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Grass-flower thrips of the genus *Chirothrips* (Thysanoptera: Thripidae), with a key to species from Iran

KAMBIZ MINAEI[1] & LAURENCE MOUND[2]

[1]*Department of Plant Protection, College of Agriculture, Shiraz University, Shiraz, Iran. E-mail: kminaei@shirazu.ac.ir*
[2]*Honorary Research Fellow, CSIRO Entomology, Canberra, ACT, Australia. E-mail: Laurence.mound@csiro.au*

Abstract

Species of the genus *Chirothrips* Haliday breed and pupate only within grass florets. Each larva is restricted to a single floret, and adult body size is thus presumably related to floret size. Despite this, some *Chirothrips* species are distinguished only on states that are related to body size. The validity of some commonly recorded members of the *C. manicatus* species-group, including C. *africanus* and *C. pallidicornis*, is therefore considered questionable. Character states that have been used to define the genus *Agrostothrips* Hood are shown to be variable, and this genus is placed as a new synonym of *Chirothrips*. An identification key, based on illustrated structural differences, is provided to the *Chirothrips* known from Iran: *C. aculeatus*, *C. atricorpus*, *C. kurdistanus*, *C. manicatus*, *C. meridionalis* and *C. molestus*.

Key words: *Chirothrips*, *Agrostothrips*, Iran, Thysanoptera, grass-thrips

Introduction

The larvae of all species of the Thripidae genus *Chirothrips* develop only within the florets of flowering grasses (Poaceae). The larvae of these thrips have very short, even atrophied, legs (Watts, 1966), and each larva feeds within a single floret, apparently unable to move to any adjoining part of the inflorescence (Doull, 1956). Each larva pupates within its floret, enclosed by the palea and lemma as these floral structures mature into a typical caryopsis or seed. This life history is shared with the species of the closely related genus *Arorathrips*, and has resulted in several species of these genera being distributed around the world in "grass seed", particularly before the days of chemical seed treatment (Fig. 1). Because a larva feeds only at a single site, the food available to each larva is dependent on the size of the grass floret within which it develops. Presumably this constraint is reflected in the size of the emerging adult.

Despite the close biological relationship between these thrips and their hosts, and the ubiquitous nature of *Chirothrips* species across Europe, there have been neither observations nor experiments on the relationship between grass floret size and the size of adult thrips. Taxonomy in this genus has continued to be entirely descriptive, based on museum specimens. There has been no statistical analysis of structural variation within and between populations, nor any attempt to place observed variation within the context of the biology of the thrips. In this paper we point out the weakness of the character states that are used to distinguish several described species within the *Chirothrips manicatus* species-group, a group that includes some of the most abundant insects of Eurasia. In the absence of statistical analysis based on good series of specimens of known provenance, we do not propose any formal species-level synonymies. However, we draw new conclusions concerning the systematic relationships between some African species of *Chirothrips*, and propose one new generic synonym.

The specimens on which the observations recorded here were based are available in the Natural History Museum, London, the Australian National Collection, Canberra, the Senckenberg Museum, Frankfurt, and the College of Agriculture, Shiraz University. Provenance of the illustrated specimens is indicated in Table 1. The

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images were prepared using a Leica DM2500 microscope with D.I.C. illumination, and processed with Automontage software. Nomenclatural details of all Thysanoptera taxa are available on the web (Mound, 2009) and are not repeated here.

TABLE 1. Provenance of illustrated specimens (all females)

C. aculeatus: California, Auburn, 27.iv.1939 (det. Bailey)
C. africanus: Egypt, Gizah, 3.xi.1929 (det. Priesner)
C. ah: Australia, N.S.W. Coonabarabran, 13.iii.2006 (det. Mound)
C. atricorpus: Australia, N.S.W. Quirindi, iv.1959 (det. Mound)
C. manicatus: England, Ham, 18.vi.1972 (det. Mound)
C. manicatus: Australia, Victoria, 31.x.2004 (det. Mound)
C. manicatus: Australia, A.C.T., xi.2002 (det. Mound)
C. meridionalis: Transvaal, Nelspruit, iv.1954 (det. zur Strassen)
C. molestus paratype: Austria, 9.viii.1925 (det. Priesner)
C. pallidicornis syntype: Hungary, Simontornya, v.1924 (Pillich)
C. pretorianus: Botswana, 12.iv.1972 (det. Mound)

This paper is part of a project to develop practical identification systems to facilitate biological studies on the Thysanoptera fauna of Iran. The extensive Iranian literature on these insects (Bhatti *et al.*, 2009) records many species, but provides little or no help with their recognition. Considering the rich flora of Poaceae in Iran it is likely that more species of *Chirothrips* will be found in this country. Poaceae provide the breeding hosts for a wide diversity of Thysanoptera. These include some members of the sub-order Tubulifera, such as *Haplothrips* (see Minaei & Mound, 2008), whilst in the sub-order Terebrantia all species in six genera breed only on Poaceae (*Aptinothrips*, *Bregmatothrips*, *Limothrips*, *Rhipidothrips*, *Sitothrips*, and *Stenothrips*), as do a few species in some other genera (*Aeolothrips*, *Caliothrips* and *Anaphothrips*).

