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Raoiella of the world (Trombidiformes: Tetranychoidea: Tenuipalpidae)

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Abstract

We describe 16 new species and redescribe six established species in the genus *Raoiella—R. argenta* **sp. nov.** Beard, *R. australica* Womersley, *R. bauchani* **sp. nov.** Beard & Ochoa, *R. calgoa* **sp. nov.** Beard & Ochoa, *R. crebra* **sp. nov.** Beard & Ochoa, *R. davisi* **sp. nov.** Beard, *R. didcota* **sp. nov.** Beard, *R. eugeniae* (Mohanasundaram), *R. goyderi* **sp. nov.** Ochoa & Beard, *R. hallingi* **sp. nov.** Beard, *R. illyarrie* **sp. nov.** Beard & Ochoa, *R. indica* Hirst, *R. karri* **sp. nov.** Ochoa & Beard, *R. macfarlanei* Pritchard & Baker, *R. marri* **sp. nov.** Beard & Ochoa, *R. pandanae* Mohanasundaram, *R. pooleyi* **sp. nov.** Beard & Ochoa, *R. shimpana* Meyer, *R. tallerack* **sp. nov.** Beard & Ochoa, *R. taronga* **sp. nov.** Beard & Ochoa, *R. todtiana* **sp. nov.** Beard & Ochoa, *R.* wandoo **sp. nov.** Beard & Ochoa. We discuss molecular evidence of species separation, shared character states among groups of species, and patterns in the additions of leg setae throughout ontogeny that occur in the genus. We provide a key to the known species of *Raoiella*.

Key words: *Angophora,* coconut, *Corymbia*, endemic, Ericaceae, *Eucalyptus*, false spider mite, flat mite, *Lophostemon*, molecular analysis, Myrtaceae, *Neoraoiella*, *Pandanus*, *Rarosiella*, red palm mite

Introduction

Worldwide there are approximately 1,200 species assignable to approximately 38 genera in the family Tenuipalpidae (Mesa *et al*. 2009; Beard & Ochoa 2011; Khanjani *et al.* 2012; Beard *et al.* 2013; Farzan *et al.* 2013; Beard *et al.* 2014; Castro *et al.* 2015; Beard *et al.* 2016). Most species of flat mite (Trombidiformes: Tetranychoidea: Tenuipalpidae) have been described from North America (33% of the total known flat mite fauna) and Africa (13%), whereas little is known about flat mites in the rest of the world (Mesa *et al.* 2009). Despite being an under-collected region with only 48 species recorded, a meagre 4.4% of the known world flat mite fauna

(Womersley 1940, 1941, 1942, 1943; Smiley & Gerson 1995; Smiley *et al*. 1996; Beard *et al.* 2005; Beard & Gerson 2009; Mesa *et al.* 2009; Seeman & Beard 2011; Beard & Ochoa 2011; Beard *et al.* 2014; Beard *et al.* 2016), 21 of the 38 known tenuipalpid genera are found in Australia, and 13 of these are endemic to the continent. This gives Australia the highest endemicity at the generic level in the world, and suggests the presence of a richly diverse fauna with many more forms remaining to be discovered.

Despite their economic significance, flat mites remain poorly understood and studied world-wide. This is due mainly to a lack of collecting globally and poor taxonomy. With most geographic regions remaining significantly under-collected, little can be concluded about the relationships within the family, and its phylogeny remains a mystery. The genus *Raoiella* is an excellent example of the poor state of taxonomy for this family.

Phytophagous mites in the genus *Raoiella* Hirst (Tenuipalpidae) have attracted recent world-wide research interest due to the rapid spread of one major pest species, the red palm mite (RPM), *R. indica* Hirst. Most species in the genus *Raoiella* actually feed on dicotyledonous plants in the family Myrtaceae (Ochoa *et al.* 2011; Beard *et al.* 2012; Dowling *et al.* 2012) (see Remarks for *R. davisi*), but the two species *R. indica* and *R. pandanae* Mohanasundaram are different in that they feed most commonly on monocotyledonous species, of palms (family Arecaceae) in the former and screwpines (family Pandanaceae) in the latter. The focus on *R. indica*, as it continues to devastate palm crops across the world (Flechtmann & Etienne 2004; Kane *et al.* 2005, 2012; Kane & Ochoa 2006; Rodrigues *et al.* 2007; Dowling *et al.* 2008, 2012; Roda *et al.* 2008; Navia *et al.* 2011; Carrillo *et al.* 2012; Gondim *et al.* 2012; Oliveira *et al.* 2016, Nusantara *et al.* 2017a,b), has created a need to better understand the genus. A great deal of biological and ecological research dedicated to *R. indica* has resulted in many interesting observations, including the discovery that all motile stages of all species of *Raoiella* studied so far feed via the stomata of their various dicot and monocot host plant species (Figs 9, 31, 134, 150, 175, 227, 246) (Kane & Ochoa 2006; Ochoa *et al.* 2011; Beard *et al.* 2012); that the eggs of many species have a pair of minute recurved spines observable using scanning electron microscopy (Figs 24b, 131d, 164a,b, 181a, 213a,b), a character state shared with the genus *Obuloides* (see *O. namibiensis* in Ueckermann *et al.* 2010: Fig. 15); and that each developmental stage (including the egg) has droplets of fluid, either clear in colour (most species) (Figs 28, 47) or orange in colour (*R. bauchani* species group—Beard pers. obs.) (Figs 48, 193), associated with the tips of the dorsal setae of motile stages or with the stipe of the egg (Fig. 49) (Kane *et al.* 2005; Carrillo *et al.* 2012). It has previously been suggested that the droplets located on the tips of the dorsal setae and stipe of the egg in *Raoiella indica* may contain repellent compounds (Zanotto & Rodrigues 2010). However, after performing feeding trials using predators identified as *Amblyseius largoensis* (Acari: Phytoseiidae), Carrillo *et al.* (2012) concluded that the marked feeding preference for *R. indica* eggs (over *R. indica* larvae or *Tetranychus gloveri* eggs/larvae (Acari:Tetranychidae)) shown by *A. largoensis* indicates that the droplets most likely do not contain repellent or toxic compounds. Carrillo *et al.* (2012) suggested that the droplets on the eggs may have a different composition to those found on the larvae, and hence the preference for eggs over larvae. However, our observations of other species of *Raoiella* indicate that it is the adult female that is responsible for accumulating the droplets on the stipe of the egg (see below).

In collaboration with Dr Noel Davies (University of Tasmania), we undertook analysis of the droplets. Gas chromatography was unsuccessful; however, using direct probe mass spectrometry, it was determined that an apparently non-polar, long-chain hydrocarbon molecule is involved, and the signal was enormously complex. Images of the frozen droplets indicate a characteristic texture to their surface (Figs 104, 183, 214). The details of how these droplets form are not known either; however, we have captured images of these droplets appearing to be produced from points along the shaft of the dorsal setae (Fig. 182). Based on such observations, we undertook preliminary transmission electron microscopy studies of sectioned *Raoiella* setae, without successful results. On the other hand, we record here for the first time, that we have observed on multiple occasions a female apparently deliberately depositing a droplet on the tip of the stipe on the egg that she had just laid. The female positions the egg on the leaf surface and slowly walks away from the egg, drawing out the stipe with her oopore as she walks. The tip of the stipe is then released from her oopore and curls upwards (perhaps as it begins to dry). The female then turns and walks back to the egg and begins to walk in a circular rotating motion rubbing each of her lateral dorsal setae across the tip of the stipe, mechanically depositing her own droplets on the stipe tip which accumulate to form a distinct droplet (see subsidiary videos: https://youtu.be/vV8K1EF7ecA; https://youtu.be/JhKOFVHXXLA).

The genus *Raoiella* has a somewhat complicated taxonomic history. Twelve species of *Raoiella* were described between 1924–2000, all of them from the Old World (Mesa *et al.* 2009). Eight species have been described from

India and Pakistan (including *R. indica*), and one species each from South Africa, Sudan, Greece and Australia. In addition, two related species in two separate genera, *Neoraoiella eugeniae* Mohanasundaram and *Rarosiella cocosae* Rimando, were described from India and The Philippines, respectively (Mohanasundaram 1996; Rimando 1996).

The region represented by India and Pakistan was suggested to be the center of diversity for the genus, based primarily on the relatively large number of species described from the area (Dowling *et al.* 2012); however, after several synonymies, this is no longer thought to be the case. Mesa *et al.* (2009) recently synonymised the Philippine species *R. cocosae* with *R. indica*, a synonymy first suggested by Kane *et al.* (2005) and corroborated by Dowling *et al.* (2008), and Mesa *et al.* (2009) also moved *N. eugeniae* into *Raoiella*. Mesa *et al.* (2009) indicated that seven other described species of *Raoiella* were suspected junior synonyms of *R. indica* (six from India or Pakistan—*R. camur* Chaudhri & Akbar, *R. empedos* Chaudhri & Akbar, *R. neotericus* Chaudhri & Akbar, *R. obelias* Hasan & Akbar, *R. pandanae* Mohanasundaram, *R. rahii* Akbar & Chaudhri; and one from Sudan—*R. phoenica* Meyer). We agree with all these suggested synonyms, except for *R. pandanae*, which appears to have several character states that indicate it is a valid species (pending examination of the type specimens). This leaves only six valid species in the genus *Raoiella*, three of which are from India or Pakistan: *R. australica* Womersley (Australia), *R. eugeniae* (Mohanasundaram) (India), *R. indica* (originally India, and now throughout Old and New World tropics), *R. macfarlanei* Pritchard & Baker (Greece), *R. pandanae* (India), and *R. shimpana* Meyer (South Africa).

Based on molecular evidence so far collected, Dowling *et al.* (2012) suggested that the origin of the genus is likely to be African, as the two most basal clades are from the Middle East and South Africa. However, as we here describe 16 new species from Australia, the geographic origin of the genus *Raoiella* is most likely to be Australian, as first proposed by Dowling *et al.* (2008).

The data presented in Dowling *et al.* (2012) indicated that there are three major clades and a large basal polytomy within the genus. There are two major Australian clades, and the third clade includes South Africa and the *R. indica* populations. This third clade is somewhat unusual as there was high bootstrap support for South Africa and Australia as a clade. In addition, *R. indica* appears to be a basal lineage within the genus, and the Australian diversity represents an older invasion of that continent followed by intense radiation. Many more species have been collected since the study undertaken by Dowling *et al.* (2012), and hence the patterns presented will likely be altered with the inclusion of additional molecular data. The additional new species, along with the species separated in Dowling *et al.* (2012), are described here.

Though immature stages provide a wealth of taxonomic data, they are largely ignored in earlier systematic and taxonomic studies of tetranychoid mites, and consequently few serious attempts have been made to determine setal homologies and the patterns of additions through ontogeny (Lindquist 1985). Without such data, phylogenetic relationships amongst the families of the Tetranychoidea have not yet been resolved convincingly. Lindquist (1985) provided a solid basis for the commencement of these studies by applying the standard notation of Grandjean (1939) to the Tetranychidae for the first time, thus facilitating comparison of structures among the tetranychoid families and in turn other related prostigmatan superfamilies. Lindquist (1985) provided an extremely detailed anatomical analysis of the Tetranychidae which has been used as a guide for the collection of information on representative tenuipalpid genera (e.g. Zhang & Fan 2004; Xu & Fan 2010; Seeman & Beard 2011; Xu *et al.* 2013; Beard *et al.* 2014, 2016; Castro *et al.* 2015, 2016a, b, 2017; Welbourn *et al.* 2017). Lindquist (1985) places great significance on ontogenetic changes in leg chaetotaxy, pointing out that until the comparative homologisation of leg setae is accomplished for representative taxa within the Tetranychoidea, a great deal of character state data of potential significance to the systematics, phylogeny and classification of these groups will remain unknown. Homologies and ontogenetic patterns in the addition of leg setae have not been fully determined in a comparative manner for any family within the Tetranychoidea. We strongly encourage the collection and presentation of such data in modern tetranychoid descriptions. Leg chaetotaxy details are provided here for each known stage of each known species of *Raoiella*, with a discussion of the patterns of ontogenetic additions.

No setae are added to the dorsum of individuals in any tetranychoid family during the development from larva to adult, therefore the adult complement of dorsal setae is fully expressed in the larval stage. This suggests that little data can be extracted from comparisons of the ontogeny of the dorsal setal complements; however, the shapes and positions of the dorsal setae change during ontogeny. These changes can be of significance for determining setal names and species limits, and were used here.

Materials and methods

Mites were collected and mounted in either PVA or Hoyer's medium (Walter & Krantz 2009) directly from field collected samples, and were examined at 1000X using a DIC Zeiss Axioscope. All measurements are given in micrometers (µm) as a range (including paratype measurements) followed by the holotype measurements (when examined) in square brackets (or paratype for some species where the holotype was a male, e.g. *R. indica*). Setae were measured from the centre of the setal base to the tip of the seta; distances between setae were measured as the distance from the centre of one setal base to the centre of the other. Body size was measured *v2–h1* and *sc2–sc2* (Saito *et al.* 1999), and *v2–f2* or *v2–e1* in immatures as the posterior dorsal opisthosomal setae are often inserted ventrally. Leg setal numbers are written as the total number of phaneres followed by number of solenidia in parentheses, and the names of leg segments are abbreviated to the first two letters of each name (e.g., fe = femur, ti = tibia, etc).

Specimens in 70% ethanol and live material were used for Low Temperature SEM (LTSEM) studies, utilising the technique outlined by Bolton *et al.* (2014), which is described briefly here. Specimens were secured to 15 x 30 mm copper plates using ultra smooth, round (12 mm diameter) carbon adhesive tabs (Electron Microscopy Sciences, Inc., Hatfield, PA, USA). The specimens were frozen conductively, in a Styrofoam box, by placing the plates on the surface of a pre-cooled (-196◦C) brass bar whose lower half was submerged in liquid nitrogen. After 20–30 seconds, the holders containing the frozen samples were transferred to the Quorum PP2000 cryo-prepchamber (Quorum Technologies, East Sussex, UK) attached to an S-4700 field emission scanning electron microscope (Hitachi High Technologies America, Inc., Dallas, TX, USA). The specimens were etched inside the cryotransfer system to remove any surface contamination (condensed water vapour) by raising the temperature of the stage to -90◦C for 10–15 min. Following etching, the temperature inside the chamber was lowered below -130◦C, and the specimens were coated with a 10 nm layer of platinum using a magnetron sputter head equipped with a platinum target. The specimens were transferred to a pre-cooled (-130◦C) cryostage in the SEM for observation. An accelerating voltage of 5 kV was used to view the specimens. Images were captured using a 4pi Analysis System (Durham, NC, USA). Because the specimens were not tightly secured to the adhesive tabs, it was often possible to remove the plates from the LT-SEM and turn the specimens over to the view their ventral position for additional imaging; thus both dorsal and ventral images were taken of individual mites.

Chaetotaxy. Leg chaetotaxy follows Lindquist (1985), as was presented in the theses of Quiros-Gonzalez (1985) and Kane (2003), and more recently, for example by Seeman & Beard (2011), Xu *et al.* (2013), Castro *et al.* (2016a,b), Beard *et al.* (2016) and Welbourn *et al.* (2017). Despite these prior works, leg chaetotaxy has rarely been provided in descriptions of tenuipalpids, although the presentation of such data is becoming increasingly more common, such as Zhang & Fan (2004) (*Dolichotetranychus*), Xu & Fan (2010) (*Tenuipalpus*), Seeman & Beard (2011) (*Aegyptobia*), Beard & Ochoa (2011) (*Cyperacarus*, *Gahniacarus*), Xu *et al.* (2013) (*Ultratenuipalpus*), Khanjani *et al.* (2013) (*Aegyptobia*), Beard *et al.* (2014) (*Chaudhripalpus*, *Crossipalpus*, *Magdalenapalpus*, *Meyeraepalpus*, *Palpipalpus*, *Pentamerismus*, *Philippipalpus*, *Tegopalpus*), Castro *et al.* (2015) (*Colopalpus*), Beard *et al.* (2016) (*Ultratenuipalpus*), Castro *et al.* (2016a,b) (*Tenuipalpus*), Welbourn *et al.* (2017) (*Tenuipalpus*), Castro *et al.* (2017) (*Terminalichus*). Many of these publications demonstrate the diagnostic value of leg chaetotaxy for species determination, in addition to highlighting the crucial character state data that simple setal counts can potentially overlook.

Body chaetotaxy essentially follows Grandjean (1939) and Lindquist (1985). Species of the genus *Raoiella* all have the maximum 16 pairs of dorsal idiosomal setae: prodorsum with *v2*, *sc1* and *sc2*; and opisthodorsum with *c1–3*, *d1–3*, *e1–3*, *f2–f3* and *h1–2*. Dorsal opisthosomal setae *f1* and *h3* are always absent in the Tenuipalpidae (Mesa *et al.* 2009).

Species Delimitation. Species were delimited based upon a combination of morphology, DNA sequences (Dowling *et al.* 2012) and biogeography, when possible. Molecular work was conducted and published in Dowling *et al.* (2012). The population level sampling used in Dowling *et al.* (2012) was not robust enough to firmly establish standard levels of intraspecific variation within species of *Raoiella*. As such, that study identified eight new species of *Raoiella*. The current study has used the molecular evidence plus other characteristics to both corroborate Dowling *et al.* (2012) and to further delineate several new species.

List of abbreviations

ANIC	Australian National Insect Collection, CSIRO Entomology, GPO Box 1700, Canberra, Australia, 2601
AQIS	Operational Science Entomology Collection, Australian Quarantine and Inspections Service, Southeast Queensland Office, 42-44 Qantas Drive, Eagle Farm, Brisbane, Queensland, 4009, Australia
BRI	Queensland Herbarium, Brisbane Botanic Gardens Mt Coot-tha, Toowong, Brisbane, Queensland, Australia, 4066
MAGNT	Museum and Art Gallery of the Northern Territory, Bullocky Point, Fannie Bay, Northern Territory, 0820, Australia
NCA	National Collection of Arachnida, National Collection of Mites, Plant Protection Research Institute, Agricultural Research Council, Plant Protection Research (ARC-PPR), Pretoria, South Africa
NHM	The Natural History Museum, Cromwell Road, London, SW7 5BD, United Kingdom
OSAL	Ohio State Acarology Laboratory collection, Department of Evolution, Ecology and Organismal Biology, The Ohio State University, Columbus, Ohio, USA
QM	Queensland Museum, PO Box 3300, South Brisbane, Queensland, 4101, Australia
SAM	South Australian Museum, North Terrace, Adelaide, South Australia, 5000, Australia
UPLBMNH	University of The Philippines Los Baños, College, Laguna, Department of Entomology and Museum of Natural History, The Philippines
USNM	United States National Mite Collection, US National Museum of Natural History, Smithsonian (located at Systematic Entomology Laboratory (SEL), United States Department of Agriculture (USDA), Building 005, 10300 Baltimore Ave, Beltsville, Maryland, USA, 20705)
WAM	Western Australian Museum, Locked Bag 49, Welshpool DC, Perth, Western Australia, 6106, Australia

Family Tenuipalpidae Berlese

Type genus—*Tenuipalpus* Donnadieu, 1875

Raoiella Hirst, 1924

Raoiella Hirst, 1924: 522. Type species: *Raoiella indica* Hirst, 1924: 522; Sayed, 1938: 605; Sayed, 1942: 81; Sayed, 1950: 1016; Pritchard & Baker, 1958: 256; Baker & Pritchard, 1960: 570; Wainstein, 1960: 234; Mitrofanov, 1973: 1316; Chaudhri *et al.*, 1974: 17; Meyer, 1979: 114; Mitrofanov & Strunkova, 1979: 120; Meyer & Gerson, 1980: 76; Hatzinikolis, 1987: 57; Smiley & Gerson, 1995: 39; Kane *et al.* 2012: 216.

Neoraoiella Mohanasundaram, 1996: 141. Type species: *Neoraoiella eugeniae* Mohanasundaram, 1996: 141—synonymy Mesa *et al.* 2009.

Rarosiella Rimando, 1996: 2. Type species: *Rarosiella cocosae* Rimando 1996: 3—synonymy Mesa *et al.* 2009.

Diagnosis. *All life stages:* full complement of 16 dorsal setae; most dorsal setae with obviously spatulate tips; setae *h2* not flagellate; anterior margin of prodorsum without projections or extensions; palp two-segmented, 1-3(1) (tibiotarsus with one distal solenidion, one distal eupathidium (blunt or tapered) and one dorsal seta; femorogenu with one dorsal seta); two pairs of *ps* setae present (*ps2–3*); tarsus I–II with seta *ft″* reduced and associated with solenidion *ω″* as a companion seta. All stages (motile and eggs) red in colour, with adults being darker, often with black patterns due to feeding, and immatures often pale reddish-orange. Large, obvious, globose droplets of clear to orange-tinted fluid accumulate at tips of each dorsal seta on motile stages, and at tip of stipe of eggs. Dorsum often appears shiny due to presence of dispersed fluid from setal tips.

Adult female: prodorsal and opisthosomal shields often weakly developed; ventral and genital plates membranous, not developed; femora I–II with three or four setae (setae *d*, *bv″*, *v′* present; setae *l′* present or absent); genua I–II with two or three setae present (setae *l′* present; setae *d* present or absent; setae *l″* present or absent—i.e. *d*, *l′*, *l″* present; *l′*, *l″* present; or *d*, *l′* present).

Adult male: body tapered, and often elongate, posteriorly; setae *ps3* modified into accessory genital stylets; femora I–II and genua I–II as in female (but note that sexual dimorphism occurs in some species).

Larva: seta *h2* with two forms, elongate flagellate or of similar size and shape to *h1* (i.e. usually short and somewhat thickened).

Egg: large relative to adult female, red in colour, somewhat globose to ellipsoid in shape, with or without a stipe; usually with a pair of minute recurved spines towards one end.

Key to adult *Raoiella* of the world

(based on females, but note that males and immatures may also be required; see Discussion for species group analysis)

1. Femur II with 4 setae (setae *d*, *bv″*, *l′*, *v′* present) (e.g. Figs 12, 35, 74, 80, 87) 2
- Femur II with 3 setae (setae *d*, *bv″*, *v′* present; setae *l′* absent) (e.g. Figs 64, 107, 112, 138). . . . . wandoo species group...15
2. Coxae III and IV each with 1 seta present (i.e. setae *3b*, *4b* present) (Fig. 3); dorsal opisthosomal setae *h1* subequal in length to *h2* (e.g. Figs 1, 149, 194); eupathidium on palp tarsus forked distally (e.g. Figs 2, 86a, 149b,c) . *macfarlanei* species group...3
- Coxae III and IV without setae (i.e. setae *3b*, *4b* absent) (Fig. 248); dorsal opisthosomal setae *h1* much longer than *h2* (e.g. Figs 7, 29, 57); eupathidium on palp tarsus not forked distally 6
3. Tibia I with seta *d* spatulate (Figs 87, 155) 4
- Tibia I with seta *d* tapered (Figs 1, 196) 5
4. Seta *d* on femora I–II subequal in length to seta *d* on tibiae I–II (Fig. 87); dorsal opisthosomal setae *f2* 40–56 (Fig. 85) ; known only from species of *Syzygium* or *Eugenia* (Myrtaceae). . . . . *eugeniae*
- Seta *d* on femora I–II shorter than seta *d* on tibiae I–II (Fig. 155); dorsal opisthosomal setae *f2* 68–79 (Fig. 148) ; known only from species of olive, *Olea* spp. (Oleaceae) . . . . . *macfarlanei*
5. Setae *d* and *l′* on femur I and genu I with tapered tip (Fig. 1); dorsal opisthosomal setae *f2* 62–68 . . . . . *argenta*
- Setae *d* and *l′* on femur I and genu I with a blunt tip (Fig. 196); dorsal opisthosomal setae *f2* 76–81 . . . . . *shimpana*
6. Genua I–II with 3 setae (*d*, *l′*, *l″*) (Fig. 122); on monocot hosts . . . . . *indica* species group...7
- Genua I–II with 2 setae (*d*, *l′*; or *l′*, *l″*) (e.g. Fig. 12); on dicot hosts 8
7. Prodorsal setae *sc1* longer than setae *v2* and *sc2*; feeds mainly on species of palm (Arecaceae) . . . . . *indica*
- Prodorsal setae *v2*, *sc1*, *sc2* all subequal in length; known only from species of screwpine, *Pandanus* spp. (Pandanaceae) . . . . . *pandanae*
8. Genua I–II with setae *d* and *l′* present, and seta *l″* absent (Figs 35, 95, 186) (male genua I–II with same chaetotaxy); dorsal opisthosomal setae *h2* spatulate, 25–41 (Figs 29, 89, 184); collected from *Lophostemon* spp. (Myrtaceae). . . . . *bauchani* species group...9
- Genua I–II with setae *l′* and *l″* present, and seta *d* absent (e.g. Figs 12, 80) (male genua I–II with *d*, *l′*, *l″* present (e.g. Figs 82, 173)); dorsal opisthosomal setae *h2* short, tapered, < 25 (e.g. Figs 7, 72, 165); collected from *Eucalyptus* or *Corymbia* spp. (both Myrtaceae). . . . . *australica* species group...11
9. Dorsal opisthosomal setae *f2* and *f3* subequal in length (or *f2* can be marginally shorter than *f3*) (Fig. 29); palp tibiotarsus elongate, twice the length of palp femorogenu (Fig. 32a); setae *d* on genua with thick blunt tips (Fig. 35). . . . . *bauchani*
- Dorsal opisthosomal setae *f2* obviously shorter than *f3* (Figs 89, 184a); palp tibiotarsus subequal in length to palp femorogenu (Figs 91a, 184b); setae *d* on genua with tapered tips (Figs 95, 186). 10
10. Dorsal opisthosomal setae *c1*, *d1*, *e1* minute (Fig. 184a); dorsal opisthosomal setae *c2*, *f2* subequal in length and longer than setae *e2*, *d2* (Fig. 184a) . . . . . *pooleyi*
- Dorsal opisthosomal setae *c1* longer than setae *d1*, *e1* (Fig. 89); dorsal opisthosomal setae *c2*, *d2*, *e2*, *f2* subequal in length (Fig. 89). . . . . *goyderi*
11. Prodorsal setae *sc1* and *sc2* subequal in length; dorsal opisthosomal setae *c1*, *d1*, *e1* short but not minute (Figs 72, 78) 12
- Prodorsal setae *sc1* obviously shorter than *sc2*; dorsal opisthosomal setae *c1*, *d1*, *e1* minute (Figs 7, 165, 215) 13
12. Dorsal opisthosomal setae *c1* > 30 microns; prodorsal setae *v2* > 60 microns (Fig. 72) . . . . . *davisi*
- Dorsal opisthosomal setae *c1* < 25 microns; prodorsal setae *v2* < 60 microns (Fig. 78) . . . . . *didcota*
13. Male: prodorsal setae *v2* > 40 microns (Fig. 219); dorsal opisthosomal setae *h1* > 25 microns (Fig. 219) . . . . . *taronga*
- Male: prodorsal setae *v2* < 30 microns; dorsal opisthosomal setae *h1* ≤ 20 microns (Figs 14, 172) 14
14. Male: prodorsal setae *sc2* > 45 microns; female: setae *d* on femora II–IV and tibiae III–IV with tapered tips (Fig. 170); on *Corymbia* in southwestern Australia. . . . . *marri*
- Male: prodorsal setae *sc2* < 45 microns; female: setae *d* on femora II–IV and tibiae III–IV with thick blunt tips (Fig. 19); on *Eucalyptus* in central eastern Australia . . . . . *australica*
15. Seta *d* on tibia I spatulate (Figs 51, 64a,b) to thick blunt tip (Figs 107, 112) 16
- Seta *d* on tibia I with thick tapered tip (Figs 207, 229, 253) 19
16. Prodorsal setae *sc1* more than half the length of setae *sc2* (Figs 51, 110) 17
- Prodorsal setae *sc1* approximately half the length or less, of setae *sc2* (Fig. 57) . . . . . *crebra*
17. Dorsal opisthosomal setae *f2* longer than setae *h2* (Fig. 51). . . . . *calgoa*
- Dorsal opisthosomal setae *f2* subequal in length to setae *h2* (Figs 105, 110) 18

18. Femur I with seta *l′* tapered, genu II with seta *l″* thick (Fig. 112); male: femur and genu I with seta *d* with thick blunt tip (Fig. 114) . . . . . *illyarrie*
- Femur I with seta *l′* thick, genu II with seta *l″* tapered (Fig. 107); male: femur and genu I with seta *d* with tapered tip (Fig. 109) . . . . . *hallingi*
19. Prodorsal setae *sc1* longer than 50 µm (Fig. 132) . . . . . *karri*
- Prodorsal setae *sc1* less than 45 µm 20
20. Companion seta *ft″* clearly longer than solenidion on tarsi I–II (Figs 207, 229, 230); deutonymph: dorsal seta *d* on tibiae I–II with thickly tapered to blunt tips (Fig. 235) 21
- Companion seta *ft″* marginally longer than or subequal in length to solenidion on tarsi I–II (Figs 252, 253, 254); deutonymph: dorsal seta *d* on tibiae I–II with finely tapered tips (Fig. 263) . . . . . wandoo
21. Seta *d* on femur I and genu I with tapered tips (Fig. 207); seta *l′* on femur I thick (Fig. 207); eupathidia on palp tibiotarsus finely tapered (Fig. 200); egg with stipe 4–5X longer than length of egg (Fig. 213) . . . . . *tallerack*
- Seta *d* on femur I and genu I with blunt tips (Fig. 229); seta *l′* on femur I fine (Fig. 229); eupathidia on palp tibiotarsus blunt to weakly tapered (Fig. 225); egg with stipe 1–2X longer than length of egg (Fig. 240) . . . . . *todtiana*

Raoiella argenta **sp. nov. Beard**
(Figs 1–6)

Material examined. Holotype. ♀. AUSTRALIA, Queensland, Springsure, 24°07’09”S 148°05’10”E, 7.x.2001, ex. silver-leaved ironbark, *Eucalyptus melanophloia* F. Muell. (Myrtaceae), J.J. Beard (QMS 108797; single paratype ♀ also present on slide).

Paratypes. 5 ♀, 4 ♂, 2 deutonymph, same data as Holotype (three slides: holotype + ♀ paratype; 3 ♀; ♀, 4 ♂, 2 deutonymphs) (QM).

Diagnosis. Opisthosomal setae *f2* longer than *f3*; setae *h1* subequal in length to *h2*. Setae *h2* short, spatulate. Dorsal setae with plumose spatulate tips. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with three setae (*d*, *l′*, *l″*); coxae I with one seta (*1b* present, *1c* absent); coxae III–IV each with one seta (setae *3b*, *4b* present). Tarsus I with companion setae (*ft″*) obviously longer than solenidia; tarsus II with companion seta (*ft″*) obviously shorter than solenidion. Dorsal setae on tibiae I–II tapered. Eupathidium on palp tibiotarsus with tapered forked tip.

Description. Female. ***Dorsum.*** (Fig. 1) Body measurements (5): length between setae *v2–h1* 227–240 [236], width between setae *sc2–sc2* 175–183 [177], *c3–c3* 176–181 [178], *f2–f2* 66–69 [67]. Prodorsum with pair large pores on posterior margin, three pairs of minute pores mesally; opisthosoma with five pairs minute pores between setae *c1–c2*, *c1–d2*, *d1–d2*, *e1–e2*, *e2–f2*. Dorsal setae with plumose spatulate tips, barbed along entire length. Dorsal setae measurements: *v2* 60–64 [64], *sc1* 56–60 [57], *sc2* 60–66 [66], *c1* 40–44 [42], *c2* 41–47 [44], *c3* 58–64 [59], *d1* 37–42 [42], *d2* 40–42 [42], *d3* 59–65 [59], *e1* 32–34 [34], *e2* 40–51 [46–51], *e3* 55–61 [58–59], *f2* 62–68 [64–67], *f3* 27–32 [30–32], *h1* 28–34 [28], *h2* 23–28 [25].

Palps. (Figs 1, 2) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) [5] and one eupathidium with tapered forked tip (9–10) [9] distally, one dorsal tapered seta (8–9) [8]; palp femorogenu with one finely tapered, barbed seta (20–27) [22–23].

Venter. (Fig. 3) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *g1*, *g2*, *ps2*, *ps3* smooth. Setal measurements: *1a* 68–76 [68], *1b* 12–17 [16], *2b* 11–12 [12], *3a* 6–8 [7], *3b* 7–9 [7–9], *4a* 33–68 [33–48], *4b* 8–10 [9], *ag* 7–11 [11], *g1* 11–12 [11], *g2* 9–10 [9], *ps2* 9–11 [9], *ps3* 10–13 [10].

Spermatheca. Only beginning of duct visible at genital opening.

Legs. (Fig. 1) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-4-3-4-9(1), 1-1-2-1-3-5, 1-1-2-0-3-5 respectively. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with three setae (*d*, *l′*, *l″*). Tarsi I and II each with one abaxial solenidion (ta I 13–18 [13–14]; ta II 11–12 [11–12]) and two eupathidia distally (ta I 11–12 [12], 10–11 [11]; ta II 10–11 [11], 9–11 [10]). Weakly barbed companion seta *ft″* on tarsus I 40–47 [40] and tarsus II 7–11 [7–8], inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta with tapered tip. Tenent hairs on claws with three attachment points. Claws short.



FIGURE 1. *Raoiella argenta* Beard, adult female: dorsal habitus with details of legs I–IV.

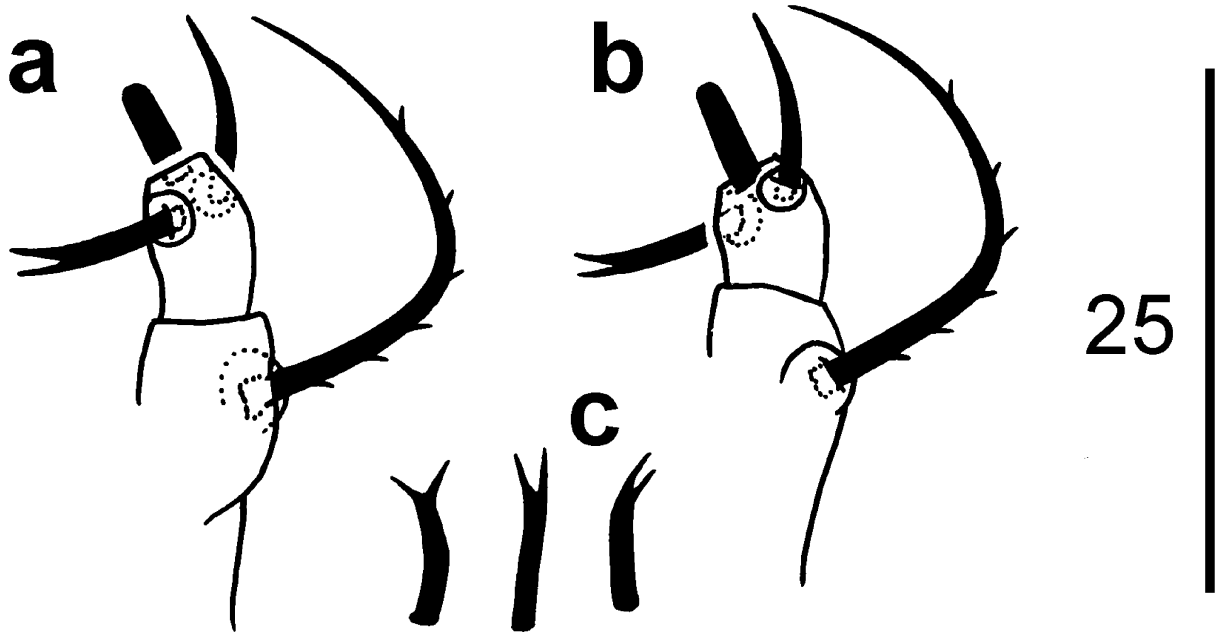


FIGURE 2. *Raoiella argenta* Beard, adult female, detail of palp: a. ventral aspect; b. dorsal aspect; c. detail of forked eupathidium.

Male. *Dorsum.* (Fig. 4) Body measurements (4): length between setae *v2–h1* 148–157, width between setae *sc2–sc2* 132–136, *c3–c3* 127–134, *f2–f2* 45–51. Prodorsum mostly smooth with few longitudinal wrinkles; opisthosoma with transverse striae, strongest between setae *d1* and *e1*. Opisthosoma with pair of minute pores between setae *c1–c2* and pair of minute pores anterad setae *f2*. Dorsal setae with pubescent spatulate tips, barbed along entire length. Dorsal setae measurements: *v2* 31–36, *sc1* 34–37, *sc2* 39–45, *c1* 30–33, *c2* 31–32, *c3* 41–45, *d1* 28–30, *d2* 28–33, *d3* 42–47, *e1* 26–28, *e2* 28–32, *e3* 41–45, *f2* 30–37, *f3* 21–24, *h1* 15–18, *h2* 17–18.

Palps. (Figs 2, 4) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one eupathidium with a tapered forked tip (8–9) distally, one tapered dorsal seta (7–8); palp femorogenu with one tapered, barbed seta (20–22).

Venter. (Fig. 5a) Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth. Setae *g1*, *g2* smooth; setae *ps3* modified into thickened, tapered accessory genital stylets. Setal measurements: *1a* 35–78, *1b* 13–17, *2b* 7–10, *3a* 5–7, *3b* 6–8, *4a* 38–75, *4b* 7–9, *ag* 7–9, *g1* 8–11, *g2* 8–11, *ps2* 7–9, *ps3* 9–11.

Aedeagus. (Fig. 5a) Aedeagus narrow, elongate and sclerotised (54–59), tapering to a blunt point distally (at genital opening).

Legs. (Fig. 4) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-4-3-4-10(2), 1-1-2-1-3-5, 1-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 11–12, abaxial 15–17; ta II adaxial 8–10, abaxial 10–14), and two eupathidia distally (ta I 9–11, 10; ta II 8–11, 8–9). Companion seta *ft″* on tarsus I 32–39 and tarsus II 8–12, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered. Tenent hairs on claws with three attachment points. Claws short.

Deutonymph. *Dorsum.* (Fig. 6) Body measurements (2): length between setae *v2–h1* 181–185, width between setae *sc2–sc2* 153–154, *c3–c3* 160–161, *f2–f2* 45–46. Dorsum mostly smooth with light transverse striations. Prodorsum with pair of minute pores mesally; no pores visible on opisthosoma. Dorsal setae with pubescent spatulate tips, barbed along entire length; setae *f3*, *h1*, *h2* thick, blunt to slightly spatulate. Dorsal setae measurements: *v2* 45–50, *sc1* 40, *sc2* 49–53, *c1* 37–38, *c2* 36–44, *c3* 42–47, *d1* 34–43, *d2* 38–42, *d3* 40–44, *e1* 33–37, *e2* 42–46, *e3* 34–41, *f2* 43–46, *f3* 16–17, *h1* 15–18, *h2* 11–15.

Palps. (Fig. 6) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–5) and one eupathidium with a tapered forked tip (7–8) distally, one tapered dorsal seta (6–8); palp femorogenu with one tapered barbed seta (19–21).

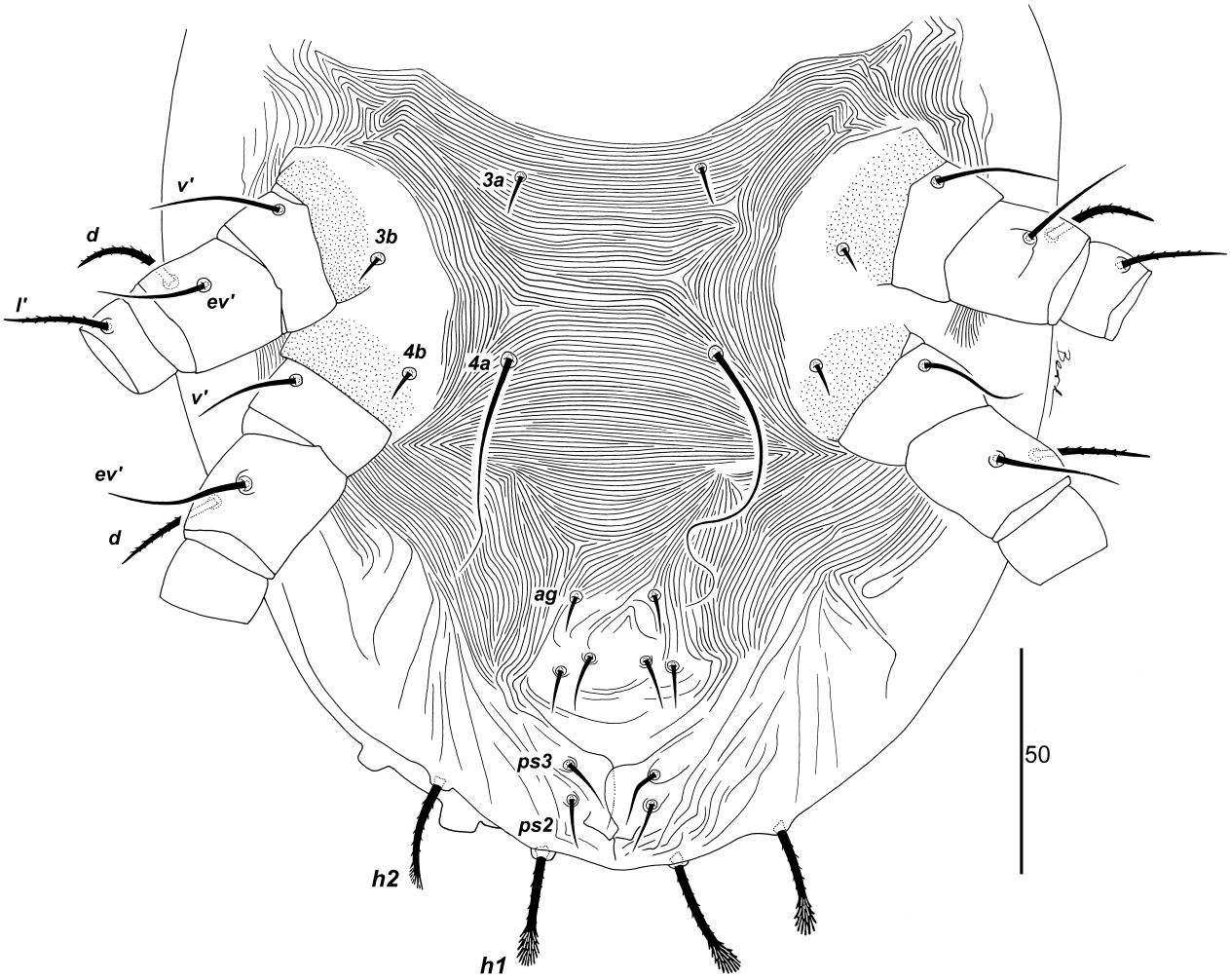


FIGURE 3. *Raoiella argenta* Beard, adult female: posterior venter.

Venter. (Fig. 5b) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Ventral setae smooth. Setal measurements: *1a* 51–60, *1b* 10–12, *3a* 6–8, *3b* 4–5, *4a* 31–32, *4b* 5–6, *g1* 6, *ag* 5–6, *ps2* 6–7, *ps3* 6–8.

Legs. (Fig. 6) Setal formula for legs I–IV (coxae to tarsi): 1-1-3-2-4-9(1), 0-1-3-2-4-9(1), 1-1-2-1-3-5, 1-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 9–10; ta II 6–7) and two eupathidia distally (ta I 9, 8; ta II 8, 7). Companion seta *ft″* on tarsus I 26–28 and tarsus II 6–7, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta with blunt tip. Tenent hairs on claws with two attachment points. Claws short.

Protonymph and Larva. Unknown.

Host. Silver-leaved Ironbark, *Eucalyptus melanophloia* F. Muell. (Myrtaceae).

Distribution. AUSTRALIA: central Queensland.

Etymology. The species name *argenta* is derived from the neutral Latin *argentum* meaning silver, and refers to the common name of its host plant, the silver-leaved ironbark.

Remarks. *Raoiella argenta* **sp. nov.** was listed as *Raoiella* sp. 12 in Beard *et al*. (2013), and is in the *R. macfarlanei* species group. *Raoiella argenta* **sp. nov.** is similar morphologically to *Raoiella shimpana*, but can be separated by the following: setae *f2 Ra* 62–68 vs *Rs* 76–81; *Ra* setae *d* on femur I and genu I with tapered tips vs *Rs* with blunt tips; *Ra* found in Australia vs *Rs* found in South Africa.

Specimens of *R. argenta* were not included in molecular analyses by Dowling *et al.* (2012).



FIGURE 4. *Raoiella argenta* Beard, adult male: dorsal habitus with details of legs I–IV and palps.

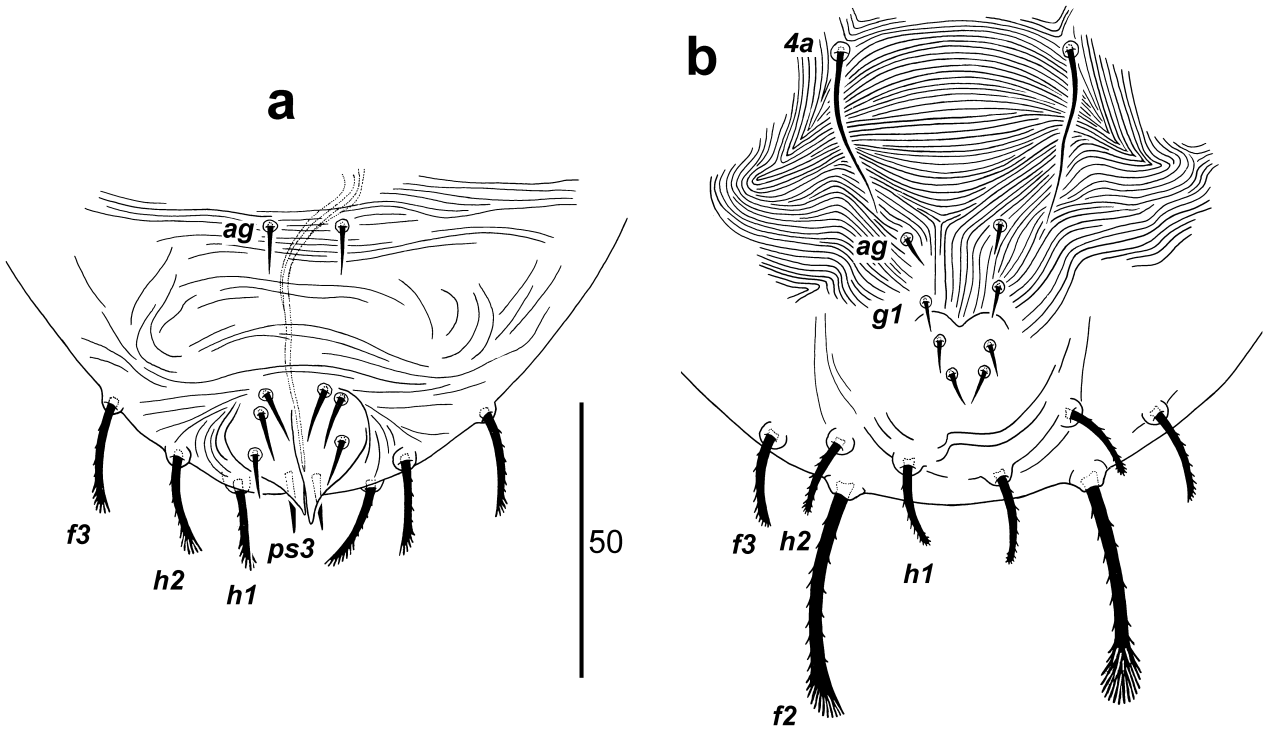


FIGURE 5. *Raoiella argenta* Beard, posterior venter: a. adult male with detail of aedeagus and setae *ps3*; b. female deutonymph.

***Raoiella australica* Womersley**
(Figs 7–28)

Material examined. Neotype. ♀. **Australia**, ex. Bangalay/southern mahogany—Sydney blue gum intergrade (*Eucalyptus botryoides—E. saligna* intergrade) (Myrtaceae), Des Creagh Reserve, Avalon Beach, 35 km north of Sydney, New South Wales, 33º37'59"S 151º19'58"E, 25.i.2012, J.J. Beard (QMS 108798).

Other material examined. **Australia**, 3 ♀, 3 ♂, 2 protonymphs, larva, same data as neotype; 12 ♀, 6 ♂, 11 deutonymphs, 6 protonymphs (1 pharate), 23 larvae, ex. *Eucalyptus* sp. (Myrtaceae), Point Hut Crossing, on the Murrumbidgee River, Gordon, Canberra, Australian Capital Territory, 35°27'04"S 149°04'31"E, 27.ii.2009, J.J. Beard & R.B. Halliday; 8 ♀, 2 ♂, 5 deutonymphs, 2 protonymphs (1 pharate), 2 larvae ex. *Eucalyptus* sp. (Myrtaceae), corner of Macpherson & Moorehouse Streets, shopping center carpark, O'Connor, Canberra, ACT, 35°15'50"S 149°07'22"E, 18.ii.2011, J.J. Beard. All material in ANIC, QM, USNM.

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* short, blunt to weakly spatulate. Adult femora I–II with four setae (*d*, *l'*, *bv"*, *v'*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Adult female genua I–II with two setae (*l'*, *l"* present; *d* absent); adult male genua I–II with three setae (*d*, *l'*, *l"*). Tarsus I with companion setae (*ft"*) longer than solenidion; tarsus II with companion seta (*ft"*) subequal to solenidion. Dorsal setae on tibiae I–II tapered distally. Eupathidium on palp tibiotarsus blunt. Egg without stipe.

Description. Female. ***Dorsum.*** (Figs 7–9) Body measurements (10): length between setae *v2–h1* 230–246 [243] 251–274, width between setae *sc2–sc2* 172–186 [176] 181–195, *c3–c3* 179–191 [181] 185–197, *f3–f3* 108–118 [115] 118–128. Prodorsal and dorsal opisthosomal shields weakly developed. Prodorsum smooth, with three pairs minute pores often visible with pair rounded pores sublaterally, and pair of pores on posterior margin (often hidden in fold of sejugal region). Dorsal opisthosoma smooth, with three pairs of large slit pores between *c1–c2* and *d1–d2*, minute pore near *c2*, one large and one minute pore between *d1–d2* and *e1–e2*; two to three minute pores *e1–e2*; pair small pores visible between *c1–d2*. Dorsal setae with large rounded spatulate tips.



FIGURE 6. *Raoiella argenta* Beard, deutonymph: dorsal habitus with details of legs I–IV.

