

Thysanoptera disjunct distribution between western America and the Mediterranean with a new *Psilothrips* species (Thripidae) from Iran

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Abstract

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The genus *Psilothrips* Hood, 1927 is one of several Thysanoptera taxa with a disjunct distribution between the west coast of North America and the Mediterranean. Despite being considered a member of the *Anaphothrips* genus-group, two species of *Psilothrips* have long pronotal posteroangular setae, thus a revised generic diagnosis is provided. One new species, *P. zygophylli* sp.n. is described from Iran, *P. indicus* Bhatti, 1967 is proposed as a new synonym of *P. bimaculatus* (Priesner, 1932), and a key is provided to the five recognized species.

Introduction

More than 100 of the 235 genera of the Thysanoptera sub-family Thripinae each include only a single species (ThripsWiki 2014), usually known from a single locality. In contrast, only three genera each include more than 100 species, *Frankliniella* Karny, 1910, *Scirtothrips* Shull, 1909 and *Thrips* Linnaeus, 1758 and each of these genera is found worldwide, and thus equally uninformative about biogeographic relationships. The genus considered in this paper, *Psilothrips* Hood, 1927, is one of the smaller genera. It is of interest because it shows a remarkable disjunct distribution between Western America and Mediterranean countries. Due to incorrect observations based on poorly prepared slide-mounted specimens, and despite a recent critical study (Bhatti and de Borbon 2008), the available literature for *Psilothrips* is confusing and its relationships are not clearly defined.

The objectives of this paper are to clarify the generic diagnosis, to describe a new species from Iran, and to suggest a new synonymy for a species recorded from India and China.

Material and methods

The specimens of new species described in this paper were collected into 95% ethanol, and subsequently mounted onto slides in Canada balsam using a form of the protocol given in ThripsWiki (2014). The photomicrographs (except Fig. 10) were prepared using a Leica DM2500 microscope using D.I.C. illumination and Automontage imaging software, and line drawings were sketched using a drawing tube attachment to Zeiss Standard 20 microscope. The measurements as well as Fig. 10 were obtained using a Motic BA310

microscope with attached camera. Terminology follows zur Strassen (2003) and Hoddle et al. (2014).

The following collection acronyms are used for the institutions cited in this paper:

ANIC	Australian National Insect Collection, Canberra.
BMNH	Natural History Museum, London.
PPSU	Department of Plant Protection, College of Agriculture, Shiraz University, Shiraz.
SMF	Senckenberg Museum, Frankfurt.

The holotype and a male paratype have been deposited in BMNH. Most other specimens listed in this paper are deposited in PPSU, and a few in the ANIC.

Results

Psilothrips Hood, 1927

Psilothrips Hood, 1927: 198. Type species *P. pardalotus* Hood, 1927, by monotypy.

