



Diversity in the Hawaiian endemic genus *Neurisothrips* (Thysanoptera, Thripidae)

LAURENCE A. MOUND

Australian National Insect Collection CSIRO, PO Box 1700, Canberra, ACT 2601

✉ laurence.mound@csiro.au; <https://orcid.org/0000-0002-6019-4762>

Abstract

The genus *Neurisothrips* is known only from the Hawaiian Islands, where it has radiated into a considerable number of species. No other species of the worldwide family Thripidae is endemic to Hawaii, and the lack of structural diversity amongst the members of this genus might suggest that they are derived from a single ancestral introduction. The phylogenetic relationships of *Neurisothrips* are unclear, but it is possibly derived from *Frankliniella*, the most species-rich Thripidae genus on the American continent. A key is provided to 14 recognised species of which the following seven are newly described: *N. bidens* sp. n., *N. fran* sp. n., *N. janis* sp. n., *N. karl* sp. n., *N. robbiei* sp. n., *N. saki* sp. n., *N. tsuda* sp. n. The type species of the genus, *N. multispinus* (Bagnall), is known only from five fragmented specimens, and its identity remains in doubt. Since each of the species is known only from adults the true host associations remain unclear, but these thrips seem to live primarily on plants that are endemic to the Hawaiian Islands, with *N. saki* breeding only on the young croziers of *Cibotium* species, a native fern genus.

Key words: genus relationships, new species, endemism

Introduction

The Thysanoptera fauna of the Hawaiian Islands is composed almost entirely of adventive species (Nishida 2002). A few of the Phlaeothripidae are possibly endemic, but there is little evidence of any Hawaiian radiation within any genera of that family (Mound & Matsunaga 2017; Mound 2017). Amongst the Thripidae, with the exception of the members of one genus, all of the recorded species are considered to be adventive (Mound *et al.* 2016). This genus, *Neurisothrips*, is known only from the Hawaiian Islands where it has undergone considerable radiation. However, the extent of this radiation remains to be fully explored. The type species of the genus was collected in 1895 by R.C.L. Perkins and described by Bagnall (1910) as *Thrips multispinus*. Unfortunately, this species is known only from fragmented, crushed and distorted specimens on four microscope slides. As a result, the identity of *multispinus* remains doubtful. Six further related species were described subsequently by Moulton, four in 1928 and two in 1937, all six being described under the generic name *Isoneurothrips*. Three of these six species were described from single specimens, and the others from three, four and 17 specimens respectively. None of the specimens were cleared and slide-mounted to modern standards, and their structural details are difficult to determine (compare Figs 11–13 with 14; or 19 with 20). There are also many slides in the Bishop Museum, Hawaii, prepared by K. Sakimura and F.A. Bianchi, but again none of these specimens are cleared. As a result, the published keys to identify these seven species (Sakimura 1967; Mound *et al.* 2016) are based largely on colour and “silhouette characters”, because few surface details can be seen on such uncleaned specimens.

Collections history

The thrips specimens that were collected on Hawaii in 1895 and described by Bagnall in 1910 were deposited at the British Museum (Natural History) in 1932. The deposited collection comprised a series of slide-mounted specimens, together with a considerable number of dry pinned thrips. Unfortunately, by the time the collection was deposited

in London many of Bagnall's pinned specimens had become extensively covered in white fungus. In 1965, these specimens were dissected free of their fungus coating and slide-mounted (Mound 1968). The type specimens of species described by Moulton (1928, 1937) are all slide-mounted specimens, and are deposited in the California Academy of Sciences (Arnaud & Lee 1973). There is no evidence that Moulton ever saw the original specimens of *multispinus*, and his comparisons in describing new species are presumably based on the words of the 1910 publication. In 2015, the types of the six species described by Moulton were sent on loan to Canberra for studies in connection with an account of the Terebrantia of Hawaii (Mound *et al.* 2016), and in 2016 the collection of *Neurisothrips* housed at the Bishop Museum, Hawaii, was taken on loan to Canberra. This collection comprised three slide boxes containing about 250 slides that had been acquired from F.A. Bianchi. Through the courtesy of Janis Matsunaga at the Department of Agriculture, Oahu, a further collection of 55 slides was borrowed from Dick Tsuda at the University of Hawaii. These slides were part of a collection that had been developed during the 1940's by K. Sakimura and sorted by him into about 25 putative species. The study reported here is based primarily on freshly mounted, cleared specimens that were collected in July 2016 during a short visit to Hawaii, Maui and Oahu, and these specimens have been compared with the historical material indicated above. The holotypes and some paratypes of all the new species of *Neurisothrips* described below are deposited in the Bishop Museum; paratypes where available will also be deposited in the major collections in Canberra, Frankfurt, London and San Francisco.

Species diversity

Associated with the Sakimura collection of slides mentioned above was a large file containing copies of his original working notes, together with a draft key to species. The major character states used in that key were the colour of the body and the colour of the setae on the fore wing, supplemented by combinations of the leg and antennal colours. The objective of the referred key seems to have been to provide a tool to help sort specimens in ethanol that had been taken in traps. None of the specimens were cleared, and structural details on most of them are difficult or impossible to observe. As a result, the identity of most of these putative species sorted by Sakimura will be determined only through more extensive, and intensive, field studies. These slides are not considered further in the studies presented here, with the exception of two species that are remarkable in having sternal discal setae.

Logically, it might be expected that species diversity in this endemic genus might be related in some way to isolation on different islands. Similarly, since all these thrips are phytophagous the species diversity might be related to association with different host plants. However, there is limited evidence to support either of these expectations. Recent collecting indicated that it is not unusual to collect on the same plant a few adults of two apparently different species. Larvae have been found only rarely of any species in this genus, and there is thus limited evidence of host specificity for most of the segregates that are here recognized as different species. Moreover, individuals of a few of the recognised species have been found on more than one island, and thrips are well known for the ease with which they are transported by human trading as well as by winds. One remarkable fact about the diversity among *Neurisothrips* species is that no wingless forms have been found, although wing loss has often been associated with the insect fauna on islands (Roff 1990).

Thrips have been collected from only a few of the Hawaiian Islands. Without intensive field studies across more of these islands, focusing on life history studies to establish host associations, it will remain impossible to understand the true significance of the observed variation in colour between samples. The structural diversity among these species is remarkably low. One species has unique metanotal sculpture, in another species the position of the metanotal setae is unique within the genus, two members of the genus have sternal discal setae, and one species has unusually long antennae. Apart from these five species, the detailed structure of the remaining members of the genus is curiously uniform. In describing seven new species and providing character states and a key to identify the 14 recognised species, the objective of this study is to draw attention to this isolated genus and its evolutionary significance. Because, judging from the structural uniformity among the species the localized diversification seems likely to have arisen subsequent to a single ancestral introduction to the islands.

Abbreviations

Postocular setae—po; pronotal posteroangular setae—pa; pronotal posteromarginal setae—pm. Nomenclatural details of all species mentioned are available on ThripsWiki (2020).

Neurisothrips Sakimura

Neurisothrips Sakimura, 1967: 419. Type species *Thrips multispinus* Bagnall.