Pest status of *Chirothrips*

Chirothrips manicatus is widely reported as a pest of grasses, particularly when these are grown for seed production. In New Zealand, this species was reported to destroy 30% of cocksfoot seed (*Dactylis glomerata*) (Doull, 1956), and later reported as the most common primary pest of brome grass (*Bromus* sp.) (Bejakovich *et al.*, 1998). In Oregon, U.S.A., infestation of Bent Grass (*Agrostis* sp.) by *Chirothrips manicatus* was estimated at 32% (Rao & Alderman, 2005). Moreover, some populations of this species in Japan were found to reduce the rate of seed set in the common reed, *Phragmites australis*, with up to 10% of florets destroyed (Ishii & Kadono, 2002).

Chirothrips Haliday

Thrips (*Chirothrips*) Haliday, 1836. Type species: *Thrips* (*Chirothrips*) *manicata* Haliday.
Chirothrips Haliday: Amyot & Serville, 1843.
Agrostothrips Hood, 1954. Type-species *A. guillarmodi* Hood. syn nov.

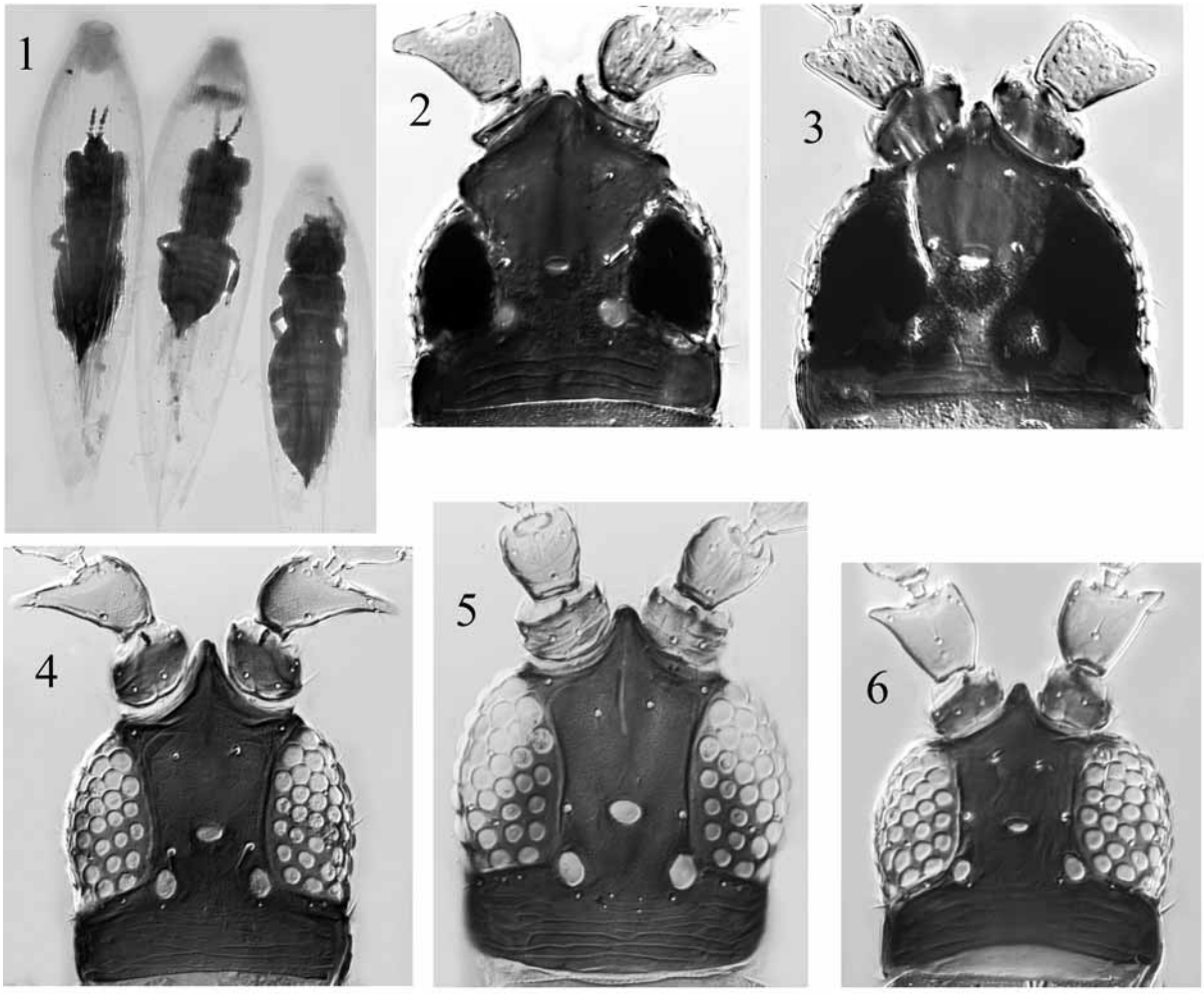
Chirothrips is one the largest genera in the Thripidae, with more than 50 species listed worldwide (Mound, 2009). Hood described *Agrostothrips* for a single new species taken from grasses at two sites in South Africa and one site in Uganda, and distinguished this genus from *Chirothrips* on three character states:

1. Antennal segment II external margin not prolonged;
2. Antennal segments III–IV with sensorium forked;
3. Abdomen slender and acuminate.

