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Identification of exotic pest and Australian native and naturalised species of *Tetranychus* (Acari: Tetranychidae)

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Abstract

An illustrated dichotomous key to the 3 endemic Australian, 9 naturalised exotic, and 14 exotic pest species of *Tetranychus* Dufour, 1832, deemed to be of greatest risk of accidental introduction to Australia is presented. Each species is diagnosed, illustrated with line drawings and/or photographs, and supplied with remarks on its biology, potential to enter Australia and economic importance. We establish that *Tetranychus desertorum* Banks, 1900, previously thought to be present in Australia, is absent. The erroneous record of *T. desertorum* is due to confusion between this species and *T. ludeni*. *Tetranychus gloveri* Banks, 1900 was absent from Australia until a recent incursion in Darwin, now considered eradicated. All previous records of *Tetranychus gloveri*, *Tetranychus tumidus* Banks, 1900 and *Allonychus braziliensis* (McGregor, 1950) in Australia are *Oligonychus digitatus* Davis, 1966. *Tetranychus ludensis* Attiah, 1969 **syn. nov**. is synonymised with *Tetranychus ludeni* Zacher, 1913. Lectotype and paralectotype specimens are designated for *Tetranychus marianae* McGregor, 1950 and *Tetranychus mexicanus* (McGregor, 1950).

Key words: Systematics, taxonomy, illustrated key, diagnostics, spider mites

Introduction

Spider mites (Acari: Tetranychidae) are among the best-known of the Acari, yet their identification remains a persistent challenge to experts and non-experts alike. The costs incurred from crop losses and control strategies are measured in millions of dollars, but our experience is that damage is blamed on a few common species, especially Two-spotted Spider Mite, sometimes without checking species identification.

The Tetranychidae Donnadieu, 1876 comprise over 1,200 described species in six tribes and 71 genera (Bolland *et al*. 1998; Migeon & Flechtmann 2004). *Tetranychus* Dufour, 1832 (143 spp.) is one of the largest genera of the Tetranychidae, being one of the five genera represented by more than 100 known species. The other major genera are *Bryobia* Koch, 1836 (129 spp.), *Eotetranychus* Oudemans, 1931 (184 spp.), *Oligonychus* Berlese, 1886 (200 spp.) and *Schizotetranychus* Trägårdh, 1915 (116 spp.). In Australia, *Tetranychus* is represented by 14 species, of which only three are native: *Tetranychus bunda* Flechtmann & Knihinicki, 2002, *T. dianellae* Davis, 1967, and *T. rhagodiae* Miller, 1966. The 11 other species recorded are *Tetranychus desertorum* Banks, 1900, *T. fijiensis* Hirst, 1924, *T. gloveri* Banks, 1900, *T. lambi* Pritchard & Baker, 1955, *T. kanzawai* Kishida, 1927 (= *T. hydrangeae* Pritchard & Baker, 1955), *T. lintearius* Dufour, 1832, *T. lombardinii* Baker & Pritchard, 1960, *T. ludeni* Zacher, 1913, *T. marianae* McGregor, 1950, *T. neocaledonicus* (André, 1933), and *T. urticae* Koch, 1836 (= *T. cinnabarinus* Boisduval, 1867). Herein we show that *T. desertorum* was not collected in Australia, and that *T. gloveri* was absent until recently (and has not established), thus reducing this number of introduced species to nine.

Tetranychus has never been thoroughly examined in Australia, despite its economic importance, and our collections indicate that native plant species are host to several undescribed species. The most significant works are those of Miller (1966), who examined the family in Tasmania and described *T. rhagodiae*, Davis (1967, 1968a), who dealt with the Queensland fauna and described *T. dianellae*, Gutierrez and Schicha (1983), who provided keys to the New South Wales *Tetranychus*, and Flechtmann and Knihinicki (2002), who described *T. bunda* and sorted the genus into several species groups. Our work is not the Australian revision that is required, nor the monumental task of dealing with the world fauna, but we attempt to demystify the taxonomy of *Tetranychus* in Australia and hope we provide a useful key and some of the necessary groundwork for future revisions.

Materials and Methods

The *Tetranychus* species examined here represent the known Australian species plus the economically important species regarded as a threat of entry to Australia. These species of quarantine importance are all polyphagous and widespread (Bolland *et al.* 1998). Some pest species from countries far removed from Australia are not included, but we expect that the key presented here could be adapted to different regions of the world. For example, the deletion of Australia's three endemic species and the biocontrol agent of Gorse, *T. lintearius* (Davies *et al.* 2007), and the addition of *Tetranychus amicus* Meyer & Rodrigues, 1965, *Tetranychus rooyenae* Meyer, 1974, and *Tetranychus zambezianus* Meyer & Rodrigues, 1966, would likely make a useful key to endemic pest species and those of quarantine importance for South Africa.

Tetranychus were obtained from previous slide-mounted collections, previous ethanol collections, and new collections. Fresh specimens were collected from leaves, killed in 75% ethanol, cleared in Nesbitt's fluid and slide-mounted in Hoyer's medium. Female mites were mounted dorso-ventrally but male mites were mounted laterally. Initially, lateral mounts were made by orientating the specimen in a minute drop of Hoyer's medium, heating the slide for approximately 10 minutes on a warm hotplate, and another drop of Hoyer's medium and a cover-slip applied (Henderson 2001). Later, better mounts were obtained simply by orientating the mite in a drop of Hoyer's medium and carefully lowering the coverslip along the longitudinal axis of the mite. Pressure was applied evenly to the coverslip with a pair of forceps, each prong on either side of the mite, and the mite then examined at 200x or 400x magnification. If a lateral view of the aedeagus was not visible, further pressure was applied to turn the aedeagus on its side.

Character states were obtained from specimens and compared with published descriptions. In the key we emphasised characters of the adult female and resorted to using the adult male only when no characters could further distinguish female mites of different species. We emphasised the adult female because collections often lack male specimens, especially in quarantine.

Specimens were examined and illustrations made with a Zeiss Axioskop, Zeiss Axioplan imaging 2, or Nikon Eclipse 80i, equipped with drawing tubes, at 400x or 1000x magnification under Differential interference contrast optics (DIC). Photographs were taken with a Nikon 4500, Olympus 770, or Zeiss Axiocam MRc5 camera directly down the eyepiece or attached to a trinocular tube.

Genetic data are not included as our manuscript deals solely with morphology, and thus far the genetics of Australian *Tetranychus* species is little studied. Of the species considered herein, sequences are available for *T. evansi*,

T. gloveri, *T. kanzawai*, *T. ludeni*, *T. mcdanieli*, *T. neocaledonicus*, *T. pacificus*, *T. piercei*, *T. truncatus*, *T. turkestani* and *T. urticae*. These sequences are available through Genbank (query through *http://www.ncbi.nlm.nih.gov/sites/gquery*), as are the citations to the literature pertaining to these sequences.

Plant systematics follows the Australian Plant Name Index (*http://www.anbg.gov.au/apni/index.html* Accessed 8 June 2011).

Abbreviations for institutions are:

ASCT—Agricultural Scientific Collections Unit, Orange Agricultural Institute, Forest Rd, Orange, New South Wales, Australia.
BMNH—British Museum of Natural History, London.
HUM—Hokkaido University Museum, Sapporo.
PPRI—Plant Protection Research Institute, Pretoria, South Africa
QDPI—Queensland Department of Primary Industries Insect Collection, Indooroopilly, Brisbane, Australia (now housed in QM).
QM—Queensland Museum, South Brisbane, Australia.
TDPI—Department of Primary Industries and Water Insect Collection, Tasmania.
UQIC—University of Queensland Insect Collection, St Lucia, Brisbane, Australia.
USNM—Acari Collection of the United States National Museum, at Systematic Entomology Laboratory, Beltsville, USA
ZCESA—Zoology Collection of Escola Superior de Agricultura "Luiz de Quiroz", University of São Paulo, Brazil.
ZIHU—Zoological Institute of Hokkaido University, Sapporo (now part of HUM).

Morphology of the Tetranychidae

The following section is an introduction to the morphology of all Tetranychidae with an emphasis on *Tetranychus*. For a detailed treatment of setal nomenclature and fine morphological details we recommend Lindquist (1985).

Tarsi

The tarsi have three types of setae: normal or *tactile* setae, which are the most common; and *solenidia* and *eupathidia*, which are sensory setae and are fewer in number (Fig. 1). Under the microscope, tactile setae are solid and appear darker, are usually hair-like with a tapered tip, and are lightly to heavily barbed. Sensory setae (eupathidia and solenidia) have a hollow, transparent appearance and a blunt tip. Eupathidia are found distally on tarsi I and II but are absent from tarsi III and IV, and are of no taxonomic significance in *Tetranychus*. Solenidia can be distinguished from eupathidia by their annulate texture along their entire length. Solenidia can be found in various combinations on all tarsi; *Tetranychus* have solenidia on tarsi I–IV and tibia I.

Duplex setae comprise a short tactile seta, called a companion seta (seta *ft*), and a solenidion (ω). These two setae have their setal sockets coalesced, or nearly so. Duplex setae are important taxonomic characters for spider mite diagnoses. In the genus *Tetranychus*, tarsus I has two pairs of duplex setae and tarsus II has one pair.

The number of setae proximal (closer to the body) to the proximal duplex setae (ω' and *ft'*) is an important character used in keys (e.g., Meyer 1974, 1987) and to form species groups (e.g., Flechtmann & Knihinicki 2002). A seta is considered proximal if its setal base does not overlap, to any extent, with the setal base of the proximal duplex setae. To do so, one looks at the sockets of the proximal duplex setae and the sockets of the four proximal tarsal setae (l_1', l_1'', v_2', v_1'') and counts how many of these setal sockets overlap with the sockets of the proximal duplex setae. This is an undeniably useful character, but is also imperfect due to natural variation within species.

For precision, we have used measurements instead of numbers of setae proximal to the proximal duplex seta. For brevity, herein we refer to this measurement as Σd_{prox} — the sum of the distances between the sockets of the proximal setae l_1', l_1'', v_2', v_1'' and the proximal duplex setae ω' and *ft'*. Furthermore, we measure the distance between the proximal and distal duplex setae and refer to this measurement as D_{duplex}.

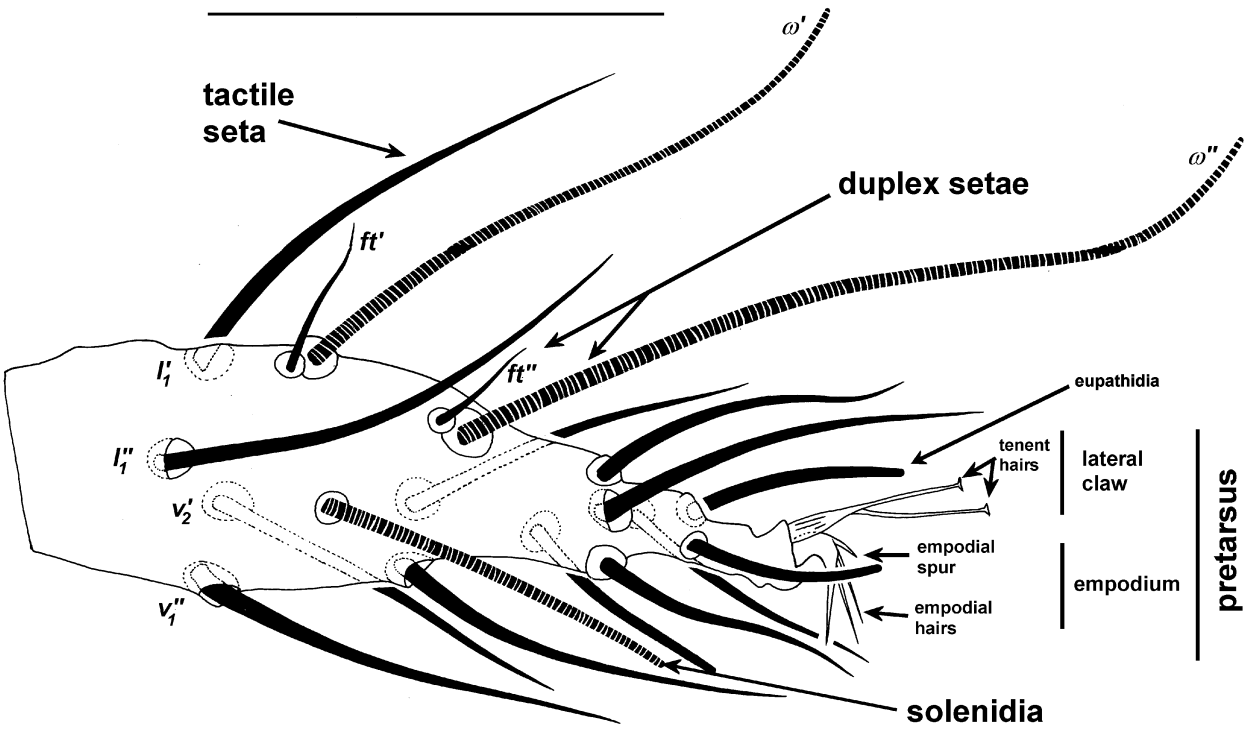


FIGURE 1. Tarsus I of a female *Tetranychus* sp. Setal names are given for the proximal tactile setae and both pairs of duplex setae. Scale bar = 50 µm.

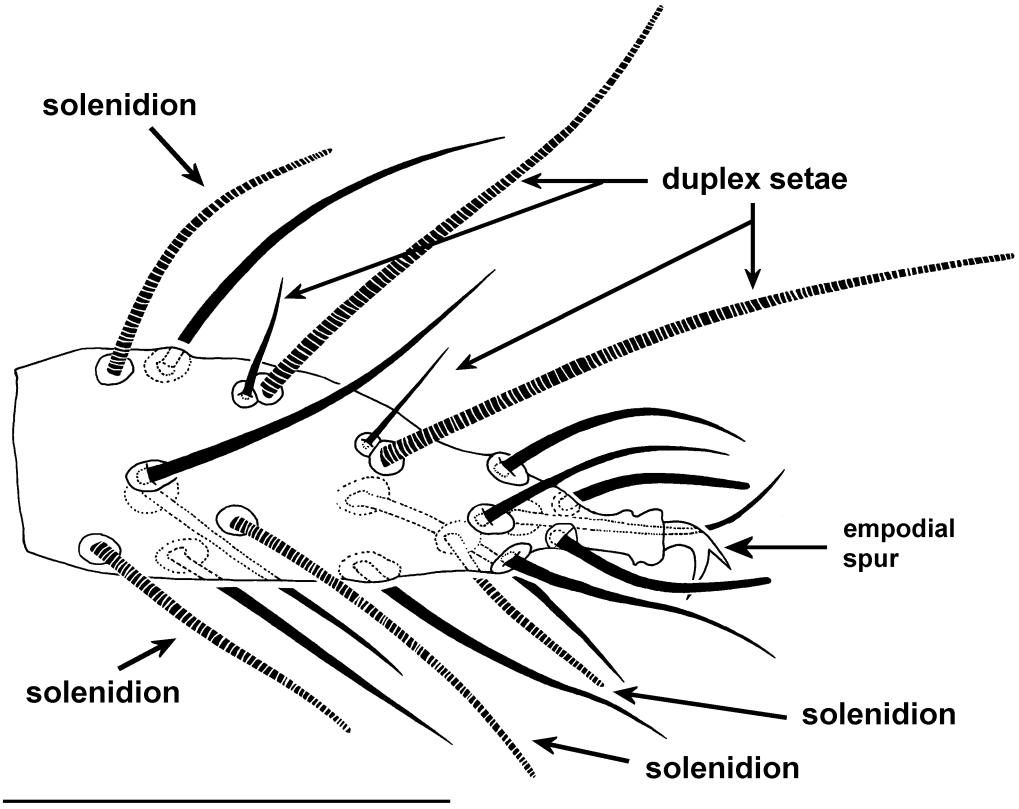


FIGURE 2. Tarsus I of a male *Tetranychus* sp. Scale bar = 50 µm.

Pretarsi

A good lateral view of the pretarsus is required for identifications, and usually the empodia of legs III or IV provide the best view. Sometimes only one half of the paired structures are clearly visible, and usually only one half of the

paired structures are illustrated. For example, in Fig. 1, two tenent hairs and three proximoventral hairs are drawn, but the specimen has four tenent hairs and six proximoventral hairs.

The structure of the pretarsus is extremely important in spider mite taxonomy. Most simply, the pretarsus comprises a pair of true *lateral claws* and a medial *empodium* (Figs 1, 3). However, these are variously modified and, *no matter what they look like*, the two outer structures are the lateral claws and the middle structure, *no matter what it looks like*, is the empodium.

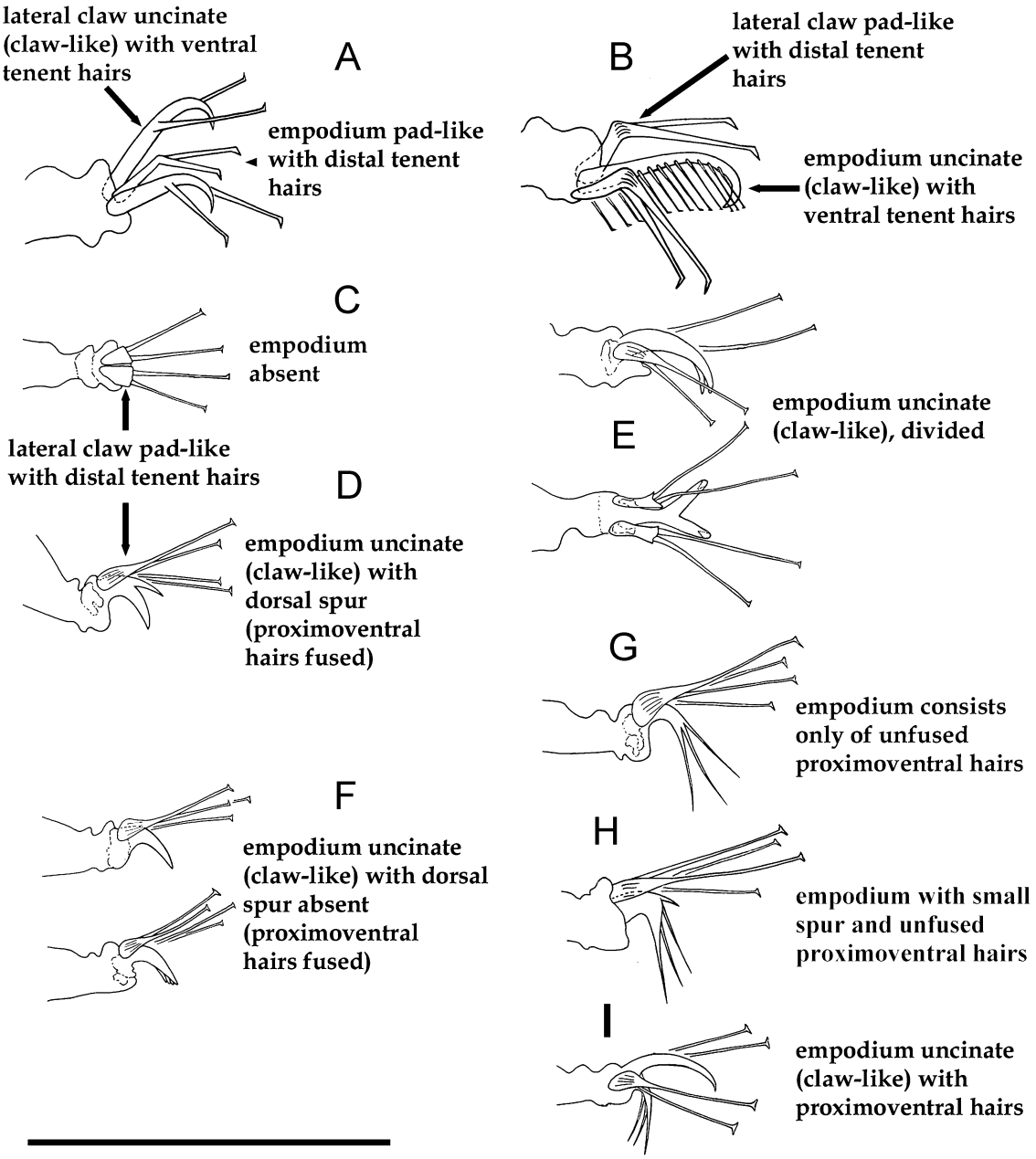


FIGURE 3. Pretarsi in the Tetranychidae. Scale bar = 50 µm.

Tenent hairs are small, usually paired hairs that end in a T-shape. The lateral claws and empodium can possess tenent hairs. In *Tetranychus*, the lateral claws are reduced to small pads each with a pair of long tenent hairs, so each claw appears to be a pair of tenent hairs alone.

The empodium can also have *proximoventral hairs*, which are considered to be fine branches of the empodium. They are distinguished from tenent hairs by the lack of the T-shaped tip. Also, the empodium may have an *empodial spur*, which arises dorsally to the proximoventral hairs (Figs 1, 3H), and probably represents a reduced unci-

nate empodium, such as the uncinate empodium of *Oligonychus* (Fig. 3I). The length of the empodial spur is measured from where it separates from the shaft of the pretarsus.

The morphology of the female's pretarsus is generally the same on legs I to IV. In male mites, the morphology of the pretarsus on legs I, and sometimes leg II, is usually different from the pretarsus of the other legs. In such cases, the proximoventral hairs of pretarsus I (and sometimes II) have fused into an uncinate empodial claw (Figs 2, 3D, E, F). In *Tetranychus*, the empodium always has proximoventral hairs (usually three pairs) and is uncinate only on pretarsus I, and sometimes pretarsus II, of male mites. An exception is *T. bunda*, which has exceptionally large empodial spurs reminiscent of *Oligonychus* and *Hellenychus* Gutierrez, 1970.

Gnathosoma

The gnathosoma comprises the palps and a capsule (stylophore) that contains the chelicerae. The most apparent features of the palp are a conspicuous tibial claw or "thumb claw" and the tarsal "thumb" (Fig. 4). The tarsus ("thumb") bears three tactile setae (*a*, *b*, *c*), three eupathidia (*ul′* ζ, *su* ζ, *ul″* ζ) and one solenidion (*ω*). One eupathidion is modified into the silk-producing spinneret *su*ζ, which is called a sensillum in older literature. The dimensions of these modified setae have been used to distinguish species, but we have found them to be of little use (Table 1).

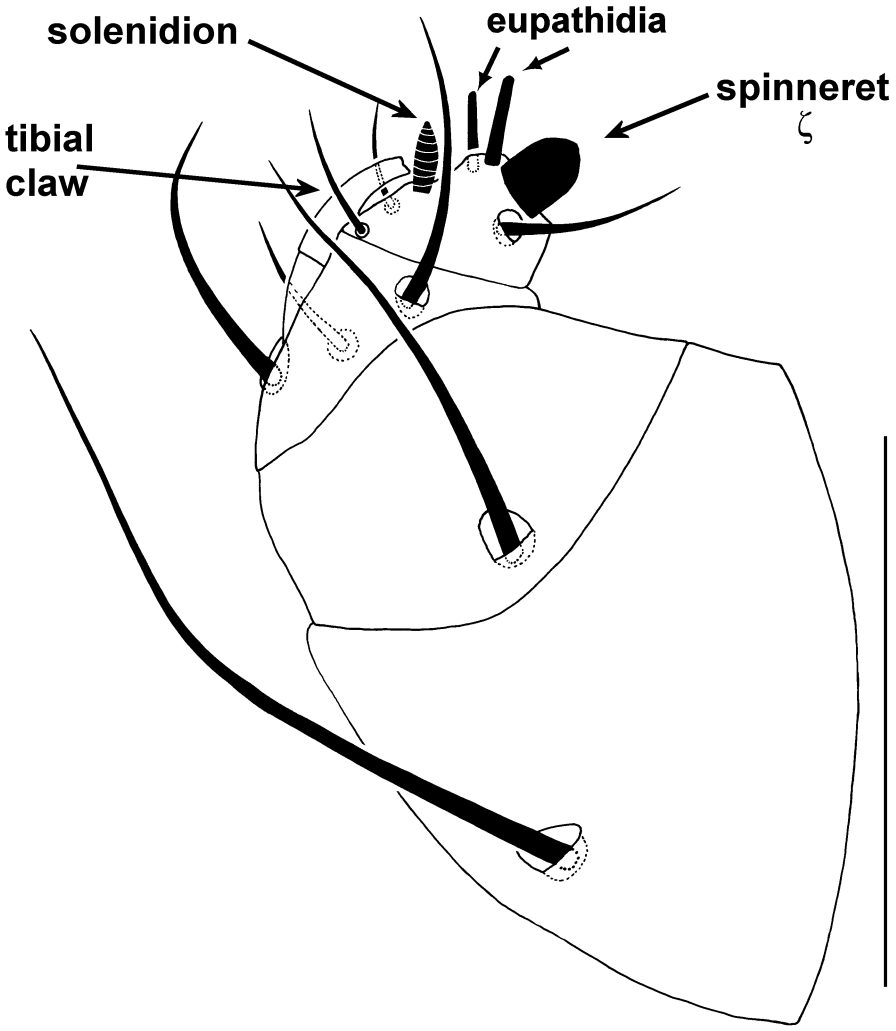


FIGURE 4. Palp of *Tetranychus fijiensis* Hirst. Scale bar = 50 µm.

The infracapitulum bears subcaptitular setae *m* (ventral, added in the protonymph), supracoxal seta *e*, and adoral setae *or1–3*. The palp chaetotaxy is, from trochanter to tibia, 0, 1 (*dPFe*), 1 (*l″PGe*), 3 (*dPTi, l′PTi, l″PTi*). The dorsal seta on the palp femur (*dPFe*) is sexually dimorphic, being long and thin in the female but a short spine in the male (Lindquist 1985).

TABLE 1. Palp and selected dorsal setal measurements for eight *Tetranychus* spp. Psl = palp spinneret length; Psw = palp spinneret width.

Mite species	Characters												
	Psl	Psw	*v2*	*sc1*	*sc2*	*c1*	*c2*	*c3*	*d1*	*d2*	*e1*	*e2*	*f1*
T. evansi (n = 4)	7–8	5–6	65–79	141–175	104–122	125–152	126–148	118–137	119–152	132–150	122–140	129–144	110–128
T. lambi (n = 5)	6	3–4	60–75	118–131	85–99	106–128	101–121	95–110	105–120	102–120	99–108	95–115	83–95
T. marianae (n = 5)	7	4–5	54–73	115–147	75–100	113–132	102–120	84–120	113–125	110–125	110–120	108–128	81–105
T. piercei (n = 8)	7–8	4–5	67–77	135–148	95–104	125–134	120–134	105–118	118–143	124–135	113–126	123–132	102–110
"urticae" group													
T. kanzawai (n = 5)	7–9	3–4	71–80	131–149	91–102	114–131	108–133	99–114	110–131	111–133	109–128	108–121	96–108
T. truncatus (n = 3)	8–9	4–5	76–80	133–152	99–111	131–135	121–133	113–124	132–159	122–133	116–130	115–130	104–113
T. turkestani (n = 7)	6–7	4	65–75	121–135	80–95	110–118	105–116	95–105	103–119	106–118	92–113	100–108	90–95
T. urticae (n = 5)	7	4	77–88	128–144	93–108	118–130	108–120	100–113	115–118	118–120	93–105	105–110	88–95

Body setae

The *idiosoma* is split into two sections: the anterior *propodosoma* and the posterior *hysterosoma*. On the dorsum, the pattern of striae changes between the propodosoma and hysterosoma, indicating the remnant of the sejugal furrow. Each of the body setae has a number and a letter, and here we follow the nomenclature of Grandjean (1939, 1944a, b, 1947). The propodosoma of spider mites has a maximum of four pairs of setae: *v1* (absent in *Tetranychus*), *v2*, *sc1* and *sc2*. On the hysterosoma, the setal rows are *c*, *d*, *e*, *f* and *h* (Fig. 5). There are three pairs of setae *c*, and two pairs each of setae *d*, *e* and *f*. Setae *h1* tend to be terminal, while *h2* and *h3* tend to be ventral, with *h3* laterad the anus. *Tetranychus* has just two pairs of *h* setae, *h2* and *h3* (Oudemans 1930; Lindquist 1985). The anus has two pairs of setae (*ps1* and *ps2*) and the genital region has setae *g1* and *g2*. Setae *g1* are on the genital flap. Setae *ag* lie between the genital region and the fourth pair of legs (Fig. 6).

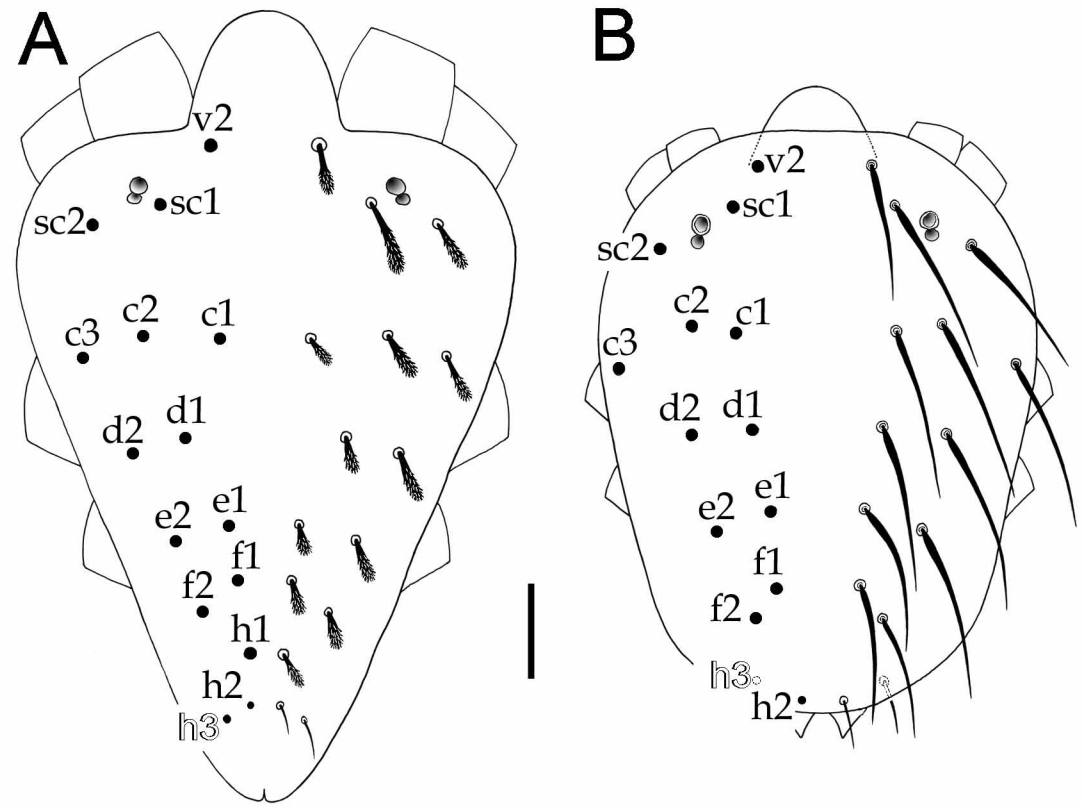


FIGURE 5. Arrangement of dorsal setae in the Tetranychidae. A. *Eutetranychus* sp. male. B. *Oligonychus* sp. female. *Tetranychus* has the same dorsal chaetotaxy as *Oligonychus* (*h1* absent). Scale bar = 100 µm.

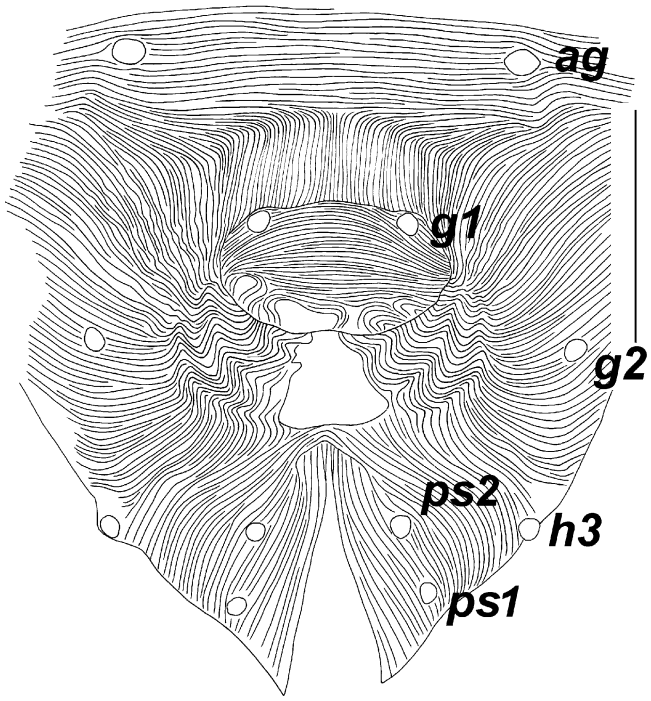


FIGURE 6. Genitoanal region of *Tetranychus*. Only setal sockets drawn. Scale bar = 50 µm.

The ventral setae are consistently present. In adult *Tetranychus*, down the midline between the coxal fields there are three pairs of setae: *1a* (between coxae I and II), *3a* (between coxae III), and *4a* (between coxae IV). Coxal fields I and II each have two pairs of setae, *1b*, *1c* and *2b*, *2c*, respectively, whereas coxal fields III and IV each have only one seta, *3b* and *4b*, respectively.

Presence/absence of body setae are useful for distinguishing genera, but we have found no useful body setae characters to distinguish species of *Tetranychus*, as the genus chaetotaxy appears consistent. The length and form of body setae are also remarkably uniform within *Tetranychus* (Table 1); therefore, are of no diagnostic value. However, mites that tend to be smaller, like *T. lambi*, usually have smaller setae than species that tend to be larger, such as *T. piercei* McGregor, 1950 (Table 1).

Striae and lobes

The integument of spider mites is covered with fine fingerprint-like striae. On female *Tetranychus* the pattern of these striae between dorsal setal pairs *e1* and *f1* has three major forms usually called "entirely transverse", "hourglass-shaped" and "diamond-shaped" (Pritchard & Baker 1955; Baker & Tuttle 1994).

The "entirely transverse" pattern is literal: striae run transversely for the entire region between *e1–e1* and *f1–f1*. Sometimes the striae can be a little oblique, but they never run longitudinally (Fig. 7a).

The "hourglass-shaped" pattern is more cryptic and not as commonly used as the other terms. Between setae *e1–e1* the striae are transverse, sometimes tending to oblique, but are not longitudinal. These transverse striae continue between *e1–e1* and *f1–f1*, but just anterior of *f1–f1* they become strongly longitudinal. This pattern is somewhat reminiscent of an hourglass, with the waist of the hourglass between setae *f1–f1* (Fig. 7b).

The "diamond-shaped" pattern has longitudinal or oblique striae between setae *e1–e1* and between *f1–f1*, but within the *e1–f1* region is a large area of transverse striae. The shape of these transverse striae is roughly that of a diamond (Fig. 7c).

The striae of most female *Tetranychus* have many tiny lobes, formed by regular incisions in the ridges of cuticle that make the striae. The shape of these lobes may be species specific, but we have avoided this characteristic here. Lobes are minute, their density and form is subject to variation according to the conditions the spider mite experienced during development (Mollet & Sevacherian 1984; Carbonnelle & Hance 2004), and their form is also variable depending on what part of the mite is examined, how the slide was prepared and the length of time since the mite moulted (Dosse & Boudreaux 1962; personal observations). However, the distribution of lobes on the body may be significant. Some species are entirely without lobes, some have no lobes on the venter, and some have lobes extending varying distances from the pregenital region through the intercoxal region of the mite. Although

we have found this character useful and largely consistent within many species, it remains unreliable as within *Tetranychus urticae* because both lobed and lobeless forms are known to exist (Carbonnelle & Hance 2004).