In describing this genus, and transferring to it all seven of the endemic thripids described from the Hawaiian Islands, Sakimura presented differences only in relation to the genus *Thrips*. However, that genus is now recognised as only distantly related and differing in several character states of the head and abdomen (Mound *et al.* 2016). Relationships of *Neurisothrips* have remained far from clear, and are not likely to be understood without molecular data. However, the genus seems most likely to have evolved from, or possibly shared a common ancestor with, *Frankliniella*, a genus that is particularly species-rich in the warmer parts of the American continent. The species placed in *Neurisothrips* share with members of *Frankliniella* the following character states: head with a pair of setae in front of the first ocellus; fore wing with two complete rows of veinal setae; tergite VIII with a ctenidium-like row of microtrichia antero-lateral to the spiracle. With very few exceptions the two genera also share the following conditions: metanotum weakly reticulate with both pairs of setae on the anterior margin; sternites without discal setae. In contrast to *Frankliniella* species the antennae of *Neurisothrips* species have seven (not eight) segments, there are no distinct ctenidia on any abdominal tergite, and the posterior margin of each tergite and sternite bears a well-developed craspedum.

Generic diagnosis

Both sexes macropterous. Antennae 7-segmented, sense cones forked on III & IV, microtrichia present on dorsal and ventral surfaces; head with 3 pairs of ocellar setae, pair III between anterior margins of hind ocelli; 3 or 4 pairs of po setae of which IV is often long; compound eyes with 6 facets weakly pigmented. Pronotum transverse, with 2 pairs of long posteroangular setae, 2, 3 or 4 pairs of posteromarginal setae. Prosternal ferna usually complete medially. Mesonotum with anterior pair of campaniform sensilla present, lateral setal pair well-developed; median setal pair close to posterior margin. Metanotum usually reticulate, median setal pair usually at anterior margin; campaniform sensilla present. Mesothoracic furca with spinula, metathoracic without. Fore wing with 2 complete rows of veinal setae, varying from 14 to 25 on first vein, 10 to 15 on second vein; clavus with one discal and 5 marginal setae. Tarsi 2-segmented; fore tibiae without tubercles. Tergites II–VII with posteromarginal craspedum, without ctenidia, median setal pair small and wide apart; tergites without sculpture between median setal pair, usually with distinctive lateral group of strong discal setae, on VI–VII some of these setae are small (Figs 22, 23); tergite VIII with comb of long microtrichia arising from a distinct craspedum (Figs 33–35); tergite IX with 2 pairs of campaniform sensilla; X usually with longitudinal split; pleurotergites without discal setae. Sternites rarely with discal setae; II–VII each with 5 craspedal lobes but median lobe usually absent on VII; male sternites III–VII usually with pore plate medially; male tergite IX with 2 pairs of setae in regular pattern (Figs 33–35).

Key to species of *Neurisothrips*

1. Metascutum with longitudinally striate sculpture lines (Fig. 21); tergite X with longitudinal split not developed. . . . *saki* **sp. n.**
- Metascutum with sculpture reticulate or weakly reticulate with striations only laterally (Figs 17, 48); tergite X with longitudinal split usually complete. 2
2. Abdominal sternites with discal setae (Figs 31, 32). 3
- Abdominal sternites without discal setae (Fig. 30) 4
3. Antennal segment III without a prominent constriction at apex (Fig. 3); ocellar setae pair III and po setae pair IV less than 25 microns long, shorter than distance between hind ocelli; pronotal pa setae about 35 microns long; major setae light brown; sternites V & VI with discal setae irregularly scattered (Fig. 31); male with sternal discal setae present medially but pore plates not visible on available paratype *janis* **sp. n.**
- Antennal segment III with apex constricted to short neck (Fig. 2); ocellar setae pair III and po setae pair IV 40 microns long, slightly longer than distance between hind ocelli; pronotal pa setae at least 60 microns long; major setae dark brown; sternites V & VI with discal setae in an irregular transverse row (Fig. 32); male pore plates on sternites IV & V about 75x18 microns with 1 or 2 discal setae only lateral to the pore plate (Fig. 25) *bidens* **sp. n.**
4. Metascutal median setae arising well posterior to anterior margin; antennal segments I–II white, III–VII brown; tergal discal setae arranged in a single row (Fig. 40) *carteri*
- Metascutal median setae on or very close to anterior margin (Figs 17, 18); antennal colour different; tergal discal setae irregular

	in arrangement	5
5.	Fore wing pale with brown band medially and at apex	<i>fasciatus</i>
-.	Fore wing almost uniformly dark brown (Fig. 10) or uniformly pale	6
6.	Body largely yellow or with abdomen pale brown	7
-.	Body brown to dark brown	9
7.	Ocellar setae III no more than 35 microns long, shorter than distance between posterior ocelli; fore wing pale	<i>dubautiae</i>
-.	Ocellar setae III at least 50 microns long, clearly longer than distance between posterior ocelli (Fig. 18); fore wing pale or with weak shading at veinal fork	8
8.	Tergites VIII–X uniformly yellow but IV–VI with dark antecostal ridge (Fig. 38); antennal segment I white, II brownish, III yellow on basal half, IV almost completely brown; fore wing uniformly pale; male pore plates about 100 x 25 microns	<i>williamsi</i>
-.	Tergites IX–X pale brown, II–VIII uniformly pale yellow to very pale brown (Fig. 44); antennal segments I–III almost uniformly yellow, IV light brown but paler on basal half (Fig. 6); fore wing sometimes with pale brown area near veinal fork; male pore plates about 50 x 5 microns	<i>fran</i> sp. n.
9.	Female with head bicoloured, anterior half almost yellow, occipital ridge dark brown (Fig. 16); thorax brownish yellow, abdomen light brown, legs yellow to light brown; male brownish yellow with sternal pore plates about 100 x 25 microns	<i>robbiei</i> sp. n.
-.	Female head as uniformly dark brown as rest of body; male pore plates more slender	10
10.	Antennal segment III almost parallel sided, 75 microns long (Fig. 1) [pronotum with 15–20 discal setae and 8 anteromarginal setae; fore wing uniformly dark]	<i>antennatus</i>
-.	Antennal segment III no more than 60 microns long, margins convex (Figs 2–8)	11
11.	Fore wing with irregular pale area between base of second vein and clavus (Fig. 9); pronotum with median anteromarginal setal pair stout; male as dark brown as female	<i>fullawayi</i>
-.	Fore wing without a sub-basal pale area (except for the subcircular window); pronotum with 2 pairs of equally small anteromarginal setae	12
12.	Tergites IV–V of female each with lateral group of about 10 robust discal setae of which 2 pairs are close to the antecostal ridge (Fig. 42); male paler than female	<i>multispinus</i>
-.	Tergites IV–V of female each with lateral group of about 6–8 discal setae but with no setae close to antecostal ridge (Figs 41, 45); male as dark brown as female	13
13.	Mid and hind tibiae uniformly dark brown in contrast to sharply yellow tarsi; fore wing dark; pronotum with about 4–6 discal setae, 2 pairs of posteromarginal setae with S1 scarcely longer than S2 (Fig. 20)	<i>karl</i> sp. n.
-.	Mid and hind tibiae light brown with apex paler and scarcely different in colour from tarsi; fore wing pale to light brown; pronotum with 10–20 discal setae, 3 or 4 pairs of posteromarginal setae with S1 elongate (Fig. 17)	<i>tsuda</i> sp. n.

Neurisothrips antennatus (Moulton, 1928)

(Figs 1, 11, 15, 24, 39, 48)

Described originally from a single male taken on Oahu, Mt Tantalus, many specimens of both sexes of this species have been studied from Hawaii, Kauai, Lanai, Maui and Oahu. These specimens were collected from the flowers of *Acacia koa*, *Astelia*, *Broussasia*, *Cheirodendron*, and *Geranium*, and there are published records from *Metrosideros*. Both sexes are brown with teneral individuals considerably paler, particularly the males. The pronotum bears many discal setae, and the posteroangular setae are exceptionally long (120 microns), but the pronotal anterior marginal setae are all little longer than the discal setae. The tergal lateral discal setae are numerous (Fig. 39), and similar in number to *multispinus*, but *antennatus* is distinguished by the elongate antennal segment III that has almost parallel sides (Fig. 1). The fore wing is uniformly brown except for the usual sub-circular pale “window” near the veinal fork.