Bhatti (1990) indicated that, by themselves, these characters were not sufficient to warrant recognition of

a separate genus. However, he added two further character states in order to distinguish *Agrostothrips*, and he then included four species in that genus: *Chirothrips ah* Girault, *Chirothrips atricorpus* Girault, *Chirothrips meridionalis* Bagnall, and *A. guillarmodi*. The two additional characters proposed were:

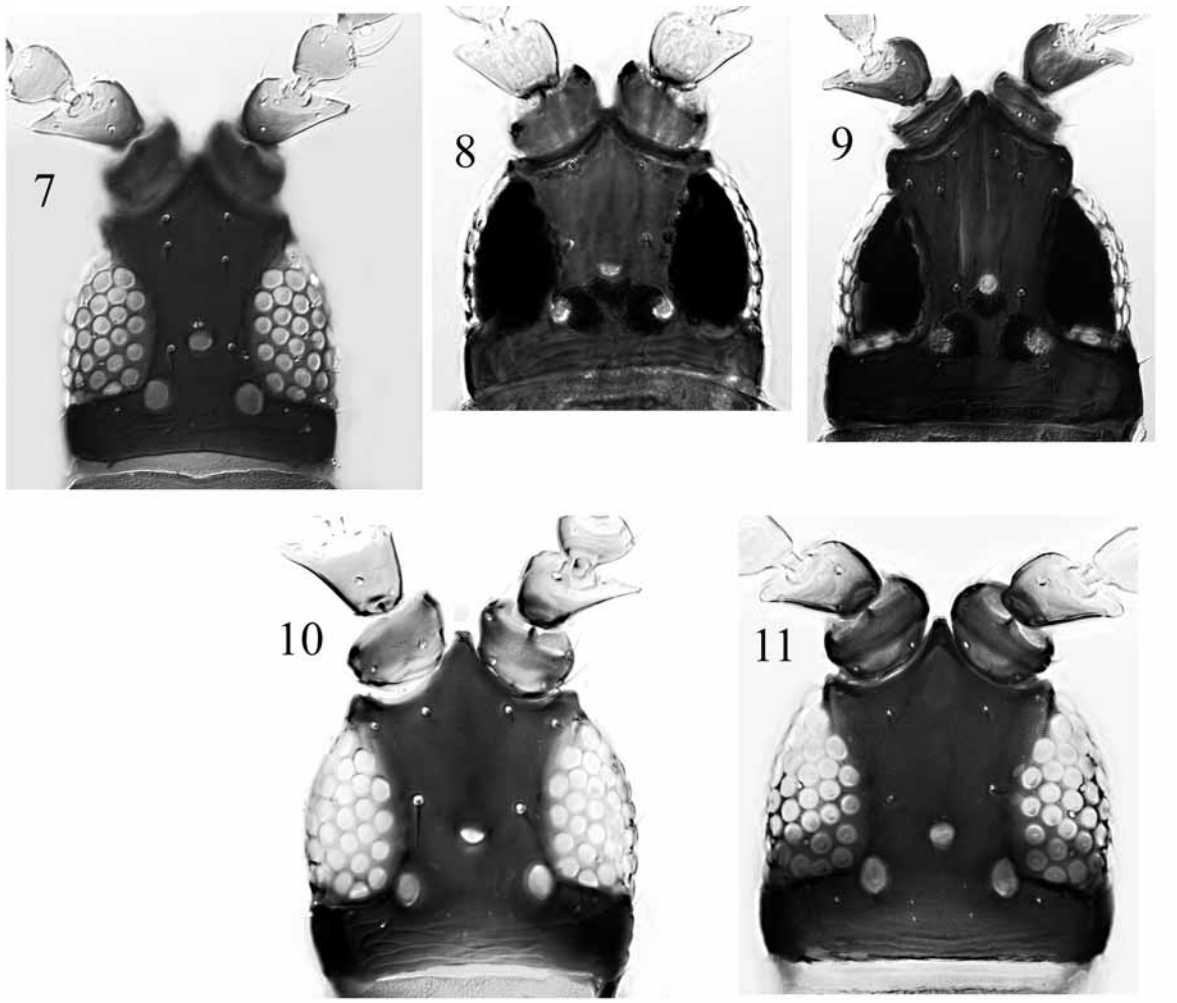
4. Craspedum on posterior margin of tergites and sternites comprising elongate plates;
5. Eyes "lack differentiated facets" (this state was not defined, but presumably refers to pigmented facets).



FIGURES 1–6 *Chirothrips* species. **(1)** adults emerged from pupae within grass seeds. *Chirothrips* heads 2–6: **(2)** *aculeatus*; **(3)** *africanus*; **(4)** *ah*; **(5)** *atricorpus*; **(6)** *meridionalis*.

Considering these five characters, it is clear that the third listed, the shape of the abdomen, is not a useful distinction because it cannot be defined satisfactorily. Moreover, the fifth character is incorrect, because *ah*, *atricorpus* and *meridionalis* all usually have several pigmented eye facets ventrally, in the same pattern as *C. manicatus*. The first character would appear to be well defined, but it applies to only two of the four species. Both *atricorpus* and *guillarmodi* have the second antennal segment almost symmetrical (Fig. 5), but *ah* and *meridionalis* have this segment projecting laterally (Figs 4, 6). The symmetrical shape of the second antennal segment is certainly interesting and probably plesiotypic, but a few other species of *Chirothrips* are known to have this segment only weakly asymmetrical, such as *C. watanabei* from Japan.