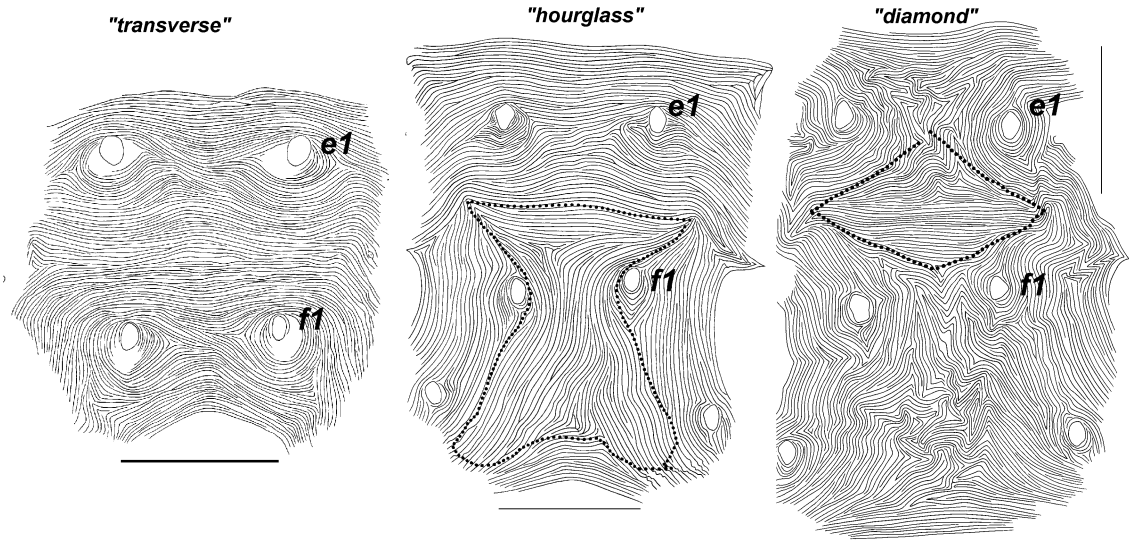


FIGURE 7. The three main forms of dorsal striae between setae *e1* and *f1* in *Tetranychus*. Scale bars = 50 μm.

Aedeagus

The aedeagus of tetranychid mites is of high taxonomic value, although there has been a tendency to create new species based on differences so minor that they seem, or are, indistinguishable. For example, *Tetranychus hydrangeae* Pritchard & Baker, 1955 and *Tetranychus kanzawai* Kishida, 1927, were distinguished by the aedeagal knob being 0.6 μm larger in *T. hydrangeae* (Ehara & Wongsiri 1975), prior to their synonymy by Navajas *et al.* (2001). A similar over-splitting of species based on trivial aedeagal differences is probable amongst the species close to *Oligonychus punicae* (Hirst, 1926): *O. coffeae* (Nietner, 1861), *O. mangiferus* (Rahman & Sapra, 1940) and *O. vitis* Zaher & Shehata, 1965, and perhaps even *O. ununguis* (Jacobi, 1905).

All characters relating to the aedeagus are based on a perfectly lateral view, i.e., the profile. The aedeagus comprises a shaft that may curve, either dorsally or ventrally, and may terminate in a knob. In *Tetranychus*, most species have a short shaft that curves abruptly upwards and often terminates in a knob. The knob can be absent, or nearly so, giving the aedeagus a sigmoid form, such as in *T. mcdanieli* McGregor, 1931. When present, the knob has a variously formed anterior and posterior projection (or prong). The orientation of the knob with the axis of the shaft and is another useful feature, as it varies from being parallel (most species), to acute (e.g., *T. marianae*) or obtuse (e.g., *T. mexicanus* McGregor, 1950).

In species with a distinct knob, the region where the shaft curves upwards towards the knob is herein referred to as the neck of the aedeagus. In a few species not treated here, there is a second posterior projection, such as in *Tetranychus armipenis* Flechtmann, 1970.

Distinguishing life stages and sexes

Spider mites have a larva and two nymphal stages, the protonymph and deutonymph, and three quiescent (resting) stages, one between each of these stages and the adult.

The adult female has an obvious genital area comprising tightly folded cuticle appearing as wavy striae around the posterior margin of the genital flap (Fig. 6). Under the stereomicroscope, females are larger, plumper, often a different colour to nymphal mites, and the wavy genital striae are visible. Spider mites overwinter as eggs or adult females; *Tetranychus* overwinter as adult females. Overwintering females are red to dark orange, making them appear strikingly different in species that are yellow-green during warmer months. Some species are red all year round.

Adult male *Tetranychus* have an aedeagus, a short blunt spur on the dorsal surface of the palp femur and a distinct leg-setal morphology; the most obvious is tarsus I, which has 4 solenidia (Fig. 2). The proximoventral hairs on empodium I are always fused into a claw. Under the stereomicroscope, males are smaller than females, often

orange-yellow to pale green in colour, have bodies that taper posteriorly to a blunt point, are often fast-moving, and can sometimes be seen guarding quiescent deutonymphs.

The protonymph and deutonymph usually have paler colouring than the adult female, and under the stereomicroscope look like small female mites. Under the compound microscope these two life stages are easily distinguished by the presence of ventral setae *4a*, *4b* and *g1* in the deutonymph only, as well as a suite of leg setal additions (Lindquist 1985).

Distinguishing the Tetranychidae from other mites

The Tetranychidae belongs to the superfamily Tetranychoidea, a group distinguished by the morphology of the mouthparts. The movable digit of the chelicerae has been highly modified to form an elongate stylet for piercing plant tissue (Reck 1952; Baker & Pritchard 1953; Krantz 1978; Walter *et al.* 2009). These recurved J-shaped chelicerae distinguish tetranychoids from all other mites. Their bases also form a deeply retractable stylophore, present only in the Tetranychoidea and some Raphignathoidea (Walter *et al.* 2009). The Tetranychidae can be distinguished from other tetranychoid families by the combination of a palp thumb-claw structure, lateral prodorsal eyes and the absence of long filamentous setae on the posterior of the mite (Donnadieu 1876; Baker & Pritchard 1953; Pritchard & Baker 1955).

Distinguishing *Tetranychus* from other Tetranychidae

The family Tetranychidae is split into two subfamilies, the Bryobiinae and Tetranychinae, with *Tetranychus* belonging to the latter subfamily. The subfamilies are distinguished by the form of the empodia in the female mite: tenent hairs are present on the empodium in Bryobiinae (Fig. 3A, B) but absent on the empodium in Tetranychinae (Fig. 3C–H). In the Tetranychinae, the empodium may be absent (Fig. 3C), claw-like (Fig. 3E–F), comprising fine hairs only (empodial or proximoventral hairs) (Fig. 3G), a claw with basal fine hairs (empodial or proximoventral hairs) (Fig. 3H), or it can have a dorsal spur (Fig. 3D)—but it never has tenent hairs. *Tetranychus* tends to have an empodium consisting of proximoventral hairs with or without a dorsal spur (Fig. 3G), except for the male empodium I (and sometimes II) where it is claw-like (Fig. 3D, F). The dorsal spur on the empodium of *Tetranychus* is usually small, but ranges from absent to obvious in different species, and is a useful diagnostic character.

After determining the structure of the empodium, the next step is to look for dorsal seta *h1*. Setal rows *c*, *d* and *e* form clearly transverse rows, but those of *f* and *h* are curved (Fig. 5). Row *h* is curved so much that setae *h3*, and sometimes *h2*, are placed on the ventral side of the mite (Fig. 5b). When determining if *h1* is present, start at row *c* and count through the rows until row *h* is reached. If setae *h1* are present, they will be inserted centrally in the next setal row behind *f1*. Setae *h1* when present tend to be the same morphology as the other dorsal setae, whereas setae *h2* and *h3* are shorter and thinner than *h1*, and are inserted more laterally (and/or ventrally) than *h1* (Fig. 5a). Setae *h2* and *h3* are often lateral of the anus (Fig. 6). Only two genera, *Tetranychus* and *Amphitetranychus* Oudemans, 1931, have the combination of empodia comprising just fine hairs (Fig. 3G) and *h1* absent. These two genera can be distinguished by their peritremes: in *Tetranychus* they are hook-like (Fig. 8), but in *Amphitetranychus* they

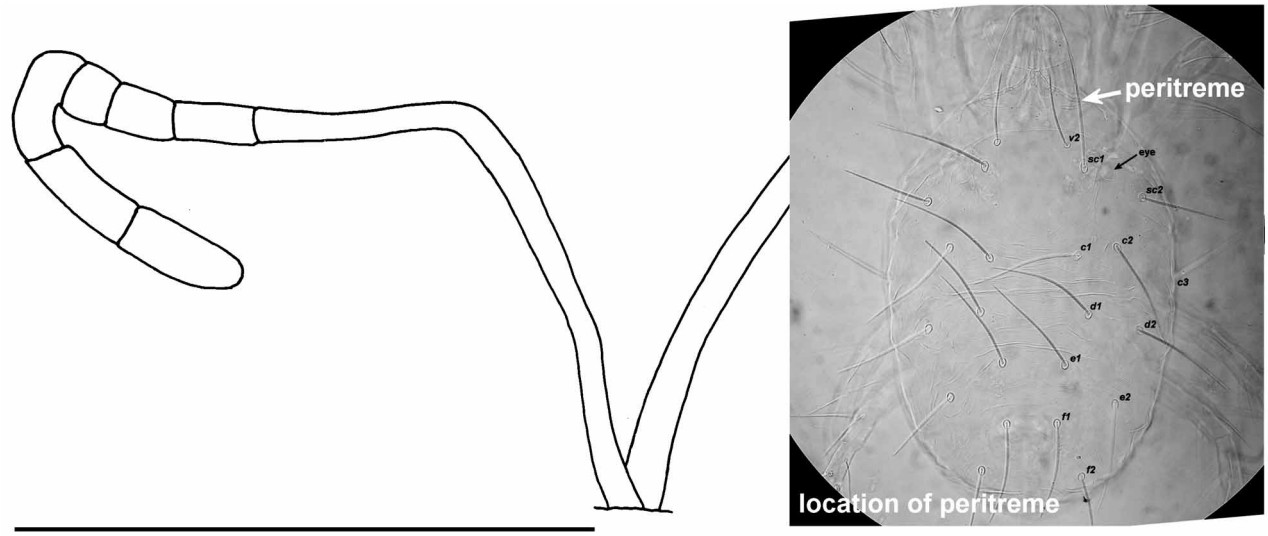


FIGURE 8. Peritreme of *Tetranychus* sp. Scale bar = 50 µm.

are anastomosing (branching) and protrude from the anterior margin of the prodorsum. *Amphitetranychus* is absent in Australia and contains the economically-important species *A. viennensis* (Zacher, 1920).'

Key to *Tetranychus*: naturalised Australian species and exotic species of quarantine concern to Australia

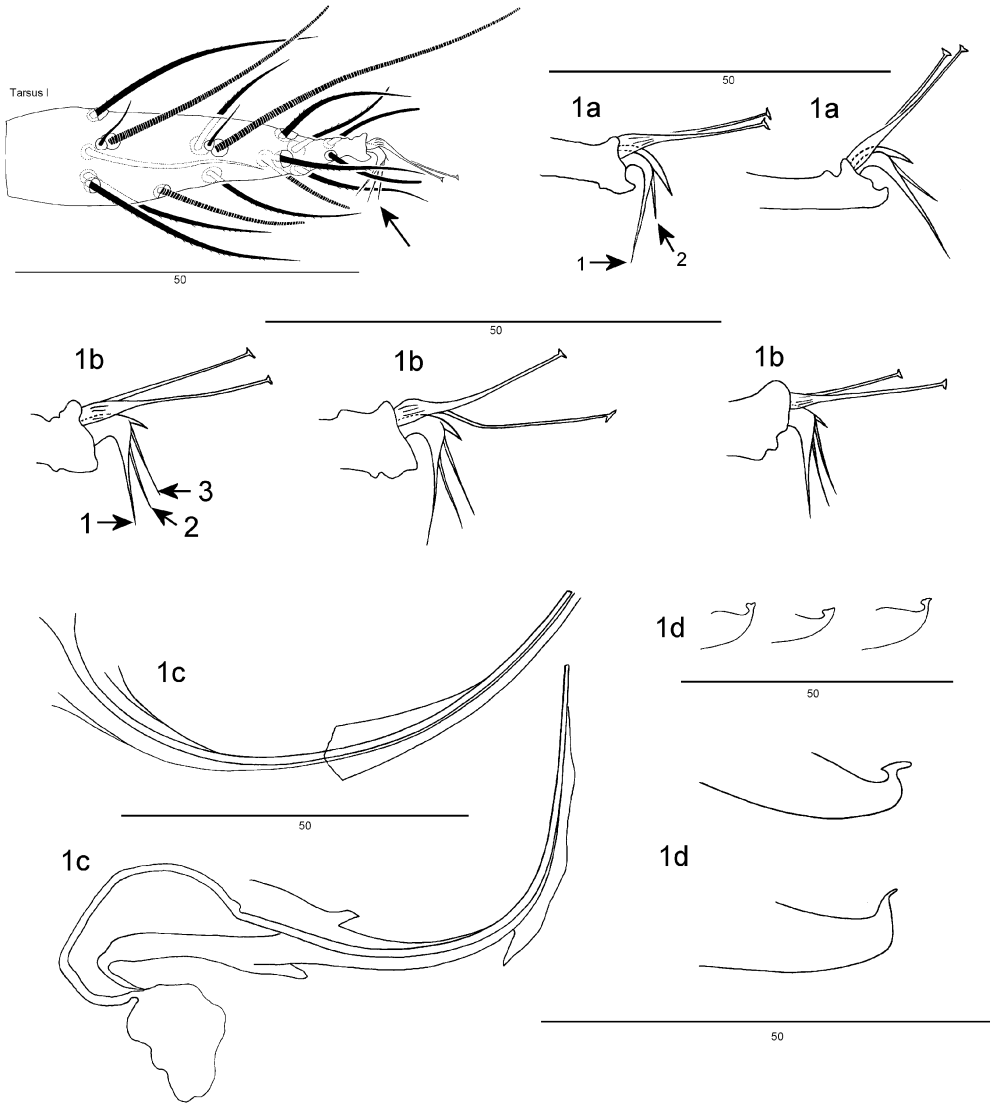
Female and male mites are required for this key. Males must be mounted laterally. A plate of line drawings of aedeagi is provided at the end of the key (Fig. 9), but we urge users to employ characters other than the aedeagus for identifications, where possible.

This key is a modification of several existing keys, notably Baker & Tuttle (1994) and Flechtmann and Knihinicki (2002). Species in bold are not known from Australia. Unlabelled scale bars are 50 μm.

Notes: **1.** Some *T. lambi* will key to couplet 21 but females of this species have entire pregenital striae sometimes with lobes. **2.** Couplet 10, the number of proximal setae overlapping with the proximal duplex setae varies. Where possible, examine several specimens and look at both left and right tarsi. **3**. Some *T. marianae* will key to couplet 12 but have a high $\sum d_{prox}$ value and different form of the aedeagus. **4.** *T. gloveri* was recently detected—and eradicated—in Darwin (L. Zhang, personal communications).

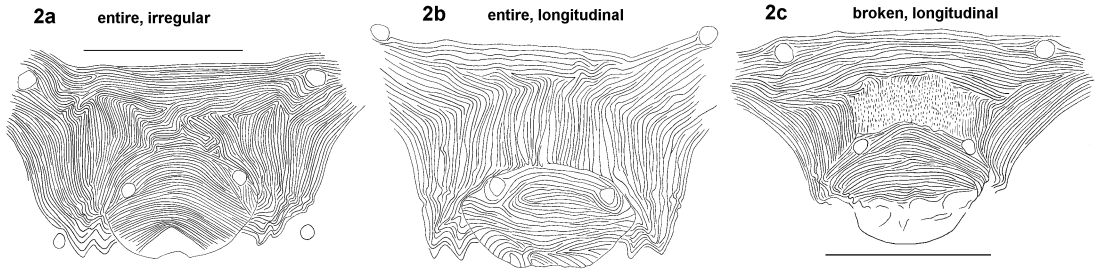
1 **Female:** Empodia with 2 pairs of proximoventral hairs, the dorsal being much smaller than the ventral (1a); dorsal empodial spur present. **Male:** aedeagus very long and tapered (1c). . . . . *T. fijiensis* Hirst

\- **Female:** Empodia with 3 pairs of proximoventral hairs (1b); dorsal empodial spur present or absent. **Male:** aedeagus usually with an apical knob (1d), if without apical knob then aedeagus not very long **2**



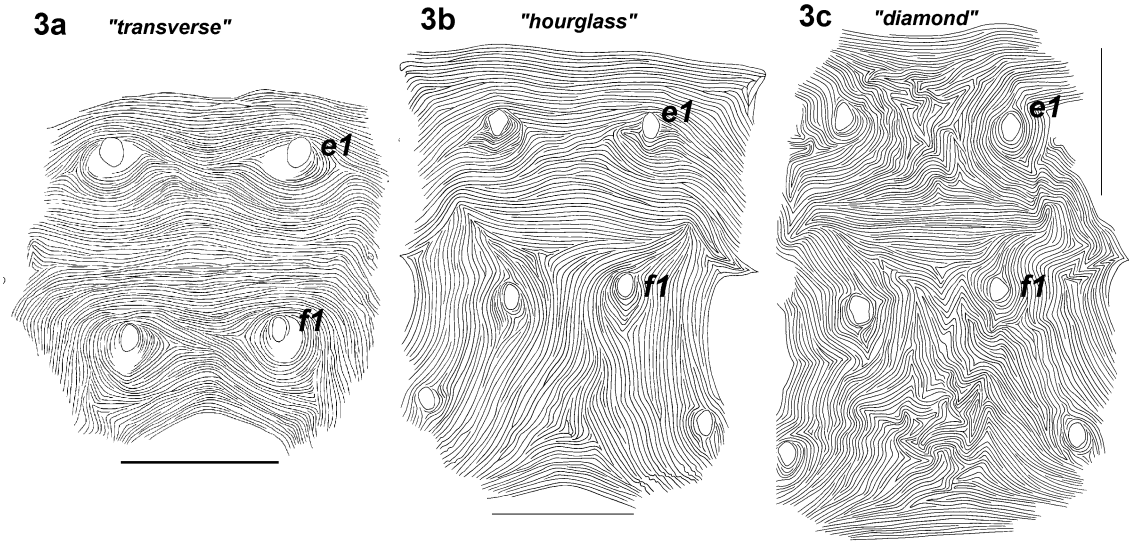
2 **Female:** Pregenital striae entire *and* irregular, comprising oblique and longitudinal sections (2a). Known only from *Rhagodia* sp. (Chenopodiaceae) in Tasmania . . . . . *T. rhagodiae* Miller

\- **Female:** Pregenital striae entire (2b) or broken (2c), sometimes nearly absent medially, but comprising only longitudinal striae **3**



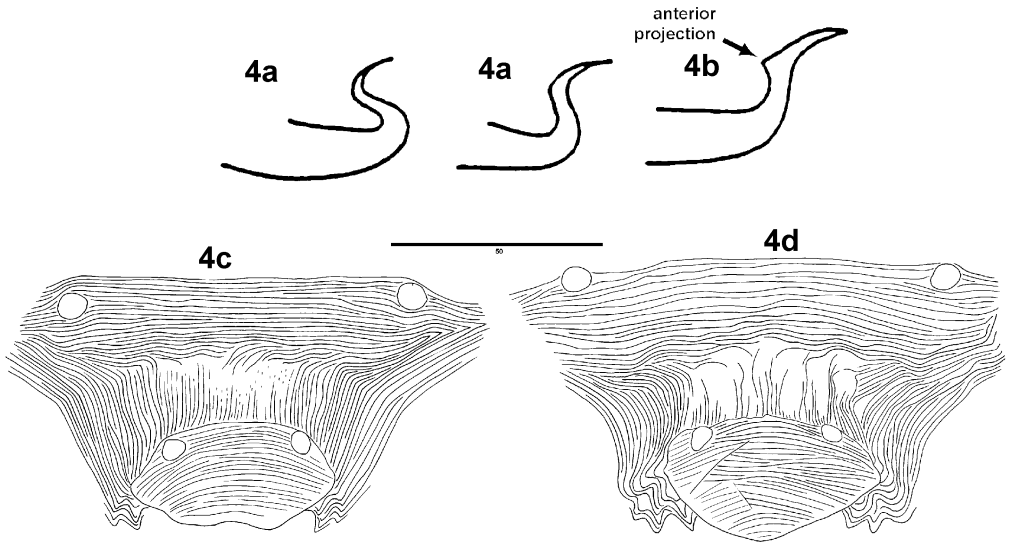
3 **Female:** Dorsal hysterosomal striae entirely transverse, no longitudinal striae present (3a) **4**

\- **Female:** Dorsal hysterosomal striae with at least some longitudinal or oblique striae, usually between setae *f1–f1* and/or *e1–e1* (3b, 3c) **5**



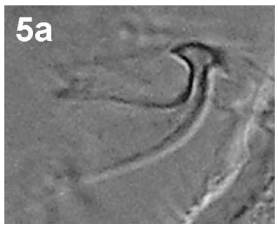
4 **Male:** Aedeagus strongly sigmoid, tapering strongly distally, without a distinct apical knob (4a). **Female:** Pregenital striae a mixture of broken and solid lines (4c); dorsal striae mostly without lobes . . . . . ***T. mcdanieli*** McGregor

\- **Male:** Aedeagus angular, with large tapered posterior projection, anterior projection small, angular (4b). **Female:** Pregenital striae irregular and vague (4d); dorsal striae with lobes . . . . . ***T. pacificus*** McGregor



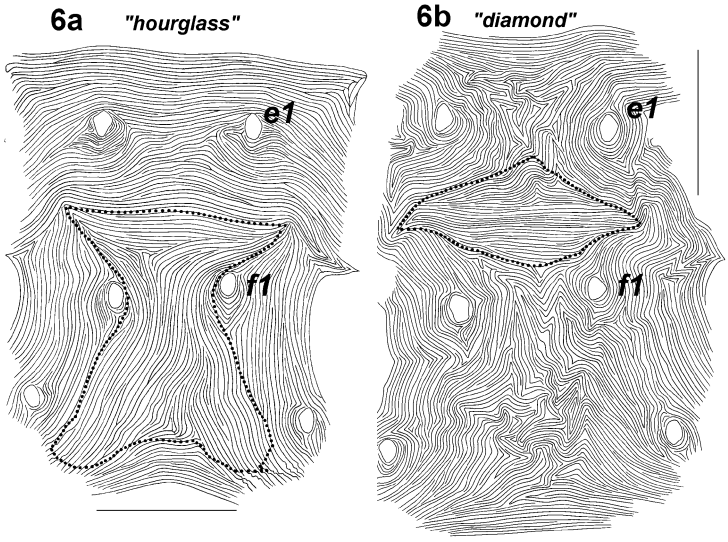
5 **Female:** Tarsus III with 2 proximal tactile setae (total of 10 setae + 1 solenidia); lobes absent on ventral striae. **Male:** Knob of aedeagus large, 2–3x the width of the neck; posterior projection and often anterior projection long, its length longer than the width of the neck (5a) . . . . . ***T. mexicanus*** (McGregor)

- **Female:** Tarsus III with 1 proximal seta (total of 9 setae + 1 solenidia); lobes present or absent on ventral striae. **Male:** Knob of aedeagus variable in size and form **6**



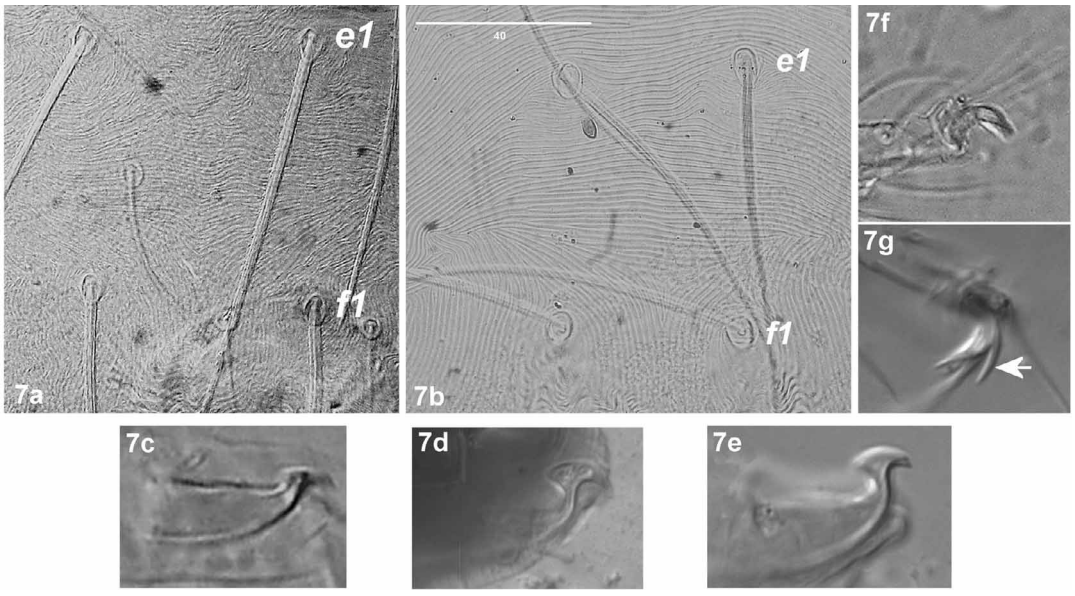
6 **Female:** Dorsal striae transverse, or mostly so, between setae *e1–e1*, forming an "hourglass" shape between setae *fl- f1* (6a). . *canadensis* species group **7**

- **Female:** Dorsal striae longitudinal between setae *e1–e1*, forming a diamond shape between setae *e1–f1* (6b) **9**



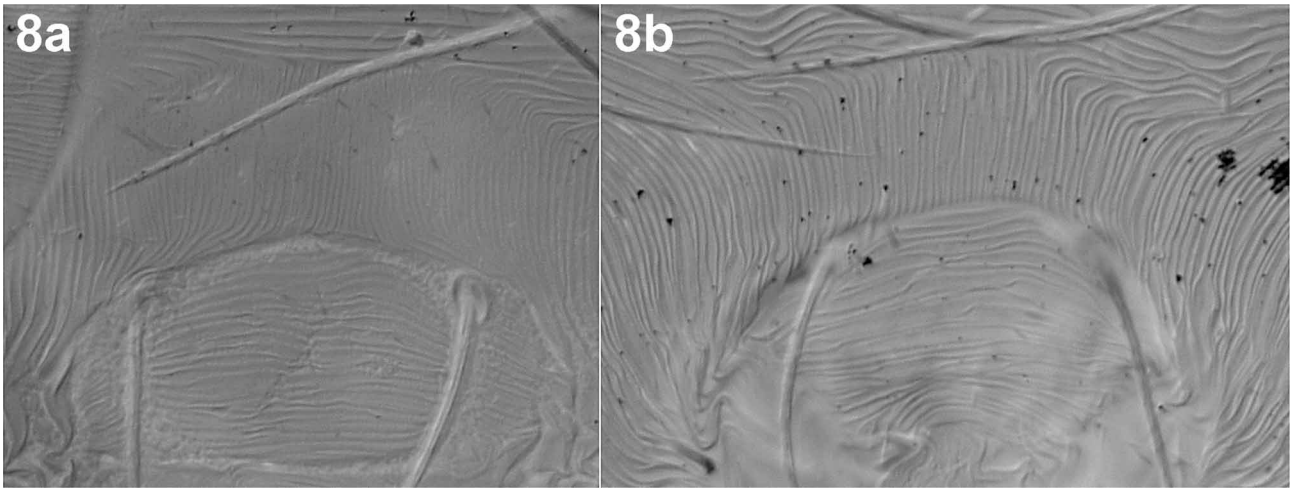
7 **Female:** Pregenital striae entire, strong, sometimes with lobes; striae between *e1–e1* often irregular, wavy (7a). **Male:** Knob of aedeagus with flattened dorsal surface (7c); empodia I–II with spurs minute or absent, ≤ 1 µm long (7f) . . . . . *T. lambi* Pritchard & Baker

- **Female:** Pregenital striae broken, always without lobes; striae between *e1–e1* mostly or entirely straight, transverse (7b). **Male:** Knob of aedeagus with convex dorsal surface (7d, 7e); empodia I–II with large spurs, > 2 µm (7g) **8**



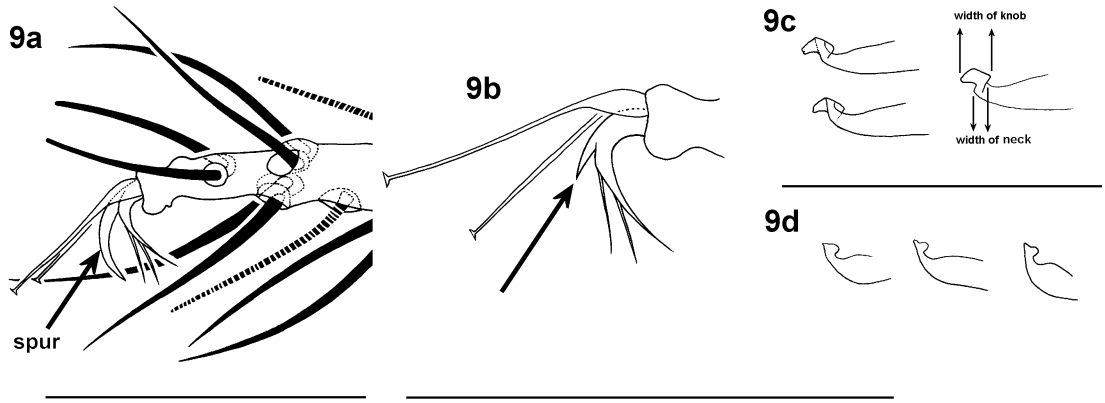
8 **Female:** Pregenital striae fine, including several incomplete longitudinal lines (8a) . . . . . ***T. canadensis*** (McGregor)

\- **Female:** Pregenital striae coarse, comprising strong longitudinal lines (8b) . . . . . ***T. schoenei*** McGregor



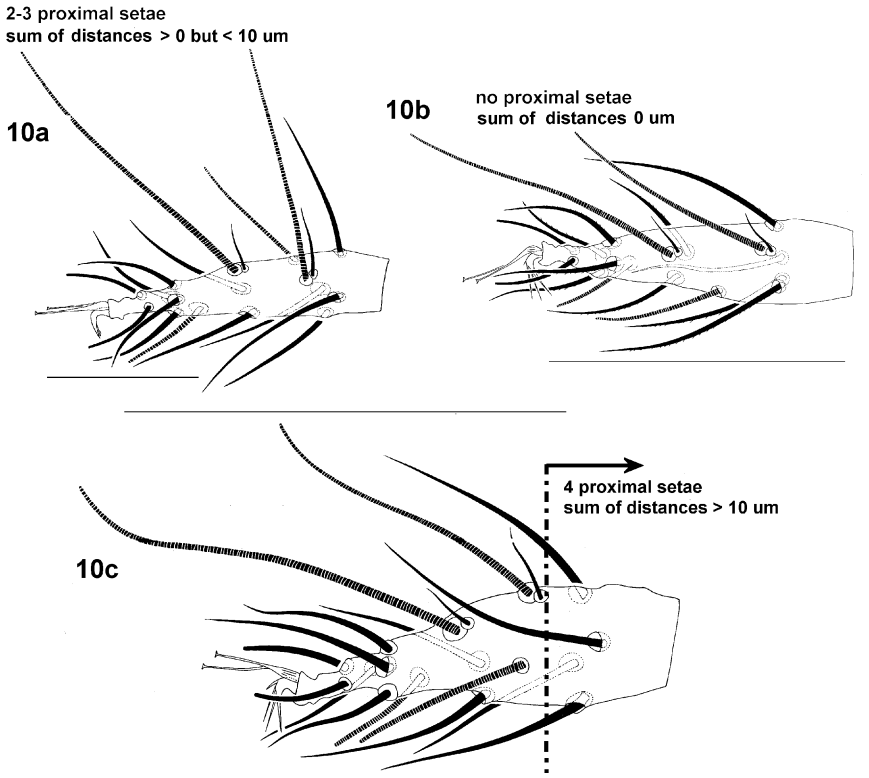
9 **Female:** Empodium of tarsus I with unusually long (> 20 µm) spur (9a). **Male:** Length of knob of aedeagus > 2x the width of the neck 9c) . . . . . *T. bunda* Flechtmann & Knihinicki

\- **Female:** Empodium of tarsus I with small (< 5 µm) spur (9b). **Male:** Length of knob of aedeagus variable, but knob of aedeagus usually < 2x width of the neck (e.g., 9d) **10**



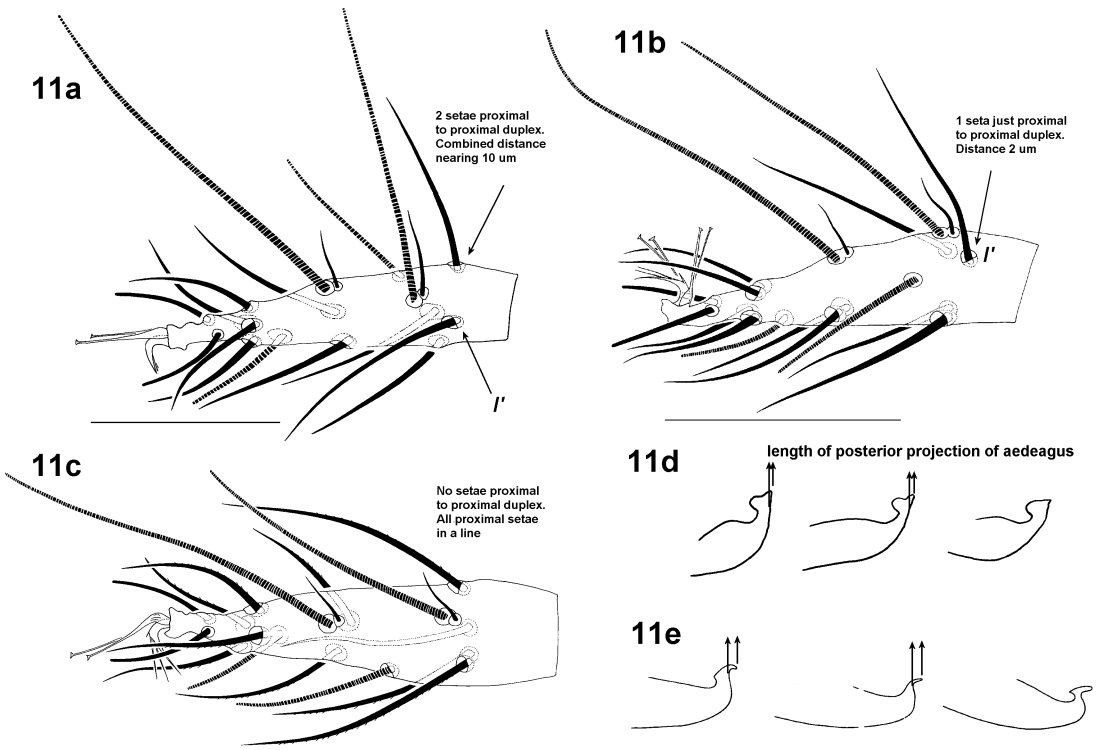
10*² **Females:** Tarsus I with the socket of proximal duplex setae overlapping with the sockets of 2–5 (usually 3 or 4) proximal tactile setae (10a,b): Σd_{prox} < 10 µm*² **11**

- **Females:** Tarsus I with the socket of proximal duplex setae distal to the sockets of 4 proximal tactile setae (10c), although some specimens may have 1–2 setae overlapping: Σd_{prox} > 10 µm*² **15**



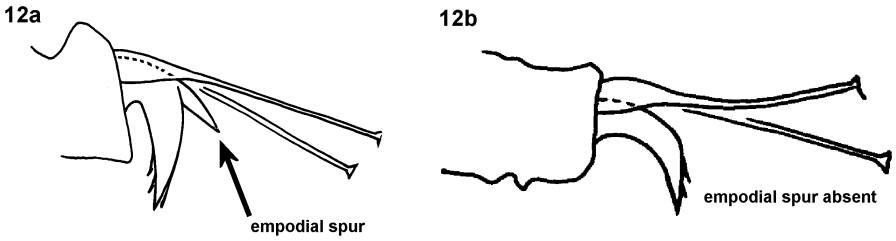
11 **Female:** Tarsus I with the sockets of 1–2 tactile setae proximal to the socket of the proximal pair of duplex setae (11a,b): Σd_{prox} 2–10 µm. Lobes present on ventral striae. **Male:** Posterior projection of aedeagus present but small (11d). **12**

- **Female:** Tarsus I with the sockets of zero tactile setae proximal to the socket of proximal pair of duplex setae (11c). Lobes present or absent on ventral striae. **Male**: Posterior projection of aedeagus absent *OR* large and directed dorsally or bent sharply downwards (11e) . . . . . *desertorum* species group. **13**