Neurisothrips bidens sp. n.

(Figs 2, 19, 25, 32)

Female. Body and legs yellow, fore wings lightly shaded, major setae dark; antennal segment I as pale as head, II washed with light brown, III–VII brown but III paler on basal half and IV with pedicel paler. With the character states of the genus: antennal segments III and IV weakly constricted to short apical neck (Fig. 2); head with ocellar setae III and po IV not particularly long, po setae pair I present; mouth cone extending to fore coxae; pronotum with 2 pairs of anteromarginal setae and one pair of anteroangular setae; discal area apparently unsculptured, with about 20 setae (Fig. 19); posterior margin with 3 pairs, median pair no more than 1.5 times as long as submedian

pairs, posteroangular setae long. Metanotal sculpture weak medially. Tergites III–VIII with no sculpture mesad of setal pair S1, reticulate sculpture lines weak on lateral areas; IV and V each with 5 to 7 discal setae laterally; X with longitudinal split not fully complete. Sternites with irregular transverse row of about 10 discal setae (Fig. 32).

Measurements (holotype female in microns). Body length 1400. Head, length 110; width across eyes 150; ocellar setae III 45; po setae IV 40. Pronotum, length 130; width 200; pm setae S1 25; pa setae 60. Metanotum median setae length 65. Fore wing length 880. Antennal segments III–VII length 45, 50, 35, 45, 20.

Male. Similar in colour and chaetotaxy to female; 2 pairs of setae on tergite IX arranged in almost straight transverse line; sternites III–VII each with large pore plate, discal setae present only lateral to pore plate (Fig. 25).

Measurements (paratype male in microns). Body length 930. Head, length 95; width across eyes 130; ocellar setae III 40; po setae IV 35. Pronotal pa setae 50.

Specimens examined. Holotype female, **Oahu**, Lanipo Trail (21° 18'N, -157° 46'W), from *Bidens* fls, 24.v.1946 (K.Sakimura).

Paratypes: 1 female, 2 males taken with holotype; **Oahu**, Waimano Trail, 2 females from *Bidens asymmetrica* flowers, 13.v.1945.

Comments. The holotype is the female with the dorsal side uppermost, mounted on the same slide as a paratype female that is mounted ventral side uppermost. This paratype female is considerably smaller, with the body length scarcely 1200 microns. This species is one of only two known *Neurisothrips* species to have sternal discal setae. It is closely similar to *janis* **sp. n.** in colour but is slightly larger with longer and darker major setae. In the male, the sternal discal setae are present only lateral to the large pore plate (Fig. 25). The Asteraceae genus *Bidens* includes widespread pest species, but on Oahu there are several endemic *Bidens* species that presumably provide the hosts for this thrips species.

Neurisothrips carteri (Moulton, 1937)

(Fig. 40)

Described from a single female taken in a wind trap on Oahu, Moulton pointed out the distinctive position of the metanotal median setae “16 microns back from anterior margin”. This character state was unique amongst the original seven species placed in *Neurisothrips* but was ignored by subsequent workers. Curiously, the metanotal median setae of *saki* **sp. n.** are also placed behind the anterior margin, but this condition is not known amongst other members of this genus. A further character state that is distinctive in *carteri* is the arrangement of the tergal discal setae in a single transverse row, and despite the uniformly yellow colour of the body and legs, antennal segments III–VII are sharply brown. This species is possibly associated with *Acacia koa*, and specimens taken from that tree having been studied from two sites in Hawaii and also from Kauai. Two males taken with females from *Acacia koa* at Volcano have large oval pore plates but only on sternites V–VII, although one of these males has a fragmented pore plate on sternite IV. Four females of a very similar species have been studied with the following data: Hawaii, Mauna Loa Trail, *Styphelia* leaves, 22.vii.2016. These females have the metanotal setae less than 10 microns back from anterior margin, and the tergal lateral discal setae are considerably smaller and weaker than in typical *carteri*.

Neurisothrips dubautiae (Moulton, 1928)

(Fig. 4)

Described from seven females and 10 males taken from a species of Asteraceae, *Dubautia*, on Mt Tantalus, Oahu, these individuals have ocellar setae III little more than 25 microns long, and the postocular setae even shorter. The body is uniformly pale yellow, the ocellar pigment is pale and scarcely red, antennal segments I–IV and base of V are yellow, and the major setae on the body and fore wings are pale, with the exception of the setae on tergites IX and X. In these colour states this species is similar to *N. janis* **sp. n.**, but that has sternal discal setae in both sexes. Apart from the type series, the only other specimen studied of this species is a female from a second site on Oahu, Konahua, on *Dubautia plantaginea*. This female is closely similar to the types in colour and chaetotaxy but has ocellar setae pair III about 30 microns long. Tergites IV and V have a small group of about five lateral discal setae.

***Neurisothrips fasciatus* (Moulton, 1937)**

(Fig. 12)

Described from a single female taken in a wind trap at Kipapa, Oahu, in October 1935, no significant details were given apart from colour: body brownish yellow, with fore wings having a brown band medially and at apex. No further specimens have been seen, and the species remains unique in the genus in having banded fore wings. Although brown in colour, it is similar to *dubautiae* in having unusually short setae on the head, with ocellar setae pair III 25 microns long, and postocular setae pair IV scarcely 15 microns. The abdomen of the holotype is shrunken, thus obscuring details, but there seem to be fewer setae laterally on the tergites than in some other members of this genus.

***Neurisothrips fran* sp. n.**

(Figs 6, 18, 26, 44)

Female. Body colour varying from clear yellow with abdominal segments IX–X light brown, to extensively palest brown with IX and X darker; legs yellow; antennal segments I–III almost uniformly yellow, IV yellow at base (Fig. 6); fore wing pale with faint shaded area around veinal fork; major setae light brown, darkest on tergites IX–X but not dark brown. With the character states of the genus: head with ocellar setae III and po IV long (Fig. 18); po setae pair I present; mouth cone not extending between fore coxae. Pronotum with 3 pairs of anteromarginal setae, none elongate; discal area with about 12 setae; posterior margin with 3 or 4 pairs, median pair longest, posteroangular setae long. Metanotal sculpture weak medially. Tergite I with transverse reticulate sculpture, but III–VIII with scarcely any lines visible even on lateral areas; IV and V each with about 6 discal setae laterally (Fig. 44); X with longitudinal split almost complete.

Measurements (holotype female in microns). Body length 1330. Head, length 110; width across eyes 135; ocellar setae III 65; po setae IV 50. Pronotum, length 120; width 175; pm setae S1 40; pa setae 70. Metanotum median setae length 55. Fore wing length 750. Antennal segments III–VII length 48, 40, 32, 37, 20.

Male. Uniformly paler than female but similar in sculpture and setal lengths; sternites III–VII with slender transverse pore plate (Fig. 26).

Measurements (paratype male in microns). Body length 950. Ocellar setae III 48; po setae IV 35. Pronotal pa setae 55.

Specimens examined. Holotype female, **Hawaii**, Volcano, Kipuka Ki (19° 25'N, -155° 17'W), from *Pipturus albidus* fls, 12.vii.2016 (LAM 6251).

Paratypes: 20 females, 5 males taken with holotype; Hawaii, Volcano National Park, 10 females from *Pipturus* fls, 6 females 5 males from *Pipturus* leaves, 9.vii.2016, one female from *Pipturus*, 15.vii.2016.