The second character state indicated above also seems clearly defined, but it is not consistent across the four species. Although in *guillarmodi* the sensoria on segments III and IV are forked, in *meridionalis* the sensorium on segment IV is forked but that on III is simple, and in *ah* and *atricorpus* the sensoria on segments III and IV are simple. Thus the only character remaining to define *Agrostothrips* from *Chirothrips* is the form of the craspedum on the posterior margins of the tergites and sternites.



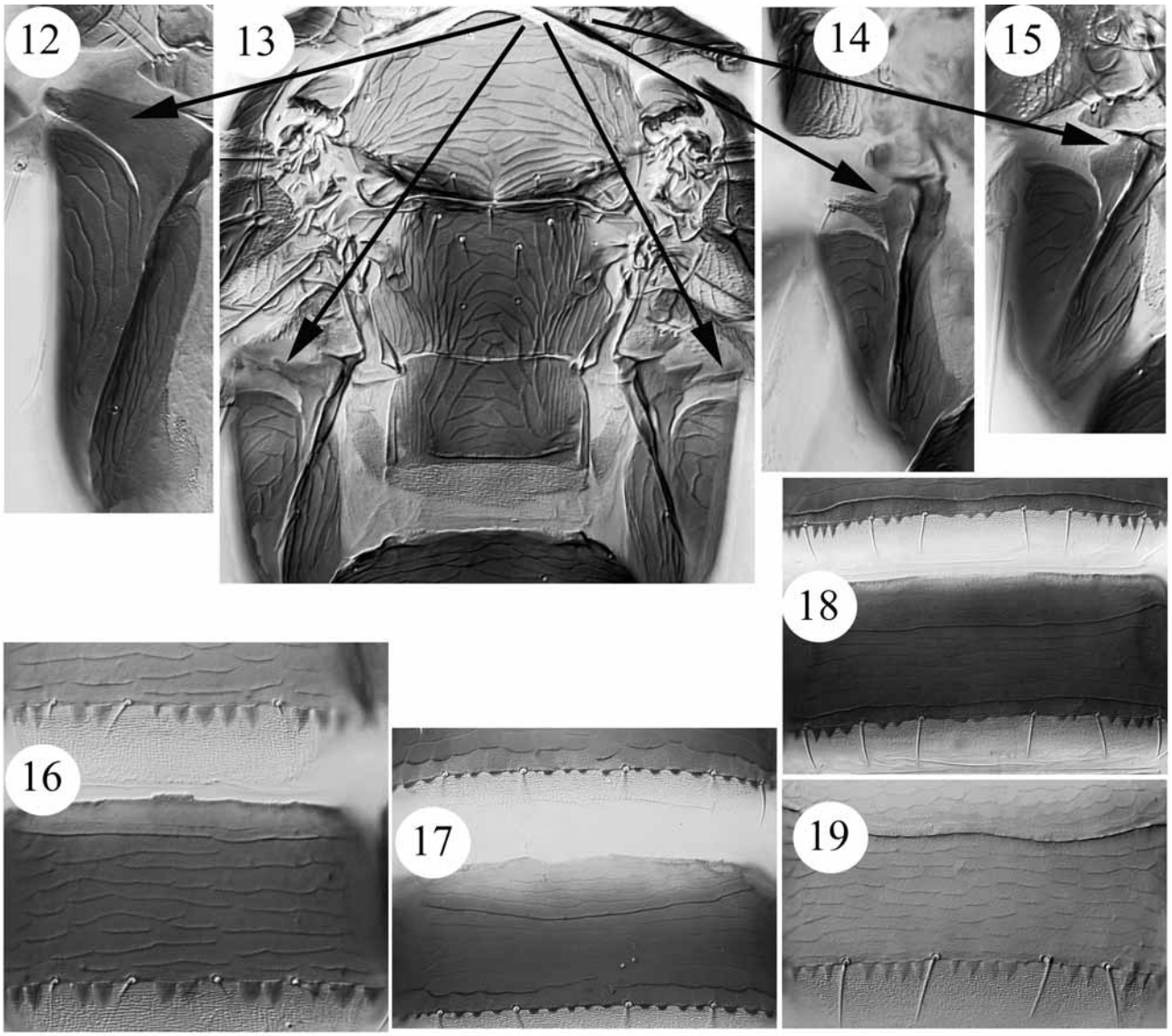
FIGURES 7–11. *Chirothrips* heads. **(7)** *kurdistanus*. **(8)** *pallidicornis*. **(9)** *molestus*. **(10)** *manicatus* [A.C.T.]. **(11)** *manicatus* [England].

