (NSW), Qld
Desmothrips steeleae	6♀ 4♂	ANIC	A.C.T.,N.S.W., Qld,
Desmothrips stepheni	5♀ 4♂	ANIC	Qld, W.A.
Desmothrips tenuicornis	3♀ 2♂	ANIC/UCR	N.S.W., Qld, S.A., Vic.
Desmothrips uniguttus	2♀ 1♂	ANIC	A.C.T.
Stomatothrips angustipennis	5 9	MCNLP/ USDA	Argentina, Brazil
Stomatothrips atratus	39	USDA	U.S.A.
Stomatothrips brunneus	2♀ 1♂	MCNLP/ USDA	Mexico, U.S.A.
Stomatothrips crawfordi	2♀ 1♂	USDA	U.S.A.
Stomatothrips flavus	3♀ 2♂	USDA	Mexico, U.S.A.
Stomatothrips rotundus	3♀ 3♂	MCNLP/SMF,	Argentina, Colombia
Stomatothrips septenarius	3♀ 1♂	USDA	Costa Rica, West Indies

A.C.T., Australian Capital Territory; ANIC, Australian National Collection, CSIRO Entomology, Canberra; MCNLP, Museo de Ciencias Naturales de La Plata; N.S.W., New South Wales; N.T., Northern Territory; Qld, Queensland; QM, Queensland Museum, Brisbane; SMF, Forschungsinstitut Senckenberg, Frankfurt; S.A., South Australia; UCR, University of California Riverside, Entomology Museum; USDA, United States Department of Agriculture, Beltsville, Maryland (collection of U.S. National Museum of Natural History); Vic, Victoria; W.A., Western Australia.

Aeolothrips intermedius Bagnall, Aeolothrips insularis Priesner, and seven species of Stomatothrips Hood (see Table 1). Males and females of all species were examined, except for two species of Stomatothrips (S. angustipennis, S. atratus) and three of Desmothrips (D. chirus, D. mendozai, D. postlei), for which only the females were available for study (Table 1). The specimens used were obtained from six Thysanoptera collections from Europe, Australia, and North and South America (Table 1). These taxa were selected because Stomatothrips is considered to be related to Desmothrips (Mound & Marullo, 1998, Pereyra in prep.), both having sternal discal setae. Stomatothrips has an American distribution and the species are ant-mimicking predators living at ground level. Desmothrips is known only from Australia, and the species are flower-living facultative predators, with a few obligate predators living at ground level. Desmothrips is equivalent ecologically to the Holarctic Aeolothrips, but in that genus sternal discal setae are absent.

Holotypes and most paratypes of the new species are deposited in the Australian National Insect Collection, CSIRO, Canberra, Australia.

Character coding

Forty-nine continuous and discrete morphological characters were coded (see Info S1). Implied weighting was used to diminish problems resulting from different scales (Goloboff *et al.*, 2006).

Desmothrips species show considerable intraspecific variation between populations from different localities. Differences in size, sculpture patterns, position of setae and coloration are usual between members of this genus. In order to work with this variation with continuous characters, we used ratios instead of absolute values of the structures considered for the analysis (Pereyra & Mound, 2009). These ratios correspond to the length and width of the pronotum, head, mesosternellum, antennal and abdominal segments, maxillary palps and thoracic setae with one another. In addition, we use for each species its mean value, plus or minus their standard deviation (Goloboff *et al.*, 2006). Normally, ratios were constant for each species.

An independent variation in some continuous characters for males and females, like the length ratio of abdominal segments, was observed (Ch 16, 17); these characters were considered separately in the analysis. In the case of discrete characters, the variation was reflected in the high number of polymorphic characters: 6.38% for *Aeolothrips* and *Stomatothrips* and 23.40% for *Desmothrips*. The coloration and sculpture patterns result in the most variable characters. Intraspecific variation is characteristic in *Desmothrips*, and therefore these characters were included. We recognize a variation pattern in seven discrete characters, and they were coded as ordered (see list of characters).