Comments. Apart from the pale colour of the body and legs, also the weak sculpture lines on the metanotum and tergites, there is little difference in structure between this species and the dark brown species such as *karl* and *tsuda*, although the male pore plates are more slender than in most species (Fig. 26).

***Neurisothrips fullawayi* (Moulton, 1928)**

(Fig. 9)

Described from four females and one male on *Broussonetia* in Oahu, this species has been recorded from Hawaii, Kauai, and Molokai. However, apart from the type series, the only specimen studied was from the leaves of *Pipturus* on Mt. Tantalus, Oahu, 23.ii.1943 (in BMNH). The fore wing colour seems to be diagnostic, with a pale area on the posterior half just distal to the clavus (Fig. 9). One pair of pronotal anteromarginal setae is as long as antennal segment III, about 45 microns long, and the posteroangulars are 80 microns long. The female cotype of *multispinosus* from Molokai is probably *fullawayi* but the fore wings are folded on the abdomen.

Neurisothrips janis sp. n.

(Figs 3, 31)

Female. Body and legs yellow with pale ocellar pigment, fore wings pale to weakly shaded, major setae pale particularly on head; antennal segment I as pale as head, II light brown at apex, III–VII brown but III paler on basal half. With the character states of the genus: antennal segments III and IV scarcely constricted at apex (Fig. 3); head with ocellar setae III and po IV short, po setae pair I present; mouth cone extending to fore coxae; pronotum with 2 pairs of anteromarginal setae and one pair of anteroangular setae; discal area with about 20 setae; posterior margin with 3 pairs, median pair less than 1.5 times as long as submedian pairs, posteroangular setae unusually short. Tergites III–VIII with sculpture lines lateral to setal pair S1; IV and V each with 5 to 7 discal setae laterally; X with longitudinal split not fully complete. Sternites with 10–12 discal setae arranged irregularly (Fig. 31), not in a transverse row.

Measurements (holotype female in microns). Body length 980. Head, length 90; width across eyes 125; ocellar setae III 25; po setae IV 23. Pronotum, length 110; width 140; pa setae 35. Metanotum median setae length 30. Fore wing length 650. Antennal segments III–VII length 38, 35, 30, 40, 20.

Male. Similar in colour and chaetotaxy to female; 2 pairs of setae on tergite IX arranged in almost straight transverse line; sternites with 1–2 discal setae present medially, but pore plates not visible because specimen not cleared.

Measurements (paratype male in microns). Body length 830. Pronotal pa setae 35.

Specimens examined. Holotype female, **Molokai**, Waikolu Valley (21° 07'N, -156° 55'W), from leaves of *Raillardia molokaiensis* (= *Dubautia*), 10.x.1943 (N.L.H.Krauss).

Paratypes: 5 females, 1 male taken with holotype.

Comments. The holotype is the female mounted dorsal side uppermost on a slide with a paratype female that is mounted ventral side uppermost (Fig. 31). The pale body colour and pale ocellar pigment are similar to the condition found in *dubautiae*, a species that was described from a plant in the same genus. However, among the species of *Neurisothrips* the presence of sternal discal setae is shared only with *bidens* described above.

Neurisothrips karl sp. n.

(Figs 5, 20, 22, 27, 33, 36, 41)

Female. Body, antennae and legs uniformly dark brown, tarsi sharply yellow; fore wings deeply shaded with sub-circular pale “window” at veinal fork; major setae dark brown. With the character states of the genus: antennal segments III and IV with constricted apical neck (Fig. 5); head with ocellar setae III and po IV not particularly long, po setae pair I absent; mouth cone extending to fore coxae (Fig. 36); pronotum with one pair of anteromarginal setae and one pair of anteroangular setae (Fig. 20); discal area weakly sculptured, with 4 to 6 setae; posterior margin with 2 pairs, median pair longest, posteroangular setae long. Metanotal sculpture weak medially. Tergite I with transverse reticulate sculpture; III–VIII with no sculpture mesad of setal pair S1, reticulate sculpture lines weak on lateral areas (Fig. 41); IV and V each with 5–7 discal setae laterally; X with longitudinal split complete (Fig. 22).

Measurements (holotype female in microns). Body length 1600. Head, length 100; width across eyes 165; ocellar setae III 40; po setae IV 45. Pronotum, length 135; width 200; pm S1 setae 30; pa setae 70. Metanotum median setae length 60. Fore wing length 850. Antennal segments III–VII length 50, 48, 30, 40, 25.

Male. Similar in colour and structure to female, or a little paler; sternites III–VII each with small transverse pore plate (Fig. 27).

Measurements (paratype male in microns). Body length 1150. Head, length 90; ocellar setae III 35; po setae IV 40. Pronotal pa setae 55.

Specimens examined. Holotype female, **Oahu**, Puu Hapapa (21° 28'N, -158° 06'W), from *Pisonia umbellifera* fls, 21.viii.2016 (Karl Magnacca), in BPBM.

Paratypes: 29 females, 16 males taken with holotype; same locality, plant species and collector, 5 females, 29.vi.2016.

Comments. Although, as indicated above, this species is similar in structure to the yellow-bodied species *fran*, most specimens identified here as *karl* lack postocular setae pair I, also they have only two pairs of pronotal postero-

marginal setae. However, a very few individuals have a full complement of one or both of these groups of setae, or the setal pairs are asymmetric in number. This emphasizes yet again our limited knowledge of the variation within and among *Neurisothrips* species in structure and host associations. The plant species from which this thrips was collected is not endemic to the Hawaiian Islands but is widespread in Southeast Asia.

***Neurisothrips multispinus* (Bagnall, 1910)**

(Figs 13, 42)

This species was described from four females and one male from Hawaii, Kilauea (Volcano), also one female from Kauai and three females from Molokai. Of these nine specimens, only five (on four slides) remain in the Natural History Museum, London. The lectotype selected by Mound (1968) is a female from Kilauea mounted by Bagnall on the same slide as the male. There are two paralectotype females with the same collection data that were slide-mounted from pinned specimens by Mound in 1965. The two females labelled by Bagnall as “co-types” from Molokai, 7.viii.1893 (Perkins 172) are not the same species as the lectotype. These specimens are probably *fullawayi*, judging from the presence of very long postocular setae IV (70 microns) and ocellar setae pair III, and the long pair of pronotal anteromarginal setae (40 microns) and very long posteroangulars (105 microns). The lectotype is without antennae, and one paralectotype female that is mounted in Hoyers Medium also has no antennae, however it has the basal half of one fore wing and this has no pale area in contrast to *fullawayi*. The original colour of the lectotype and paralectotype is difficult to determine, due to their condition, but was probably brownish yellow with the sternal antecostal ridges darker. The lectotype is only 1100 microns long, with ocellar setae III about 65 microns, and po setae IV 50 microns. The pronotal pa setae are lost, but one is present on the paralectotype female and this is 100 microns long. The pronotal am setae are no longer than the discal setae, and there are only about six setae on the median area of the pronotum. The small male is paler and appears to be teneral, but it was probably never “yellow”; it has one antenna attached and one detached, and this has segment III 50 microns long. Despite the many specimens of *Neurisothrips* that have been studied, and the presence in the Bishop Museum collection of slides that bear this name, no specimens have been seen apart from the types indicated that can be identified with any confidence as representing *multispinus*.