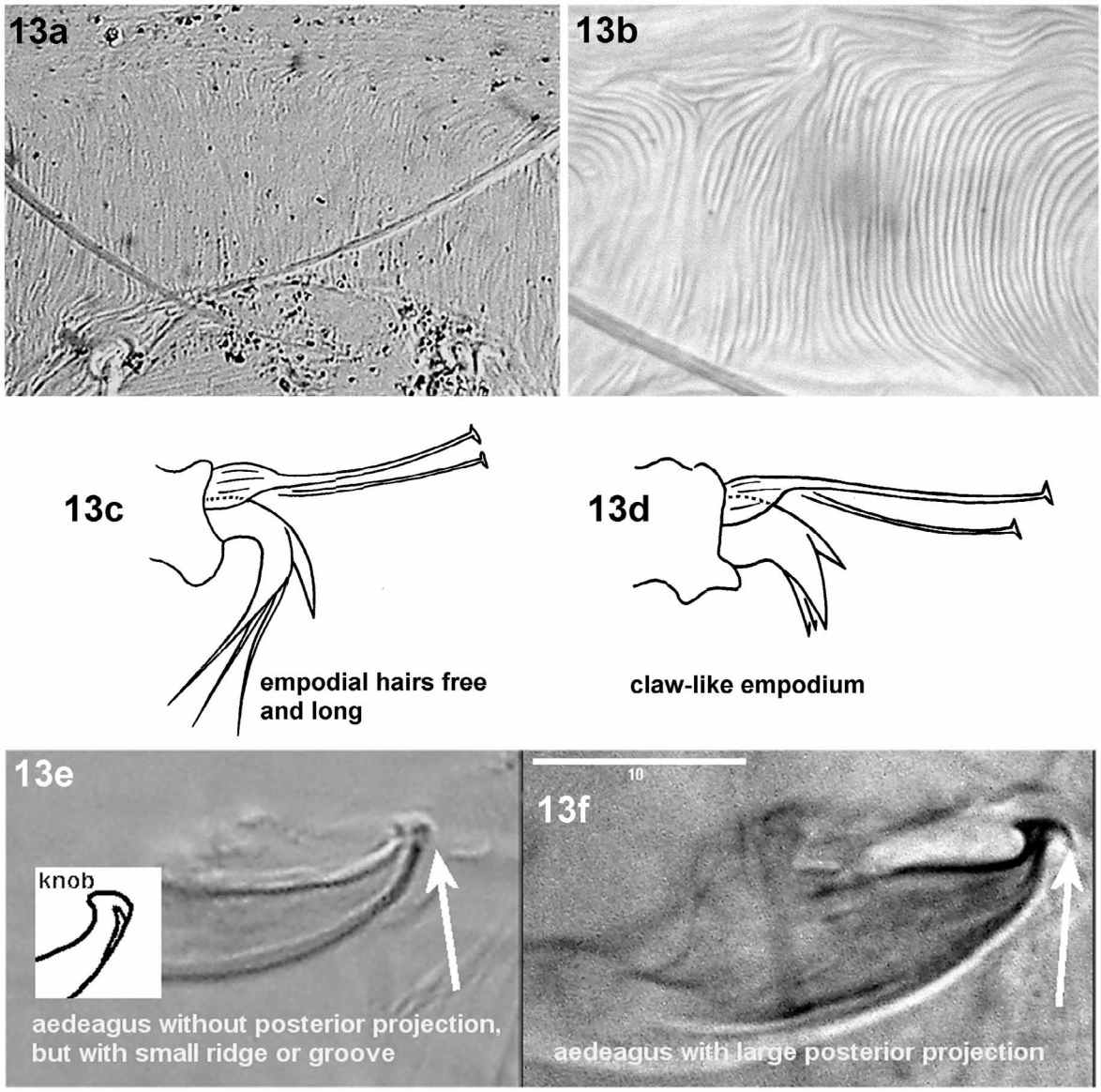
12*[3] **Female:** On tarsus I, socket of *l′* just proximal to the proximal duplex setae (ca. 2 µm), the other 3 proximal tactile setae clearly overlapping with duplex setae (see 11b). Lobes on ventral striae between genital area and setae *1a*. **Male:** All empodia with large (4 µm) dorsal spurs (12a) . . . . . ***T. macfarlanei*** Baker & Pritchard

- **Female:** On tarsus I, socket of *l′* 5–7 µm from the proximal edge of the proximal duplex setae, the sockets of the other 3 proximal tactile setae overlapping or slightly proximal to the proximal duplex setae (see 11a). Lobes on ventral striae only between genital region and setae *4a*. **Male:** All empodia with small (2 µm) spurs or spurs absent (12b) . . . . . ***T. yusti*** McGregor



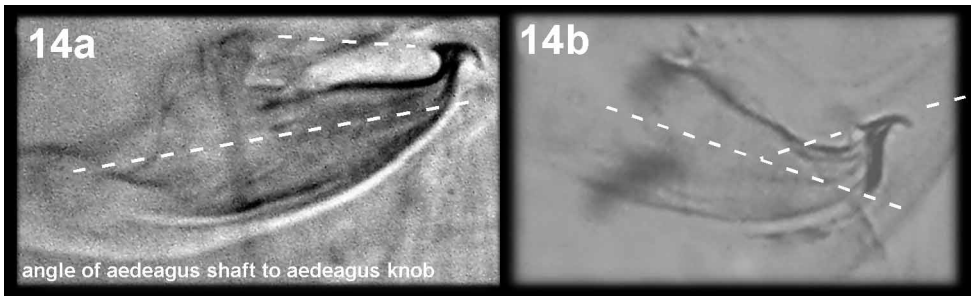
13 **Female:** Pregenital striae broken anteromedially (13a). Lobes present on ventral striae extending from genital area to at least setae *2a*. **Male:** Empodia II with long, thin proximoventral hairs, unlike empodia I, similar to empodia III–IV (13c). Aedeagus with knob directed dorsally, short anterior projection, posterior margin smoothly curved with medial ridge that can appear like a hook (13e). . . . . *T. ludeni* Zacher

- **Female:** Pregenital striae entire (13b), but may be sparse medially with small breaks. Lobes absent on ventral striae. **Male:** Empodia II claw-like, like empodia I, different from empodia III–IV (13d). Posterior projection of aedeagus present (13f) **14**



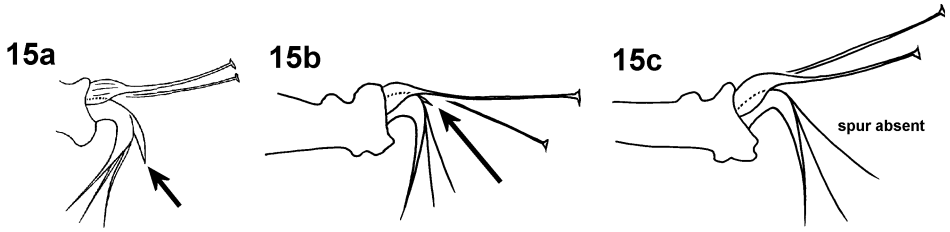
14 **Male:** Knob of aedeagus with axis parallel or at slight angle to that of the main shaft; posterior projection of aedeagus a large sharp hook, bent downwards (14a). **Female:** Pregenital striae entire and dense laterally and medially . . ***T. desertorum*** Banks

\- **Male:** Knob of aedeagus directed at dorsal angle to axis of shaft (14b). **Female:** Pregenital striae entire, sometimes sparse and slightly broken medially . . . . . ***T. evansi*** Baker & Pritchard



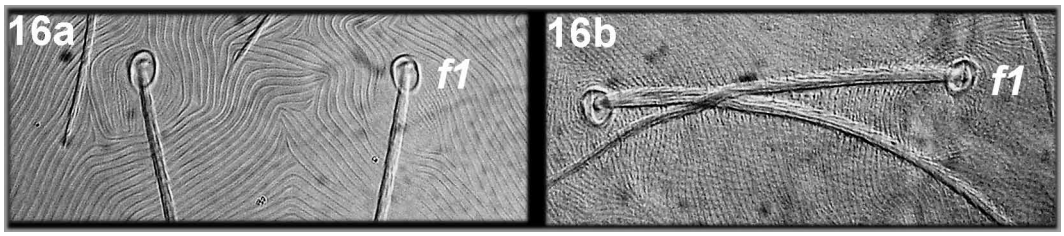
15 **Female:** Empodia I–II with a large (≥ 4 µm long) spur (15a) **16**

\- **Female:** Empodia I–II with spur absent or small (≤ 2 µm long) (15b, 15c). **17**



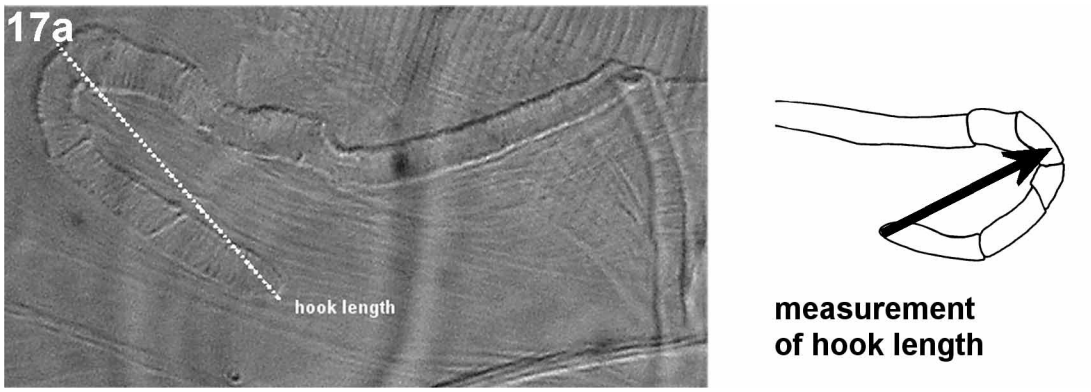
16*[4] **Female:** Lobes entirely, or almost entirely, absent on dorsal and ventral striae (16a). Rarely found on host plants other than *Ulex* spp. (Fabaceae) . . . . . *T. lintearius* Dufour

\- **Female:** Lobes present on dorsal and ventral striae (16b) . . . . . ***T. gloveri*** Banks



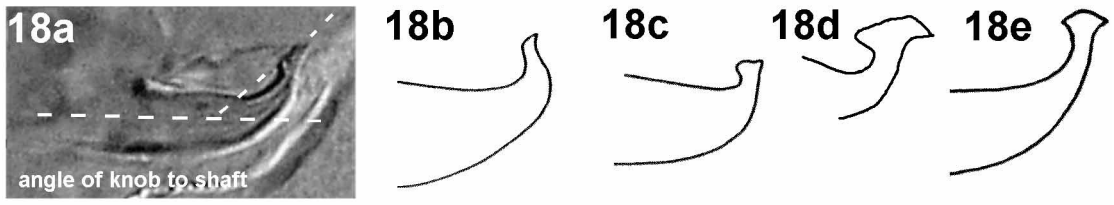
17 **Female:** Peritreme with hook 10–15 µm long. Found only on *Dianella* spp. (Phormiaceae) . . . . . *T. dianellae* Davis

\- **Female:** Peritreme with hook > 15 µm long, usually > 20 µm (17a). **18**



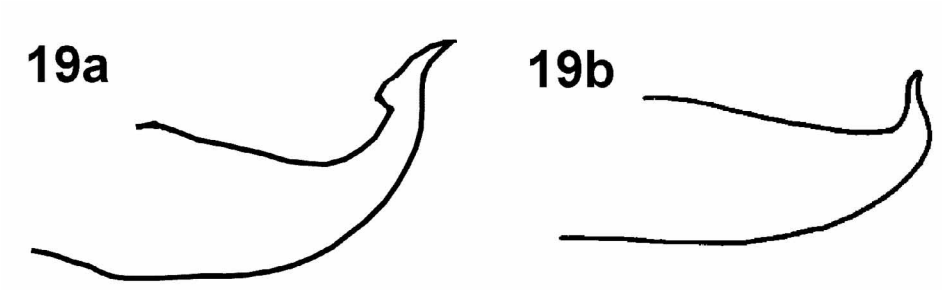
18 **Male:** Knob of aedeagus at a conspicuous angle (30–45 º) to the main shaft of aedeagus (18a) *OR* knob indistinct or absent (18b) **19**

- **Male:** Knob of aedeagus small to large, but distinct, parallel to shaft of aedeagus, or nearly so, forming an angle of 0–20 º (18c,d,e). **20**



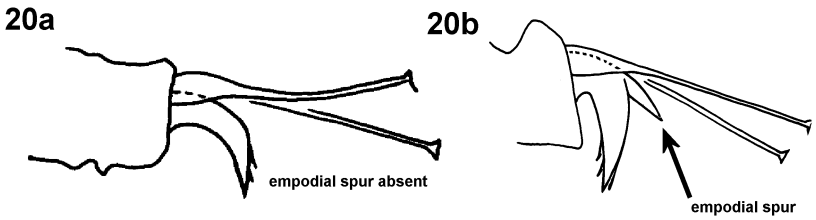
19 **Male:** Aedeagus with a distinct knob, the posterior projection long (19a). . . . . *T. marianae* McGregor

- **Male:** Aedeagus without a distinct knob, weakly sigmoid, with neck tapering to a pointed tip (19b) . . . . ***T. piercei*** McGregor



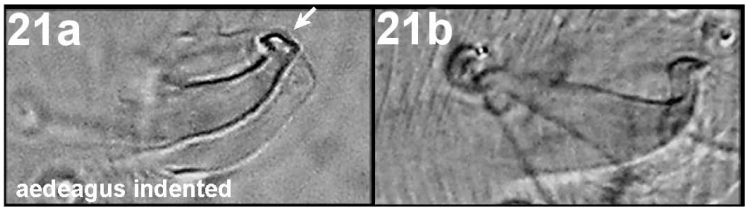
20 **Male:** Empodia I–II with spurs minute or absent, ≤ 1 µm long (20a) **21**

- **Male:** Empodial I–II with larger spurs, ≥ 2 µm long (2b) **22**



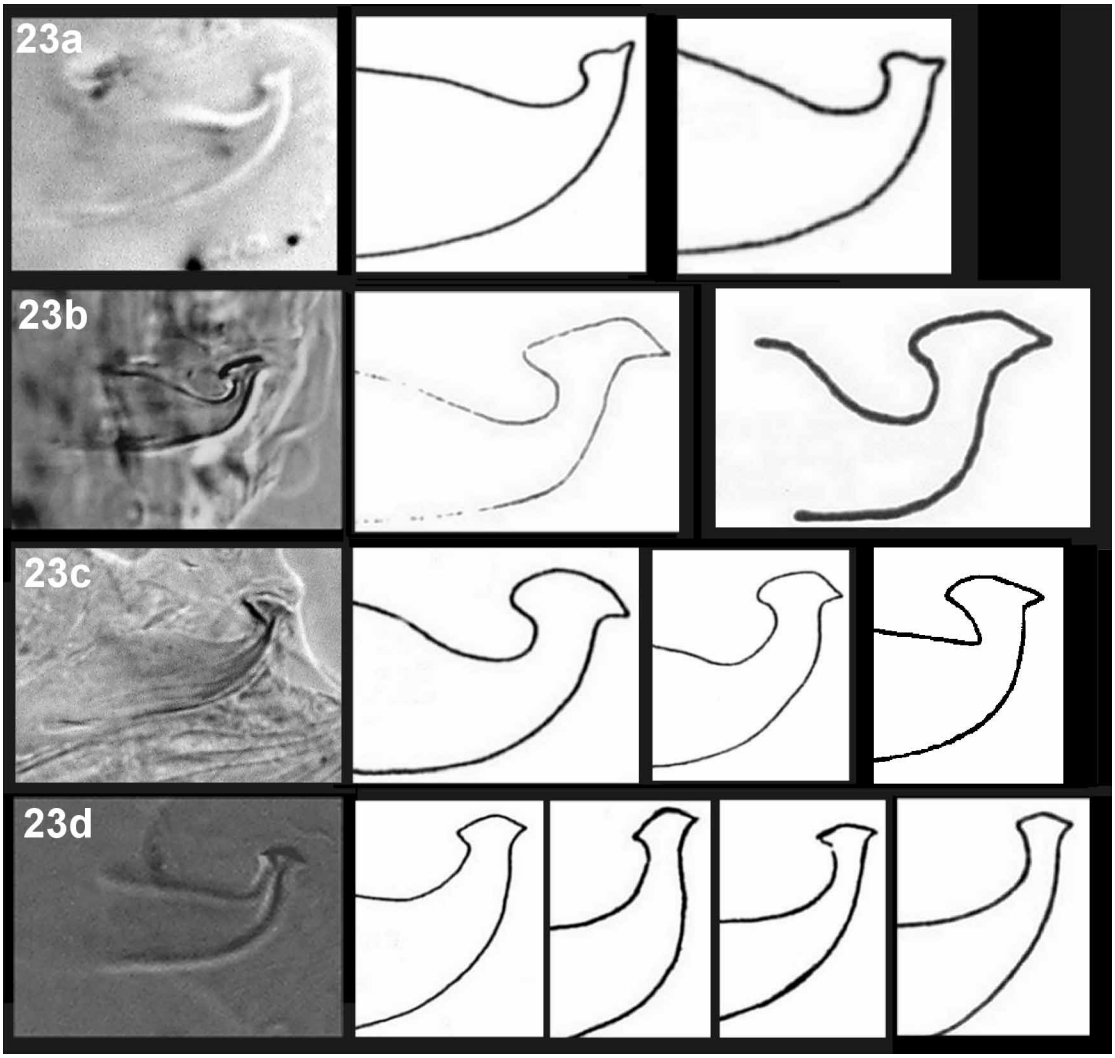
21*[1] **Males:** Dorsal margin of knob of aedeagus highly rounded, with medial indentation (21a) . . . . . *T. neocaledonicus* (Andre)

- **Males**: Dorsal margin of knob of aedeagus slightly rounded, without medial indentation (21b) . . *T. lombardinii* Baker & Pritchard



22 **Male:** Dorsal margin of knob of aedeagus with a medial indentation (23a) . . . . . ***T. truncatus*** Ehara
- **Male:** Dorsal margin of knob of aedeagus angulate flat or evenly rounded (23b, 23c, 23d) **23**

23 **Male:** Knob of aedeagus with large posterior projection, its length approximately equal to the width of the neck; dorsal margin of the knob angulate (23b) . . . . . ***T. turkestani*** (Ugarov & Nikolskii)
- **Male:** Knob of aedeagus with smaller posterior projection, its length shorter than the width of the neck; dorsal margin of the knob rounded or angulate (23c, 23d) **24**



24 **Male:** Knob of aedeagus large, about twice as wide as the width of the neck; dorsal margin of knob tends to be rounded (23c). **Female:** Females collected in summer are red . . . . . *T. kanzawai* Kishida
- **Male:** Knob of aedeagus small, less than twice as long (about 1.5x) as the width of the neck; dorsal margin of knob tends to be angulate (23d). **Female:** Females collected in summer are green, yellow or red . . . . . *T. urticae* Koch

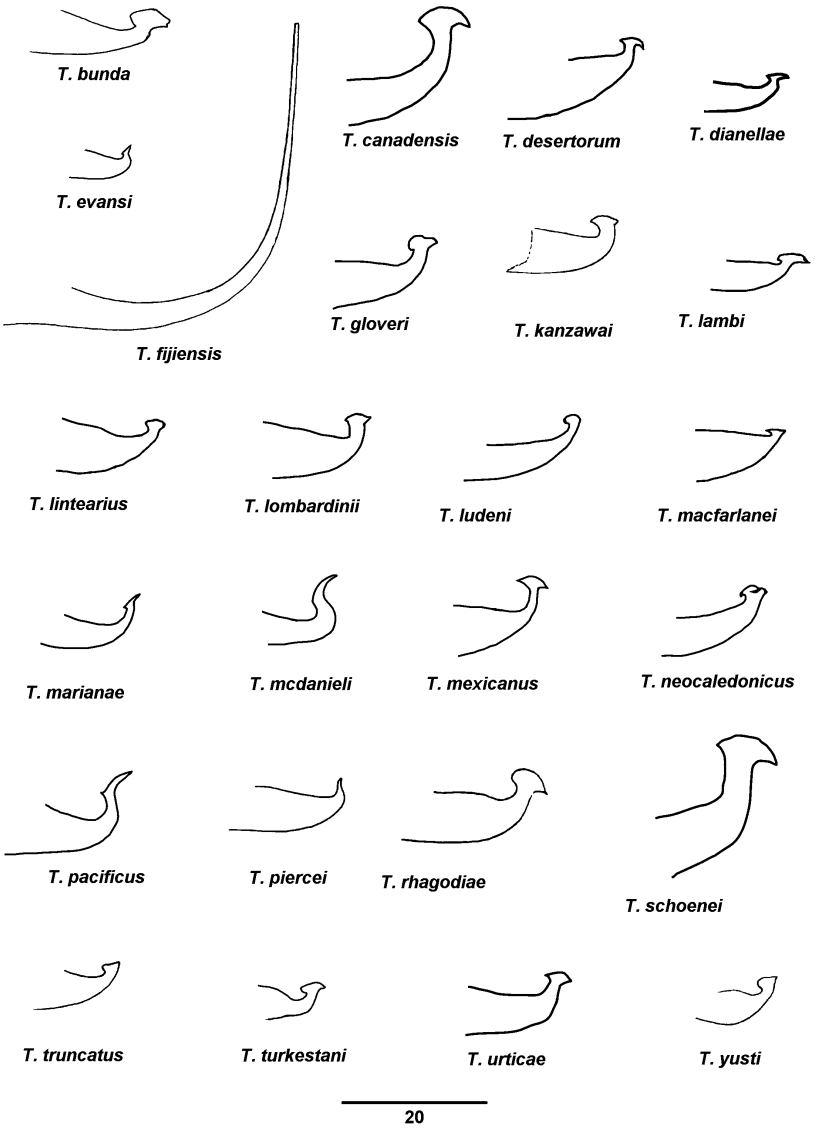


FIGURE 9. Lateral view of the aedeagus of *Tetranychus* spp., with posterior projections to the right hand side.

Tetranychus bunda Flechtmann & Knihinicki, 2002 (Fig. 10)

Non-type specimens examined, Australia: Northern Territory: 2 females, 1 male, Port Hill Wharf, 2.xi.1999, S. Smith, ex Florida Beggarweed *Desmodium tortuosum* (Fabaceae). Duplicates of 41173. In QM.

Diagnosis

Female: Empodia with 6 hairs; spurs on empodia I–IV present and unusually large (20 µm long); *tarsus I* with socket of 1 tactile seta (seta l_1'') proximal to socket of the proximal duplex setae, the other 3 proximal tactile setae entirely overlapping with the socket of the proximal duplex setae, or just 1–2 tactile setae slightly proximal to the socket of the duplex setae; $\sum d_{prox}$ = 3–8 µm; D_{duplex} = 15–19 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 20–25 µm long; *dorsal striae* between setae *e1–e1* and *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse, forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* from genital region to setae *3a* with lobes; *pregenital striae* broken.

Male: Empodia I–IV each with long (20 µm) dorsal spur; empodia I claw-like (uncinate), empodia II–IV with long and free proximoventral hairs. Knob of aedeagus large, dorsally angulate, with bluntly pointed anterior and posterior projections.

Remarks

Tetranychus bunda is known only from two collections made in Darwin during November 1999 on introduced Florida beggarweed *Desmodium tortuosum* (Fabaceae). The mites were common, with over 200 individuals on some leaves, and most occurred on the underside of leaves (Flechtmann & Knihinicki 2002). Live newly-moulted female mites are initially light to dark green, but become light to deep purple and dark-orange upon maturity. The legs are pale yellow. Live male mites are pale to light green (Flechtmann & Knihinicki 2002). Webbing is sparse. As the host plant is not native to Australia but is native to Central America (Flechtmann & Knihinicki 2002), this species either has an unknown native Australian host or is an exotic species not yet known in its native range.

Importance

Not significant.

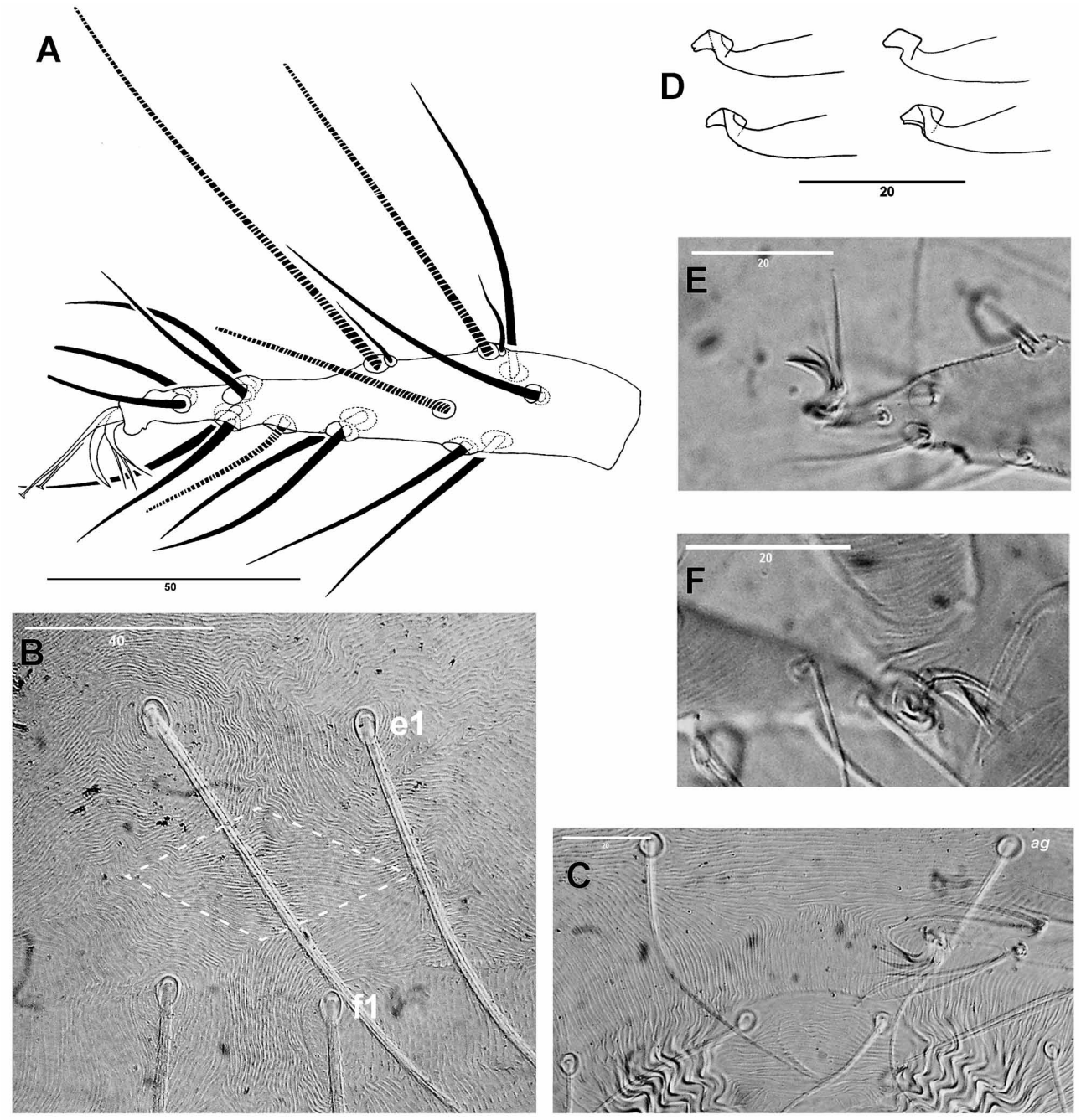


FIGURE 10. *Tetranychus bunda* Flechtmann & Knihinicki, female. (a) Tarsus and pretarsus I; (b) Diamond pattern of dorsal striae between setae e and f; (c) Pregenital striae. Male: (d) Aedeagus at four different focal points; (e) Pretarsus I; (f) Pretarsus II.

***Tetranychus canadensis* (McGregor, 1950)**
(Fig. 11)

Type specimens examined, Canada: Approximately 40 specimens on one slide, of which about 20 are circled on the slide; the single male on this slide is assumed to be the holotype. Ontario, 1938, ex Apple *Malus domestica* (Rosaceae), Type 1733, 38-12699. In USNM.

Non-type specimens examined, U.S.A.: 2 females, 2 males, Washington D.C., 13.vi.1961, E.W. Baker, ex Horse Chestnut *Aesculus hippocastanum* (Sapindaceae). In USNM. 1 male, Estey, Michigan, 13.vii.1962, D.M. Tuttle, ex Staghorn Sumach *Rhus typhina* (Anacardiaceae), det. D.M. Tuttle. 3 females, Mesa, Arizona, 16.x.1964, R.D. Gerhart, ex Arizona Ash *Fraxinus vekutina* (Oleaceae), det. D.M. Tuttle (two slides). 1 male, Yuma, Arizona, 6.v.1967, ex Fieldbind Weed *Convolvulus arvensis* (Convolvulaceae). 1 female, Somerton, Arizona, 21.v.1962, G.L. Arviza, ex White [or Silver] Horse Nettle, Bull-nettle, Trompetilla *Solanum elaeagnifolium* (Solanaceae). All in QDPI.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with minute-absent dorsal spur; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 20–28 μm; D_{duplex} = 7–9 μm; *tarsus III* with 1 proximal tactile seta; peritreme hook = 19–22 μm long; *dorsal striae* between setae *e1–e1* and *e1–f1* transverse, dorsal striae between *f1–f1* longitudinal, forming an hourglass pattern between *f1–f1*; dorsal striae usually with small lobes or lobes absent; *ventral striae* without lobes; *pregenital striae* weak but complete.

Male: Empodia I–IV each with an obvious dorsal spur, 3–4 μm long. Empodia I uncinate, empodia II with free proximoventral hairs. Knob of aedeagus large, dorsal margin convex, with long posterior projection and short anterior projection.

Remarks

Tetranychus canadensis is almost identical to *T. schoenei*. McGregor (1950), Pritchard and Baker (1952), Reeves (1963) and Jeppson *et al.* (1975) distinguish *T. canadensis* from *T. schoenei* on the basis of the aedeagal shape alone: *T. schoenei* has a larger aedeagus, with a more convex dorsal margin and stronger hook (posterior projection). However, we found this comparison weak because the difference is barely perceptible, and we were unable to find any measurement to quantify the difference—if it exists.

The pregenital striae may differ slightly by being finer in *T. canadensis* in comparison to *T. schoenei*. This observation is in contrast to Baker and Tuttle (1994), who described the pregenital striae of *T. canadensis* as broken and *T. schoenei* as entire. We think the great similarity between *T. canadensis* and *T. schoenei* suggests the species are synonymous, with these minor differences representing variation across a wide geographic range, but further evidence is required before this action is taken.

Although Jeppson *et al.* (1975) records this species as a pest on several crops, we have little information on the biology of this species. They cause typical spider mite damage: rusty-speckling of leaves followed by leaf senescence (White 1964, 1965). Damage from *T. canadensis* is typically confined to tree-tops (Jeppson *et al.* 1975). These mites produce little webbing in their colonies. Females overwinter on tree-trunks and in soil at the base of trees (Jeppson *et al.* 1975). Its distribution suggests that *T. canadensis* is a cool-climate species (Bolland *et al.* 1998).

Importance

Entry potential: Its presence in Poland (Boczek & Kropczynska 1964) and Hungary (Hetenyi 1954), but no other part of Europe, suggests this species has the capacity to be moved long distances. Their overwintering life stage is probably obligate (Jeppson *et al.* 1975), thus, overwintering females may hide in natural cavities in produce and nursery stock. Its reasonably extensive and diverse host-list of 51 spp. (Bolland *et al.* 1998) suggests that the mites have a high chance of establishment on live plants. *Tetranychus canadensis* occurs in temperate countries, so we would expect this species could spread through southern Australia or apple growing areas such as Stanthorpe.

Economic: This species is occasionally a pest of apple, plum and cotton (Lienk & Chapman 1951; Pritchard & Baker 1955), and damage has been recorded on at least another 20 species (Jeppson *et al.* 1975).

The paucity of literature on *T. canadensis* supports Pritchard and Baker's (1955) observation that the species is only an occasional pest. Thus, we would expect *T. canadensis* to cause sporadic damage to a variety of hosts, espe-

cially in southern parts of Australia. However, the presence of *T. canadensis* in Australia could be detrimental to our access to some international markets. For example, South Africa prohibits apple and pear imports from areas infested with *T. canadensis*.

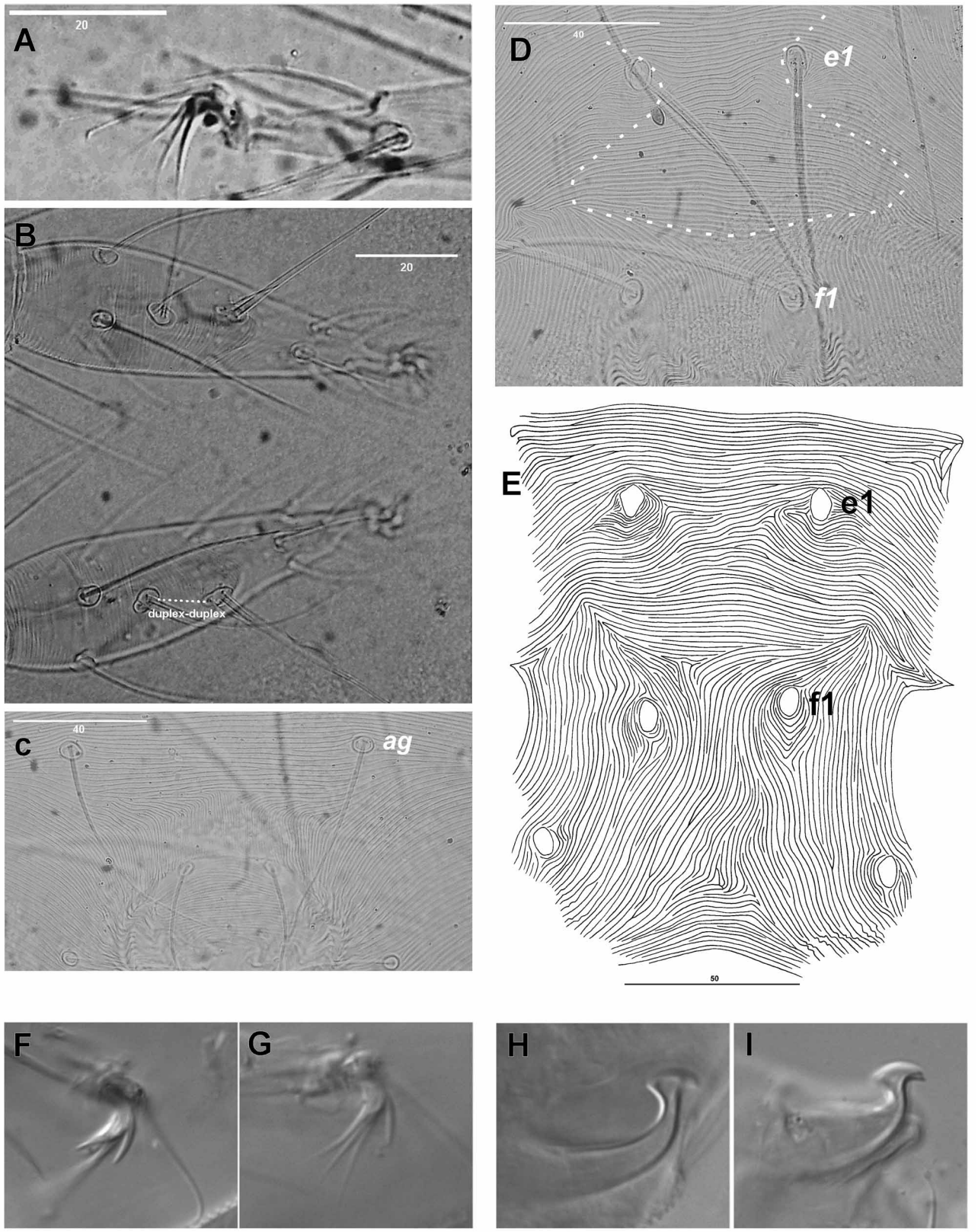


FIGURE 11. *Tetranychus canadensis* (McGregor), female. (a) Pretarsus I; (b) Tarsi I; (c) Pregenital striae; (d) Dorsal striae between setae e and f; (e) Hourglass pattern of dorsal striae between setae e and f. Male: (f) Pretarsus I, type specimen; (g) Pretarsus II, type specimen; (h) Aedeagus, type specimen; (i) Aedeagus.

***Tetranychus desertorum* Banks, 1900**
(Fig. 12)

Non-type specimens examined, U.S.A: 1 female, 1 male, Pinedale, Arizona, 25.vii.1966, D.H. Tuttle, ex Ragweed *Ambrosia confertiflora* (Asteraceae). 2 females, Yuma, Arizona, 8.vi.1967, D.H. Tuttle, ex White Horse Nettle *Solanum claeaynifolium* (Solanaceae). 1 male, Dome Valley, Yuma County, Arizona, 18.v.1962, G.L. Aryizo, ex Creosote Bush *Larrea tridentata* (Zygophyllaceae). All in QDPI.