Phylogenetic analysis

Parsimony analyses were carried out using implied weighting in TNT 1.1 (Goloboff et al., 2008), under ten concavity values (i.e. K = 10-19). Symmetric resampling (Goloboff et al., 2003) and relative Bremer support (Goloboff & Farris, 2001) were used as support measures. The relative Bremer support was calculated from 5145 suboptimal trees, found in two rounds, with a fit up to 0.05 units lower than the previous trees. The symmetric resampling was calculated using twenty random addition sequences for each replication (1000 altogether) followed by tree bisection-reconnection (TBR) and keeping five optimal trees per random addition sequence. Symmetric resampling values are shown as GC values (Goloboff, et al., 2003). GC values indicates the differences in frequency between a group and the most frequent contradictory group. GC values vary between -100 (maximum contradiction) and 100 (maximum support).

Phylogenetic results

The same optimal tree was recovered under each concavity value (Fig. 1). The monophyly of Stomatothrips and Desmothrips was obtained, the American Stomatothrips being the sister group of the Australian Desmothrips. This genus is defined by the presence of a longitudinal sensorium that curves around the apex on antennal segment III (Ch 19) (Figs 1, 6, 12-15), and by a decrease in the value of the length ratio between antennal segments III and IV (Ch 3); this value also decreases for several species inside the Desmothrips clade, namely D. mendozai, D. broomei, D. darwini, D. bagnalli and D. barrowi (Fig. 2). The aberrant species in the genus, such as D. mendozai and D. uniguttus (Fig. 10), are near the base of the Desmothrips cladogram. Two major groups are recognized (Fig. 1), the first group represented by the species from northern Australia (D. broomei + (D. chirus + (D. postlei +D darwini))). The synapomorphies that support this group are an increase in the value of the length-width mesosternellum ratio (Ch 2); a decrease in the length ratio of maxillary palps segments II and III (Ch 11) (Fig. 2); and the presence of a longitudinal sculpture pattern in the metanotum (Ch 32) (Fig. 29). These four species all occur in a broad area across the northern Northern Territory and northern Western Australia. The remaining species are grouped by having the metanotal sculpture arcuate (Ch 32) (Fig. 28), and the supernumerary setae



Fig. 1. Optimal tree for *Desmothrips* species from parsimony analysis under ten concavity values (i.e. K = 10-19). Synapomorphies that support branches are mapped on the tree.



Fig. 2. Maximum decreases for continuous characters mapped in the optimal tree. (A) Antennal segment III/IV length ratio; the decrease in this value is in grey in the optimal tree. (B) Segment II/III maxillary palps length ratio; the decrease in this value is in grey in the tree. In the *Stomatothrips* clade the increase in this value also is in grey.

aligned with the marginal setae on abdominal sternite VII (Ch 42) (Fig. 16). Mound & Marullo (1998) pointed out the close relationship between *D. bagnalli* and *D. propinquus*, on the basis of the forewing coloration; we recovered this group here and found that they also share an increase in the median length ratio of female abdominal segments IX/VIII (Ch 14). Another interesting group is (*D. steeleae* + *D. marylinae*), sharing the pale basal half of antennal segment III (Ch 17) (Fig. 15), the length of the sensoria on antennal segment IV (which is longer than half the apical diameter of the segment) (Ch 20), and the position of the sensoria on abdominal sternite VII (Ch 45).

The monophyly of Stomatothrips is well supported; characters in this part of the tree are almost non-homoplastic (Fig. 1). This group is defined by the presence of a pale antennal segment III (Ch 17); the broad joint between head and pronotum (Ch 24); similar metanotal posterior sculpture patterns (Ch 32); and the number of marginal and supernumerary setae on abdominal sternite VII (Ch 39). In this group there is an increase in the value of the length-width pronotum ratio (Ch 0), as well as in the length ratio between maxillary palps segments II/III (Ch 11) (Fig. 2); and a decrease in the value of the length ratio between sensoria on antennal segments III and IV (Ch 6, 7), as well as between the median length ratio of abdominal segments IX/VIII in females (Ch 14). The distribution pattern in Stomatothrips species is interesting as there is a progression from the southern U.S.A. at the base of the cladogram to Central and South America toward the apex. This cladogram has medium to high support values; by contrast, support measures for the Desmothrips cladogram are low (Fig. 3a), and only (D. steeleae + D. marilynae) and (D. postlei + D. darwini) showed medium to high values for both support measures. In general, Desmothrips shows very low values of GC. A positive GC value indicates that a group is present more times than its more frequent contradictory group, while a negative value indicates that the occurrence of the group is less frequent than that of the contradictory group (Goloboff *et al.*, 2003). The values of relative Bremer support are also low, indicating that some characters contradict the groups.