In *guillarmodi* the tergites and sternites bear a series of closely approximated, but independent, elongate lobes. The tergites of *ah*, *atricorpus* and *meridionalis* all bear a craspedum that comprises rounded lobes (Fig. 23), unlike the elongate lobes of *guillarmodi*. Moreover, in these species although each of the lobes is independent on some segments, they are broadly fused at the base to form a continuous structure on the more posterior segments, and in *ah* this lobed tergal craspedum is often weakly developed or even absent. Among other *Chirothrips* species there is considerable variation in the form of the tergal craspeda. Many species have a more or less continuous and weakly lobed tergal craspedum, as in *manicatus* (Fig. 20), but other species have very different structures, such as a series of independent small, triangular lobes in *pretorianus* (Fig.22), or a series of widely and evenly spaced microtrichia-like teeth in *molestus* (Fig. 24).

On the sternites, the lobed craspedum of *ah*, *atricorpus* and *meridionalis* also takes a rather different form from that found in *guillarmodi*, in that the lobes are long, slender and widely-separated (Fig. 16, 19). Moreover, *hamatus* and *falsus* have slender independent lobes laterally that are similar to the lobes of *meridionalis*, but are small or absent medially (Fig. 18). Many species of *Chirothrips* lack any craspedum on the sternites, including *frontalis*, *kurdistanus*, and *pretorianus*, but others, including *manicatus*, *molestus*, and *aculeatus*, have a series of tubercles on the sternal posterior margins (Fig. 17) that vary from prominent to insignificant, partly in relation to body size.

The four species, *ah*, *atricorpus*, *guillarmodi* and *meridionalis*, are unusual within the genus *Chirothrips* in having fully winged males (Mound & Palmer, 1972), and it is possible that they represent a species-lineage from the Afro-tropical Region. Masami Masumoto has pointed out (in litt., 2009) that the metathoracic pre-

episternum is reduced in those Thripinae species that are related to *Chirothrips*. In typical species of Thripinae, including *Limothrips cerealium* (Fig. 12), this sclerite is broadly band-like, with parallel or slightly tapering sides, extending laterally around the anterior margin of the meta-episternum. However, in the available species of *Chirothrips* and *Arorathrips* this sclerite is reduced to a pointed triangle, of varying size among species (Fig. 15). In *ah*, *atricorpus*, and *meridionalis* the metathoracic pre-episternum is intermediate in condition, extending from the triangular base for a short distance ventro-laterally as a narrow, and irregularly sclerotised strip (Figs 13, 14).