***Neurisothrips robbiei* sp. n.**

(Figs 7, 16, 23, 28, 29, 34, 43, 47)

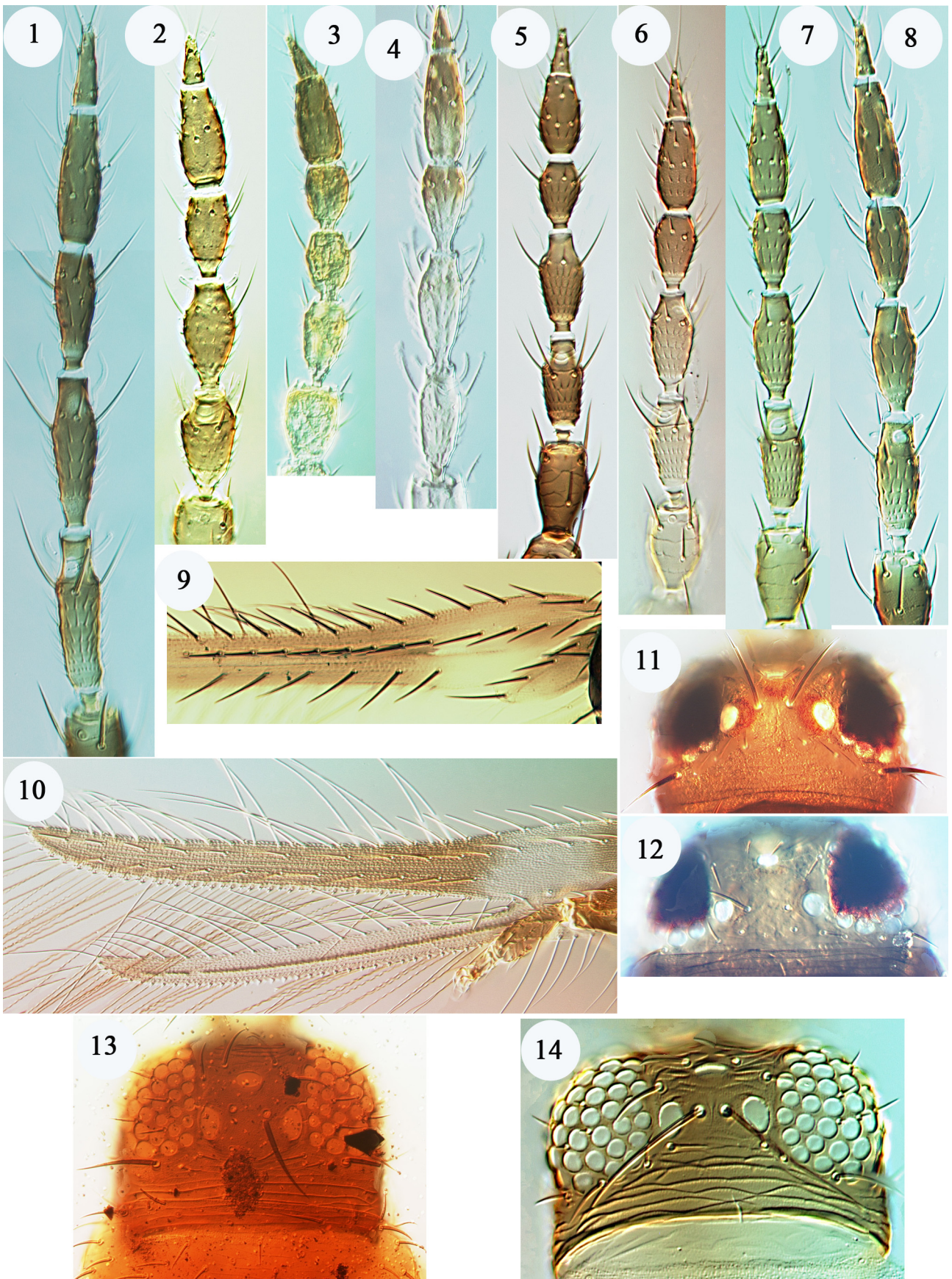
Female. Body almost bicoloured, head with postoccipital area dark but anterior half almost yellow; thorax yellowish brown, abdomen brown; antennae brown; legs mainly yellow, femora brownish yellow; fore wing uniformly shaded; major setae on body and wings dark brown. With the character states of the genus: antennal segments III and IV with constricted apical neck (Fig. 7); head with ocellar setae III and po IV long (Fig. 16); mouth cone extending to fore coxae; pronotum with 3 pairs of anteromarginal setae, none elongate; discal area with about 12 to 15 setae; posterior margin with 3 pairs, median pair longest, posteroangular setae long. Metanotal sculpture weak medially. Tergite I with transverse reticulate sculpture, but III–VIII with no sculpture mesad of setal pair S1 and lines weak on lateral areas; IV and V each with about 8 discal setae laterally (Fig. 43); X with longitudinal split complete (Fig. 23).

Measurements (holotype female in microns). Body length 1700. Head, length 100; width across eyes 165; ocellar setae III 60; po setae IV 70. Pronotum, length 150; width 220; pm S1 setae 50; pa setae 85. Metanotum median setae length 80. Fore wing length 1000. Antennal segments III–VII length 60, 50, 40, 48, 25.

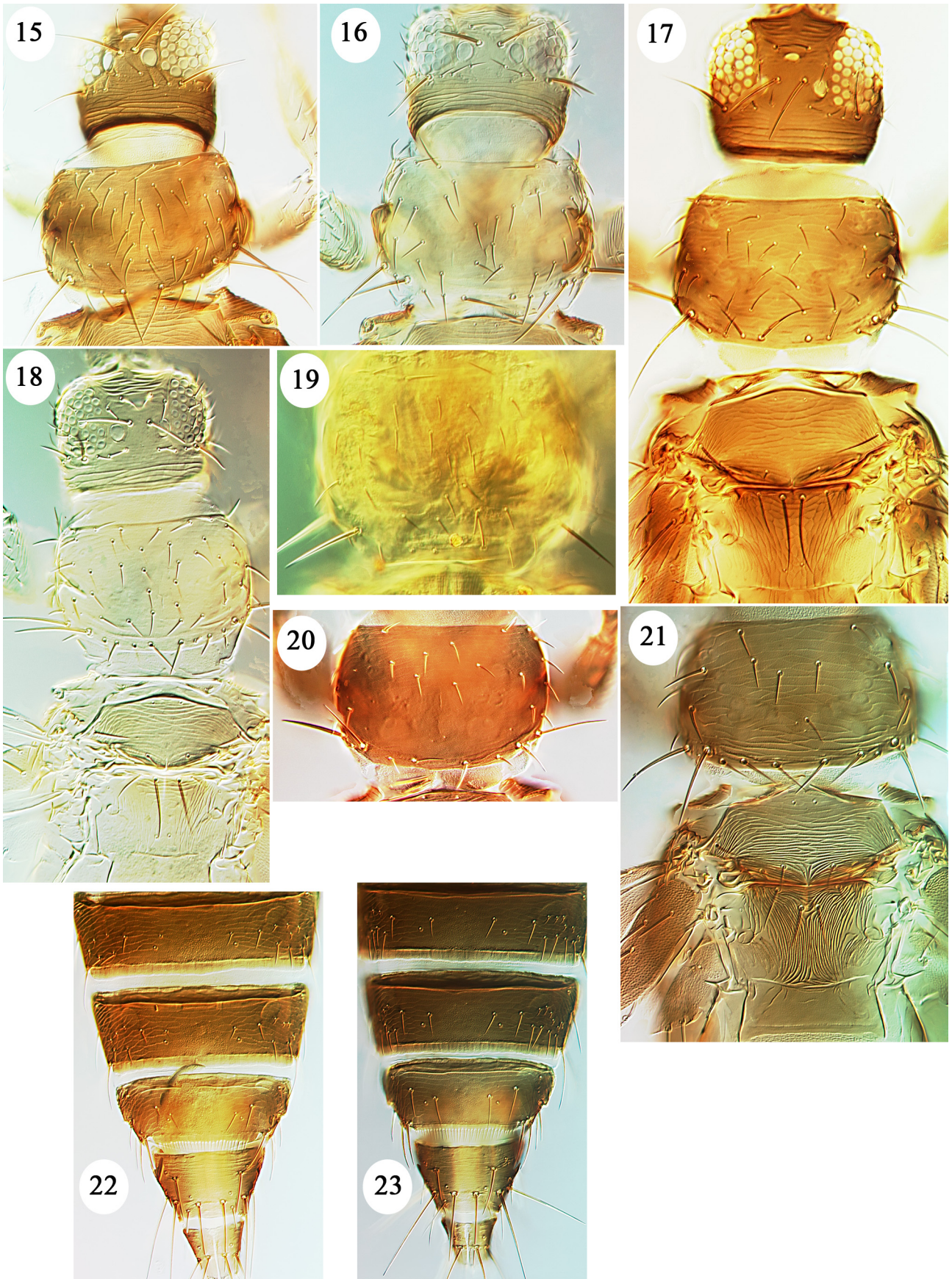
Male. Body pale with weak brown markings laterally on meso and metanotum, major setae dark; antennal segment I white, II weakly shaded, III–VII brown; similar to female in sculpture; sternites III–VII with large, transversely oval pore plate (Figs 28, 29).