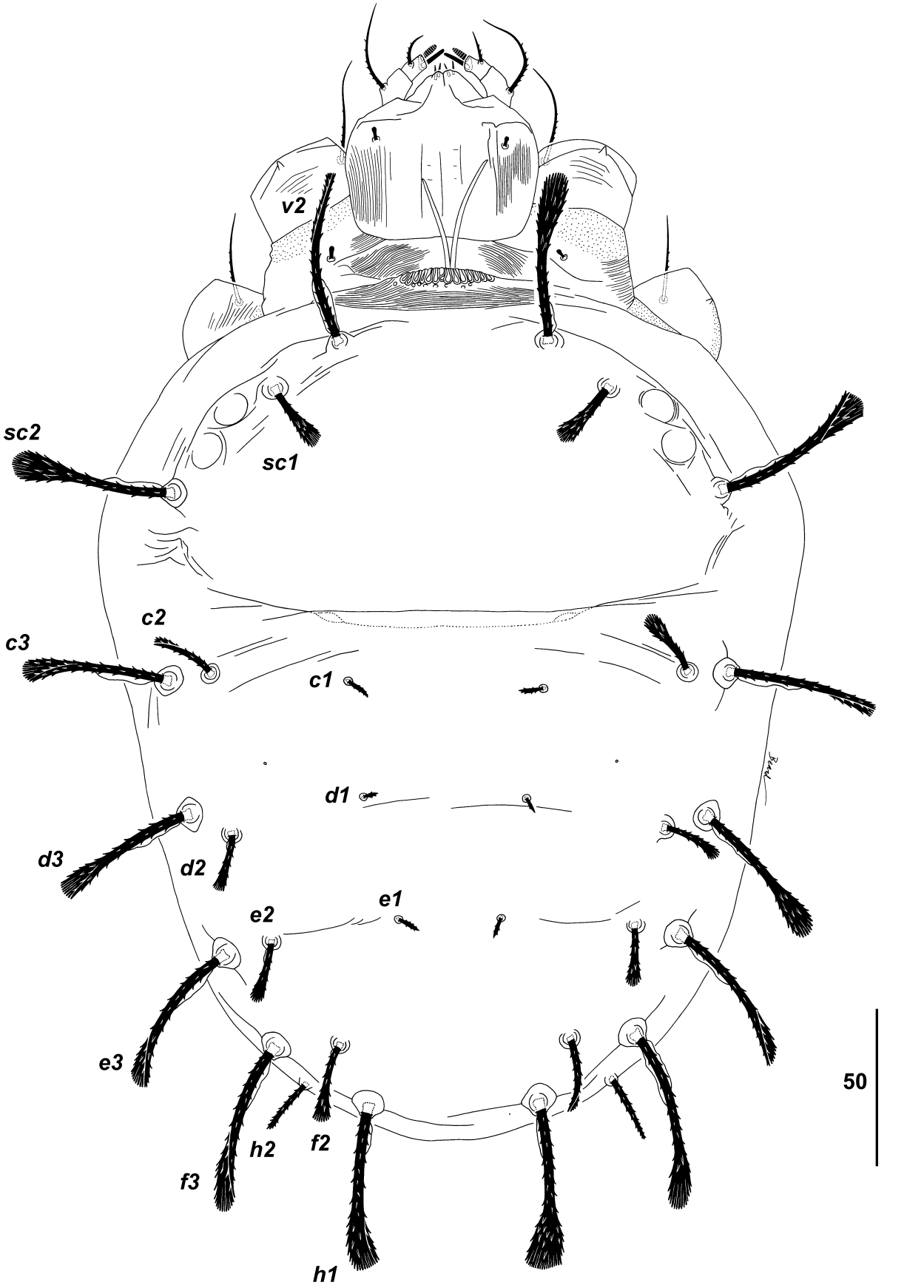


FIGURE 7. *Raoiella australica* Womersley, adult female (Avalon population): dorsal habitus with details of palps.

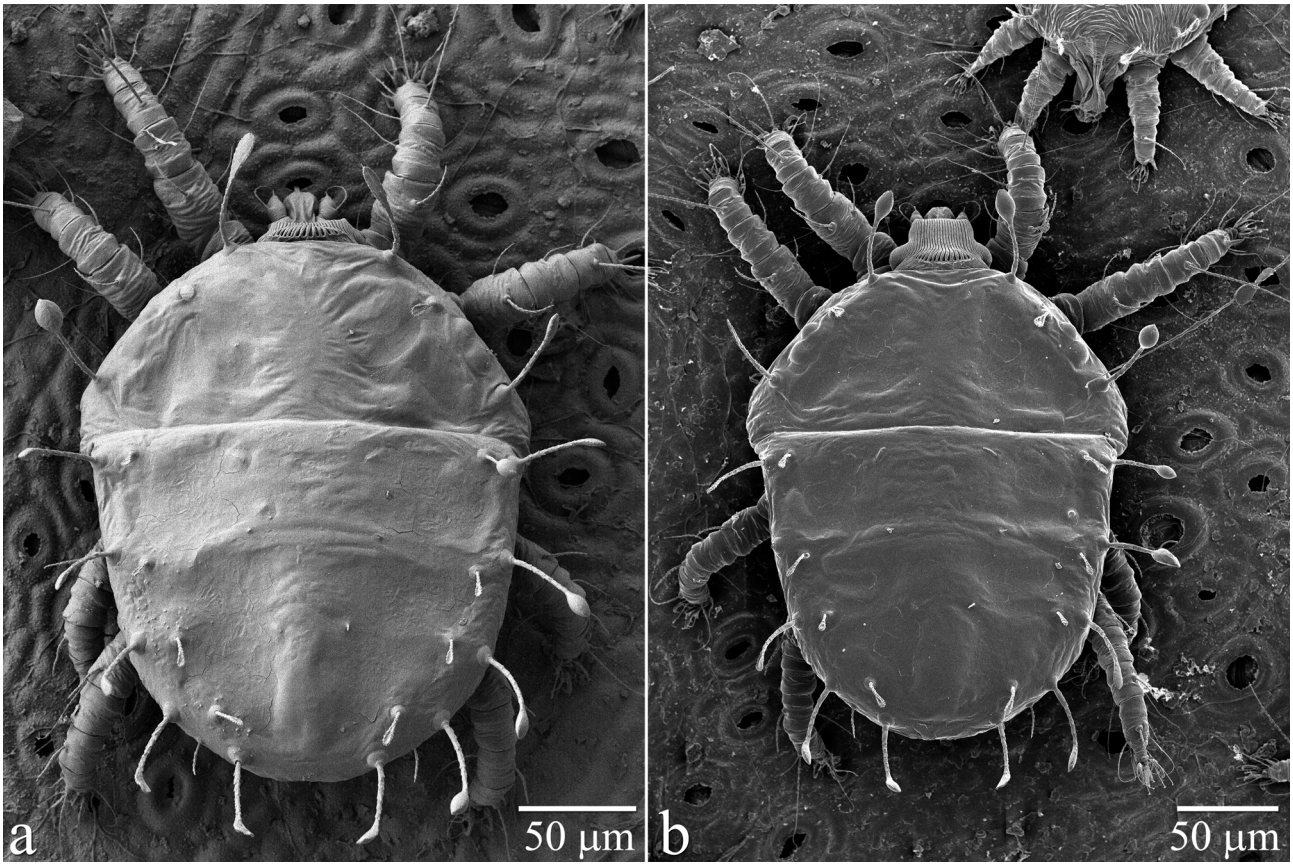


FIGURE 8. *Raoiella australica* Womersley, adult female (Avalon population): dorsal habitus on host plant (two different individuals).

Lateral setae (*c3*, *d3*, *e3*, *f3*) longer than sublateral setae (*c2*, *d2*, *e2*, *f2*); central setae much shorter than all other setae, almost minute; setae barbed along length; setae *h2* short, blunt, weakly tapered not spatulate. Dorsal setae measurements: *v2* 54–61 [56–57], *sc1* 20–31 [23–25], *sc2* 45–58 [54–56], *c1* 7–10 [9–10], *c2* 17–27 [22–23], *c3* 44–54 [49–50], *d1* 7–10 [4–6], *d2* 16–23 [20–21], *d3* 43–55 [53–54], *e1* 6–10 [7–8], *e2* 17–26 [20–21], *e3* 46–55 [53–54], *f2* 18–37 [25–27], *f3* 49–73 [58–61], *h1* 52–61 [54–56], *h2* 15–24 [21–22].

Palps. (Figs 7, 10a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–7) [6] and one blunt eupathidium (9–11) [9–10] distally, one dorsal seta (11–14) [13]; palp femorogenu with one seta (26–30) [29].

Venter. (Fig. 11) Cuticle almost completely plicate, covered with mostly transverse striae, except some longitudinal striae between *1b–1b* and laterad genital region, and coxal fields smooth. Setae *g1* and *g2* inserted in more-or-less transverse row on posterior margin of genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *g1*, *g2*, *ps2*, *ps3* barbed. Setae *3b*, *4b* absent. Setal measurements: *1a* 41–112 [79], *1b* 19–27 [20], *2b* 14–21 [19–21], *3a* 8–18 [12–13], *4a* 39–96 [74–78], *ag* 9–16 [13], *g1* 10–16 [16], *g2* 10–17 [16], *ps2* 15–23 [22–23], *ps3* 10–15 [14–15].

Spermatheca. (Fig. 10b) An elongate (> 100), narrow, convoluted duct. The basal section of the duct has a granular appearance, and broadens slightly towards external opening.

Legs. (Figs 12, 13) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-9(1), 1-1-4-2-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 9–11 [11–12]; ta II 8–11 [10–11]) and two eupathidia *pζ′–pζ″* distally (ta I 13–14 [14], 13–14 [13–14]; ta II 12–14 [13–14], 12–14 [12–13]). Weakly barbed companion seta *ft″* on tarsus I 14–21 [17–18] and tarsus II 11–19 [12], inserted adjacent to solenidion *ω″* (Fig. 13); *ft″* has a fine tip and is often broken, appearing to be short, thick, and somewhat blunt. Tibiae I–II with dorsal seta thick and tapered, but not finely tapered. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with two setae (*l′*, *l″*). Claws long; claw I 18–20 long, claw IV 18–20; tenent hairs with three attachment points.

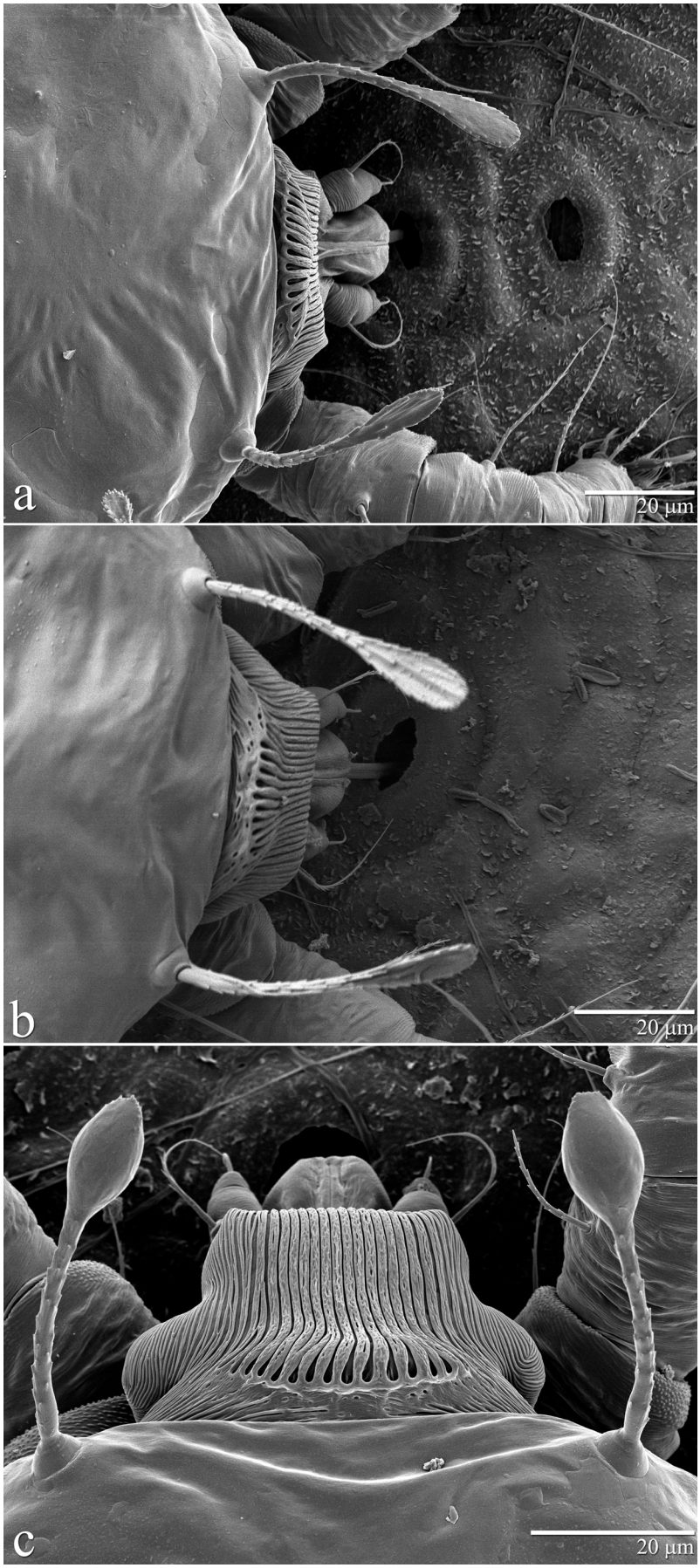


FIGURE 9. *Raoiella australica* Womersley, adult female: feeding through stomatal openings on host leaf surface.

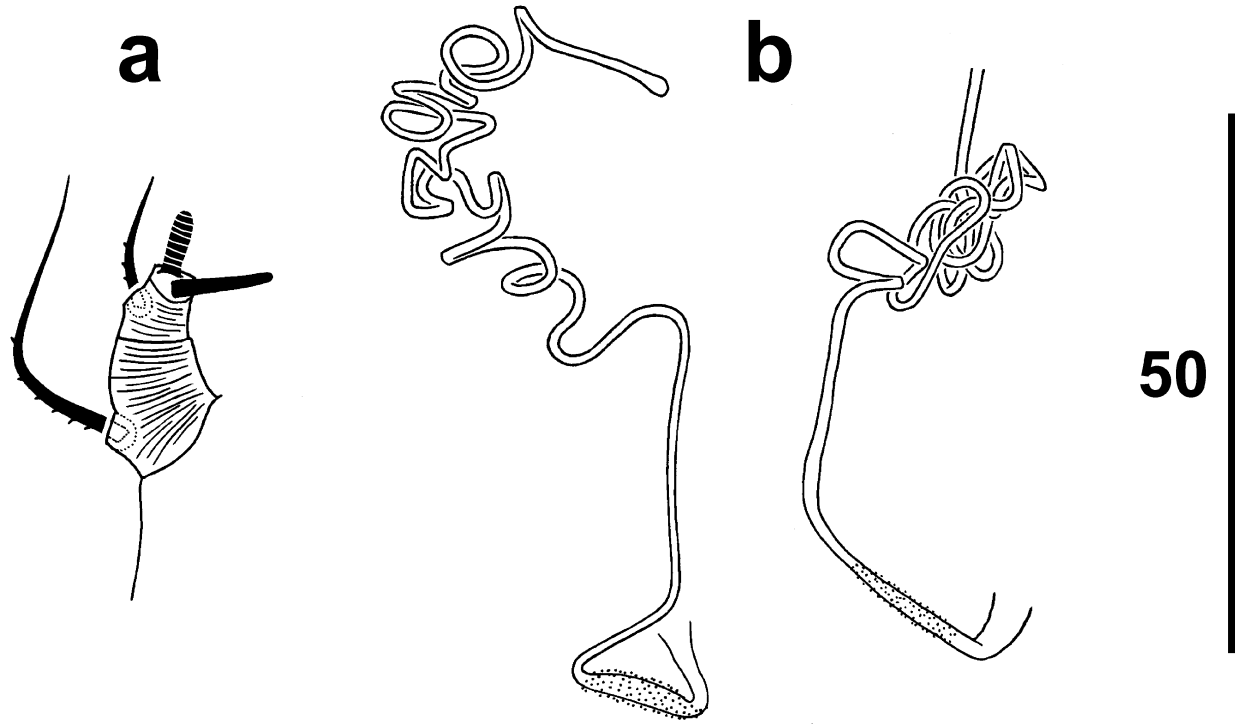


FIGURE 10. *Raoiella australica* Womersley, adult female: a. detail of palp; b. detail of spermatheca.

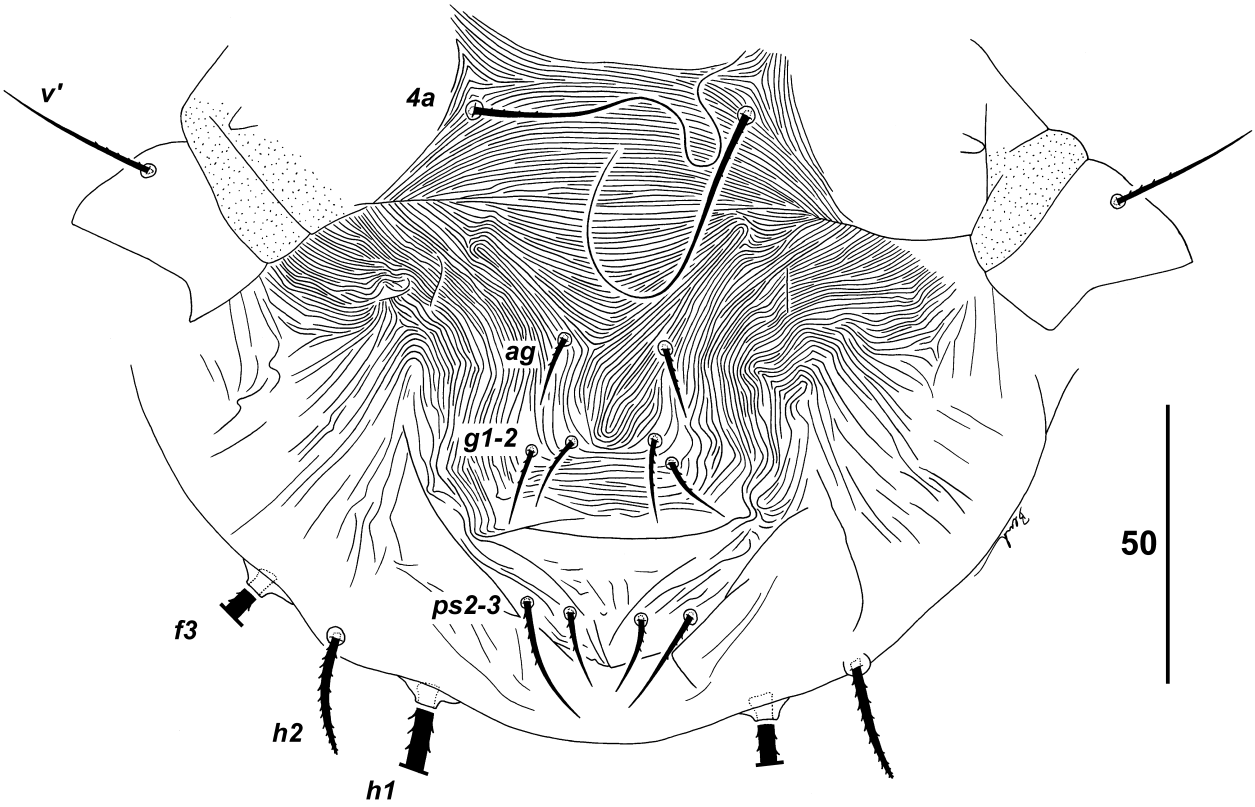


FIGURE 11. *Raoiella australica* Womersley, adult female (Avalon population): posterior venter.

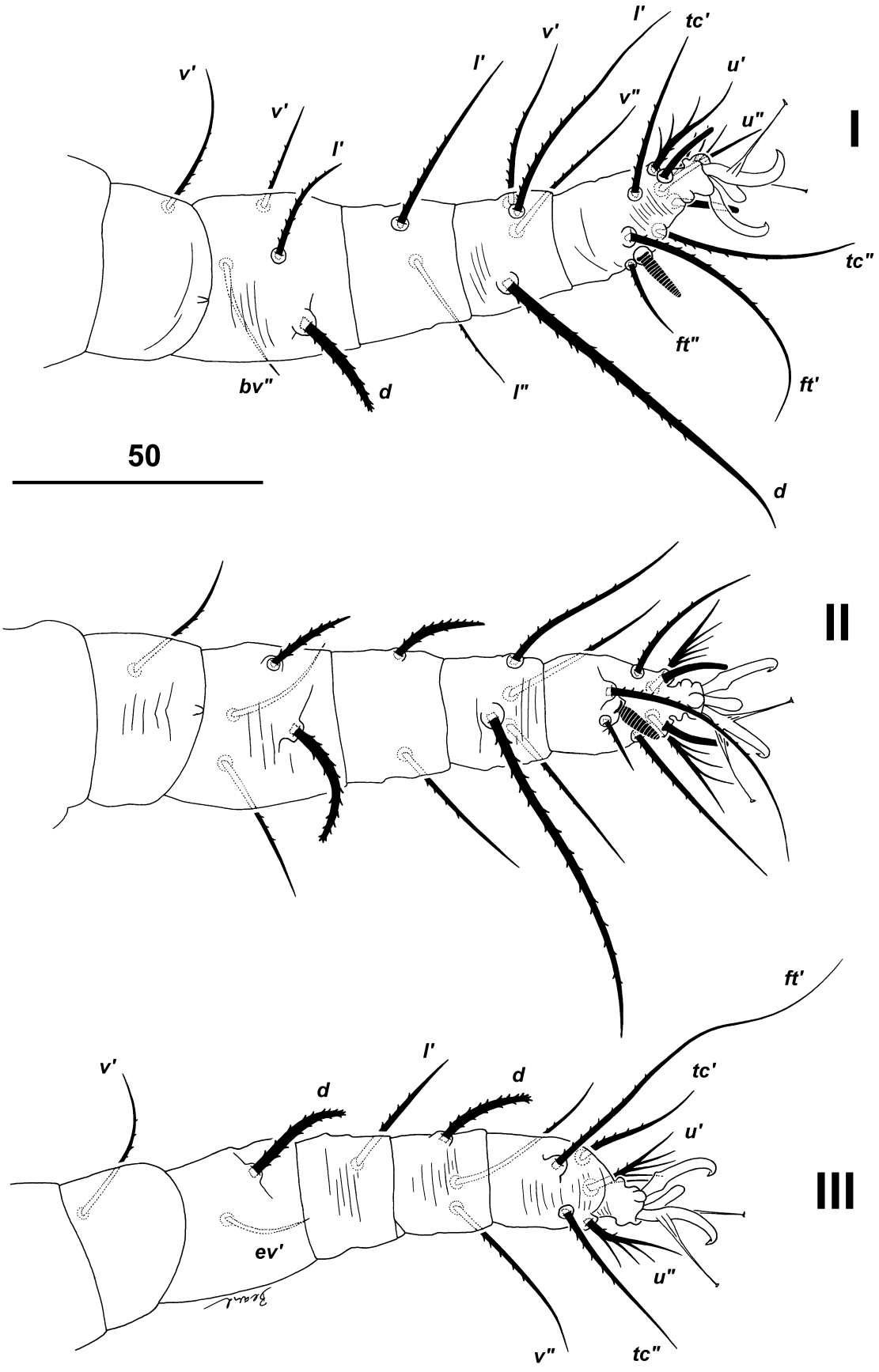


FIGURE 12. *Raoiella australica* Womersley, adult female: legs I–III (right side, dorsal aspect).

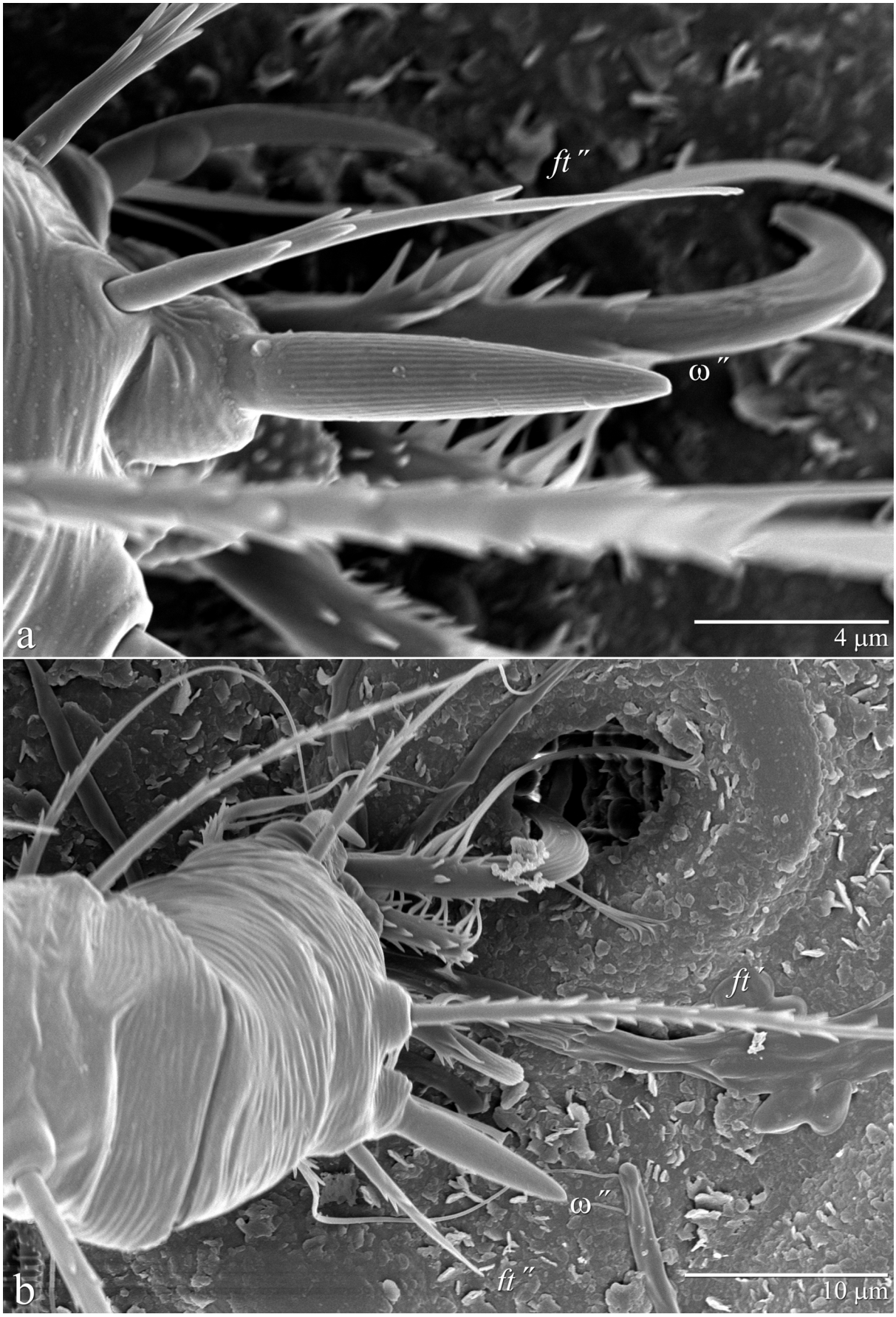


FIGURE 13. *Raoiella australica* Womersley, adult female: a. detail of tarsus I, indicating solenidion (*ω″*) and companion seta (*ft″*); b. detail of tarsus II. Note the mite using the stomatal lip for anchorage.

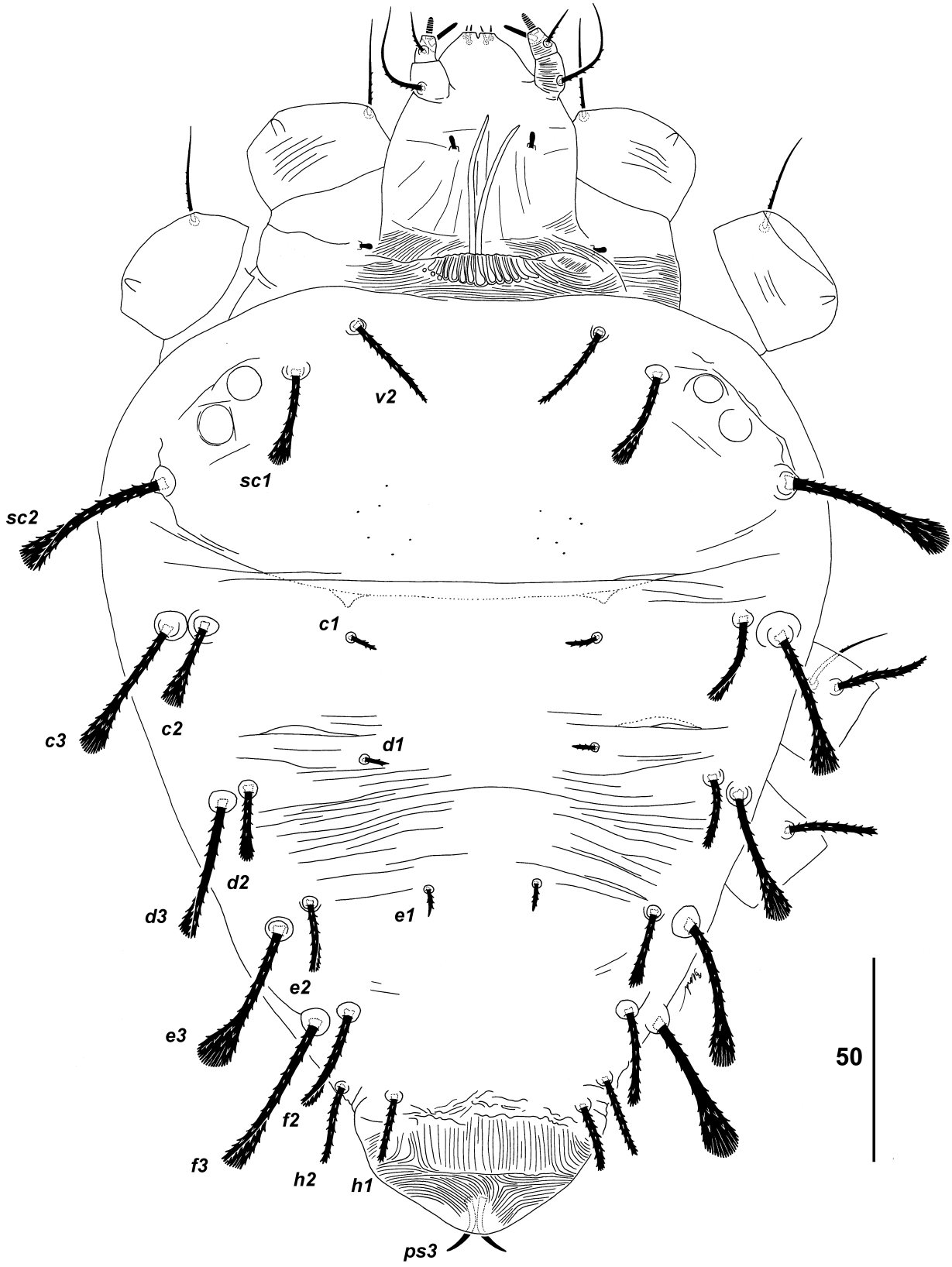


FIGURE 14. *Raoiella australica* Womersley, adult male (Avalon population): dorsal habitus with details of palp and setae *ps3*.

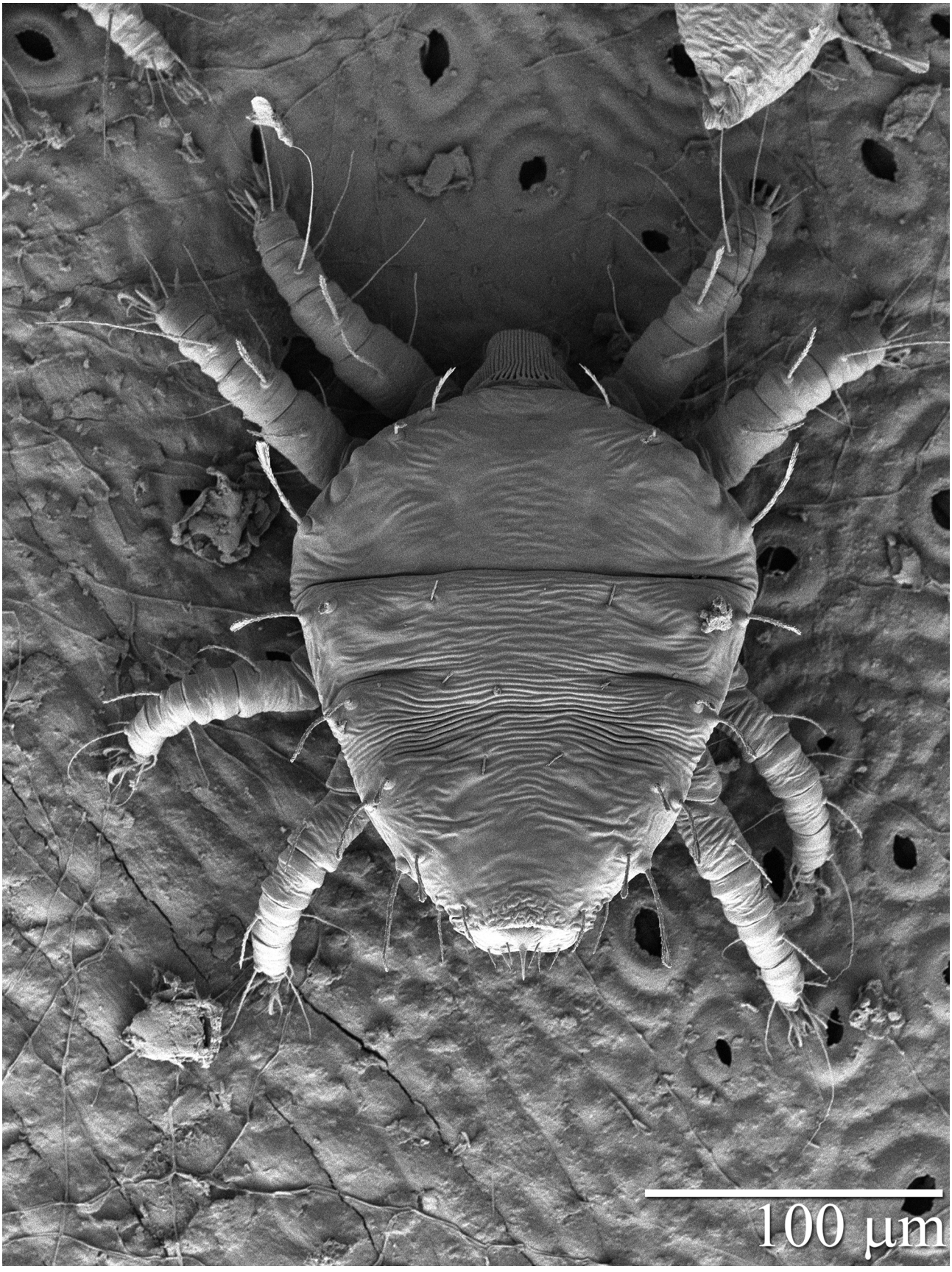


FIGURE 15. *Raoiella australica* Womersley, adult male (Avalon population): dorsal habitus on host plant.

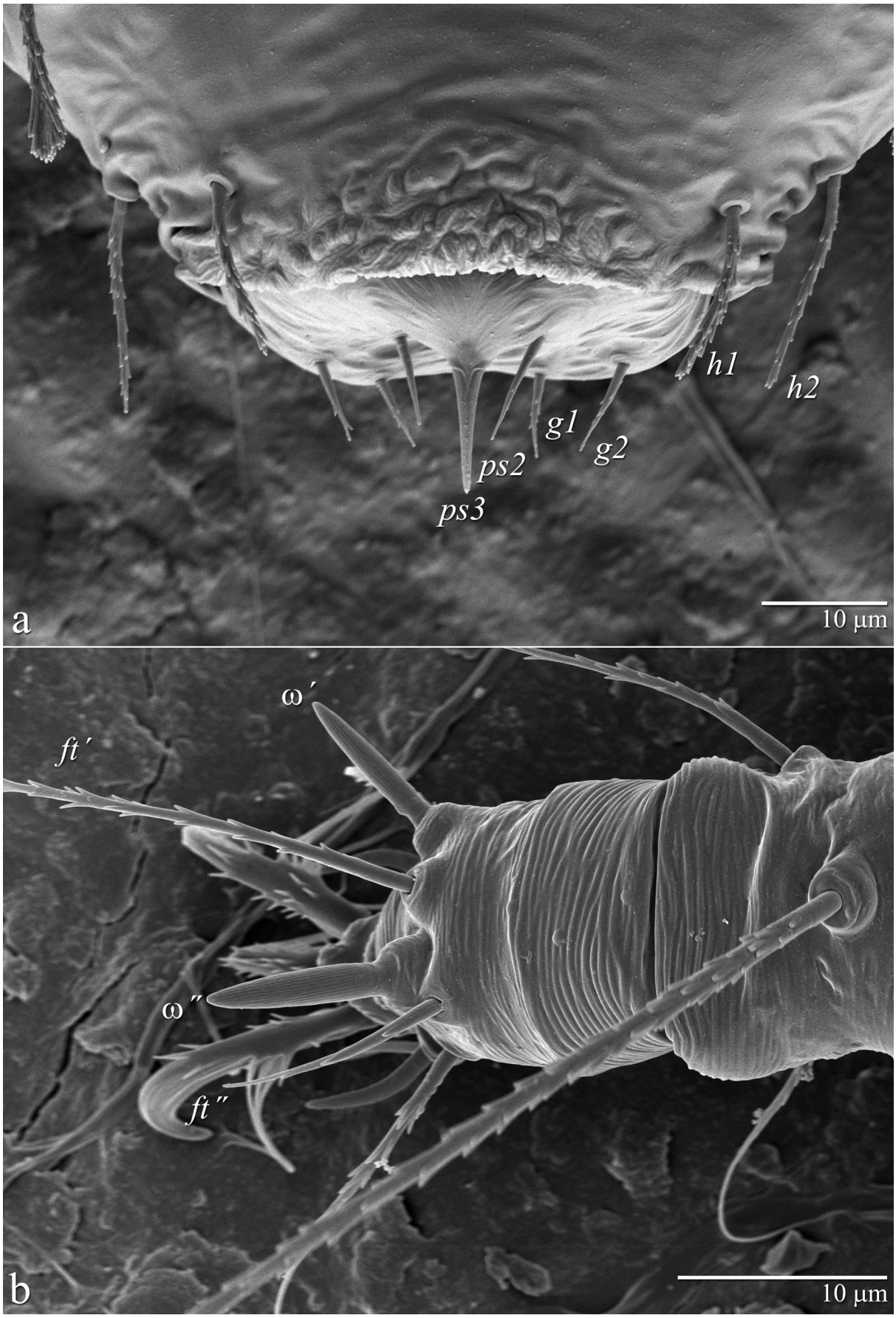


FIGURE 16. *Raoiella australica* Womersley, adult male (Avalon population): a. detail of posterior dorsum, indicating pattern on cuticle and modified setae *ps3*; b. tarsus II, indicating solenidion (*ω″*) and companion seta (*ft″* ; tip broken).

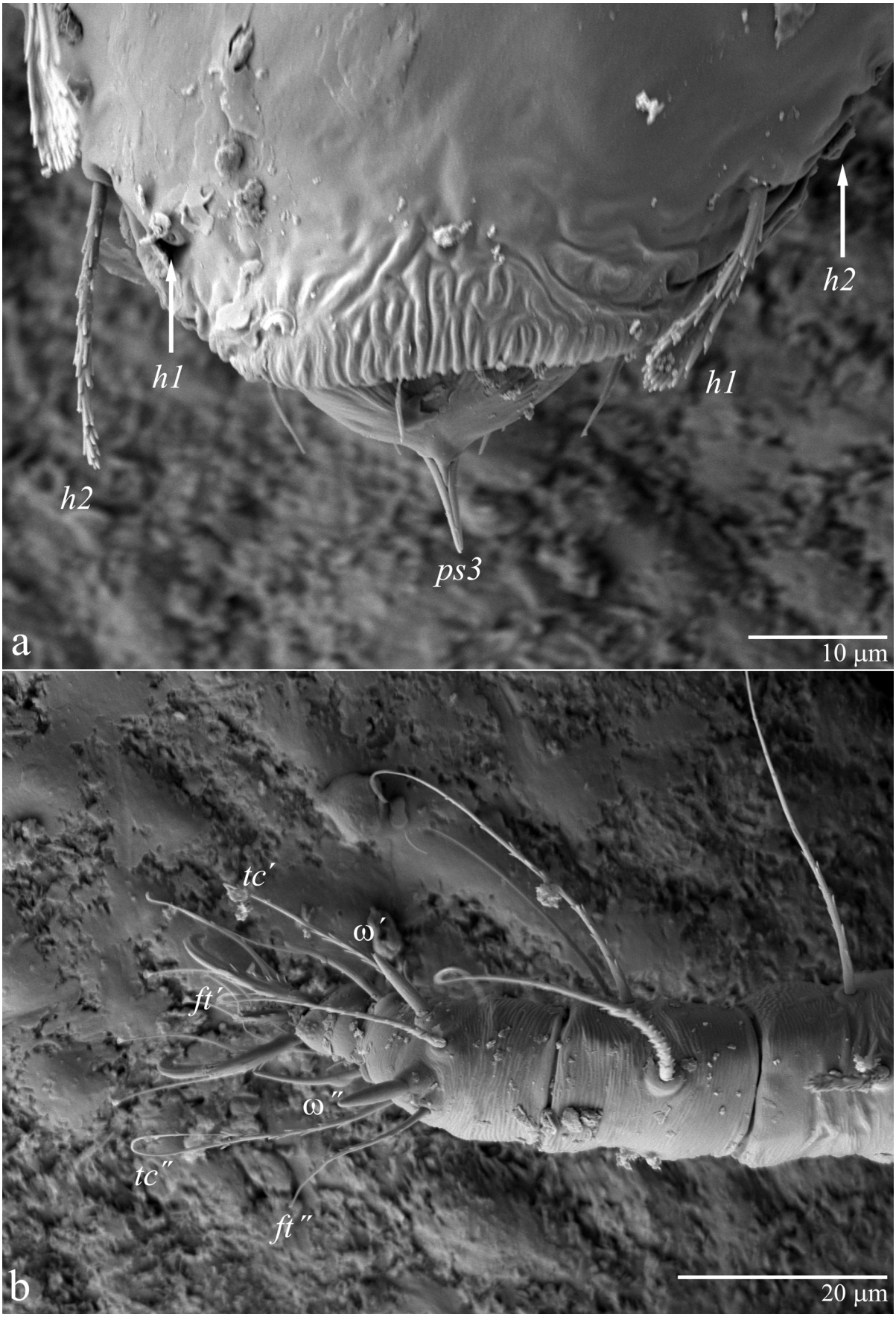


FIGURE 17. *Raoiella australica* Womersley, adult male (Canberra population): a. detail of posterior dorsum, indicating pattern on cuticle and modified setae *ps3*; b. tarsus II, indicating solenidion (*ω″*) and companion seta (*ft″*, not broken).

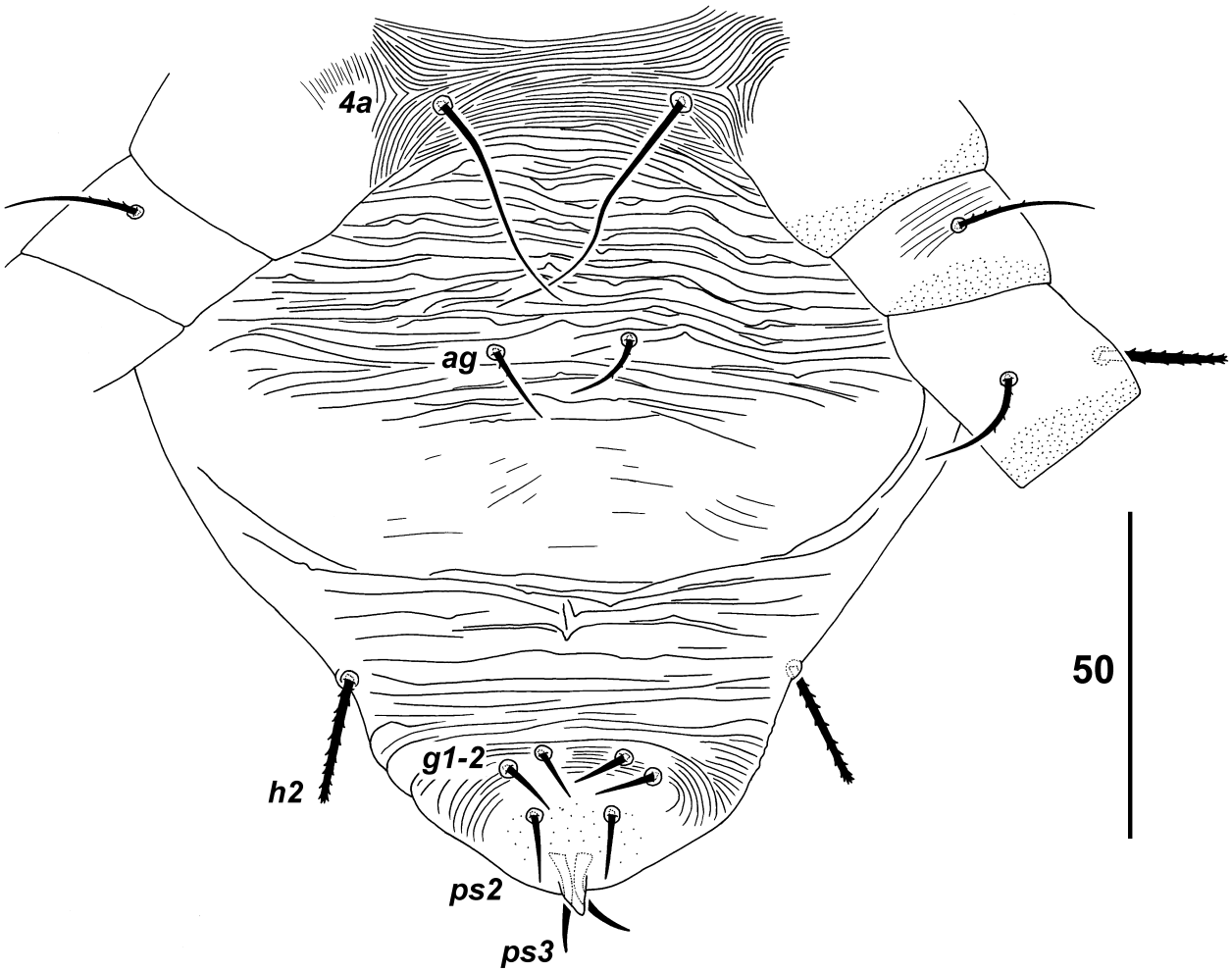


FIGURE 18. *Raoiella australica* Womersley, adult male: posterior venter, with detail of *ps3* setae.

Male. ***Dorsum.*** (Figs 14, 15, 16a, 17a) Body measurements (8): length between setae *v2–h1* 177–198, width between setae *sc2–sc2* 145–153, *c3–c3* 141–151, *f3–f3* 80–92. Prodorsum smooth with a few scattered punctations posteriorly, and a few weak folds, and a pore on the posterior margin (often hidden in fold of sejugal region). Dorsal opisthosoma mostly smooth, with some transverse striae between setae *d1* and *e1*; with two pairs large slit pores between *c2–d1*; dorsal cuticle posterior to *h1–h1* with a narrow band of rounded reticulation followed by a broader band of longitudinal and oblique striae. Dorsal setae barbed along entire length; setae *f2* weakly spatulate; setae *h1*, *h2* short, blunt to weakly spatulate; setae *h2* often inserted ventro-laterally. Dorsal setae measurements: *v2* 21–29, *sc1* 18–27, *sc2* 34–44, *c1* 7–9, *c2* 18–23, *c3* 27–38, *d1* 5–8, *d2* 16–21, *d3* 26–36, *e1* 6–10, *e2* 17–22, *e3* 25–40, *f2* 20–26, *f3* 36–43 (one seta 27), *h1* 14–20, *h2* 18–25.

Palps. (Fig. 14) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–7) and one blunt eupathidium (8–10) distally, one dorsal seta (11–13); palp femorogenu with one seta (21–25).

Venter. (Fig. 18) Ventral cuticle almost completely plicate, covered in mostly transverse striae; broad band of strong widely spaced striae posterior to *4a–4a*; band of smooth cuticle posterior to *ag–ag*; coxal fields smooth. Setae *g1*, *g2*, *ps2* weakly barbed. Setae *3b*, *4b* absent. Setae *ps3* modified as accessory genital stylets into thickened curved to angulate spines. Setal measurements: *1a* 42–73, *1b* 15–26, *2b* 12–17, *3a* 8–12, *4a* 32–62, *ag* 8–13, *g1* 8–10, *g2* 8–11, *ps2* 10–12, *ps3* 15–17.

Aedeagus. Aedeagus narrow, elongate and sclerotised (84–90), tapering to a blunt point distally (towards genital opening).

Legs. (Figs 16b, 17b, 19) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-4-3-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 8–9, abaxial 8–10; ta II adaxial 8–9, abaxial 8–10), and two eupathidia distally (ta I 12–13, 12–13; ta II 11–12, 11–12). Weakly barbed companion

seta *ft″* on tarsus I 11–22 (with fine tip that is often broken) and tarsus II 12–16, inserted adjacent to solenidion *ω″*. Tibiae I with dorsal seta *d* somewhat finely tapered, tibiae II with dorsal setae *d* tapered but not finely. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with three setae (*d*, *l′*, *l″*). Claw I 15–17 long, claw IV 16–17; tenent hairs with three attachment points.