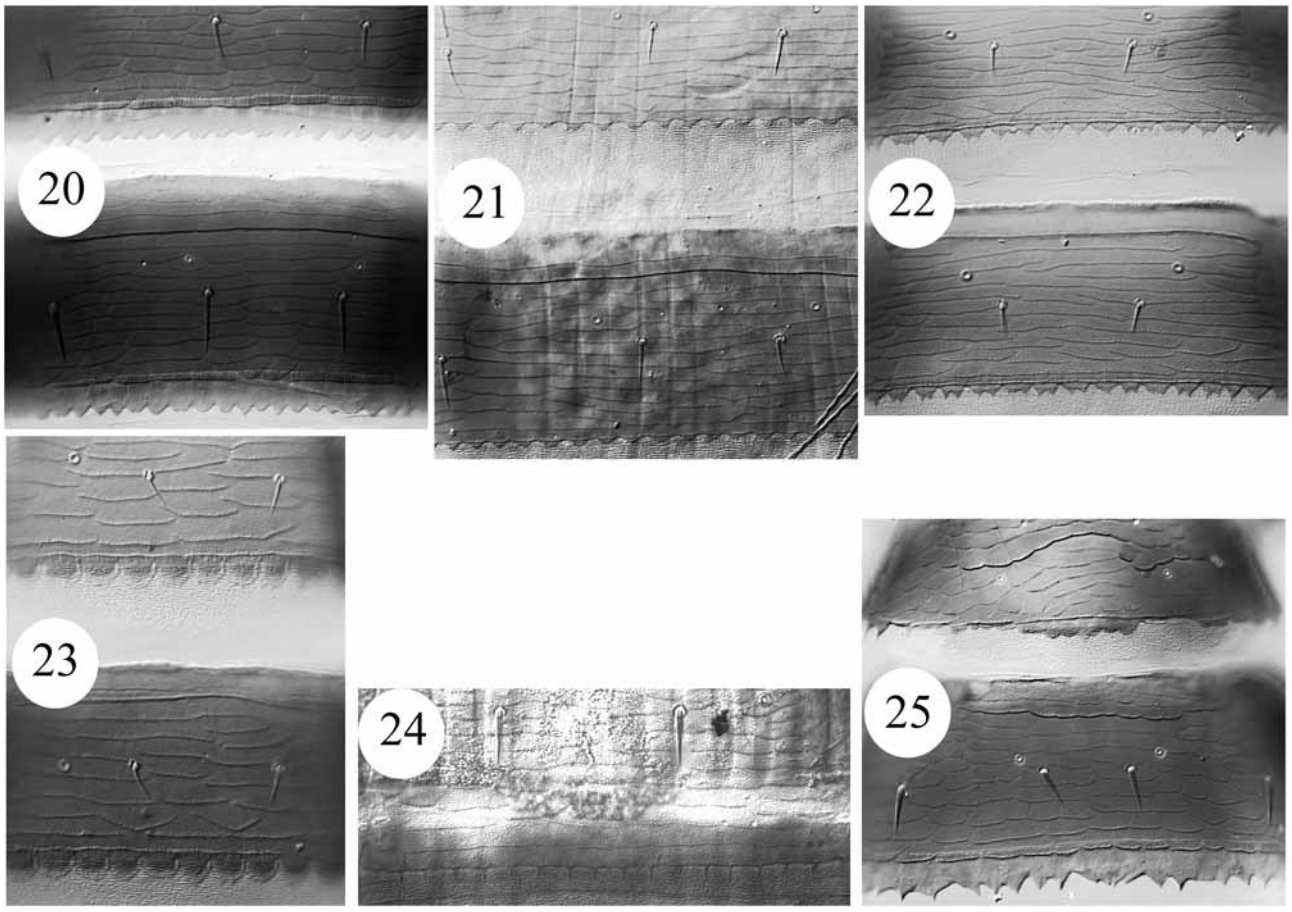


FIGURES 12–19. *Chirothrips* and *Limothrips* species. **(12)** *Limothrips cerealium*, meta pre-episternum arrowed. **(13)** *C. meridionalis* pteronota. **(14)** *C. ah* meta pre-episternum arrowed. **(15)** *C. manicatus* meta pre-episternum arrowed [Victoria]. Abdominal sternites: **(16)** *C. meridionalis* IV–V; **(17)** *C. manicatus* III–IV [A.C.T.]; **(18)** *C. hamatus* IV–V; **(19)** *C. ah* VI.

Each of the four species placed by Bhatti in *Agrostothrips* seems to retain one or more characters in a plesiotypic state. However, given the wide range of variation in the posterior margins of the sternites and tergites indicated here, and also the lack of consistency in other character states including antennal sensoria, there seems little support for placing these four species into a genus separate from *Chirothrips*. Thus, *Agrostothrips* is here placed into synonymy.

Generic diagnosis: Head variably prolonged in front of eyes, smaller than pronotum; usually with at least

three pairs of ocellar setae, and four pairs of postocular setae; maxillary palps 3-segmented. Antennae 8-segmented; segment I without median dorsal apical setae; II usually projecting laterally; III–IV with sensorium simple, rarely forked. Pronotum trapezoidal, with two pairs of posteroangular setae. Mesonotum with median pair of setae situated medially, anterior campaniform sensilla present. Metanotum with two pairs of setae near anterior margin, campaniform sensilla present. Prosternal ferna divided medially; basantra rugose, triangular; prospinasternum transverse, narrow. Mesothoracic sternopleural sutures complete; meta pre-episternum reduced, not broadly band-like. Meso and metasternal furca without spinula. Forewings slender, first vein with long gap in setal row, two distal setae; second vein with four to five setae arranged irregularly; clavus with about four veinal and one discal setae. Tarsi 2-segmented. Abdominal terga without ctenidia; terga I–VIII with varied posteromarginal craspedum, VIII without comb; sterna without discal setae, craspeda present or absent; sterna II with two pairs of posteromarginal setae, III–VII with three pairs. Male generally similar to but smaller than female, usually micropterous, with sternal pore plates.



FIGURES 20–25. *Chirothrips* tergites. **(20)** *manicatus* V–VI [Victoria]. **(21)** *aculeatus* IV–V. **(22)** *pretorianus* III–IV. **(23)** *meridionalis* IV–V. **(24)** *molestus* III. **(25)** *kurdistanus* I–II.

Key to *Chirothrips* species from Iran

1. Antennal segment II symmetrical (Fig. 5); campaniform sensilla on abdominal tergites posterolateral to median setae ..... *atricorpus*
-. Antennal segment II asymmetrical (Figs 2–4); campaniform sensilla on abdominal tergites usually anterolateral to median setae (Fig. 22, 23)..... 2
2. Sensorium on antennal segment IV forked..... 3
-. Sensorium on antennal segment IV simple..... 4
3. Tergites II–VII posterior margin with continuous craspedum bearing long broad lobes (Fig. 23); antennal segment I without dorsal transverse ridge (Fig. 6), II with apex almost acute ..... *meridionalis*

-. Tergites II–VII posterior margin with series of small tubercle-like lobes (Fig. 21); antennal segment I with transverse ridge dorsally (Fig. 2), II with apex softly rounded ..... *aculeatus*
4. Tergites II–VII posterior margins with row of widely spaced microtrichia (Fig. 24); antennal segment I with median dorsal setal pair closer together than width of base of segment II (Fig. 9) ..... *molestus*
-. Tergites II–VII posterior margins with distinct craspedum (Figs 20, 25); antennal segment I with median dorsal setal pair wider apart than width of base of segment II (Figs 10, 11) 5
5. Tergite I with craspedum present only on median third of posterior margin (Fig. 25) ..... *kurdistanus*
-. Tergite I with craspedum complete across posterior margin ..... "*manicatus* group"

Chirothrips aculeatus Bagnall

Chirothrips aculeatus Bagnall, 1927a: 567.
Pezothrips (?) *pedestris* Karny, 1910: 55

The name *aculeatus* is well established in the literature, including the recent keys to European species (zur Strassen, 2003a). Moreover, the ISI Web of Knowledge refers to 37 usages of this name by various authors. In contrast, this web resource refers to the name *pedestris* once only, this being when zur Strassen (1975) indicated that the unique male specimen on which it was based was the same species as *aculeatus*. However, zur Strassen (1975) indicated that as an old, dis-used, name *pedestris* should be set aside, in accord with the clear recommendation given in the Code of Zoological Nomenclature concerning the treatment of dis-used names. In contrast, Bhatti *et al.* (2009) chose to use the older name, despite this action being contrary to the spirit of the Code in maintaining nomenclatural stability. Richard zur Strassen (pers. comm. 2009) has stated that he did not see a draft of the 2009 paper to which his name was attached, and the reversed synonymy adopted in that paper is therefore rejected here with his approval.