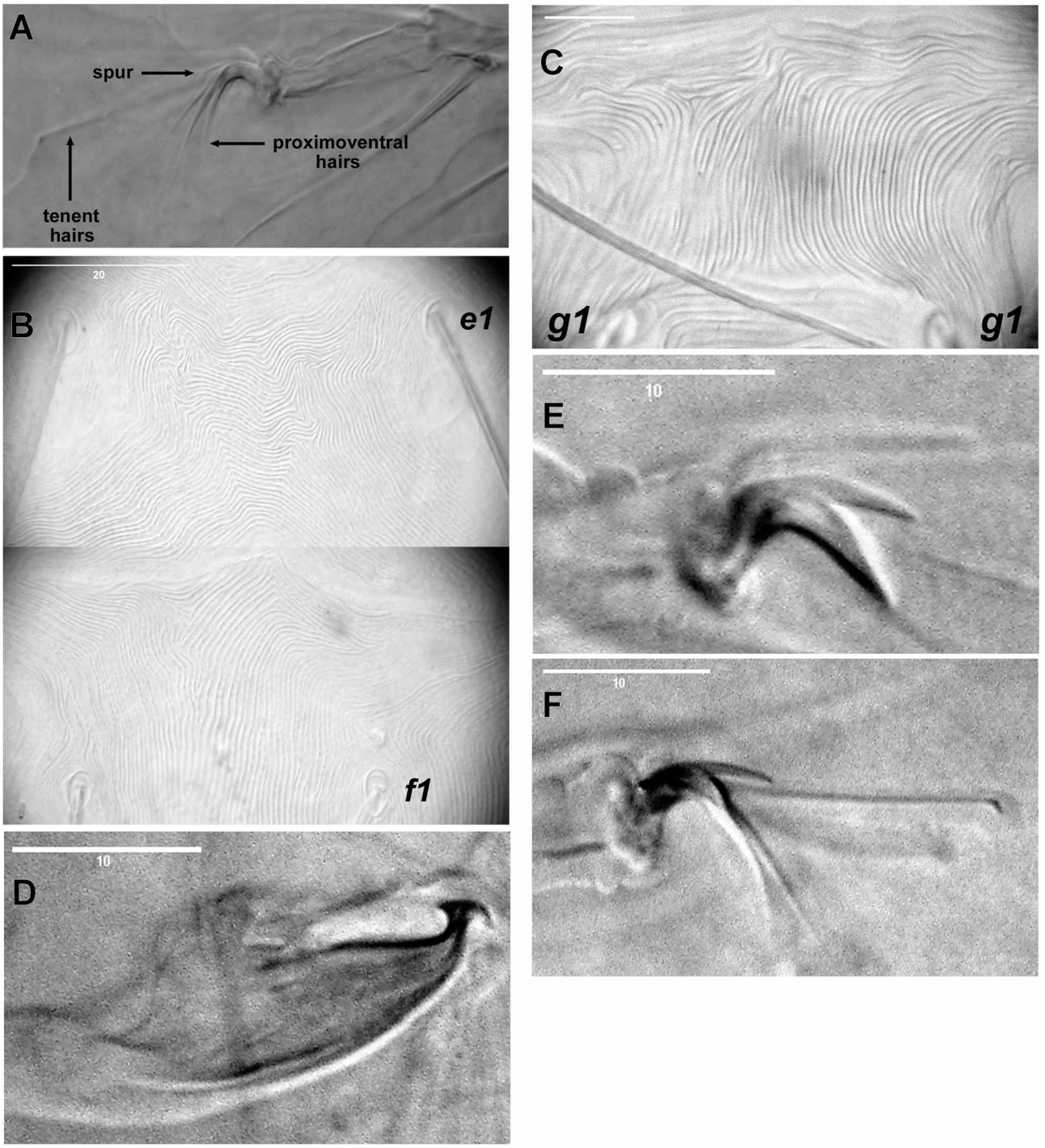


FIGURE 12. *Tetranychus desertorum* Banks, female. (a) Pretarsus I; (b) Weak diamond-shaped pattern of dorsal striae between setae e and f; (c) Pregenital striae. Male: (d) Aedeagus; (e) Pretarsus I; (f) Pretarsus II.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with small to minute dorsal spur (≤ 2 µm); *tarsus I* with sockets of 4 tactile setae overlapping (sometimes 1–2 setae ≤ 2 µm proximal) with the socket of the proximal duplex setae; $\sum d_{prox}$ = 0–2 µm; D_{duplex} = 23–25 µm; *tarsus III* with 1 proximal tactile seta; peritreme hook ca. 30 µm long; *dorsal striae* between setae *e1–e1* mixed oblique, transverse and longitudinal; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between *e1* and *f1* transverse/oblique forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* without lobes; *pregenital striae* entire.

Male: Empodia I–IV each with obvious dorsal spur 3–4 µm long; empodia I–II uncinate, empodia III–IV with proximoventral hairs long and free. Aedeagus with large knob, anterior projection short and pointed, posterior projection large and strongly hooked, dorsal surface slightly convex.

Taxonomy

This species can be mistaken for *T. ludeni*, presumably based on the structure of the aedeagus: at some focal points the aedeagus of *T. ludeni* looks as though it has a hook, thus causing misinterpretation. However, the two species also differ in several other respects. Female *T. desertorum* have entire pregenital striae, and the lobes on the ventral striae (medially, especially between setae *4a*) are absent, irregular or poorly formed. Female *T. ludeni* have broken pregenital striae, and the ventral striae bear lobes, extending anteriorly to setae *2a*. Male *T. desertorum* have uncinate empodia II, different to those on empodia III–IV, while *T. ludeni* have empodia II with fine hairs, similar to those on empodia III–IV.

In Australia, *T. desertorum* was recorded by Dodd (1929, 1940) from *Opuntia* (Cactaceae) but no further collection details were provided. However, we have not located these specimens in any collection. Dodd (1929, 1940) probably assumed that the spider mites on *Opuntia* were *Tetranychus opuntiae* Banks, 1908, a species later synonymised with *T. desertorum* by Pritchard and Baker (1955). This assumption was not unreasonable since *T. desertorum* is the only spider mite collected from *Opuntia*, which in Australia was a widespread weed prior to the introduction of the cactoblastis moth for biological control. The only other record of *T. desertorum* in Australia is provided by Walter (1999), who recorded it from *Lantana camara* (Verbenaceae). We have re-examined these specimens and found them to be *T. ludeni*. Therefore we conclude that *T. desertorum* does not occur in Australia.

We are not the first to notice the confusion between *T. desertorum* and *T. ludeni*. Ehara (1956, 1960) recorded *T. desertorum* in Japan, but Ehara and Masaki (1989) later discovered these were *T. ludeni*; therefore the record of this species in Japan reported in Bolland *et al.* (1998) is in error. Quirós-González (1981) also found that the specimens identified by Baker and Pritchard (1963) as *T. desertorum* were in fact *T. ludeni*, and also noted the differences in ventral lobes and male aedeagus that differentiate the two species. The optical illusion of an aedeagus with a posterior hook in *T. ludeni* was also mentioned in Meyer (1974).

Remarks

Confusion of *T. desertorum* with *T. ludeni* makes interpreting host-lists and records on its biology prone to error. Its distribution is likely to be tropical to sub-tropical, and the mites appear to be a problem in warm, humid zones (Jeppson *et al.* 1975). In winter in Paraguay, these mites can be found on low-growing native hosts (including weeds present in Australia, such as *Sonchus oleraceus* (Asteraceae), *Marrubium vulgare* (Lamiaceae) and *Verbena* (Verbenaceae)) that are protected by grasses (Jeppson *et al.* 1975). In mid-late spring the mites attack seedling cotton and maximum reproduction occurs in mid-summer. As with most or all spider mites, heavy rains adversely affect populations (Jeppson *et al.* 1975).

The optimum temperature for development was 30 ºC when tested at 17, 25, 30 and 33.5 ºC and 85–90% RH. The mites do not survive for extended periods below 10 ºC (Nickel 1960; Jeppson *et al.* 1975). Further life history data is provided by Rivero and Vasquez (2009).

Importance

Entry potential: The presence of *T. desertorum* in China most likely represents an introduction, but it could be its natural range or a result of confusion with *T. ludeni*. Overwintering females hide in natural cavities in produce and nursery stock. However, its reported inability to survive at low temperatures would reduce the chance of survival on produce in cold-storage. Although its reasonably extensive (193 spp.) and diverse list of host species is probably inflated by confusion with *T. ludeni*, the high chance of establishing in Australia cannot be ignored at this point in time.

Economic: The species is a pest of cotton in the southern USA (Baker & Pritchard 1953). Jeppson *et al.* (1975) considers this species a pest in Argentina, Brazil, Nicaragua, Paraguay, Peru, Australia, Japan, and Mexico.

Tetranychus dianellae Davis, 1967
(Fig. 13)

Type specimens examined, Australia: Queensland: Holotype male, Perwillowen, 5.vii.1966, D.A. Ironside, ex *Dianella caerulea* (Phormiaceae) (W2495). Paratypes, 2 females, same data as holotype (W2498, W2494). The holotype and paratype W2494 are mounted in Hoyer's medium and are in good condition. The paratype W2498 is mounted in Heinze PVA medium and is in poor condition.

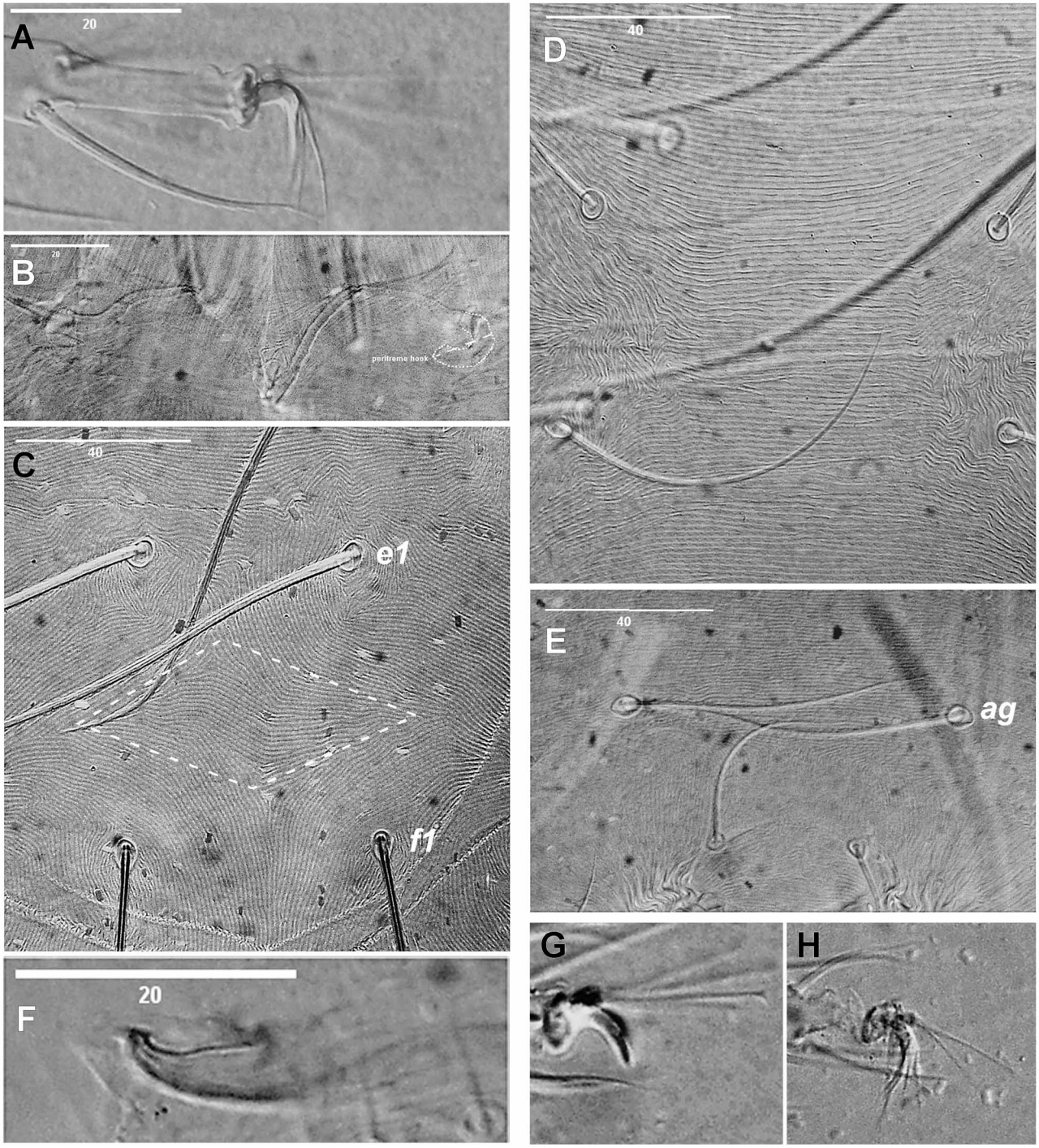


FIGURE 13. *Tetranychus dianellae* Davis, Female. (a) Pretarsus I; (b) Peritreme; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Ventral striae; (e) Pregenital striae. Male. (f) Aedeagus; (g) Pretarsus I; (h) Pretarsus II.

Non-type specimens examined, Australia: Queensland: 1 female, 2 males, M.H.R.S. Nambour, 20.xi.1967, D.A.I., ex *D. caerulea*, det. J.J.D. (N2862, three slides). 2 females, Nambour, 12.x.1966, D.A.I., ex *D. caerulea* (N2373, 1 slide). 3 females, 1 male, Nambour, 18.vii.1966, D.A.I., ex *D. caerulea* (N2173, 2 slides). In QDPI. 5 females, 3 males, Beachmere, 15.ii.2009, O. Seeman, ex leaves *Dianella caerula*. In QM.

Diagnosis

Female: Empodia with 6 hairs; spurs on empodia I–IV minute or absent; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 19–23 µm; tarsus I, D_{duplex} = 11–12 µm; *tarsus III* with 1 proximal tactile seta; peritreme hook 10–14 µm; *dorsal striae* between setae *e1–e1* longitudinal, sometimes oblique; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse, forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* with lobes between genital region and setae *3a*; *pregenital striae* weak, broken, sometimes appearing to have lobes.

Male: Empodia I–IV each with minute to absent dorsal spur; empodia I claw-like (uncinate) with little or no dorsal spur, empodia II–IV with proximoventral hairs long and free. Aedeagus with knob, anterior projection small and pointed, posterior projection pointed, dorsal surface slightly curved, knob directed dorsally at slight angle (ca. 20–30 °) to shaft.

Remarks

Blue Flax Lily *Dianella caerulea* is native to Australia, but grown throughout the world via the nursery trade.

Economic Importance

Not significant.

Tetranychus evansi Baker & Pritchard, 1960
(Fig. 14)

Non-type specimens examined, South Africa: 1 female, 1 male, Grobblersdal (G. Minnaar), 12.ii.1987, M. Greeff, ex *Nicotiona tabacum* (Solanaceae), det. M.K.P. Meyer (AcY: 87/90; X87/66; two slides). 1 male, Watervaal Witr., ii.1987, T. Potgieter, ex *Natura ferox* (Solanaceae), det. M.K.P. Meyer (AcY: 87/62; X87/36). 1 female, Watervaal Witr., 4.ii.1987, T. Potgieter, ex *Acanthaspermum hispidum* (Asteraceae), det. M.K.P. Meyer (AcY: 87/63; X87/37); 1 female, 1 male, Potchefstroom, 3.x.1987, S. Neser, ex *Solanum elaeanifolium* (Solanaceae), det. M.K.P. Meyer (AcY 89/197; X89/47; two slides). 1 female, Friedenheim, ii.1987, J. du Plessis, ex *Nicandra physaloides* (Solanaceae), det. M.K.P. Meyer (AcY: 87/69; X87/33). Donated to QM from PPRI.

Brazil: 1 female, 1 male, Itaporanga SP, iv.984, C.H.W. Flechtmann, ex Potato *Solanum tuberosum* (Solanaceae), #1689. 3 females, 1 male, Itabaiana, SE, 7.iv.1995, D.L.Q. Santana, ex Tomato *Lycopersicon esculentum* (Solanaceae), ESALQ Zool. No. 2094. All in ZCESA.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with minute dorsal spur (< 2 µm); *tarsus I* with sockets of 4 tactile setae overlapping with the socket of the proximal duplex setae; $\sum d_{prox}$ = 0 µm; D_{duplex} = 18–25 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 33–41 µm long; *dorsal striae* between setae *e1–e1* longitudinal and oblique; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* without lobes; *pregenital striae* entire, but sometimes weak medially.

Male: Empodia I–IV each with obvious dorsal spur 4 µm long; empodia I and II uncinate, empodia III–IV with proximoventral hairs long and free. Aedeagus with knob, pointed anterior projection, posterior projection is a blunt hook (note that the hook changes shape depending on focal points: from a clear posterior hook to a short dorsally directed point (Figure 14G-2). Additionally, in some specimens the posterior margin appears to be rounded, similar to *T. ludeni* (Figure 14G-1).

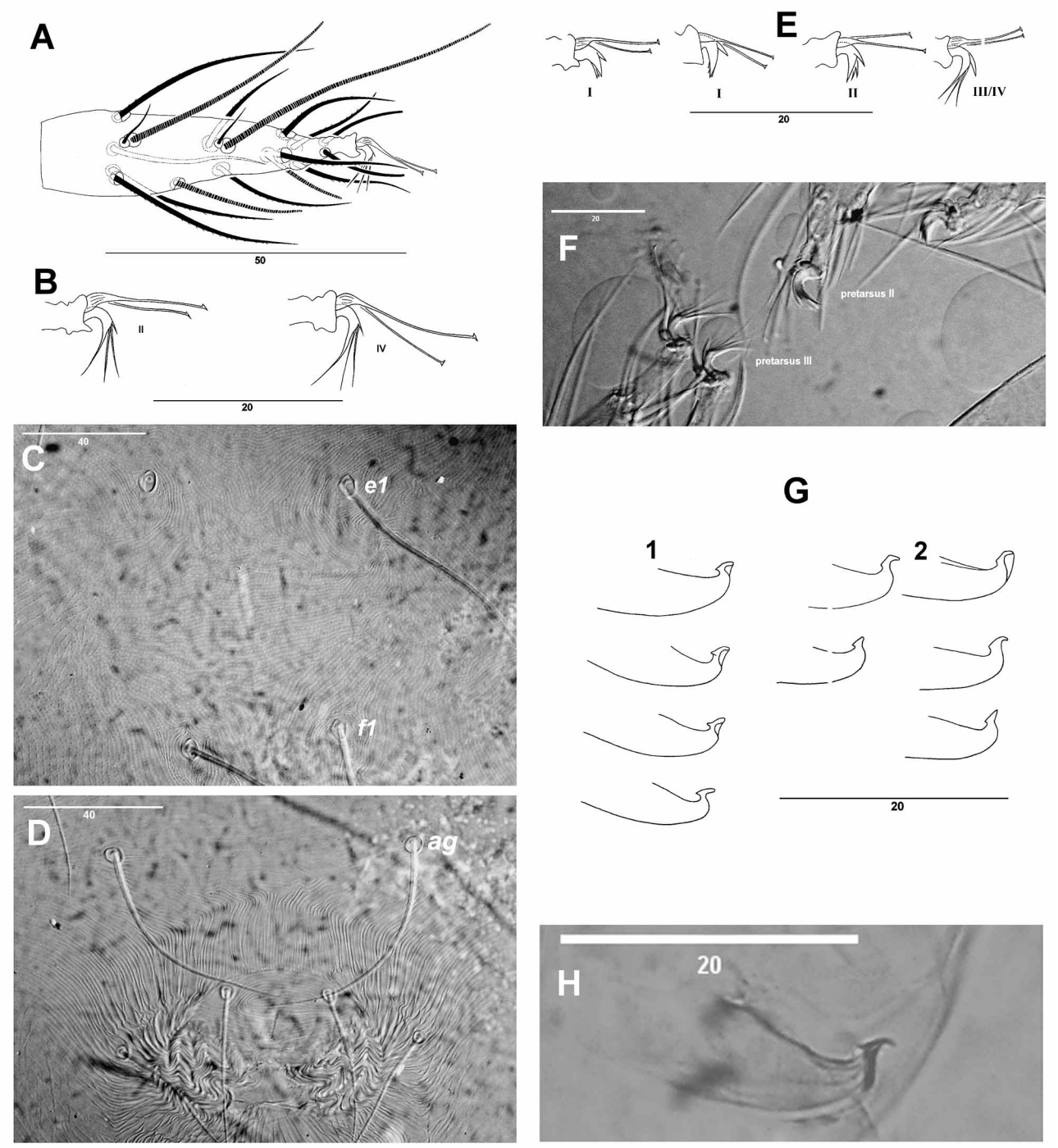


FIGURE 14. *Tetranychus evansi* Baker & Pritchard, female. (a) Tarsus I; (b) Pretarsi II and IV; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Pregenital striae. Male. (e) Pretarsi I, II and III-IV; (f) Pretarsi II, III, showing empodial spurs; (g) Aedeagus of two specimens at different focal points (1,2); (h) Aedeagus.

Remarks

The first eggs a female lays are deep orange in colour. As the female lays more eggs during her life their colour changes to pale orange an eventually they become transparent; however, all eggs become rust-red prior to hatching (Qureshi *et al.* 1969; Bolland & Vala 2000). Larvae and nymphs are greenish-yellow except when newly moulted they are cream-coloured; adult males are light-orange, adult females are reddish-orange (Qureshi *et al.* 1969).

Tetranychus evansi is a well-known pest of tomato, as well as several other crops, in tropical and sub-tropical climates. Colonies usually occur beneath leaves, but at high humidity they also infest the dorsal surfaces. High populations of *T. evansi* can create extensive webbing over their host plants (Qureshi *et al.* 1969). The mites remain

active throughout the year where winters are mild, but do have the ability to overwinter (Qureshi *et al.* 1969; Jeppson *et al.* 1975). The recorded life-cycle data is conflicting, but broadly confirms their preference for warm climates (Bonato 1999; Moraes & McMurtry 1987; Gotoh *et al.* 2010). Bonato (1999) concluded that 34 ºC would be the optimum temperature for *T. evansi*. Other life-history data is presented for this species on *Solanum* spp. (Murungi *et al.* 2010)

Recent surveys found that *Stethorus tridens* Gordon (Coleoptera: Coccinellidae) and *Neozygites floridana* Weiser & Muma (Entomophthorales: Neozygitaceae) are promising natural enemies that could be further examined for use in control methods (see Fiaboe *et al.* (2007) and Britto *et al.* (2009) on *Stethorus*, and Ribeiro *et al.* (2009), Duarte *et al.* (2009) and Guanilo *et al.* (2010) on *Neozygites*).

Importance

Entry potential: Its wide distribution is a result of several introduction events, at least in the cases of Portugal (Bolland & Vala 2000) and southern Africa (Baker & Pritchard 1960). In the latter countries this species has caused significant damage to tomato crops. *Tetranychus evansi* shows a preference for Solanaceae in its host list of 44 species (Bolland *et al.* 1998).

Economic: This species of mite may severely damage and kill its host plant within 3–5 weeks after infestation, especially on tomato, potato, peanut and eggplant (Qureshi *et al.* 1969). *Tetranychus evansi* is a major pest in many countries, especially in tropical and subtropical regions. Its incursion into Australia would be expected to have significant economic impact on primary producers through reduced yield and increased costs in control measures for this pest.

Tetranychus fijiensis Hirst, 1924
(Fig. 15)

Type specimens examined, Fiji: Holotype male, Ovalau, 30.v.1924, H.W. Simmonds, ex coconut *Cocos nucifera* (Arecaceae). Paratype female, same data as holotype. In BMNH.

Non-type specimens examined, Australia: 3 females, 1 male, Flametree Nursery, River Farm Rd, N of Kununurra, 15º 43′ S, 128º 41′E, 19.viii.2010, L. Halling, ex Hooker's Sugar Palm *Arenga hookeriana* (Arecaceae).

Maldive Islands: 2 females, 1 male, 1990, E. Hassan, no host or determination. In QDPI.

Diagnosis

Female: empodia I–IV with 4 proximoventral hairs and large dorsal spur; very short peritreme hook; pregenital striae entire though can be weak medially.

Male: extremely long, slender aedeagus lacking knob, empodia I claw-like (uncinate), with obvious dorsal spur, empodia II–IV with proximoventral hairs free and obvious dorsal spur.

Remarks

Tetranychus fijiensis is exceptional amongst *Tetranychus* in having empodia with four, not six, proximoventral hairs and the form of the aedeagus. Females are orange-red, eggs are purple, nymphs are pale yellow to green (Daniel 1977). *Tetranychus fijiensis* is known from relatively few host species (21), and is best-known as a pest of palm trees (Arecaceae). The species has a tropical distribution. On coconut, mites are most abundant in early summer and mid-autumn, reaching densities of 5–6 mites per leaflet (Sarkar & Somchoudhury 1989). On betelnut, they are an occasional pest during summer (Daniel 1977).

Importance

Tetranychus fijiensis was first collected in the Northern Territory in 1992 (Flechtmann & Knihinicki 2002), but it remained undiagnosed for about a decade. *Tetranychus fijiensis* is common on coconut in India, but damage is not serious (Gupta & Gupta 1994), although Sarkar & Somchoudhury (1989) suggest otherwise. This species has also been recorded as a minor pest of *Citrus* spp. (Gerson 2003), but this record may represent collections from coconut-growing areas.

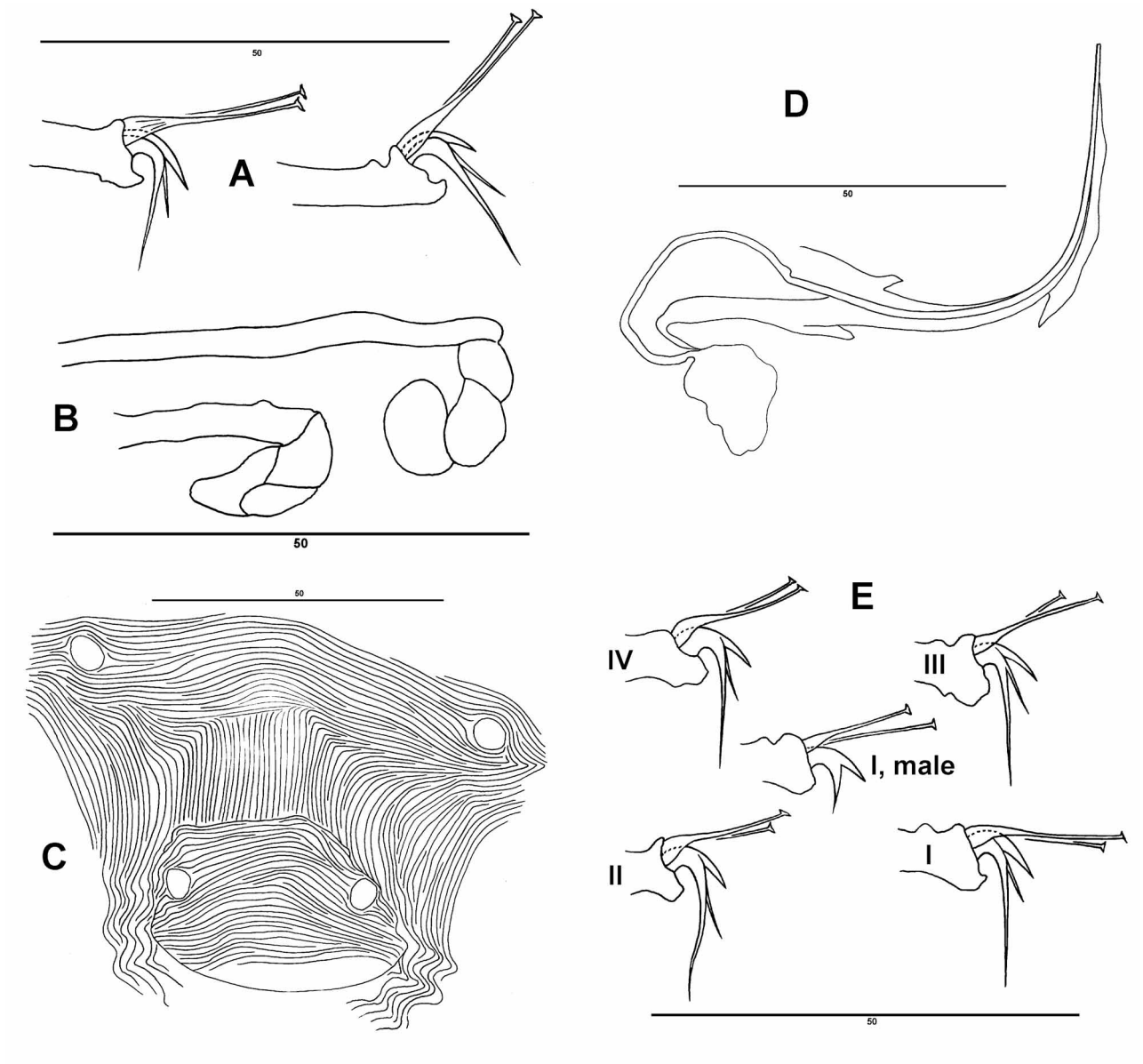


FIGURE 15. *Tetranychus fijiensis* Hirst, female, paratype. (a) Pretarsus I; (b) Peritreme; (c) Pregenital striae. Male, holotype. (d) Aedeagus, in sheath. Male and Female: (e) Pretarsi.

Tetranychus gloveri Banks 1900
(Fig. 16)

Non-type specimens examined, Caribbean: 1 female, 1 male, Anse Maréchal Hotel, Saint Barthélemy, 1.iv. 1998, G.J. Moraes, ex *Livistona* sp. (Arecaceae), det. C.H.W. Flechtmann, ESALQ Zool. No. 2473. 1 female, 1 male, Vauclin, Martinique, 2.v.1997, G.J. Moraes, ex *Brassica oleracea* (Brassicaceae), det. C.H.W. Flechtmann, ESALQ Zool. No. 2356. All ZCESA.

Australia: Northern Territory: 4 females, 4 males, Stokes Hill Wharf, Darwin, 3.xii.2008, L. Zhang, ex leaves Spider Lily *Hymenocallis littoralis* (Amaryllidaceae). In QM.

Comparative specimens of *Oligonychus digitatus* examined, Australia: Queensland: 17 females, Murgon, xi.1931, J.A.W., webbing on Rhodes Grass *Chloris gayana* (Poaceae) (J10359, J10360). 5 females, Brigalow, 27.xi.1942, ex Rhodes Grass. Burncluith near Chinchilla, A.R.P., 1953, ex grass (J10361–10366). 3 females, 1 male, Brisbane, 21.ix.1953, ex Blue Couch Grass *Digitaria didactyla* (Poaceae), A.R.B. (J10367-10370). All in SAMA. **New South Wales:** 9 females, Blackburn, 17.xi.1948, S.L.A., ex Buffalo Grass (Poaceae) lawn (J10357). 17 females, Leeton, 22.i.1942, ex Kikuyu grass *Pennistum clandestinum* (Poaceae) (J10355, J10356). All in

SAMA. **Victoria:** 3 females, 1 male, Melbourne, iii.1942, R.T.M.P., ex Buffalo Grass. Remounted and identified by Davis (1968b). In QDPI. All specimens originally misidentified as *T. tumidus* by Womersley (1942) and *Allonychus braziliensis* by Pritchard and Baker (1955).

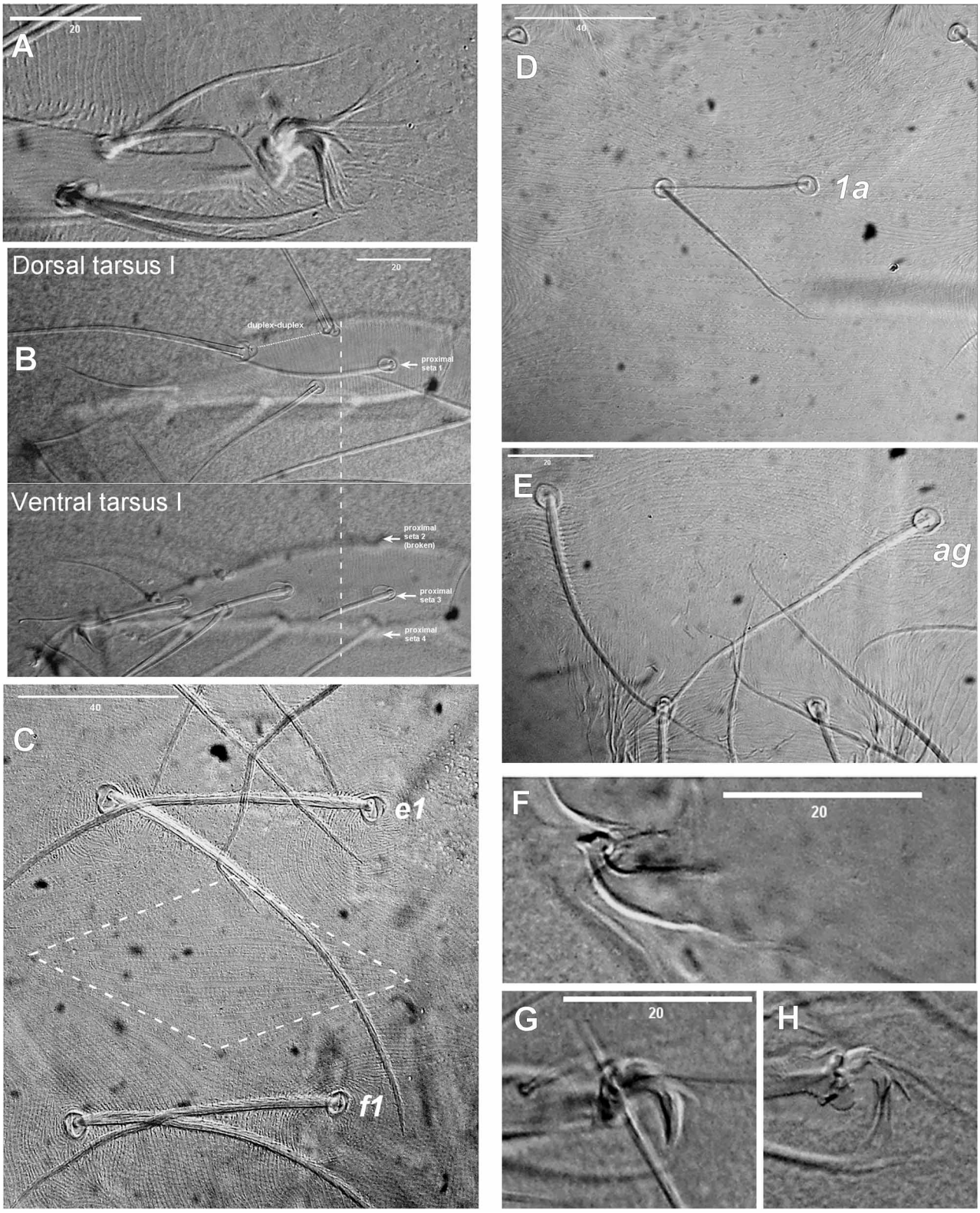


FIGURE 16. *Tetranychus gloveri* Banks, female. (a) Pretarsus IV; (b) Tarsus I, dorsal and ventral view, dashed line indicates level of proximal duplex setae; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Ventral striae with lobes (e) Pregenital striae. Male. (f) Aedeagus; (g) Pretarsus I; (h) Pretarsus II.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with obvious dorsal spur 4–5 µm long; *tarsus I* with sockets of 1–3 tactile setae overlapping with the socket of the proximal duplex setae; $\sum d_{prox}$ = 10–12 µm; D_{duplex} = 16–19 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 21–27 µm long; *dorsal striae* between setae *e1–e1* longitudinal; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* between genital area and setae *1a* with lobes; *pregenital striae* broken, becoming dots antero-medially, and sometimes appearing to have lobes.

Male: Empodia I–IV each with obvious dorsal spur 4–5 µm long; empodia I claw-like (uncinate), empodia II–IV each with proximoventral hairs long and free. Aedeagus with knob, rounded globular anterior projection, pointed posterior projection, dorsal surface curved, especially anteriorly.

Taxonomy

The taxonomic history of *Tetranychus gloveri* Banks is a jumble, with *T. gloveri* and *T. tumidus* Banks, 1900 being misidentified as each other on several occasions. The species were synonymised (Pritchard & Baker 1955), and separated again (Boudreaux 1958), but during this process, taxa originally called *T. gloveri* became *T. tumidus* and vice-versa. Further errors ensued, even after Boudreaux (1979) rectified the situation (e.g., Baker & Tuttle 1994; see Halliday 2000 for an account).

In Australia, *T. gloveri* was reported by Womersley (1942), but as *T. tumidus*, attacking lawn in Melbourne. Pritchard and Baker (1955), on the basis of Womersley's photo of webbing on grass, decided that the mite responsible was *Allonychus braziliensis* (McGregor, 1950). Previously, this species was known from Brazil, on quince, and Nicaragua, on an unknown tree. Accordingly, Halliday (1998) reported *A. braziliensis* in Australia. However, Bolland *et al.* (1998) decided the specimens were not *A. braziliensis*, but *T. gloveri*, and therefore reported *T. gloveri* present in Australia. Halliday (2000) concurred with Bolland *et al.* (1998) and listed *T. gloveri* as present in Australia.