Both genera were paraphyletic when the continuous characters were analysed alone. The monophyly of the two genera was recovered if discrete characters were used, but relationships differ from those found in the matrix analysis with all the data. In the *Stomatothrips* cladogram, *S. atratus* remains sister species of the rest of *Stomatothrips*, but the relationships between these species are unresolved (Fig. 3b). Relationships within *Desmothrips* species differ from those of previous analyses (Fig. 3b). *Desmothrips mendozai* is still at the base of this group, *D. steeleae* + *D. chirus* form a group with negative value according to GC, and the same applies to the rest of *Desmothrips*; the only group with medium to high support values is *D. postlei* + *D. darwini*.

Even if support values are low in both analyses for *Desmothrips*, in general these values are increased slightly if continuous characters are excluded. The Bremer support value is maximum for the *Desmothrips* node, and no characters contradict this group; by contrast, this value is low when all the data are analysed. In the case of *Stomatothrips*, support values are medium to high, but are a little lower when continuous characters are excluded. Furthermore, relationships between the species appear as unresolved (Fig. 3b). It can be seen how the exclusion of continuous characters affects relationships within *Desmothrips* and *Stomatothrips* in different ways.

A third analysis was made under equal weights and with continuous characters rescaled in different intervals (i.e. [0 0.5]; [0 1]; [0 2]). In these analyses, the monophyly of *Stomatothrips* and *Desmothrips* was also recovered but relationships between species were quite different. The agreement subtree of the trees obtained under the different intervals has only 17 taxa (Fig. 4), with only nine *Desmothrips* species.



Fig. 3. Support measures for the optimal tree obtained in the analysis of: (A) all evidence; (B) discrete characters alone. Numbers on branches indicate values of GC (below branches) and relative Bremer support (above branches).



Fig. 4. Agreement subtree of trees obtained in the analysis of both datasets with continuous characters rescaled in different intervals ([0 0.5] [0 1] [0 2]), with only 50% of *Desmothrips* species, and 86% of *Stomatothrips* species.

Desmothrips Hood

Desmothrips Hood, 1915: 57

Type species. Orothrips australis Bagnall, by monotypy

The species of *Desmothrips* are the ecological equivalent of the species in the large Holarctic genus *Aeolothrips*. However, despite their similarities these two genera are not closely related. The genus most closely related to *Desmothrips* is presumably the monotypic Australian genus *Andrewarthaia*, which is associated with the flowers of *Eucalyptus*. Also related is *Desmidothrips*, a genus of two species from New Zealand and New Caledonia. These generic relationships are the subject of current research (Pereyra, in preparation), but it seems likely that these Australasian genera are together sister group to the American genus *Stomatothrips*, a small group of antmimicking predatory species that live at ground level, not in flowers (Hoddle *et al.*, 2008).