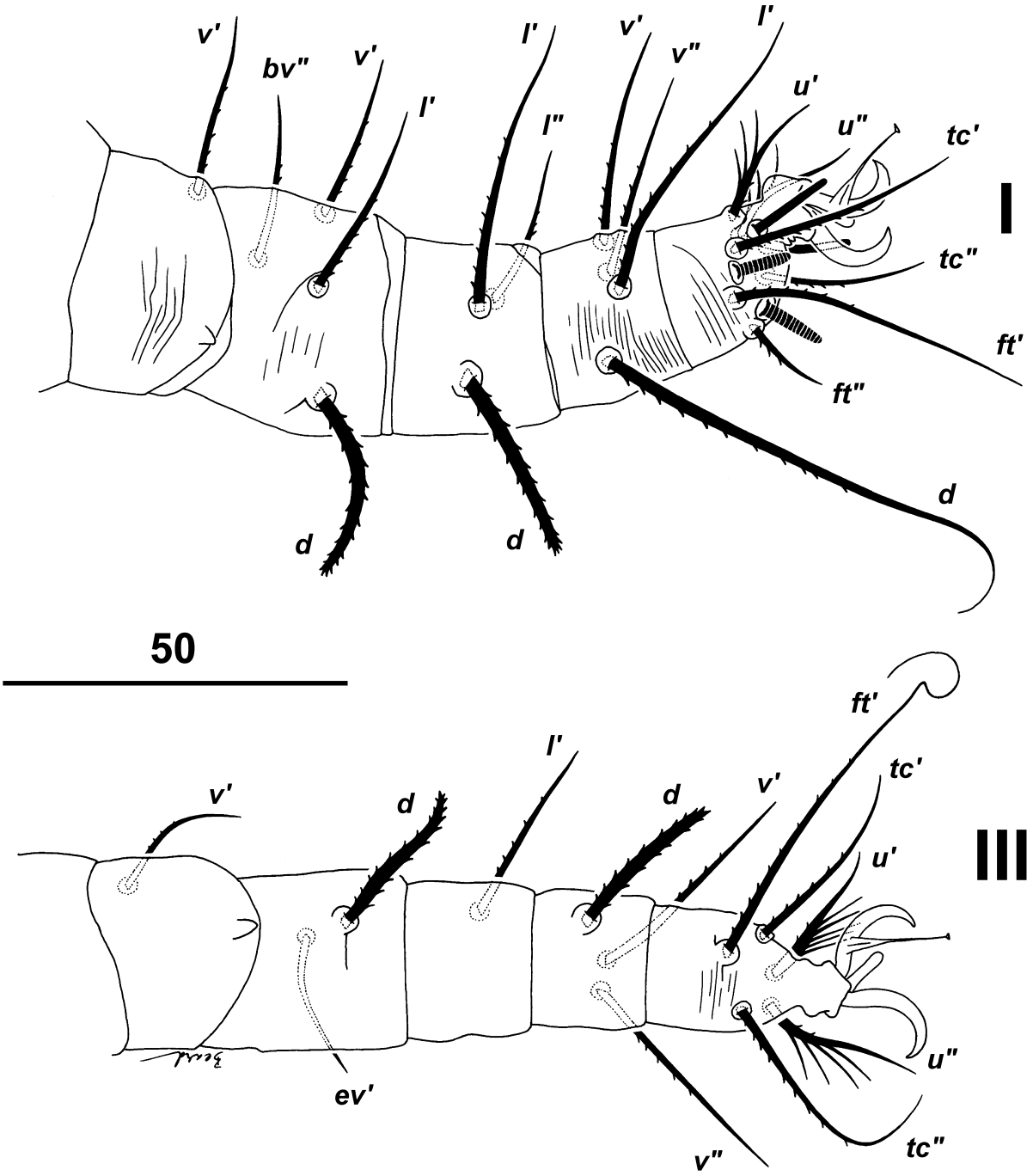


FIGURE 19. *Raoiella australica* Womersley, adult male: legs I and III (right side; tarsus I dorsal to adaxial aspect, tarsus III dorsal to abaxial aspect).

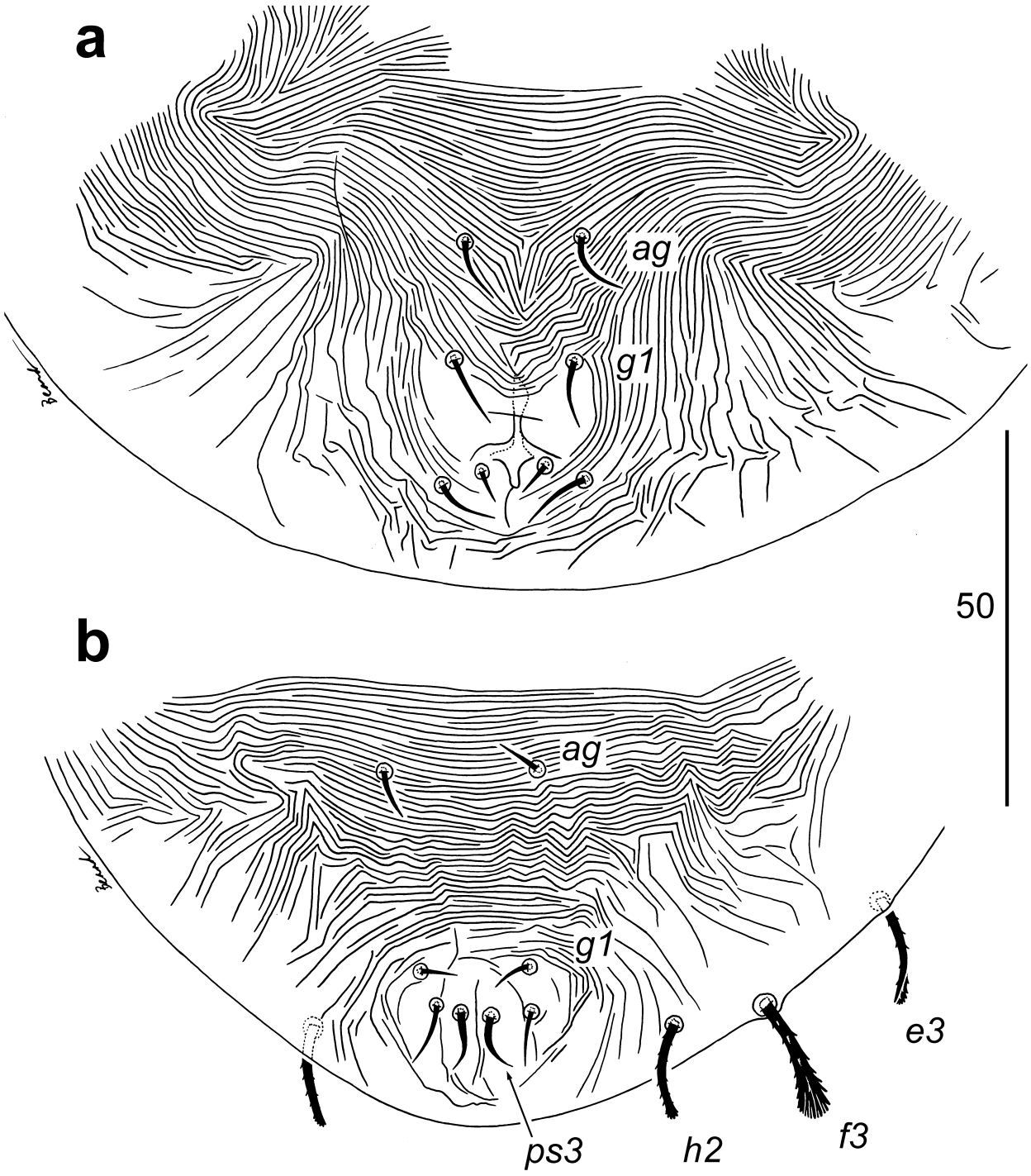


FIGURE 20. *Raoiella australica* Womersley, deutonymph posterior venter (Canberra population): a. female deutonymph; b. male deutonymph (note *ps3* differentiating into genital stylets on male).



FIGURE 21. *Raoiella australica* Womersley, larva (Canberra population): a. dorsal habitus with details of legs; b. detail of palp.

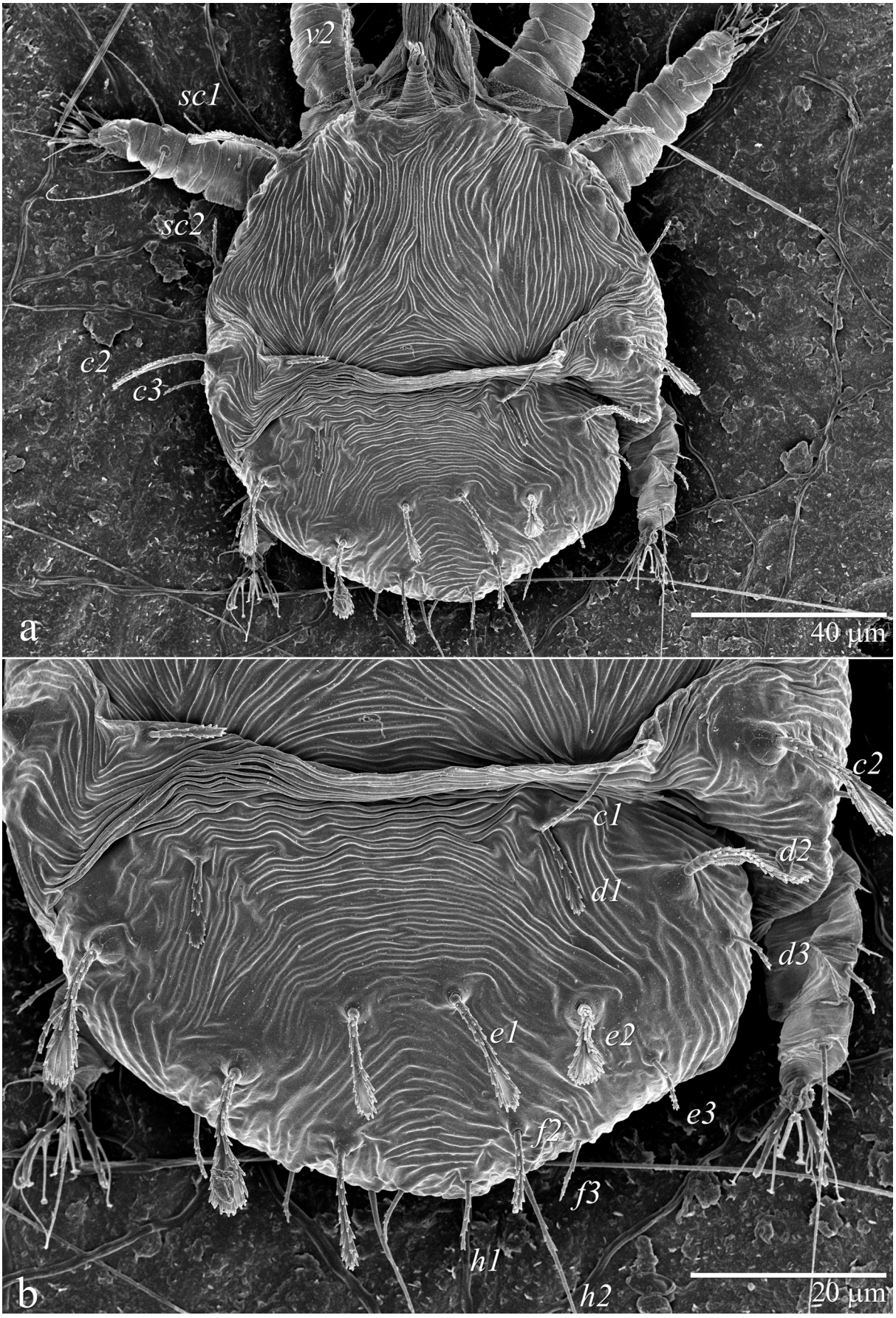


FIGURE 22. *Raoiella australica* Womersley, larva: a. dorsal habitus on host plant; b. detail of posterior dorsum.

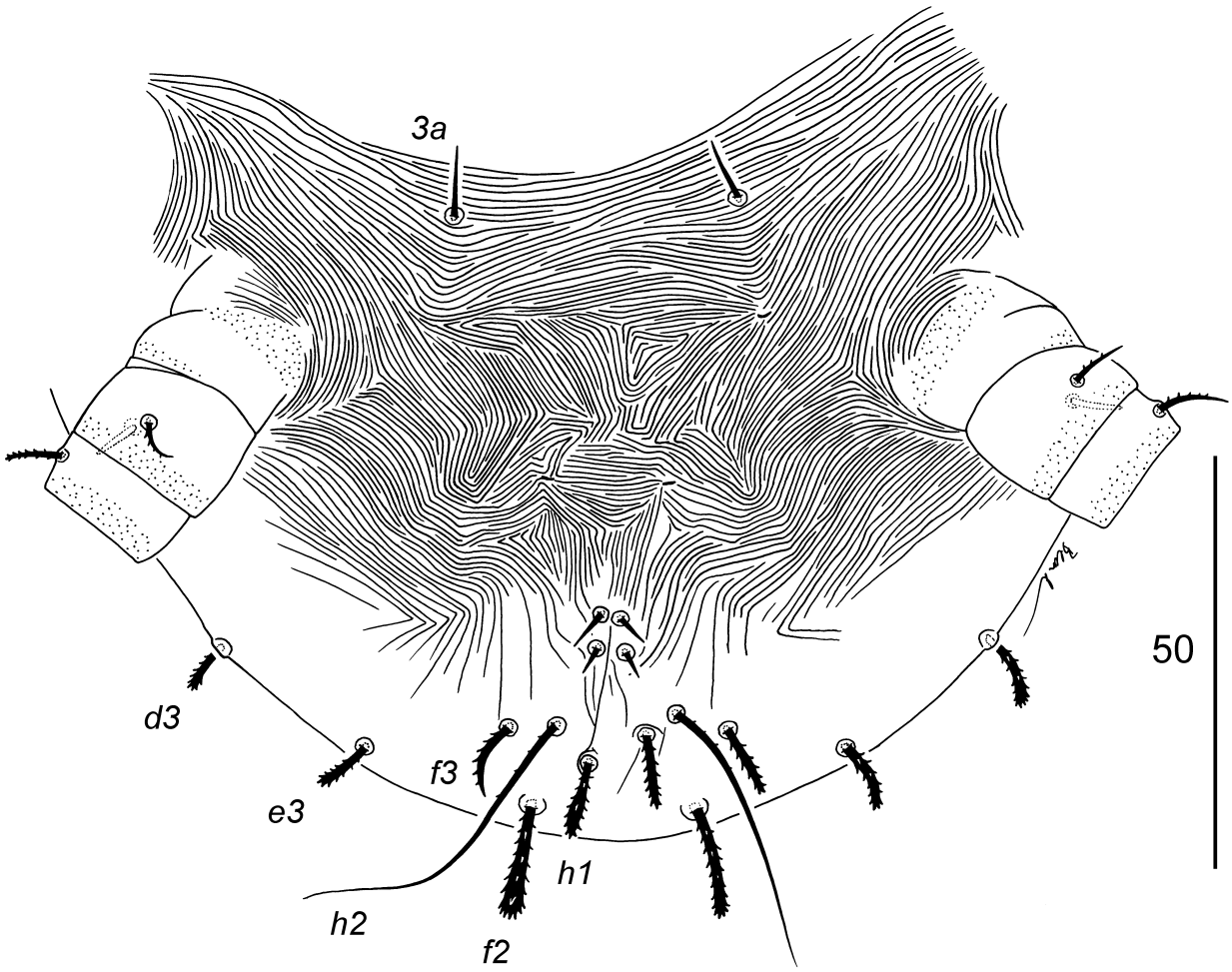


FIGURE 23 *Raoiella australica* Womersley, larva (Canberra population): posterior venter.

Deutonymph. ***Dorsum.*** Sexually dimorphic. Body measurements (5 female; 2 male): length between setae *v2–h1* female 200–240 (male 172–182), width between setae *sc2–sc2* 161–175 (143–144), *c3–c3* 173–184 (151–153), *f3–f3* 82–100 (69–70). Prodorsum mostly smooth with arching striations posteromesally, with some weak oblique striations laterally; one pair pores sometimes discernible sublaterally. Dorsal opisthosoma with weak, widely spaced transverse striations between *c1–e1*; with oblique folds between *e1–f2* forming an inverted V shape. Most dorsal setae with broadly spatulate tips, barbed along entire length; *h1* spatulate, barbed; *h2* finely tapered. Dorsal setae measurements: *v2* 43–47 (29–33), *sc1* 30–37 (26–27), *sc2* 32–37 (27–31), *c1* 8–10 (7–8), *c2* 38–42 (27–36), *c3* 17–20 (16–17), *d1* 7–10 (7–8), *d2* 38–40 (25–29), *d3* 15–21 (13–15), *e1* 7–10 (7–8), *e2* 40–44 (27–32), *e3* 16–20 (15–18), *f2* 34–45 (22–26), *f3* 18–27 (14–17), *h1* 17–25, *h2* 12–16.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one thick blunt eupathidium (7–9) distally, one dorsal seta (9–11); femorogenu with one seta (19–23).

Venter. (Fig. 20) Cuticle almost completely plicate, covered with mostly transverse striae in both sexes; transverse striae *1b–1b*, longitudinal *1b–1a*, transverse *1a–g1*; female with patch of V-shaped striae between *ag–g1* (Fig. 20a); male with transverse striae *ag–g1*; male with setae *ps3* starting to modify into accessory genital stylets, thick and strongly curved (Fig. 20b) (see also Figs 128a–b, 190a–b, 234a–b). Seta *1a* elongate, fine (difficult to determine full length). Most ventral setae smooth. Setal measurements: *1a* 41–61, *1b* 14–16, *3a* 8–11, *4a* 26–46, *ag* 7–10, *g1* 8–13 (6), *ps2* 8–12, *ps3* 5–8 (8–9).

Legs. Setal formula for legs I-IV (coxae to tarsi): female 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively; male 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5. Tarsi I and II each with one abaxial solenidion (ta I 7–8; ta II 6–7) and two eupathidia distally (ta I 9–11, 9–11; ta II 9–11, 9–11). Weakly barbed to

smooth companion seta *ft″* on tarsus I 8–11 and tarsus II 7–8, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta *d* tapered but not finely tapered. Femora I–II with three setae (*l′*, *v′*, *bv″* present; *d* absent); female genua I–II with one seta (*l′* present; *d*, *l″* absent) and male genua I–II with two setae (*d*, *l′* present; *l″* absent). Claw I 15–16 long, claw IV 12–14 long; tenent hairs with two–three attachment points.

Protonymph. *Dorsum.* Body measurements (6): length between setae *v2–h1* 142–181, *v2–f2* 130–182, width between setae *sc2–sc2* 124–147, *c3–c3* 134–155, *f2–f2* 27–35, *f3–f3* 46–58. Prodorsum with well developed shield, mostly smooth, with weak transverse striae medially and oblique striae laterally. Dorsal opisthosoma with widely spaced transverse striae between *c1–e1*. Dorsal setae spatulate, barbed along entire length; setae *f3* spatulate to weakly spatulate, barbed; *h1* thick, weakly spatulate, barbed; *h2* thin, tapered, barbed. Lateral setae (*c3*, *d3*, *e3*, *f3*) shorter than sublateral setae (*c2*, *d2*, *e2*, *f2*); central setae short. Dorsal setae measurements: *v2* 28–37, *sc1* 27–31, *sc2* 17–20, *c1* 5–9, *c2* 29–37, *c3* 10–13, *d1* 6–9, *d2* 29–32, *d3* 10–12, *e1* 6–11, *e2* 25–32, *e3* 9–12, *f2* 17–24, *f3* 10–13, *h1* 9–13, *h2* 10–14.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–5) and one blunt eupathidium (7–9) distally, one dorsal seta (8–9); palp femorogenu with one seta (13–19).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, longitudinal striae between *1b–1a*, transverse *1a–ag*, oblique *ag–ps2*, longitudinal striae laterad *ps* setae; coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 27–55, *1b* 11–13, *3a* 7–11, *ag* 5–7, *ps2* 4–6, *ps3* 4–7.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 6–7; ta II 5–6) and two eupathidia distally (ta I 8–9, 8–9; ta II 8–9, 7–9). Smooth companion seta *ft″* on tarsus I 5–7 and tarsus II 3–5, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta, *d*, tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with one seta (*l′* present; *d*, *l″* absent). Claw I 11–14 long, claw IV 11–12; tenent hairs with two–three attachment points.

Larva. *Dorsum.* (Figs 21, 22) Body measurements (6): length between setae *v2–e1* 93–132, *v2–f2* 109–149, width between setae *sc2–sc2* 109–128, *c3–c3* 111–143, *f2–f2* 17–19, *f3–f3* 27–35. Prodorsum with well developed shield, with longitudinal to oblique striations. Dorsal opisthosoma with some mesal transverse striae between setae *c1–e1*. Lateral setae (*c3*, *d3*, *e3*, *f3*) shorter than sublateral setae (*c2*, *d2*, *e2*, *f2*); central setae (*c1*, *d1*, *e1*) longer than in other stages. Dorsal setae spatulate, barbed along entire length; setae *e3*, *f2*, *f3*, *h1*, *h2* may be ventral; setae *f2* weakly spatulate; setae *f3*, *h1* tapered to blunt, barbed; setae *h2* fine, elongate, flagellate. Dorsal setae measurements: *v2* 22–26, *sc1* 26–29, *sc2* 9–14, *c1* 9–11, *c2* 23–28, *c3* 8–10, *d1* 10–15, *d2* 22–27, *d3* 7–10, *e1* 16–22, *e2* 16–23, *e3* 7–10, *f2* 12–17, *f3* 8–11, *h1* 8–11, *h2* 33–58.

Palps. (Fig. 21) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–5) and one fine eupathidium (9–10) distally, one dorsal seta (8–9); palp femorogenu with one dorsal seta (12–14).

Venter. (Fig. 23) Cuticle almost completely strongly plicate, except coxal fields smooth; cuticle with longitudinal striae between *1b–1a*, transverse striae *1a*–leg III, then with patches of transverse striae and longitudinal striae between leg III and *ps* setae. Setae *1a* elongate, finely tapered. Setal measurements: *1a* 28–44, *1b* 10–14, *3a* 7–9, *ps2* 3–5, *ps3* 3–5.

Legs. (Fig. 21) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 4–5; ta II 4–5) and two eupathidia distally (ta I 7–8, 7–8; ta II 6–8, 6–8). Companion seta *ft″* on tarsus I 4–5 and tarsus II 3–5, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal setae, *d*, finely tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with one seta (*l′* present; *d*, *l″* absent). Claw I 11–12 long, claw IV 11–12 long; tenent hairs with two attachment points.

Egg. (Figs 24–26, 28) Ellipsoid in shape to slightly elongate globose, 90–100 long, 75–80 wide, red, shiny or glistening (Figs 26, 28). The egg of this species lacks a stipe (Figs 24, 25); with pair of minute recurved spines present 2.5–3.5 µm (Fig. 24).

Host. Bangalay/southern mahogany—Sydney blue gum intergrade (*Eucalyptus botryoides—E. saligna* intergrade) (Myrtaceae); *Eucalyptus* sp. The following hosts listed in the literature are considered to be incorrect—New England blackbutt *Eucalyptus andrewsii* Maiden (listed as *E. andrewsiana*); forest red gum *E. tereticornis* Sm. (Myrtaceae).

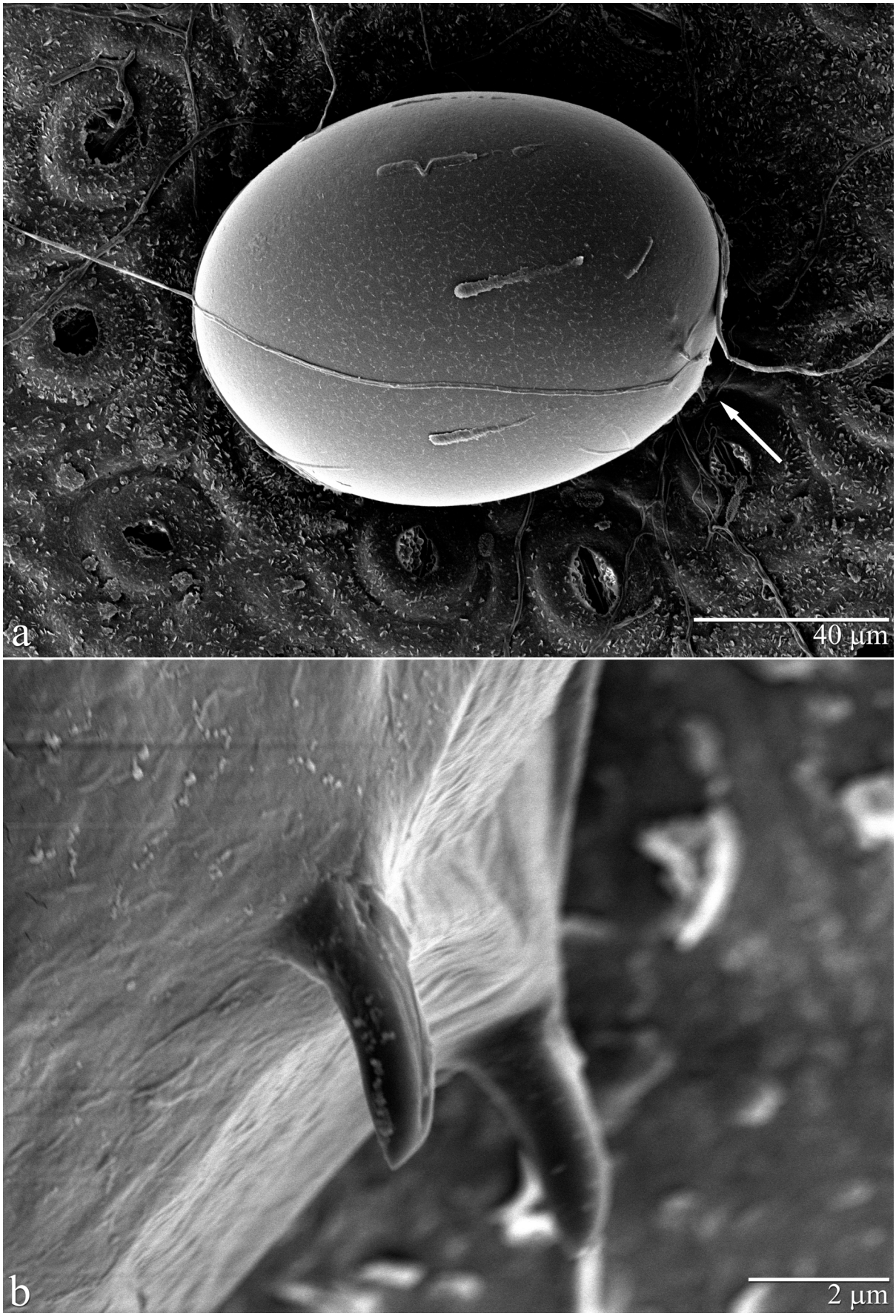


FIGURE 24. *Raoiella australica* Womersley, egg: a. on host plant, with pair of minute recurved spines indicated by arrow; b. detail of spines.

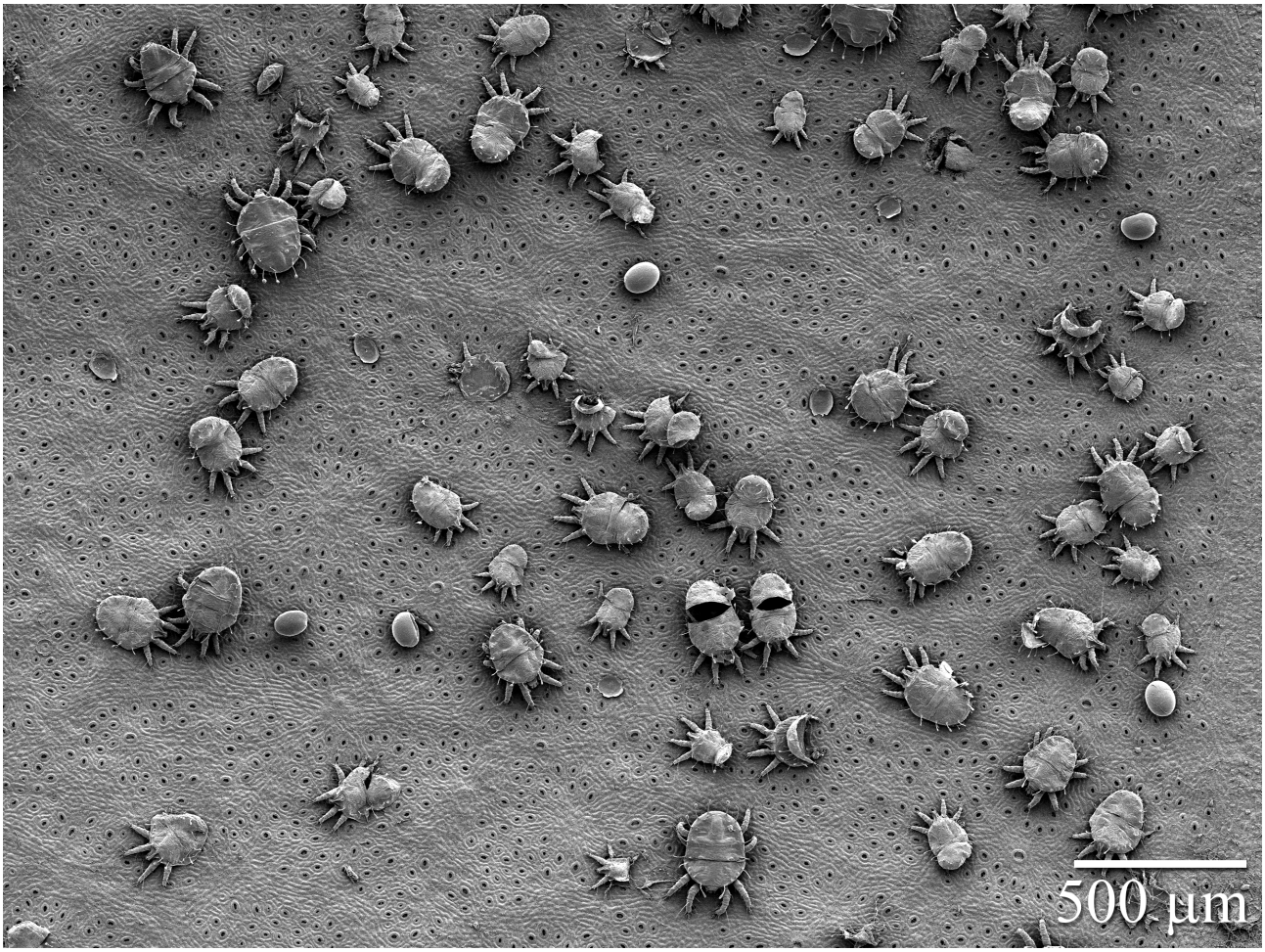


FIGURE 25. *Raoiella australica* Womersley, colony on host plant.

Distribution. AUSTRALIA: New South Wales: Dee Why (17 km north of Sydney; holotype collection site) and Avalon (35 km north of Sydney; neotype collection site); Australian Capital Territory: Canberra.

Remarks. *Raoiella australica* has a somewhat confusing history. The type specimens for *R. australica* are considered to be lost from SAM. Beard borrowed all material located in SAM pertaining to *R. australica*. All that remained were a few poor unmounted specimens mixed in a vial with two different labels listing two different collection sites, neither of which is Dee Why (the type locality for the species listed by Womersley in 1940). All of these miscellaneous specimens, referred to as "*Raoiella australis* n. sp." and determined by H. Womersley, were mounted by Beard and none of them matched the original description and illustration of *R. australica*, which is not surprising as the two collection sites are geographically very distant from Dee Why—Passchendaele (listed as Passchendale on labels and in Womersley (1940)) is approximately 760 km north of Dee Why and Maryborough is approximately 1150 km north of Dee Why. The specimens consisted of a small part of one female from Passchendaele and four immatures in poor condition from Maryborough. Beard searched for *R. australica* in Dee Why but was unsuccessful; however, Beard was able to recollect *R. australica* in Avalon, approximately 20 km north of Dee Why, and in Canberra, approximately 300 km southwest of Dee Why. The newly collected specimens are indistinguishable from the original description of Womersley (1940), and we here designate a neotype from the Avalon material. Recollections need to be made in Passchendaele and Maryborough to confirm the identity of these other specimens.

Raoiella australica was listed as *Raoiella* sp. 6 (DNA codes RaIn 50, RaIn51) in Dowling *et al.* (2012; Table 1 and Figs 1, 2), which is the Point Hut Crossing population from Canberra. The Avalon Beach (neotype) population and the Canberra population are inseparable using morphology, and all measurements match, except that the Canberra specimens have slightly larger body size than the Avalon specimens. We aim to confirm conspecificity between the two populations with further molecular analyses.

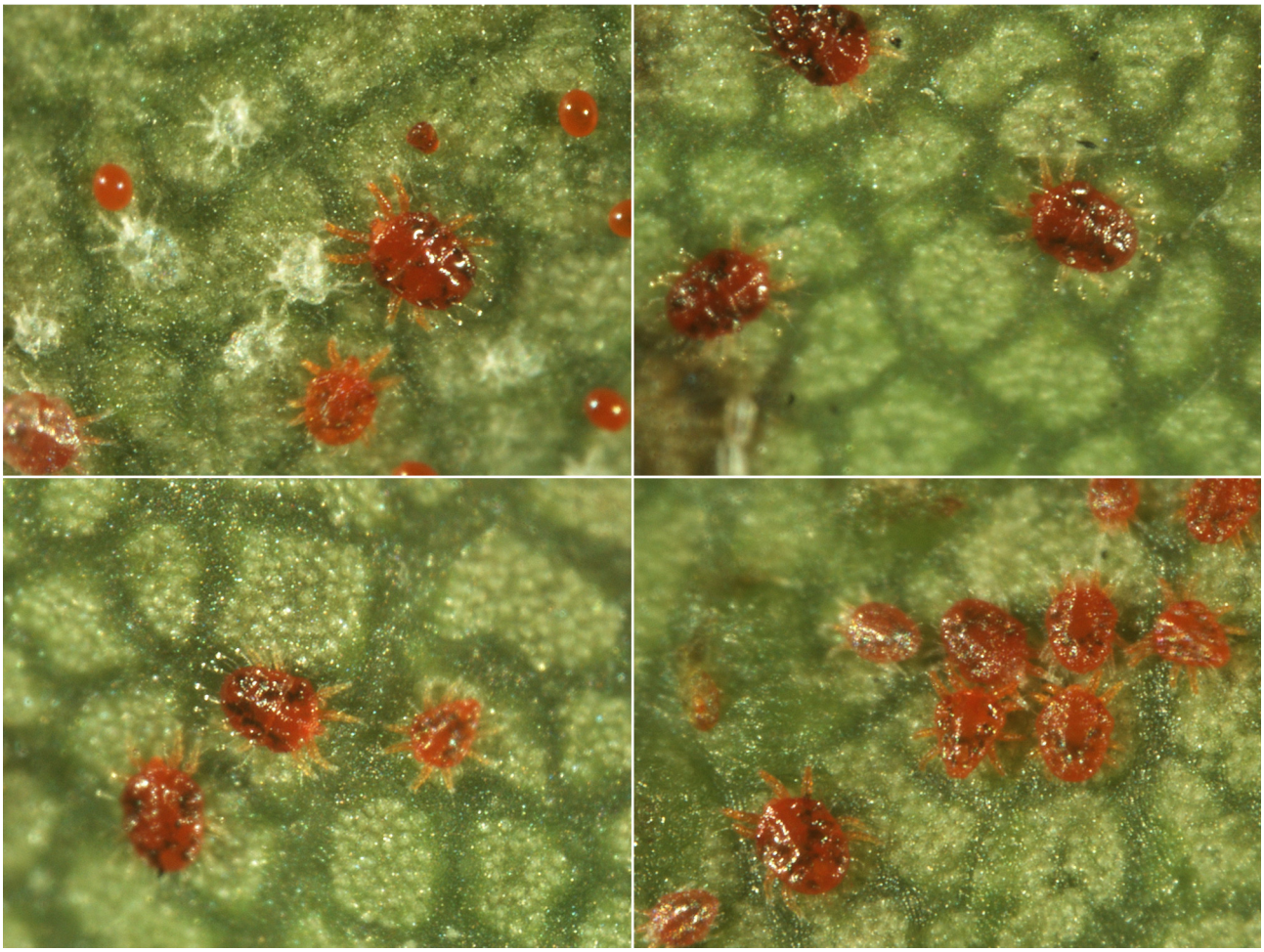


FIGURE 26. *Raoiella australica* Womersley, live individuals (Avalon population): adults, immatures and eggs.



FIGURE 27. *Raoiella australica* Womersley, live individuals (Canberra population), dorsal habitus on host plant: a. female; b. male.



FIGURE 28. *Raoiella australica* Womersley, live individuals (Avalon population): moulting immature with details of droplets on tips of setae, with eggs (note absence of stipe).

Raoiella australica is morphologically similar to *R. marri* from Western Australia and *R. taronga* from Sydney (species 7 and 8 in Dowling *et al.* 2012, respectively). The three species form a clade in Dowling *et al.* (2012). *Raoiella australica* can be separated from *R. marri* by the following: *Ra* (both sexes) setae *d* on femora II–IV and tibiae III–IV with blunt tips vs *Rm* (both sexes) with setae *d* on femora II–IV and tibiae III–IV with tapered tips; *Ra* male prodorsal setae *sc2* < 45 µm vs *Rm* male *sc2* > 45; *Ra* male cuticle between setae *h1–h1* with band of longitudinal striae vs *Rm* male cuticle between setae *h1–h1* with longitudinal striae mixed with rugose or rounded reticulate pattern. *Raoiella australica* can be separated from *R. taronga* by the following: *Ra* (both sexes) setae *c1*, *d1*, *e1* all minute and tapered vs *Rt* (both sexes) setae *c1*, *d1*, *e1* larger, weakly spatulate; *Ra* setae *h2* thicker and blunt tipped vs *Rt* setae *h2* narrow, tapered; *Ra ps2* longer than *ps3* vs *Rt ps2* and *ps3* subequal in length; *Ra* genua I with setae *l'* thin, finely tapered vs *Rt* genua I with setae *l'* thickened; *Ra* male setae *h1* marginally shorter than *h2* vs *Rt* male with setae *h2* obviously longer than *h2*; *Ra* male prodorsal setae *v2* < 30 µm vs *Rt* male *v2* > 40.

***Raoiella bauchani* sp. nov. Beard & Ochoa**
(Figs 29–50)

Material examined. Holotype. ♀. **Australia,** ex. swamp box *Lophostemon suaveolens* (Myrtaceae), Walton Bridge Reserve, Waterworks Road, The Gap, Brisbane, Queensland, 27º26'41"S 152º57'14"E, 16.v.2009, J.J. Beard and R. Ochoa (QMS 108799).

Paratypes. 23 ♀, 10 ♂, 5 deutonymphs, 10 protonymphs, same data as Holotype; 6 larvae, ex. *L. suaveolens* (Myrtaceae), 604 Mt Crosby Road, Anstead, Brisbane, Queensland, 27°32'25"S 152°51'26"E, 07.v.2016, J.J. Beard. (QM, USNM).

Other material examined. **Australia,** 14 ♀, 11 ♂, 7 deutonymphs, 7 protonymphs, 5 larvae, ex. *L. suaveolens* (Myrtaceae), 604 Mt Crosby Road, Anstead, Brisbane, Queensland, 27°32'25"S 152°51'26"E, 07.v.2016, J.J. Beard (QM).

Diagnosis. Opisthosomal setae *e1* minute; *f2* usually subequal in length with *f3*; setae *h1* longer than *h2*. Setae *h2* spatulate, or blunt. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with two setae (*d*, *l′* present; *l″* absent); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft″*) much shorter than solenidion. Dorsal setae on tibiae I–II tapered. Eupathidium on palp tibiotarsus blunt. Larva with setae *h2* short, tapered to blunt.

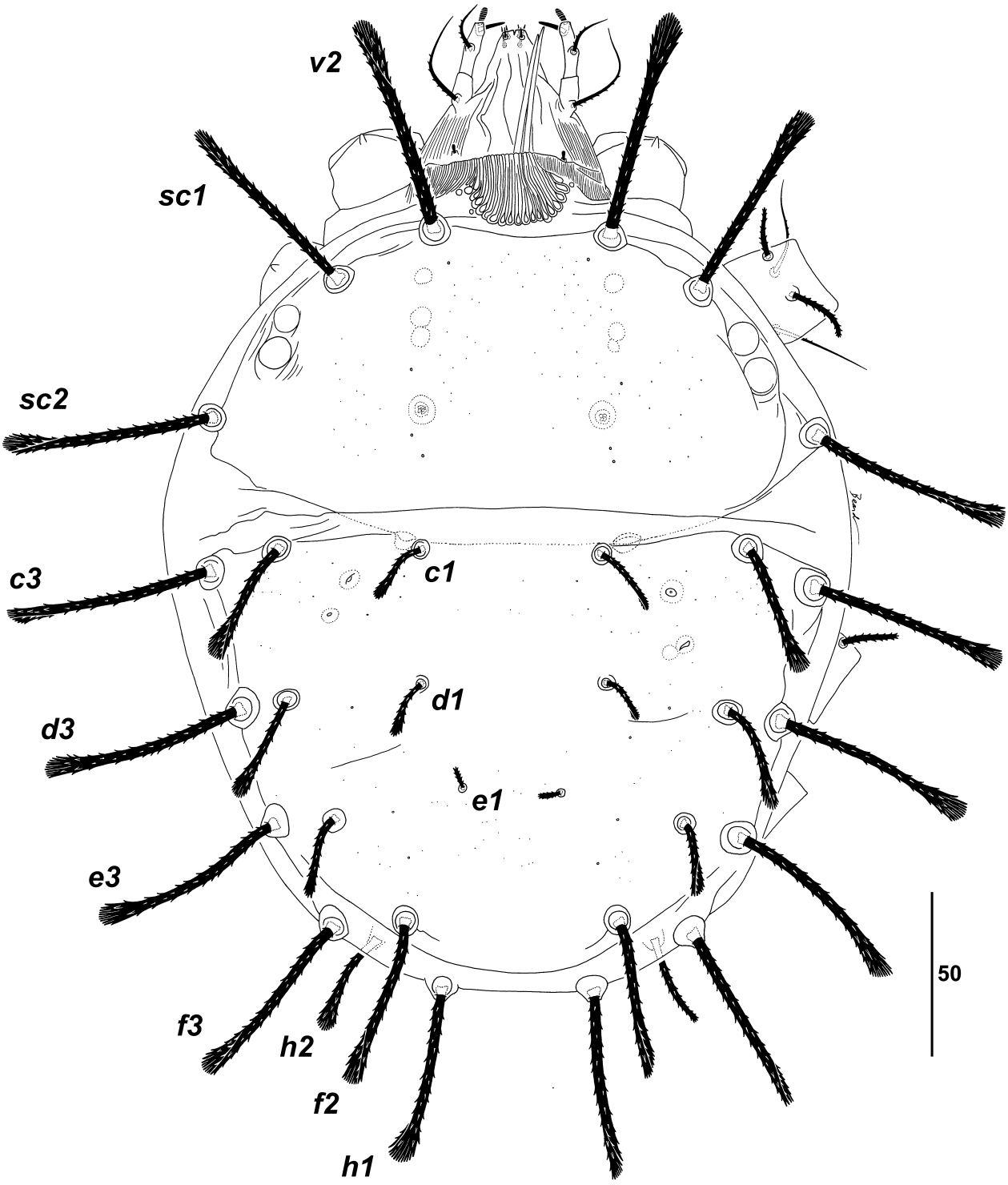


FIGURE 29. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, adult female: dorsal habitus with details of palp.

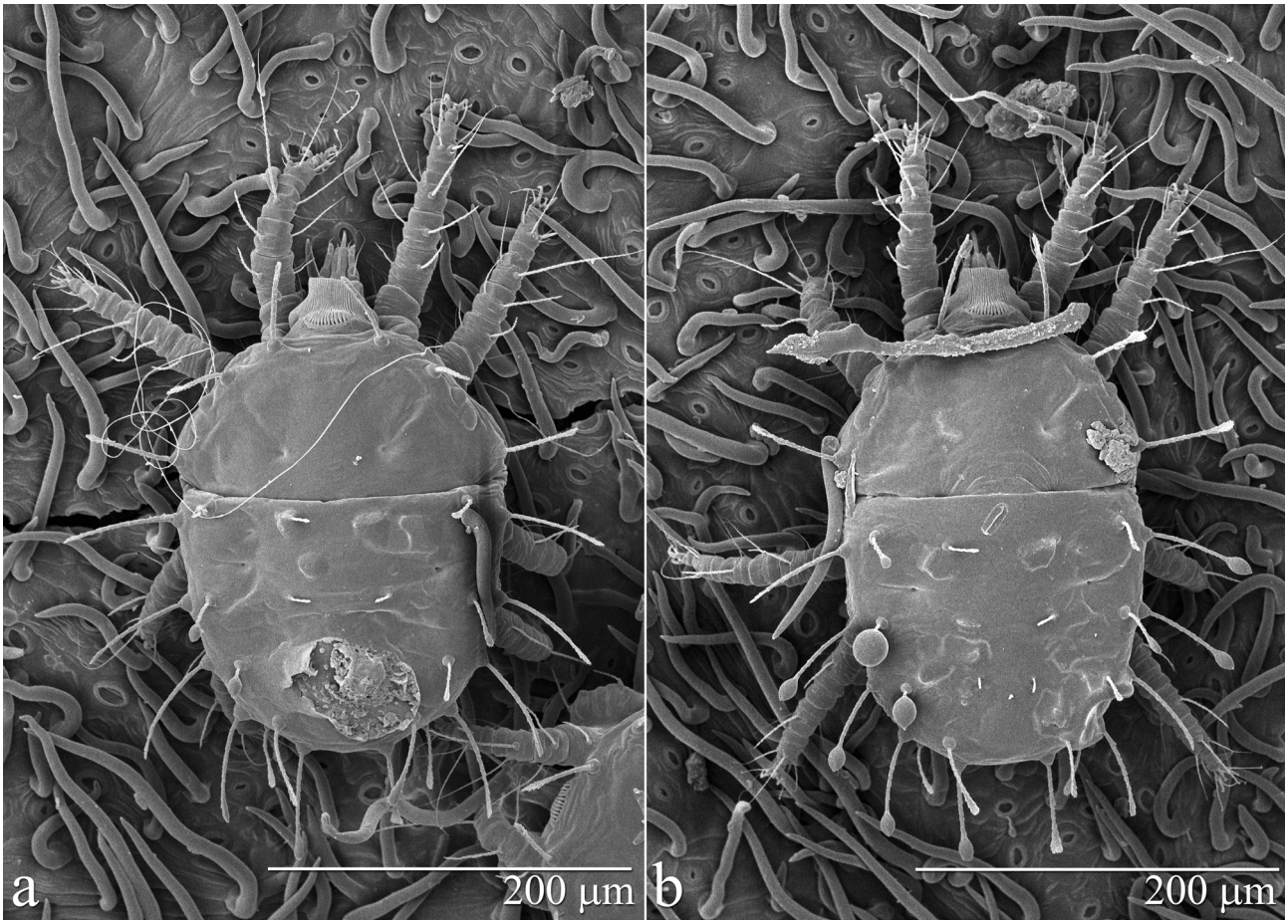


FIGURE 30. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, adult female: dorsal habitus on host plant (two different individuals).

Description. Female. ***Dorsum.*** (Figs 29–31) Body measurements (7): length between setae *v2–h1* 231–258 [237], width between setae *sc2–sc2* 178–192 [183], *c3-c3* 176–191 [185], *f3–f3* 103–117 [103]. Prodorsal and dorsal opisthosomal shields weakly developed, with smooth finely punctate cuticle. Prodorsum with a pair of large pores mesally, pair of large pores on posterior margin (often hidden in fold of sejugal region), and three pairs of minute pores mesally. Dorsal opisthosoma with two pairs of small pores between *c1–d2*, and several minute pores between *d1–d2* and *e1–e2*. Lateral setae (*c3*, *d3*, *e3*) longer than sublateral setae (*c2*, *d2*, *e2*); central setae (*c1* > *d1* > *e1*) shorter than all lateral setae. All dorsal setae, except central setae, barbed along entire length, spatulate. Dorsal setae measurements: *v2* 65–72 [70–72], *sc1* 61–69 [64], *sc2* 60–70 [66], *c1* 19–23 [23], *c2* 32–50 [40–43], *c3* 61–69 [63–66], *d1* 15–21 [17–21], *d2* 28–39 [35–36], *d3* 61–70 [64–66], *e1* 6–11 [7–9], *e2* 24–29 [24–28], *e3* 57–65 [63–65], *f2* 50–60 [50–55], *f3* 57–65 [60–62], *h1* 52–61 [56–60], *h2* 29–41 [29–33].

Palps. (Figs 29, 32a) Palps two-segmented. Palp tibiotarsus elongate (Fig. 32a), 17–20 [17]. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–7) [5] and one narrow blunt eupathidium (8–9) [8] distally, one dorsal seta (15–17) [15]; palp femorogenu with one seta (29–33) [30]. Stylets with 10–14 small lateral teeth distally (Fig. 33).

Venter. (Figs 32b, 34) Cuticle almost completely plicate, covered with mostly transverse striae, except some longitudinal striae between *1b–1b* and laterad genital region, and coxal fields smooth. Setae *g1* and *g2* inserted in more-or-less transverse row on posterior margin of genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *ag*, *g1*, *g2*, *ps2*, *ps3* slightly barbed. Setae *3b*, *4b* absent. Setal measurements: *1a* 86–112 [86–102], *1b* 35–39 [38], *2b* 18–21 [19], *3a* 15–22 [18], *4a* 76–108 [76], *ag* 18–23 [20], *g1* 15–21 [19–20], *g2* 13–17 [16], *ps2* 17–20 [17], *ps3* 11–15 [12].

Spermatheca. (Fig. 32c) An elongate, narrow, weakly convoluted duct. The basal section of the duct broadens slightly towards external opening.

Legs. (Fig. 35) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-9(1), 1-1-4-2-4-9(1), 0-1-2-1-3-5, 0-1-2-

0-3-5 respectively. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 12–14 [12–13]; ta II 11–12 [11]) and two eupathidia *pζ′–pζ″* distally (ta I 13–15 [15], 13–15 [14]; ta II 12–14 [14], 12–14 [14]). Short, smooth companion seta *ft″* on tarsus I 6–9 [7–8] and tarsus II 6–8 [7], inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta thick, tapered, but not finely tapered. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″* present; *l′* added in adult, delayed from deutonymph); genua I–II with two setae (*d*, *l′*). Claw I 15–16 [15] long.

Male. *Dorsum.* (Figs 36a, 37) Body measurements (4): length between setae *v2–h1* 182–191, width between setae *sc2–sc2* 135–145, *c3–c3* 135–140, *f3–f3* 67–70. Prodorsum smooth with a few scattered punctations posteriorly and a pore on the posterior margin (often hidden in fold of sejugal region). Dorsal opisthosoma mostly smooth, with some transverse striae between setae *d1* and *e1*; with pair large slit pores just anterior to *d1–d2*; dorsal cuticle posterior to *h1–h1* with band of fine transverse striae. All dorsal setae barbed along entire length; most dorsal setae spatulate to weakly spatulate, except *v2* tapered to blunt; central opisthosomal setae *c1*, *d1*, *e1* blunt; setae *f2*, *h1*, *h2* weakly spatulate. Dorsal setae measurements: *v2* 24–28, *sc1* 40–50, *sc2* 44–54, *c1* 20–28, *c2* 25–34, *c3* 48–55, *d1* 16–21, *d2* 26–36, *d3* 48–56, *e1* 7–11, *e2* 18–24, *e3* 49–54, *f2* 15–23, *f3* 45–52, *h1* 28–33, *h2* 31–34.