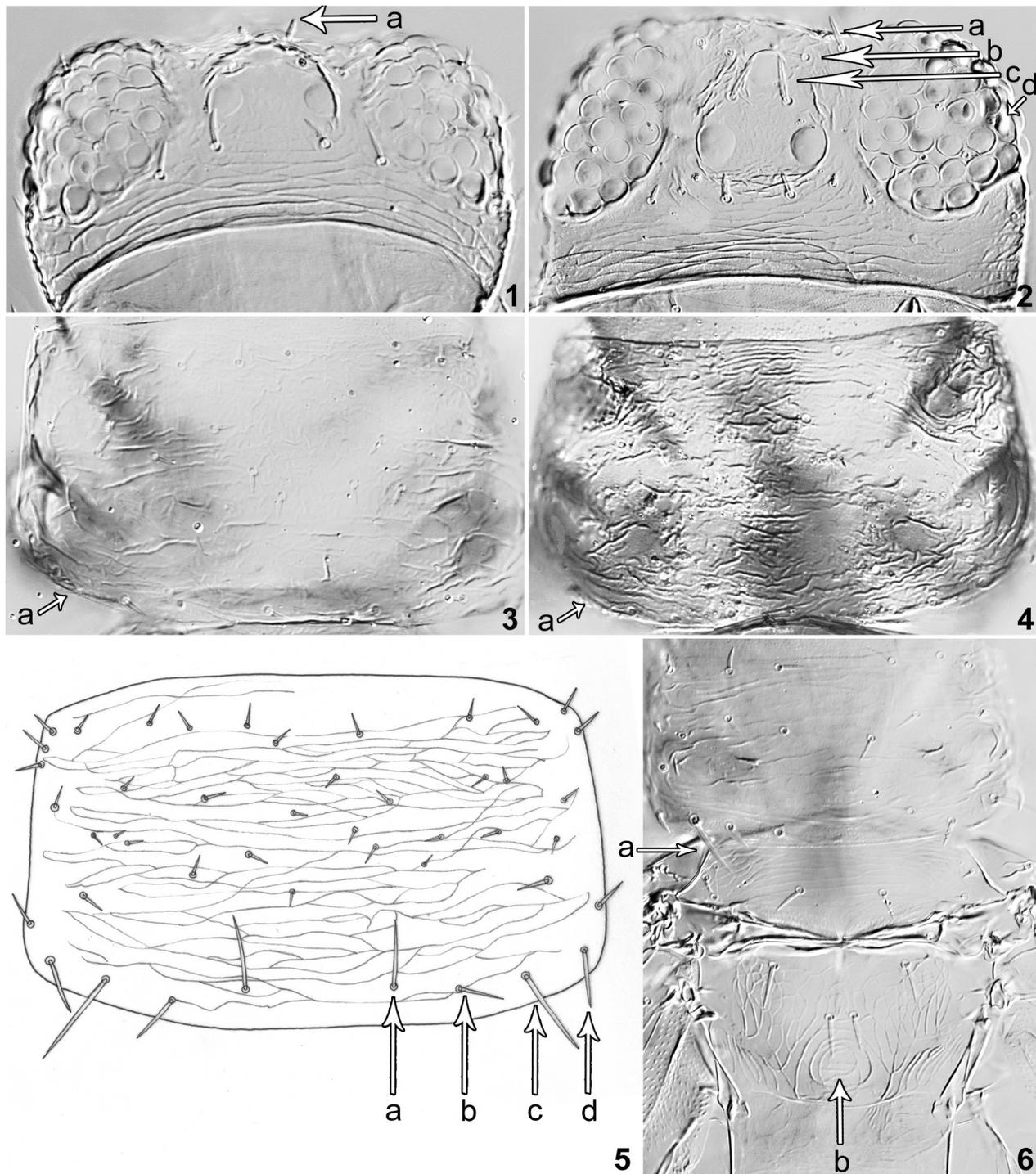
Remarks. Members of this genus can be distinguished from other Thripinae by the lack of a comb of microtrichia on the posterior margin of tergite VIII, and the presence of a particularly long pair of setae arising in a unique position on the antecostal ridges of tergites III–VII (Figs 11, 13). Only one other genus shares these two character states, *Apsilothrips* Bhatti & de Borbon, 2008 from western Argentina (Mendoza and Jujuy). The single species placed in that genus could equally well be interpreted as an unusual species of *Psilothrips*, but is weakly distinguished by the presence of small cilia on the anterior margin of the fore wing and complete absence of sternal discal setae. In contrast, other Thripinae taxa in which the median tergal setae are unusually long have these setae arising just posterior to the antecostal ridge; they also usually have a comb on tergite VIII, and cilia present on the anterior margin of the fore wing. A generic definition of *Psilothrips* was provided by O'Neill (1960), but that failed to mention several important character states, including the number of ocellar setae, the presence

of six prominently pigmented facets ventrally on each compound eye, and the presence of a prominent spinula on both the meso and metafurca. The number of ocellar setae is particularly important because of the failure of earlier workers to note the presence of ocellar setae pair I in front of the first ocellus, including O'Neill's failure to illustrate these setae (see her Fig. 1/6). This led Bhatti (1967) to refer to an "additional" pair of anteo-cellular setae when describing *P. indicus* as a new species. This pair of setae is often very small, and is difficult to see due to the curvature of the head except when a specimen is very well cleared or the head crushed (Figs 1, 2).