Tetranychus gloveri is a significant pest of several crops in several countries (Jeppson *et al.* 1975), and is of quarantine importance to Australian exporters (B. Crowe, AQIS, personal communications), so we set out to investigate the problem further. We were uncomfortable with the evidence for *T. gloveri*'s presence in Australia, not only because of its turbulent history, but also because it seemed odd that a pestiferous species should have been recorded only once from Australia. Furthermore, the nature of the damage was unlike *Tetranychus*, as it seemed highly irregular that a population of *Tetranychus* could overcome grass as photographed by Womersley (1942).

The answer proved simple: Davis (1968b) described two new species of *Oligonychus*, *O. araneum* and *O. digitatus*, from grasses in Queensland, New South Wales and Victoria. He reported that Womersley's (1942) record of *T. tumidus*, and Pritchard and Baker's (1955) record of *A. braziliensis*, were misidentifications of *O. digitatus*. Mites in the genus *Oligonychus* are common pests of grasses, and the Australian grass-feeding species were revised by Beard *et al.* (2003).

We borrowed Womersley's specimens, and several others identified as *A. braziliensis*, from the South Australian Museum, and concur with Davis (1968b). The presence of only two pairs of *h* setae, the claw-like empodia long as or longer than the empodial hairs, duplex setae adjacent to each other, and two pairs of anal setae are, in combination, characteristic of *Oligonychus*. Therefore, all Australian records of *Tetranychus gloveri* (Bolland *et al.* 1998; Halliday 2000; Flechtmann & Knihinicki 2002), *T. tumidus* (Womersley 1942 [as *Septonychus*]; Baker & Tuttle 1994) and *Allonychus braziliensis* (Pritchard & Baker 1955; Jeppson *et al.* 1975) are actually *O. digitatus*, and until late 2008, *T. gloveri* was absent from Australia. In early December 2008, specimens of *T. gloveri* were found by Dr Lanni Zhang (DPIF&M, Northern Territory) infesting spider lilies. As of April 2009, the initial incursion was considered eradicated, with no other specimens located since its initial discovery.

A taxonomic summary of the misidentification of *O. digitatus* in Australia, courtesy of Dr Bruce Halliday (ANIC, Canberra) is:

Oligonychus digitatus Davis, 1966: 569.

= *Septanychus tumidus* (Banks) — Womersley, 1942: 87 (misidentification)
= *Oligonychus digitatus* — Davis, 1968b: 124.

= *Allonychus braziliensis* (McGregor) — Pritchard and Baker, 1955: 137 (Australian record only)
= *Allonychus braziliensis* (McGregor) — Jeppson *et al.*, 1975: 165 (Australian record only)
= *Tetranychus tumidus* — Baker and Tuttle, 1994: 317 (Australian record only)
= *Tetranychus gloveri* Banks 1900 — Bolland *et al.*, 1998: 185 (Australian record only)
= *Tetranychus gloveri* Banks 1900 — Halliday, 2000: 234 (Australian record only)
= *Tetranychus gloveri* — Flechtmann & Knihinicki, 2002: 125 (Australian record only)

Remarks

The aedeagus of *T. gloveri* is apparently different to *T. tumidus* as it has a larger aedeagal knob (Boudreaux 1979). Females are red (Jeppson *et al*. 1975), eggs are colourless when laid, as opposed to *T. tumidus* which have red eggs when laid (Boudreaux 1979). In the specimens we examined, there was variation in the number of proximal setae on tarsus I that overlap with the proximal duplex setae (1–3 setae).

Tetranychus gloveri is reported as a serious pest of cotton, celery, beans, eggplant, beetroot, okra, peas and sweet potato, where it causes rusty speckling and blotches on leaves and the eventual death of the host (Jeppson *et al.* 1975). Despite reports of its seriousness, little seems to be known of the biology of *T. gloveri*. The species prefers tropical and warm sub-tropical climates.

Importance

Entry potential: This species is widespread in the Pacific and Americas, which may represent its natural range. Overwintering females hide in natural cavities in produce and nursery stock. *Tetranychus gloveri* is known from 88 host species (Bolland *et al.* 1998).

Economic: Although reported as a major pest of several crops (Jeppson *et al.* 1975), the impact of *T. gloveri* has been measured only for cotton, where infestations cause leaf senescence and can decrease yield of the crop by 45% (Roussel *et al.* 1951). If introduced to Australia, the host range of *T. gloveri* would overlap that of several naturalised pest species such as *T. ludeni* and *T. urticae*.

Tetranychus kanzawai Kishida, 1927
(Fig. 17)

Non-type specimens examined, India: 1 female, 1 male, Gopalpora, 20.ii.1987, A.Q. Rather, ex Common Walnut, *Juglans regia* (Juglandaceae), det. M.K.P. Meyer (AcY: 87/110; X87/70). Donated to QM from PPRI.

Japan: 4 females, 4 males, Shizuoka Pref., 19.v.1993, T. Gotoh, ex Tea *Camellia sinensis* (Theaceae). Donated to QM by T. Gotoh.

1 female, 3 males, Japan Quarantine Glasshouse 10c, 19.viii.1992, M. Williams, ex Tea, det. E. Schicha (ASCT 00012371, 12373, 12374, 12376, 12378). 2 males, Daiei-cho, Tottori Pref., 30.viii.1989, 1 male. Uchida, ex Snap Bean *Phaseolus* sp. (Fabaceae) (ASCT 00012388, 12389). 1 male, Koge-cho, Tottori Pref., 31.viii.1989, M. Uchida, ex Japanese Pear *Pyrus communis* (Rosaceae) (ASCT 00012387). All in ASCT.

Australia: New South Wales: 1 male, Springwood, 28.xii.1966, ex *Polyanthus* (Primulaceae), det. J. Gutierrez (ASCT 00012360). 2 males, Parkes, 9.xii.1966, ex *Polyanthus*, det. J. Gutierrez (ASCT 00012361, 12363). 1 female, 1 male, Gosford, 11.xii.1956, P.C. Hely, ex *Hydrangea* (Hydrangeaceae) (ASCT 00012327, 12328).1 male, Old Toongabbie, 5.i.1965, ex potted *Hydrangea* (ASCT 00012329). 3 males, Gosford, 14.xii.1963, ex *Hydrangea* (ASCT 00012335, 12337, 12339). 1 male, Macksville, 4.x.1983, G. Summers, ex Strawberry plant (Tottes) *Fragaria* sp. (Rosaceae), det. E. Schicha (ASCT 00012383). 1 male, Kingscliff, 1.xii.1967, ex *Hydrangea* (ASCT 00012349). All in ASCT. **Queensland:** 1 male, Alan Fletcher Research Station, Sherwood, 2.xii.1987, J. Melksham, ex *Mimosa invisa* (Mimosaceae), det. E. Schicha (ASCT 00012386). In ASCT.

Diagnosis

Female: Empodia with 6 hairs; spurs on empodia I–IV minute or absent; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 22–29 µm; D_{duplex} = 9–13 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 24–27 µm long; *dorsal striae* between setae *e1–e1* and *f1–f1* longitudinal and oblique; striae between setae *e1* and *f1* transverse, forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* without lobes; *pregenital striae* generally entire, sometimes weak with small breaks medially.

Male: Empodia I–II each with an obvious dorsal spur, I–II 3–4 μm long, III–IV 1–2 μm long; empodia I claw-like (uncinate), empodia II–IV with proximoventral hairs long and free. Aedeagus with large knob (knob twice as long as neck), with blunt anterior projection and pointed posterior projection, dorsal surface convex.

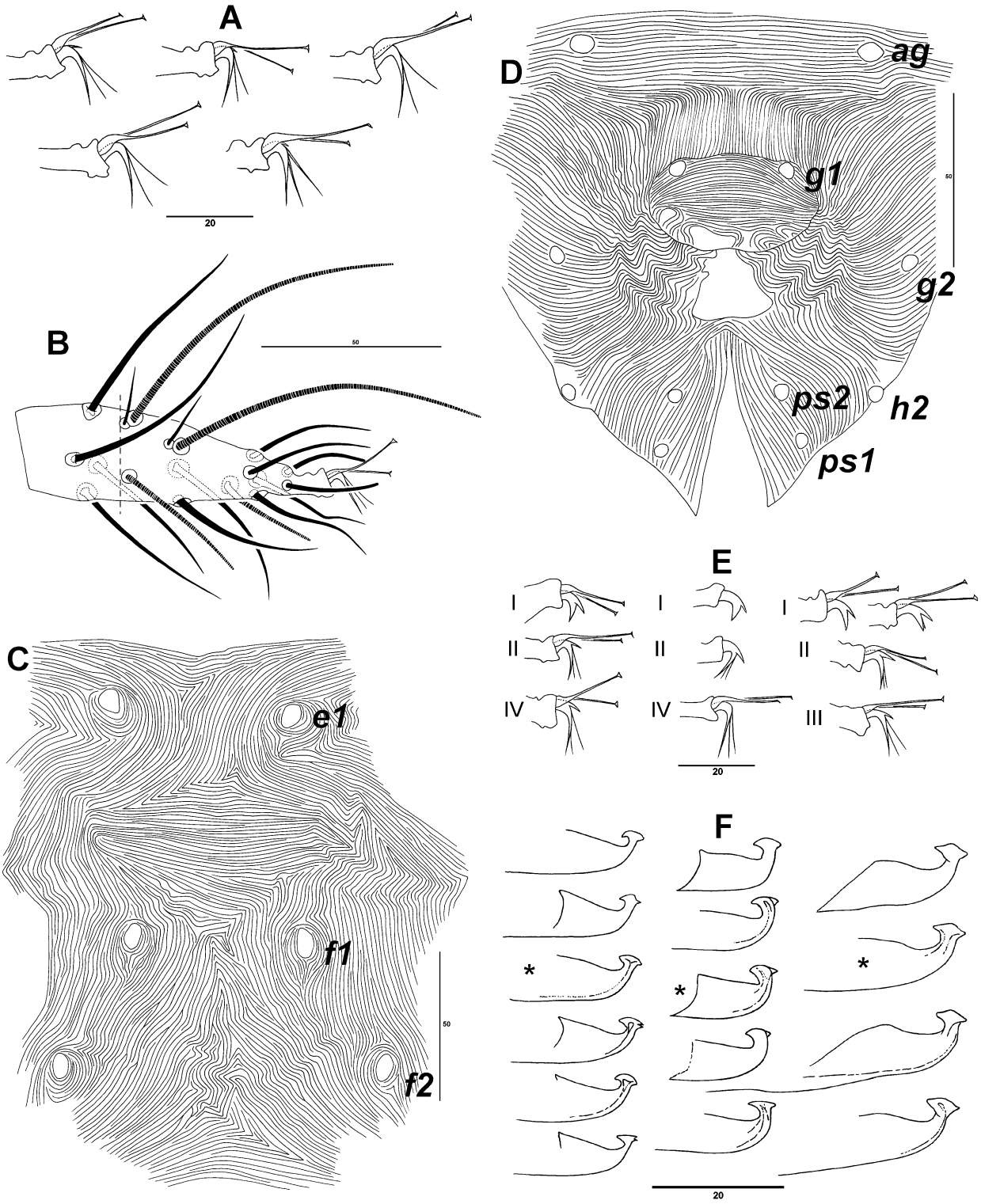


FIGURE 17. *Tetranychus kanzawai* Kishida, female. (a) Pretarsi; (b) Tarsus I; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Pregenital striae and genitoanal region. Male. (e) Pretarsi I, II and IV; (f) Aedeagi of three specimens at different focal points, * = medial focal point.

Remarks

Living female mites are carmine in colour (Meyer 1974; Gutierrez & Schicha 1983). Nothing is known of the biology of *T. kanzawai* in Australia, but the species is reasonably well-studied in Japan. Although it is well-known from tea and hydrangea, mulberry is a better host plant (Gotoh & Gomi 2003). At 25 ºC, development of egg-adult ranges from 9.3 to 12.2 days (females) and 8.6–11.6 days (males), with variation attributed mostly to host plant differences (Gotoh & Gomi 2003). Variation in aedeagal shape exists in the literature and we feel that there could be several different taxa being referred to under this species name.

Importance

Tetranychus kanzawai occasionally causes significant damage to crops (e.g., tea), nursery stock and plants in urban landscaping (Ehara 1956, 1960; Ehara & Masaki 1989; Jeppson *et al.* 1975), and is the target of biological control methods (e.g., Todokoro *et al.* 2010).

Tetranychus lambi Pritchard & Baker, 1955 (Fig. 18)

Non-type specimens examined, Australia: Queensland: 2 females, Kairi R.S., 4.viii.1966, RJ Elder, ex *Centrosema plumieri* (Fabaceae), det. J.J.D. (N2215); 1 male, Atherton, 4.vii.1966, R.J. Elder, ex *Ctenanthe* sp. (Marantaceae), det. J.J.D. (N2160); 1 male, Atherton, 16.viii.1966, R. Elder, ex *Desmodium intortum* (Fabaceae), det. J.J.D. (N2234); 2 females, 1 male, Minbun, 16.viii.1966, R. Elder, ex *Glycine javanica* (Fabaceae), det. J.J.D. (N2235, two slides). 1 female, 2 males, Mission Beach, 3.xii.1968, L. Payton, ex Banana, *Musa* sp. (Musaceae), det. J.J.D. (N3205, two slides). 4 females, 1 male, Tully, 6.xi.1968, L.R. Payton, ex leaves Banana, det. J.J.D. (N3172, two slides). 4 females, 2 males, Euramo, 28.xi.1968, L. Payton, ex Banana, det. J.J.D. (N3198, three slides). 1 female, 1 male, Nambour, 16.vi.1965, J.J. Davis, ex Banana, det. H.B.B. (N1476, two slides). All in QDPI. 5 females, 6 males, The Gap, Brisbane, 27°26'S 152°57'E, 2.v.2005, J.J. Beard, ex *Drymaria cordata cordata* (Caryophyllaceae). In UQIC. **Torres Strait**: 2 females, 1 male, Murray Island, 11.vi.2009, ex Cassava *Manihot esculenta* (Euphorbiaceae). In QDPI, Cairns. **Tasmania:** 1 female, Nubeena, 7.iii.1964, ex *Goodenia ovata* (Goodeniaceae), det. L.W. Miller 1964 (pencilled "not lambi" on identification) (K155, 67988); 3 females, 2 males, Lindisfarne, 22.vii.1963, ex *Amperea sparlioides* (Euphorbiaceae), det. L.W. Miller 1964 (K143, 67976; K144, 67977; K146, 67979; K147, 67980; K149, 67982). All in TDPIC. **Victoria:** 4 females, 1 male, Otway Mountains, Wild Dog Rd, 25.v.1992, ex leaf of *Hedycarya angustifolia* (Monimiaceae), D.E. Walter. In UQIC. **Western Australia:** 3 females, 5 males, Albany, 22.iii.2005, S. Micac, ex pasture grasses. In QM. 5 females, 2 males, Kimberley Research Station, 2.xi.1959, K.T. Richards, ex Cassava. In QDPI.

New Zealand: 1 female, 1 male, no locality (probably New Zealand), 19.ii.1958, A. Mitchell, ex leaves Granny Smith Apple *Malus domestica* (Rosaceae); 1 female, 1 male, Auckland, i.1961, E. Collyer, ex leaves Strawberry *Fragaria* sp. (Rosaceae) , det. K.P.L.; 5 males, Oratio, Auckland, 10.iii.1953, D. McKenzie, ex leaves Apple, "type collection". All in Landcare Research, Auckland, New Zealand.

Comparative specimens examined (aff. *T. lambi*): 6 females, 3 males, Pompuraaw, entry to crocodile farm, 14º54.2538′S 141º37.1036′E, 26.v.2009, S. Cowan, ex Cassava. In QDPI, Cairns.

Diagnosis

Female: Empodia with 6 hairs; spurs on empodia I–IV minute or absent; *tarsus I* usually with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae, occasionally socket of 1 tactile setae overlapping with the level of socket of the proximal duplex setae; $\sum d_{prox}$ = 13–30 µm; D_{duplex} = 7–10 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 15–20 µm long; *dorsal striae* between setae *e1–e1* and *e1–f1* transverse and/or oblique, dorsal striae between *f1–f1* longitudinal, forming an hourglass pattern between *f1–f1*; dorsal striae with lobes; *ventral striae* with (Queensland and New Zealand specimens) or without (some Tasmanian specimens) lobes; when ventral lobes present, then extending from genital region to *1a*; pregenital striae entire, often with lobes.

Male: Empodia I–IV each with minute dorsal spur; empodia I short, thick, claw-like (uncinate), empodia II–IV with proximoventral hairs long and free. Aedeagus with knob, small anterior projection and longer posterior projection wedge-shaped, dorsal surface flat.

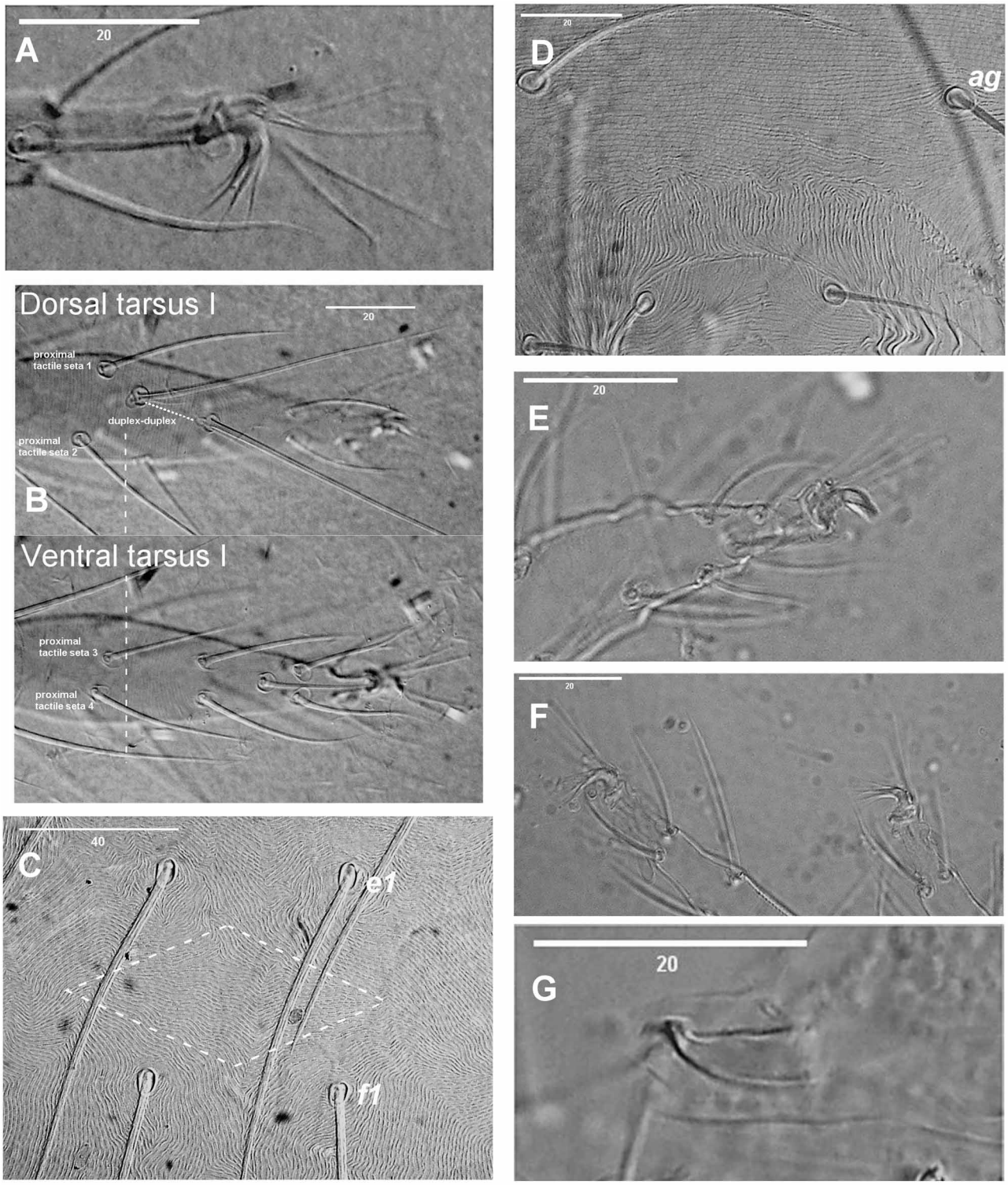


FIGURE 18. *Tetranychus lambi* Pritchard & Baker, female. (a) Pretarsus IV; (b) Tarsi I, dorsal and ventral view, dashed line indicates level of proximal duplex setae; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Pregenital striae, with lobes. Male. (e) Empodium I; (f) Empodium III-IV; (g) Aedeagus.

Remarks

These mites are generally small in comparison to other naturalised species of *Tetranychus* (Gutierrez & Schicha 1983; Table 1). Females are green or yellowish in colour with dark spots along each side of body (Davis 1968a; Gutierrez & Schicha 1983; personal observations).

The specimens we have examined are variable. Tarsus I of female mites have 0–1 proximal setae overlapping with the socket of the duplex setae, and all specimens from Queensland and New Zealand have lobes on the ventral

striae whereas some specimens from Tasmania do not. We consider the variation in tarsus I to be minor intraspecific because both conditions have been seen on one individual. However, the differences in lobe distribution are of more significance and could indicate the presence of more than one species.

There is considerable confusion over the pattern of striae between setae *e1* and *f1*. According to Pritchard & Baker (1955), *T. lambi* the striae between *e1* and *f1* form the hourglass pattern; but according to Jeppson *et al.* (1975), it has a diamond-shape, and to Flechtmann & Knihinicki (2002), the species has entirely transverse striae. Most collections we examined have an hourglass-shaped striae pattern, with the exception of the specimens from Pompuraaw, which have a diamond-shaped pattern. These Pompuraaw specimens are also much larger than all other *T. lambi*. However, the male empodia and aedeagus is a good match for *T. lambi*, so we tentatively include them in *T. lambi* but do not include them in the diagnosis or measurements (Table 1).

Of those specimens with an hourglass-shaped pattern, the striae between *e1–e1* are usually wavy (see key) or oblique (as in Figure 18c), and rarely perfectly transverse as in *T. canadensis* and *T. schoenei*. Thus, some authors may consider the pattern a diamond shape.

This species is known from many introduced plants in Queensland (Davis 1968a) and New South Wales (Gutierrez & Schicha 1983).

Importance

Tetranychus lambi can be a significant pest on strawberries (Davis & Heather 1962) and bananas in tropical Queensland (JB, personal observations).

Tetranychus lintearius Dufour, 1832
(Fig. 19)

Non-type specimens examined, Australia: Tasmania: 3 female, New Town Research Laboratories, New Town, 4.i.2000, J. Davies and J. Ireson, ex laboratory culture of Säo Pedro strain reared on Gorse *Ulex europaeus* (Fabaceae); 2 females, 6 males, New Town, 5.iv.2004, J. Davies, ex gorse; 1 female, Longford, 7.iv.2004, R. Holloway, ex *Boronia* sp. (Rutaceae). All specimens deposited in QM.

Diagnosis

Female: Empodia with 6 proximoventral hairs; obvious spurs on empodia I–IV 4 µm long; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 26–42 µm; D_{duplex} = 11–13 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 19–22 µm long; *dorsal striae* between setae *e1–e1* and *e1–f1* longitudinal and oblique; striae between setae *e1* and *f1* transverse, forming a diamond-shape medially; dorsal striae without lobes; *ventral striae* without lobes; *pregenital striae* entire.

Male: Empodia I–IV each with obvious dorsal spur 4–5 µm long; empodia I and II claw-like (uncinate), empodia III–IV with free proximoventral hairs. Aedeagus with small knob, anterior projection rounded and small, posterior projection rounded and small (but larger than anterior projection), dorsal surface slightly convex.

Remarks

Gorse spider mite is specific to its host plants, especially Gorse, *Ulex europaeus*, a serious weed species in temperate Australia (e.g., Davies *et al.* 2007). *Tetranychus lintearius* creates masses of webbing over its host plant. A morphological study of this species by Stone (1986) emphasised the important diagnostic features of the claw-like empodia I–II on male mites, and also noted the irregular striae between *e1–e1*.

Importance

The species has established in Tasmania where it is a biological control agent for gorse (Ireson *et al.* 2003; Davies *et al.* 2007).

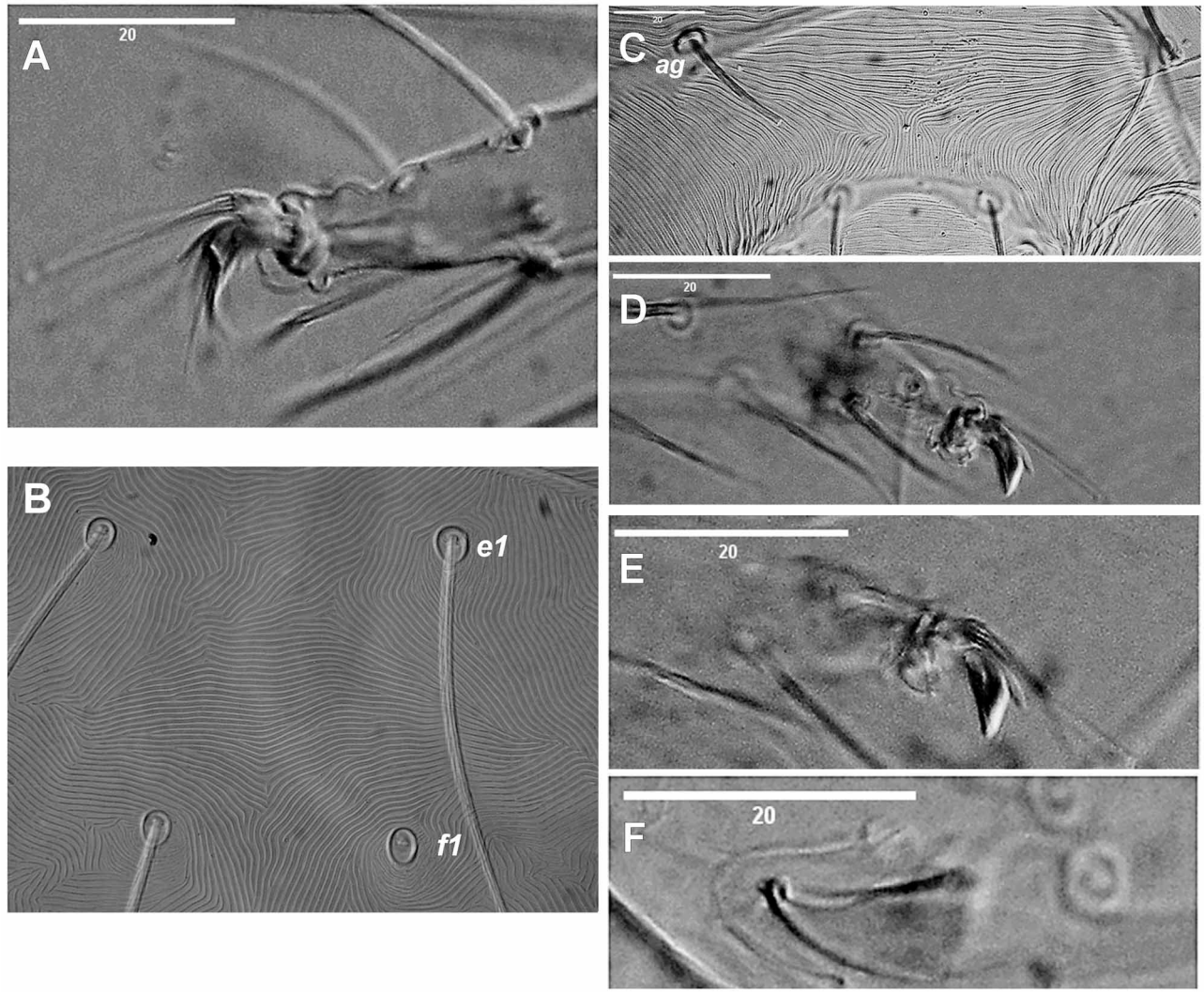


FIGURE 19. *Tetranychus lintearius* Dufour, female. (a) Pretarsus I; (b) Diamond-shaped pattern in dorsal striae between *e* and *f*; (c) Pregenital striae. Male. (d) Pretarsus I; (e) Pretarsus II; (f) Aedeagus.

Tetranychus lombardinii Baker & Pritchard, 1960
(Fig. 20)

Non-type specimens examined, South Africa: 1 female, 1 male, Brits, near Pretoria, 14.v.1985, J.H. Botha, ex *Gossypium* sp. (Malvaceae), det. M.K.P. Meyer (AcY: 85/219; X85/30; two slides); 1 female, 1 male, Kwekeny Nursery, Ludwig, Pretoria, 4.iv.1985, V. Nel, ex *Cotyledon orbiculata* (Crassulaceae), det. M.K.P. Meyer (AcY: 85/247; X85/43; two slides); 2 females, 1 male, Skeurpoort, 20.iii.1986, V. Nel, ex *Lycopersicon esculentum* (Solanaceae), det. M.K.P. Meyer (AcY: 86/172; X86/54; two slides). Donated to QM from PPRI.

Australia: New South Wales: 1 female, 1 male, Bayview Drive (sic: no such street exists in Sydney, but the suburb Bayview does), Sydney, 27.x.1976, E. Schicha, ex Passion Vine (Passifloraceae), det. E. Schicha (ASCT 00017890, 17891). In ACST.

Diagnosis

Female: Empodia with 6 proximoventral hairs; spurs on empodia I–IV absent; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; d_{prox} variable 13–33 μm; D_{duplex} = 12–15 μm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 28–34 μm long; *dorsal striae* between setae *e1–e1* longitudinal and/or oblique; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming diamond-shape medially; dorsal striae with lobes; *ventral striae* between genital region and setae *3a* with lobes; *pregenital striae* broken and dotted.

Male: Empodia I–IV each with minute dorsal spur (< 2 µm) or absent; empodia I claw-like (uncinate), empodia II–IV with proximoventral hairs long and free. Aedeagus with small knob, thick neck, anterior projection absent (anterior margin rounded), posterior projection short, rounded, dorsal surface convex.

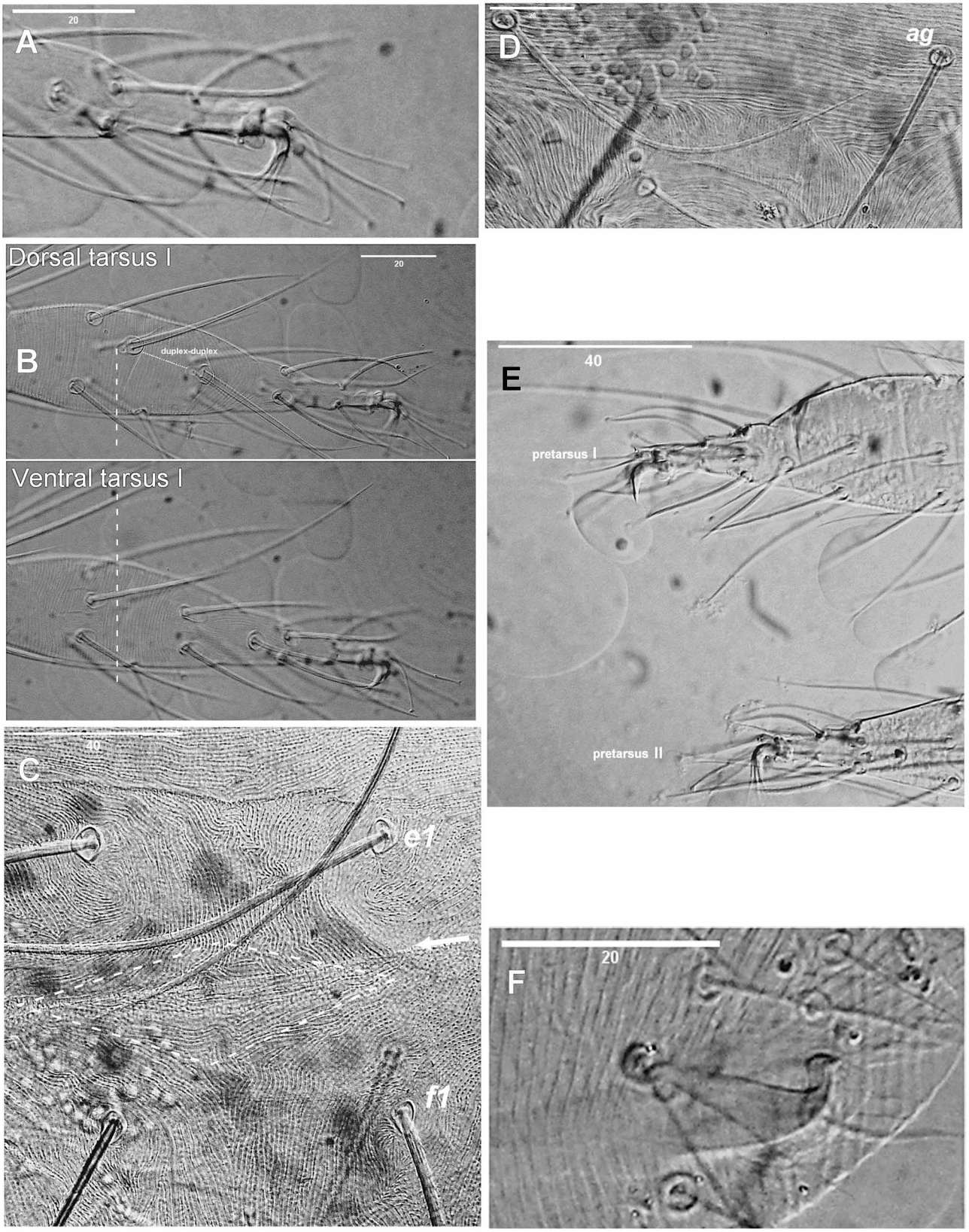


FIGURE 20. *Tetranychus lombardinii* Baker & Pritchard, female. (a) Pretarsus I; (b) Tarsi I, dorsal and ventral view, dashed line indicates level of proximal duplex setae; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Pregenital striae. Male. (e) Pretarsus I and II; (f) Aedeagus.

Remarks

Females are dark-red with dark spots on each side of the body (Meyer 1974); males are greenish-yellow (Gutierrez & Schicha 1983). Recorded in Australia from just a single collection in Sydney on *Passiflora* sp. (Gutierrez & Schicha 1983).

Importance

Although reported damaging several crops, especially cotton, the actual impact of this species has never been examined (Jeppson *et al*. 1975). This species has only been recorded in Australia once, suggesting it is not important or is frequently confused with other species.