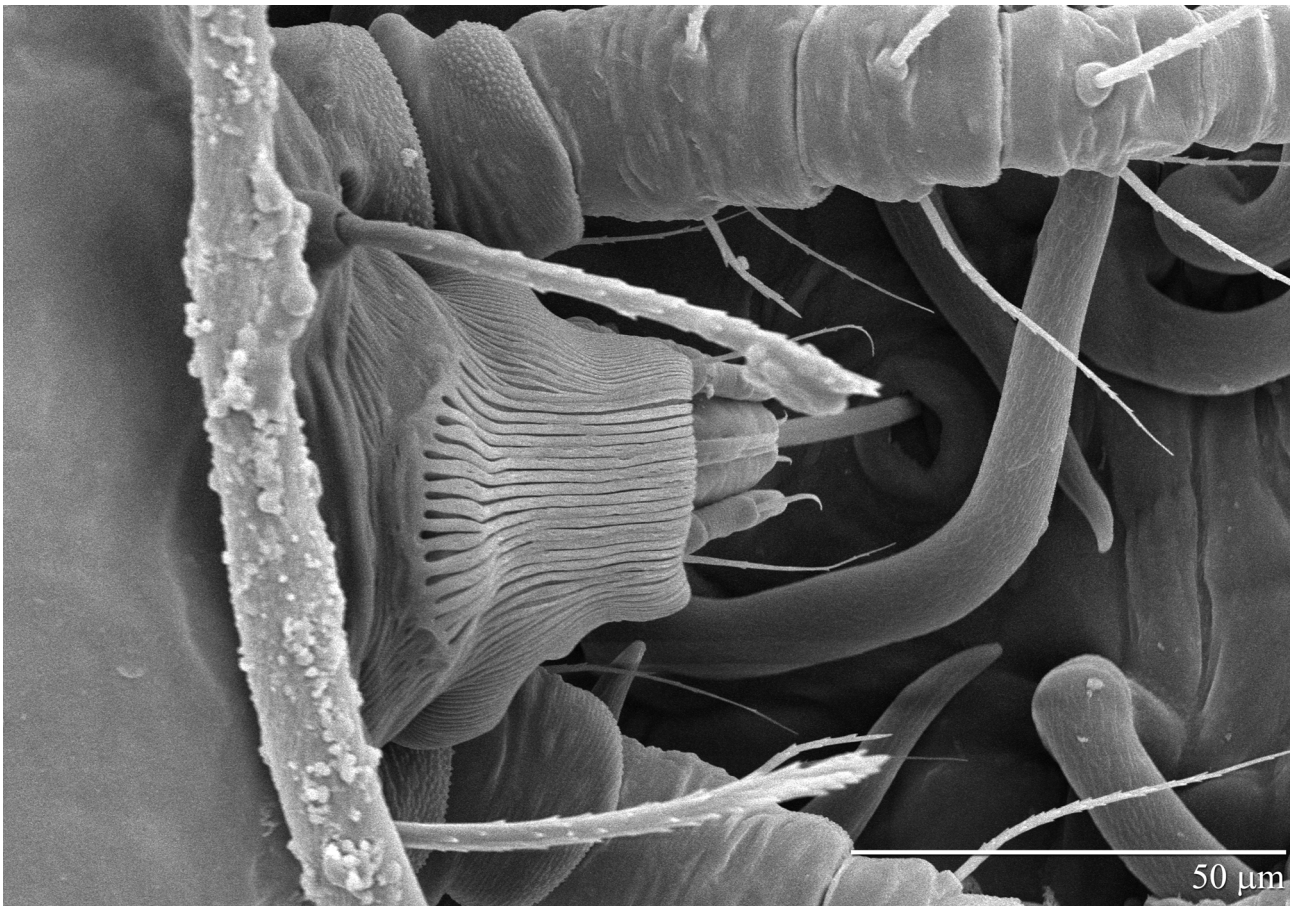


FIGURE 31. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, adult female: feeding via a stomatal opening of host plant.

Palps. (Fig. 36b) Palps two-segmented. Palp tibiotarsus elongate, 13–15. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6) and one narrow blunt eupathidium (8) distally, one dorsal seta (12–14); palp femorogenu with one seta (18–22).

Venter. (Fig. 36c) Ventral cuticle almost completely plicate, covered in mostly transverse striae; widely spaced striae posterior to *4a–4a*; coxal fields smooth. Setae *3b*, *4b* absent. Setae *ag*, *g1*, *g2*, *ps2* smooth to weakly barbed. Setae *ps3* modified into accessory genital stylets as thickened curved spines. Setal measurements: *1a* 60–108, *1b* 24–31, *2b* 14–19, *3a* 12–14, *4a* 57–87, *ag* 15–20, *g1* 12–14, *g2* 12–14, *ps2* 14–16, *ps3* 19–22.

Aedeagus. Aedeagus narrow, elongate and sclerotised (71–75), tapering to a blunt point distally (towards genital opening).

Legs. (Fig. 38) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-10(2), 1-1-4-2-4-10(2), 0-1-2-1-3-5, 0-1-

2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial ω' 5–6, abaxial ω'' 10–11; ta II adaxial ω' 6, abaxial ω'' 10–11), and two eupathidia $p\zeta'$–$p\zeta''$ distally (ta I 11–12, 11–12; ta II 11, 11). Short smooth companion seta *ft″* on tarsus I 5–7 and tarsus II 5–7, inserted adjacent to solenidion ω''. Tibiae I–II with dorsal seta finely tapered. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″* present; *l′* added in adult delayed from deutonymph); genua I–II with two setae (*d*, *l′*). Claw I 13–15 long.

Deutonymph (female, with male measurement in parentheses). ***Dorsum.*** (Fig. 39) Sexually dimorphic. Body measurements (3 female, 1 male): length between setae *v2–h1* female 188–203 (male 150), *v2–f2* 178–195 (136), width between setae *sc2–sc2* 145–164 (134), *c3–c3* 156–169 (143), *f2–f2* 34–47 (43), *f3–f3* 58–73 (58). Prodorsal cuticle smooth. Dorsal opisthosoma with widely spaced transverse striations between *c1–e1*; no pores visible. Lateral setae (*c3*, *d3*, *e3*, *f3*) shorter than sublateral setae (*c2*, *d2*, *e2*, *f2*). Dorsal setae with spatulate tips, barbed along entire length; setae *f3, h1*, *h2* weakly spatulate, barbed, often inserted ventrally. Dorsal setae measurements: *v2* 60–65 (48), *sc1* 64–70 (50–57), *sc2* 51–57 (44–47), *c1* 42–53 (42), *c2* 61–65 (47–52), *c3* 47–54 (41–43), *d1* 42–49 (31–38), *d2* 58–66 (45–47), *d3* 43–50 (40–42), *e1* 13–25 (14–15), *e2* 49–62 (38–42), *e3* 34–43 (33–35), *f2* 51–59 (42–43), *f3* 29–38 (30–32), *h1* 30–36 (25–27), *h2* 20–22 (18–21).

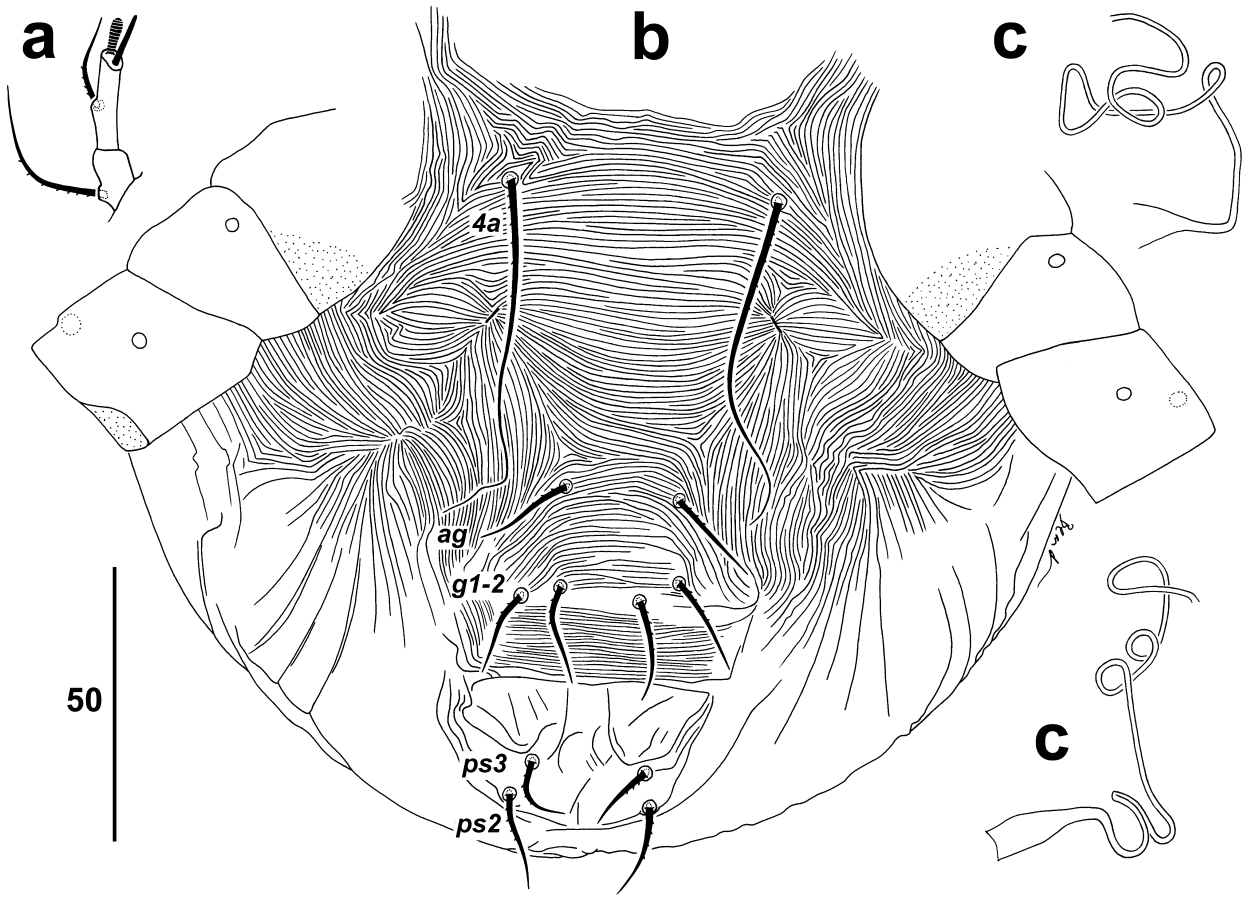


FIGURE 32. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, adult female: a. detail of palp; b. posterior venter; c. spermatheca.

Palps. Palps two-segmented. Palp tibiotarsus elongate, 15–16 (12). Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5) (4–5) and one narrow, blunt eupathidium (8) (7) distally, one dorsal seta (12–14) (11–12); palp femorogenu with one seta (25–28) (22).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae; longitudinal striae between *1b–1a*, transverse striae *1a–g1*, with longitudinal striae laterad genital region. Seta *1a* elongate, fine (difficult to determine full length). Setae *ag*, *g1*, *ps2*, *ps3* weakly barbed. Setal measurements: *1a* 58–87, *1b* 23–26, *3a* 10–14, *4a* 38–61, *ag* 12–15, *g1* 9–13, *ps2* 10–11 (11), *ps3* 9–10 (11).

Legs. (Fig. 40) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 9–10; ta II 8–9) and two eupathidia distally (ta I

10–11, 10–11; ta II 10–11, 10–11). Short smooth companion seta *ft″* on tarsus I 4–7 and tarsus II 5–7, adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; seta *l′* absent (*l′* normally added in deutonymph); genua I–II with two setae (*d*, *l′* present; *d* added in deutonymph). Claw I 13 (12).

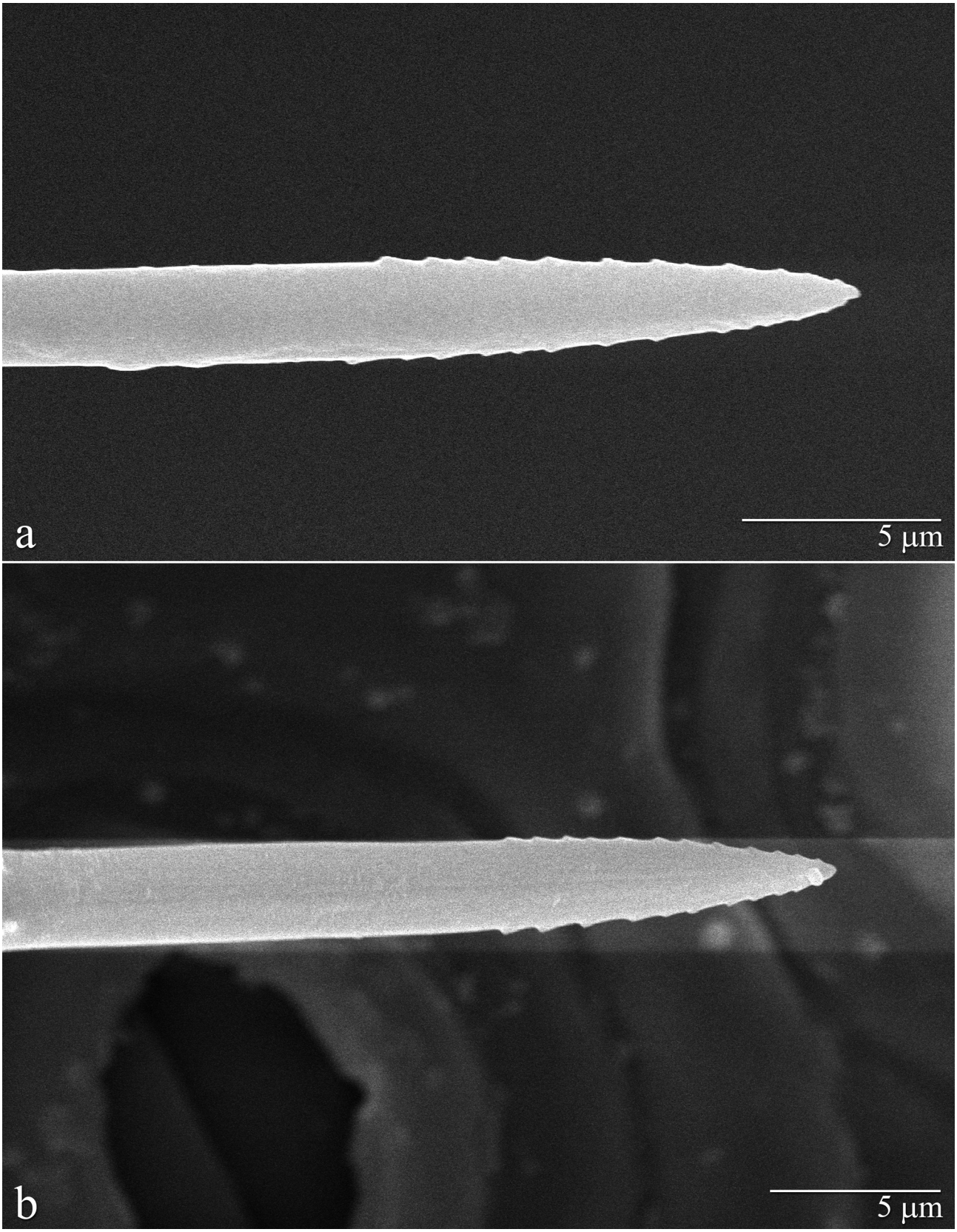


FIGURE 33. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, dorsal view of joined stylets, detail of stylet tip with lateral serrations (two different individuals).

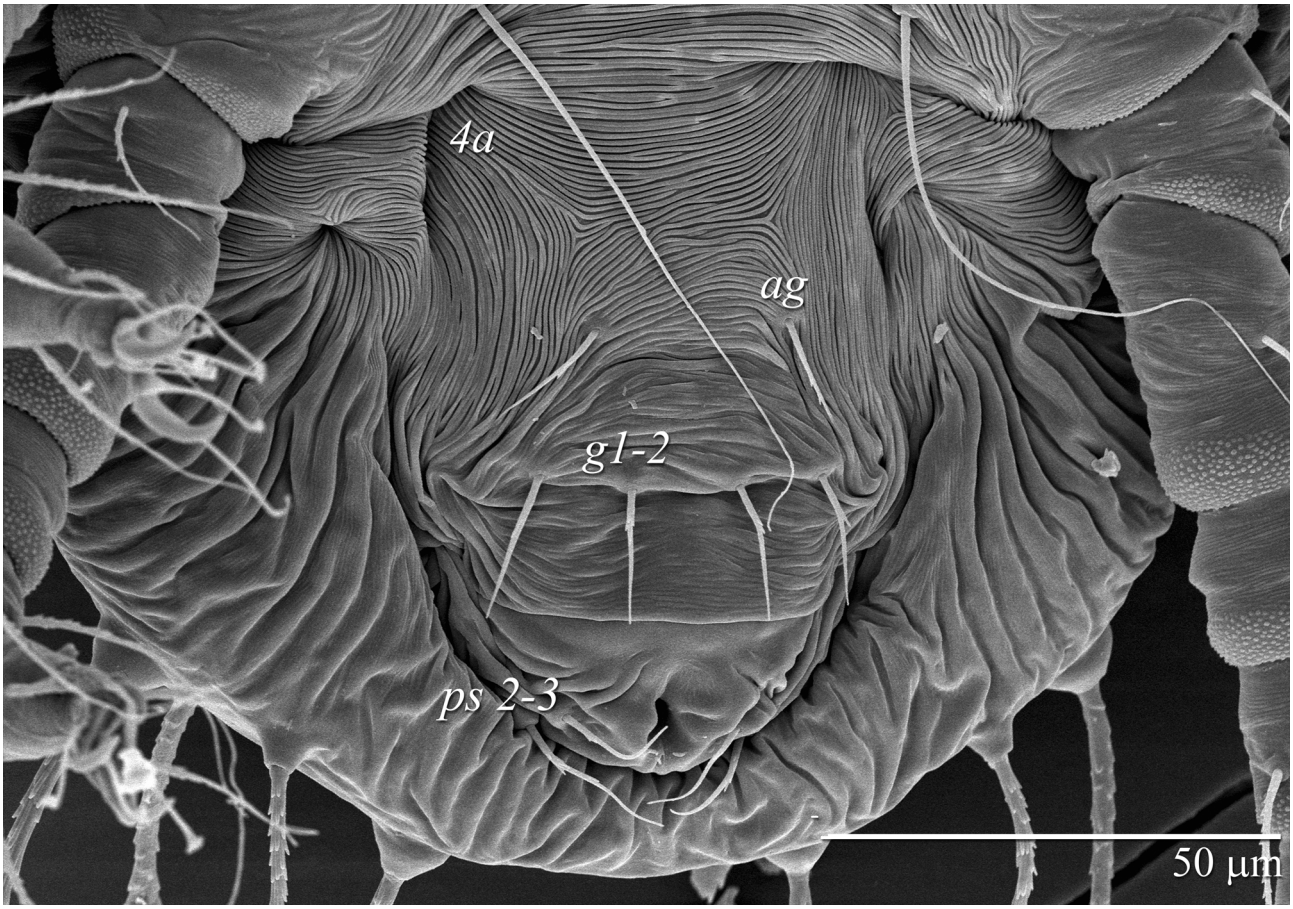


FIGURE 34. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, adult female: posterior venter (note weakly barbed setae *ag*, *g1–2*, *ps2–3*).

Protonymph. *Dorsum.* (Fig. 41) Body measurements (3): length between setae *v2–f2* 165–171, width between setae *sc2–sc2* 138–140, *c3–c3* 148–154, *f2–f2* 26–30, *f3–f3* 42–50. Prodorsum with well developed shield, wrinkled, with weak longitudinal to oblique striae. Dorsal opisthosoma with widely spaced transverse striae between *c1–e1*. Dorsal setae spatulate, barbed along entire length; setae *f3* weakly spatulate inserted ventrolaterally; setae *h1*, *h2* weakly spatulate, barbed, inserted ventrally. Lateral setae (*c3*, *d3*, *e3*, *f3*) shorter than sublateral setae (*c2*, *d2*, *e2*, *f2*). Dorsal setae measurements: *v2* 48–51, *sc1* 56–61, *sc2* 35–38, *c1* 38–44, *c2* 51–56, *c3* 26–34, *d1* 38–40, *d2* 47–50, *d3* 22–28, *e1* 22–30, *e2* 37–42, *e3* 18–20, *f2* 32–34, *f3* 14–16, *h1* 14–16, *h2* 10–13.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–5) and one narrow, blunt eupathidium (7–8) distally, one dorsal seta (11–12); palp femorogenu with one seta (19–22).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, longitudinal striae between *1b–1a*, transverse *1a–ag*, oblique *ag–ps2*, longitudinal striae laterad *ps* setae; coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 48–64, *1b* 18–22, *3a* 8–10, *ag* 8–9, *ps2* 7–8, *ps3* 7–8.

Legs. (Fig. 42) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 7–8; ta II 6–7) and two eupathidia distally (ta I 8–9, 8–9; ta II 8–9, 8–9). Smooth companion seta *ft″* on tarsus I 3–5 and tarsus II 4–5, adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta, *d*, tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; seta *l′* absent); genua I–II with one seta (*l′* present; *d* absent). Claw I 11–12 long.

Larva. *Dorsum.* (Fig. 43) Body measurements (6): length between setae *v2–f2* 131–145, width between setae *sc2–sc2* 108–117, *c3–c3* 118–132, *f3–f3* 25–31. Prodorsum with weak longitudinal striations. Opisthosoma with weak transverse striae between setae *c1–d1*; lateral setae *c3*, *d3*, *e3*, *f3* obviously shorter than other setae, weakly spatulate to blunt, barbed; setae *f3*, *h1*, *h2* short, tapered to blunt, barbed, *h1* slightly thicker than *h2*, *f3*; setae *f2* inserted posterolaterally; setae *f3*, *h1*, *h2* inserted ventrally. Dorsal setae measurements: *v2* 33–38, *sc1* 44–49, *sc2*

19–26, *c1* 27–33, *c2* 29–36, *c3* 17–21, *d1* 26–32, *d2* 22–28, *d3* 13–16, *e1* 21–26, *e2* 16–23, *e3* 10–12, *f2* 14–18, *f3* 7–10, *h1* 8–13, *h2* 8–10.

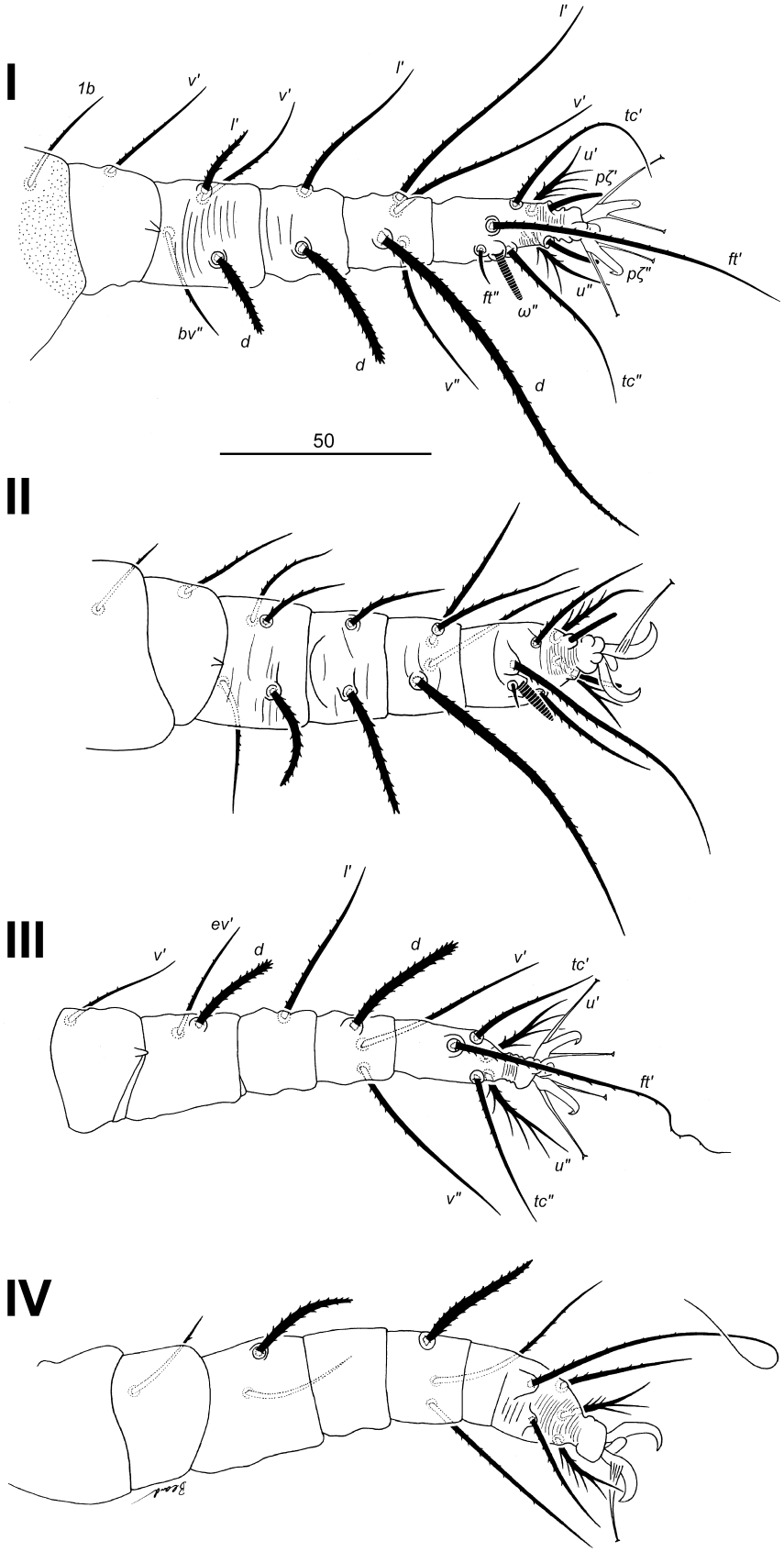


FIGURE 35. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, adult female: legs I–IV (right side; legs I–II dorsal aspect, legs III–IV abaxial aspect).

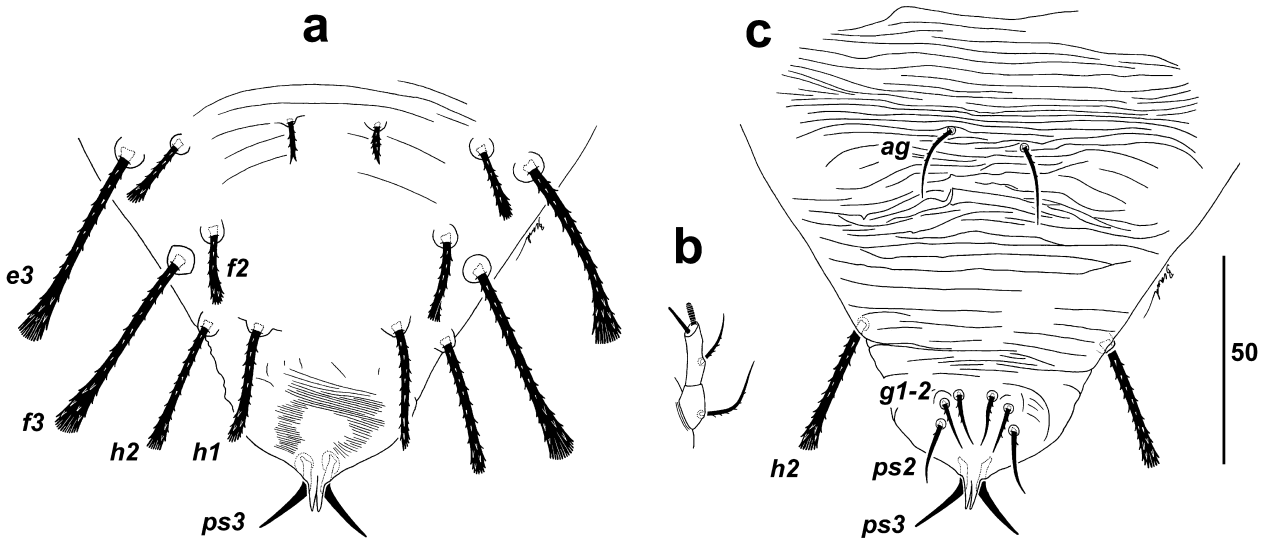


FIGURE 36. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, adult male: a. posterior dorsal opisthosoma, with detail of setae *ps3*; b. detail of palp; c. posterior venter (same individual as 36a.).

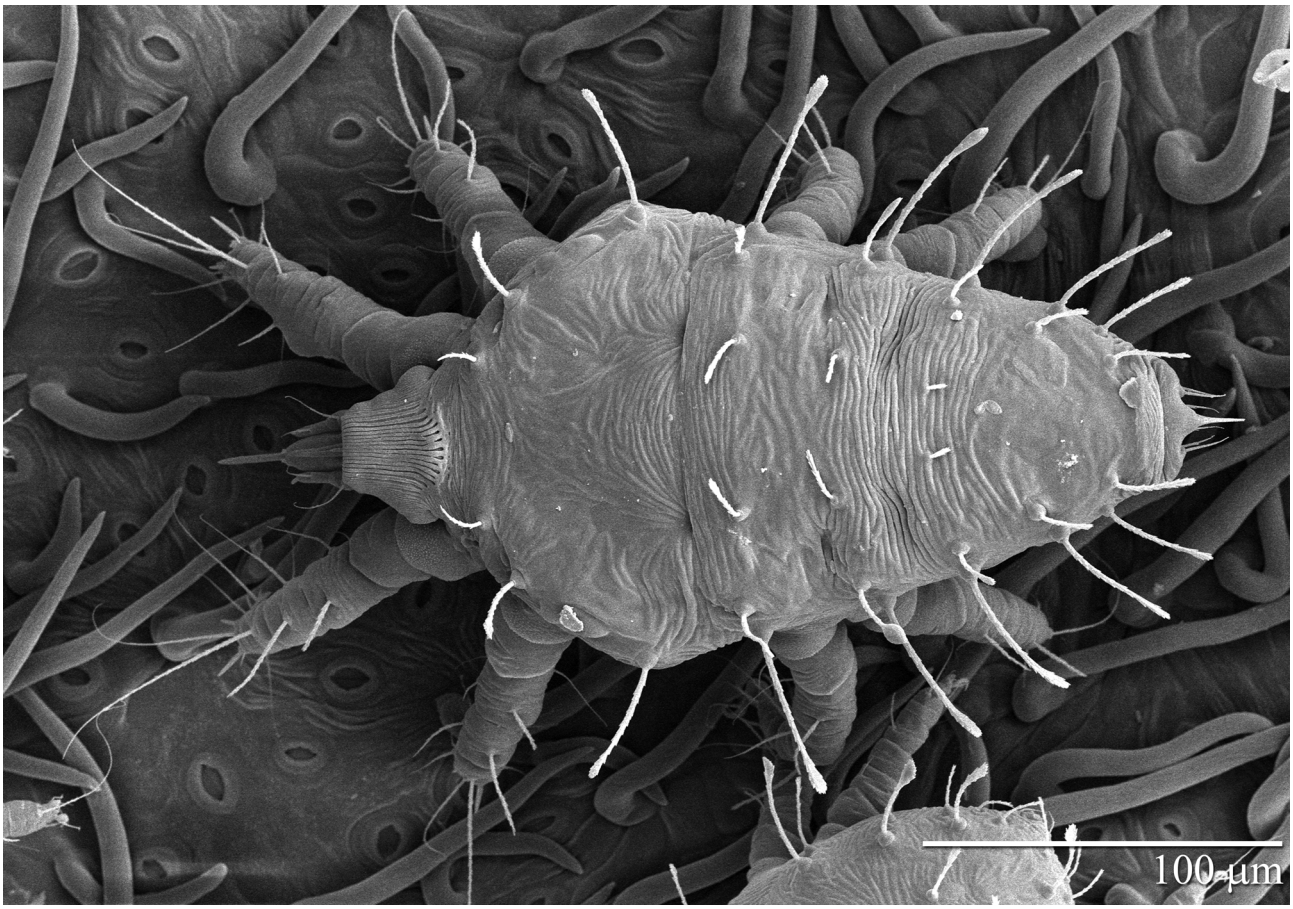


FIGURE 37. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, adult male: dorsal habitus on host plant.

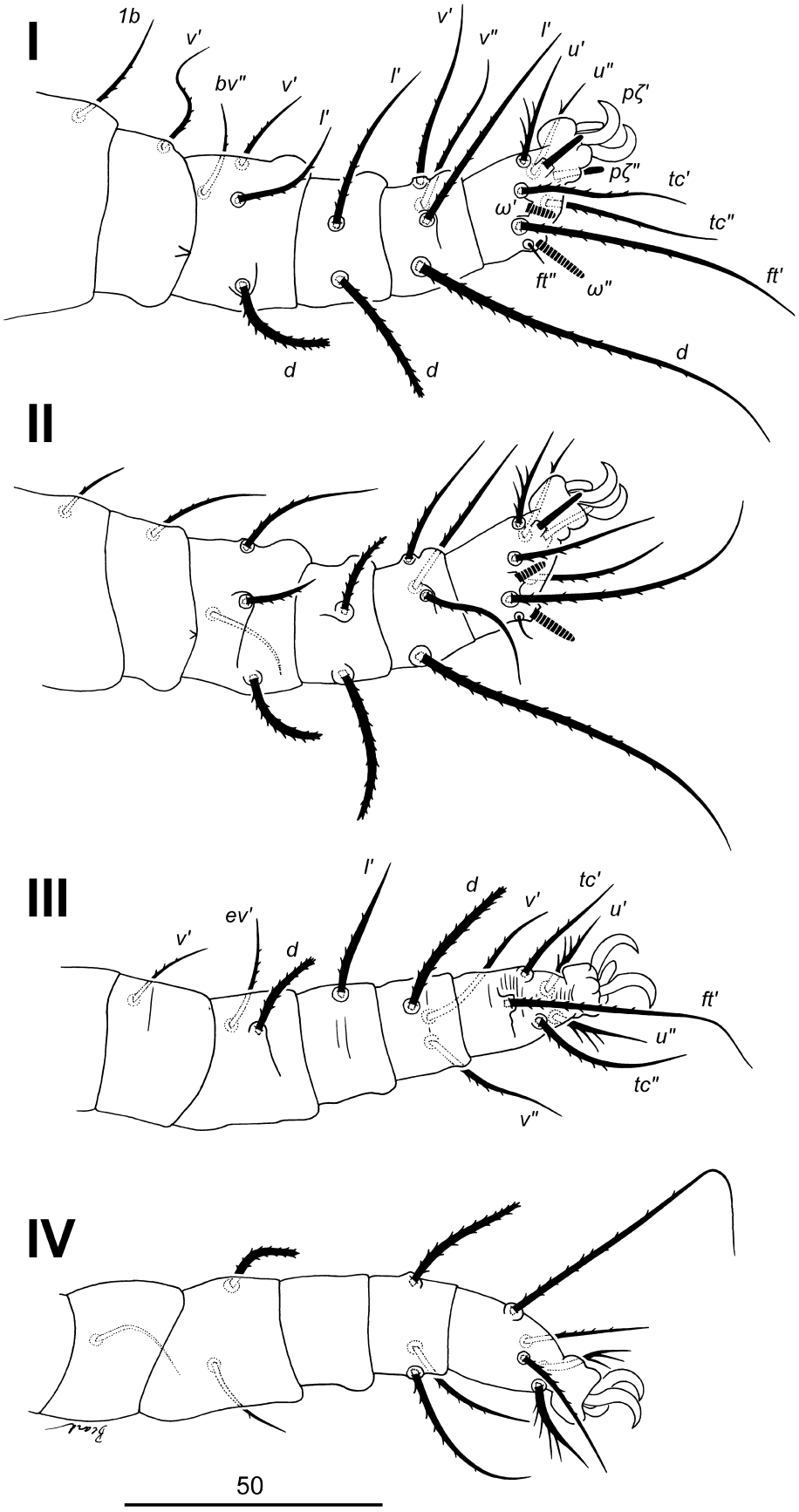


FIGURE 38. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, adult male: legs I–IV (right side; legs I–II dorsal to adaxial aspect, leg III dorsal aspect, leg IV abaxial aspect).

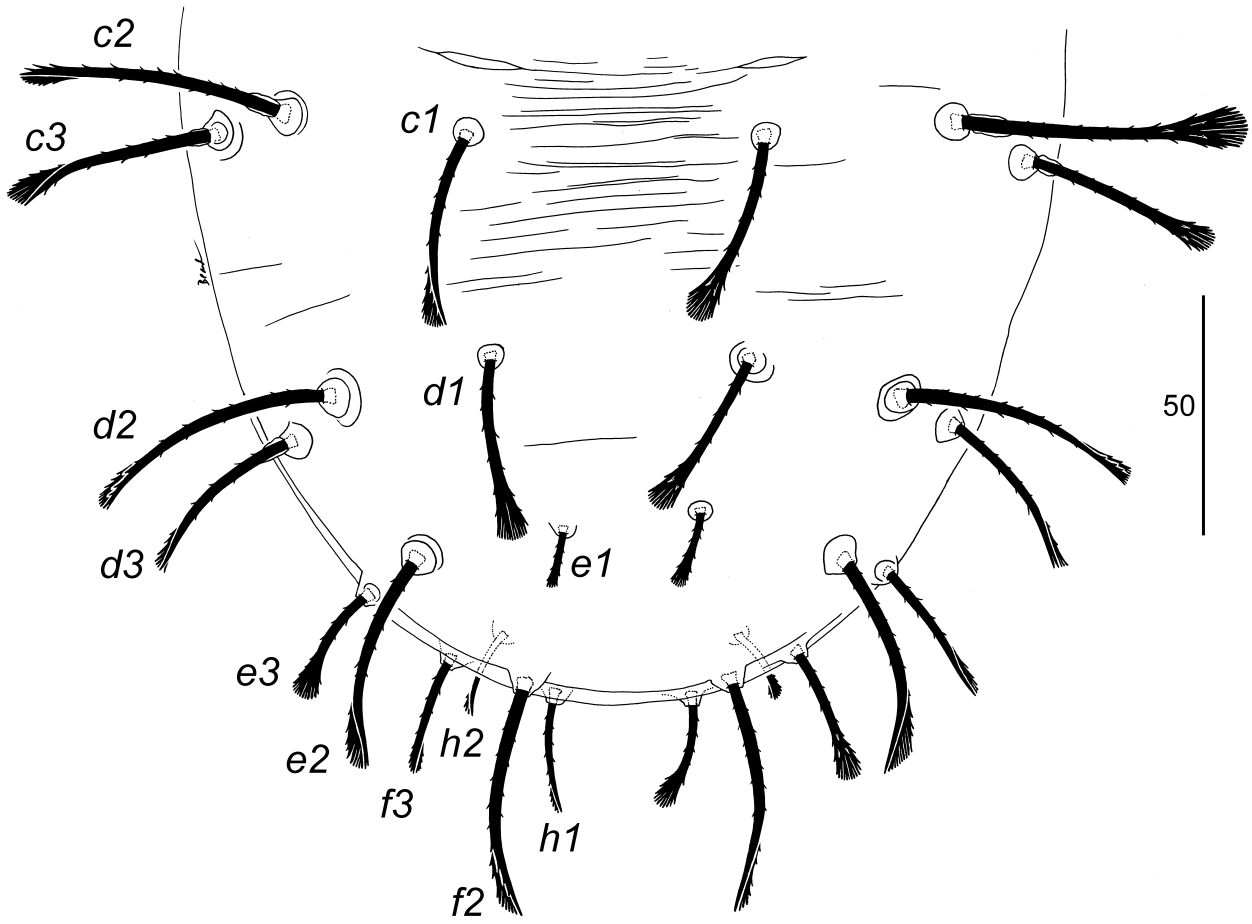


FIGURE 39. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, deutonymph: dorsal opisthosoma.

Palps. (Fig. 43) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (3–4) and one tapered eupathidium (7–9) distally, and one seta dorsally (7–9); palp femorogenu with one seta (10–14).

Venter. (Fig. 44) Cuticle almost completely plicate, except coxal fields smooth; striae transverse *1b–1b*, striae longitudinal *1b–1a*, striae transverse *1a–3a*; just posterior to *3a* with small patch of longitudinal striae followed by a small diamond of transverse striae (Fig. 44) (see also Figs 23, 56, 70, 100, 115b, 129a, 146, 161b, 178, 191b, 238, 268); with longitudinal and oblique striae surrounding *ps* setae. Setal measurements: *1a* 29–39, *1b* 10–15, *3a* 5–14, *ps2* 4–6, *ps3* 4–5.

Legs. (Fig. 45) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Genua I–II with one seta (*l′*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 5–6; ta II 4-6) and two eupathidia *pζ′–pζ″* distally (ta I 7–8, 7–8; ta II 6–8, 7–8). Companion seta *ft″* on tarsus I 3–5 and tarsus II 4–5, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta long, finely tapered, barbed. Claws I and III both 9; tenent hairs on claws with three attachment points.

Egg. (Figs 46, 47, 49, 50) Red, ellipsoid in shape to slightly globose, 110–115 long 70–75 wide, often with multiple fine longitudinal bands on surface (Fig. 46), and a distal stipe approximately 120–140 long.

Host. Swamp box, *Lophostemon suaveolens* (Myrtaceae).

Distribution. AUSTRALIA: Brisbane, Queensland.

Etymology. This species is named in honour of Dr Gary R. Bauchan, our collaborator, co-author and LTSEM specialist, for his dedication and continued contributions to our acarological research.

Remarks. *Raoiella bauchani* **sp. nov.** was mistakenly listed as *R. australica* (DNA code RaIn47) in Dowling *et al.* (2012; Table 1 and Figs 1, 2), and was listed as *Raoiella* sp. 13 in Beard *et al*. (2013).

The three species *Raoiella bauchani*, *R. goyderi* and *R. pooleyi*, all belong to the *R. bauchani* species group, and are hence all morphologically similar to each other, but can be separated by the following: *Rb* setae *f2* subequal in length to *f3*, *Rp* and *Rg* setae *f2* shorter than *f3*; *Rb* palp tibiotarsus elongate, *Rp* and *Rg* with palp segments of regular length; *Rb* with dorsal setae *c1* > *d1* > *e1*, *Rp* with setae *c1*, *d1*, *e1* minute, *Rg* with setae *c1*, *d1*, *e1* short.

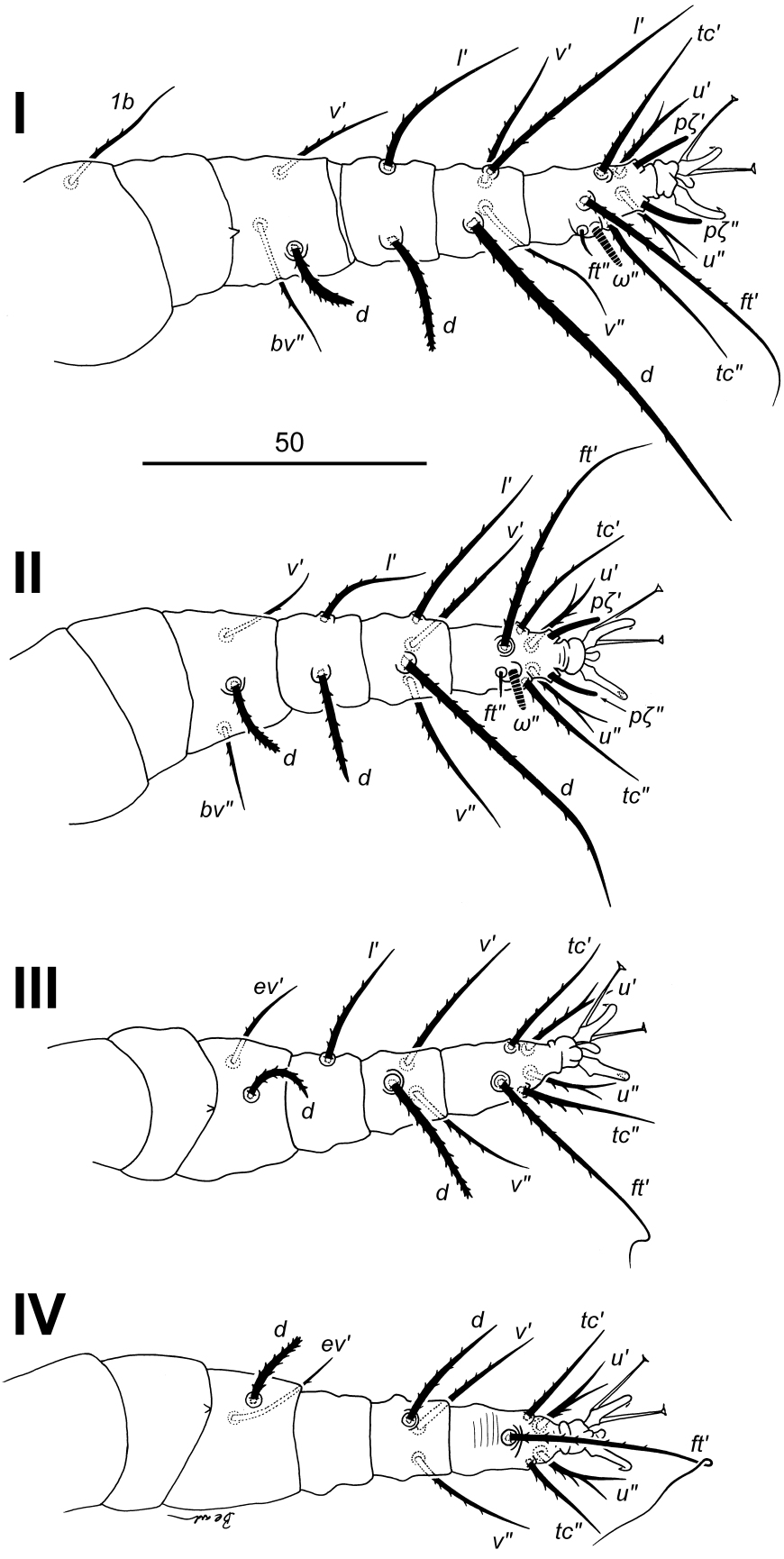


FIGURE 40. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, deutonymph: legs I–IV (right side, dorsal aspect).

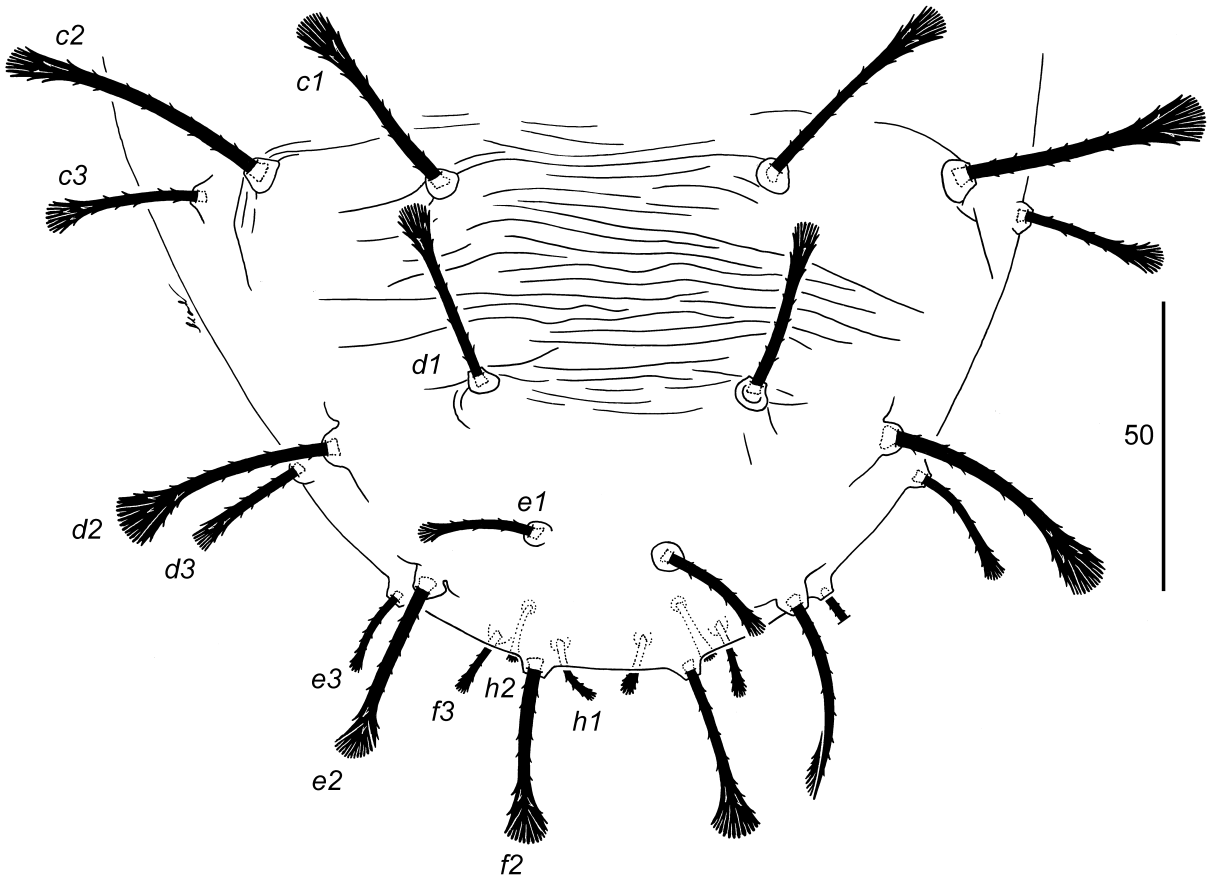


FIGURE 41. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, protonymph: dorsal opisthosoma.

Raoiella bauchani has clear (Fig. 47) to orange-tinted (Fig. 48) droplets at the tips of the dorsal setae. Feeding by this mite causes the host leaves to turn from the normal olive green to a characteristic dark purple. Mites lay their eggs in large clusters (Fig. 50), and form small populations on the underside of the host leaves.

Beard and Ochoa collected a new species of thrips, *Scolothrips ochoa* Mound, Tree & Goldarazena (Thysanoptera: Thripidae), feeding on *R. bauchani* at the type locality which was described in Mound *et al.* (2010) (Figs 49, 50).

Raoiella calgoa sp. nov. Beard & Ochoa

(Figs 51–56)

Material examined. Holotype. ♀. **Australia**, Queensland, ex. leaves of silver-leaved ironbark *Eucalyptus melanophloia* F. Muell. (Myrtaceae), Calgoa Creek, Calgoa, 25°51’23”S 152°17’59”E, 02.viii.2005, (QM: UQIC 89523).