Generic diagnosis. Macropterous Thripinae. Antennae 8-segmented (Fig. 9), segment I with no dorso-apical setae, II with no long setae, sense cones on III–IV forked, III–VI with rows of microtrichia. Head transverse, with 3 pairs of ocellar setae, pair III near anterior margins of triangle (Figs 1, 2); maxillary palps 2-segmented; compound eyes with 6 pigmented facets (Fig. 2). Pronotum transverse (Figs 3, 4, 5, 6), weakly sculptured, discal setae small; with 4 pairs of posteromarginal setae, of which one posteroangular pair sometimes longer than other pairs. Meso- and metafurca with spinula. Mesonotal anterior campaniform sensilla absent, median pair of setae distant from posterior margin. Metanotal sculpture irregularly reticulate, median setae arise medially; no campaniform sensilla (Figs 6, 7, 8). Tarsi 2-segmented. Fore wing costa with setae but no cilia (Fig. 10); first vein with 3 widely spaced setae on distal half; second vein with continuous, widely spaced, row of setae; clavus with 4 veinal setae and one discal seta; posterior fringe straight. Tergites with weak transverse reticulation, posterolaterally these lines bear small microtrichia; II–VIII with setae S1 (median pair) elongate (Figs 11, 12, 13), on III–VII arising on antecostal ridge; V–VII with setae S2 unusually elongate, almost as long as S1; tergites without ctenidia, VIII with no posteroangular comb; tergite IX with one pair of campaniform sensilla (Fig. 12), without discal microtrichia (except *P. priesneri*), X with no median split (Fig. 12); pleurotergites with or without discal setae; sternites III–VII with 3 pairs of marginal setae (lateral pair on VII sometimes absent), discal setae varying in number from zero to eight. Male with sternal pore plates present or absent.

Key to species of *Psilothrips*

- 1 Pronotum with 1 pair of posteroangular setae as long as, or longer than, width of antennal segment II (Figs 5, 6); pleurotergal discal setae absent 2
- Pronotum with no elongate setae, posteroangular setae less than 0.5 times as long as width of antennal segment II (Figs 3, 4); pleurotergal discal setae present or absent 3
- 2 Metanotum posterior third with concentric sculpture lines (Fig. 6); major setae on pronotum setiform; western USA *pardalotus*
- Metanotum posterior third with equiangular reticulation (Fig. 8); major setae on pronotum longitudinally grooved; Iran *zygophylli* sp.n.
- 3 Metanotum posterior third with many complex markings within each reticle (Fig. 7); tergite IX anterior third with prominent transverse band of microtrichia (Fig. 12); western USA *priesneri*



Figures 1–6. *Psilothrips* spp: Head (1) *P. pardalotus*; female (a: ocellar setae I) (2) *P. zygophylli*; paratype (a, b, c: ocellar setae I–III; d: pigmented facet). Pronotum (3) *P. bimaculatus*; female (a: no elongate posteroangular setae) (4) *P. priesneri*; female (a: no elongate posteroangular setae) (5) *P. zygophylli*; holotype (a: S1, b: S2, c: S3, d: S4). Pro, meso and metanotum (6) *P. pardalotus*; female (a: posteroangular setae, b: metanotal sculpture).

- Metanotal reticles with few or no internal markings; tergite IX with no prominent microtrichia..... 4
- 4 Head and body uniformly brown (in life with bright red internal pigment); macropterae and micropterae; Canary Islands *minutus*
- Head and pronotum yellow with brown areas, tergites II–VII yellow posterolaterally (in life with orange pigment in pterothorax); only macropterae known; Morocco, Egypt, Yemen, Israel, India, China..... *bimaculatus*

***Psilothrips bimaculatus* (Priesner, 1932)**

Fig. 3

Thamnothrips bimaculatus Priesner, 1932: 3.
Psilothrips indicus Bhatti, 1967: 12. **Syn.n.**