Biological diversity

Although primarily flower-living, the species of Desmothrips are facultative predators, feeding on both flower tissues and small arthropods such as the larvae of other thrips. Despite this, at least one species, D. reedi, lives only at ground level, where it is an obligate predator, presumably on mites. In both structure and behaviour this thrips is an excellent ant-mimic. In D. reedi the first abdominal tergite of females is closely and transversely striate (Fig. 25), a character state that also occurs in one ground-living Holarctic species of the large genus Aeolothrips, and is partially developed in a few other species of that genus living at ground level. A second species of *Desmothrips* has also been taken at the base of grasses, but D. darwini is a less convincing ant-mimic, despite its having a 'wasp-waist' and running around at the base of grasses like a small hymenopteran. Desmothrips postlei is described below from only two specimens, but this species probably also lives at ground level in association with grasses. Another species found on grasses at Darwin, D. chirus, is remarkable amongst Aeolothripidae because of the incrassate fore femora in which the external apical margin is slightly recurved (Fig. 26). These fore femora thus resemble the femora of Chirothrips species that breed in the florets of grasses. Most of the other species of Desmothrips differ from each other mainly in the colour patterns of the wings, antennae and legs, and these species all seem to be associated with flowers. A few of these species have strict host-plant relationships, for example D. aliceae in the flowers of Brachychiton trees (Sterculiaceae), and D. steeleae in the flowers of Pultenaea shrubs and herbs (Fabaceae), but some have been taken from flowers of various species,

Key to species of Desmothrips

- Antennal segment III never darker at base than apex; mesonotum usually with more than two setae medially; metanotal reticles usually with internal markings......3
- 3. All femora yellow, washed with brown, clearly paler than dark brown tibiae and tarsi (Fig. 11); prothorax and metathorax largely yellow *postlei* **sp.n**.
- Femora never paler than tibiae; body colour different ... 4
- 4. Mid and hind tibiae and tarsi clear yellow (Fig. 5); antennal segments I–IV largely yellowaliceae **sp.n.**
- 5. Sensoria on antennal segments III–IV elongate and strongly wavy (Fig. 15)steeleae Mound

- Female tergite I with more than 15 transverse lines of sculpture (Fig. 25); abdominal segments II–III (or IV) bright yellow, contrasting with remaining segments, which are brown; pronotum brown......reedi Mound

- Median metanotal reticles not longer than wide10
- 9. Forewing uniformly shaded in distal two-thirds; metanotal reticles without internal markings; sternite VII with only three pairs of marginal setae *mendozai* Girault
- Forewing banded, with a subapical pale band; metanotal reticles with internal markings; sternite VII with four pairs

of marginal setae [head narrowed to anterior, fore femora with apical external margin reflexed (Fig. 26)] chirus Mound & Marullo 10. Distal half of forewing uniformly shaded light brown, 11. Head with one pair of postocular setae medially 1.2-1.5 × as long as longitudinal diameter of a posterior ocellus (Fig. 23) stepheni Mound & Marullo - Postocular setae uniformly weakcrespii Marullo 12. Postocular region short, less than 0.6 of dorsal length of eyes (Fig. 22), distance between posterior margin of eye and posterior margin of head less than $3 \times$ the length of a posterior ocellus obsoletus Bagnall - Postocular region not exceptionally short, usually at least 0.8 as long as dorsal length of compound eyes, more than $3 \times as$ long as longitudinal length of a posterior 13. Forewing median dark band shorter than wing width (Fig. 8); abdominal sternites with sculpture lines bearing many microtrichia broomei sp.n. - Forewing median dark band longer than wing width (Fig. 21); abdominal sternites usually without microtrichia on lines of sculpture14 14. Antennal segment IV clear yellow (Fig. 12) barrowi sp.n. - Antennal segment IV mainly brown 15 15. Forewing costa darker than membrane around distal pale area; this pale area wider at costal region than near posterior margin, sometimes not extending across wing16 - Forewing costa not darker than membrane around distal pale area; this pale area often parallel-sided across wing 16. Antennal segment III sharply brown in distal half; sensoria on antennal segments III-IV with discoid internal markings; sternite VII of female medially without discal setae bagnalli Karny - Antennal segment III weakly shaded near apex; sensoria on antennal segments III-IV without internal markings; sternite VII of female medially with a row of discal setaepropinquus Bagnall 17. Antennal segment III yellow with a dark ring at apex; distal pale area of forewing usually longer than wing width, sometimes micropteroustenuicornis Bagnall - Antennal segment III variably brown in apical half; distal pale area of forewing shorter than wing widthaustralis Bagnall

Desmothrips aliceae sp.n.