Paratypes. 9 ♀, pharate ♀, ♂, 9 deutonymphs, 7 protonymphs, 6 larvae, same data as holotype (QM; UQIC 89543); ♀, same data as holotype, except 30.viii.2004; 3 ♀, same data as holotype except 18.ix.2006; 3 ♀, 5 ♂, 4 deutonymphs, 3 protonymphs, 2 larvae, ex. leaves of *E. melanophloia*, “Nora Creina”, 1.5km NNE Didcot, Queensland, 25°27’S 151°53’E, 17.ix.2006, J.J. Beard (QM).

Other material examined. **Australia,** 12 ♀, 9 ♂, 5 deutonymphs, 5 protonymphs, 10 larvae, ex. leaves of *E. melanophloia*, Milo Station, NNW of Adavale, 100 km NNE of Quilpie, Queensland, 25°36’13”S 144°24’41”E, 07.viii.2009, J.J. Beard & P.I Forster (BRI voucher PIF35677); 7 ♀, 5 ♂, protonymph, larva, 65 km south of Hebel along Castlereagh Highway, Queensland, at Queensland-New South Wales border, 28°35’33”S 148°24’53”E, 06.v.2007, ex. *E. melanophloia*, J.J. Beard (QM) (BRI voucher PIF32484).

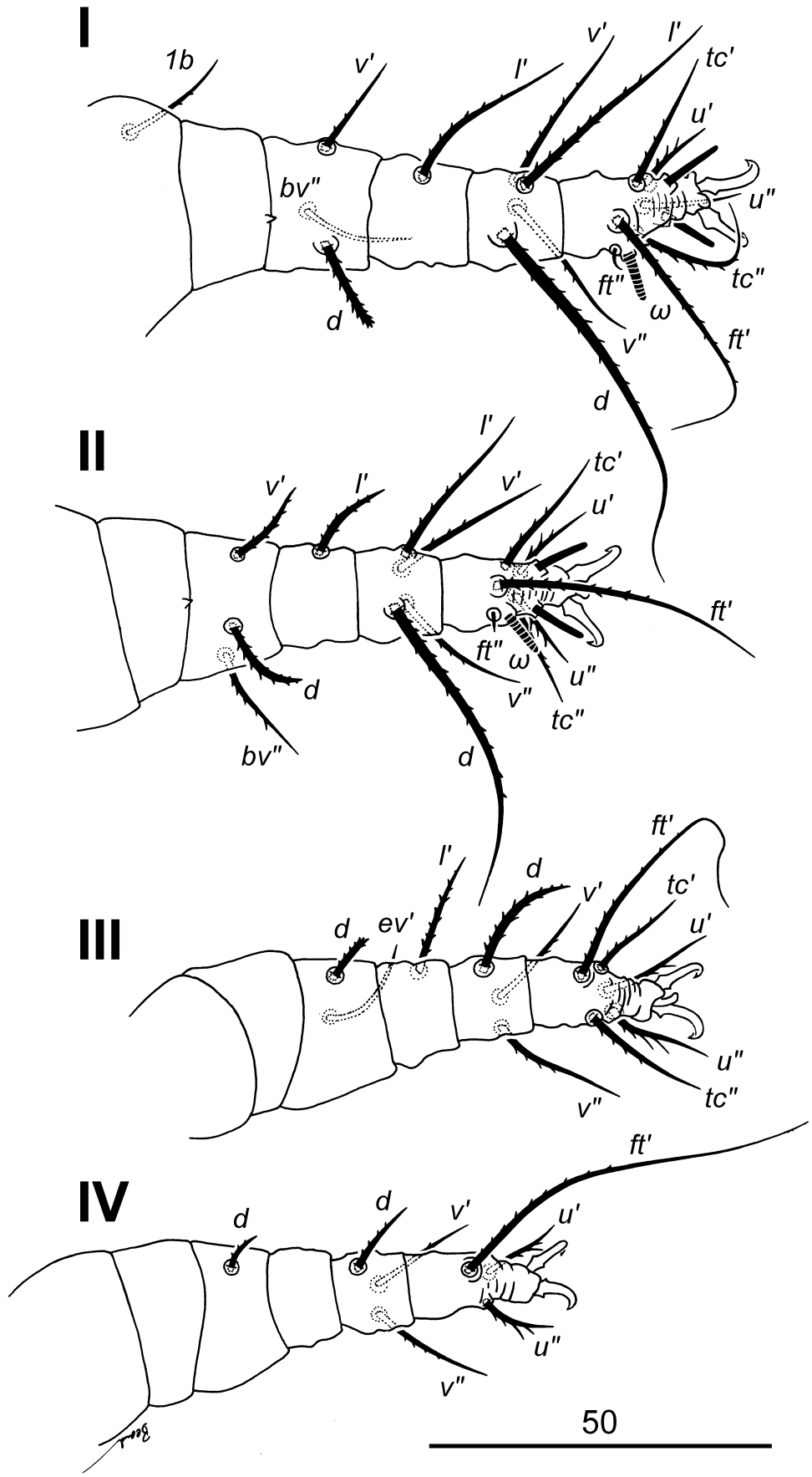


FIGURE 42. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, protonymph: legs I–IV (right side, dorsal aspect).

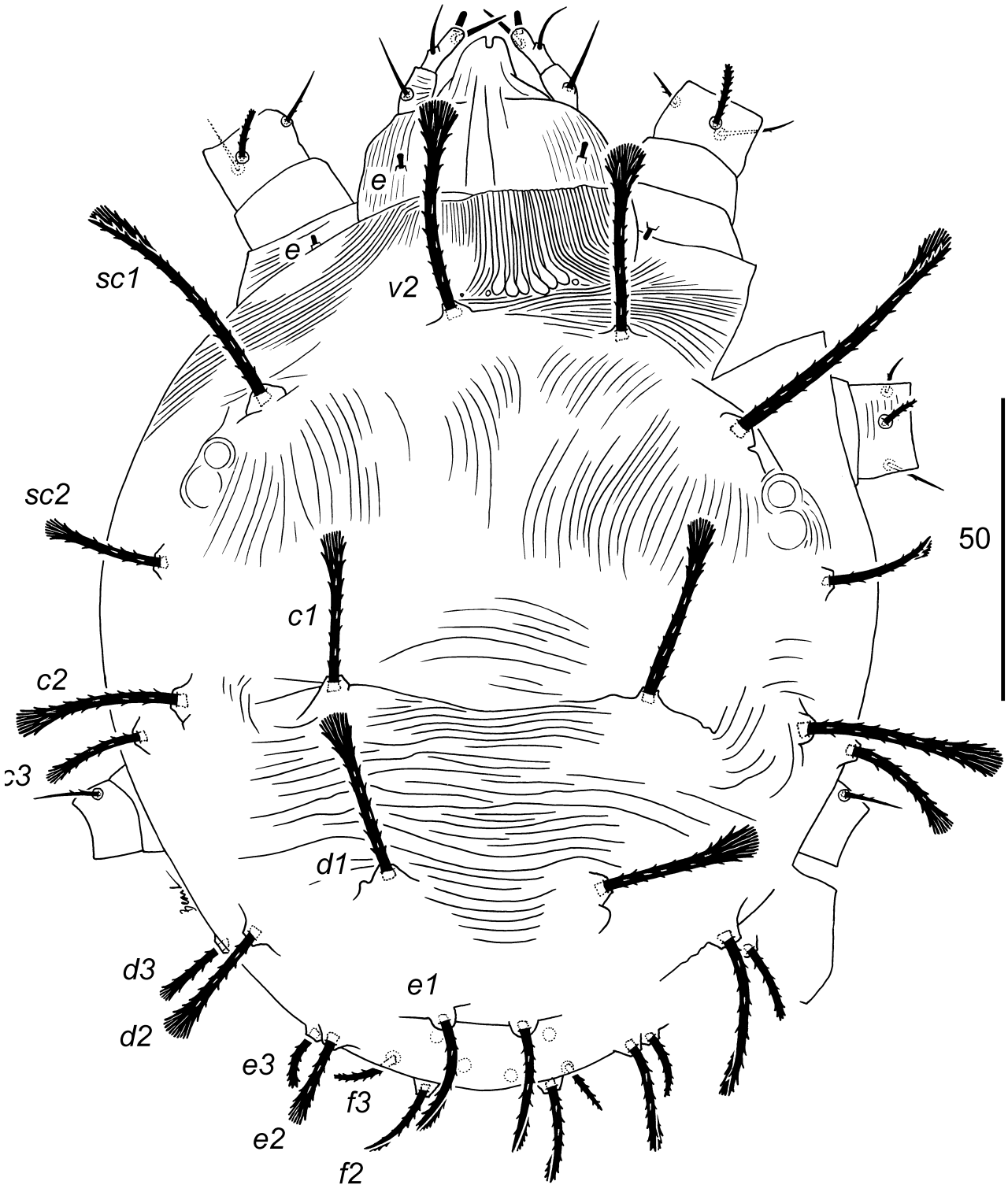


FIGURE 43. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, larva: dorsal habitus, with detail of palp.

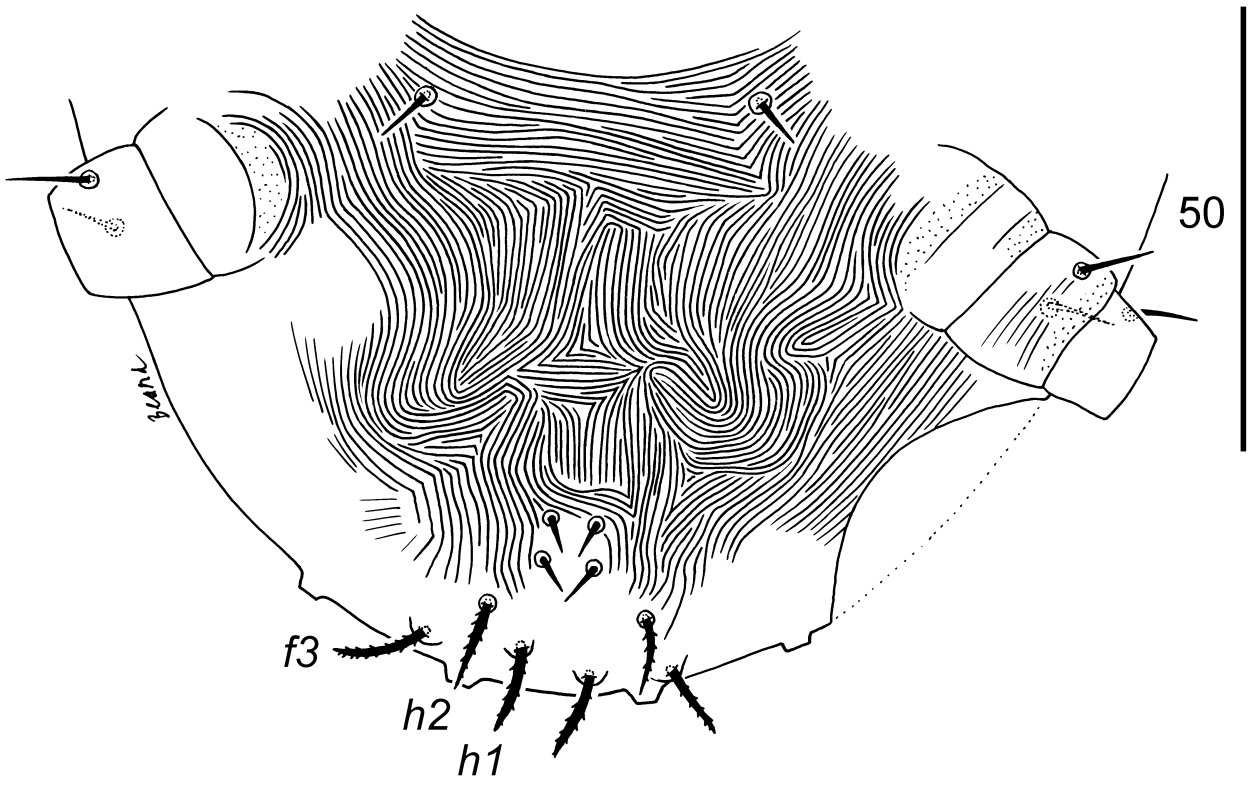


FIGURE 44. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, larva: posterior venter (same specimen as Fig. 43).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* spatulate. Adult femora I with four setae (*d*, *l'*, *v'*, *bv"*), femora II with three setae (*d*, *v'*, *bv"* present; *l'* absent); genua I–II with three seta (*d*, *l'*, *l"*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft"*) longer than solenidion. Dorsal setae *d* on tibiae I–II thick, spatulate in female; dorsal setae *d* finely tapered on tibia I and thick to blunt tipped in male. Eupathidium on palp tibiotarsus finely tapered. Larva with setae *h2* elongate, filiform.

Description. Female. ***Dorsum.*** (Fig. 51) Body measurements (11): length between setae *v2–h1* 221–262 [258], width between setae *sc2–sc2* 173–193 [193], *c3–c3* 176–200 [200], *f3–f3* 106–122 [118]. Lightly sclerotised prodorsal and opisthonotal shields evident. Prodorsum with pair large pores mesally with one–two pairs minute pores anterior to large pore and two pairs minute pores posterior to large pore; pair large pores on posterior margin (often concealed in sejugal furrow). Opisthosoma with three pairs of large pores and two–three pairs minute pores between setae *c1* and *d2*; one–two pairs large pores between setae *d1* and *e2*; pair of minute pores between *d1–d2*; pair large pores and two pairs minute pores between setae *e2* and *f2*. Dorsal setae strongly spatulate, with large rounded spatulate tips, setae barbed along entire length. Setae *h2* spatulate. Dorsal setae measurements: *v2* 50–73 [67–69], *sc1* 43–61 [56–61], *sc2* 61–70 [68], *c1* 33–41 [39–41], *c2* 36–45 [43–44], *c3* 60–70 [66–70], *d1* 28–36 [33–34], *d2* 38–43 [41–42], *d3* 61–73 [70], *e1* 32–39 [37–39], *e2* 38–48 [48], *e3* 65–78 [71–77], *f2* 42–51 [44–47], *f3* 78–95 [83–86], *h1* 47–61 [52–54], *h2* 31–41 [33–36].

Palps. (Fig. 51) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–9) [9] and one finely tapered eupathidium (10–15) [13] distally, one dorsal seta (12–18) [15]; palp femorogenu with one seta (27–35) [33].

Venter. (Fig. 52) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a*, *4a* often elongate, fine (difficult to determine full length). Setal measurements: *1a* 53–107 [68], *1b* 18–31 [28], *2b* 17–25 [22], *3a* 12–22 [17], *4a* 42–87 [68], *ag* 10–17 [11], *g1* 14–22 [17], *g2* 15–19 [18], *ps2* 13–18 [15], *ps3* 11–15 [14].

Spermatheca. (Fig. 53) A narrow, coiled membranous tube; broadens proximally, at the genital opening (mesad setae *ps2*); distally terminates in small rounded vesicle.

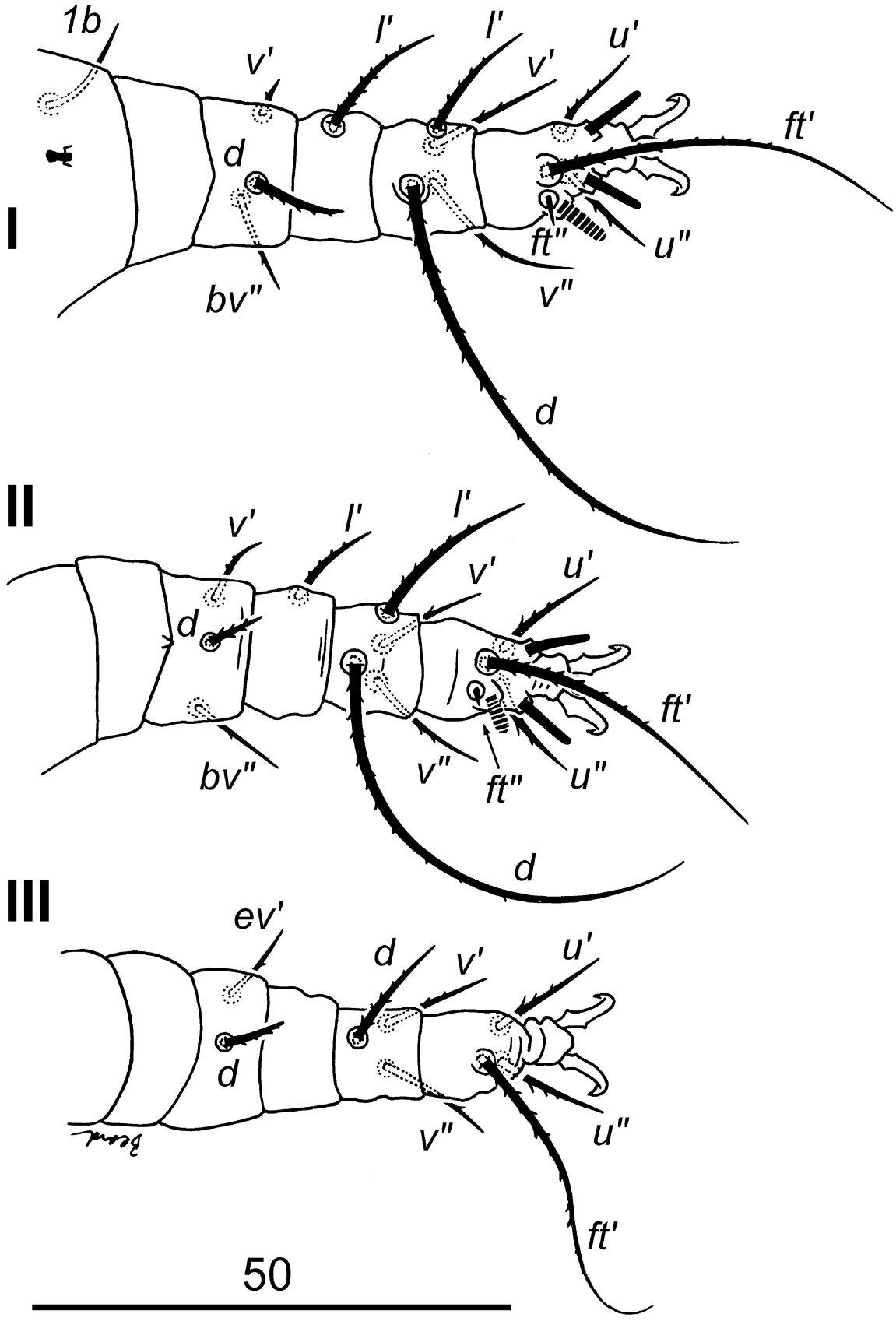


FIGURE 45. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, larva: legs I–III (right side, dorsal aspect).

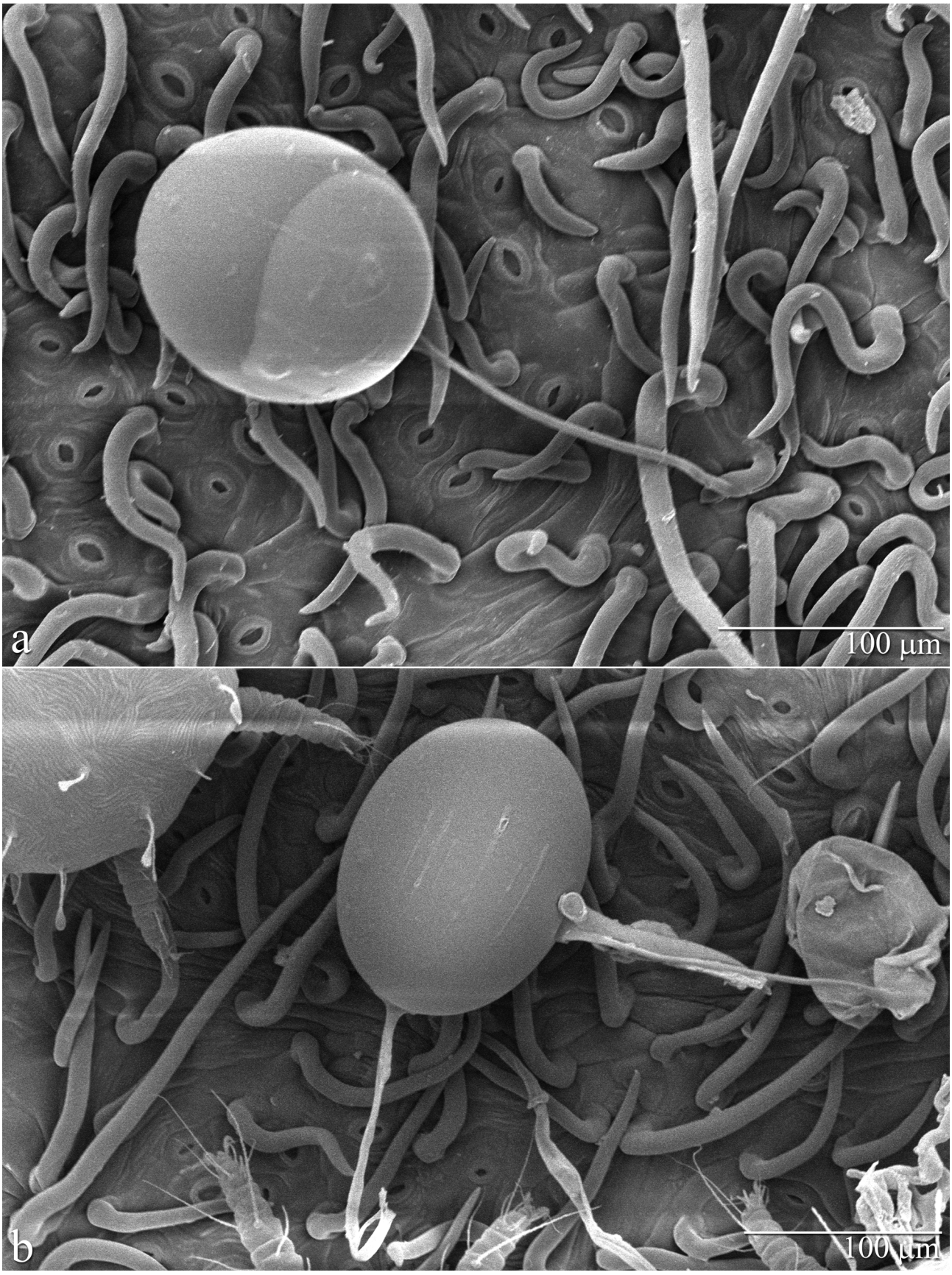


FIGURE 46. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, eggs on host plant.

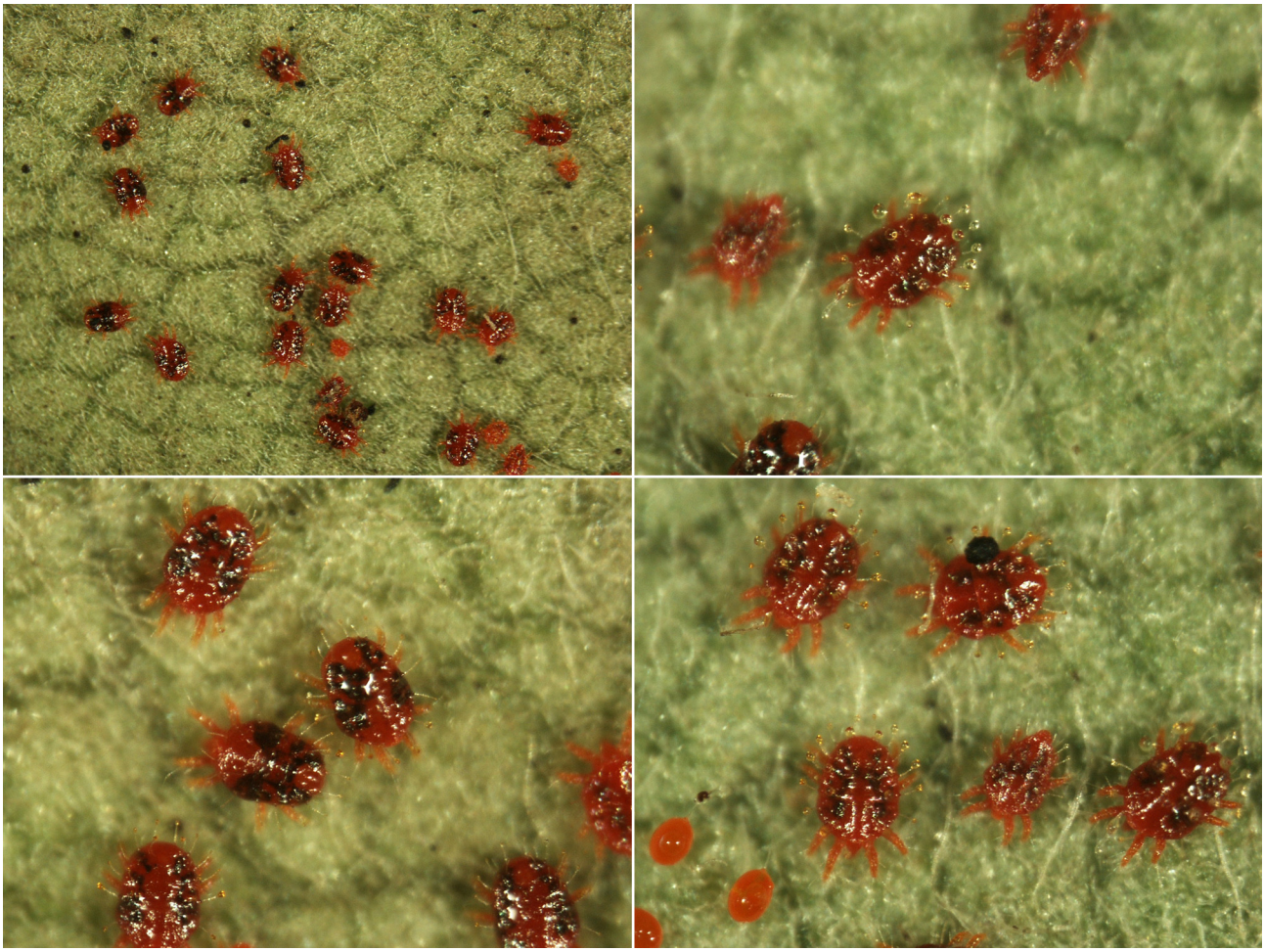


FIGURE 47. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, live individuals: eggs, immatures, adults on host plant (note clear droplets on tips of setae).

Legs. (Fig. 51) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-3-3-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 15–18 [17–18]; ta II 12–16 [15–16]) and two eupathidia distally (ta I 13–16 [14–15], 13–16 [14]; ta II 14–15 [14–15], 13–15 [14]). Finely tapered, barbed companion seta *ft″* on tarsus I 21–28 [27] and tarsus II 16–23 [19–21], inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta with small spatulate tip. Claw I 19–21 long, claw IV 19–21 long. Tenent hairs on claws with three attachment points.

Male. ***Dorsum.*** (Fig. 54) Body measurements (6): length between setae *v2–h1* 163–178, width between setae *sc2–sc2* 128–143, *c3–c3* 121–132, *f3–f3* 61–65. Lightly sclerotised prodorsal shield evident. Prodorsum with pair large pores on posterior margin, three pairs of minute pores mesally; opisthosoma with three pairs of large pores and pair of minute pores between setae *c2* and *d2*; three pairs transverse slit pores between setae *d1* and *e2*; pair transverse slit pores between setae *e1* and *f2*. Opisthonotum with transverse striations between *d1* and *e1*. Dorsal setae spatulate, barbed along entire length, narrower than female. Seta *h2* weakly spatulate. Dorsal setae measurements: *v2* 28–35, *sc1* 32–39, *sc2* 37–51, *c1* 24–33, *c2* 28–34, *c3* 50–60, *d1* 22–28, *d2* 29–37, *d3* 52–61, *e1* 23–29, *e2* 30–37, *e3* 53–63, *f2* 28–40, *f3* 52–65, *h1* 22–33, *h2* 20–29.

Palps. (Fig. 54) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–8) and one finely tapered eupathidium (9–12) distally, one dorsal seta (12–16); palp femorogenu with one seta (24–29).

Venter. Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and a distinct patch of smooth cuticle on either side of setae *ag*. Setae *ps2* barbed, *ps3* modified as accessory genital stylets into short, stout spurs. Setal measurements: *1a* 50–94, *1b* 16–23, *2b* 14–21, *3a* 13–18, *4a* 35–77, *ag* 10–12, *g1* 12–17, *g2* 11–17, *ps2* 9–12, *ps3* 10–12.



FIGURE 48. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, live individuals: adult females on host plant (note orange droplets on tips of setae).

Aedeagus. (Fig. 54) Aedeagus narrow, elongate and sclerotised (70–78), tapering to a blunt point distally (at genital opening); a narrow membranous tube emerges basally from the sclerotised portion (from the end distant to genital opening) and broadens terminally.

Legs. (Fig. 54) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-3-3-4-10(2), 0-1-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 16–17, abaxial 14–17; ta II adaxial 12–17, abaxial 15–19), and two eupathidia distally (ta I 13–14, 12–14; ta II 12–13, 12–14). Barbed companion seta *ft″* on tarsus I 22–28 and tarsus II 15–19, inserted adjacent to solenidion *ω″*. Tibia I with dorsal seta with finely tapered tip; tibia II with dorsal seta slightly spatulate to thick tipped. Tenent hairs on claws with two–three attachment points.

Deutonymph (female, with male measurement in parentheses). ***Dorsum.*** Body measurements (7 female, 2 male): length between setae *v2–h1* female 203–223 (male 161–170), width between setae *sc2–sc2* 157–167 (128–129), *c3–c3* 162–171 (132–133), *f3–f3* 72–78 (53–56). Prodorsal cuticle with a few oblique folds mesolaterally and a few transverse folds posteromesally; with a pair of round pores often visible mesolaterally; with a pair of large pores on posterior margin (often concealed within sejugal fold). Dorsal opisthosoma with widely spaced transverse striations between *c1–e1*; no pores visible. Lateral setae (*c3*, *d3*, *e3*, *f3*) longer than sublateral setae (*c2*, *d2*, *e2*, *f2*). Dorsal setae with spatulate tips, barbed along entire length; setae *f3, h1*, *h2* weakly spatulate, barbed, often inserted ventrally. Dorsal setae measurements: *v2* 52–63 (36–37), *sc1* 44–57 (35–36), *sc2* 53–61 (37–40), *c1* 30–44 (24–26), *c2* 35–42 (30–32), *c3* 54–64 (42–45), *d1* 27–35 (22–25), *d2* 34–47 (28–29), *d3* 58–64 (41–45), *e1* 30–41 (26–27), *e2* 36–46 (31–36), *e3* 59–64 (42), *f2* 39–49 (27–32), *f3* 58–65 (42–43), *h1* 31–37 (20–21), *h2* 17–23 ([16–17).

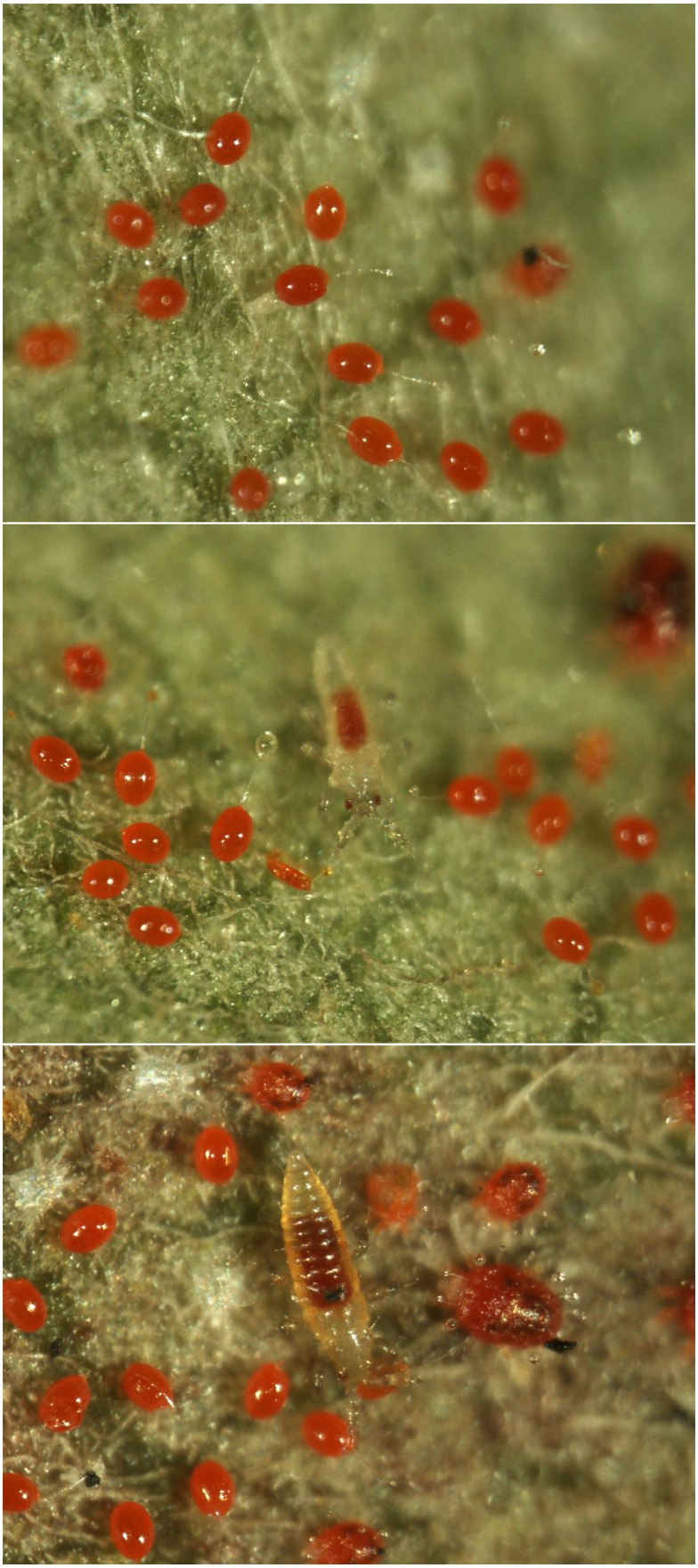


FIGURE 49. *Raoiella bauchani* **sp. nov.** Beard & Ochoa, live eggs on host plant. Note long stipe on eggs with droplet at tip, and immature *Scolothrips ochoa* Mound, Tree & Goldarazena feeding on the eggs.



FIGURE 50. Adult predatory thrips *Scolothrips ochoa* Mound, Tree & Goldarazena feeding on eggs of *Raoiella bauchani* **sp. nov.** Beard & Ochoa.

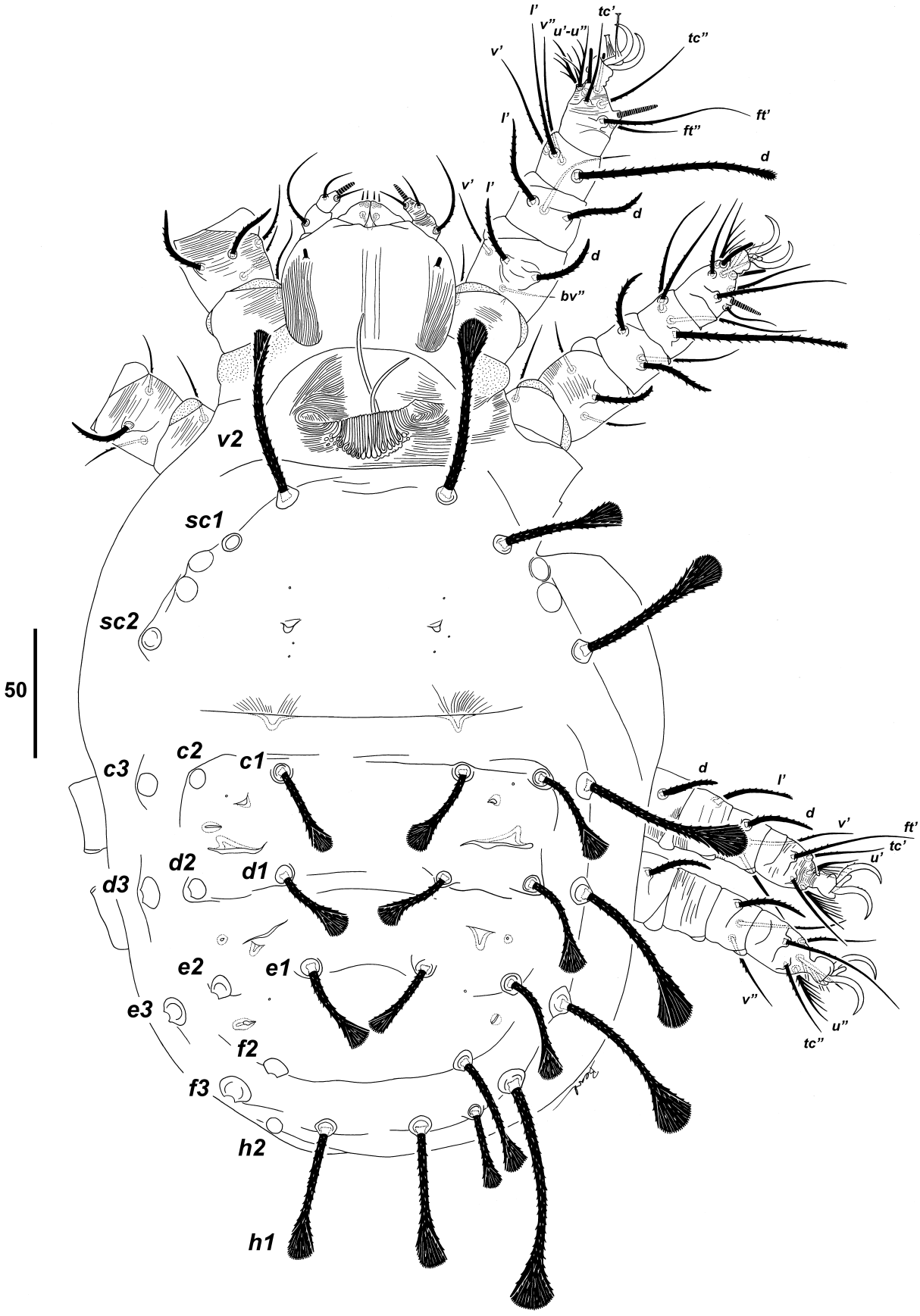


FIGURE 51. *Raoiella calgoa* Beard & Ochoa, adult female: dorsal habitus with details of legs I–IV and palps.



FIGURE 52. *Raoiella calgoa* Beard & Ochoa, adult female: posterior venter (setae *ps2–3* hidden beneath expanded membranous ovipore).

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–8) (6) and one finely tapered eupathidium (9–11) distally, one dorsal seta (11–12); palp femorogenu with one seta (19–26).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae. Both sexes: transverse striae between *1b–1b*, longitudinal striae between *1b–1a*. Female: transverse striae *1a–ag*, with oblique striae *ag–g1* forming a V-shape, with transverse striae laterad *ps* setae (see also Figs 20a, 128a, 234a). Male: transverse striae *1a–g1*, with *ps* setae inserted on pair smooth plate-like areas (see also Figs 20b, 128b, 234b). Setae *1a* and *4a* elongate, fine (difficult to determine full length). Setae *ag*, *g1*, *ps2*, *ps3* weakly barbed. Setal measurements: *1a* 23–60, *1b* 13–18, *3a* 11–12, *4a* 26–49, *ag* 9–11, *g1* 9–13, *ps2* 8–11, *ps3* 7–9.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 12–13 [11–12]; ta II 10–12 [11–12]) and two eupathidia distally (ta I both 11–12 [10–11]; ta II both 11 [10]). Short barbed companion seta *ft″* on tarsus I 9–12 [11–12] and tarsus II 7–10 [10], adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta *d* with spatulate tip. Femora I–II with three setae (*d*, *v′*, *bv″* present; seta *l′* absent (*l′* normally added in deutonymph); genua I–II with two setae (*d*, *l′* present; *d* added in deutonymph). Claw I 15–17; claw IV 14–15; tenent hairs with two–three attachment points.

Protonymph. ***Dorsum.*** Body measurements (6 female, 2 male; females represent the upper values in the range): length between setae *v2–h1* 145–185, width between setae *sc2–sc2* 121–136, *c3–c3* 123–142, *f3–f3* 36–55. Lightly sclerotised prodorsal shield evident, with light longitudinal folds. Opisthosoma with transverse striae *c1–e1*. Dorsal setae strongly spatulate, barbed along entire length; setae *h1* weakly spatulate; setae *h2* finely tapered to blunt. Dorsal setae measurements: *v2* 40–50, *sc1* 38–52, *sc2* 36–43, *c1* 27–35, *c2* 31–44, *c3* 38–48, *d1* 24–42, *d2* 32–39, *d3* 36–47, *e1* 27–41, *e2* 33–41, *e3* 33–47, *f2* 31–42, *f3* 23–43, *h1* 8–23, *h2* 10–15.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one finely tapered eupathidium (8–10) distally, one dorsal seta (10–11); palp femorogenu with one seta (16–21).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Both sexes: transverse striae *1b–1b*, longitudinal striae *1b–1a*. Female: transverse striae *1a–ag*, oblique striae *ag–ps*. Male: transverse striae *1a–ps* setae. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 26–51, *1b* 14–18, *3a* 9–11, *ag* 7–10, *ps2* 6–7, *ps3* 5–6.



FIGURE 53. *Raoiella calgoa* Beard & Ochoa, adult female: detail of spermatheca.

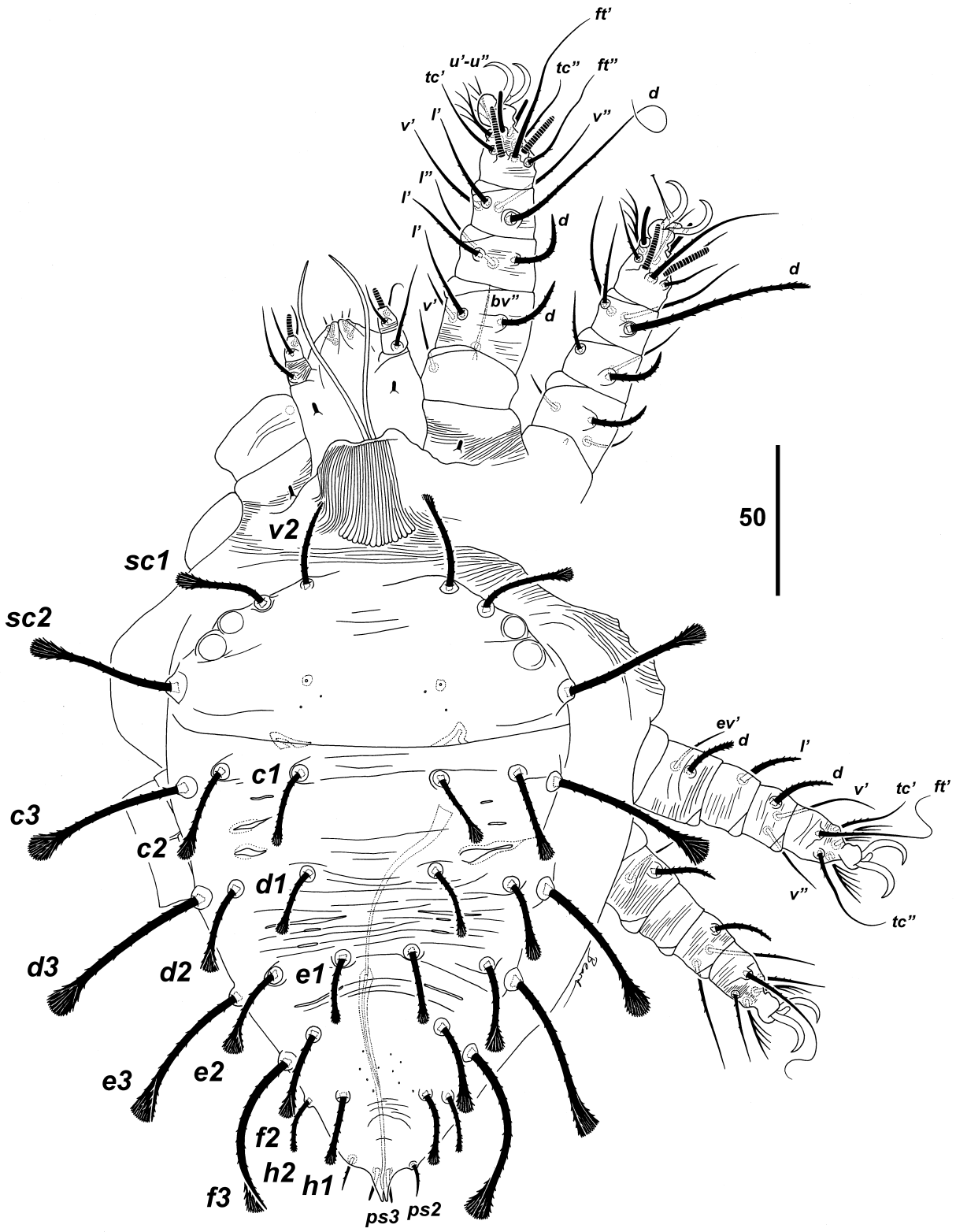


FIGURE 54. *Raoiella calgoa* Beard & Ochoa, adult male: dorsal habitus with details of legs I–IV, aedeagus and palps.

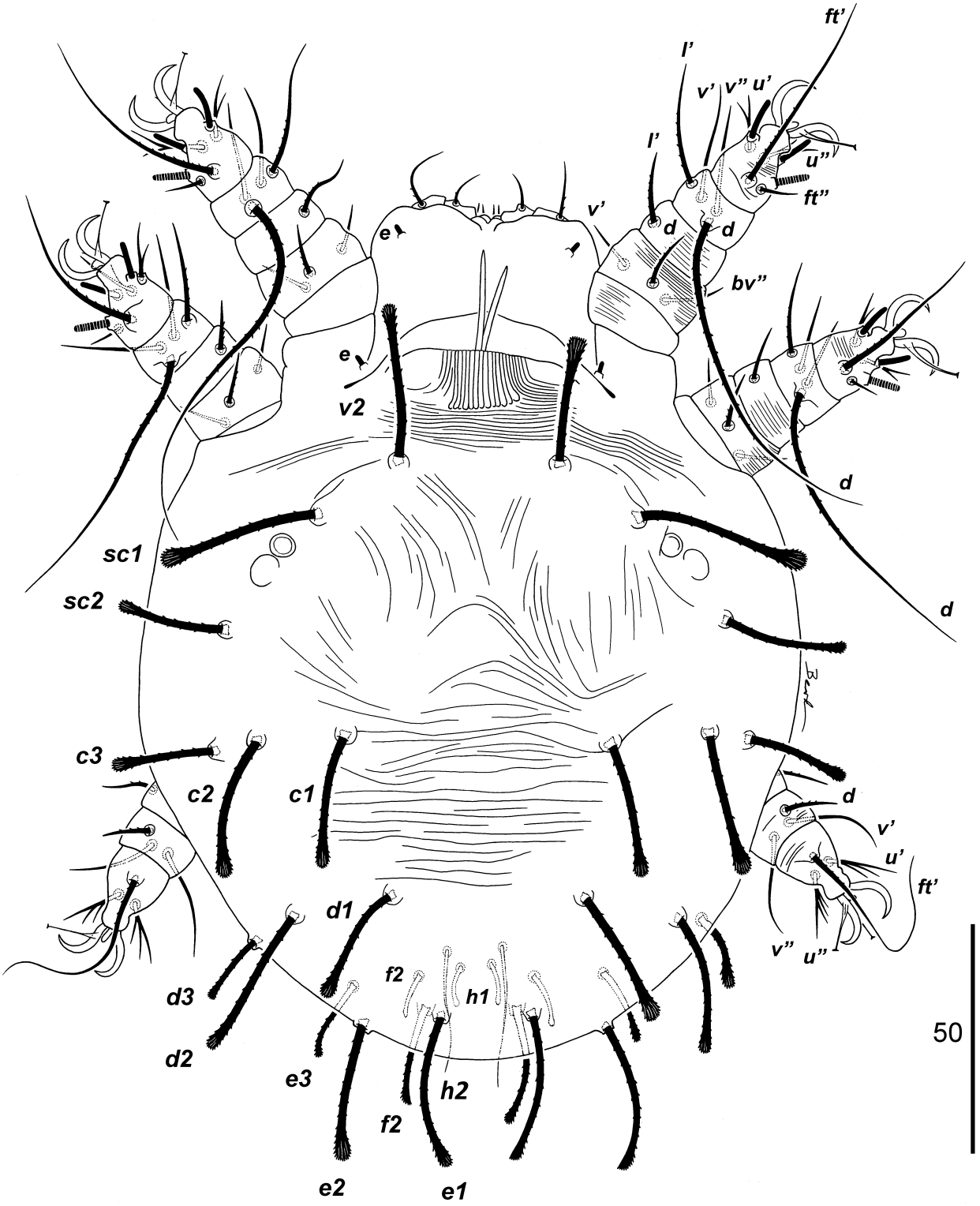


FIGURE 55. *Raoiella calgoa* Beard & Ochoa, larva: dorsal habitus with details of legs I–III and palps.