Tetranychus ludeni Zacher, 1913
(Fig. 21)

Non-type specimens examined, Australia: Queensland: 2 females, Nambour, 5.v.1966, D.A.I., ex *Dahlia* (Asteraceae), det. J.J.D. (N2021). 1 male, Elimbah, 22.ii.1966, J.H.B., ex *Erigeron bidens* (Asteraceae) and *Sida* sp. (Malvaceae), det. J.J.D. (N1788). 2 females, Montville, 5.xi.1963, D.A.I., ex Cucumber *Cucumis sativa* (Cucurbitaceae) (N957). 2 females, Brisbane, x.1964, A.R.B., ex *Impatiens* sp. (Balsaminaceae) (N2189). 1 female, Brisbane, 6.ix.1966, J.J.D, ex *Oxalis* sp. (Oxalidaceae) (N2249). 1 female, Beerwah, 10.xi.1967, J.J.D., ex *Macadamia integrifolia* (Proteaceae) (N2842). 3 females, Brisbane, 4.xi.1967, A.R.B., ex *Gloxinia* (Gesneriaceae) (N1618). 1 female, Kairi Research Station, 4.viii.1966, R.J. Elder, ex *Teramnus uncinatus* (Fabaceae) (N2216). 1 female, Nambour, 28.ix.1964, D.A.I., ex *Passiflora edulis* (Passifloraceae) (N1171). 3 females, Nambour, 21.viii.1964, D.A.I., ex *Solanum torvum* (Solanaceae) (N1123). All in QDPI. 2 females, 4 males, Miala National Park, J. Beard, ex *Solanum* sp. All in QM. 2 females, Kingfisher Park, Birdwatcher's Lodge, Lot 1, Mt Kooyong Rd, Julatten, 16°36'S 145°21'E, 23.iv.2002, J.J. Beard, ex guava *Psidium* sp. (Myrtaceae), Reg.#86699-86700. 8 females, 4 males, Goodnight Scrub NP, ca. 20 km NNW of Biggenden, 25°20'27''S 151°54'52''E, 30.viii.2005, J.J. Beard and P.I. Forster, ex *Leucas zeylanicum* (Lamiaceae), Reg.#89500-89508. 10 females, 6 males, Benarkin State Forest, AMG 417940 7023320, 15.x.1998, P. Bannick and D.E. Walter, ex *Lantana camara* (Verbenaceae). 3 females, 2 males, Lamington National Park Monument, 28°11'S 153°07'E, 30.xi.1999, D.E. Walter, ex leaves *Lantana camara*, rainforest margin. 1 male, same data except 16.xii.1998. 1 female, 3 males, Conondale Ranges, Lobster Ck, 26°40'S 152°39'E, 20.xii.1998, D.E. Walter, ex *Lantana camara* in riparian rainforest. 4 females, Palmerston NP, Goolagan Ck, 17°37'S, 145°46'E, 24.x.1997, D.E. Walter, ex *Lantana camara*. 2 females, Atherton, Halloran's Hill, 4.xii.1998, M. Shaw and D.E. Walter, ex *Lantana camara* in rainforest. 8 females, Behana Ck, Site 2, South of Cairns, 17°10'S 145°50'E, 24.x.1997, D.E. Walter, ex *Lantana camara*. All in UQIC. The specimens identified from *L. camara* were originally identified as *T. desertorum*. **Western Australia:** 4 females, South Perth, 6.vi.1968, P.J. Lawrence, ex oak (N3096). In QDPI. 5 females, 9 males, Department of Agriculture Glasshouse, Kensington, Perth, v.2005, J. Botha, ex *Vicia faba* (Fabaceae). In UQIC. **Tasmania:** 3 females**,** 4 males, "Inverquharity", Richmond, 13.i.1988, damaging *Mentha piperita* (Lamiaceae) (N566, 68048; N567, 68049; N568, 68050; N569, 68051; N571, 68057; N572, 68054; N570, 68052). 2 females, 4 males, Hobart, 7.v.1961, ex Sweet Pea *Lathyrus odoratus* (Fabaceae), det. L.W. Miller (K297, 68099; K298, 68100; K299, 68101; H411, 68095; H412, 68094; H415, 68098). 1 female, Hobart, 13.vi.1961, ex Sweet Pea *Lathyrus odoratus*, det. L.W. Miller (K296, 68106). 1 female, Ranga, Flinders Is., 12.viii.1954, ex Cape Gooseberry *Physalis veruviana* (Solanaceae), det. L.W.M. (G283, 68085). 2 males, Insectary, New Town, 26.ix.1957, ex bean (Fabaceae), L.W.M. det. (G946, 68012; G948, 68015). All in DPITC.

Brazil: 1 female, 1 male, Piracicaba, SP, Brazil, 28.xii.1966, C.H.W. Flechtmann, ex *Phaseolus vulgaris* (Fabaceae), #741. 1 female, 1 male, Frei Rogério, Santa Catarina, 19.i.2000, I. Nora, ex leaves *Pyrus communis* (Rosaceae), ESALQ Zool. No. 2535. All in ZCESA. These specimens were originally identified as *T. desertorum*.

Japan: 6 females, 6 males, Ibarak Pref., 17.x.1995, T. Gotoh, ex Goldenrod *Solidago* sp. (Asteraceae). In QM.

Diagnosis

Female: Empodia with 6 proximoventral hairs; spurs on empodia I–IV minute or absent; *tarsus I* with sockets of 4 tactile setae overlapping with the socket of the proximal duplex setae; $\sum d_{prox}$ = 0 µm; D_{duplex} = 21–30 µm; *tarsus III*

with 1 proximal tactile seta; *peritreme hook* = 25–31 µm long; *dorsal striae* between setae *e1–e1* longitudinal and/or oblique; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* between genital region and setae *1a* with lobes; *pregenital striae* obviously broken and dotted.

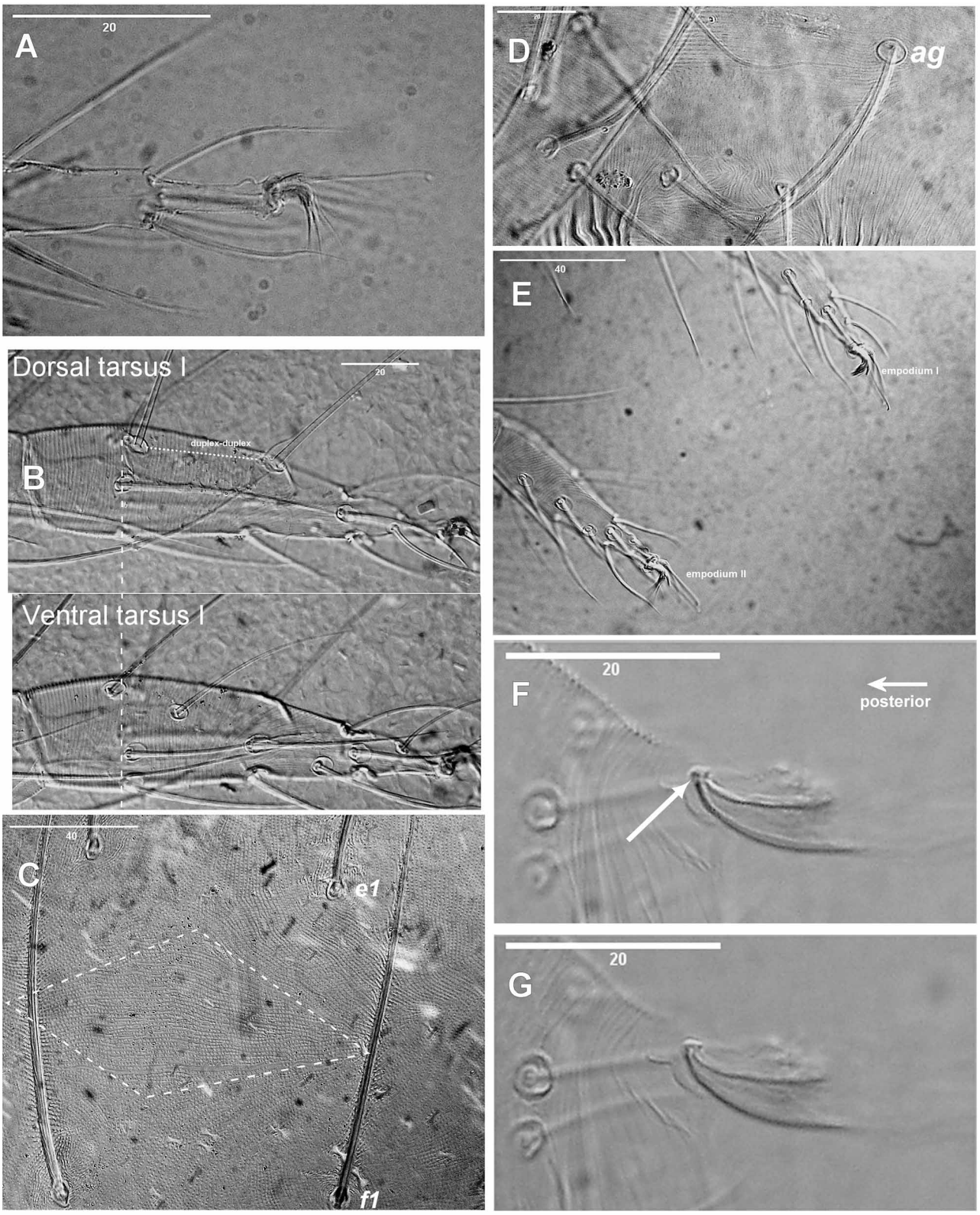


FIGURE 21. *Tetranychus ludeni* Zacher, female. (a) Pretarsus III; (b) Tarsi I, dorsal and ventral view, dashed line indicates level of proximal duplex setae; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Pregenital striae. Male. (e) Pretarsus I and II; (f) Aedeagus, arrow indicating false hook; (g) Aedeagus.

Male: Empodia I–IV each with strong obvious dorsal spur 4 μm long; empodia I claw-like (uncinate), empodia II–IV with proximoventral hairs long and free. Aedeagus with small knob, anterior projection small, blunt, posterior projection absent, dorsal surface slightly angulate; posterior margin evenly curved, thin ridge parallel with posterior margin gives the impression of a small hook in some focal points (Figure 21f).

Taxonomy

This species has often been confused with *T. desertorum* due to misinterpretation of the aedeagal structure (see remarks of *T. desertorum*). A similar misinterpretation also resulted in the description of *Tetranychus ludenensis* Attiah, 1969. This species is the same as *T. ludeni* in every respect, except for the male aedeagus, and Attiah (1969) speculated that the male aedeagus was similar, pending examination with the type specimens of *T. ludeni*. The aedeagus drawn by Attiah (1969) clearly shows the small hook-like structure that can be seen at some focal points of the *T. ludeni* aedeagus. Therefore we declare *Tetranychus ludenensis* Attiah, 1969 **syn. nov**. as a junior synonym of *T. ludeni*.

Remarks

Female mites are dark red, male mites are orange-yellow in colour (Boudreaux & Dosse 1963; Gutierrez & Schicha 1983). This species is widespread in eastern Australia, especially coastal areas, on numerous host species (Miller 1966; Davis 1968a; Gutierrez & Schicha 1983). *Tetranychus ludeni* is often found in mixed populations with *T. urticae* (Gutierrez & Schicha 1983). Some life history data is presented by Adango *et al.* (2006), Moros and Aponte (1994), Puttaswamy (1980) and Zhang (2002).

Importance

A pest species of many crops (Davis 1961; Davis & Heather 1962; Jeppson *et al.* 1975), sometimes requiring management through application of pesticides and natural enemies (e.g., Reddy 2001).

Tetranychus macfarlanei Baker & Pritchard, 1960
(Fig. 22)

Non-type specimens examined, India: 1 female, 1 male, Jammu, 20.ii.1987, A.Q. Rather, ex *Hibiscus esculentus* (Malvaceae), det. M.K.P. Meyer (AcY: 87/115, X87/73; two slides). Donated to QM from PPRI.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with dorsal spur 2–3 μm long; *tarsus I* with the sockets of 3 tactile setae overlapping with the socket of the proximal duplex setae, socket of 1 tactile seta proximal to socket of proximal duplex setae; $\sum d_{prox}$ = 2 μm; D_{duplex} = 20–24 μm; *tarsus III* with 1 proximal tactile seta; peritreme hook not measurable in specimen we examined; *dorsal striae* between setae *e1–e1* longitudinal; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and f1 transverse forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* between genital region and setae *1a* with lobes; *pregenital striae* almost entire but weak and/or broken medially.

Male: Empodia I–IV each with obvious dorsal spur 4 μm long; empodia I claw-like (uncinate), empodia II–IV each with proximoventral hairs long and free. Aedeagus with small anvil-shaped knob, anterior and posterior projections tiny, dorsal surface flat to slightly convex.

Remarks

Newly-emerged female mites are bright red and become deep red with age (Jose & Shah 1989a).

This species is known from tropical and warm sub-tropical zones where it reputedly causes severe damage to cucumber, eggplant, gourd, okra and pumpkin (Jeppson *et al.* 1975; Jose & Shah 1989a). In India it is an occasional pest of eggplant (Gupta & Gupta 1994). Like many spider mites, *T. macfarlanei* are able to use weeds as a host when host crops are not available (Jose & Shah 1989b). Damage is typical for spider mites: yellowish speckling, followed by leaf senescence.

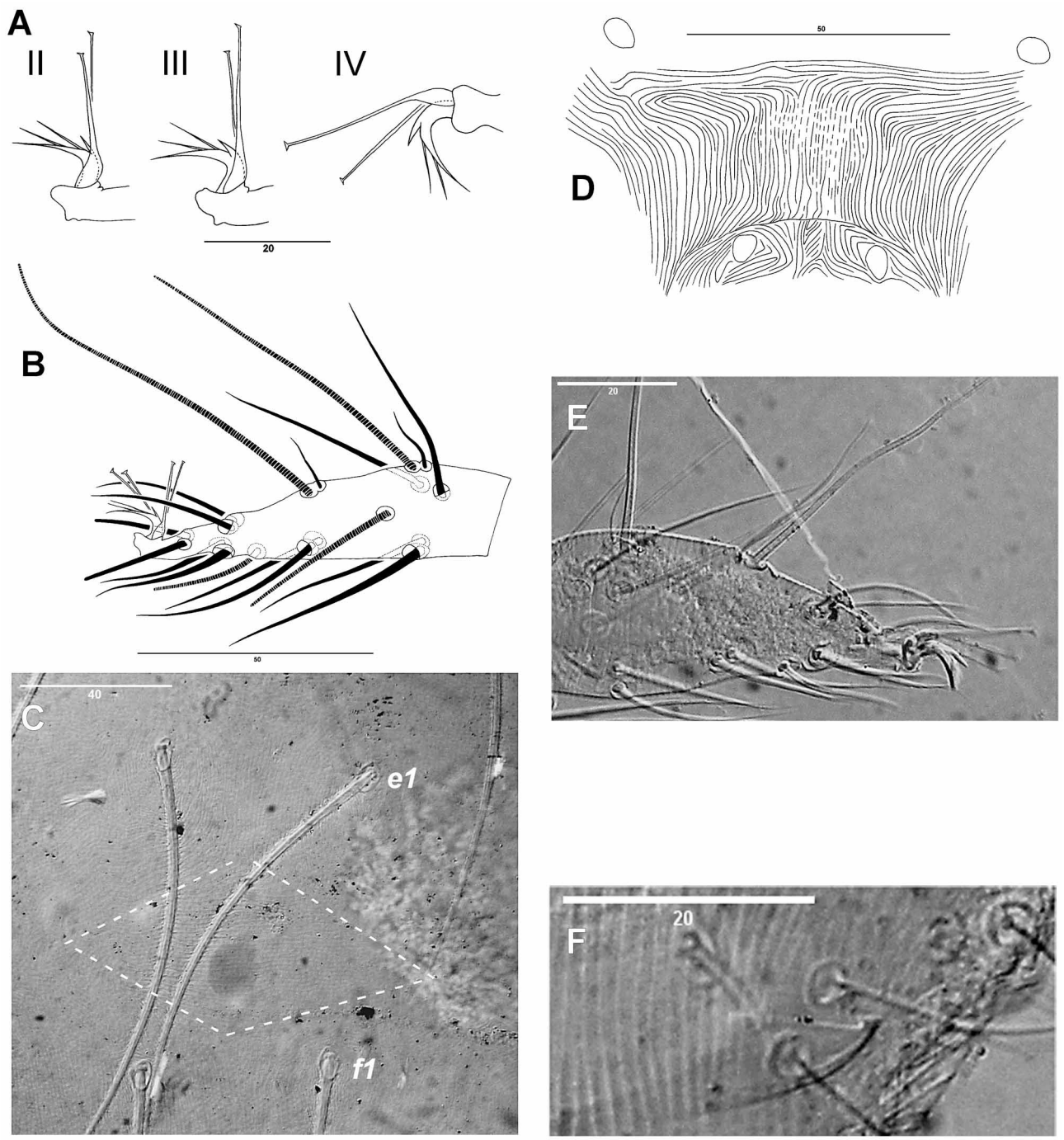


FIGURE 22. *Tetranychus macfarlanei* Baker & Pritchard, female. (a) Pretarsi II, III, IV; (b) Tarsus I; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Pregenital striae. Male. (e) Tarsus I; (f) Aedeagus.

Importance

Entry potential: Its presence in the Canary Islands shows it has the capacity to be moved long distances. Overwintering females hide in natural cavities in produce and nursery stock. Its limited host-list of 23 spp. represents a reasonable diversity of host plants (Bolland *et al.* 1998), suggesting that the mites have a high chance of living on many more species.

Economic: A sporadic to serious pest of eggplant in India, causing leaf fall (Jose & Shah 1989b; Gupta & Gupta 1994). It is also reported as a serious pest of cotton and okra (Jose & Shah 1989b). We would expect this species to become a persistent problem on several vegetable crops in tropical Australia.

***Tetranychus marianae* McGregor, 1950**
(Fig. 23)

Type specimens examined, Micronesia: Lectotype male, Mt Lasso, Tinian Island, 12.vi.1946, H. Townes, ex *Passiflora foetida* (Passifloraceae), USNM 1722. Paralectotypes, 5 females, 5 males, same data as lectotype. All specimens are from the type series of McGregor (1950), but he did not designate a holotype specimen. We have therefore designated lectotypes here as per the unpublished thesis of Quirós-Gonzáles (1981).

Non-type specimens examined, Central America: 1 male, La Calera, Manaqua, Nicaragua, 8.iv.1959, ex squash, E.W. Baker, slide has several other species on it. 3 females, 1 male, Lima, Honduras, 30.x.1958, J.G. Matthysse, ex *Thunbergia alata* (Acanthaceae). 1 male, Hanacal, San Pedro, Honduras, 7.ii.1959, ex *Abutilon permalle* (Malvaceae), J.G. Matthysse. All in USNM.

Australia: Northern Territory: 1 female, 3 males, Nakara, 26.x.2007, L. Zhang, ex leaves *Acalypha* (Euphorbiaceae), M310. In QM. **Queensland**: 6 females, 8 males, Tully, 6.xi.1968, L.R. Payton, ex Banana fruit *Musa* sp. (Musaceae) (N3172). 3 females, 1 male, Biboohra, v.1972, G.D. Adams, ex *Dolichos lablab* (Fabaceae) (M831[12931]). All in QDPI. 8 females, 1 male, Bamaga, N. 15.x.1982, J. Turner, ex wild Passionfruit *Passiflora* sp. (CY55). In QDPI, Cairns. 1 female, 2 males, New Mapoon, Family Res. Centre, 10°52.035'S 142°23.074'E, 23.v.2007, A.D. Rice, ex *Abelmoschus manihot* (Malvaceae), SAC019. In QM. **Torres Strait:** 1 male, Stephen Is., 21.iii.1984, J. Turner, no host recorded (TS391). 2 females, 1 male, Saibai Is., 9º22.554′S 142º37.4954′E, 3.iii.2009, A. Rice, ex leaves *A. manihot*. In QDPI, Cairns.

Papua New Guinea: 3 females, 2 males, Popondetta, 12.ix.1966, F.A.E., ex *Dolichos lablab* (N2510). In QDPI. 4 females, 3 males, Popondetta, 12.ix.1966, ex *Dolichos lablab* (ASCT 00018564, 18566, 18569, 18570, 18590). 2 females, same data except ex *Glycine javanica* (Fabaceae) (ASCT 00018575, 18578). 4 females, same data except 6.x.1966, ex French bean (Fabaceae) (ASCT 00018579, 18581). All in ASCT.

Comparative specimens (aff. *T. marianae***):** 1 female, 1 male, Goyave, Guadeloupe, Caribbean Sea, 28.iv.1998, J. Etienne, ex *Passiflora edulis* (Passifloraceae), det. C.H.W. Flechtmann. (ESALQ Zool. No. 2488). 1 female, 1 male, Caacupé, Paraguay, Y. Kimura and S. Ehara, 20.xii.1999, ex *Lycopersicon esculentum* (Solanaceae), det. C.H.W. Flechtmann, ESALQ Zool. No. 2559 (two slides). All in ZCESA.

Diagnosis

Female: Empodia with 6 proximoventral hairs; spurs on empodia I–IV minute (2 µm); *tarsus I* with sockets of 0–2 tactile setae in line with the socket of the proximal duplex setae, 2–4 tactile seta just proximal to socket of proximal duplex setae; $\sum d_{prox}$ = 7–14 µm; D_{duplex} = 6–15 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 20–30 µm long; *dorsal striae* between setae *e1–e1* longitudinal; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming diamond-shape medially; dorsal striae with obvious lobes; v*entral striae* between genital region and setae *3a* with lobes; *pregenital striae* strongly broken anteromedially, complete posteromedially and laterally.

Male: Empodia I–IV each with small dorsal spur 2 µm long; empodia I claw-like (uncinate), empodia II–IV with proximoventral hairs long and free. Aedeagus with small knob, anterior projection tiny and rounded, posterior projection pointed and directed at 45° angle to shaft, dorsal margin of knob may have small lump.

Remarks

This species is common in northern Queensland, Torres Strait (Davis 1968a, 1969; personal observations) and the Northern Territory (personal observations).

Importance

Although recorded as a pest of cotton (Jeppson *et al.* 1975) and as an important pest of tomato in Texas (Schuster 1959), the effect of this species is largely unknown. Some life history data is provided for *T. marianae* on passionfruit by Noronha (2006).

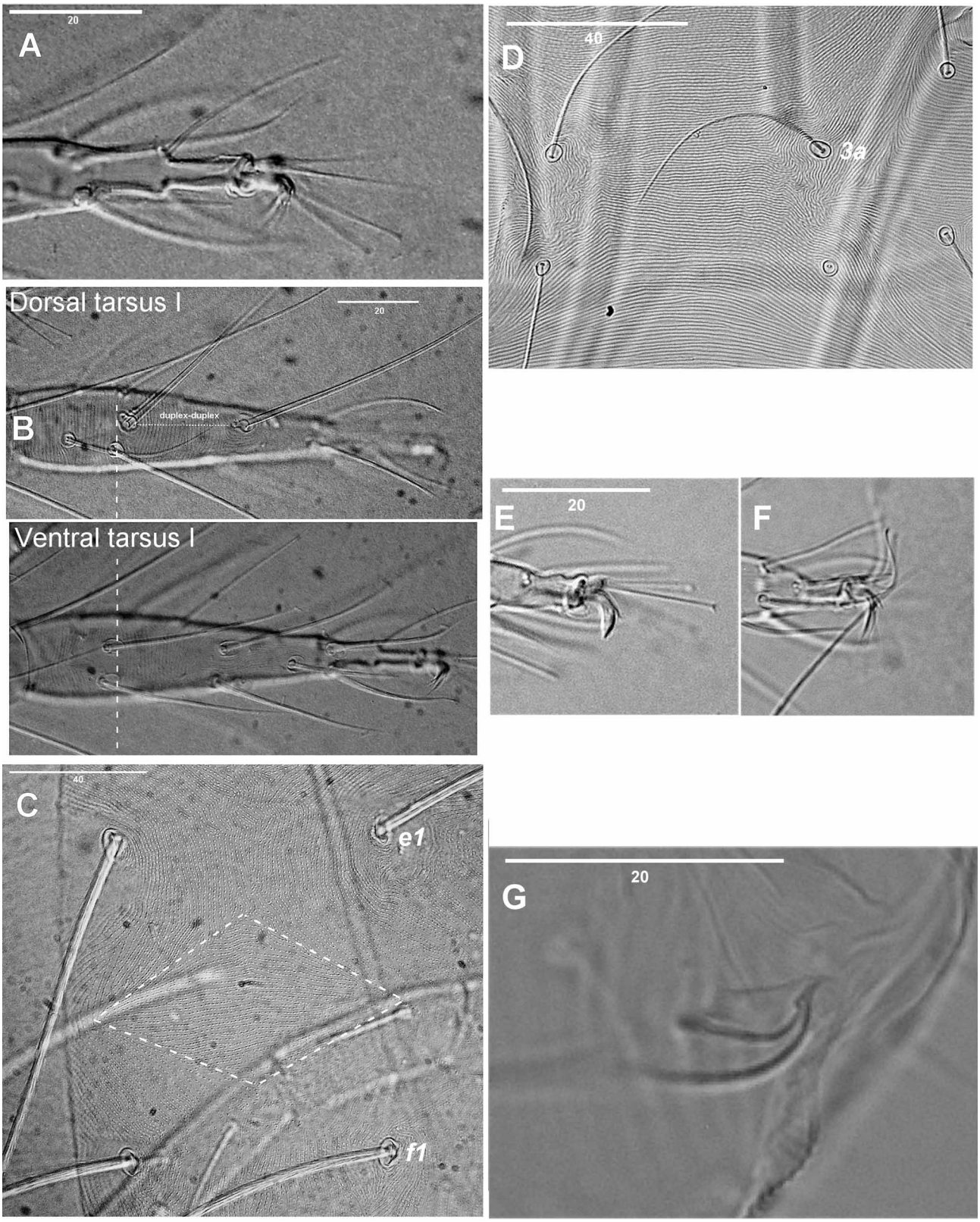


FIGURE 23. *Tetranychus marianae* McGregor, female. (a) Pretarsus III; (b) Tarsi I, dorsal and ventral view, dashed line indicates level of proximal duplex setae; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Ventral striae between setae *3a*. Male. (e) Pretarsus I; (f) Pretarsus II; (g) Aedeagus.

***Tetranychus mcdanieli* McGregor, 1931**
(Fig. 24)

Type specimens examined, U. S. A.: 4 females, 2 males, Bridgman, Michigan, 19.vi.1930, ex Raspberry *Rubus* sp. (Rosaceae), USNM Type 1029 (one slide, with 17 specimens comprising 2 males, plus female and immature mites). Cotype: 1 male, St Joseph, Michigan, 12.vii.1928, McGregor, EM1969-1.

Non-type specimens examined, U. S. A.: 2 females, 2 males, Fargo, North Dakota, 5.viii.1948, R.L. Post, ex small fruit seedlings, Lot 48-13799. In USNM. 15 females, The Dalles, Oregon, 2.iv.1956, E.C. Burts, Cherry tree trunk *Prunus* sp. (Rosaceae).1 male, The Dalles, Oregon, USA, R. Ellertson, 28.viii.1956, ex Cherry [male of another species and 2 DN on same slide]. In QM, donation from G.W. Krantz at Oregon State University.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV without dorsal spurs; *tarsus I* with the sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 17–43 µm (types 17–30); D_{duplex} = 9–13 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* 20–30 µm long; *dorsal striae* between setae *e1–e1* transverse; dorsal striae between setae *f1–f1* transverse; dorsal striae between setae *e1* and *f1* transverse; dorsal striae without lobes; *ventral striae* without lobes; *pregenital striae* sparse medially and incomplete.

Male: Dorsal striae without lobes; empodia I with obvious strong spur (4–5 µm), empodia II–IV with minute (< 2 µm) dorsal spurs; empodia I claw-like (uncinate); empodia II–IV with proximoventral hairs long and free. Aedeagus without knob, shaft sigmoid, dorsally directed, bending anteriorly then recurving posteriorly and tapering.

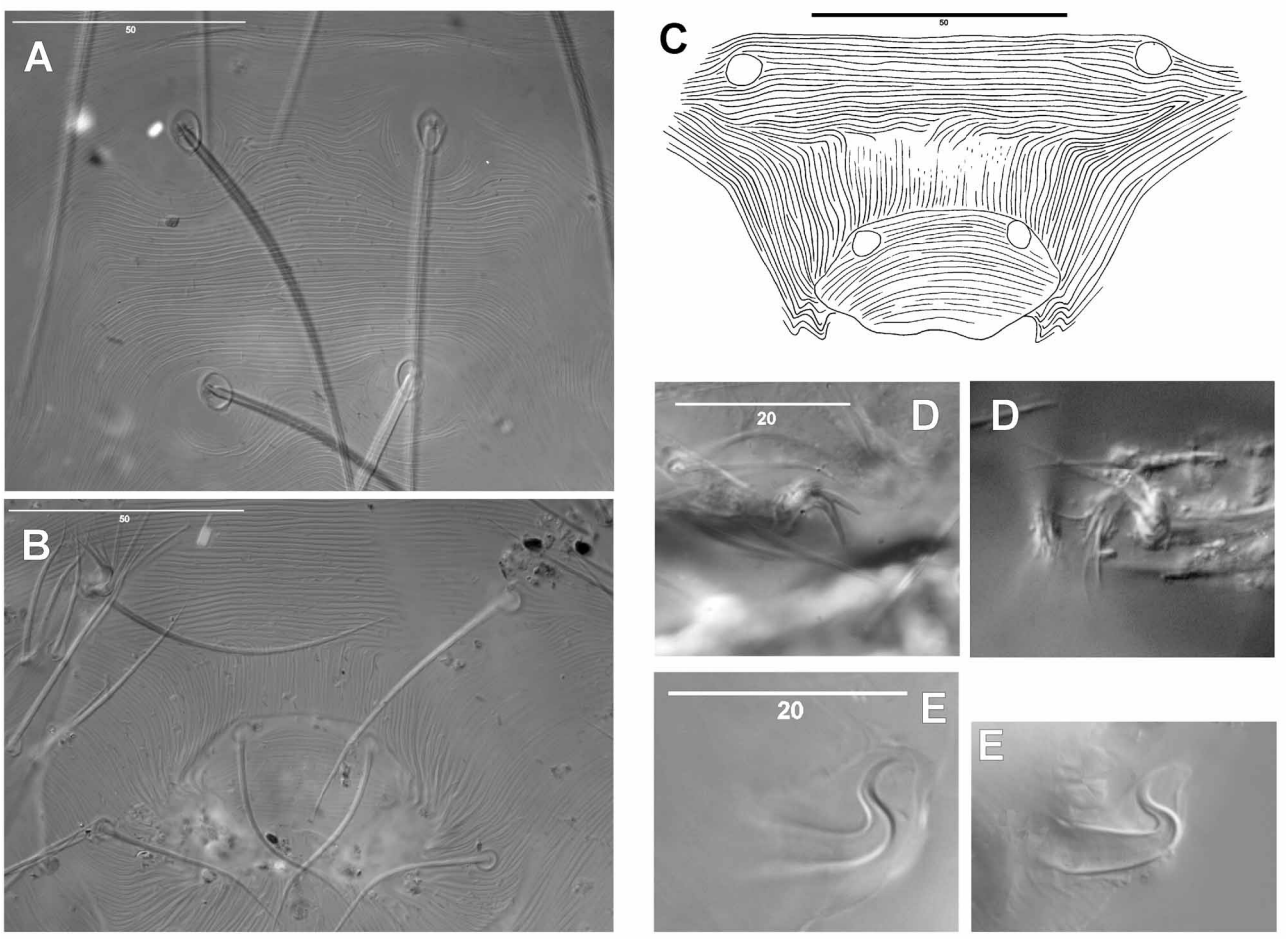


FIGURE 24. *Tetranychus mcdanieli* McGregor, female. (a) Entirely transverse striae between setae e and f; (b) Pregenital striae; (c) Pregenital striae, drawing from another specimen. Male. (d) Pretarsi I and III, holotype specimen; (e) Aedeagus.

Remarks

Tetranychus mcdanieli and *T. pacificus* are similar species, both having transverse striae between setae *e1–e1*, *e1–f1* and *f1–f1*. According to Baker and Tuttle (1994), female *T. mcdanieli* can be distinguished from *T. pacificus* by having some sparse broken pregenital striae, whereas the pregenital striae are almost absent in *T. pacificus*. However, based on the specimens we had available to us, we could not split unequivocally *T. mcdanieli* and *T. pacificus* using the pregenital striae. One obvious and consistent difference between the species was the presence of lobes on the striae of *T. pacificus* that were absent on *T. mcdanieli*. Although this character was consistent amongst the specimens examined, we know of one specimen of *T. mcdanieli* with dorsal lobes present (Dr Frederic Beaulieu, personal communications), thus limiting the diagnostic use of this character. The aedeagi of both species are similar but can be separated with experience. Male *T. mcdanieli* have a strongly sigmoid, smooth aedeagus that lacks an anterior projection; while the aedeagus of *T. pacificus* has a small but distinct angular anterior projection.

Females are a deep amber colour with blackish spots around body margin with legs the same colour as the body (McGregor 1950).

Tetranychus mcdanieli is a temperate-zone species known to cause serious damage to raspberries (Pritchard & Baker 1952; Roy *et al.* 1999) and is also reported damaging deciduous fruit trees, grapes and ornamental plants (Reeves 1963; White 1965; Jeppson *et al.* 1975). Like most pest spider mites, *T. mcdanieli* thrives on weed species, which act as reservoirs for the pest (Nielsen 1958). The adult females overwinter under bark and in the soil (to at least 15 cm depth) at the base of host trees (Nielsen 1958). In hot weather under field conditions, egg to adult takes 8 days (range 16.3 days at 20 ºC to 6.3 days at 35 ºC) and the optimum temperature for oviposition is 29 to 32 ºC. Mites die at 40 ºC (Nielsen 1958). Infestations are initially restricted to the ventral surface of leaves, but mites will use the upper surfaces when the population density becomes higher. Webbing can become thick when populations increase (Nielsen 1958).

Importance

Entry potential: Their presence in France, in addition to North America, indicates they have the capacity to be moved long distances. Overwintering of females is probably obligate, so they may hide in natural cavities in produce and nursery stock, especially on produce in cold storage. Their limited host-list of 15 spp. (Bolland *et al.* 1998) seems to under-represent reports of this species causing damage to several crops. Jeppson *et al.* (1975) claims that the species can live on “more than 30 species of weeds”, citing Reeves (1963), but Reeves does not make this claim.

Importance: This major pest of raspberries (Roy *et al.* 1999) would probably also have significant impacts on pome fruit and viticulture industries. For example, South Africa prohibits pome and stone fruit imports from infested areas, as does Chile for grape imports.

Tetranychus mexicanus (McGregor, 1950) (Fig. 25)

Type specimens examined, U.S.A.: Lectotype male, Laredo, Texas, 5.vi.1945, S.H. Coleman, ex Orange rind *Citrus* sp. (Rutaceae) Type/1735. Here designated formally as a lectotype. This specimen was informally designated as the lectotype in the Master of Science Thesis by Magally Quirós-González (1981), and hence the label reads “Lectotype designated by M. Quiros and E.W. Baker, 1981”. A further 14 slides (7 female, 3 male, 5 nymphs) with the same collection data are designated as paralectoypes. Similarly, these were informally designated by Quirós-González (1981).

Non-type specimens examined, Brazil: 2 females, Caraguatatuba SP, 23.iv.1967, C.H.W. Flechtmann, ex *Theobroma* (Sterculiaceae), det. C.H.W. Flechtmann, #267. 1 male, Piracicaba SP, 7.v.1967, C.H.W. Flechtmann, ex *Morus nigra* (Moraceae), det. C.H.W. Flechtmann, #184.

Caribbean Sea: 1 male, Saint Bathelémy, 2.iv.1998, S. Kreiter, ex *Roystonea regia* (Arecaceae), female red, det. C.H.W. Flechtmann, ESALQ Zool. No. 2444. All in ZCESA.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with obvious dorsal spur 4–6 µm long; *tarsus I* with the sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; d_{prox} = 19–25 µm; D_{duplex} =

19–25 µm; *tarsus III* with 2 proximal tactile setae; *peritreme hook* ca. 28 µm long; *dorsal striae* between setae *e1*–*e1* transverse to oblique; dorsal striae between setae *f1*–*f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming an hourglass-shape; dorsal striae with lobes; *ventral striae* mostly without lobes, low lobes present between setae *4a*; *pregenital striae* weak and broken medially, dotted.

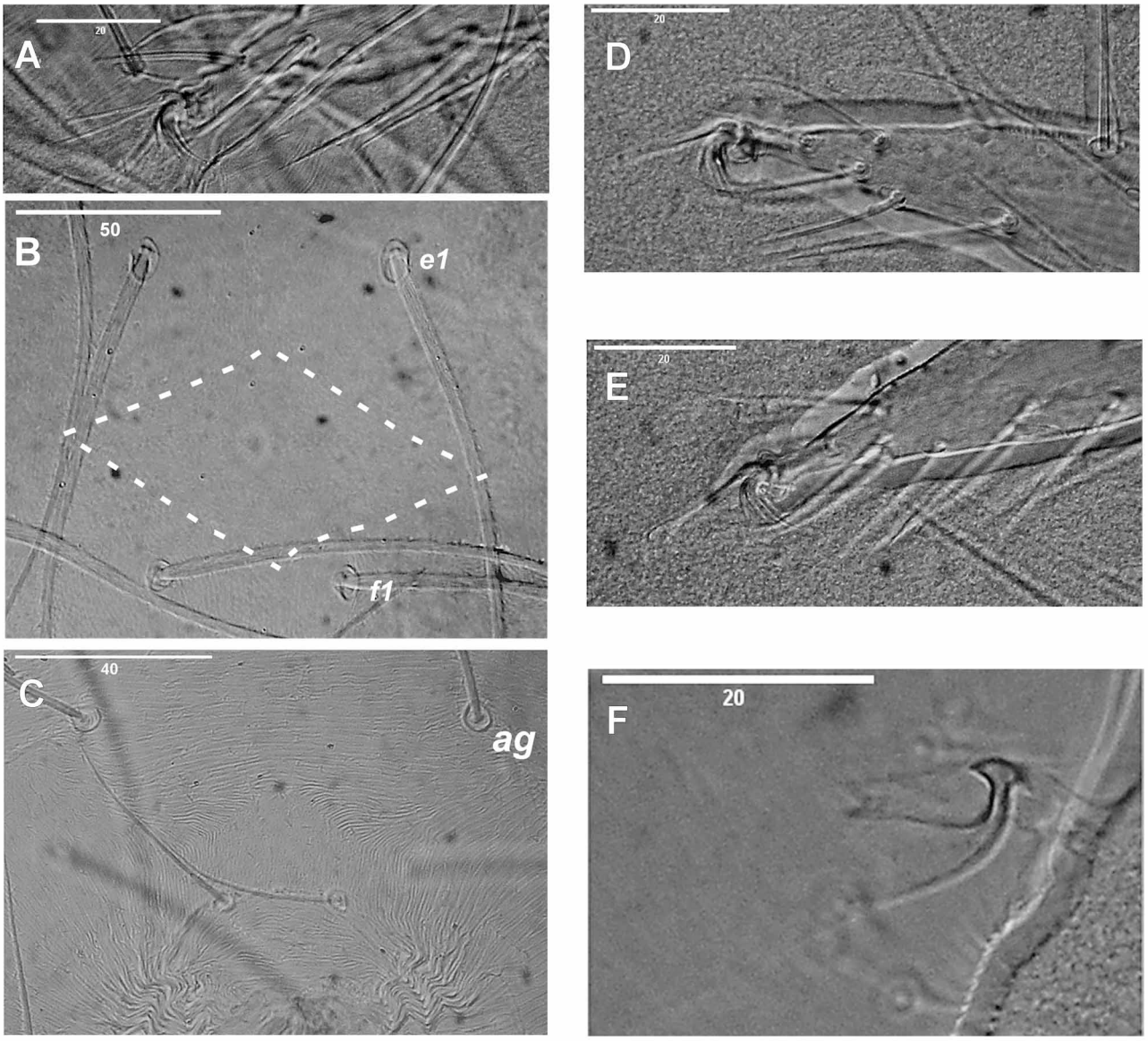


FIGURE 25. *Tetranychus mexicanus* (McGregor), female. (a) Pretarsus I; (b) Hourglass pattern in dorsal striae between *e* and *f*; (c) Pregenital striae. Male. (d) Pretarsus I; (e) Pretarsus II; (f) Aedeagus.