Female

Body brown, abdomen paler medially in newly emerged individuals (Fig. 5); femora brown, fore tibiae yellow washed with brown, mid and hind tibiae and tarsi clear yellow; antennal segment I light brown, II mainly yellow with base

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Figs 5–10. Desmothrips species. (5) D. aliceae; (6) antenna of D. aliceae; (7) D. barrowi; (8) D. broomei; (9) D. reedi; (10) D. uniguttus.



Figs 11–21. *Desmothrips* species. (11) *D. postlei*; (12) antenna of *D. barrowi*; (13) antenna of *D. broomei*; (14) antenna of *D. postlei*; (15) antennal segments II–V of *D. steeleae*; (16) sternites V–VII of *D. barrowi*; (17) sternites VI–VII of *D. aliceae*; (18) sternites VI–VII of *D. broomei*; (19) pronotum of *D. broomei*; (20) forewing of *D. marilynae*; (21) forewing of *D. barrowi*.



Figs 22-27. Desmothrips species. (22) Head and pronotum of D. obsoletus; (23) head and pronotum of D. stepheni; (24) meso and metanota of D. aliceae; (25) meso and metanota and abdominal tergite I of D. reedi; (26) head and pronotum of D. chirus; (27) meso and metanota of D. broomei.

slightly shaded, III–IV yellow with extreme apex brown, V–IX brown; forewing brown at extreme apex and base, with long median brown area, and two clear transverse bands each with costa pale.

Head typical of genus, distal maxillary palp segment subdivided. Antennal segments III–IV with sensorium broad, extending to basal half or basal third of segment; VI–IX connate, V–VIII with elongate sensorium base (Fig. 6). Pronotum with no long setae; fore tarsus with typical recurved tooth meeting stout seta. Mesonotum with only one or two pairs of accessory setae medially. Metanotal reticles transverse at anterior, small and almost longitudinal medially, with internal markings (Fig. 24). Abdominal tergite I with faint transverse lines medially; tergites II–VII median setal pair small and slender; trichobothria on X no larger than base of major setae on X. Sternal chaetotaxy irregular, usually with four pairs of marginal setae and zero to four pairs of discal setae laterally but none medially (Fig. 17).

Measurements (holotype φ in microns). Body length 2000. Head, length 200; width 215. Pronotum, length 200; width 250.



Figs 28–30. Desmothrips species. (28) Meso and metanota of D. australis; (29) meso and metanota of D. chirus; (30) meso and metanota of D. postlei.

Forewing length 1000; median width 170. Antennal segments I–IX length 40, 55, 115, 95, 45, 40, 30, 18, 12.

Male

Similar to but smaller than female, pronotum and fore femora more yellow; antennal segment IV more extensively brown. Abdominal tergite I with two longitudinal ridges. Sternal marginal setae arising submarginally, at least laterally; sternite IX with no discal setae.

Material examined

Holotype φ , AUSTRALIA: New South Wales, Wee Jasper, from *Brachychiton populneus* (Sterculiaceae) flowers, 2.xii. 2006 (L.A. Mound 4974). Paratypes: 11 $\varphi \varphi$ 3 $\sigma \sigma$ collected with holotype; 1 φ same host and locality, 1.i.2004.

Others: AUSTRALIA: Western Australia, Kununurra, 2 qq from mango flowers, 2.vii.2003 (J. Moulden).

Comments

This species appears to be strictly seasonal and hostspecific in the flowers of *Brachychiton populneus*, although it is not necessarily phytophagous. It is particularly unusual because the whitish-yellow mid and hind tibiae are sharply paler than the brown femora. The two females taken in the northern part of Western Australia have much paler femora than those of the type series, and moreover the coxae are yellow. These two females possibly represent a further undescribed species, but, because the tree genus *Brachychiton* is widespread across Australia, it is possible that *D. aliceae* is equally widespread but unrecorded because of a seasonal occurrence only when the host trees are in flower.

Desmothrips barrowi sp.n.

Female

Body brown, also all femora and tibiae, tarsi variably paler (Fig. 7); antennal segment I brown, II yellow at apex, III–IV clear yellow, V brownish yellow, VI–IX brown; forewing apparently without brown marking at base, median brown area longer than wing width, costa slightly shaded around distal pale area, apex with oblique brown area.