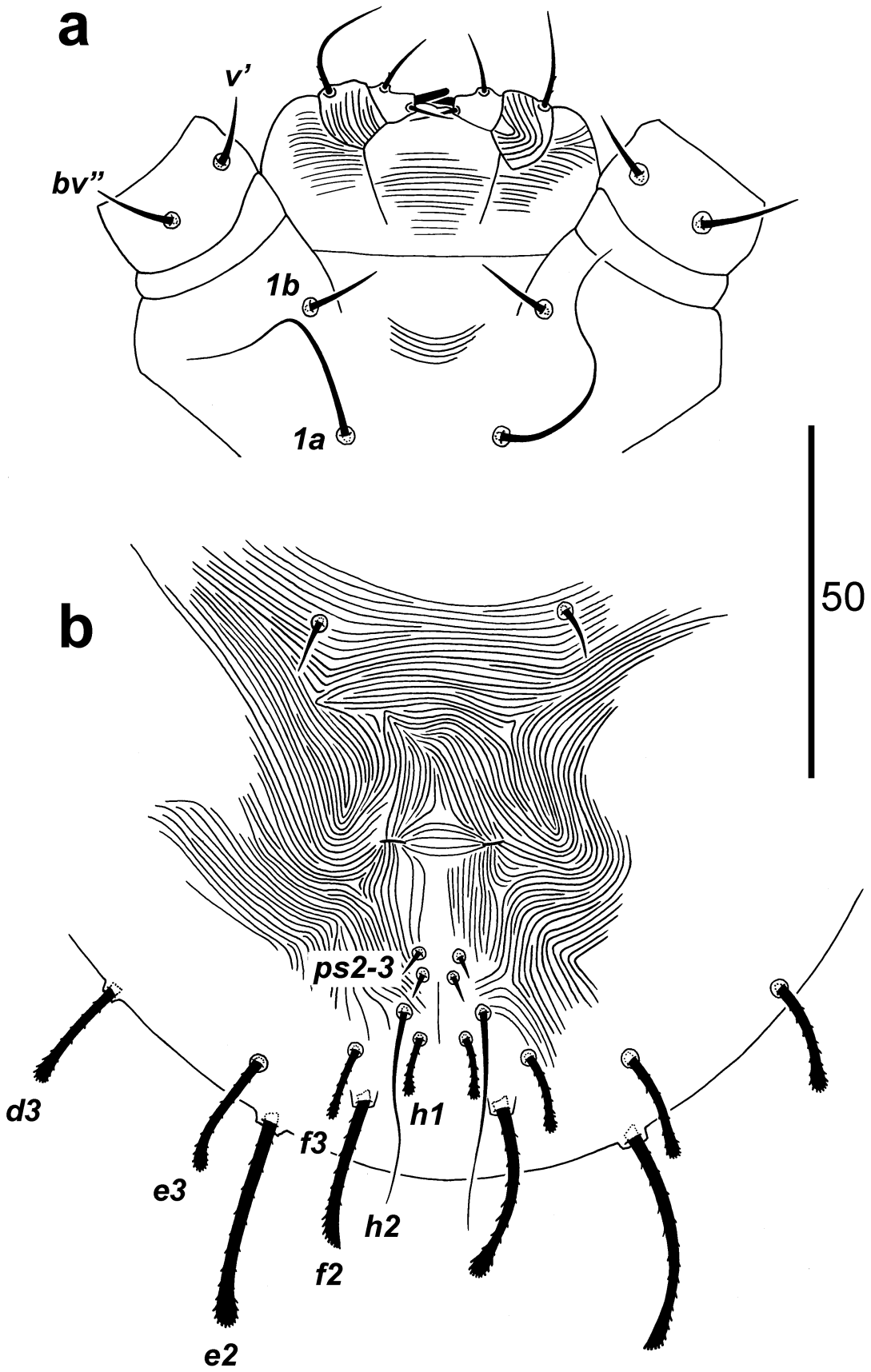


FIGURE 56. *Raoiella calgoa* Beard & Ochoa, larva: a. ventral infracapitulum with details of palps; b. posterior venter.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 10; ta II 8–9) and two eupathidia distally (ta I 9–10, 10–11; ta II both 9–10). Barbed companion seta *ft″* on tarsus I 8–11 and tarsus II 6–10, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta *d* weakly spatulate. Claw I 12–14; claw IV 12–13; tenent hairs on claws with two attachment points.

Larva. *Dorsum.* (Fig. 55) Body measurements (8): length between setae *v2–f2* 110–140, width between setae *sc2–sc2* 104–117, *c3–c3* 113–132, *f3–f3* 21–31, *f2–f2* 19–27. Prodorsum with longitudinal striae; opisthosoma with mesal transverse striae between setae *c1–e1*. Dorsal setae weakly spatulate, barbed along entire length; setae *e3*, *f2*, *f3*, *h1*, *h2* ventral; setae *h1* short, blunt, *h2* fine, elongate, filiform. Dorsal setae measurements: *v2* 25–35, *sc1* 32–40, *sc2* 17–27, *c1* 25–32, *c2* 27–36, *c3* 19–32, *d1* 27–35, *d2* 25–34, *d3* 14–23, *e1* 29–36, *e2* 28–34, *e3* 12–19, *f2* 16–27, *f3* 9-13, *h1* 7–12, *h2* 28–41.

Palps. (Fig. 55) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one finely tapered eupathidium (9–11) distally, one dorsal seta (9–11); palp femorogenu with one seta (13–17).

Venter. (Fig. 56) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth, and region between *3a–ps* with small diamond of transverse striae surrounded by patch of longitudinal striae (Fig. 56b) (see also Figs 23, 44, 70, 100, 115b, 129a, 146, 161b, 178, 191b, 238, 268). Setal measurements: *1a* 28–49, *1b* 10–13, *3a* 8–11, *ps2* 4–6, *ps3* 4–6.

Legs. (Fig. 55) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 7–8; ta II 6–8) and two eupathidia distally (ta I 8–9, 7–8; ta II 7–8, 8). Companion seta *ft″* on tarsus I 7–12 and tarsus II 6–11, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta *d* finely tapered. Claw I 12–14, claw III 12–13; tenent hairs on claws with two attachment points.

Host. Silver-leaved ironbark, *Eucalyptus melanophloia* F. Muell. (Myrtaceae).

Distribution. AUSTRALIA: southeastern Queensland.

Etymology. This species is named for the nearest town to the type collection site, Calgoa.

Remarks. *Raoiella calgoa* **sp. nov.** is listed as *Raoiella* sp. 1 in Dowling *et al.* (2012; Table 1 and Figs 1, 2) and by Beard *et al*. (2013). RaIn01 and RaIn03 were from Didcot, RaIn04 was from Calgoa Creek (100 km southeast of Didcot, and RaIn55 was from near Adavale (1000 km west of Didcot). These localities were hundreds of kilometres apart, yet intraspecific divergences listed in Dowling *et al.* (2012) only ranged from 0.6–1.0%.

Raoiella calgoa is in the australica species group and is morphologically similar to *R. crebra*, *R. hallingi* and *R. illyarrie*. *Raoiella calgoa* can be separated from these species by the following: *Rca* dorsal seta *f2* longer than *h2*, dorsal seta *sc1* longer than half seta *sc2*; *Rcr* seta *f2* subequal in length with *h2*, *sc1* half the length of *sc2*; *Rh* seta *f2* subequal in length with seta *h2*, seta *sc1* longer than half seta *sc2*; *Ri* seta *f2* subequal in length with *h2*, seta *sc1* longer than half seta *sc2*. In addition, dorsal opisthosomal setae *c1*, *c2*, *d1*, *d2*, *e1*, *e2* range between 30–48 in length on *R. calgoa*, whereas these setae range between 15–32 on the other three species.

Mites collected from the same host in Hebel, 710 km southwest of Didcot, are morphologically indistinguishable from *R. calgoa*, and are here considered to be *R. calgoa* until molecular analysis of this population is undertaken, and are listed in *Other material examined*.

Raoiella crebra sp. nov. Beard & Ochoa

(Figs 57–71)

Material examined. Holotype. ♀. **Australia,** ex. narrow-leaved ironbark, *Eucalyptus crebra* (Myrtaceae), Laidley Creek West, Queensland, 27°38’59.18”S 152°21’54.7”E, 08.iii.08, J.J. Beard (QMS 108801).

Paratypes. 30 ♀, 8 ♂, 4 deutonymphs, 2 protonymphs, 9 larvae, same data as Holotype (QM, USNM).

Other material examined. **Australia,** 6 ♀, ex. *Eucalyptus* indet. sp. (Myrtaceae), Gympie-Kilkivan Road, Queensland, 10.iii.1965, J.J. Davis (QM; Reg# N1414).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* spatulate. Femora I with four setae (*d*, *l′*, *v′, bv″*); femora II with three setae (*d*, *v′, bv″* present; *l′* absent); genua I–II with three setae (*d*, *l′*, *l″*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft″*) subequal to or shorter than solenidion. Dorsal setae on tibiae I–II with spatulate to blunt tip. Eupathidium on palp tibiotarsus tapered. Larva with setae *h2* elongate, filiform.

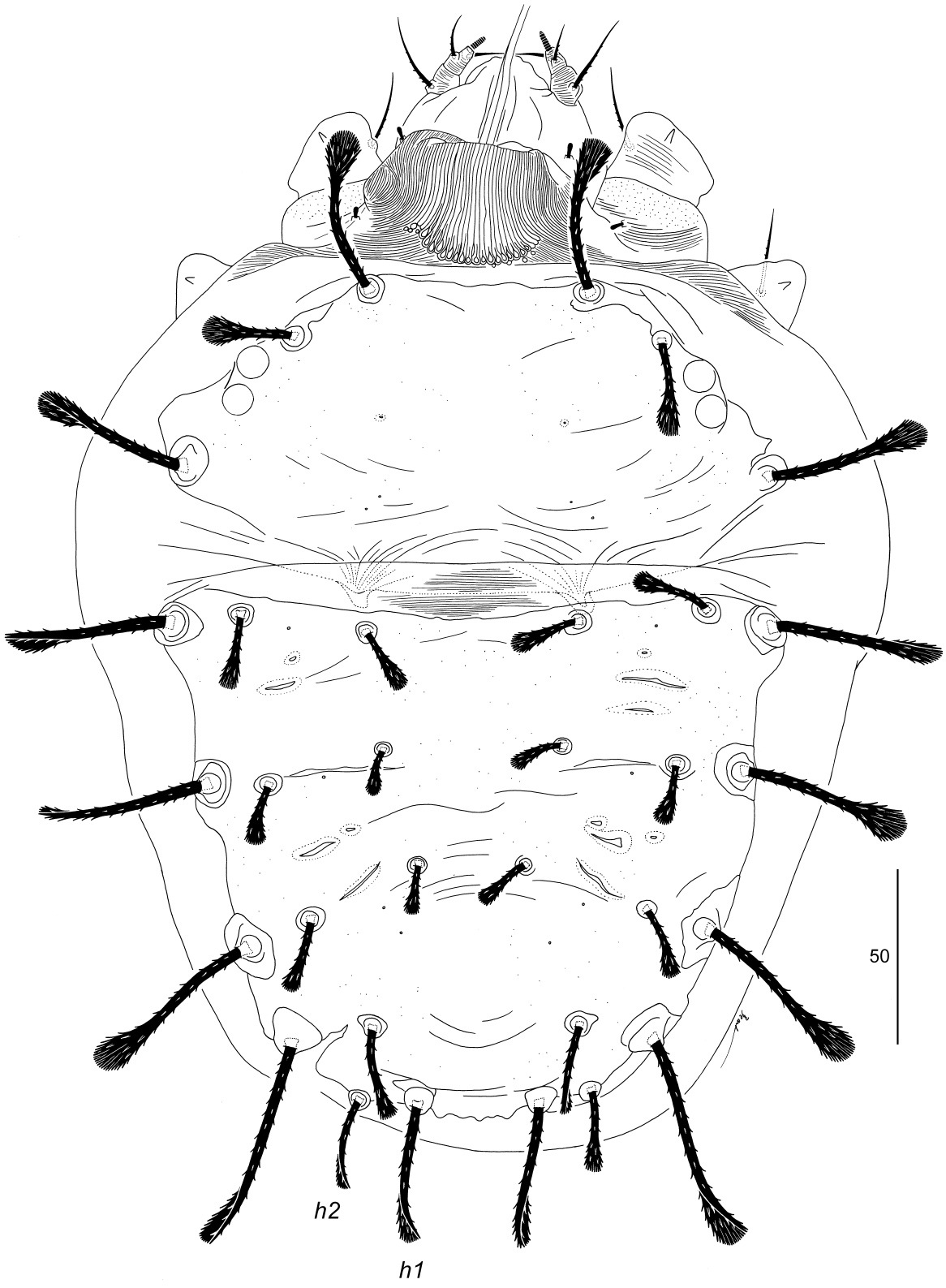


FIGURE 57. *Raoiella crebra* Beard & Ochoa, adult female: dorsal habitus with detail of palps.

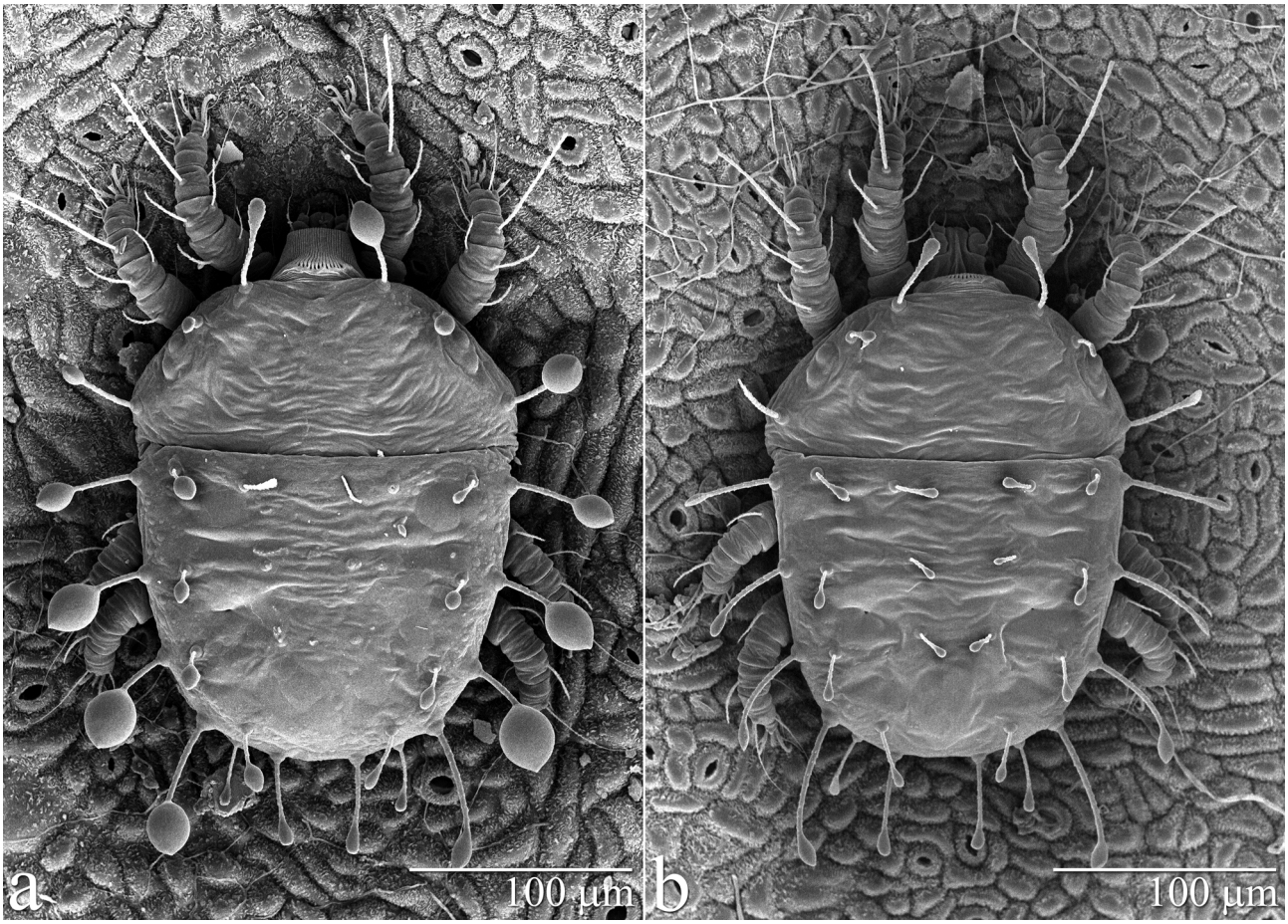


FIGURE 58. *Raoiella crebra* Beard & Ochoa, adult female: dorsal habitus on host plant (two different individuals).

Description. Female. ***Dorsum.*** (Figs 57–59) Body measurements (18): length between setae *v2–h1* 230–250 [238], width between setae *sc2–sc2* 163–180 [178], *c3–c3* 170–182 [177], *f3–f3* 101–109 [105]. Prodorsal and dorsal opisthosomal shields weakly to well developed, with smooth finely punctate cuticle, with some fine weak transverse folds posteriorly. Prodorsum with three pairs of minute pores mesally and a pair of large pores on posterior margin (often hidden in fold of sejugal region). Dorsal opisthosoma with a cluster of three large pores between *c1–c2* and *d1–d2*, and three large pores between *d1–d2* and *e1–e2*; and four pairs minute pores spread between *c1–c2*, *d1–d2*, *e1–e2*. All dorsal setae barbed along entire length, spatulate. Dorsal setae measurements: *v2* 47–53 [51], *sc1* 25–31 [31], *sc2* 43–52 [52], *c1* 21–27 [25–27], *c2* 23–28 [26], *c3* 46–56 [50], *d1* 16–21 [17], *d2* 20–26 [23], *d3* 50–60 [52], *e1* 18–21 [19], *e2* 23–27 [23–26], *e3* 53–68 [53], *f2* 28–35 [30], *f3* 64–76 [66], *h1* 43–51 [45–48], *h2* 26–33 [30].

Palps. (Figs 57, 60a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–8) [7] and one fine, tapered eupathidium (10–13) [10] distally, one dorsal seta (12–16) [12]; palp femorogenu with one seta (22–26) [23–24]. Stylets with 11–16 small lateral teeth distally (Fig. 61).

Venter. (Figs 62–63) Cuticle almost completely plicate, covered with mostly transverse striae; cuticle between *1b–1b* with transverse striae, *1b–1a* longitudinal, *1a–g1* transverse; genital flap with transverse striae; laterad genital flap with oblique to longitudinal striae; coxal fields smooth. Setae *g1* and *g2* inserted in more-or-less transverse row on posterior margin of genital flap; genital flap with fine transverse striae. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *ag*, *g1*, *g2*, *ps2*, *ps3* slightly barbed. Setae *3b*, *4b* absent. Dorsal setal measurements: *1a* 56–86 [57], *1b* 19–23 [19], *2b* 11–20 [12], *3a* 10–14 [11], *4a* 48–86 [60], *ag* 10–12 [12], *g1* 13–15 [13], *g2* 13–16 [14], *ps2* 11–14 [13], *ps3* 9–11 [11].

Spermatheca. (Fig. 60b) An elongate, narrow, weakly convoluted duct, > 100. The basal section of the duct broadens slightly towards external opening.

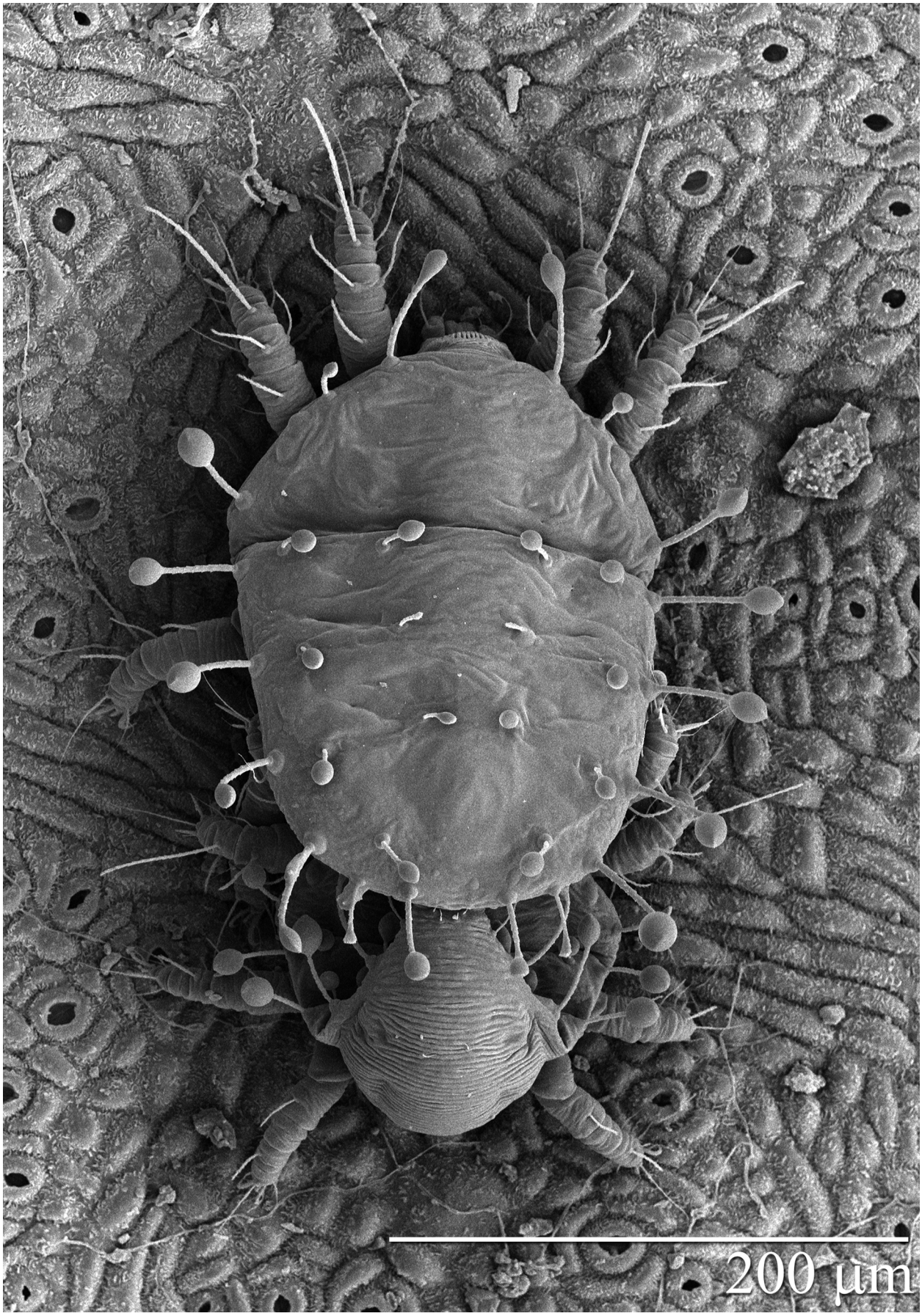


FIGURE 59. *Raoiella crebra* Beard & Ochoa, mating pair on host plant.

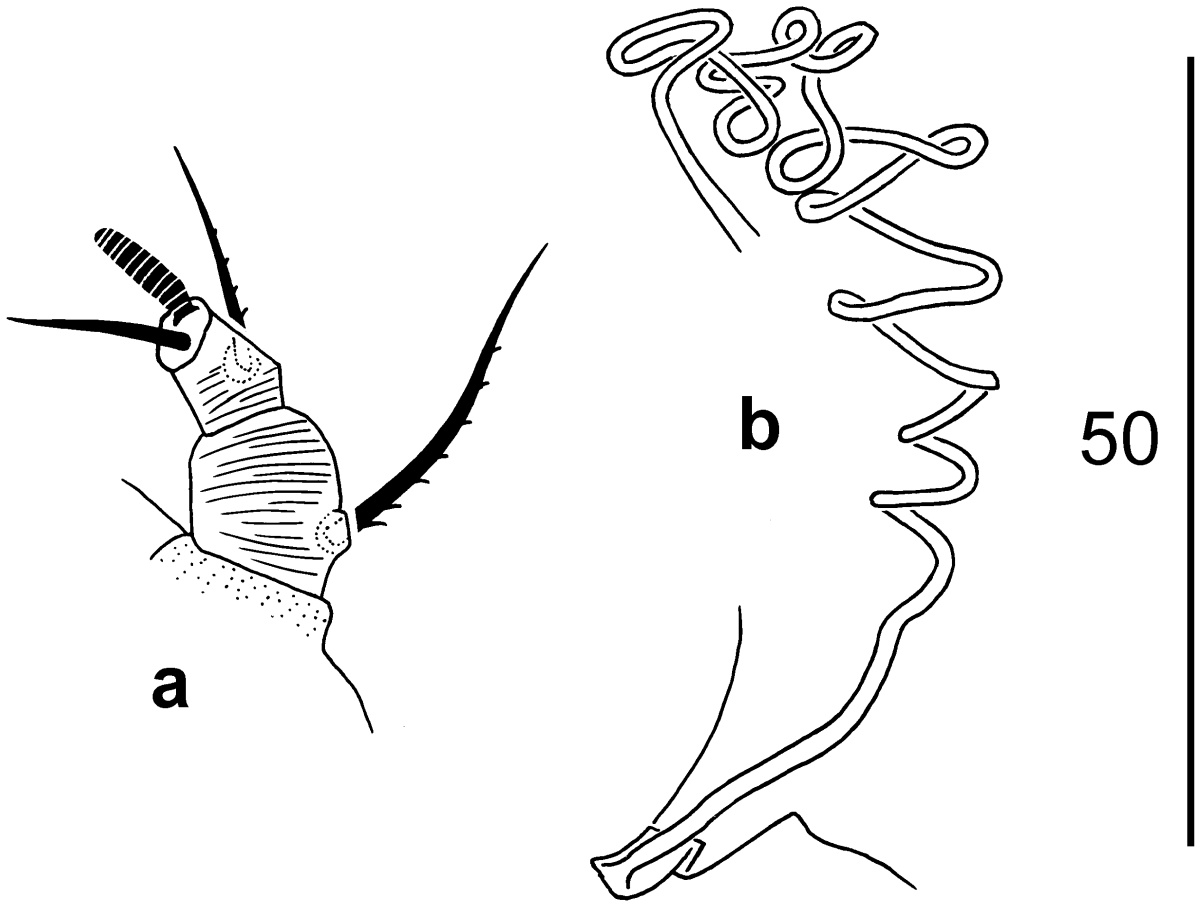


FIGURE 60. *Raoiella crebra* Beard & Ochoa, adult female: a. detail of palp; b. detail of spermatheca.

Legs. (Figs 64, 65) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-3-3-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 13–15 [13–14]; ta II 11–12 [11]) and two eupathidia *pζ′*–*pζ″* distally (ta I 11–12 [11–12], 11–12 [11–12]; ta II 11–12 [11], 11–12 [11]). Short, barbed companion seta *ft″* on tarsus I 10–15 [12] and tarsus II 8–13 [8–10], inserted adjacent to solenidion *ω″* (Fig. 65). Tibiae I–II with dorsal seta thick, spatulate, may appear blunt (dtiI 58–65 [62–64], dtiII 55–61 [58–61]). Femora I with four setae (*d*, *l′*, *v′*, *bv″*), femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with three setae (*d*, *l′, l″*). Claw I 17–19 [18–19], claw IV 17–18 [18] long.

Male. ***Dorsum.*** (Figs 59, 66–67a) Body measurements (6): length between setae *v2–h1* 167–179, width between setae *sc2–sc2* 134–135, *c3–c3* 125–126, *f3–f3* 56–60. Prodorsum smooth with a few weak transverse folds, and large pore on the posterior margin (often hidden in fold of sejugal region). Dorsal opisthosoma mostly smooth, with some transverse striae between setae *c1* and *e1*; with two pairs transverse slit pores between *c1–c2* and *d1–d2*, pair transverse pores between *d1–d2* and *e1–e2*; a weakly defined pygidial shield present with finely punctate cuticle *f2–h1*. Dorsal setae barbed along entire length; setae *h1*, *h2* weakly spatulate to blunt. Dorsal setae measurements: *v2* 22–30, *sc1* 20–23, *sc2* 30–34, *c1* 17–20, *c2* 16–20, *c3* 36–43, *d1* 15–17, *d2* 16–19, *d3* 37–42, *e1* 14–18, *e2* 16–20, *e3* 37–44, *f2* 21–22, *f3* 40–45, *h1* 17–21, *h2* 18–21.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–7) and one finely tapered eupathidium (10–11) distally, one finely tapered dorsal seta (12–20); palp femorogenu with one seta (19–24).

Venter. Ventral cuticle almost completely plicate, covered in mostly transverse striae; widely spaced striae posterior to *4a–4a*; coxal fields smooth. Setae *3b*, *4b* absent. Setae *ag*, *g1*, *g2*, *ps2* weakly barbed. Setae *ps3* modified as accessory genital stylets into thickened spines. Setal measurements: *1a* 34–78, *1b* 15–19, *2b* 13–19, *3a* 9–11, *4a* 40–58, *ag* 10–11, *g1* 12–13, *g2* 12–14, *ps2* 8-10, *ps3* 8–10.

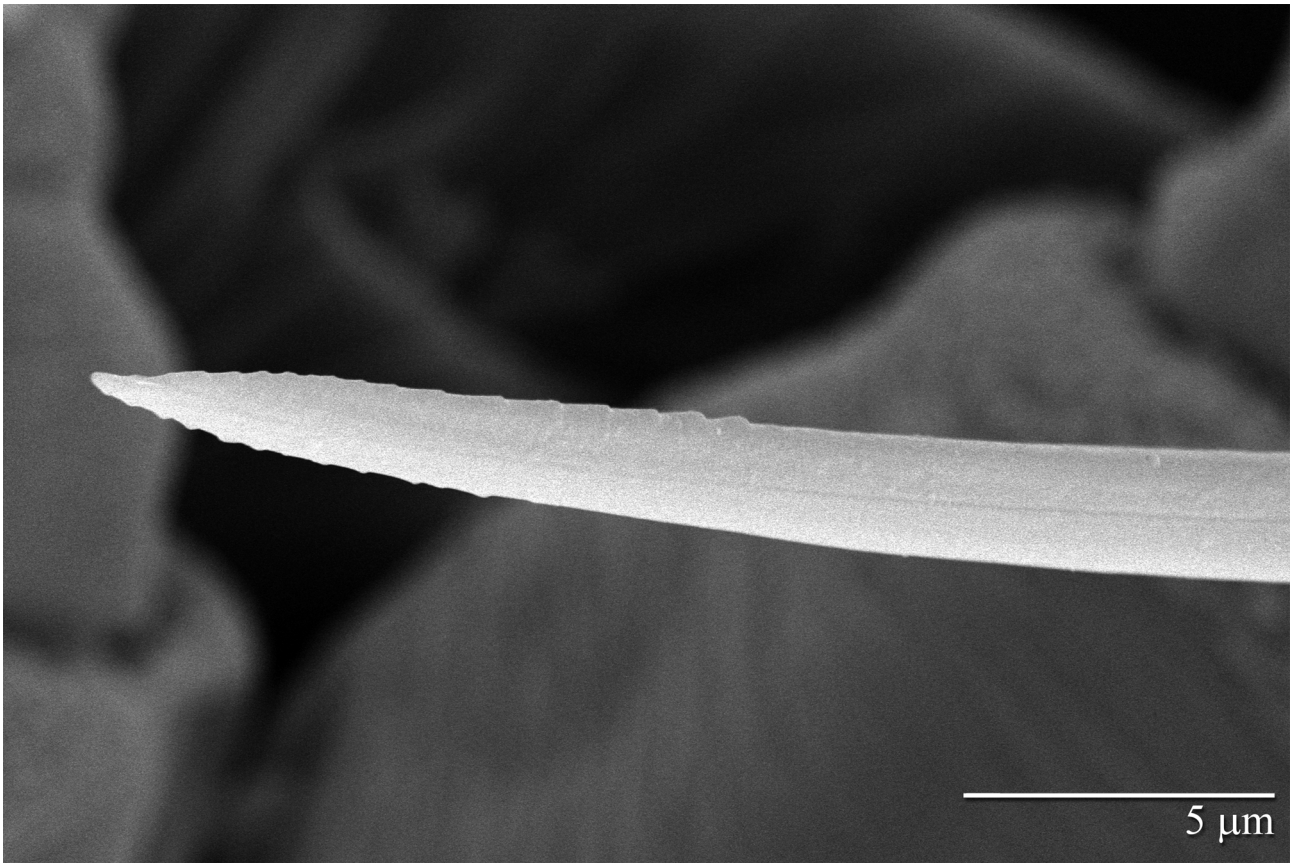


FIGURE 61. *Raoiella crebra* Beard & Ochoa, dorsal view of joined stylets, detail of stylet tip with lateral serrations.

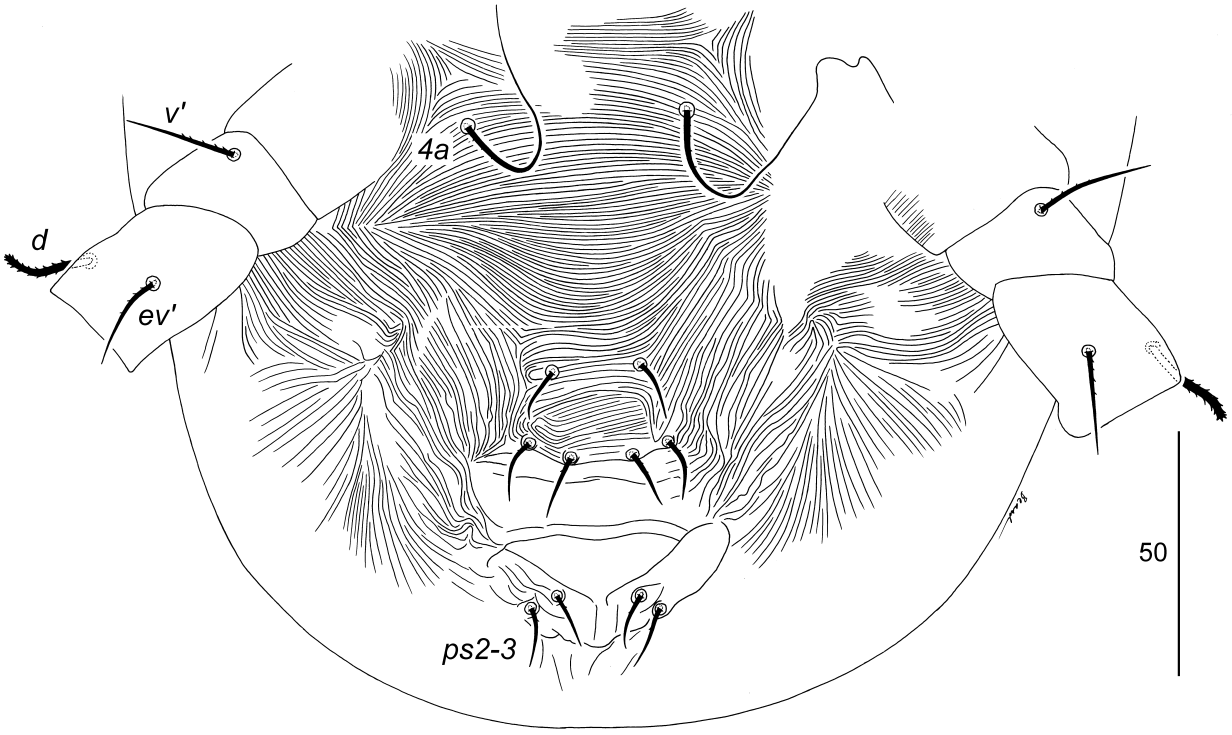


FIGURE 62. *Raoiella crebra* Beard & Ochoa, adult female: posterior venter.

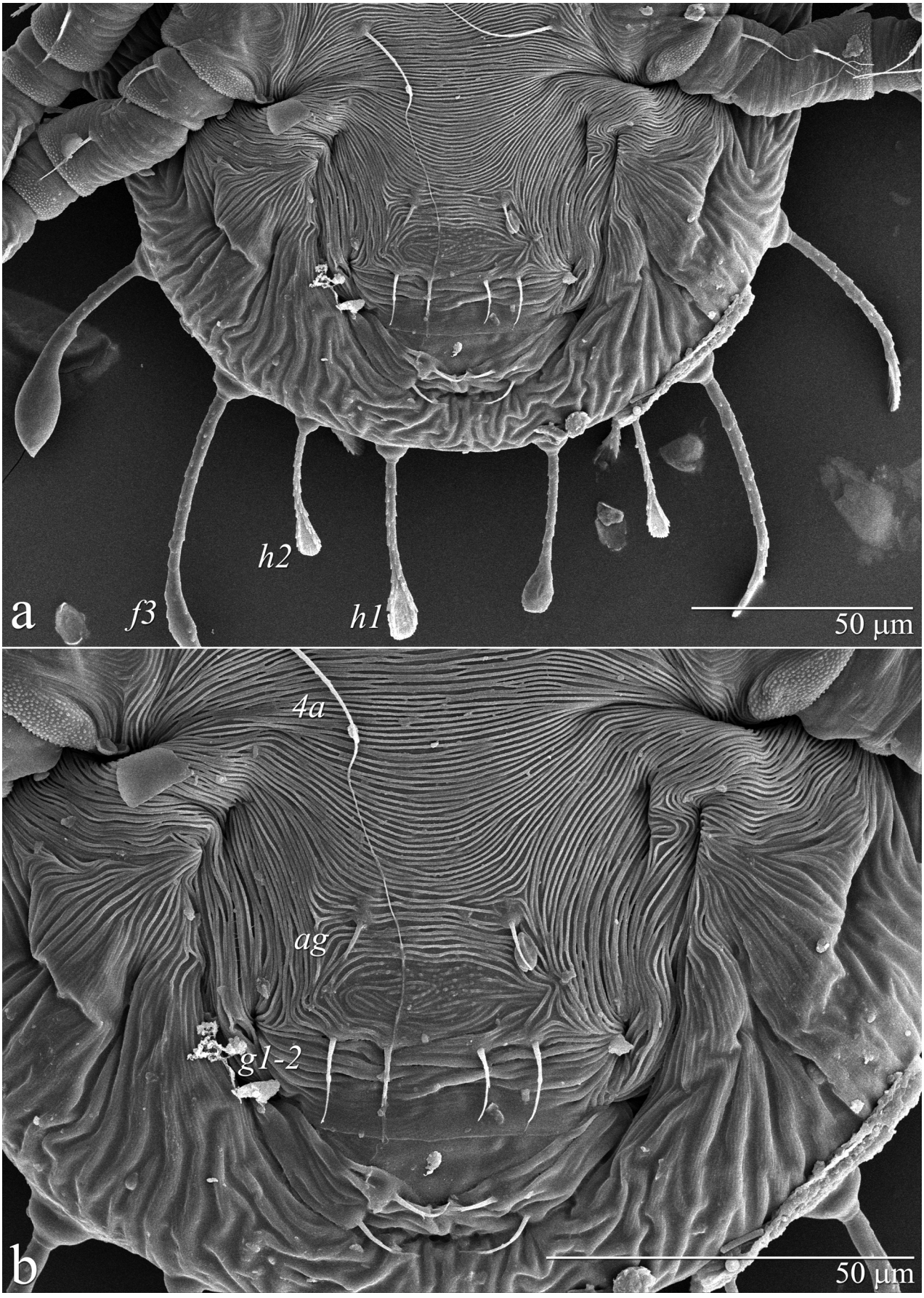


FIGURE 63. *Raoiella crebra* Beard & Ochoa, adult female: a. posterior venter; b. detail of genital region.

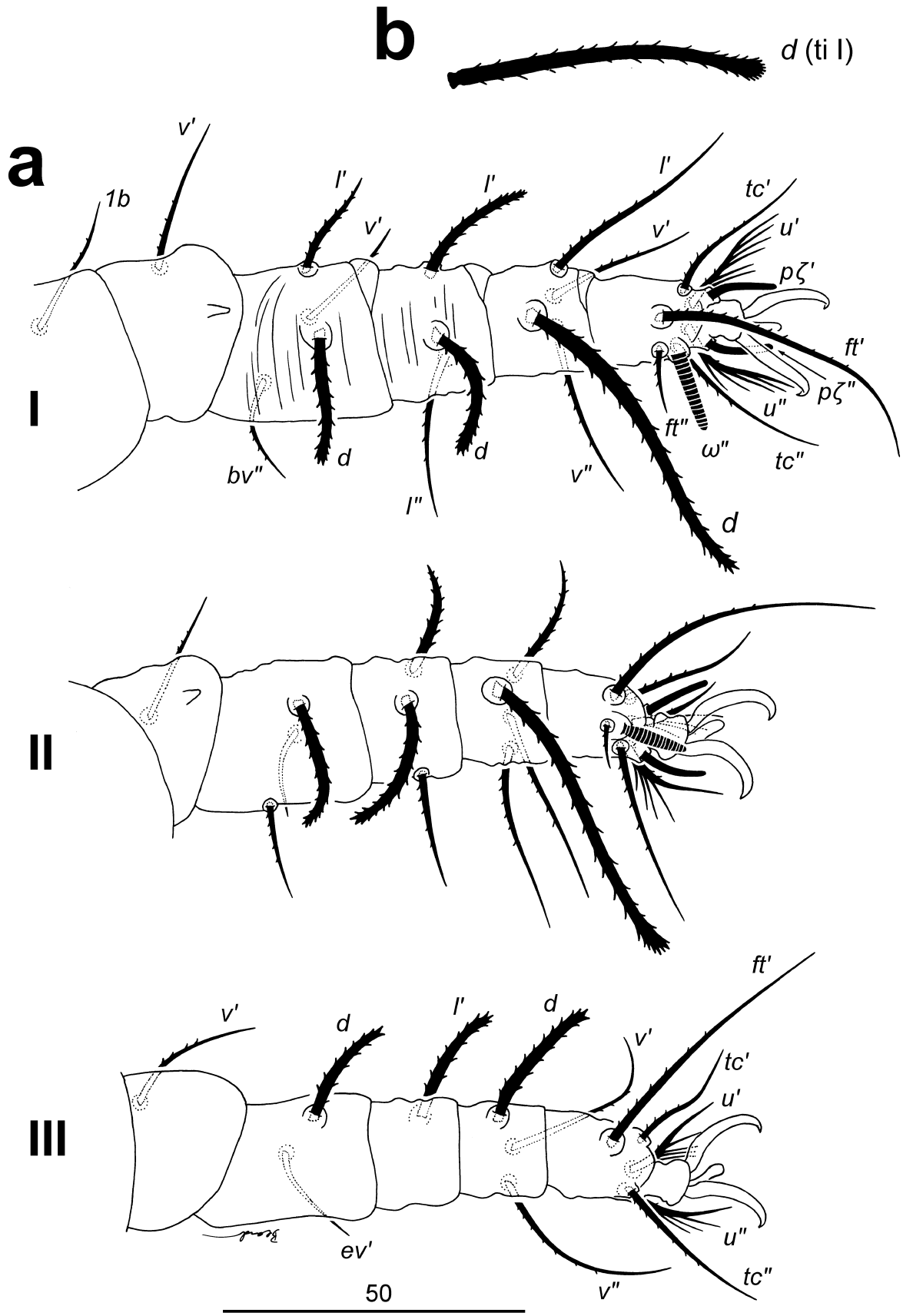


FIGURE 64. *Raoiella crebra* Beard & Ochoa, adult female: a. legs I, II, III (right side; legs I–II dorsal aspect, leg III abaxial aspect); b. detail of dorsal seta on tibia I.

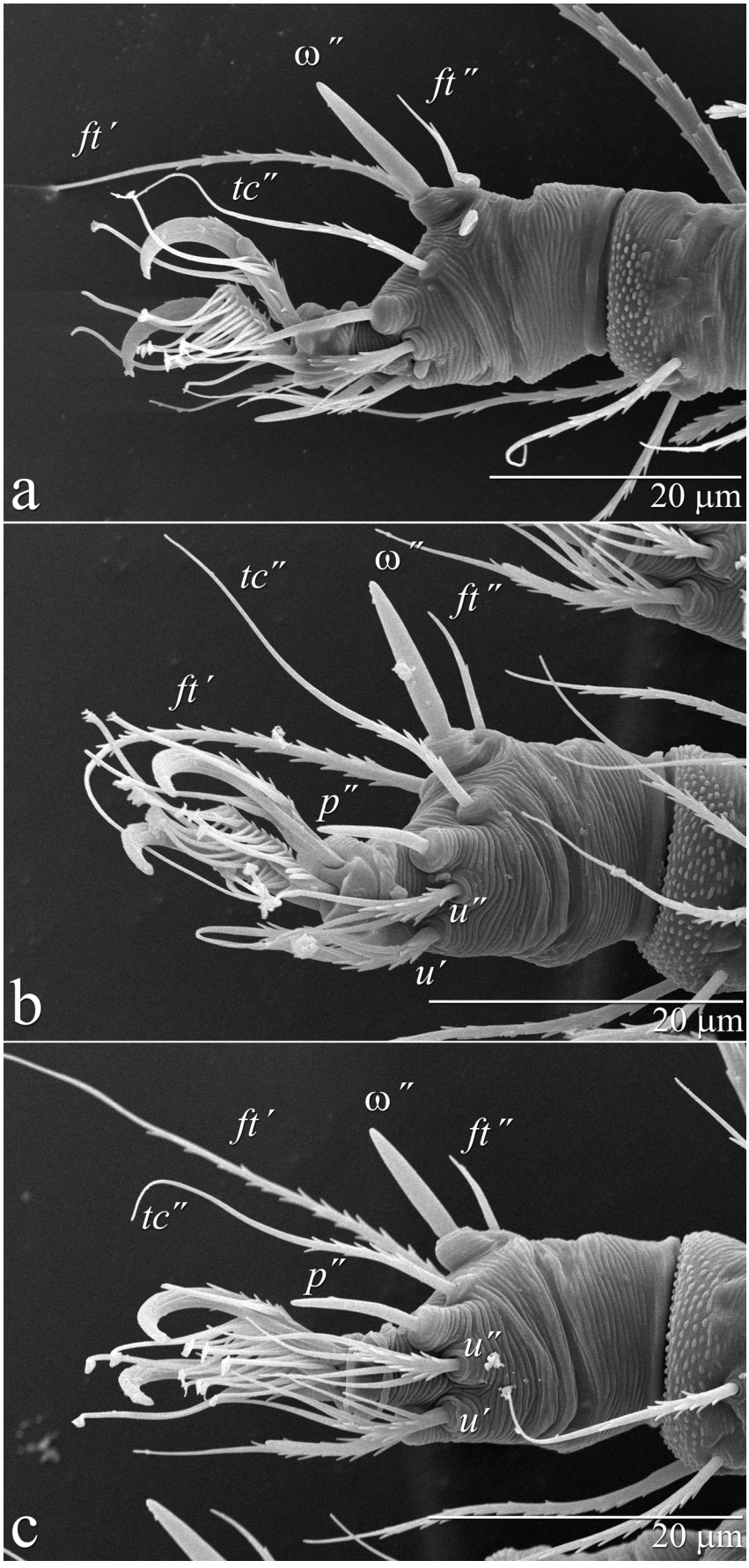


FIGURE 65. *Raoiella crebra* Beard & Ochoa, adult female: a., b. detail of tarsus I, indicating solenidion (*ω″*) and companion seta (*ft″*); c. detail of tarsus II.

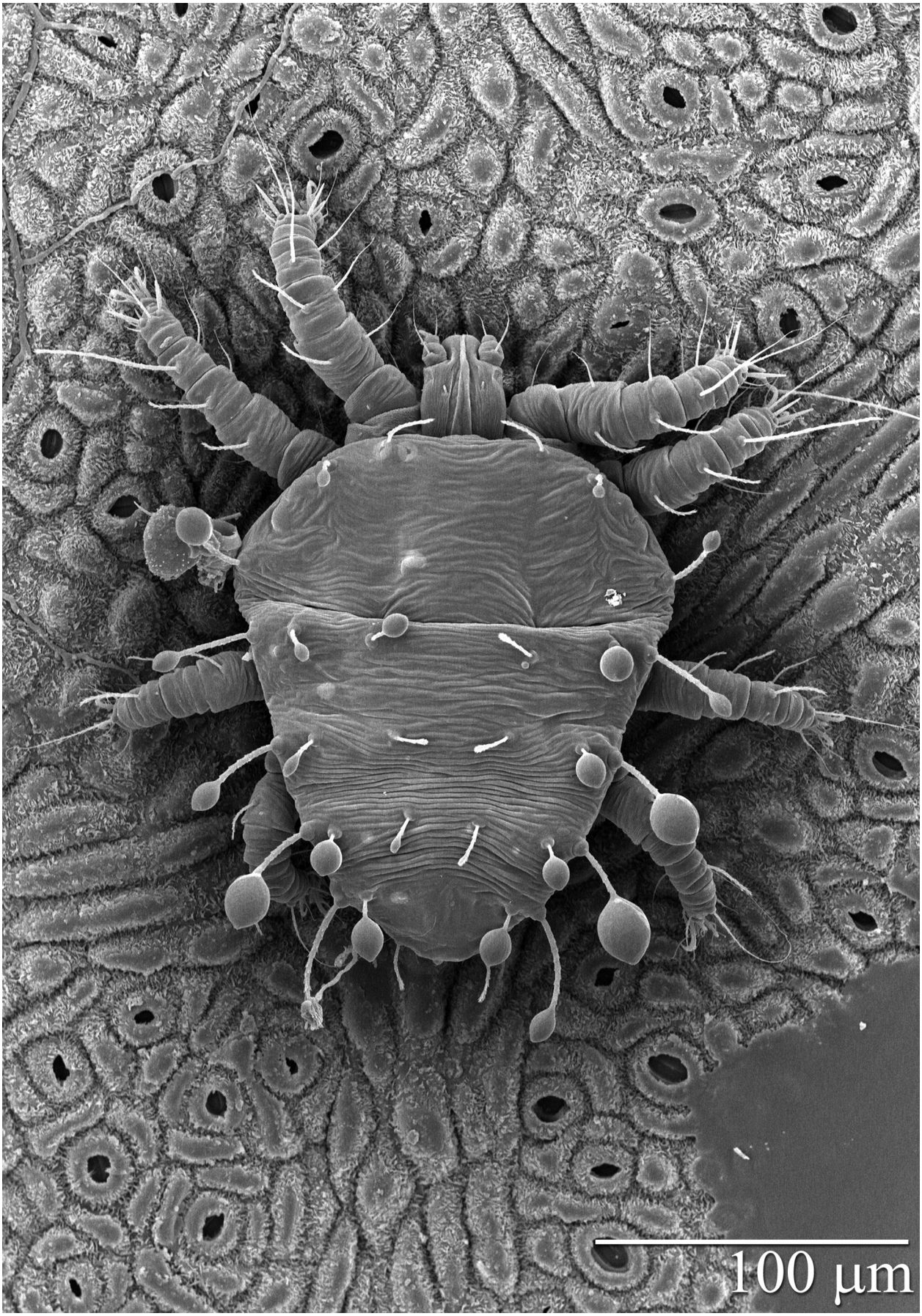


FIGURE 66. *Raoiella crebra* Beard & Ochoa, adult male: dorsal habitus on host plant.