Diagnosis: Body colour brown, tarsi yellow, forewing and clavus shaded. Head distinctly produced in front of eyes; vertex with two pairs of setae, ocellar setae lateral to fore ocellus (Fig. 2). Antennal segment I with strong transverse ridge dorsally; segment II with apex of prolongation rounded, with sub-terminal small seta; sensoria on segment III simple and slender, on IV forked and slender with inner branch of fork at broadly oblique angle to outer branch. Tergal campaniform sensilla anterior to median setae; posterior margins of tergites II–VIII with small rounded and independent craspedate lobes not forming continuous craspedum (Fig. 21); sternites II–VI posterior margins with small tubercles. Male apterous, smaller than female.

Chirothrips atricorpus Girault

Chirtothrips (sic) *atricorpus* Girault, 1927:1.

Although this species was described originally from Australia, it is not considered to be native to that continent. Mound & Palmer (1972) suggested that it was probably introduced to Australia by shipping from one of the East African ports, and these authors also reported the species from Ethiopia. Bhatti *et al.* (2009) list it from Iran together with earlier references from that country.

Diagnosis: Body colour brown, tarsi light brown, forewing and clavus shaded. Head weakly produced in front of eyes (Fig. 5); vertex with two pairs of setae, ocellar setae lateral to fore ocellus. Antennal segment II not produced on external margin; sensoria on segments III–IV simple and stout; antennal segment I without transverse ridge on dorsal surface. Tergal campaniform sensilla posterior to median setae; posterior margins of tergites I–VIII with broadly-based oval craspedate lobes that fuse at their bases to a continuous craspedum; sternites II–VI posterior margins with slender craspedate lobes, VII with lobes present only laterally. Male macropterous, craspedum on posterior tergites entire with small rounded lobes.

Chirothrips kurdistanus zur Strassen

Chirothrips kurdistanus zur Strassen, 1967: 49.

This species was described on specimens from Turkey that were collected from *Digitaria* sp. during quarantine inspection at Washington DC, USA. The species was recorded from Iran by Minaei *et al.* (2002) from Fars province, zur Strassen (2003b) recorded three females from Tehran taken on *Cynodon dactylon*, and also listed the species from Israel (zur Strassen, 2003a).

Diagnosis: Body colour brown, tarsi yellow, forewing and clavus weakly shaded. Head distinctly produced in front of eyes (Fig. 7); vertex with three to four pairs of setae, ocellar setae posterolateral to fore ocellus. Antennal segment II external margin almost straight, with small seta at apex; sensoria on segments III–IV simple and slender; antennal segment I large, without transverse ridge on dorsal surface. Tergal campaniform sensilla anterior to median setae (Fig. 25); posterior margins of tergites II–VIII with continuous craspedum with angulate lobes, tergite I with small lobed craspedum on median third only; sternites III–IV posterior margins with small tubercles laterally. Male apterous, smaller than female.

Chirothrips manicatus species-group

This group includes some of the most common grass thrips of Europe and western Asia. Four species are discussed here, each of which is characterised in the key to European Terebrantia by zur Strassen (2003a). These four species are:

Thrips (*Chirothrips*) *manicata* Haliday, 1836: 444.

Chirothrips pallidicornis Priesner, 1925: 312.

Chirothrips ammophilae Bagnall, 1927b: 564

Chirothrips africanus Priesner, 1932: 46

The distribution of each of these four nominal species is as follows:

C. manicatus is a European species that has been distributed widely in temperate areas around the world, presumably in grass seeds. It has been reported from various parts of Iran (Bhatti *et al.*, 2009). Adults vary considerably in body size, and have been swept from many different grass species. However, there is little reliable information on which species of Poaceae are used for development.

C. pallidicornis is reported from several European countries, between Poland and Sicily (zur Strassen, 2003a), and also from Iran (Bhatti *et al.*, 2009). The available evidence suggests that it shares the same host species as *C. manicatus*.

C. africanus is reported from a range of grass species in many warmer parts of the world (Mediterranean, Egypt, Sudan, United Arab Emirates, India, Taiwan; see zur Strassen & Harten, 2008). In Iran, it was reported by Alavi (2000) from Golestan Province.

C. ammophilae is not reported from Iran, but was described from southern France on *Ammophila arenaria*, and is otherwise reported only from Spain (zur Strassen, 2003a).