Male: Dorsal striae with small lobes; empodia I–IV each with obvious dorsal spur 5–6 µm long; empodia I uncinate; empodia II–IV with proximoventral hairs long and free. Aedeagus with large knob, posterior and anterior projections pointed, dorsal margin convex (reminiscent of a mushroom head).

Remarks

Tetranychus mexicanus is known from tropical and subtropical countries where, although recorded from 90 spp. of host plants, it is only occasionally a pest (Jeppson *et al.* 1975; Bolland *et al.* 1998). Water stressed plants are probably more susceptible to attack (Quiros-Gonzalez 2000) and it occasionally reaches damaging levels on citrus (Quiros-Gonzalez 2000; Gerson 2003).

Importance

Entry potential: Its occurrence in China (Cheng 1994) in addition to the Americas demonstrates a capacity to be moved long distances. Overwintering females can hide in natural cavities in produce and nursery stock. Their extensive host-list of 90 spp. (Bolland *et al.* 1998) suggests not only a relatively high chance of being on imported plant material, but also an increased chance of finding a suitable host and establishing.

Economic: Although recorded from many host plants, *T. mexicanus* does not appear to be a species of great importance. Its outbreaks seem to be sporadic and mostly restricted to unhealthy plants (Quiros-Gonzalez 2000; Gerson 2003). This species could have a minor impact on citrus (Gerson 2003), and several other cropping systems in tropical and warm subtropical areas, such as soursop (Sousa de *et al.* 2010).

Tetranychus neocaledonicus (André, 1933)
(Fig. 26)

Non-type specimens examined, Australia: Queensland: 2 females, 1 male, Brisbane, 6.ix.1966, J.J.D., ex *Glycine wightii* (Fabaceae), det. J.J.D. (N2250, two slides); 2 females, Skyring Ck, Pomona, 15.viii.1968, J.J.D., ex *Pittosporum revolutum* (Pittosporaceae), det. J.J.D. (N3129); 1 male, Mareeba, 11.ix.1968, I.C.C., ex Umbrella Tree *Schefflera actinophylla* (Araliaceae), det. J.J.D. (N3154). All in QDPI. 2 males, Bracken Ridge, 13.iii.2004, O. Seeman, ex leaves Rose *Rosa* sp. (Rosaceae) ; 4 females, 2 males, Woolloongabba, 6.ii.2004, O. Seeman, ex leaves Frangipani *Plumeria* sp. (Apocynaceae); 3 females, 4 males, University of Queensland, St Lucia, 10.ii.2004, O. Seeman, ex leaves *Cassia* sp. (Caesalpiniaceae). 8 females, 2 males, University of Queensland, St Lucia, 7.viii.2008, O. Seeman, ex leaves *Erythrina variegata* (Fabaceae), red females, yellow males. 5 females, 1 male, Lord's Table Mountain (western slopes), 600 m alt., 22°39.5'S 148°00.7'E, 5–7.iii.2006, O. Seeman, ex leaves Sandpaper Fig *Ficus opposita* (Moraceae). 3 females, 3 males, Woolloongabba, Brisbane, 21.iii.2005, O. Seeman, ex Okra *Abelmoschus esculentus* (Malvaceae). All in QM. 8 females, 4 males, Kingfisher Park, Birdwatcher's Lodge, Lot 1, Mt Kooyong Rd, Julatten, 16°36'S 145°21'E, 23.iv.2002, J.J. Beard, ex guava *Psidium* sp. (Myrtaceae), Reg.#86688-86698. 4 females, 2 males, Abattoir Conservation Park, near Julatten, 16°36'S 145°20'E, 21.iv.2001, J.J. Beard, ex *Macroptilium atropurpureum* (Fabaceae), Reg.#86529-86534. 10 females, 10 males, Rockhampton City Hall, Rockhampton, 23°22'58''S 150°30'45''E, 18.iii.2005, J.J. Beard and P.I. Forster, ex *Bauhinia purporeum* (Caesalpinaceae), Reg.#89435-89451. All in UQIC. 2 females, 1 male, Rex Lookout, Captain Cook Highway, 16º38.809′S 145º33.906′E, 14.viii.2009, S.A. Cowan and S. McKenna, ex leaves Butterfly Pea *Clitoria ternatea* (Fabaceae). In QDPI, Cairns. **Torres Strait:** 1 female, 2 males, Boigu Is., 10.vi.2009, ex *C. ternatea*. 2 females, 1 male, Boigu Is., 10.vi.2009, S. McKenna, ex Aibika *Abelmoschus manihot* (Malvaceae). 2 females, 1 male, Hammond Is., 15.vi.2009, ex leaves Papaya *Carica papaya* (Caricaceae). 3 females, 5 males, Hammond Is., 15.vi.2009, A. Postle, ex leaves Cassava *Manihot esculenta* (Euphobiaceae). 6 females, 3 males, Horn Is., 13.vi.2009, ex *M. esculenta*. All in QDPI, Cairns.

Papua New Guinea: 2 females, 2 males, #41 Moem Army Barracks, 3º33.623′S, 143º41.684′E, 19.x.2007, A.D. Rice, ex leaves Peanut *Arachis hypogaea* (Fabaceae). All in QDPI, Cairns.

Diagnosis

Female: Empodia with 6 proximoventral hairs; spurs on empodia I–IV minute or absent; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 23–28 μm; D_{duplex} = 13–14 μm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 20–26 μm long; *dorsal striae* between setae *e1–e1* longitudinal; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming diamond-shape medially; dorsal striae with lobes; *ventral striae* without lobes; *pregenital striae* obviously broken and dotted anteriorly.

Male: Empodia I–IV each with minute dorsal spur; empodia I claw-like (uncinate); empodia II–IV with proximoventral hairs long and free. Aedeagus with knob, anterior projection short and pointed, posterior projection short and broadly rounded, dorsal surface highly convex with postero-medial indentation.

Remarks

The aedeagus is described as berry-like by Gutierrez and Schicha (1983), but it is not as distinctive as many authors

suggest, and we have noticed variation in specimens identified as *T. neocaledonicus* from Australia. Care should be taken not to confuse this species with those with small aedeagal knobs, such as *T. urticae* and *T. lombardinii*.

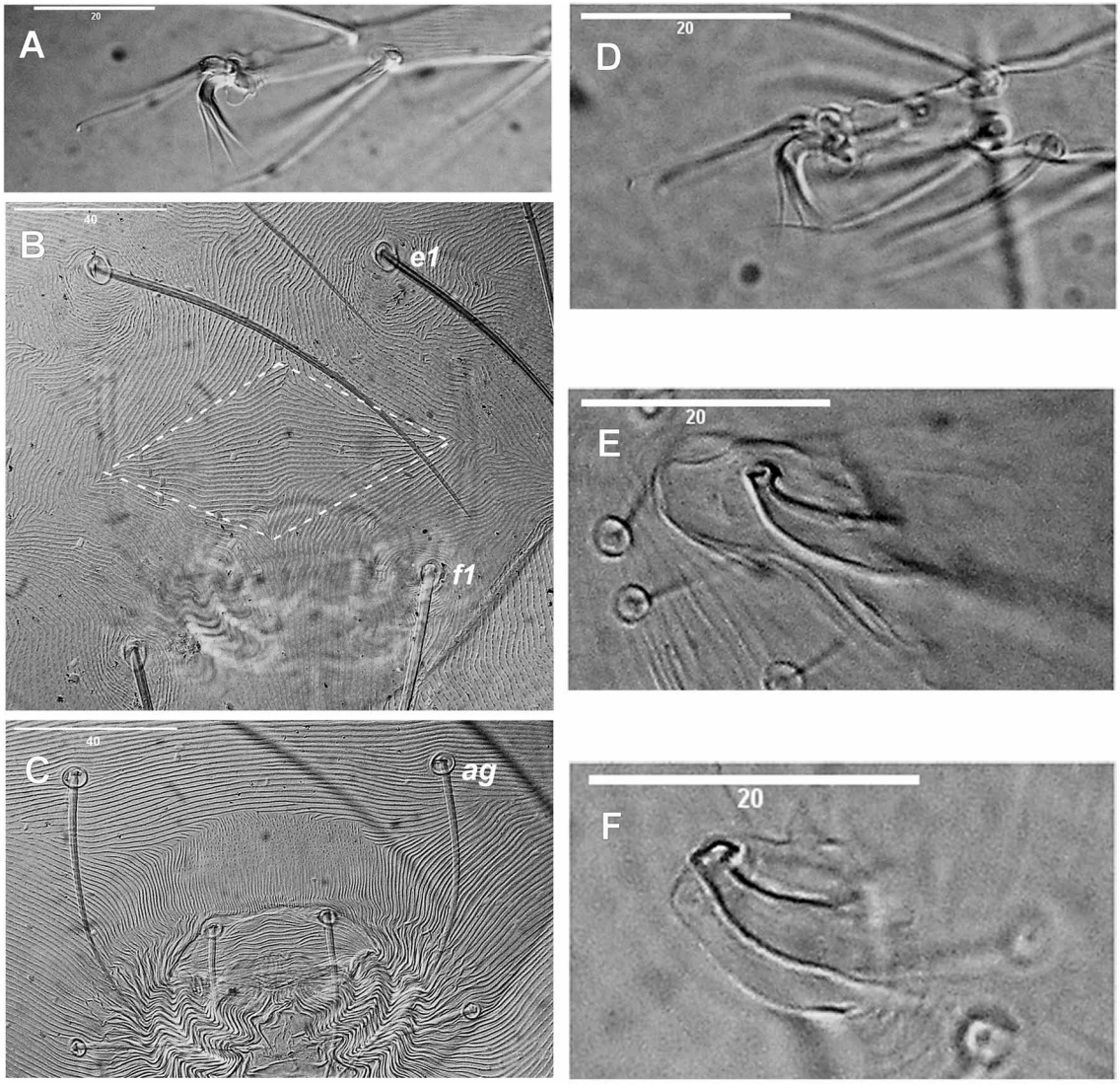


FIGURE 26. *Tetranychus neocaledonicus* (Andre), female. (a) Pretarsus I; (b) Diamond-shaped pattern of dorsal striae between setae e and f; (c) Pregenital striae. Male. (d) Pretarsus II; (e) Aedeagus; (f) Aedeagus, different specimen.

Live females are bright red with pale white legs; males are greenish-yellow (Gutierrez & Schicha 1983; personal observations). This species is not a major pest in New South Wales and is probably restricted to warmer areas where the temperature rarely goes below 10 °C (Gutierrez & Schicha 1983). *Tetranychus neocaledonicus* is common in Brisbane on many weeds and cultivated plants (Davis 1968a; personal observations). Our collecting suggests that *T. neocaledonicus* is the most common *Tetranychus* in urban Brisbane. Some life history data is presented by Puttaswamy (1981), Ghoshai *et al.* (2006), and Kaimal and Ramani (2007).

Importance

A pest species that can require management through biological control or miticides (Jeppson *et al.* 1975).

Tetranychus pacificus McGregor, 1919
(Fig. 27)

Non-type specimens examined, U.S.A: 5 females, 1 male, Yakima, Washington State, v–vi.1952, E.J. Newcomer, reared on bean. 1 female, Portal, Arizona, 02.ix.1967, D.M. Tuttle, ex. Birch-leaf Buckthorn *Rhamnus betulaefolia*

(Rhamnceae). 4 males, reared on Apple *Malus domestica* (Rosaceae), Yakima, Washington State, vii–viii.1952, E.J. Newcomer. All material in USNM. McGregor (1919) states that the type specimens were deposited at USNM, but USNM have no records of ever receiving the specimens. 2 females, Milton-Freewater, Oregon, 19.vii.1956, S. Capizzi, ex Strawberry *Fragaria* (Rosaceae). At Oregon State University Collection.

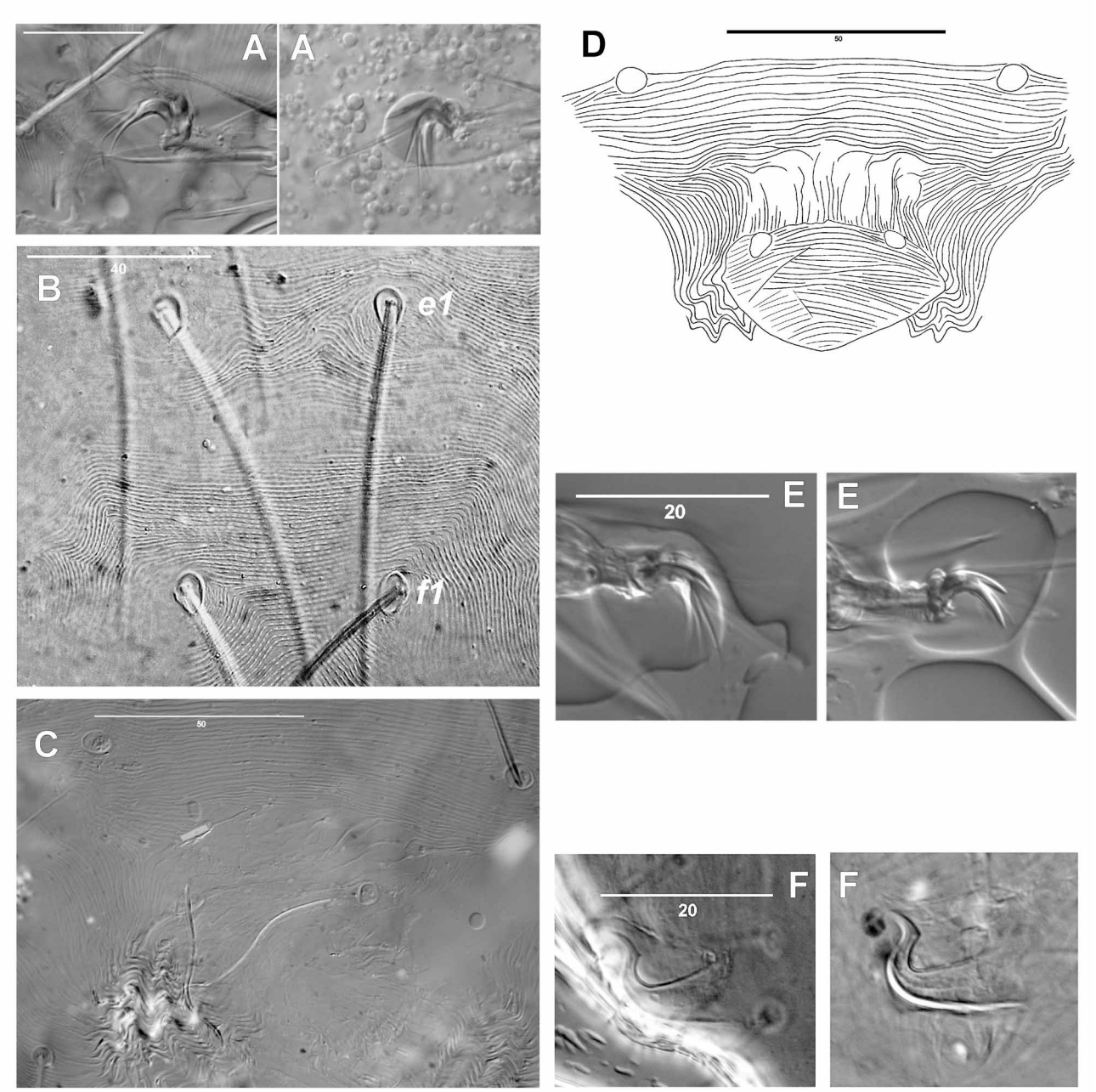


FIGURE 27. *Tetranychus pacificus* McGregor, female. (a) Pretarsus I, IV; (b) Transverse pattern of dorsal striae between setae e and f; (c) Pregenital striae; (d) Pregenital striae, different specimen. Male. (e) Pretarsi I and II; (f) Aedeagus, different specimens.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV without dorsal spurs; *tarsus I* with the sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 19–38 µm; D_{duplex} = 9–12 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* 23–28 µm long; *dorsal striae* between setae *e1–e1* transverse or oblique; dorsal striae between setae *f1–f1* transverse; dorsal striae between setae *e1* and *f1* transverse; dorsal striae with lobes; *ventral striae* without lobes; *pregenital striae* weak and incomplete or absent or with extremely weak striae laterally.

Male: Dorsal striae without lobes; empodia I with strong spur (4–6 µm), empodia II with spur 3–4 µm, III–IV with minute (< 2 µm) dorsal spurs; empodia I claw-like (uncinate); empodia II–IV with proximoventral hairs long and free. Aedeagus without knob; largely sigmoid, but with small but distinct projection on anterior margin.

Remarks

Tetranychus pacificus is very similar to *T. mcdanieli*; see the Remarks section on *T. mcdanieli* for comparisons between the species.

Living female *T. pacificus* are variable in colour: amber, salmon, orange-red, greenish-yellow, or other colours depending on the food plant, stage of development, or season. The dorsum can be unspotted or have as many as four blackish spots along each side, and the legs and palps are pale (McGregor 1950; Baker & Pritchard 1953). Overwintering females are bright orange to deep amber, shiny and lack food spots (Pritchard & Baker 1952). Nymphs are pale amber with several food spots. Eggs are initially colourless, becoming deep amber (McGregor 1950).

Tetranychus pacificus is a serious pest throughout its range, from the warm subtropical areas of northern Mexico into temperate Canada, especially in interior agricultural areas (Pritchard & Baker 1952; Jeppson *et al.* 1975). Damage is similar to that of other spider mites, except that low populations are able to cause an inordinate amount of damage, suggesting that the mites inject toxins into their host plants (Jeppson *et al.* 1975). Damage on trees usually begins within the crowns, starting with characteristic speckling but soon turning the leaves brown. The damage can appear as though the tree crowns have been burnt by fire (Jeppson *et al.* 1975).

This species experiences a wide range of climes throughout its distribution, although it does not occur in tropical climates. In warm subtropical zones the mites do not overwinter, but in temperate zones females overwinter in cracks and crevices on stems of their hosts and in soil (Laminman 1935; Jeppson *et al.* 1975), and their presence in Canada shows they can tolerate very low temperatures. Conditions of high temperature and low humidity seem to promote damage. Grape, prune and almond seem to be highly susceptible, with populations reaching 1400 mites per leaf on grapes (Laminman 1935). This species is sometimes found in mixed populations with *Tetranychus urticae*. The life history of this species is well studied (e.g., Stavrinides *et al.* 2010).

Nitrogen fertilisation of the host plants increases fecundity and development times of both *T. pacificus* (Wilson *et al.* 1988) and *T. urticae* (Wermelinger *et al.* 1985). Also, fecundity and development rate of *T. pacificus* on almond increases with water stress, probably as a result of increased leaf temperature (Youngman *et al.* 1988; Oi *et al.* 1989).

An unusual method of control is used for *T. pacificus* on grapes. The deliberate introduction of an innocuous spider mite, *Eotetranychus willamettei* (McGregor, 1917), prior to the natural infestation of *T. pacificus*, causes a systemic reaction that reduces the later infestation by *T. pacificus* (English-Loeb *et al.* 1993; Hougen-Eitzman & Karban 1995). However, this does not seem to work for all grape cultivars (Hanna *et al*. 1997).

Importance

Entry potential: *Tetranychus pacificus* has not yet been spread to countries outside of North America, but in a survey of nectarine fruit packed in California, *T. pacificus* was one of the most common species found (10–60/100,000 fruit) (Curtis *et al.* 1992). Overwintering females hide in natural cavities in produce and nursery stock, and could survive on produce in cold storage. The host-list of 35 spp. represents a reasonable diversity of host plants (Bolland *et al.* 1998), suggesting a good chance of establishment.

Economic: *Tetranychus pacificus* is a serious pest and is amongst the *Tetranychus* species we consider the greatest threat to Australia's agricultural industries. McGregor (1950) considered *T. pacificus* as "one of the most destructive crop pests in the great agricultural interior valleys of the Pacific Coast. When crop plants, ornamental and shade trees are considered together, it may be the most serious pest of central California". This species is a major pest of almonds (Welter *et al*. 1984) and grapes (Hanna *et al.* 1996, 1997).

If introduced to Australia, we would expect substantial costs to be incurred by the deciduous tree crop industry and viticulturists, through losses in yield, increased control measures, and added economic drain of resistance to acaricides. Australian markets for pome and stone fruits and grapes could be affected. For example, South Africa prohibits apple and pear imports from areas infested with *T. pacificus*, and Brazil requires either area-freedom or fumigation prior to accepting produce from a country.

***Tetranychus piercei* McGregor, 1950**
(Fig. 28)

Non-type specimens examined, Japan: 5 females, 5 males, Kagoshima Pref., 6.viii.1997, T. Gotoh, ex *Alocasia macrorrhiza* (Araceae). All deposited in QM.

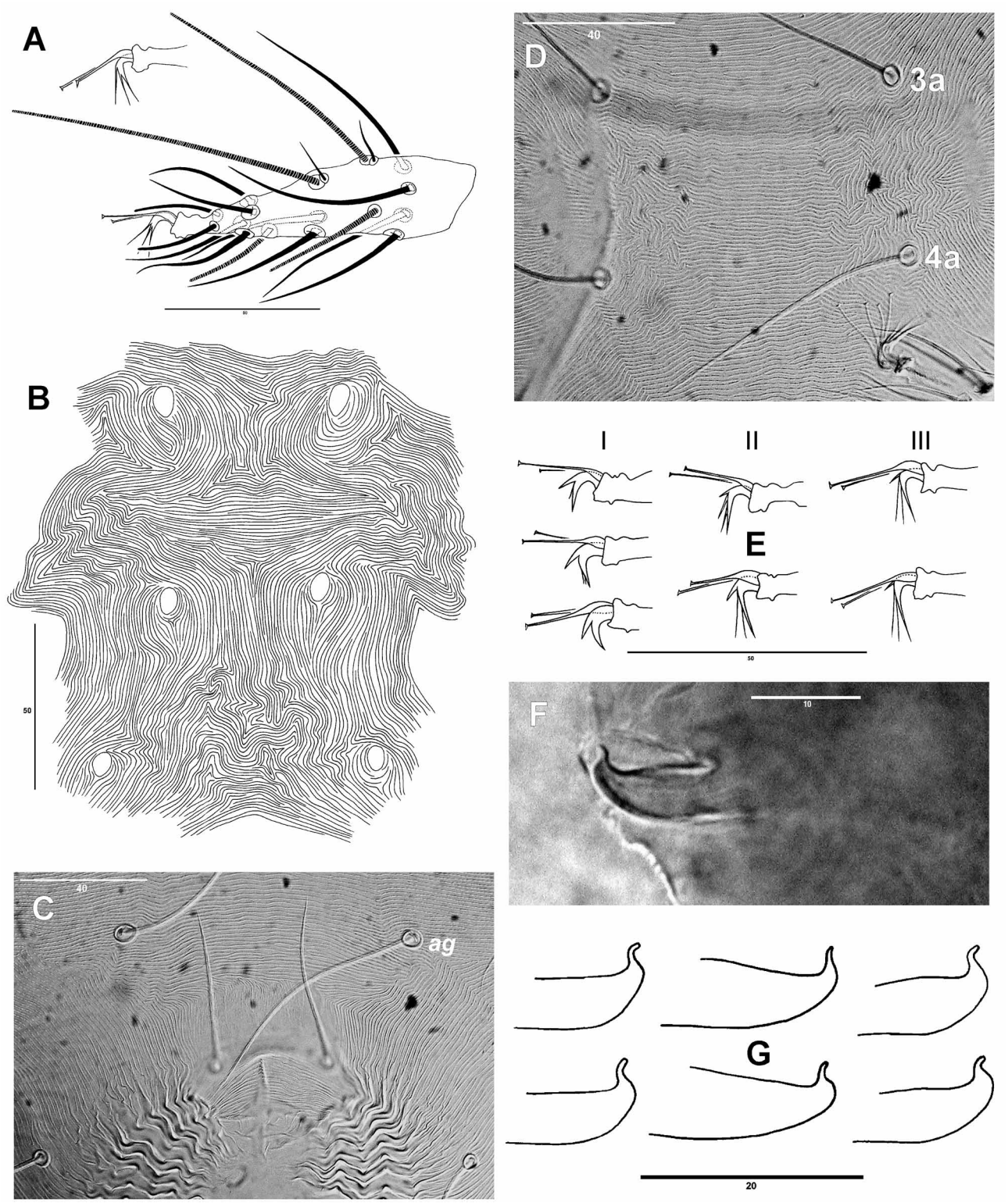


FIGURE 28. *Tetranychus piercei* McGregor, female. (a) Tarsus and pretarsus I; (b) Diamond-shaped pattern of dorsal striae between setae e and f; (c) Pregenital striae; (d) Ventral striae between setae *3a* and *4a*. Male. (e) Pretarsi I, II, III; (f) Aedeagus; (g) Aedeagi from different specimens.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with minute or absent dorsal spur; *tarsus I* usually with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae, occasionally socket of 1 tactile setae overlapping with the level of socket of the proximal duplex setae; $\sum d_{prox}$ = 14–28 µm; D_{duplex} = 14 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 22–28 µm long; *dorsal striae* between setae *e1–e1* longitudinal; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming a diamond-shape; dorsal striae with lobes; *ventral striae* with small lobes from just posterior of setae *4a* to just anterior of setae *4a*; *pregenital striae* broken, sometimes weakly so.

Male: Empodia I–IV each with an obvious dorsal spur 3–4 µm long; empodia I claw-like (uncinate), empodia II–IV each with proximoventral hairs long and free. Aedeagus without distinct knob, tip sigmoid, much narrower than shaft, short finger-like tip directed posteriorly.

Remarks

In the specimens we examined, there was minor intra-population variance in the number of proximal setae overlapping with the proximal duplex setae on tarsus I (0–1 overlapping).

Tetranychus piercei is a tropical and warm sub-tropical species of south-east Asia and the Indonesian region. The species seems to be only an occasional pest (Jeppson *et al.* 1975), but can reach high numbers on banana (Fu *et al*. 2002) and is a pest of papaya (Liu & Liu 1981).

Importance

Entry potential: Overwintering females may hide in natural cavities in produce and nursery stock. *Tetranychus piercei* has a relatively diverse host list of 43 spp. (Bolland *et al.* 1998; Ohno *et al.* 2009).

Economic: The impact of this species is unknown, but is regarded as a pest of banana (Fu *et al*. 2002) and papaya (Liu & Liu 1981). Otherwise, this species is probably a minor pest of other crops.

Tetranychus rhagodiae Miller, 1966
(Fig. 29)

Non-type specimens examined, Australia: **Tasmania:** 4 females, Cremorne, 10.vi.1963, ex *Rhagodia billardieri* (Chenopodiaceae), det. L.W. Miller 1963 (K330, 68113; K331, 68114; K332, 68115; K329, 68112). All in TDPIC.

Diagnosis

Female: Empodia with 6 proximoventral hairs; spurs on empodia I–IV minute or absent; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 37–47 µm; D_{duplex} = 6–7 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 10–12 µm long; *dorsal striae* between setae *e1–e1* transverse and oblique; dorsal striae between setae *f1–f1* mixed, mostly oblique; dorsal striae between setae *e1* and *f1* transverse and oblique forming a weak diamond shape medially; dorsal striae with lobes; *ventral striae* without lobes; *pregenital striae* generally entire, not all longitudinal (some oblique).

Male: Empodia I–IV each with a minute dorsal spur; empodia I–II claw-like (uncinate), empodia III–IV with proximoventral hairs long and free. Aedeagus with large knob, anterior projection rounded, posterior projection sharply pointed, dorsal surface highly convex.

Remarks

This species is known only from the Tasmanian saltbush.

Importance

Not significant.

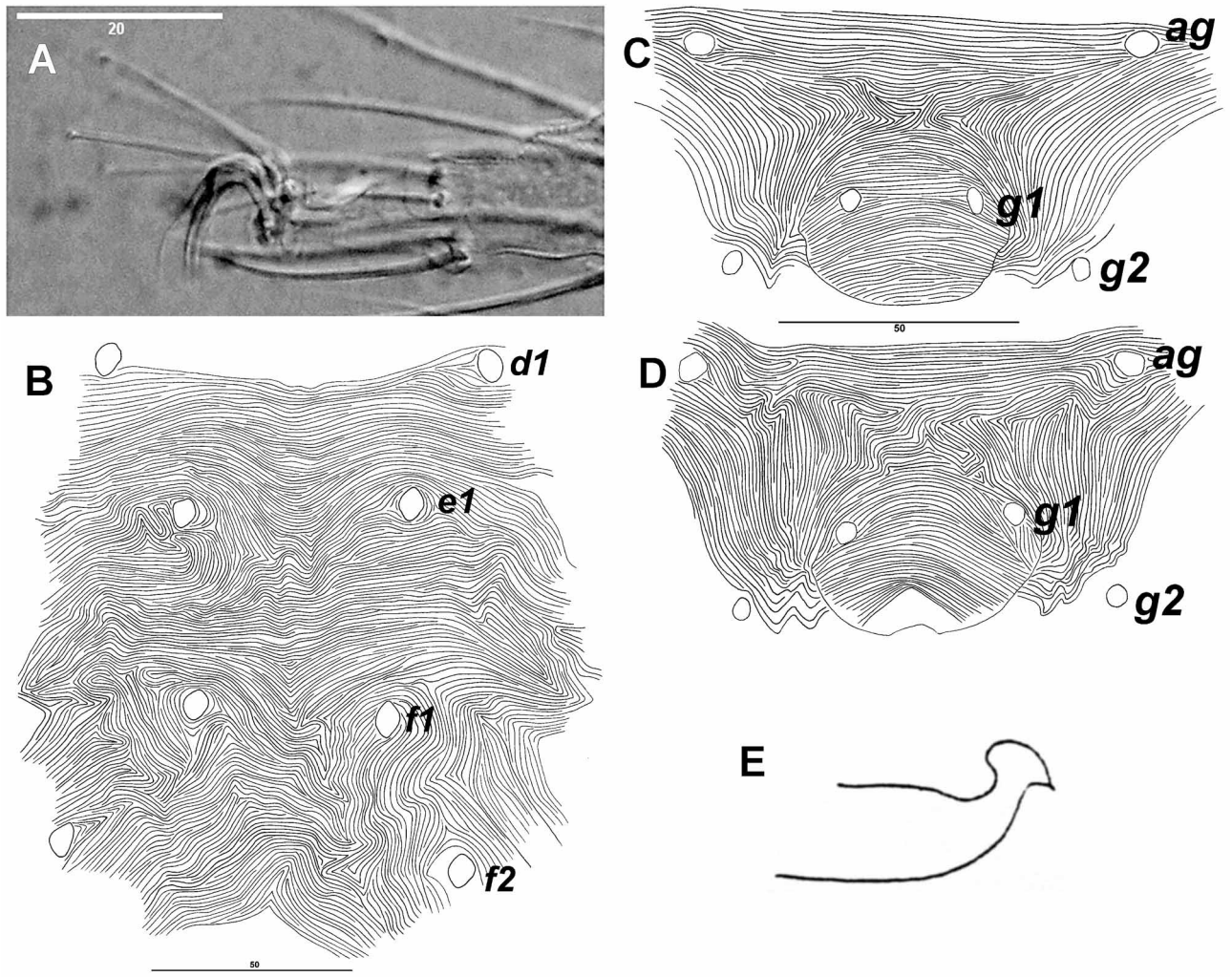


FIGURE 29. *Tetranychus rhagodiae* Miller, female. (a) Pretarsus I; (b) Diamond-shaped pattern of dorsal striae between setae e and f; (c, d) Variation in pregenital striae. Male. (e) Aedeagus.

Tetranychus schoenei McGregor, 1941
(Fig. 30)

Type specimens examined, U.S.A.: Approximately 40 of male and female syntypes. Winchester, Virginia, 14.iii.1941, W.J. Schoene, ex Apple *Malus domestica* (Rosaceae), Bureau No. 41-6426, USNM 1418. In USNM.

Non-type specimens examined, U.S.A.: 2 females, 2 males, Louisiana, Missouri, 12.viii.1952, D.W. Hamilton, lot 52-12703, bright orange, ex Raspberry *Rubus* sp. (Rosaceae). 2 females, Kearneysville, West Virginia, 6.xii.1949, E. Gould, bright orange, ex bark Apple *M. domestica*. 2 males, College Park, Maryland, 22.vi.1951, F.F. Smith, TC-7535, lot 51-5740, ex Rambler Rose *Rosa* sp. (Rosaceae). In USNM.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with minute (2 µm) dorsal spur; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 14–31 µm; D_{duplex} = 7–10 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 19–25 µm long; *dorsal striae* between setae *e1–e1* and *e1–f1* transverse, dorsal striae between *f1–f1* longitudinal, forming an hourglass pattern; dorsal lobes small or absent; *ventral striae* without lobes; *pregenital striae* entire, sometimes weak medially.

Male: Empodia I–IV each with obvious dorsal spurs 3 µm long, empodia I claw-like (uncinate), empodia II–IV with proximal hairs long and free. Aedeagus with large knob, short pointed anterior projection, posterior projection sharp and hook-like, dorsal surface strongly convex.

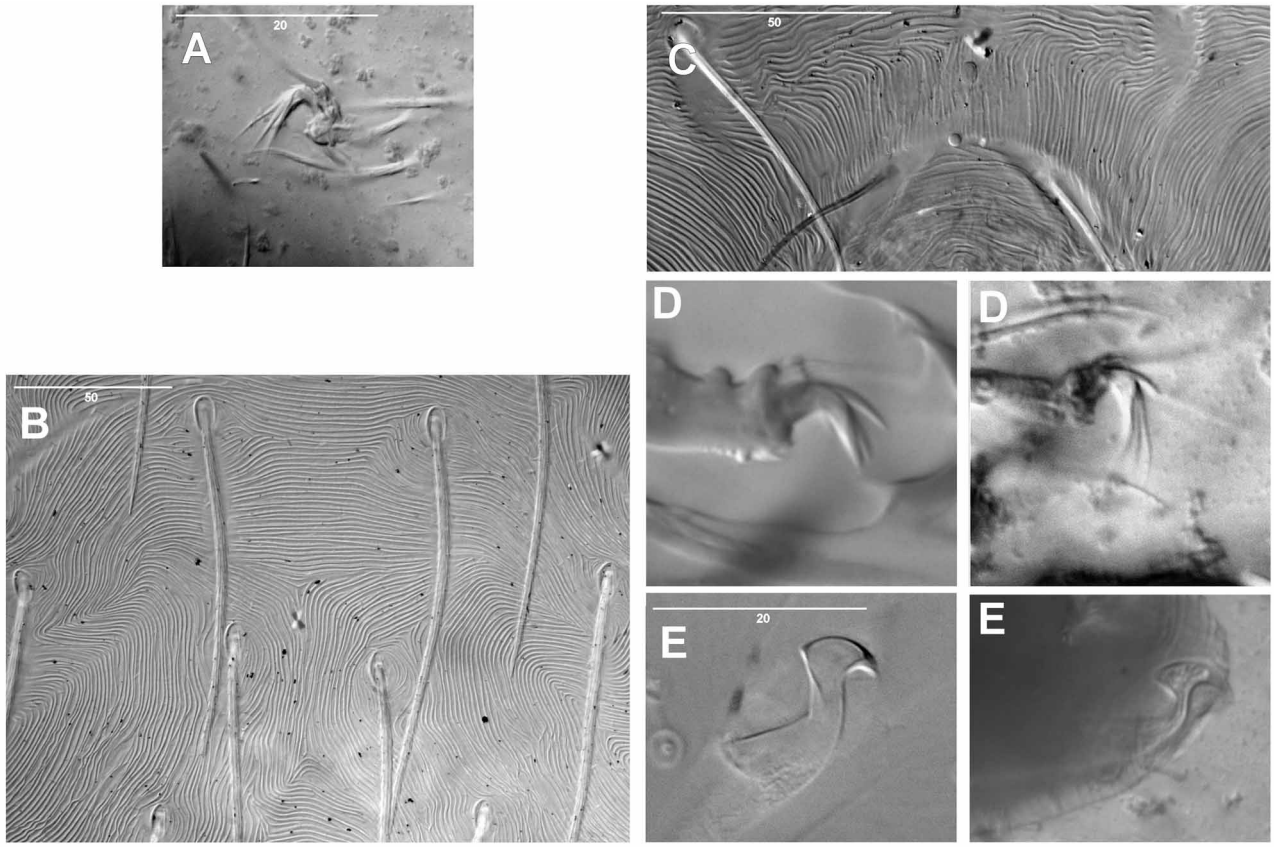


FIGURE 30. *Tetranychus schoenei* McGregor, female. (a) Pretarsus IV, from specimen on type slide; (b) Hourglass-shaped pattern of dorsal striae between setae e and f; (c) Pregenital striae. Male. (d) Pretarsi I and II, from specimens on type slide; (e) Aedeagi from non-type and type specimen.