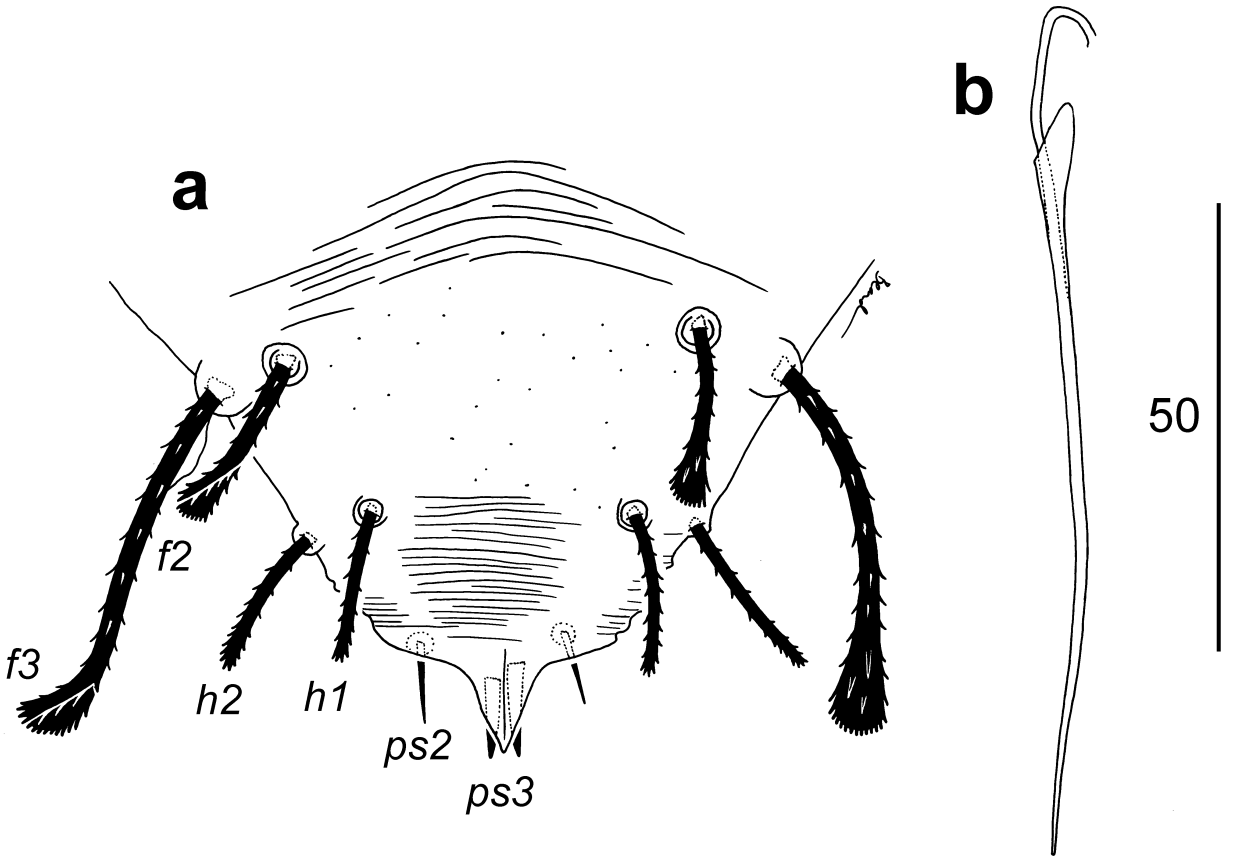


FIGURE 67. *Raoiella crebra* Beard & Ochoa, adult male: a. posterior dorsum with detail of setae *ps3*; b. detail of aedeagus.

Aedeagus. (Fig. 67b) Aedeagus narrow, elongate and sclerotised (75–80), tapering to a blunt point distally (towards genital opening).

Legs. (Figs 68, 69) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-3-3-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 11–14, abaxial 13–14; ta II adaxial 9–11, abaxial 12–13), and two eupathidia distally (ta I 11–12, 11; ta II 10–11, 10). Finely tapered, weakly barbed companion seta *ft″* on tarsus I 12–15 and tarsus II 8–9, inserted adjacent to solenidion *ω″* (Fig. 69). Tibiae I–II with dorsal seta tapered to finely tapered or weakly spatulate at tip (dtiI 57–64, dtiII 46–53). Femora I with four setae (*d*, *l′*, *v′*, *bv″*), femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with three setae (*d*, *l′, l″*). Claw I 15–16 long.

Deutonymph (female). ***Dorsum.*** Body measurements (4): length between setae *v2–h1* 188–215, width between setae *sc2–sc2* 148–152, *c3–c3* 150–153, *f3–f3* 67–69. Prodorsal cuticle smooth with a few faint transverse folds. Dorsal opisthosoma with widely spaced transverse striations between *c1–e1*; no pores visible. Dorsal setae with spatulate tips, barbed along entire length; setae *h2* often weakly spatulate to blunt. Dorsal setae measurements: *v2* 38–45, *sc1* 23–27, *sc2* 37–40, *c1* 19–21, *c2* 21–24, *c3* 37–45, *d1* 16–18, *d2* 19–22, *d3* 42–44, *e1* 17–18, *e2* 20–22, *e3* 44–47, *f2* 22–27, *f3* 40–46, *h1* 21–24, *h2* 12–17.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6) and one narrow eupathidium (9–11) distally, one dorsal seta (9-11); palp femorogenu with one seta (16–20).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae; transverse striae between *1b–1b*; longitudinal *1b–1a*; transverse striate *1a–g1*; oblique to longitudinal *g1–g1*, becoming transverse towards *ps3*; longitudinal striae laterad genital region. Seta *1a* elongate, fine (difficult to determine full length). Setae *ag*, *g1*, *ps2*, *ps3* weakly barbed. Setal measurements: *1a* 44–93, *1b* 10–15, *3a* 9–11, *4a* 35–44, *ag* 8–10, *g1* 7–9, *ps2* 6–8, *ps3* 6–7.

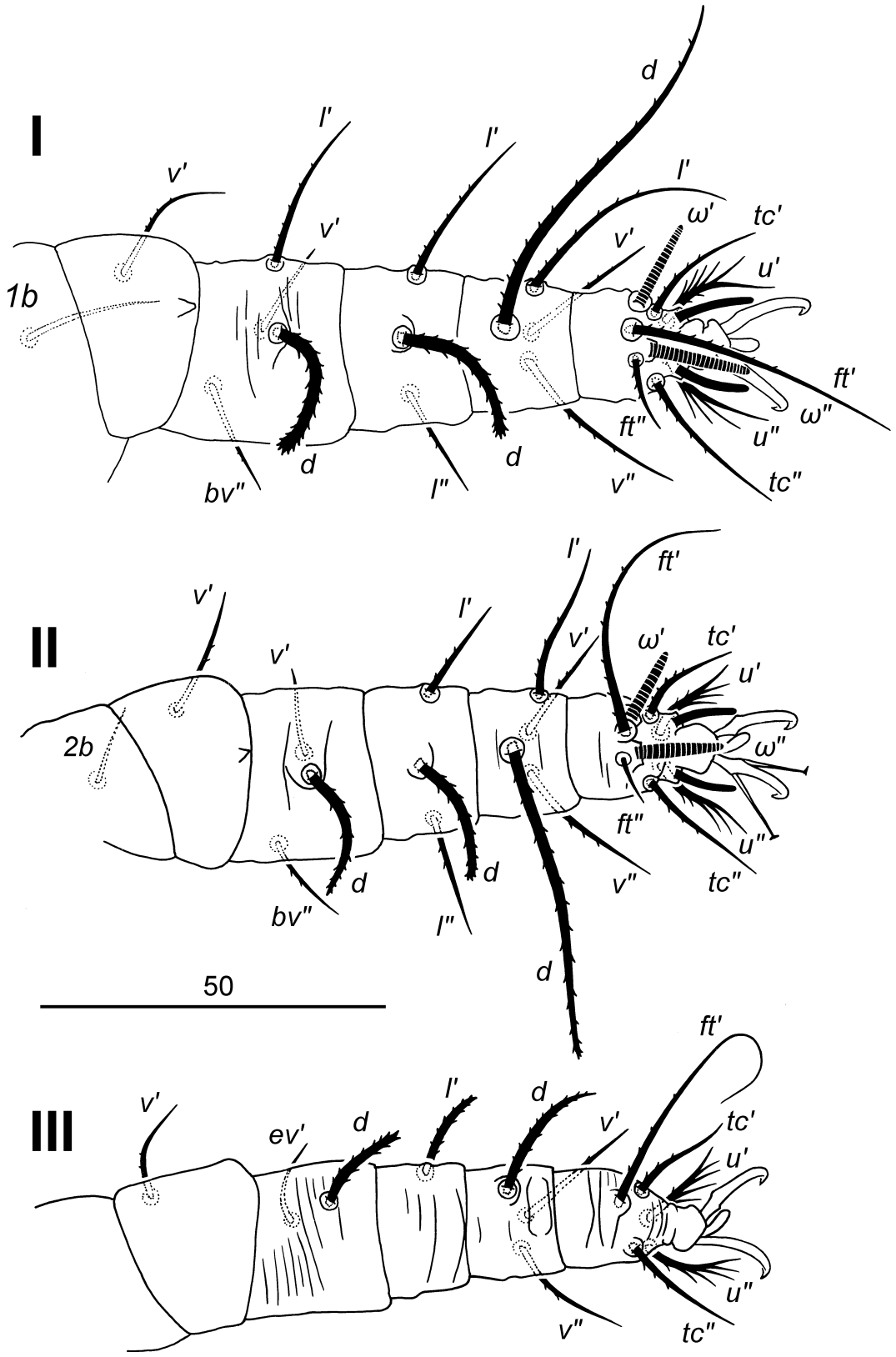


FIGURE 68. *Raoiella crebra* Beard & Ochoa, adult male: legs I, II, III (right side; legs I–II dorsal aspect, leg III abaxial aspect).

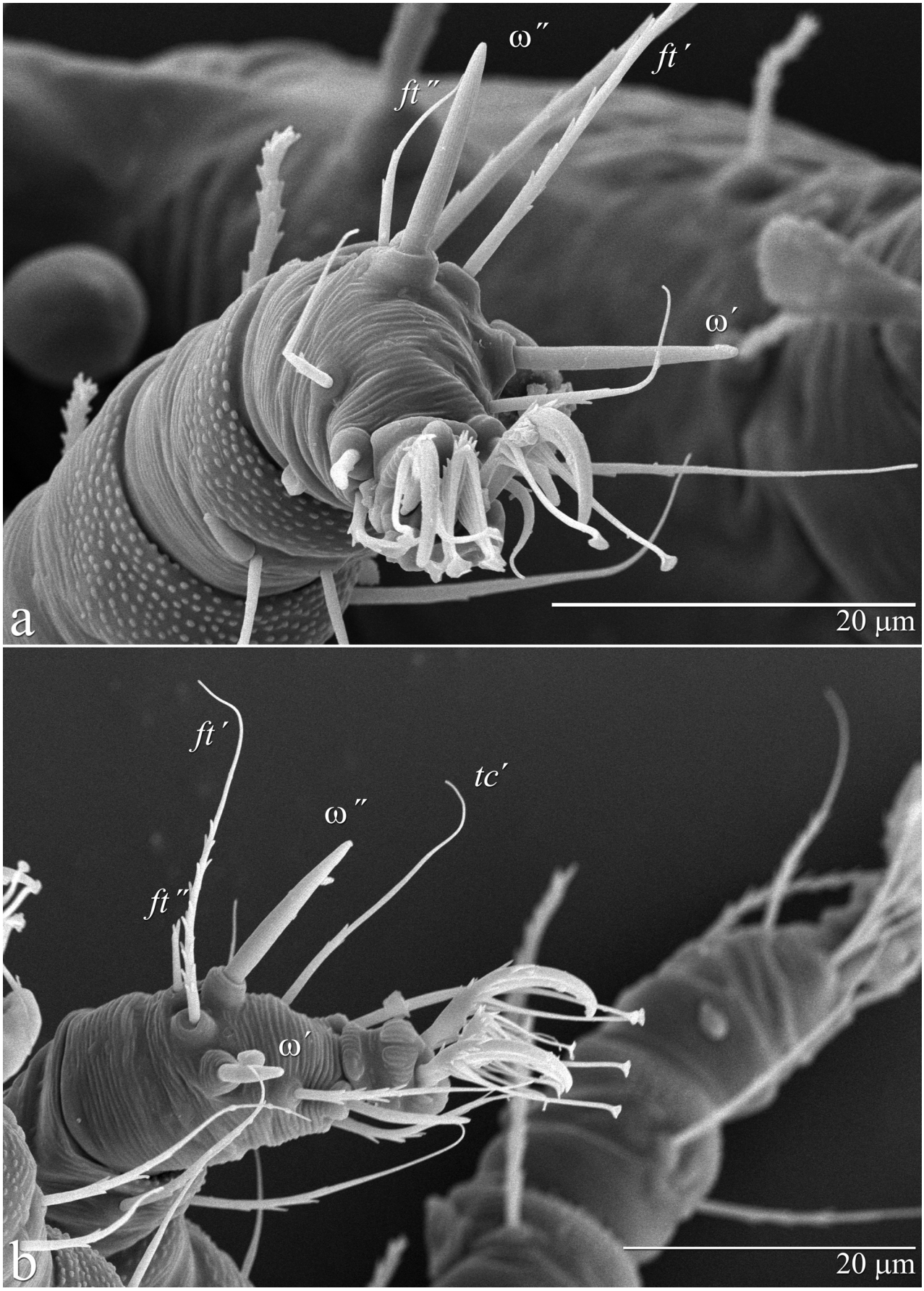


FIGURE 69. *Raoiella crebra* Beard & Ochoa, adult male: a. detail of tarsus I, indicating solenidion (*ω″*) and companion seta (*ft″*); b. detail of tarsus II (note that solenidion *ω′* is foreshortened).

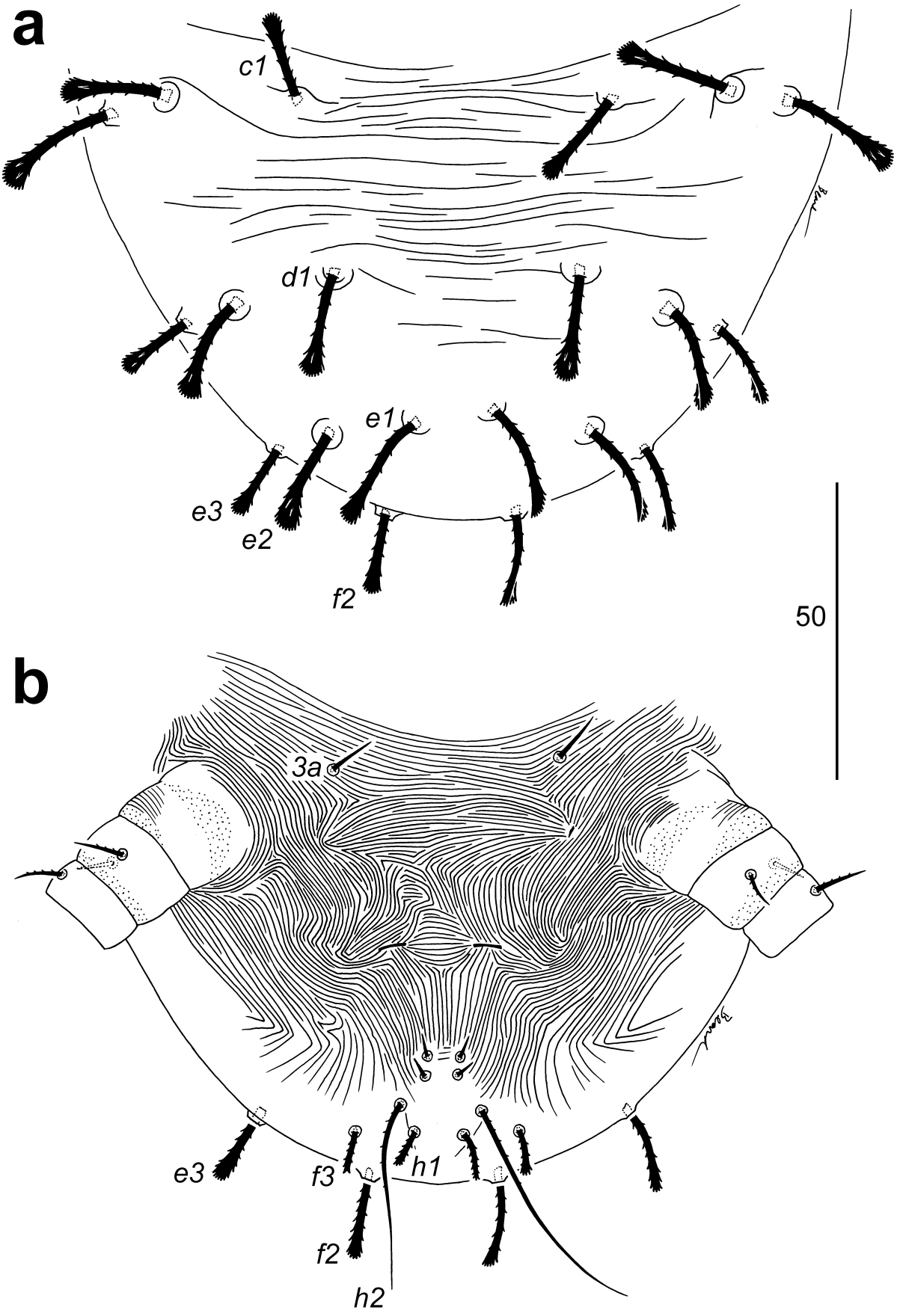


FIGURE 70. *Raoiella crebra* Beard & Ochoa, larva: a. dorsal opisthosoma; b. posterior venter.

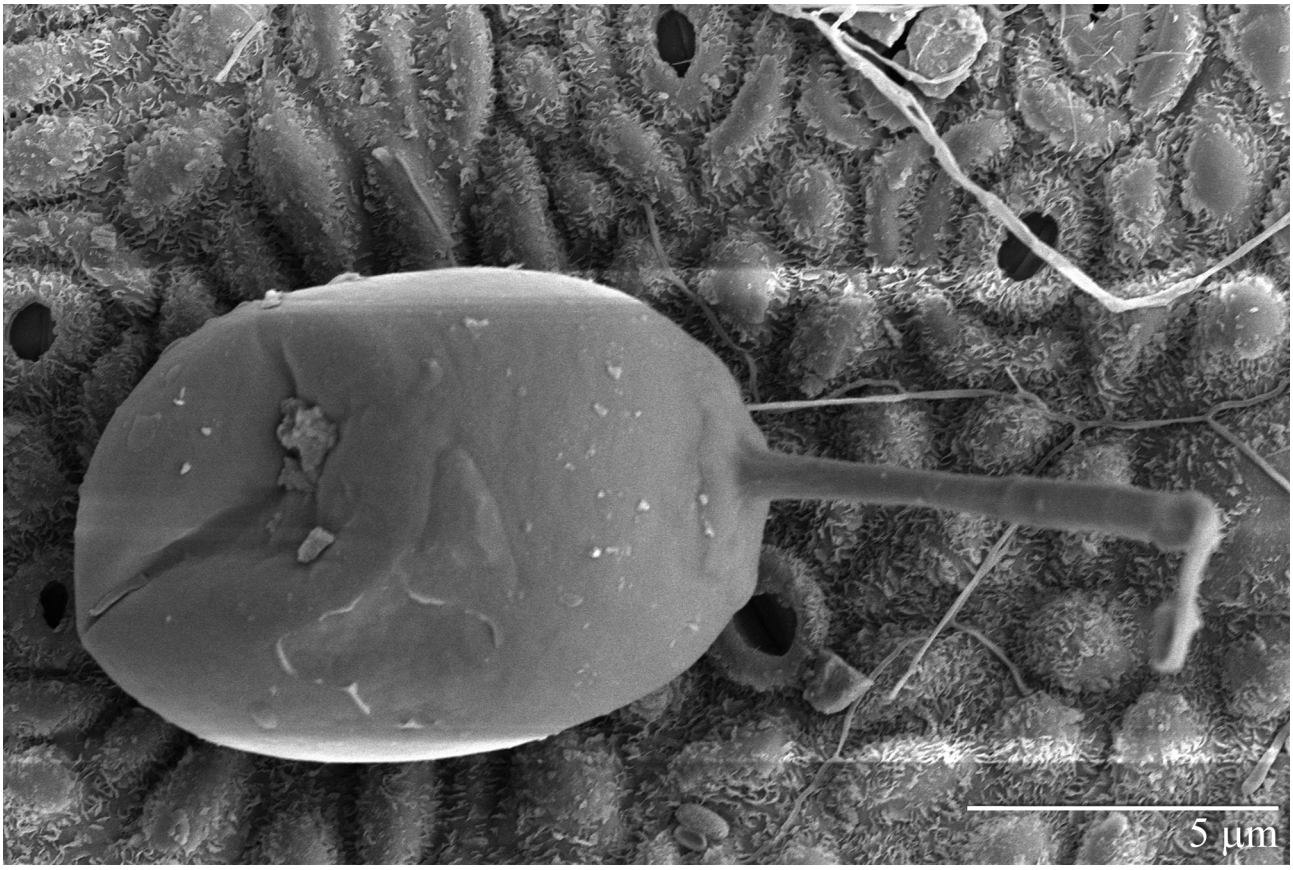


FIGURE 71. *Raoiella crebra* Beard & Ochoa, egg on host plant.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 9–10; ta II 8–9) and two eupathidia distally (ta I 9, 9; ta II 8–9, 8–9). Short weakly barbed companion seta *ft″* on tarsus I 6–7 and tarsus II 5–6, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta *d* spatulate (ti I 52–53, ti II 45–50). Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with two setae (*d*, *l′* present ; *l″* absent). Claw I 14–15.

Protonymph. ***Dorsum.*** Body measurements (2): length between setae *v2–f2* 155–174, width between setae *sc2–sc2* 123–124, *c3–c3* 127–128, *f3–f3* 43–45. Prodorsum smooth. Dorsal opisthosoma with weak, widely spaced transverse striae between *c1–e1*. Dorsal setae spatulate, barbed along entire length; setae *f3* often inserted ventrally; setae *h1* weakly spatulate, *h2* blunt to tapered; *h1*, *h2* inserted ventrally. Dorsal setae measurements: *v2* 31–34, *sc1* 23–26, *sc2* 30–34, *c1* 12–19, *c2* 19–22, *c3* 30–34, *d1* 15–16, *d2* 18–19, *d3* 30–33, *e1* 15–19, *e2* 18–19, *e3* 25–32, *f2* 18–21, *f3* 19–20, *h1* 9–11, *h2* 8–11.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5) and one narrow eupathidium (8–9) distally, one dorsal seta (8-9); palp femorogenu with one seta (12–16).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, longitudinal striae between *1b–1a*, transverse *1a–ag*, oblique *ag–ps2*, longitudinal striae laterad *ps* setae; coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 35–41, *1b* 9–10, *3a* 6–9, *ag* 7, *ps2* 4, *ps3* 4.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 7–8; ta II 7) and two eupathidia distally (ta I 6–7, 7; ta II 6–7, 6–7). Short companion seta *ft″* on tarsus I 5–6 and tarsus II 3–5, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta, *d*, spatulate (dtiI 42–45, dtiII 38–39). Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with one seta (*l′*). Claw I 12–13 long.

Larva. ***Dorsum.*** (Fig. 70a) Body measurements (5): length between setae *v2–f2* 124–137, width between setae *sc2–sc2* 102–113, *c3–c3* 108–114, *f3–f3* 20–34. Prodorsum with longitudinal to oblique striations. Opisthosoma with transverse striae between setae *c1–d1*. Setae *f3*, *h1* short, blunt to weakly spatulate, barbed; *h2* fine, elongate, tapered; setae *f3*, *h1*, *h2* inserted ventrally. Dorsal setae measurements: *v2* 24–27, *sc1* 22–25, *sc2* 19–22, *c1* 16–19,

c2 18–22, *c3* 20–23, *d1* 18–21, *d2* 19–22, *d3* 16–17, *e1* 19–22, *e2* 18–20, *e3* 12–16, *f2* 15–17, *f3* 8–10, *h1* 8–10, *h2* 37–43.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5) and one narrow eupathidium (9–11) distally, and one seta dorsally (8–10); palp femorogenu with one seta (9–12).

Venter. (Fig. 70b) Cuticle almost completely strongly plicate, except coxal fields smooth; transverse striae between *1b–1b*, oblique striae *1b–1a*, transverse striae *1a–3a*, with transverse, longitudinal and oblique striae *3a–ps3*, *3a–3a* transverse, anterior to *ps3* longitudinal. Setal measurements: *1a* 28–46, *1b* 10–13, *3a* 8–9, *ps2* 3–5, *ps3* 3–4.

Legs. Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Femora I–II with three setae (*d*, *v′*, *bv″*; seta *l′* absent); genua I–II with one seta (*l′*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 6–7; ta II 5–6) and two eupathidia *pζ″–pζ″* distally (ta I 6–7, 6–7; ta II 6–7, 6–7). Barbed tapered companion seta *ft″* on tarsus I 4–5 and tarsus II 4–5, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta finely tapered. Claw I 11–12.

Egg. (Fig. 71) Red, ellipsoid, 120–130 long 75–80 wide; stipe strong, 100–115 long, with strong attachment point.

Host. Narrow-leaved ironbark, *Eucalyptus crebra* (Myrtaceae).

Distribution. AUSTRALIA: southeast Queensland.

Etymology. This species is named for its host plant, *Eucalyptus crebra*.

Remarks. *Raoiella crebra* **sp. nov.** was listed in Dowling *et al.* (2012) as *Raoiella* sp. 4 (DNA code RaIn45) along with a specimen labelled RaIn66, which we consider here to be a separate species, *Raoiella illyarrie* **sp. nov.**, and was listed as *Raoiella* sp. 4A in Beard *et al*. (2013). The two populations considered as species 4 in the Dowling *et al.* (2012) study were shown to exhibit 2.81% sequence divergence, which greatly exceeds the intraspecific variation seen in species 1 (0.6–1.0%), but is still a low amount of interspecific divergence across *Raoiella*. Our subsequent morphological analysis has shown that the two populations collected from different host plants and from opposite sides of the Australian continent, do actually represent two distinct species, *R. crebra* and *R. illyarrie*.

Raoiella crebra differs from *R. illyarrie* in the following manner: *Rc* setae *sc1* 28–31 vs *Ri sc1* 30–47; *Rc* seta *d* on tibiae I 58–65 and tibiae II 58–61 vs *Ri* seta *d* on tibiae I 74–81 and tibiae II 65–69; *Rc* companion seta on tarsus I subequal or shorter than solenidion vs *Ri* companion seta on tarsus I longer than solenidion. *Raoiella crebra* is also similar to *R. hallingi* (not included in the molecular analyses by Dowling *et al.* 2012), though it can be easily separated from this species as male *R. crebra* have one seta present on trochanter IV, while male *R. hallingi* is considered to have a nude trochanter IV (pattern of expression is uncertain—see Remarks for *R. hallingi*). See also Remarks for *R. calgoa.*

Raoiella davisi sp. nov. Beard

(Figs 72–77)

Material examined. Holotype. ♀. **Australia,** ex. prickly broom heath *Monotoca scoparia* (Sm.) R. Br. (Ericaceae), State Forest 1294, Aramara, Queensland, 25°27’35”S 152°18’54”E, 21.xii.2002, J.J. Beard (QM, UQIC 52819).

Paratypes. 8 ♀, 10 ♂, protonymph, larva, same data as holotype. (QM, USNM—♀ UQIC 52812–13, 52815–17, 52819–20, ♂ 52821–52830, immatures on same slide 52831).

Other material examined. **Australia,** 4 ♀, 1 ♂, ex. *M. scoparia*, Mudjimba, Queensland, 27.vi.1965, J.J. Davis (QM; N1496).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* short, tapered. Adult femora I–II with four setae (*d*, *l′*, *bv″*, *v′*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Adult female genua I–II with two setae (*l′*, *l″* present; *d* absent); adult male genua I–II with three setae (*d*, *l′*, *l″*). Tarsi I–II with companion setae (*ft″*) just longer than or subequal to solenidion. Dorsal setae on tibiae I–II tapered, blunt. Eupathidium on palp tibiotarsus blunt.

Description. Female. ***Dorsum.*** (Fig. 72) Body measurements (10 + {4 Mudjimba specimens}): length between setae *v2–h1* 208–221 [208] {236–247}, width between setae *sc2–sc2* 163–168 [163] {181–187}, *c3–c3*

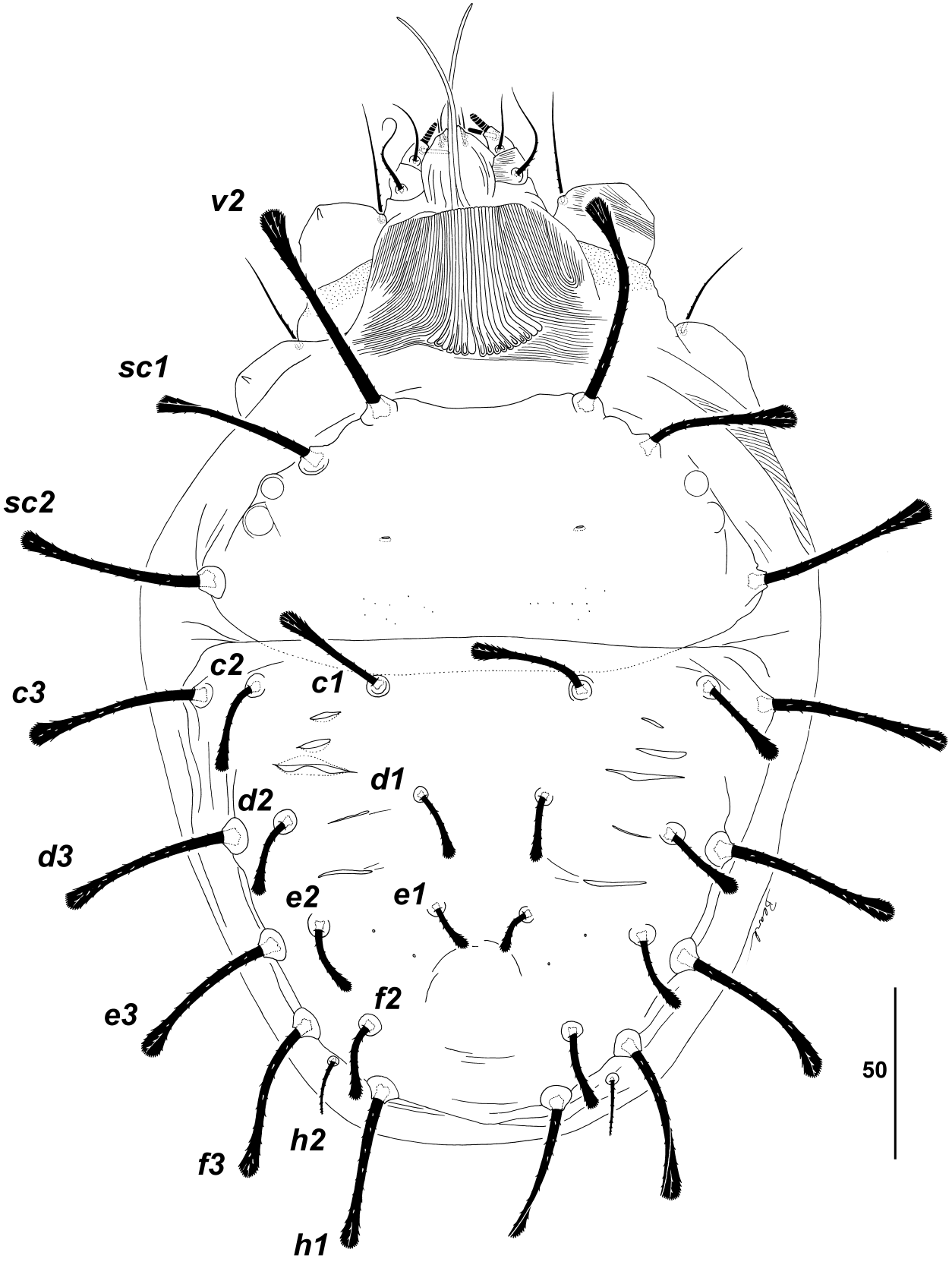


FIGURE 72. *Raoiella davisi* Beard, adult female: dorsal habitus with detail of palps.

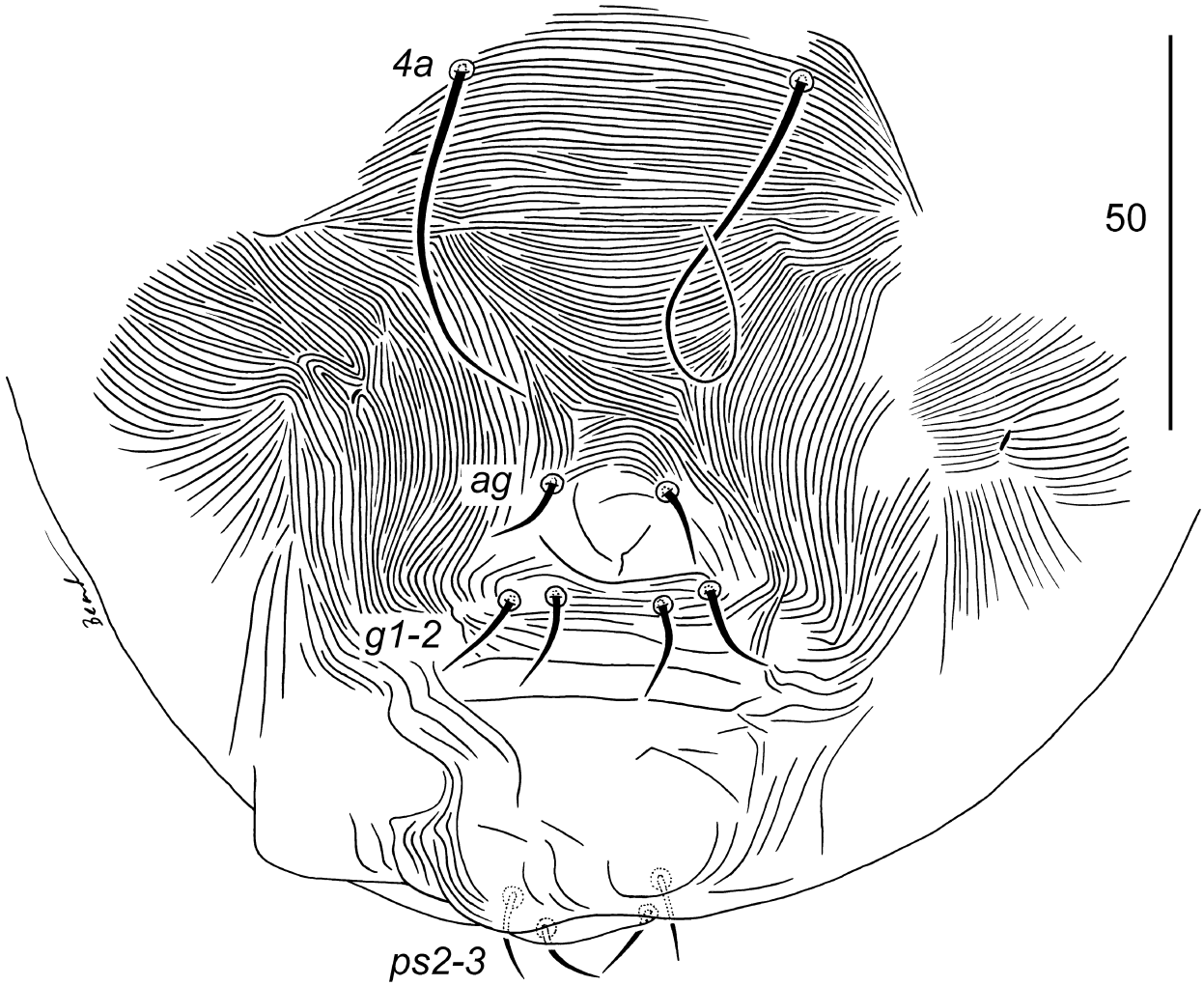


FIGURE 73. *Raoiella davisi* Beard, adult female: posterior venter.

168–174 [168] {182–196}, *f3–f3* 87–101 [93] {107–113}. Lightly sclerotised prodorsal and opisthonotal shields evident. Prodorsum with pair of pores mesally; opisthosoma with three pairs of large pores between setae *c2–d2*, pair slit pores between *d1–d2* and *d2–e2*, pair of minute pores between setae *e1–e2*; two pairs large pores between setae *d2–e2*; pair of minute pores between setae *e1–e2*. Dorsal setae thick, spatulate, barbed along entire length. Setae *h2* short, blunt. Dorsal setae measurements: *v2* 61–70 [70] {72–80}, *sc1* 48–55 [53] {49–61}, *sc2* 55–61 [60] {67–70}, *c1* 32–39 [37] {33–38}, *c2* 29–33 [31] {32–38}, *c3* 52–60 [52] {65–71}, *d1* 20–27 [20] {15–19}, *d2* 24–31 [27] {29–30}, *d3* 54–60 [56] {63–69}, *e1* 13–-18 [17] {12–15}, *e2* 23–28 [26] {30–32}, *e3* 48–57 [57] {59–62}, *f2* 24–28 [26] {29–34}, *f3* 49–55 [51] {61–64}, *h1* 48–51 [50] {57–63}, *h2* 15–17 [17] {16–19}.

Palps. (Fig. 72) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–8) [7–8] {7–8} and one blunt eupathidium (6–8) [8] {10–11} distally, one dorsal seta (13–15); palp femorogenu with one seta (26–30).

Venter. (Fig. 73) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth; genital flap small, mostly smooth between *ag* and *g1–2*. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *ag*, *g1–2*, *ps2–3* smooth to sparsely barbed. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 61–100 [88] {73}, *1b* 23–32 [30–31] {24–26}, *2b* 18–27 [21] {17–20}, *3a* 14–22 [17] {16–17}, *4a* 48–86 [64] {49–69}, *ag* 11–15 [11] {11}, *g1* 11–13 [13] {12}, *g2* 10–14 [13] {10–13}, *ps2* 10–13 [13] {11–16}, *ps3* 9–12 [10] {15–16}.

Spermatheca. Not visible.

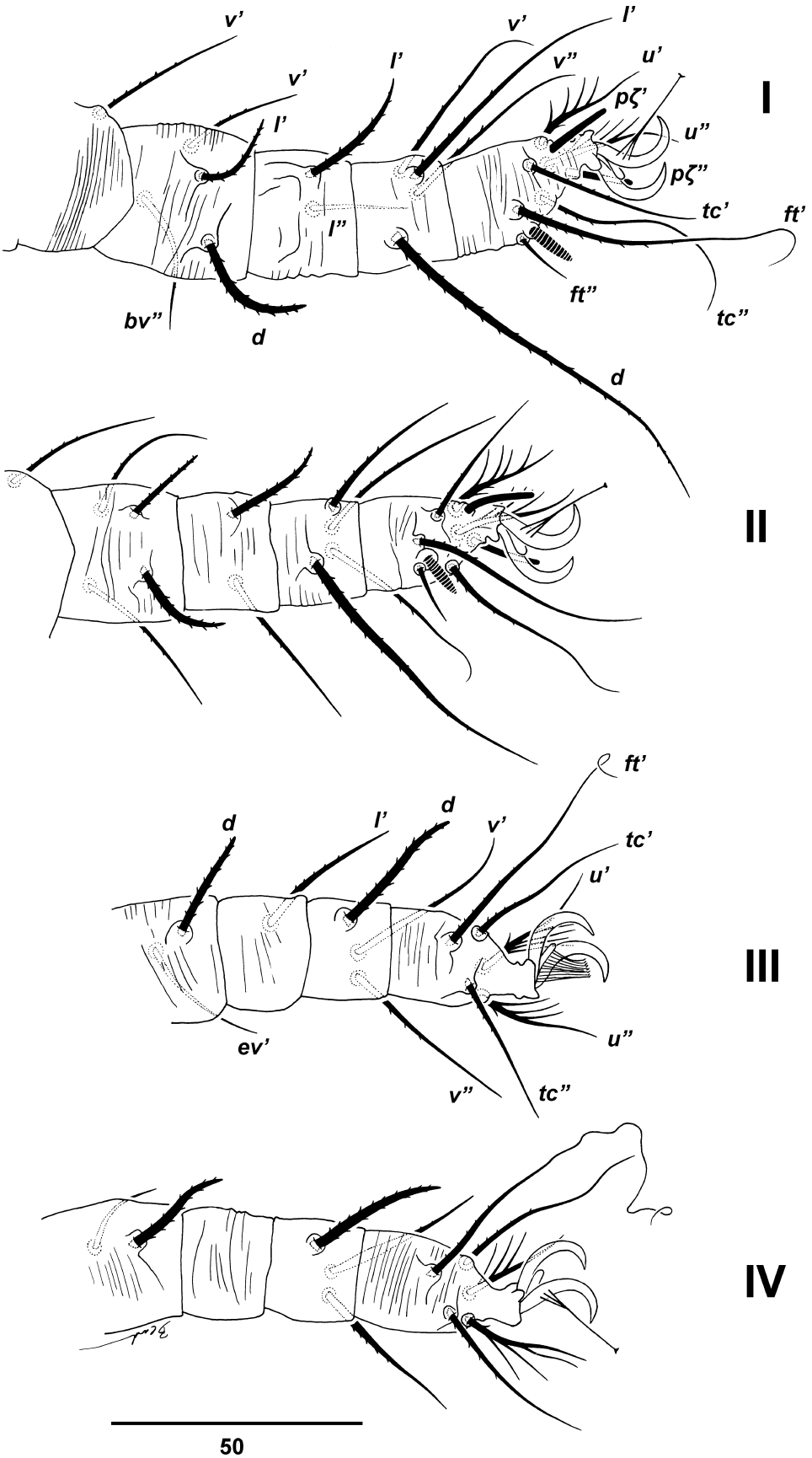


FIGURE 74. *Raoiella davisi* Beard, adult female: legs I–IV (right side; legs I–II dorsal to adaxial aspect, legs III–IV abaxial aspect).

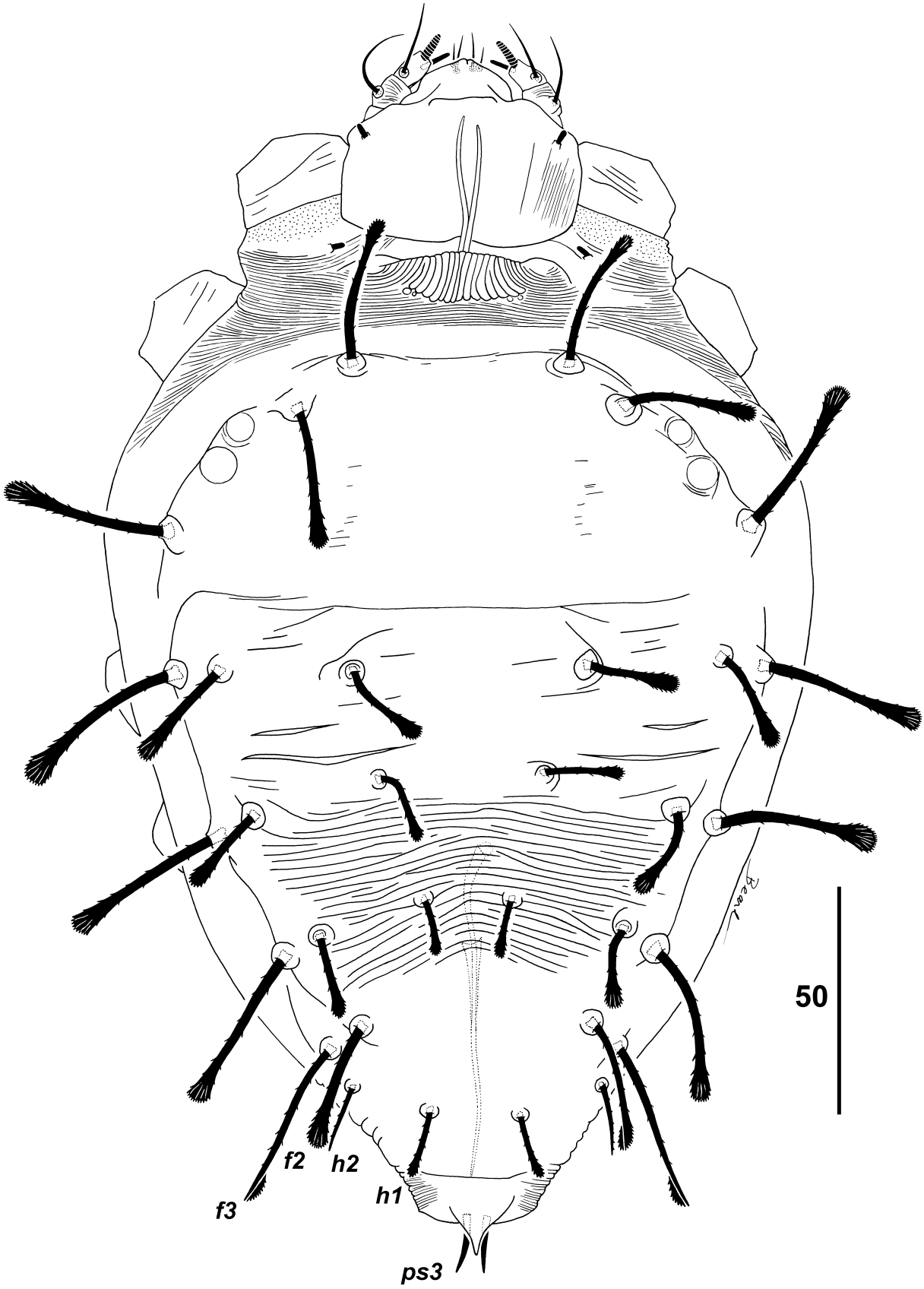


FIGURE 75. *Raoiella davisi* Beard, adult male: dorsal habitus, with detail of palps, aedeagus and setae *ps3*.

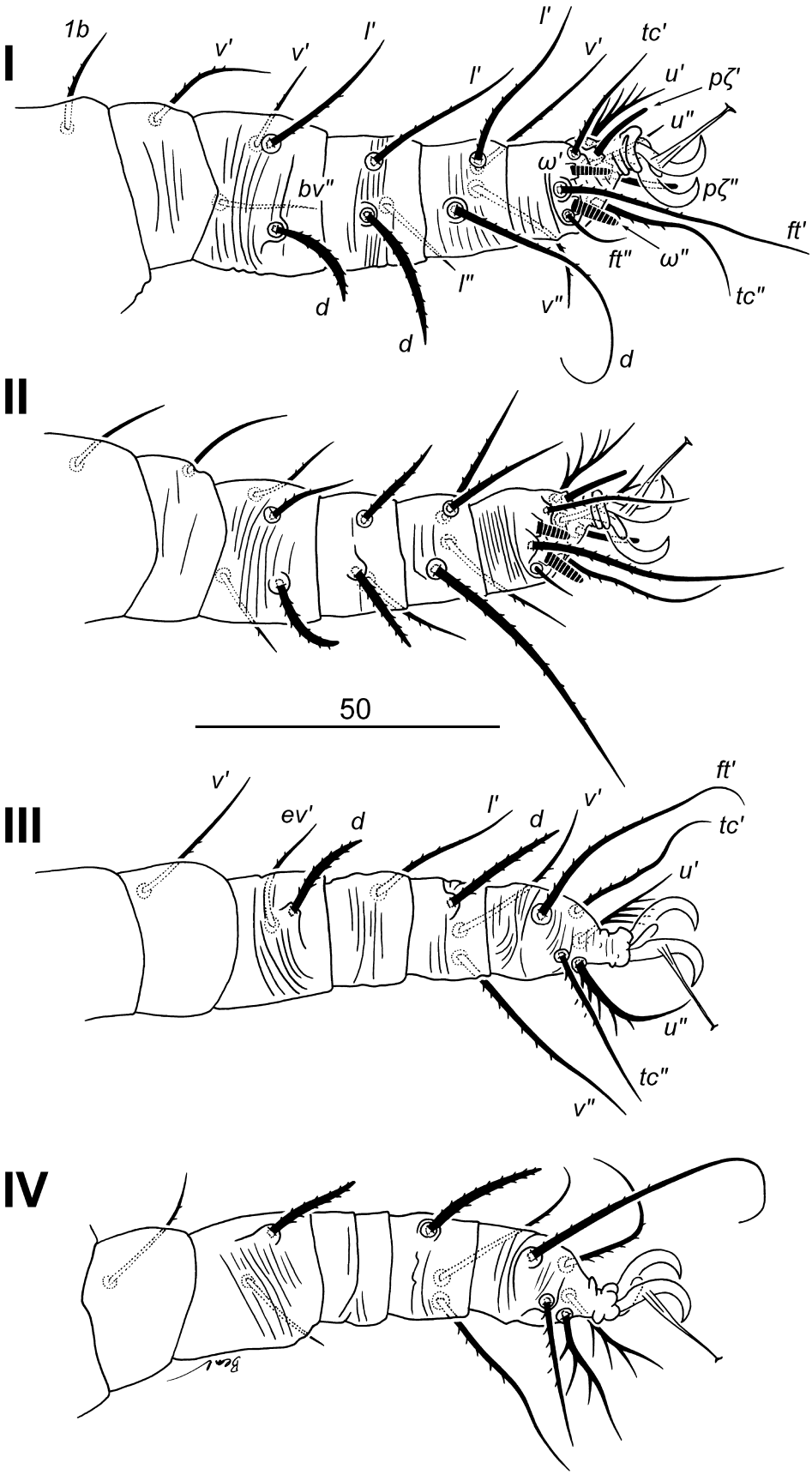


FIGURE 76. *Raoiella davisi* Beard, adult male: legs I–IV (right side; legs I–II dorsal aspect, legs III–IV dorsal to abaxial aspect).