The most recent taxonomic treatment of these species (zur Strassen, 2003a) uses the following character states to distinguish *africanus* (Fig. 3) and *pallidicornis* (Fig. 8) from *ammophilae* and *manicatus* (Figs 10, 11):

1. Head prolongation in front of eyes scarcely 7 microns (contrast: 3–16 microns);
2. Ocellar region with 4 ante-ocellar setae (contrast: usually 6 such setae);
3. Antennal segment II outer margin almost straight (contrast: curved).

All three of these differences are dependent to a variable extent on the precision with which a specimen has been slide-mounted. The first is undoubtedly related to body size, and is also affected by slight differences in the horizontality of a slide-mounted specimen. The antero-lateral pair of ocellar setae is frequently difficult to see, and its presence also seems to be related to body size. The shape of the external margin of the second antennal segment is particularly difficult to evaluate, due to variation in body size and the precise orientation of the segment in slide mounted specimens (Figs 10, 11). Despite these problems, specimens from warmer

parts of the world seem to be smaller, with the head prolongation consistently shorter, and antennal segment III smaller and thus with a straighter inner margin; it is to these that the name *africanus* is given. Whether this represents a different species from, or merely a size variant of, *manicatus* is a point that merits experimental investigation and statistical analysis of suitably acquired data. The form referred to as *pallidicornis* is distinguished from *africanus* by zur Strassen (2003a) because the distance between the pair of dorsal setae on the fourth antennal segment is 11–13 microns rather than 4–6 microns. Despite this, there is no biological evidence that *pallidicornis* is more than a small form of *manicatus*.

Of the other two species in this group, *ammophilae* was formally synonymised with *manicatus* by Mound (1968), but is distinguished by zur Strassen (2003a) on the following character states:

1. Head prolongation in front of eyes 11–16 microns (contrast: 3–12 microns);
2. Antennal segment VII longer than VIII (contrast: shorter than VIII);
3. Ovipositor length 235–265 microns (contrast: 140–230 microns);
4. Sternites IV–V marginal craspedum not lobed (contrast: lobed).

Considering these differences, it is relevant to mention that the flowering spike of *Ammophila* is about 10–16 mm long, whereas that of *Dactylis*, a common host of *manicatus*, is only 5–9 mm long. Adults developing in the larger spikes can be expected to grow larger. The first three character states listed are likely to be a function of body size, and the presence and size of small tubercles (not lobes) on the posterior margins of the sternites in females of *manicatus* is too variable within populations for distinguishing between species (Fig. 17). Currently there appears to be no good biological nor morphological evidence that *ammophilae* represents a distinct species.

Diagnosis: Body colour brown, tarsi yellow to yellowish brown, forewing and clavus shaded. Head weakly produced in front of eyes (Figs 10, 11); vertex with three pairs of setae, ocellar setae anterolateral to fore ocellus. Antennal segment II external margin usually concave, apex acute with terminal seta; sensoria on segments III–IV simple; antennal segment I without transverse ridge on dorsal surface. Tergal campaniform sensilla anterior to median setae; posterior margins of tergites I–VIII with continuous craspedum with margin of rounded lobes (Fig. 20); sternites II–V posterior margins with row of tubercles (Fig. 17), also laterally on VI but not on VII. Male apterous, smaller than female; tergal craspeda with margin straight.

***Chirothrips meridionalis* Bagnall**

Chirothrips meridionalis Bagnall, 1927a: 566

Described originally from southern France, this species is listed by zur Strassen (2003a) from the following areas: Mediterranean Region, Yemen, Iran, Pakistan, India, South Africa, Nigeria, Madeira, Canary Islands. Bhatti *et al.* (2009) provide references to records from Iran.

Diagnosis: Body colour brown, tarsi yellow, forewing and clavus weakly shaded. Head weakly produced in front of eyes (Fig. 6); vertex with two pairs of setae, ocellar setae lateral to fore ocellus. Antennal segment II external margin almost straight, apex acute with sub-terminal seta; sensorium on segment III simple and curving around segment, on IV distinctly Y-shaped; antennal segment I without transverse ridge on dorsal surface. Tergal campaniform sensilla posterior to median setae; posterior margins of tergites II–VIII with broadly rounded independent lobes fused at bases into continuous craspedum (Fig. 23); sternites II–VI posterior margins slender independent craspedate lobes (Fig. 16), also laterally on VII. Male macropterous, smaller than female; antennal segment II only weakly produced on external margin.

***Chirothrips molestus* Priesner**

Chirothrips molestus Priesner, 1926: 142.

Reported as a widespread **"**Euro-Siberian species" by zur Strassen (2003a), this species was recorded from

wheat and barley in Iran, Golestan Province by Alavi (2000) and from Bojnourd by Alavi & Kamali (2003) on *Cynodon dactylon*.

Diagnosis: Body colour brown, tarsi yellow, forewing and clavus shaded. Head distinctly produced in front of eyes (Fig. 9); vertex with three to four pairs of setae, ocellar setae posterolateral to fore ocellus. Antennal segment II external margin almost straight, but apex rounded and at an angle, with small subterminal seta; sensoria on segments III–IV simple and stout; antennal segment I with transverse ridge on dorsal surface. Tergal campaniform sensilla anterior to median setae; posterior margins of tergites with no craspedum but II–VI with widely-spaced fringe of microtrichia (Fig. 24); sternites III–IV posterior margins with small tubercles laterally. Male apterous, smaller than female.

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