Head typical of genus, distal maxillary palp segment subdivided. Sensorium on antennal segments III–IV with weak internal markings, extending to basal half of segment; VI–IX connate, V–VI with elongate sensorium base (Fig. 12). Pronotum with no long setae; fore tarsus with typical recurved tooth meeting stout seta. Mesonotum with up to five pairs of accessory setae medially. Metanotum with small equiangular reticles medially, with internal markings. Abdominal tergite I with transverse reticulate lines; tergites II–VIII transversely reticulate, median setal pair small and slender; trichobothria on X no larger than base of major setae on X. Sternites with four or five pairs of small marginal setae, III–VII with band of at least 20 small discal setae transversely across sternite (Fig. 16).

Measurements (holotype φ in microns). Body length 1950. Head, length 150; width 175. Pronotum, length 175; width 220. Forewing length 820; median width 140. Antennal segments I–IX length 25, 45, 80, 75, 40, 30, 23, 12, 12.

Male

Similar to but smaller than female, fore femora paler; antennal sensoria slightly shorter. Abdominal tergite I with two longitudinal ridges. Sternites with four pairs of marginal setae and transverse row of discal setae; sternite IX with four to six discal setae.

Material examined

Holotype φ AUSTRALIA: Western Australia, Barrow Island, beaten from vegetation, ix.2006 (J. Majer).

Paratypes. 6 qq, 5 d d with same data as holotype.

Comments

Nothing is known of the biology of this species. It is unusual in having the base of the forewing lacking any prominent dark marking, and in the clear yellow third and fourth antennal segments. Despite these colour differences, this is one of the *D. australis* group (Fig. 1), and is particularly similar to *D. propinquus*.

Desmothrips broomei sp.n.

Female

Body and legs brown, fore tarsi and fore tibiae paler (Fig. 8); antennal segment I brown, II yellow at apex, III yellow with extreme apex sometimes slightly brown, IV yellow in basal half, VI–IX brown; forewing apparently without brown marking at base, median brown area shorter than wing width, costa shaded around distal pale area, apex brown.

Head typical of genus, distal maxillary palp segment subdivided. Sensorium on antennal segments III-IV with weak internal markings, extending to mid-point of segment; VI-IX connate, V-VI with elongate sensorium base (Fig. 13). Pronotum with all setae minute, surface with closely spaced sculpture lines bearing many microtrichia (18); fore tarsus with typical recurved tooth meeting stout seta. Mesonotum with up to five pairs of accessory setae medially. Metanotum with equiangular reticles medially, with internal markings (Fig. 27). Abdominal tergite I with widely spaced transverse reticulation; tergites II-VIII transversely reticulate, median setal pair small and slender; trichobothria on X no larger than base of major setae on X. Sternites covered with narrow transverse reticulate lines bearing microtrichia, usually with four pairs of marginal setae, III-VI with irregular transverse row of 8-13 discal setae, VII with this transverse row incomplete medially (Fig. 18).

Measurements (holotype φ in microns). Body length 1600. Head, length 150; width 170. Pronotum, length 155; width 200. Forewing length 730; median width 120. Antennal segments I–IX length 25, 45, 75, 70, 40, 30, 25, 15, 15.

Male

Similar to but smaller than female, antennal segment IV darker; antennal sensoria slightly shorter. Abdominal tergite I with two longitudinal ridges. Sternites with four pairs of marginal setae, about 6–10 discal setae in irregular transverse row medially; sternite IX with 4–6 discal setae.

Material examined

Holotype ç, AUSTRALIA: Western Australia, 20 km east of Broome, from *Acacia eriopoda* (Mimosaceae) flowers, 1.iii.2005 (L.A.Mound 4652).

Paratypes: 12 _{QQ} , $3 \text{ }_{\text{C}}^{\text{o}}$ collected with holotype; 6 _{QQ} , $3 \text{ }_{\text{C}}^{\text{o}}$ from *Trichodesma zeylanicum* (Boraginaceae), same locality and date.