Measurements (paratype male in microns). Body length 1250. Ocellar setae III 48; po setae IV 50. Pronotal pa setae 65.

Specimens examined. Holotype female, **Hawaii**, Volcano, from *Psychotria hawaiiensis*, 9.vii.2016 (LAM 6246).



FIGURES 1–14. *Neurisothers* species. Antennae 1–8: (1) *antennatus*; (2) *bidens* sp. n.; (3) *janis* sp. n.; (4) *dubautiae*; (5) *karl* sp. n.; (6) *fran* sp. n.; (7) *robbiei* sp. n.; (8) *tsuda* sp. n. Fore wing colour 9–10: (9) *fullawayi*; (10) *saki* sp. n. Head 11–14: (11) *antennatus*; (12) *fasciatus*; (13) *multispinus*; (14) *saki* sp. n.

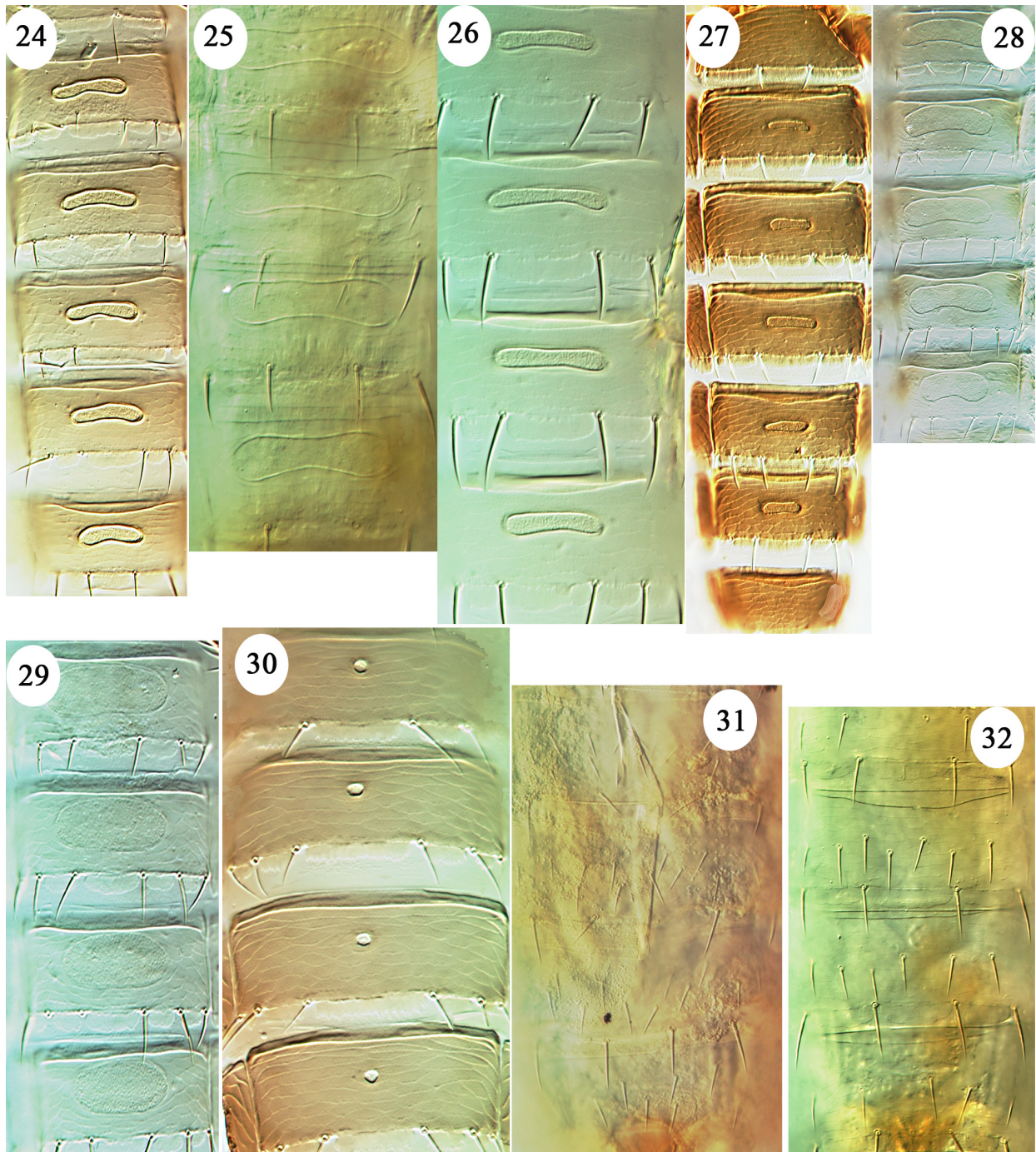


FIGURES 15–23. *Neurisothrips* species. Head & pronotum 15–16: (15) *antennatus*; (16) *robbiei* sp. n. Head & thorax 17–18: (17) *tsuda* sp. n.; (18) *fran* sp. n. Pronotum 19–20: (19) *bidens* sp. n.; (20) *karl* sp. n. (21) *saki* sp. n. pronotum & metanotum. Female tergites VI–X: (22) *karl* sp. n.; (23) *robbiei* sp. n.

Paratypes: 10 females, 4 males taken with holotype; **Hawaii**, Volcano, Kipuka Ki, 7 females, 3 males from *Psychotria hawaiiensis*, 12.vii.2016. **Oahu**, Puu Hapapa, 3 females from *Psychotria* fls, 29.vi.2016.

Non-paratypes: **Maui**, Haleakala, 8 females, 6 males from *Santalum haleakalae* fls, 25.vii.2016.

Comments. The tergal chaetotaxy of this species is quite similar to that of *multispinus* (Figs 42, 43), and the type series came from a site very close to the collecting site of that species. However, despite their poor condition, the head of the *multispinus* females from Kilauea are slightly darker than the pronotum, not paler as in *robbiei*. This species shares with *williamsi* the unusually large form of the sternal pore plates of males (Fig 29), but the body colour is considerably darker than in that species. Even the particularly sharply bicoloured non-paratype specimens listed from *Santalum* are much darker than any available specimens of *williamsi*, in particular the fore wings are dark and antennal segment III is brown, even in the palest of the available males.