Remarks. Widespread in southern Mediterranean countries, from Morocco to Israel and Yemen, also in Iran from siris trees (*Albizia* sp., Fabaceae) in Khozestan Province (Alavi and Mohiseni 2002), this species is here interpreted to include records from India and central China. The type specimens of *P. indicus*, three females collected in Delhi on *Ipomoea carnea* (Convolvulaceae), are not available for study but are presumably in the “J.S. Bhatti Private collection” (Bhatti and de Borbon 2008). The proposed new synonymy is based on the original description, together with two females from Ningxia, China, collected from *Lycium halimifolium* (Solanaceae), 20.VII.1980, and identified as *P. indicus* by Han Yun-fa (in BMNH and SMF). These two females have been compared with females from Morocco, Egypt, Israel and Yemen. The colour, as described by Bhatti (1967) is distinctive, with abdominal tergites II–VII sharply paler posterolaterally, and the metanotal equiangular reticulations with few or no internal markings. This species, under the name of *P. indicus*, has been considered a pest on Chinese wolfberry (*Lycium* spp.) in China (Li et al. 2012).

***Psilothrips minutus* zur Strassen, 1965**

Psilothrips minutus zur Strassen, 1965: 27.

Remarks. Known only from the Canary Islands on *Suaeda fruticosa*, this species is unusually dark, and is the only member of the genus for which micropterous individuals are known. None of the available specimens are suitably cleared, but pleurotergal discal setae are not discernable. The tergal antecostal ridge is weaker in this species than among the other members of this genus, and the micropterae have the median tergal setae irregular in size and on some tergites arising posterior to the antecostal ridge.

***Psilothrips pardalotus* Hood, 1927**

Figs 1, 6, 11

Psilothrips pardalotus Hood, 1927: 198.

Remarks. As recognised by O’Neill (1960), the metanotal sculpture of this species is diagnostic (Fig. 6), and the major pronotal posteroangular setae are about 30 µm long. The species is recorded from Arizona, California, Idaho, Nevada, New Mexico, Texas, and Utah, and appears to be associated with *Sarcobatus vermiculatus*. In contrast to *P. priesneri*, the abdominal pleurotergites lack discal setae, and tergite IX lacks discal microtrichia.

***Psilothrips priesneri* (Moulton, 1926)**

Figs 4, 7, 12

Anaphothrips priesneri Moulton, 1926: 123.

Remarks. The metanotal reticulation of this species, with extensive markings inside each reticle as illustrated by O’Neill (1960), is diagnostic for this species (Fig. 7). The pleurotergites bear several discal setae, and tergite IX has a distinctive transverse band of microtrichia (Fig. 12). This species has been recorded in western USA from Arizona, California, and Texas.

***Psilothrips zygophylli* sp. n.**

<http://zoobank.org/203380BE-3F22-4BF2-83C0-073E8EFF8D23>

Figs 2, 5, 8, 9, 10, 13

Female macroptera. Body yellow to light brown, antennal segments I, III and IV pale, remaining segments shaded; head and pronotum with posterior margins weakly shaded; pterothorax light brown medially, including metascutellum; abdominal tergites I–VIII yellow laterally but with light brown patch medially; fore wings weakly shaded.

With the character states in the generic diagnosis; antennal segments slender (Fig. 9) with reduced microtrichia. Head weakly reticulate in basal third, ocellar setae III on anterior margins of ocellar triangle (Fig. 2).