Comments

This flower-living species was abundant at the site where it was found. It is unusual for the dark markings medially and at the apex on the forewing being so small, and also for the large number of microtrichia on the sternites and pronotum. It is similar to *D. bagnalli* in the antennal sensoria, and lack of discal setae medially on sternite VII.

Desmothrips crespii Marullo

Desmothrips crespii Marullo, 1995

Although possibly a group of unrecognized sibling species, D. crespii is treated here as a single variable species that is widespread in the arid country between Mt Isa in western Queensland, Tennant Creek in Northern Territory, and Tom Price in Western Australia. The holotype from Boulia in Western Queensland has the metanotal reticles with weak internal dot-like markings, and the sensorium on antennal segments III-IV is at least 0.5 as long as the segment. Paratypic specimens from Tennant Creek and Darwin have a mixture of dots and lines within the metanotal reticles, and antennal sensoria that are scarcely 0.5 as long as their segment. More recently collected specimens from the area near Tom Price either have distinct lines within the metanotal reticles or have no internal markings, the antennal sensoria are distinctly shorter, 0.3-0.5 as long as their segment, and in some of these specimens the pronotal posteromarginal setae are stouter than normal in this genus. The postocular area of the head of D. crespii is rather short, although not as short as in D. obsoletus, and the forewings are almost uniformly grey. Desmothrips mendozai that is known only from a single damaged female taken near Perth, and S. stepheni that is known from a few specimens taken at Lawn Hill in northern Queensland near the Northern Territory border, are also part of this extensive species complex.

Desmothrips postlei sp.n.

Female (holotype possibly not fully mature)

Head and all tibiae and tarsi dark brown, femora yellow (Fig. 11), pronotum yellow with fore coxae light brown; pterothorax yellowish with light brown markings; tergites VI–VIII brown, X yellow; antennal segment I brown, II mainly yellow, III clear yellow, IV–IX brown; forewing brown at base

and apex, with long median brown area, costa pale around distal pale area.

Head relatively long, distal maxillary palp segment subdivided. Sensorium on antennal segments III–IV slender with internal markings, extending to basal half of segment; VI–IX connate, V–VI with elongate sensorium base (Fig. 14). Pronotum with no long setae; fore tarsus with typical recurved tooth meeting stout seta. Mesonotum with one pair of accessory setae medially. Metanotum with equiangular reticles medially, with internal markings (Fig. 30). Forewings unusually slender. Abdominal tergites I–III apparently with no transverse lines medially; tergites IV–VIII transversely reticulate, median setal pair small and slender; trichobothria on X no larger than base of major setae on X. Sternites with four pairs of marginal setae, II–V apparently without discal setae, VI with one or two pairs placed anterolaterally, VII with four pairs of discal setae laterally.

Measurements (holotype \circ in microns)

Body length 1750. Head, length 165; width 165. Pronotum, length 165; width 200. Forewing length 700; median width 90. Antennal segments I–IX length 35, 50, 100, 75, 45, 35, 27, 18, 15.

Male

Similar to but smaller than female, femora more extensively shaded brown, antennal segments I–III yellow; antennal sensoria distinctly longer. Abdominal tergite I with two longitudinal ridges. Sternites with numerous microtrichia, four pairs of marginal setae, II–VI with no discal setae, VII–VIII each with two pairs laterally; sternite IX with two discal setae.

Material examined

Holotype φ , AUSTRALIA: Western Australia, Kununurra, Frank Wise Institute, from grasses, 24.ii.2005 (L.A. Mound 4586).

Para: one rightarrow collected with the holotype.

Comments

Collected together with the more common grass-living aeolothripid, *Gelothrips cinctus* (Hood), this new bicoloured species is almost certainly also a predator breeding at the base of grasses. It is closely related to *D. darwini*, another bicoloured, grass-living species, but has antennal segment IV dark. The forewings are unusually narrow for a member of *Desmothrips*, and further field studies may well discover shortwinged adults of this species.

Supporting Information

Additional Supporting Information may be found in the online version of this article under the DOI reference: DOI: 10.1111/j.1365-3113.2009.00511.x

Info S1. Data matrix, character list.

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