FIGURES 24–32. *Neurisothisrips* species. Male sternal pore plates 24–29: (24) *antennatus*; (25) *bidens* sp. n.; (26) *fran* sp. n.; (27) *karl* sp. n.; (28) *robbiei* sp. n. [from *Santalum*]; (29) *robbiei* sp. n. [from *Psychotria*]; (30) *saki* sp. n.. Female sternites 31–32: (31) *janis* sp. n.; (32) *bidens* sp. n.

***Neurisothrips saki* sp. n.**

(Figs 10, 14, 21, 30, 37, 49)

Female. Body and legs mainly light brown, all tarsi and fore tibiae yellowish; antennae mainly brown, segments III variable brownish yellow; fore wing and clavus brown (Fig. 10) but with broad sharply pale area distal to clavus apex extending fully across wing. With the character states of the genus: Head transverse with mouth cone long and extending beyond the fore coxae (Fig. 37); ocellar setae pair III long, po setae pair I absent, pair IV slightly longer than an ocellus (Fig. 14). Pronotum transversely reticulate, one pair of anteromarginal setae, 3–5 discal setae, midlateral pair long. Mesonotum with narrow transverse reticulations. Metanotal median setae arise behind anterior margin (Fig. 21), sculpture transverse at anterior, medially with converging closely spaced striae. Fore wing venal setae relatively widely spaced, about 14 on first vein and 11 on second vein (Fig. 10). Tergites with irregular transverse reticulation laterally, without a group of setae; tergite X without a longitudinal split.

Measurements (holotype female in microns). Body length 1060. Head, length 35; width across eyes 115; ocellar setae III 60; po setae IV 20. Pronotum, length 100; width 160; pa setae 55. Metanotum median setae length 30. Fore wing length 600. Antennal segments III–VII length 40, 35, 35, 40, 23.

Male. Similar to female but smaller; tergite IX median setal pair arising posterior to lateral setae and to campaniform sensilla; sternites III–VII with small circular pore plate medially (Fig. 30).

Measurements (paratype male in microns). Body length 900. Ocellar setae III 45; po setae IV 15. Pronotal pa setae 40.

Specimens examined. Holotype female, **Hawaii**, Volcano National Park (19° 25'N, -155° 17'W), from *Cibotium* expanding crozier, 6.vii.2016 (A.Wells), in BPBM.

Paratypes: 6 females 2 males taken with holotype; **Hawaii**, Toms Trail, 7 females beaten from vegetation including *Cibotium*, 9.vii.2016. **Oahu**, Kaala Summit, 14 females from *Cibotium* expanding croziers, 29.vii.2016 (LAM 6315); Puu Lanipo Trail, from *Cibotium chamissoi* terminals, 2 females 2 males, 18.xi.1945, 2 females, 22.v.1946 (Sakimura); Mt Tantalus, 2 females from *Cibotium chamissoi* terminals, 30.vi.1946 (Sakimura).

Comments. In addition to the type series listed above, there are further specimens of this species from *Cibotium* fronds in the Bishop Museum (slide-mounted by F.A.Bianchi), and in the USNM collection at Beltsville, Maryland (slide-mounted by J.D.Hood). Although most specimens studied are brown, the mid and hind tibiae are yellow in some specimens. However, a few specimens have been studied in which the body is largely yellow, with light brown shadings on the head, metanotum and tergite III, and antennal segments I–II clear yellow. It is possible that these yellow individuals represent a further new species, but both colour forms have been found on the Puu Lanipo Trail, Oahu. Since no structural differences can be found between them the yellow and brown individuals are here considered to be conspecific. This species is particularly unusual within the genus, for the longitudinally striate metanotum (Fig. 21), the few discal setae laterally on the abdominal tergites (Fig. 49), the unusually long mouth cone, and the habit of living on the very young tissues of a tree fern.

***Neurisothrips tsuda* sp. n.**

(Figs 8, 17, 35, 45)

Female. Body and antennae dark brown, legs light brown with mid and hind tibiae paler distally; tarsi brownish yellow; fore wing pale to weakly shaded; major setae dark. With the character states of the genus: antennal segment III with apex weakly constricted (Fig. 8); head with ocellar setae III and po IV long, po setae pair I present (Fig. 17); mouth cone extending to fore coxae. Pronotal anterior margin with 3 or 4 pairs of setae including anteroangulars; discal area transversely reticulate, with at least 12 setae; posterior margin with 3 pairs, median pair longer than discal setae, posteroangular setae long. Metanotum reticulate medially. Fore wing first vein with about 21 setae, second vein with about 16 setae. Tergite I with transverse reticulate sculpture; III–VIII with no sculpture mesad of setal pair S1 but with transverse reticulation on lateral areas (Fig. 45); IV and V each with 6 to 8 discal setae laterally; X with longitudinal split usually incomplete.

Measurements (holotype female in microns). Body length 1700. Head, length 125; width across eyes 160; ocellar setae III 70; po setae IV 70. Pronotum, length 130; width 210; pm S1 setae 55; pa setae 105. Metanotum median setae length 70. Fore wing length 950. Antennal segments III–VII length 60, 50, 40, 50, 25.

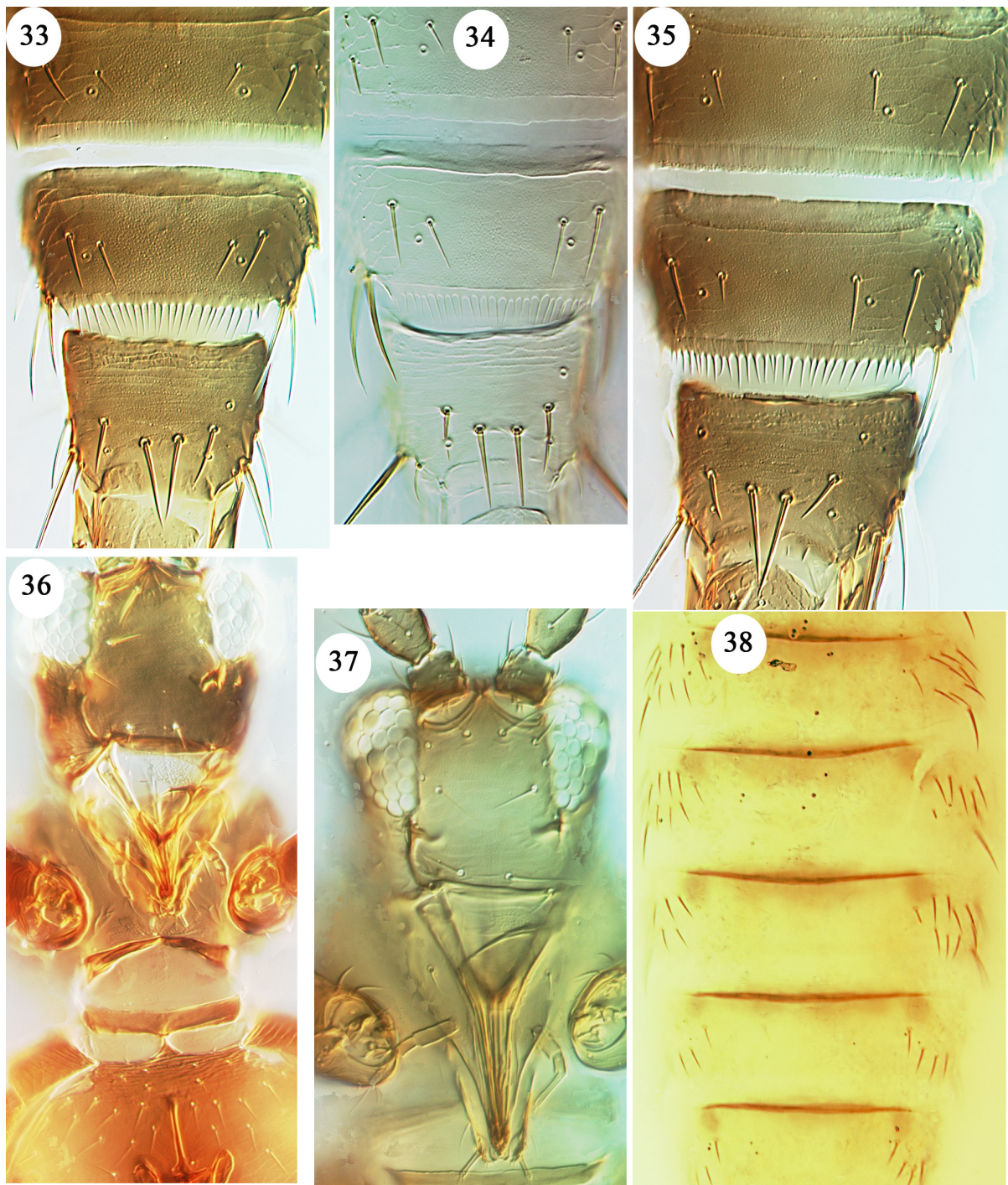
Male. Similar in colour and structure to female; sternites III–VII each with transverse pore plate.