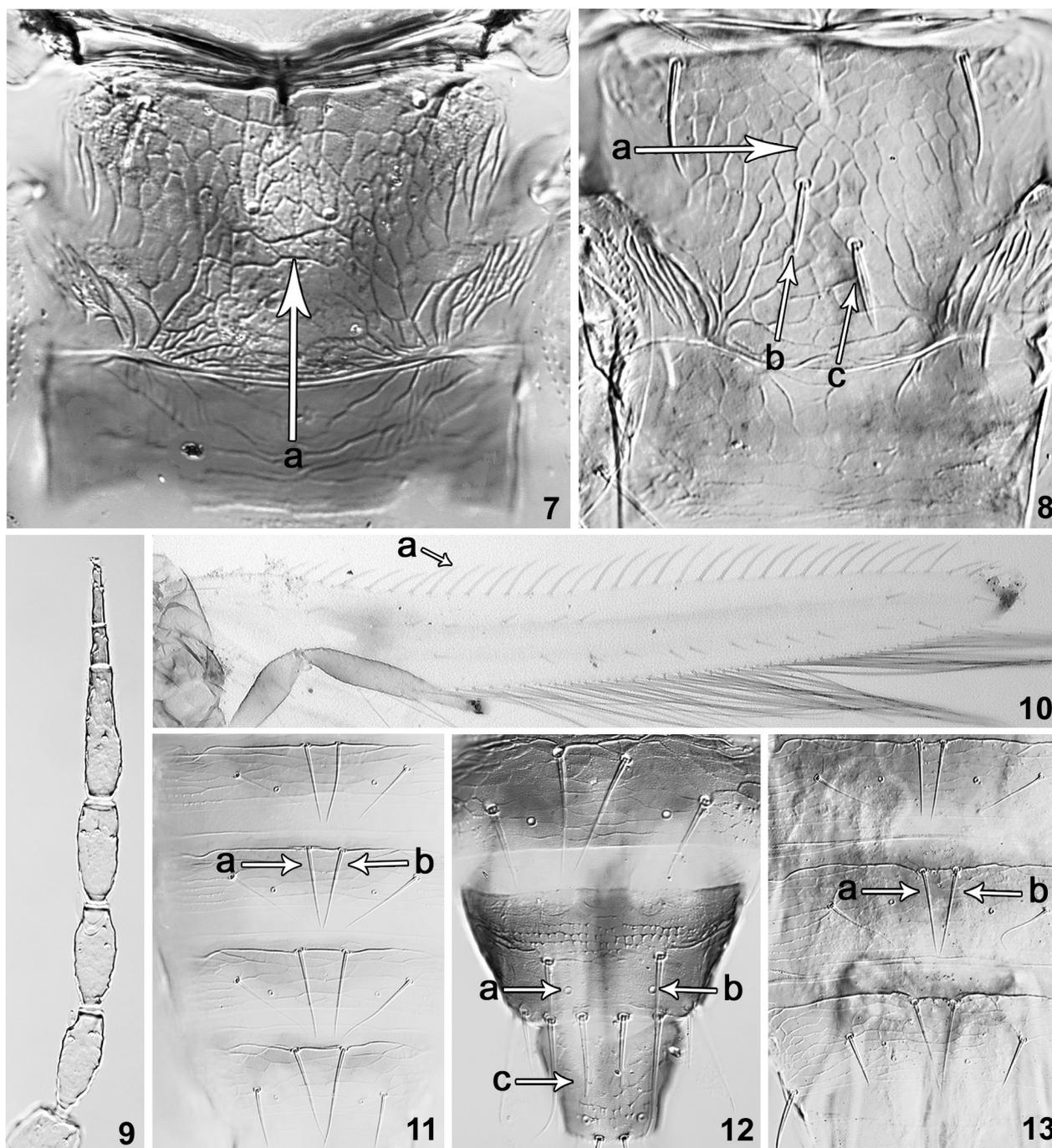
Pronotum with irregular transverse sculpture lines; 4 pairs of posteromarginal setae, S1 and S3 longer than S2 and S4 (Fig. 5). Metanotum with equiangular reticulation on posterior half, median setae often asymmetric in position (Fig. 8). Fore wing relatively broad; first vein with two setae distally, second vein with about 11 setae (Fig. 10); apex with small sub-apical lobe bearing many long microtrichia ventrally. Abdominal tergites with transverse reticulation medially (Fig. 13), setae S2 slightly shorter than setae S1; tergites IV–VI with striate sculpture laterally bearing a few short microtrichia; sternites III–VII with about eight discal setae.

Measurements (holotype female; measurements in micrometer). Table 1.

Male macroptera. Similar to female but paler. Tergite IX without any processes or stout setae; sternites apparently without pore plates.

Table 1. Measurements of various parts of holotype female and paratype male in micrometer.