Remarks

This species is almost identical to *T. canadensis* and their distributions overlap; see the Remarks section for *T. canadensis* for a comparison.

The summer female of *T. schoenei* is faded green to dark green (but this can depend on the food plant) with four dark spots, the most anterior pair being the largest (Pritchard & Baker 1952). These spots appear only after feeding commences. Larvae and protonymphs have only two spots. Male mites are pale yellowish-green and have four tiny spots. Hibernating female mites are orange (Cagle 1943), as noted on slides by collectors.

This species is prevalent throughout the eastern USA where it is an occasional pest in several crops, such as beans, pome fruit, raspberries and cotton (Jeppson *et al.* 1975). When *T. schoenei* reaches pest levels, it causes the typical bronzing of foliage and eventual leaf senescence, but can also prevent fruit from ripening. *Tetranychus schoenei* readily spins webbing (Pritchard & Baker 1952). Life history data is presented in Cagle (1943).

Importance

Entry potential: This species has apparently not spread from eastern U.S.A. Overwintering is probably obligate over most of its range, and females may hide in natural cavities in produce and nursery stock, and could survive on goods in cold storage. *Tetranychus schoenei* has a diverse host list of 50 spp. (Bolland *et al.* 1998), giving it a high chance of being on imported plant material and finding a suitable host.

Economic: Damage to apple can be severe, causing bronzing of foliage, failure of fruit colouring and subsequent down-grading of fruit (Cagle 1943). However, serious infestations are likely to be sporadic rather than a persistent annual event.

If introduced to Australia we would expect this species to have a small but significant impact on the production of several crops, especially pome and stone fruits. In years where outbreaks are experienced, growers could suffer crop losses, increased costs associated with the control of the mite, and perhaps shortened life of acaricides through the development of resistance. Existing Australian markets for pome and stone fruits and grapes could be affected if this species is introduced into this country as, for example, South Africa prohibits apple and pear imports from areas infested with *T. schoenei*.

***Tetranychus truncatus* Ehara, 1956**
(Fig. 31)

Type specimens examined, Japan: Holotype male, Suginami, Tokyo, 12.x.1954, G. Ishii and S. Ehara, ex Mulberry *Morus* sp. (Moraceae). Paratypes, 2 females, same data as holotype. Holotype in ZIHU, paratypes in HUM (see Ehara *et al*. 2009).

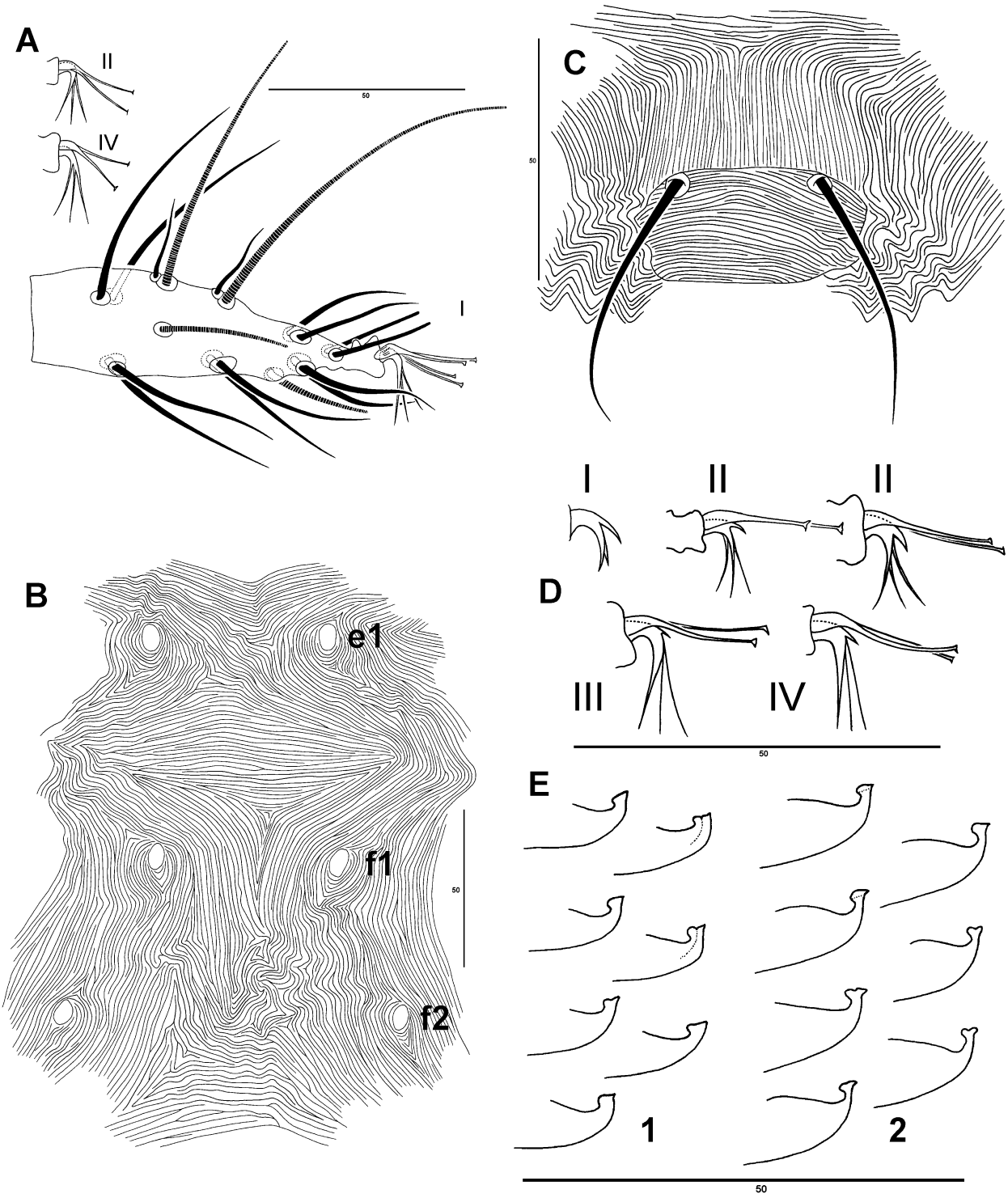


FIGURE 31. *Tetranychus truncatus* Ehara, female, paratypes. (a) Tarsus I and pretarsus II and IV; (b) Diamond-shaped pattern of dorsal striae between setae e and f; (c) Pregenital striae. Male, holotype. (d) Pretarsi I-IV; (e) Aedeagus of two specimens from several focal points.

Diagnosis

Female: Empodia with 6 proximoventral hairs, empodia I–IV each with a minute spur (< 2 µm long or absent); *tarsus I* with sockets of 4 tactile setae proximal to proximal pair of duplex setae; d_{prox} 27; D_{duplex} 9–10; *tarsus III* with 1 proximal tactile seta; *peritreme hook* 22–25 µm long; *dorsal striae* between setae *e1–e1* mixed longitudinal and oblique; dorsal striae between setae *f1–f1* longitudinal (sometimes combined with oblique); dorsal striae between setae *e1* and *f1* transverse forming a diamond-shape medially; *ventral striae* without lobes; *pregenital striae* entire, unbroken (but may be sparse medially).

Male: Empodia I–II each with an obvious dorsal spur, I–II 3–4 µm long, III–IV 2 µm long; empodium I claw-like (uncinate); empodia II–IV with proximoventral hairs free and long; aedeagus with small knob, anterior projection rounded, short, posterior projection pointed, short, dorsal surface flat to slightly convex, with medial indentation.

Remarks

This species occurs throughout south-east Asia and Indonesia, extending to Japan and Korea, covering tropical and temperate zones. This wide distribution is reflected by the range of temperatures, 24–31 ºC, at which development can occur (Sakunwarin *et al*. 2003). Life history data is presented by Chen *et al.* (1999) and Sakunwarin *et al*. (2003). Like most species of *Tetranychus*, *T. truncatus* tends to feed on the underside of leaves (Sakunwarin *et al.* 2003). Life history data is presented by Sakunwarin *et al*. (2003), Pang *et al*. (2004) and Yuan *et al.* (2008).

Damage is typical for spider mites; speckling of leaves, leading to large areas of yellowing and bronzing of foliage, and populations seem to thrive during drier periods (Chen *et al.* 1999). Females overwinter under bark and at the base of plants in the upper soil layer and leaf-litter. The adult female is carmine red (Jeppson *et al*. 1975).

Importance

Entry potential: This species has not spread from south-eastern Asia, but within the region it is difficult to determine if its range has extended from their original distribution of Japan and the Philippines (Jeppson *et al.* 1975). Overwintering females hide in natural cavities in produce and nursery stock, and could survive on goods in cold storage. The host list of 61 spp. is an extensive range (Bolland *et al.* 1998), increasing the chances of finding a suitable host and establishment.

Economic: *Tetranychus truncatus* could cause significant damage, at least on eggplant, corn and cotton (Ehara & Wongsiri 1975; Li *et al.* 1998; Chen *et al.* 1999; Sakunwarin *et al*. 2003). If introduced, this species could become an occasional problem throughout Australia. Agricultural industries may also experience market restrictions; for example, *T. truncatus* is of quarantine concern for quince exported to Canada.

Tetranychus turkestani (Ugarov & Nikolskii 1937) (Fig. 32)

Non-type specimens examined, South Africa: 1 female, 1 male, Onderstepoort, Pretoria, 19.x.1979, B.J.v.Straaten, ex Lucerne, *Medicago sativa* (Fabaceae), det. M.K.P. Meyer (AcY: 79/426; X79/92). Donated to QM from PPRI.

Non-type specimens examined, U.S.A.: 1 male, Bard, California, 29.viii.1967, R. Flock, ex *Medicago sativa*, det. D.M. Tuttle. 1 female, Columbus, Ohio, 7.vii.1965, D.M. Tuttle, ex Canadian Violet *Viola canadensis* (Violaceae), det. D.M. Tuttle. Both identified as *Tetranychus atlanticus* (recognised synonym of *T. turkestani*). All in QDPI.

Iran: 2 females, 1 male, Mashhad, 22.vii.2009, ex Elm *Ulmus* sp. (Ulmaceae). 4 females, 2 males, Mashhad, 17.vii.2007, ex Maple *Acer* sp. (Hippocastanoideae).

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with minute dorsal spur < 2 µm long, or spur absent; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 22–23 µm; D_{duplex} = 9–10 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 22–24 µm long; *dorsal striae* between setae *e1–e1* longitudinal; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and

f1 transverse forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* without lobes; *pregenital striae* becoming sparse and broken medially.

Male: Empodia I–II each with an obvious dorsal spur, I–II 3–4 μm long, III–IV 2 μm long; empodia I uncinate or claw-like, empodia II–IV with proximoventral hairs long and free. Aedeagus with large knob, anterior projection rounded, posterior projection bluntly pointed, dorsal surface flat with posterior angle.

Remarks

The colour of adult females varies but is often yellow-green and there is a large spot on either side of the body, with an occasional additional pair of posterior spots (Jeppson *et al*. 1975; Meyer 1974).

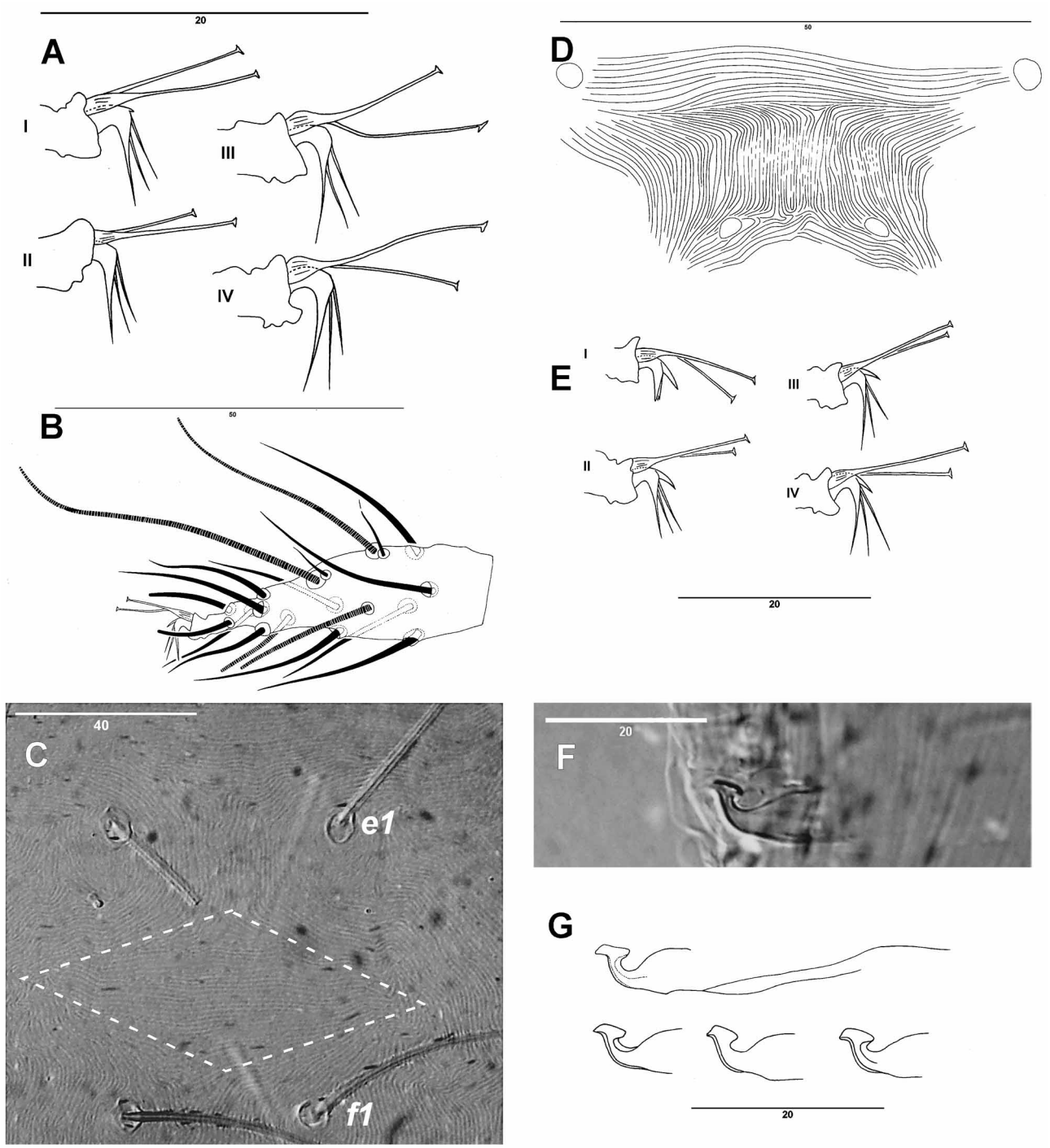


FIGURE 32. *Tetranychus turkestani* (Ugarov & Nikolskii), female. (a) Pretarsi I-IV; (b) tarsus I; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Pregenital striae. Male. (e) Pretarsi I-IV; (f) Aedeagus; (g) Aedeagus, from several focal points.

Tetranychus turkestani has a wide distribution covering temperate zones to subtropical areas of Europe, Asia, Africa, Japan and New Zealand. Bright-orange females spend winter hibernating beneath bark or at the base of plants in upper soil layers (Mellott & Connell 1965; Baker & Tuttle 1994). Damage is the typical speckling of foliage, leading to bronzing, leaf senescence and sometimes complete defoliation (Jeppson *et al.* 1975). This defoliation may be associated with a toxin injected by the mites during feeding (Simons 1964). Mites prefer the underside of leaves, and large populations produce copious amounts of webbing, sometimes binding leaves together (Jeppson *et al.* 1975). In cotton, *T. turkestani* thrives during dry warm periods (Canerday & Arant 1964). Life history data was presented by Carey and Bradley (1982), Sohrabi and Shishehbor (2008) and Yuan *et al.* (2008).

Bailly *et al.* (2004) demonstrated that the large host range of this species (175 spp.; Bolland *et al.* 1998) represents the true host-plant range rather than a group of cryptic species.

Importance

Entry potential: This species has spread further than any of the species not present in Australia, and has the greatest number of known host plants. Thus, *T. turkestani* has the highest chance of entering Australia of any *Tetranychus*. Overwintering females hide in natural cavities in produce and nursery stock, and could survive on goods in cold storage.

Economic: A widespread and serious pest of many crops throughout the world (Jeppson *et al.* 1975). For example, on cotton they cause defoliation and a decrease in yield (Canerday & Arant 1964; Simons 1964).

Establishment of this species in Australia would affect several industries, and some quarantine restrictions could result, particularly to South America where the species is absent.

***Tetranychus urticae* Koch, 1836**

(Fig. 33)

Non-type specimens examined, Australia: Queensland: 2 females, 5 males, Ormiston D.P.I. Horticultural Station, 6.vii.1972, M. Bengston, ex Strawberry *Fragaria* sp. (Rosaceae); 7 females, 3 males, Forest Hill, ex Cotton *Gossypium* sp. (Malvaceae), 20.i.1965, J.W.T., det. J.J.D. (N1793, two slides); 1 male, Orimiston, 20.xi.1964, ex Tomato *Lycopersicon esculentum* (Solanaceae), det. J.J.D. (N1700); 1 male, Belmont, 10.xi.1965, J.H.B., ex Cape Gooseberry *Physalis peruviana* (Solanaceae), det. J.J.D. (N1621); 1 male, M.H.R.S. Nambour, 15.v.1964, D.A.I., ex Papaya *Carica papaya* (Caricaceae), det. J.J.D. (N1060). All in QDPI. 8 females, 4 males, Woolloongabba, 6.viii.2004, O. Seeman, ex leaves *Nasturtium* sp. (Brassicaceae); 8 females, 4 males, Ormiston D.P.I. Horticultural Station, 6.vii.1972, M. Bengston, ex strawberry plants. All in QM. **Tasmania:** 1 male, Summerleas, 25.i.1954, ex Strawberry, det. L.W.M. (J533, 68242). 1 female, same data (J530, 68239); 1 male, New Norfolk, 15.ii.1963, ex Elderberry *Sambucus nigra* (Caprifoliaceae), det. L.W.M. 1964 (J623, 68198); 1 male, Hobart, 14.i.1958, ex peas, det. L.W.M. 1964 (J601, 68221); 1 male, Bellerive, 4.v.1961, ex Banana Passionfruit *Passiflora mollisima* (Passiforaceae), det. L.W.M. 1964 (J566, 68210). All TDPIC. **Western Australia**: 11 females, 2 males, Kimberley R.S., 12.vii.1961, K.T. Richards, ex Cotton, det. J.J.D. (N3101, six slides). In QDPI.

Diagnosis

Female: Empodia with 6 proximoventral hairs; spurs on empodia I–IV absent; *tarsus I* with sockets of 4 tactile setae proximal to the socket of the proximal duplex setae; d_{prox} = 25 µm; D_{duplex} = 10–12 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* 21–29 µm long; *dorsal striae* between setae *e1–e1* longitudinal; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* without lobes; *pregenital striae* generally entire, sometimes sparse and with small breaks medially.

Male: Empodia I–II each with an obvious dorsal spur, I–II 3–4 µm long, III–IV 1–2 µm long; empodia I claw-like (uncinate), empodia II–IV with proximoventral hairs long and free. Aedeagus with small knob, pointed anterior and posterior projections of equal size, dorsal surface convex.

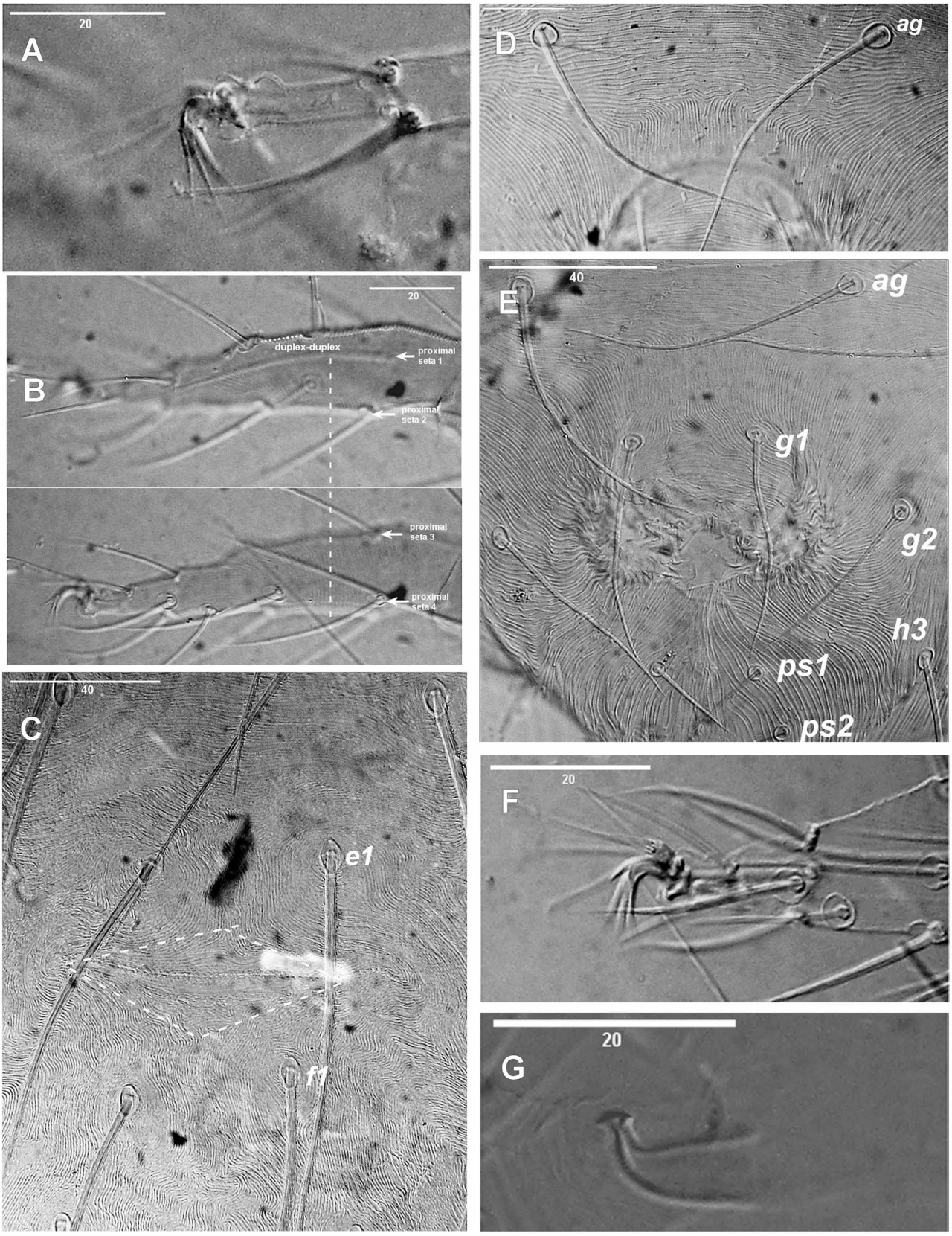


FIGURE 33. *Tetranychus urticae* Koch, female. (a) Pretarsus IV; (b) Tarsi I, dorsal and ventral view, dashed line indicates level of proximal duplex setae; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Pregenital striae; (e) Pregenital region, setae labelled. Male. (f) Pretarsus II; (g) Aedeagus.

Remarks

Here, *T. urticae* is considered the same species as *T. cinnabarinus* after Dupont (1979). *Tetranychus cinnabarinus* is usually the name applied to the carmine form of the two-spotted spider mite, but some authors recognise a green form of *T. cinnabarinus* (e.g., Zhang & Jacobson 2000). These taxa comprise populations that, in some localities, seem to be distinguishable (Zhang & Jacobson 2000). Nevertheless, the forms can exhibit reproductive compatibility, suggesting the species are conspecific (Sugasawa *et al*. 2002), a finding supported by most genetic data (e.g., Xie *et al*. 2008).

Zhang and Jacobson (2000) recommended morphological characters to distinguish the species. The procedure is to mount several female mites and take measurements of: (a) number of solenidia on tibia I; (b) ratio of the length of seta *v2* to the distance between seta *v2* and seta *sc1*, i.e., *v2*/(*v2–sc1*); (c) distance between the genital setae *g1–g1*; and (d) ratio of the length of the subcapitular seta to the distance between the subcapitular setae, i.e., *m*/(*m–m*).

Tetranychus urticae and *T. cinnabarinus* are distinguished by the following characteristics (Zhang & Jacobson 2000):

T. urticae: (a) 9 setae and 1 solenidion on tibia I; (b) *v2*/(*v2–sc1*) = 3.06 ± 0.06; (c) *g1–g1* 38.1 ± 0.07; (d) *m*/(*m–m*) = 0.93 ± 0.01.

T. cinnabarinus: (a) 9 setae and 1–4 solenidia on tibia I; (b) *v2*/(*v2–sc1*) = 3.18 ± 0.02; (c) *g1–g1* 31.5 ± 0.4; (d) *m*/(*m–m*) = 0.88 ± 0.01.

Note that the species cannot be distinguished without a significant sample of mites: at least five and preferably ten adult female specimens.

Our Australian *T. urticae* did not match either species as defined above. The tibial solenidia were variable (we have found one population of *T. urticae* with individuals having 1 or 4 tibial solenidia), but variability in the number of tibial solenidia was also observed in other species and was usually the female expressing the male condition. More significantly, the other character states were never close to the reported means of either *T. urticae* or *T. cinnabarinus*. Although only one of our collections consisted of ten specimens, we would have expected the ranges to include the values of the means reported by Zhang and Jacobson (2000), should their diagnosis be useful on a global scale. However, this was rarely the case. Our data, expressed as ranges, are:

T. urticae, Forest Hill, Queensland, Cotton, *Gossypium* sp., 7 females: Tibia I = 9+1; *v2*/(*v2–sc1*) = 4.11–4.76; *g1–g1* = 26–28; m/(m–m) = 1.08–1.19.

T. urticae, Ormiston DPI, Queensland, Tomato, *L. esculentum* 8 females: Tibia I = 9+1; *v2*/(*v2–sc1*) = 3.85–4.72; *g1–g1* = 25–30; *m/(m–m)* = 0.93–1.08.

T. urticae, Woolloongabba, Queensland, *Nasturtium* sp., 8 females: Tibia I = 9+1 or 9+4; *v2*/(*v2–sc1*) = 4.04–4.41; *g1–g1* = 25–29; *m/(m–m)* = 0.92–1.04.

T. urticae, Kimberley R.S., Western Australia, Cotton, *Gossypium* sp., 11 females: Tibia I = 9+1 or 9+4; *v2/(v2–sc1)* = 3.11–3.86; *g1–g1* = 22–33; *m*(*m–m*) = 0.96–1.15.

Cuticular lobes have also been used to distinguish *T. cinnarbarinus* and *T. urticae* (Brandenburg & Kennedy 1981), but this character is of limited use due to variation in lobe shape within species (Mollet & Sevacherian 1984; Carbonnelle & Hance 2004). Additionally, Carbonnelle and Hance (2004) report some *T. urticae* with no lobes on their dorsal and ventral surfaces. Here, we have avoided using lobe shape as a diagnostic character, but did find that the distribution of lobes on the body has proven useful for some species determinations.

Green forms are collected in cool temperate climates, carmine forms in warm temperate and subtropical zones. The carmine forms can reproduce all-year round, but green forms have a diapause form that is yellow-orange in colour (Gutierrez & Schicha 1983). Summer females have a dark spot on each side of the body (Gutierrez & Schicha 1983). Overwintering adults occur on ground or in sheltered places such as bark (Gutierrez & Schicha 1983). Extensive data on life history is available (e.g., Carey & Bradley 1982; Kavousi *et al*. 2009).

Importance

Amongst the most damaging of mite pests; heavy infestations can destroy crops and kill trees (Jeppson *et al*. 1975). Control is usually achieved through careful applications of pesticides and the use of natural enemies as part of a pest-management program (e.g., Hussey *et al.* 1965; Easterbrook 1992). Outbreaks of this species are often caused by the over-use of insecticide intended for other pests (e.g., Wilson *et al.* 1998), which kills the predators of *T. urticae* or can allow resistant populations of mites to thrive.

***Tetranychus yusti* McGregor, 1955**
(Fig. 34)

Non-type specimens examined, Guadeloupe: 1 female, 1 male, lower Pointe des Chateaux, 18.xii.1997, C.H.W. Flechtmann, ex *Canavalia maritima* (Fabaceae), female mite red, det. C.H.W. Flechtmann, ESALQ Zool. No. 2314. In ZCESA (slide also has a female of *T. urticae* group).

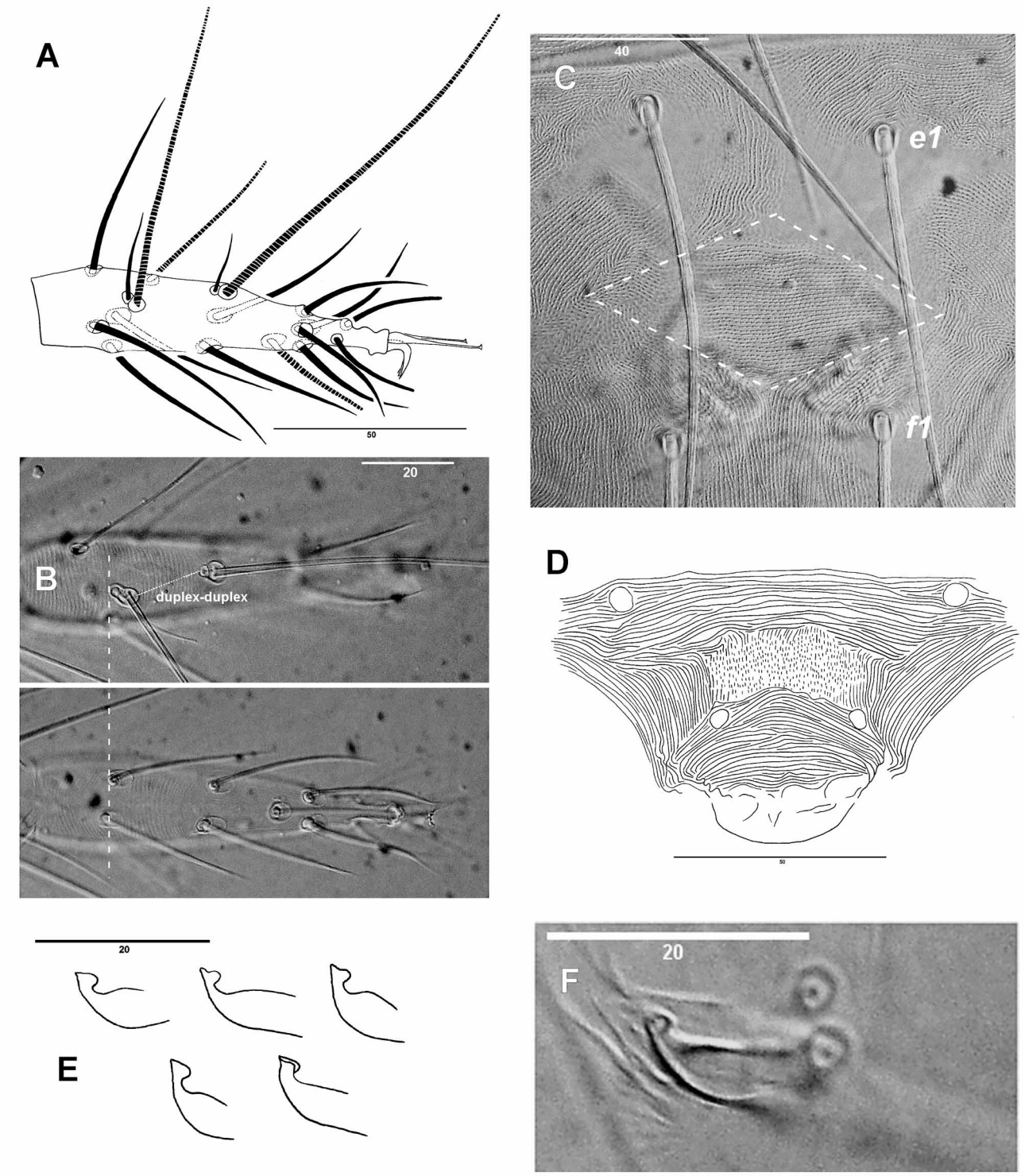


FIGURE 34. *Tetranychus yusti* McGregor, female. (a) Tarsus I; (b) Tarsi I, dorsal and ventral view, dashed line indicates level of proximal duplex setae; (c) Diamond-shaped pattern of dorsal striae between setae e and f; (d) Pregenital striae. Male. (e) Aedeagus at several focus points; (f) Aedeagus.

Diagnosis

Female: Empodia with 6 proximoventral hairs; empodia I–IV each with minute or absent spur; *tarsus I* usually with sockets of 3 tactile setae overlapping with the socket of the proximal duplex setae, and usually 1 tactile seta (seta l_1'') proximal to socket of proximal duplex setae, but there can be up to 3 setae slightly proximal to the socket of the proximal duplex setae; $\sum d_{prox}$ = 5–7 µm; D_{duplex} = 15 µm; *tarsus III* with 1 proximal tactile seta; *peritreme hook* = 21–23 µm long; *dorsal striae* between setae *e1–e1* longitudinal; dorsal striae between setae *f1–f1* longitudinal; dorsal striae between setae *e1* and *f1* transverse forming a diamond-shape medially; dorsal striae with lobes; *ventral striae* with weak lobes, only between genital region and setae *4a*; pregenital striae almost entirely broken, strongly dotted.

Male: Empodia I–IV each with small dorsal spur 2 µm long; empodia I claw-like (uncinate), empodia II–IV with proximoventral hairs long and free. Aedeagus with small knob, anterior projection rounded, posterior projection pointed, dorsal surface slightly convex, with medio-posterior indentation.

Remarks

The summer female has a deep carmine-red body (Boudreaux 1956), with dark spots of different sizes; male and immature life stages are pale green (Saba 1971).

Tetranychus yusti is mostly tropical and subtropical in distribution, although it has also been recorded in Greece (Hatzinikolis 1986). The diverse host-plant list of 51 spp. includes many species of economic importance, but also many weeds (Saba 1971; Bolland *et al.* 1998). Damage is the typical speckling of foliage followed by browning off of leaves. Although the species can be common, such as on soybeans (Baker & Connell 1961), the species seems to be an infrequent pest. Life history data was presented by Saba (1971).

Importance

Entry potential: *Tetranychus yusti* is widespread in the Americas (Bolland *et al.* 1998) and has likely spread to Thailand (Baker 1975) and Greece (Hatzinikolis 1986) through accidental introductions, highlighting its potential to enter Australia. The diverse host list of 51 spp. increases the chances of *T. yusti* finding a suitable host and establishing.

Economic: *Tetranychus yusti* is a tropical and subtropical species known to cause significant damage to soybeans (Baker & Connell 1961; Jeppson *et al*. 1975). However, this species is not as significant as most other *Tetranychus* in cropping systems (Saba 1971).

We would expect *T. yusti* to become a widespread but sporadic pest species in Australia, probably affecting mostly cotton and soybean crops (Jeppson *et al.* 1975).

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