Measurements (paratype male in microns). Body length 1200. Ocellar setae III 55; po setae IV 40. Pronotal pa setae 90.

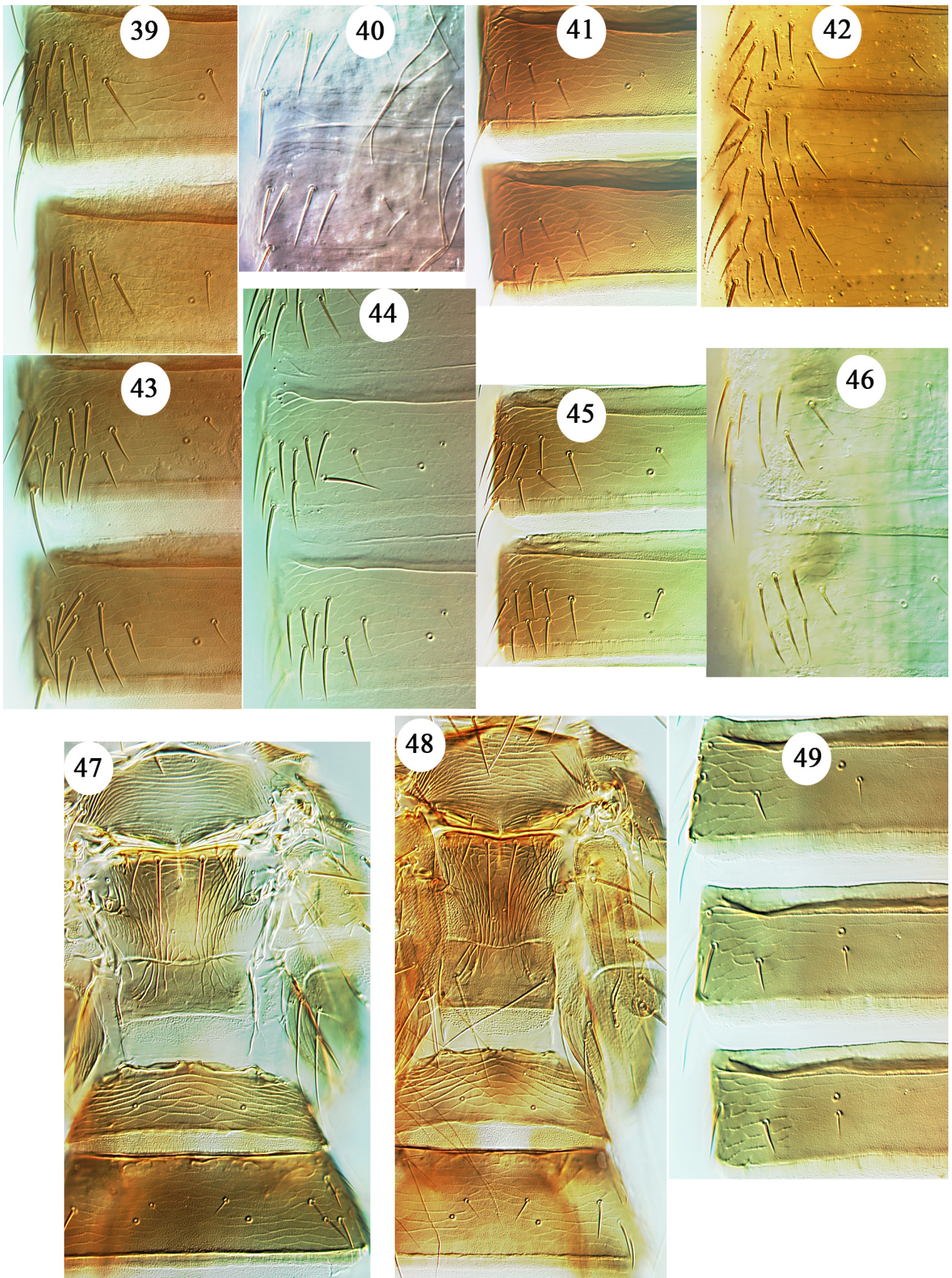
Specimens examined. Holotype female, **Maui**, Haleakala (20° 42'N, -156° 15'W), on *Styphelia* lvs, 25.vii.2016 (LAM 6292).

Paratypes: 5 females, 7 males taken with holotype; same locality, 9 females, 6 males from *Geranium* fls, 25.vi.2016; same locality and date, 4 females, 5 males from flowers of *Dubautia*, *Vaccinium* and dead branch of *Coprosma*. **Hawaii**, Mauna Loa Trail, 11 females, 7 males from *Styphelia* lvs, 22.vii.2016.

Comments. This species is closely similar to *multispinus*, with which it appears to share a similar pronotal chaetotaxy, although the pronotal sculpture of the *multispinus* type specimens appears to be weaker. The species are distinguished here by the single tergal character state indicated in the key above.



FIGURES 33–38. *Neurisothisrips* species. Male tergites VII–IX 33–35: (33) *karl* sp. n.; (34) *robbiei* sp. n.; (35) *tsuda* sp. n. (36) Prosternites *karl* sp. n. (37) Mouth cone *saki* sp. n. (38) Tergites *williamsi*.



FIGURES 39–49. *Neuroisothrips* species. Female tergites IV–V 39–46: (39) *antennatus*; (40) *carteri*; (41) *karl* sp. n.; (42) *multispinus*; (43) *robbiei* sp. n.; (44) *fran* sp. n.; (45) *tsuda* sp. n.; (46) *williamsi*. Mesonotum, metanotum & tergites I–II 47–48: (47) *robbiei* sp. n.; (48) *antennatus*. (49) *saki* sp. n. female tergites III–V.

Neurisothrips williamsi (Moulton, 1928)

(Figs 38, 46)

Described from three females taken on Mt Tantalus, Oahu, the only additional specimens of this species that have been studied are two females from the same site, also three females and two males from a site nearby on *Metrosideros* (in BPBM). Other published records (Mound *et al.* 2016) will require further confirmation, because a single female (in BMNH) from *Sophora* flowers, at Kilauea, Hawaii, differs from the type specimens in having the antennae slightly longer. Females, but not males, of this yellow species have the tergal antecostal ridges dark (Fig. 38), and the major setae are also dark, with a group of well-developed setae laterally on the tergites. Antennal segments IV–VII are uniformly brown, and segments III and IV have their apices narrowed. The male of this species has unusually large sternal pore plates, similar to those of *robbiei* (Fig. 29), that occupy almost 50% of the area of each of sternites III–VII.

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