Feature	Female	Male
Body distended length	1440	800
Head length (width)	124 (212)	82 (140)
Pronotum length (width)	133 (240)	93 (142)
Posteroangular setae	36	24
Fore wing length (median width)	1048 (115)	567 (50)
Tergite II S1 setae	48	-
Ovipositor length	240	-
Antennal segments III–VIII length	46, 43, 40, 56, 18, 21	36, 35, 34, 42, 15, 19



Figures 7–13. Metanotum (7) *P. priesneri*; female (a: metanotal sculpture) (8) *P. zygophylli*; paratype (a: metanotal sculpture; b, c: median setae). Antenna (segments II–VIII) (9) *P. zygophylli*; paratype. Forewing (10) *P. zygophylli*; paratype (a: setae). Abdominal tergites (11) *P. pardalotus* (V–VIII); female (a, b: median tergal setae) (12) *P. priesneri* (VIII–X); female (a, b: campaniform sensilla; c: tergite X without split) (13) *P. zygophylli* (VI–VIII); paratype (a, b: median tergal setae).

Measurements (paratype male; measurements in micrometer). Table 1.

Specimens examined (slide-mounted). Holotype female, **IRAN, Fars Province**, Sarvestan, 100 km west of Shiraz, from leaves of *Zygophyllum* sp. (Zygophyllaceae), 17.IV.2014 (KM 1151) (in BMNH).

Paratypes: 7 females, taken with the holotype; 17 females, 6 males, 4 larvae, **IRAN, Fars Province**, Sarves-

tan, from leaves of *Zygophyllum* sp., 9.V.2014 (KM 1185) (in PPSU), 2 females, 1 male, 1 larva, **IRAN, Fars Province**, Sarvestan, from leaves of *Zygophyllum* sp. (in ANIC).

Etymology. This species is named after the genus of plant from which it was collected.

Comments. This new species shares many character states with the North American species *P. pardalotus*.

It differs in the form of the metanotal sculpture, longer major setae on the head and pronotum which are more prominently longitudinally grooved, shorter setae S2 on the abdominal tergites, and more slender antennae.

Discussion

Disjunct distribution in Thysanoptera

This paper considers the interesting zoogeographical distribution of the five species now recognised in the Thripinae genus *Psilothrips*. Two of the species are from the drier areas of western North America, whereas three are from similar low rainfall areas across North Africa and Asia. Among Thysanoptera, a similar distribution pattern is found in the genus *Orothrips* Moulton, 1907 of the family Aeolothripidae, with three species from western North America and one from the Mediterranean region (Marullo and Mound 1993), and at genus level in the family Stenurothripidae that comprises two monobasic genera in western USA and one small genus in the Mediterranean region (Mound 1983, Mound and Marullo 1999). Similarly the genus *Ankothrips* Crawford, 1909 in the family Melanthripidae shows remarkable disjunction, with seven species from western North America, one from Namibia in south-west Africa, and five from the western Palaearctic including one recently described from Iran (Minaei et al. 2012). Regardless of any possible historical component involved in such disjunctions, for *Psilothrips* the distribution is probably related to ecological conditions and the available flora. Available records of plants from which *Psilothrips* adults have been collected include many that are typical of semi-arid areas: *Amaranthus* (Amaranthaceae), *Allenrolfea*, *Atriplex*, *Sarcobatus* and *Suaeda* (Chenopodiaceae), *Calotropis* (Asclepiadaceae), *Lycium* (Solanaceae), and *Nitraria* and *Zygophyllum* (Zygophyllaceae).

Pronotal setal lengths and Thysanoptera systematic relationships

The new species described above emphasizes one of the problems involved in assessing systematic relationships among Thysanoptera. *Psilothrips* is presumed to be a member of the *Anaphothrips* group of genera, in which species do not bear any long setae on the pronotum (Bhatti 1978, Mound and Masumoto 2009). Certainly three of the species are essentially “anaphothripoid”, but two have prominent posteroangular setae on the pronotum and, if considered in isolation, might well be considered unrelated. Although setal lengths have traditionally been considered important in assessing relationships among the taxa within several families, there is increasing evidence that reduction in setal length (i.e. loss of long setae) occurred convergently in widely unrelated genera (Mound and Palmer 1981, Pereyra and Mound 2009, Minaei et al. 2012). In contrast, it appears that within *Psilothrips* one

or more reversions from an *Anaphothrips*-like condition to long pronotal posteroangular setae have taken place.

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