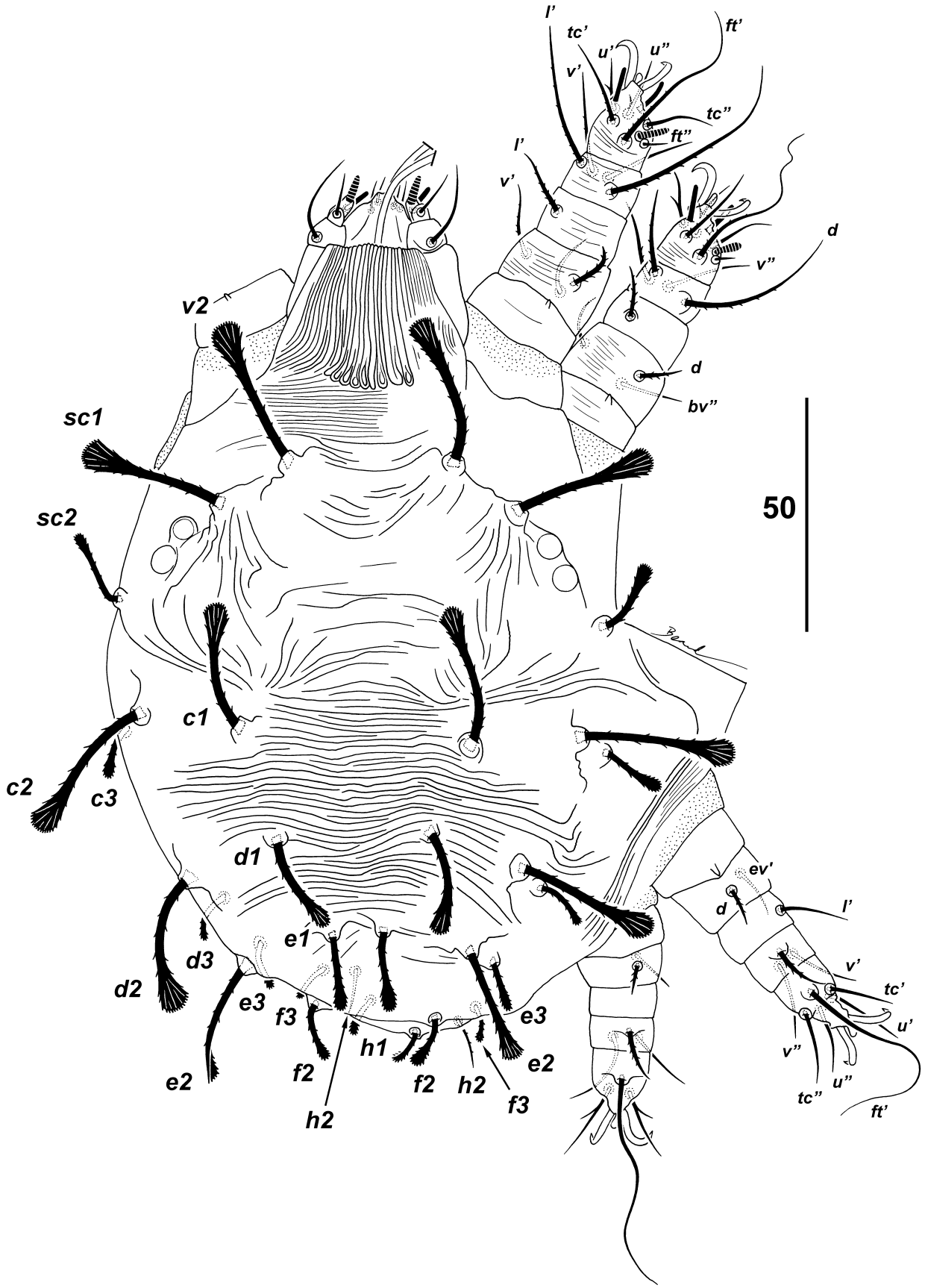


FIGURE 77. *Raoiella davisi* Beard, protonymph: dorsal habitus with details of legs I–IV.

Legs. (Fig. 74) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-9(1), 1-1-4-2-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 9–10 [9] {9–10}; ta II 7–8 [8] {8–9}) and two eupathidia *pζ′–pζ″* distally (ta I 14–15 [14], 14 [14]; ta II 13–14 [14], 12–14 [13]). Companion seta *ft″* smooth, fine, on tarsus I 11–15 [12] {12–17} and tarsus II 8–12 [12] {12–15}, inserted on shared tubercle with solenidion *ω″* almost forming a duplex seta. Tibiae I–II with dorsal seta tapered but not finely tapered. Femora I–II with four setae (*d*, *l′*, *bv″*, *v′*), genua I–II with two setae (*l′*, *l″* present; *d* absent). Tenent hairs on claws with three–four attachment points. Claw I 17–18 {19–20}, claw IV 17–18 {19–20}.

Male. *Dorsum.* (Fig. 75) Body measurements (8): length between setae *v2–h1* 158–170 {183} , width between setae *sc2–sc2* 124–134 {137}, *c3–c3* 129–136 {136}, *f3–f3* 63–68 {68}. Prodorsum smooth; opisthosoma with transverse striae, strongest between setae *d1* and *f2*. Dorsal setae spatulate, barbed along entire length, narrower than female. Seta *h1* weakly spatulate, *h2* setose. Dorsal setae measurements: *v2* 29–38 {40–41}, *sc1* 30–35 {38–39}, *sc2* 38–46 {51–52}, *c1* 22–28 {26–30}, *c2* 25–33 {27–29}, *c3* 37–41 {54–57}, *d1* 17–20 {13–14}, *d2* 21–27 {23–27}, *d3* 38–41 {53–54}, *e1* 12–17 {11–13}, *e2* 17–23 {24–25}, *e3* 37–40 {48–52}, *f2* 27–31 {25–27}, *f3* 33–39 {38–46}, *h1* 15–18 {19–23}, *h2* 14–17 {16}.

Palps. (Fig. 75) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion 5–6 {7} and one blunt eupathidium 5–7 {9} distally, and one dorsal seta 12–14; palp femorogenu with one seta 16–19.

Venter. Setal measurements: *1a* 56–75 {68}, *1b* 17–26 {23}, *2b* 16–19 {13}, *3a* 13–17 {13}, *4a* 46–77 {63}, *ag* 9–12 {12}, *g1* 7–9 {9}, *g2* 8–10 {10}, *ps2* 9–12 {11–12}, *ps3* 12–14 {13–14}.

Aedeagus. (Fig. 75) Aedeagus narrow, elongate and sclerotised 52–59 {50}, tapering to a blunt point distally (at genital opening).

Legs. (Fig. 76) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-4-3-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial *ω′* 6–8 {7–8}, abaxial *ω″* 6–8 {9}; ta II adaxial *ω′* 6–7 {7}, abaxial *ω″* 7–8 {8}), and two eupathidia distally (ta I 11–12, 10–12; ta II 11–12, 11–12). Companion seta *ft″* smooth, fine, on tarsus I 10–13 {15} and tarsus II 8-10 {11}, inserted on shared tubercle with solenidion *ω″* almost forming a duplex seta. Tibiae I–II with dorsal seta tapered. Femora I–II with four setae (*d*, *l′*, *bv″*, *v′*), genua I–II with three setae (*d*, *l′*, *l″*). Tenent hairs on claws with three attachment points. Claw I 15–16, claw IV 13–15 {15–16}.

Deutonymph. Unknown.

Protonymph. *Dorsum.* (Fig. 77) Body measurements (1): length between setae *v2–h1* 126, width between setae *sc2–sc2* 105, *c3–c3* 108, *f2–f2* 25. Dorsal setae spatulate, barbed along entire length; setae *d3*, *d3*, *f3*, *h1* weakly spatulate; setae *h2* tapered. Dorsal setae measurements: *v2* 35, *sc1* 33, *sc2* 19, *c1* 32, *c2* 36, *c3* 12–15, *d1* 25, *d2* 33, *d3* 13, *e1* 18, *e2* 28, *e3* 12, *f2* 15, *f3* 8, *h1* 10, *h2* 9.

Palps. (Fig. 77) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6) and one blunt eupathidium (5–6) distally, and one dorsal seta (10–11); palp femorogenu with one seta (17–19).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 58, *1b* 17, *3a* 13, *ag* 4, *ps2* 5, *ps3* 5.

Legs. (Fig. 77) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 6; ta II 5) and two eupathidia distally (ta I 7, 8; ta II 8, 8). Companion seta *ft″* smooth, fine, on tarsus I 4 and tarsus II 4, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta setose, not finely tapered. Femora I–II with three setae (*d*, *bv″*, *v′* present; *l′* absent), genua I–II with one seta (*l′*).

Larva. *Dorsum.* Body measurements (1): length between setae *v2–f2* 135, width between setae *sc2–sc2* 103, *c3–c3* 111, *f2–f2* 20. Prodorsum with longitudinal striations; opisthosoma with some transverse striae between setae *c1–e1*. Dorsal setae spatulate, barbed along entire length; setae *h1* short, tapered, *h2* fine, elongate. Dorsal setae measurements: *v2* 31–32, *sc1* 38–42, *sc2* 11–12, *c1* 31–32, *c2* 34–36, *c3* 9–10, *d1* 30–31, *d2* 30–32, *d3* 9, *e1* 22–26, *e2* 21, *e3* 8–9, *f2* 8–9, *f3* 9–10, *h1* 10, *h2* 37.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion and one blunt eupathidium distally, one dorsal seta.

Venter. Cuticle almost completely strongly plicate, except coxal fields smooth. Setal measurements: *1a* 55, *1b* 10, *3a* 8, *ps2* 4, *ps3* 4.

Legs. Setal formula for legs I–III (coxae to tibiae): 1-0-3-1-4, 0-0-3-1-4, 0-0-2-1-3 respectively. Tarsi I and II each with one abaxial solenidion and two eupathidia distally.

Host. Initially we felt that the recorded host, prickly broom heath, *Monotoca scoparia* (Ericaceae), was not the true host for *R. davisi* as there are no other *Raoiella* species known to have been collected from this plant family in the world. The type specimens of this species were collected on *M. scoparia* growing as undergrowth in a *Eucalyptus* forest, with the dominant tree species being narrow-leaved iron bark *E. crebra* F. Muell. and lemon-scented gum *Corymbia citriodora* (Hook.) K.D. Hill & L.A.S. Johnson, with smaller numbers of broad-leaved apple *Angophora subvelutina* (all Myrtaceae). We suspected that one of these three species would be the true host for this species. However, the senior author recently located specimens that were collected by Davis in 1965 from the same host plant, and from a similar geographic location, Mudjimba, indicating that broom heath could be the true host. However, as it is not known what the dominant tree species at the Mudjimba site were, the true host could still be a mystery. Although the body size, claws, and some setal measurements for this population (presented separately in the description above, within curly brackets) are generally larger than those for the type specimens, we feel that they represent the same species. The type specimens from Aramara were mounted in PVA, while those collected by Davis were mounted in Hoyer's medium. As we have seen occur with *Raoiella pooleyi* (see Remarks for this species), specimens mounted in PVA begin to shrink and thus their associated body measurements can be lower than those for specimens of the same species mounted in Hoyer's medium.

An alternative is that *R. davisi* is in fact conspecific with *R. didcota* (Fig. 78) collected in the same general geographic location from *A. subvelutina* (see Remarks below) with which it is morphologically quite similar, and that feeding on the non-preferred host *M. scoparia* has slightly altered the morphology of the individuals. However, until such time that the mite is recollected and molecular analyses can shed more light on the situation, we have to assume that the host for *R. davisi* is *M. scoparia*, even though on both the occasions that the mite was collected on this host, it was only present in low numbers (which can be an indicator that the plant species is not the preferred host).

Distribution. AUSTRALIA: southeast Queensland.

Etymology. This species is named after John James Davis, Queensland's first specialist in tetranychoid mite taxonomy, for his excellent detailed work on spider mites, and for being the first person to collect this species.

Remarks. *Raoiella davisi* was listed as *Raoiella* sp. 9 in Beard *et al*. (2013), and is in the *Raoiella australica* species group. This species is morphologically similar to *Raoiella didcota* **sp. nov.** which was collected within the same general geographic region from broad-leaved apple *Angophora subvelutina* (Myrtaceae). These two species can be separated by differences in the lengths of several dorsal setae: adult female *v2* (*Rdav* 61–70 vs *Rdid* 51–56), *c1* (32–39 vs 20–21), *d3* (54–60 vs 41–50), *e3* (48–57 vs 41–47), *f3* (49–55 vs 43–48), companion seta *ft″* ta I (11–15 vs 16–18), ta II (8–12 vs 11–16); male *c1* (22–28 vs 14–21), *h1* (15–18 vs 21–28); protonymph *sc2* (19 vs 29), *c3* (12–15 vs 22), *e1* (18 vs 27), *f2* (15 vs 29), palp eupathidium (5–6 vs 8–9). Dorsal setae on tibia I–II are tapered with blunt tips on *R. davisi*, but these setae are finely tapered on *R. didcota*. The solenidia on tarsi I–II are cylindrical on *R. davisi*, but trullate on *R. didcota*. Specimens of *R. davisi* were not included in the molecular analyses by Dowling *et al.* (2012).

Raoiella didcota **sp. nov. Beard**

(Figs 78–84)

Material examined. Holotype. ♀. **Australia**, ex. broad-leaved apple *Angophora subvelutina* F. Muell. (Myrtaceae), along Didcot Creek, 3.5 km east of Didcot, Queensland, 25°27'54"S 151°53'47"E, 29.viii.2004, J.J. Beard (QM, UQIC # 59787; single ♂ paratype also present on same slide).

Paratypes. 19 ♀, 1 pharate ♀, 11 ♂, 3 deutonymphs, 2 protonymphs, 1 larva, same data as holotype (QM, USNM—♀ UQIC # 59779–59786, ♂ 59787–59792, 59794, deutonymph 59796–97, protonymph 59799).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* short, tapered. Adult femora I–II with four setae (*d*, *l′*, *bv″*, *v′*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Adult female genua I–II with two setae (*l′*, *l″* present; *d* absent); adult male genua I–II with three setae (*d*, *l′*, *l″*). Tarsi I–II with companion setae (*ft″*) slightly longer than or subequal to solenidion. Dorsal setae on tibiae I–II finely tapered. Eupathidium on palp tibiotarsus blunt. Larva with setae *h2* elongate, filiform.

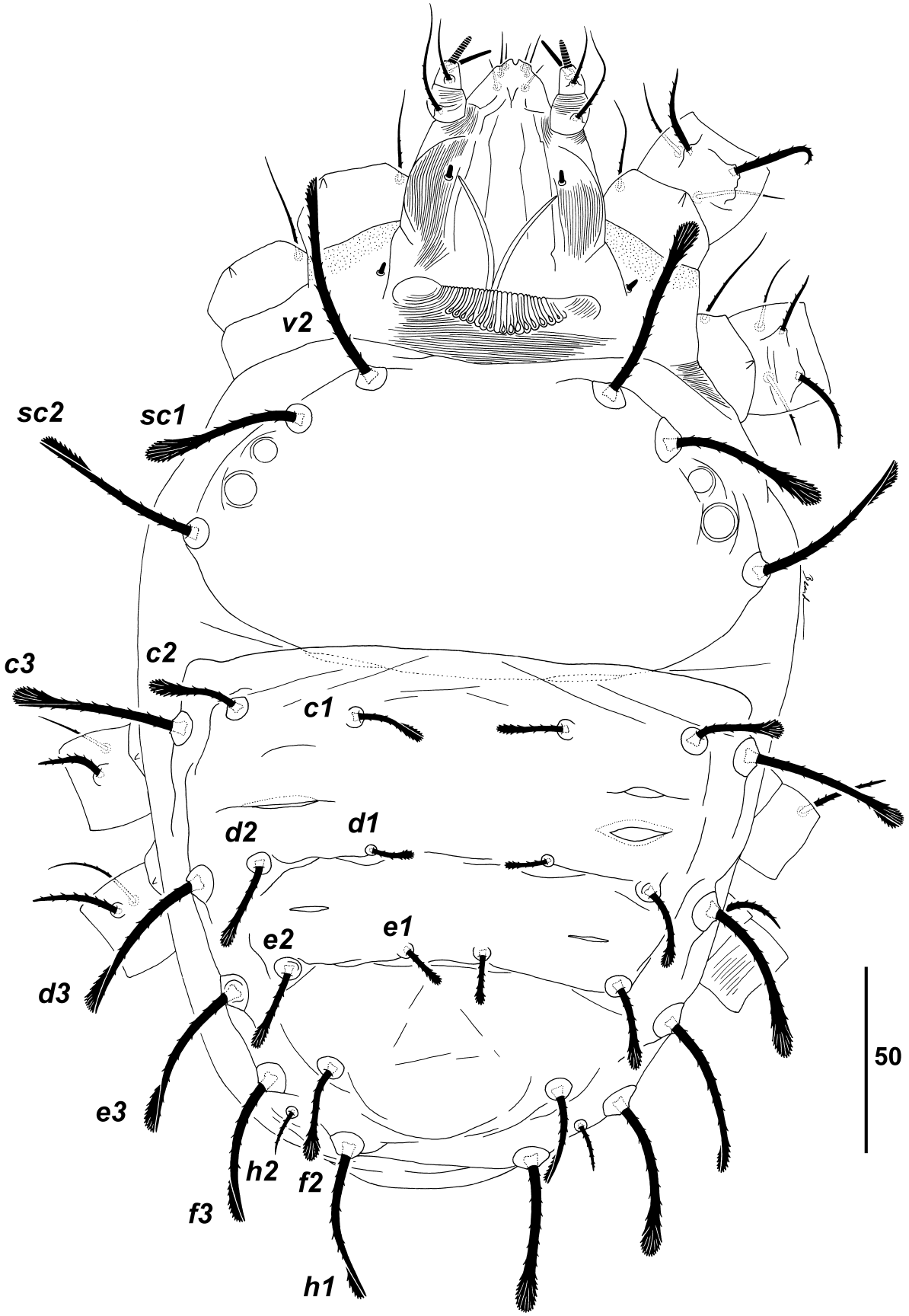


FIGURE 78. *Raoiella didcota* Beard, adult female: dorsal habitus with detail of palps.

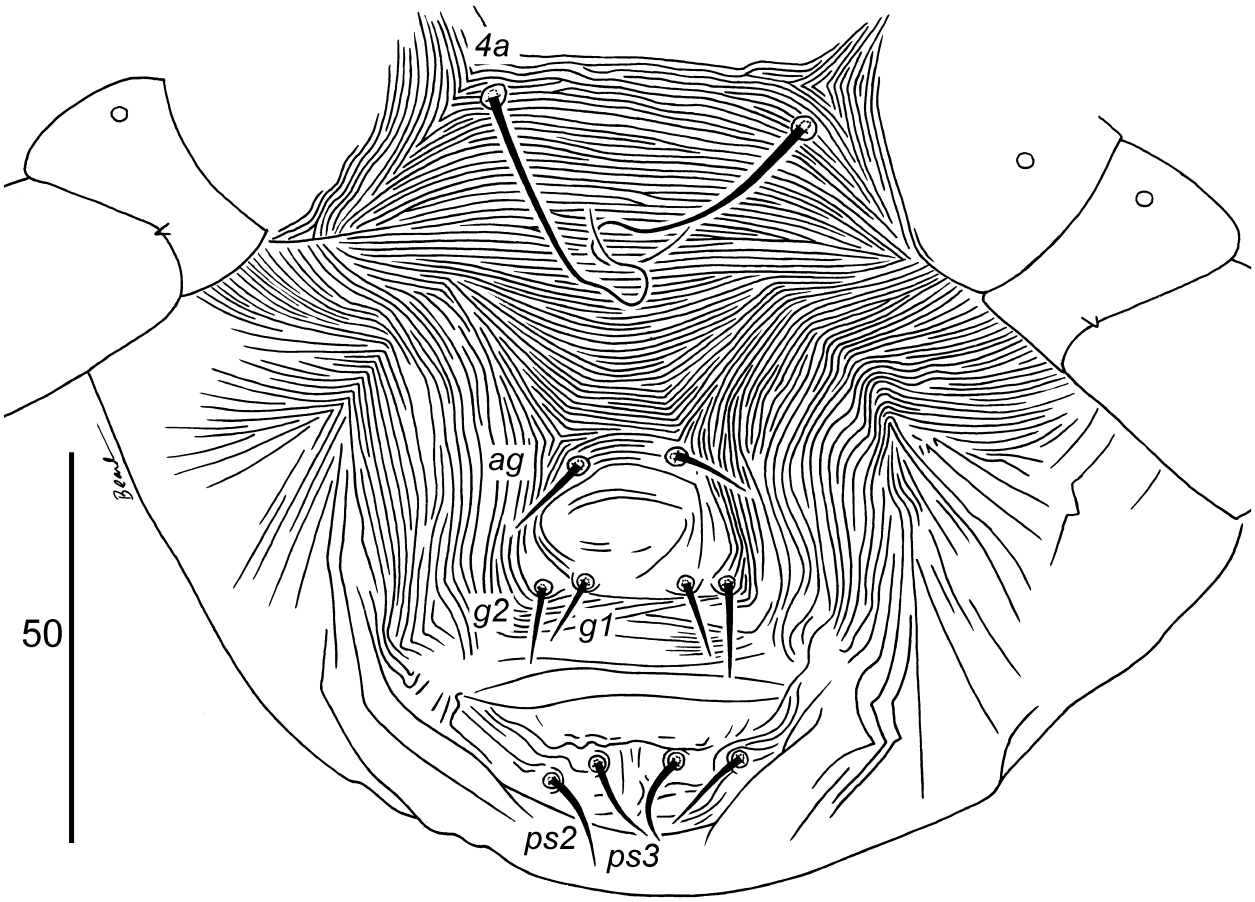


FIGURE 79. *Raoiella didcota* Beard, adult female: posterior venter.

Description. Female. ***Dorsum.*** (Fig. 78) Body measurements (6): length between setae *v2–h1* 207–226, width between setae *sc2–sc2* 154–168, *c3–c3* 153–176, *f3–f3* 96–103. Lightly sclerotised prodorsal and opisthonotal shields evident. Prodorsum with pair pores on posterior margin (often in folded cuticle between prosoma and opisthosoma); opisthosoma with two pairs of large pores between setae *c1–d2*; pair large pores between setae *d1–e2*. Dorsal setae spatulate, barbed along entire length. Setae *h2* short, tapered, barbed. Dorsal setae measurements: *v2* 51–56 [54], *sc1* 39–45 [45], *sc2* 46–53 [48], *c1* 20–21 [20], *c2* 26–31 [27], *c3* 44–50 [46], *d1* 12–18 [12], *d2* 23–25 [23], *d3* 41–50 [47], *e1* 15–21 [15], *e2* 22–30 [24], *e3* 41–47 [44], *f2* 25–35 [25], *f3* 43–48 [45], *h1* 40–49 [42], *h2* 12–17 [12].

Palps. (Fig. 78) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–8) [8] and one blunt eupathidium (11–13) [11] distally, one dorsal seta (13–15); palp femorogenu with one seta (23–27).

Venter. (Fig. 79) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *g1*, *g2*, *ps2*, *ps3* smooth to weakly barbed. Setal measurements: *1a* 67–87 [72], *1b* 21–25 [22], *2b* 16–22 [18], *3a* 10–17 [17], *4a* 43–61 [49], *ag* 11–13 [11], *g1* 10–13 [11], *g2* 12–15 [13], *ps2* 12–15 [15], *ps3* 10 [10].

Spermatheca. Not visible.

Legs. (Fig. 80) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-9(1), 1-1-4-2-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial trullate solenidion (ta I 9–11 [11]; ta II 8–10 [10]) and two eupathidia distally (ta I 14–15 [15], 13–15 [15]; ta II 12–14 [13], 13–14 [13]). Companion seta *ft″* on tarsus I 16–18 [18] and tarsus II 11–16 [15–16], inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta with finely tapered tip. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*), genua I–II with two setae (*l′*, *l″* present; *d* absent). Tenent hairs on claws with three–four attachment points.

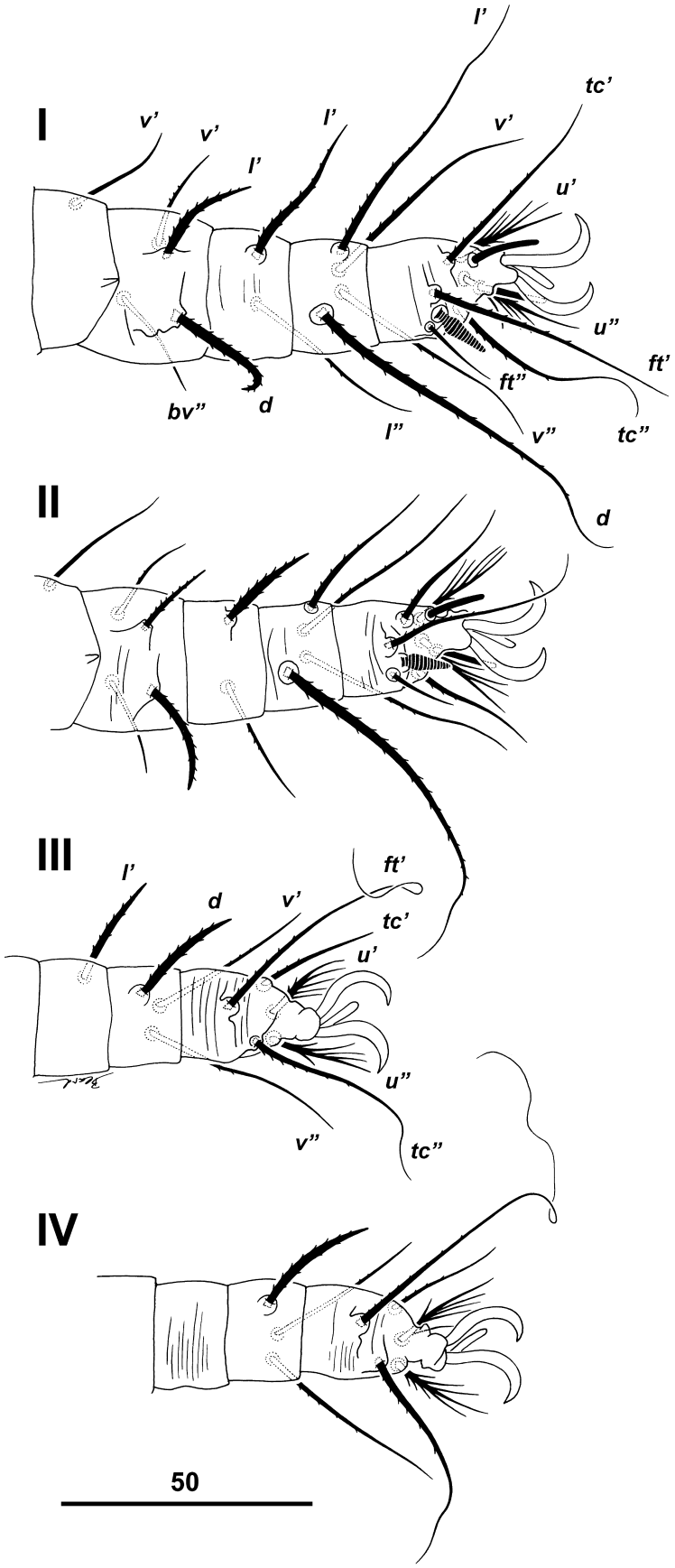


FIGURE 80. *Raoiella didcota* Beard, adult female: legs I–IV (right side, dorsal aspect).

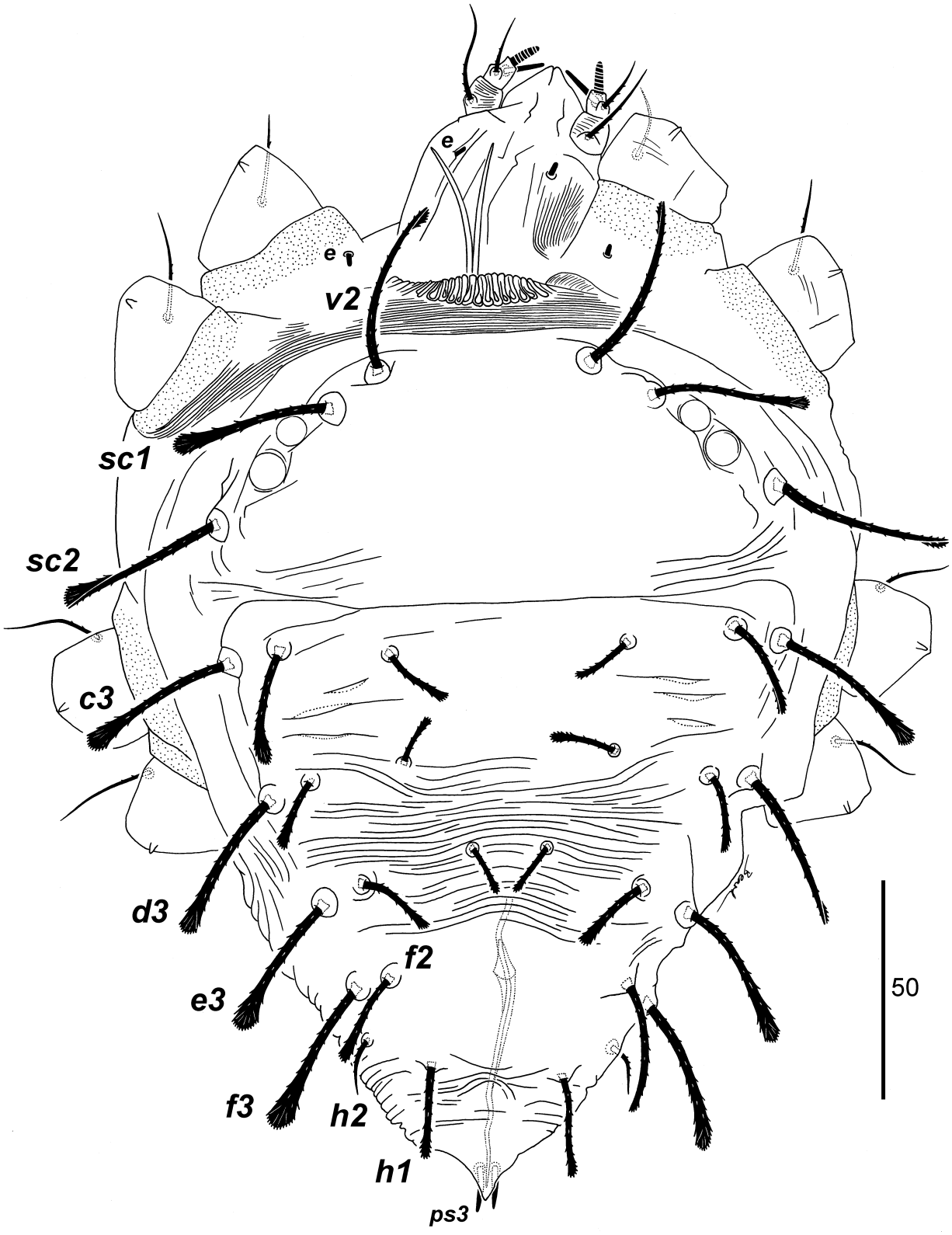


FIGURE 81. *Raoiella didcota* Beard, adult male: dorsal habitus, with detail of palps, aedeagus and setae *ps3*.

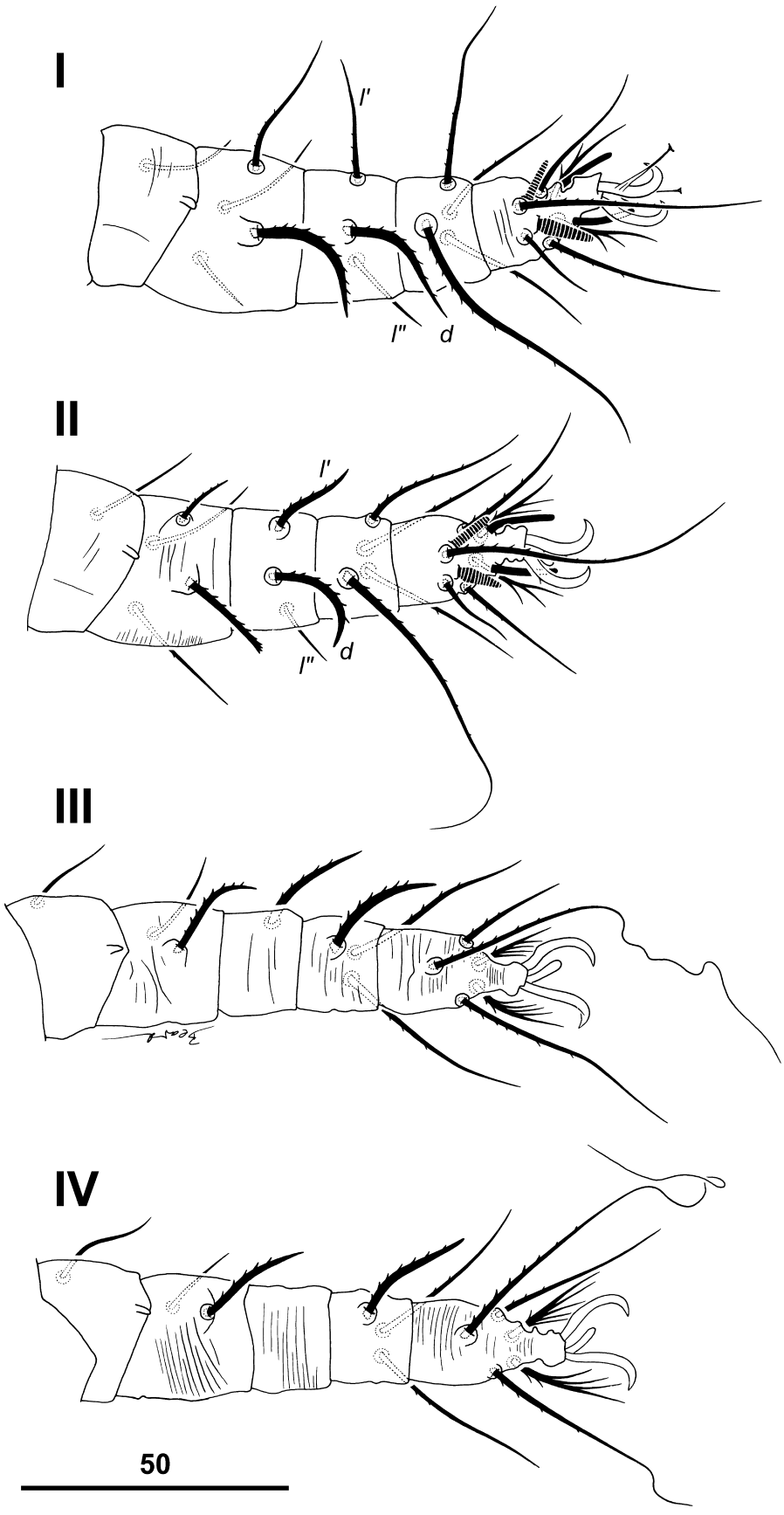


FIGURE 82. *Raoiella didcota* Beard, adult male: legs I–IV (right side, dorsal aspect).

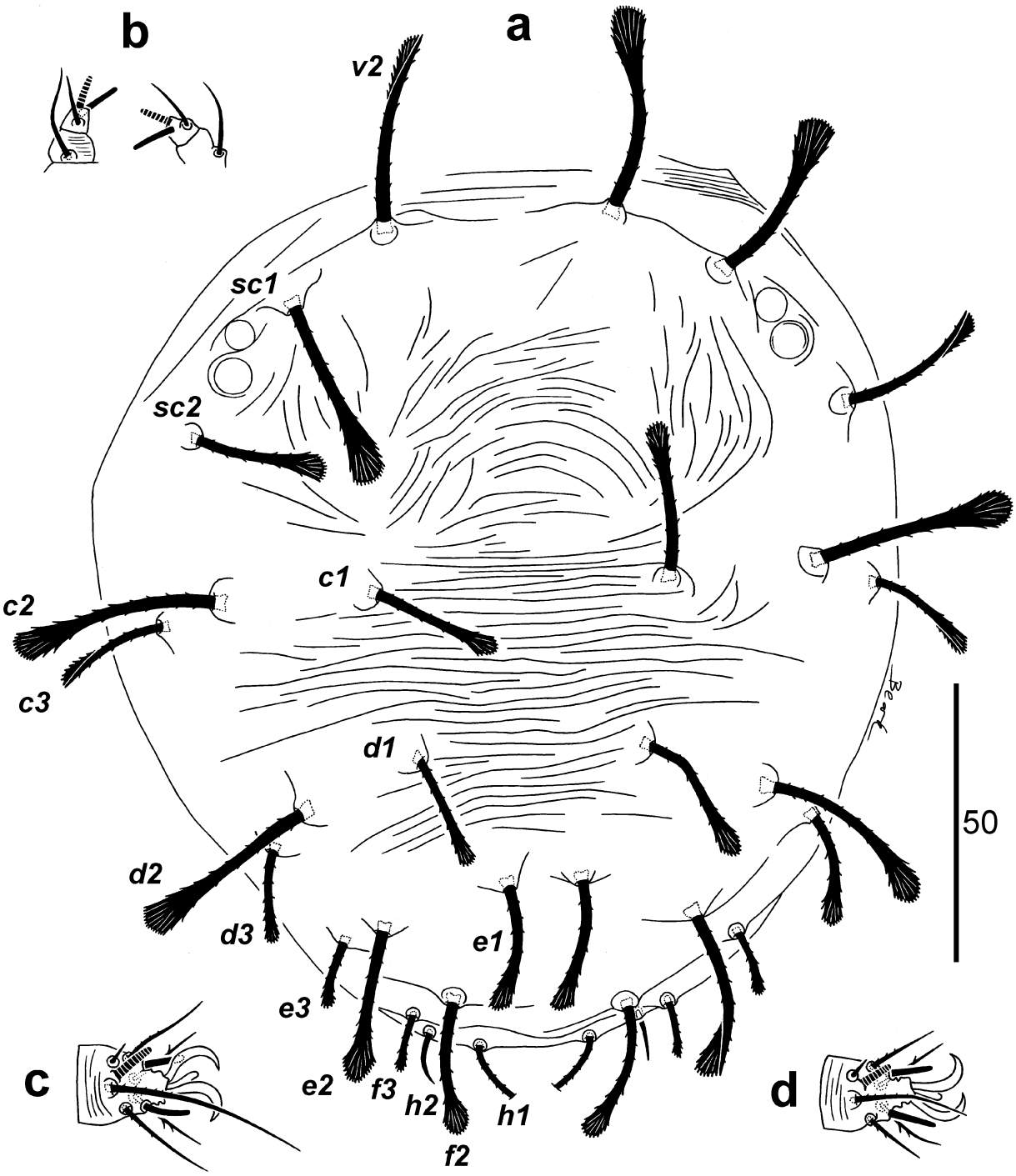


FIGURE 83. *Raoiella didcota* Beard, a. protonymph dorsal habitus; b. protonymph detail of palps; c. deutonymph tarsus I (left side, dorsal aspect); d. protonymph tarsus I (left side, dorsal aspect).

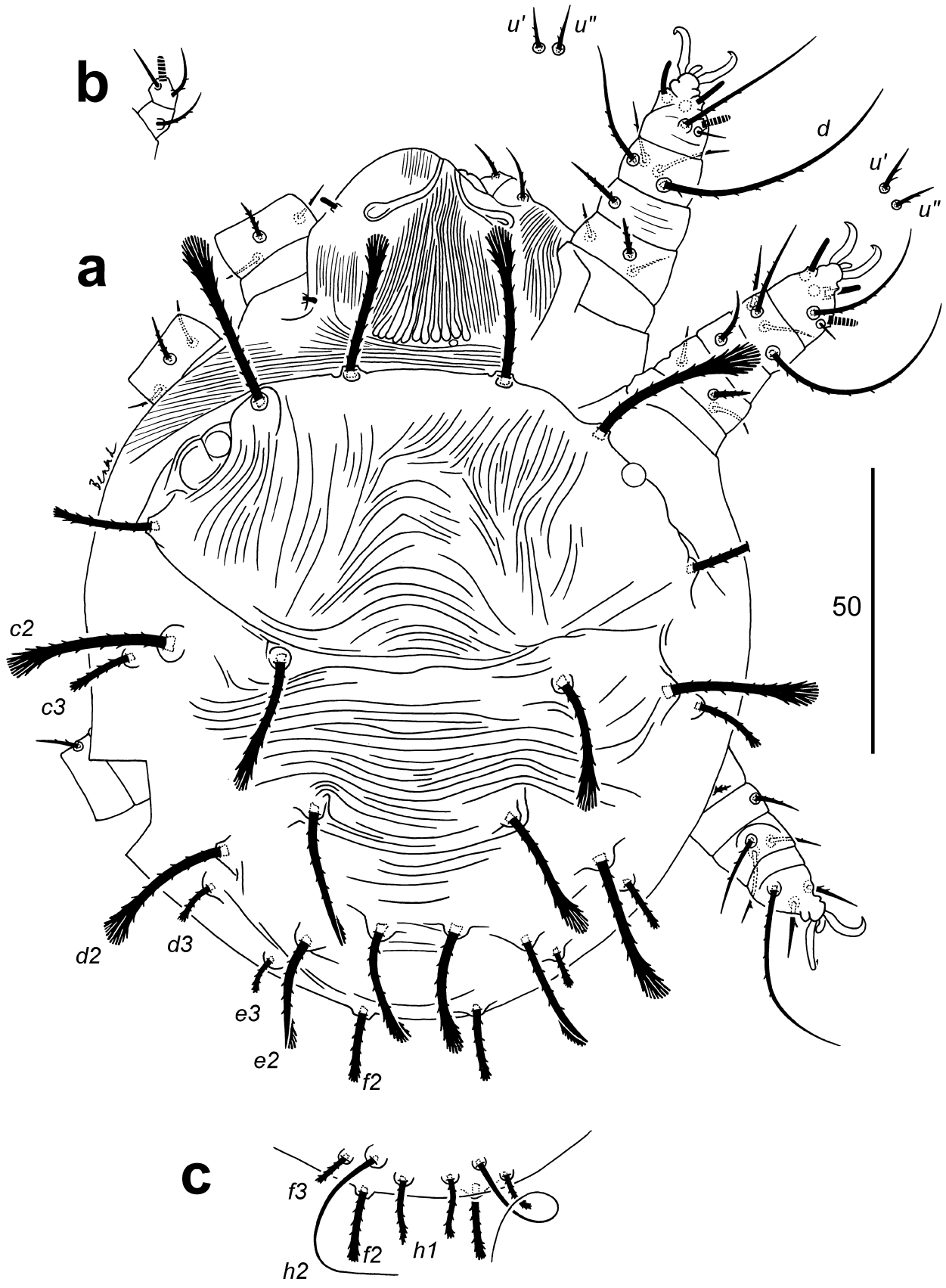


FIGURE 84. *Raoiella didcota* Beard, larva: a. dorsal habitus with detail of legs; b. detail of palp; c. posterior venter.

Male. *Dorsum.* (Fig. 81) Body measurements (6): length between setae *v2–h1* 167–176, width between setae *sc2–sc2* 133–146, *c3–c3* 131–137, *f3–f3* 68–75. Prodorsum smooth; opisthosoma with transverse striae between setae *d1–f2*. Dorsal setae spatulate, barbed along entire length, narrower than female. Seta *h1* weakly spatulate, setae *h2* tapered. Dorsal setae measurements: *v2* 40–46, *sc1* 38–43, *sc2* 40–45, *c1* 14–21, *c2* 24–27, *c3* 38–44, *d1* 12–17, *d2* 21–24, *d3* 39–44, *e1* 13–14, *e2* 21–24, *e3* 37–40, *f2* 22–31, *f3* 37–44, *h1* 21–28, *h2* 12–20.

Palps. (Fig. 81) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–8) and one blunt eupathidium (10–11) distally, one dorsal seta (11–13); palp femorogenu with one seta (18–21).

Venter. Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and a distinct patch of smooth cuticle on either side of setae *ag*. Setal measurements: *1a* 46–74, *1b* 10–20, *2b* 12–18, *3a* 10–11, *4a* 42–74, *ag* 8–10, *g1* 8–11, *g2* 8–11, *ps2* 12–13, *ps3* 11-13.

Aedeagus. (Fig. 81) Aedeagus narrow, elongate and sclerotised (56–68), tapering to a blunt point distally (at genital opening).

Legs. (Fig. 82) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-4-3-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (abaxial trullate, adaxial cylindrical) (ta I adaxial 7–9, abaxial 9–11; ta II adaxial 7–8, abaxial 8–10), and two eupathidia distally (ta I 12–14, 12–13; ta II 12, 11–13). Companion seta *ft″* on tarsus I 12–17 and tarsus II 11–12, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta finely tapered. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*), genua I–II with three setae (*d*, *l′*, *l″*). Tenent hairs on claws with three attachment points.

Deutonymph (female). *Dorsum.* Body measurements (2): length between setae *v2–h1* 181–186, width between setae *sc2–sc2* 138–141, *c3–c3* 143–149, *f3–f3* 48–50. Prodorsum with arching striations mesally; dorsal opisthosoma with weak, widely spaced transverse striations between setae *c1–d1*. Dorsal setae spatulate, barbed along entire length; setae *h2* short, tapered, barbed. Dorsal setae measurements: *v2* 42–47, *sc1* 42–43, *sc2* 39–42, *c1* 31–37, *c2* 45–47, *c3* 36–40, *d1* 19–23, *d2* 39–46, *d3* 33–41, *e1* 32, *e2* 40–44, *e3* 23–32, *f2* 24–30, *f3* 40–43, *h1* 23–26, *h2* 7–8.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–7) and one blunt eupathidium (9) distally, one dorsal seta; palp femorogenu with one seta.

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 45–51, *1b* 15–16, *3a* 11, *4a* 27–32, *ag* 7–8, *g1* 5–7, *ps2* 6–7, *ps3* 6–7.

Legs. (Fig. 83c) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 10; ta II 7–10) and two eupathidia distally (ta I 8–9, 9–10; ta II 8, 8). Companion seta *ft″* on tarsus I 6–8 (Fig. 83c) and tarsus II 3–5, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta finely tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with one seta (*l′* present; *d*, *l″* absent). Tenent hairs on claws with three attachment points.

Protonymph. *Dorsum.* (Fig. 83a) Body measurements (1): length between setae *v2–h1* 152, width between setae *sc2–sc2* 119, *c3–c3* 131, *f2–f2* 32. Dorsal setae spatulate, barbed along entire length; setae *h2* tapered. Dorsal setae measurements: *v2* 40, *sc1* 35, *sc2* 29, *c1* 29, *c2* 38, *c3* 22, *d1* 22, *d2* 37–38, *d3* 19–23, *e1* 27, *e2* 33, *e3* 13, *f2* 12, *f3* 29, *h1* 14, *h2* 8.

Palps. (Fig. 83b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6) and one blunt eupathidium (8–9) distally, one dorsal seta (8–9); palp femorogenu with one seta (19–21).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 32, *1b* 13, *3a* 8, *ag* 5, *ps2* 5, *ps3* 4.

Legs. (Fig. 83d) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 8; ta II 6) and two eupathidia distally (ta I 9, 8; ta II 9, 9). Companion seta *ft″* on tarsus I 4 (Fig. 83d) and tarsus II 4, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta finely tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with one seta (*l′* present; *d*, *l″* absent). Tenent hairs on claws with three attachment points.

Larva. *Dorsum.* (Fig. 84a) Body measurements (1): length between setae *v2–f2* 115, width between setae *sc2–sc2* 99, *c3–c3* 104, *f3–f3* 31. Prodorsum with weak longitudinal to oblique striations, with arching striae medially. Opisthosoma with weak transverse striae between setae *c1–e1*; lateral setae *c3*, *d3*, *e3*, *f3* obviously shorter than other setae, weakly spatulate to blunt, barbed; *h1* short, weakly spatulate, barbed; *h2* fine, elongate,

filiform; setae *f2* inserted posterolaterally; setae *f3*, *h1*, *h2* inserted ventrally. Dorsal setae measurements: *v2* 27–29, *sc1* 33–34, *sc2* 20, *c1* 24–26, *c2* 28–31, *c3* 13–14, *d1* 26, *d2* 28–29, *d3* 9–11, *e1* 24, *e2* 21–23, *e3* 8, *f2* 14–15, *f3* 7–8, *h1* 11–12, *h2* 35–38.

Palps. (Fig. 84b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5) and one tapered eupathidium (9) distally, and one seta dorsally (9–10); palp femorogenu with one seta (11–12).

Venter. (Fig. 84c) Cuticle almost completely plicate, except coxal fields smooth; striae transverse *1b–1b*, striae 1ongitudinal *1b–1a*, striae transverse *1a–3a*; just posterior to *3a* with small patch of longitudinal striae followed by a small diamond of transverse striae (see also Figs 23, 44, 56, 70, 100, 115b, 129a, 146, 161b, 178, 191b, 238, 268); with longitudinal and oblique striae surrounding *ps* setae. Setal measurements: *1a* 22–28, *1b* 8, *3a* 6–7, *ps2* 2–3, *ps3* 5–6.

Legs. (Fig. 84a) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Genua I–II with one seta (*l′*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 5; ta II 4-5) and two eupathidia *pζ″–pζ″* distally (ta I 5–6, 6–7; ta II 6, 6–7). Companion seta *ft″* on tarsus I 5–6 and tarsus II 4, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta long, finely tapered. Claws I and IV 10–11; tenent hairs on claws with three attachment points.

Host. Broad-leaved apple, *Angophora subvelutina* F. Muell. (Myrtaceae).

Distribution. AUSTRALIA: southeast Queensland.

Etymology. This species is named for the town and creek, Didcot, near its collection location.

Remarks. *Raoiella didcota* **sp. nov.** was listed as *Raoiella* sp. 10 in Beard *et al*. (2013), and is morphologically similar to *R. davisi* **sp. nov.**, though there are differences in the lengths of several dorsal setae: adult female *v2* (*Rdid* 51–56 vs *Rdav* 61–80), *c1* (20–21 vs 32–39), *d3* (41–50 vs 54–69), *e3* (41–47 vs 48–62), *f3* (43–48 vs 49–64); male *c1* (14–21 vs 22–30), *h1* (23–28 vs 15–23); protonymph *sc2* (29 vs 19), *c3* (22 vs 12–15), *e1* (27 vs 18), *f2* (29 vs 15), palp eupathidium (8–9 vs 5–6). Dorsal setae on tibia I–II have finely tapered tips on *R. didcota* but have blunt tips on *R. davisi*. The solenidia on tarsi I–II are trullate on *R. didcota* but cylindrical on *R. davisi*. Specimens of *R. didcota* were not included in the molecular analyses by Dowling *et al.* (2012).

Raoiella eugeniae (Mohanasundaram)

(Figs 85–88)

Neoraoiella eugeniae Mohanasundaram 1996: 141
Raoiella eugeniae (Mohanasundaram 1996): 141—new combination Mesa *et al.* 2009.
Raoiella macfarlanei Pritchard & Baker—Nageshachandra & Channabasavanna 1974:392, Figs 1–4. Misidentification.
Raoiella macfarlanei Pritchard & Baker—Mohanasundaram & Parameswaran 1991:76. Misidentification.

Material examined. India, 9 ♀, 3 ♂, Bangalore, Karnataka, ex. *Syzygium* sp. (Myrtaceae), 25.xi.1970, no collector listed (two slides; USNM).

Diagnosis. Opisthosomal setae *f2* longer than *f3*. Setae *h1* subequal to *h2*; short, spatulate. Lateral dorsal setae (*sc2*, *c3*, *d3*, *e3*) with broad, plumose spatulate tips. Adult femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with three setae (*d*, *l′*, *l″*); coxae I with two setae (*1b*, *1c* present); coxae III–IV with one seta (setae *3b*, *4b* present). Tarsus I with companion setae (*ft″*) much longer than solenidion; tarsus II with companion seta (*ft″*) shorter than, or subequal to, solenidion. Dorsal setae on tibiae I thick, spatulate; dorsal seta on tibiae II weakly spatulate or with thick blunt tip. Eupathidium on palp tibiotarsus forked.

Description. Female. ***Dorsum.*** (Fig. 85) Body measurements (9): length between setae *v2–h1* 232–246, *v2–f2* 222–240, width between setae *sc2–sc2* 166–182, *c3–c3* 174–186, *f2–f2* 40–52, *f3–f3* 67–81. Dorsal shields not evident; dorsal cuticle weakly sclerotised to membranous, smooth. Prodorsum with a pair of pores sublaterally; dorsal opisthosoma with two pairs of slit pores between *c1–d1* and minute pore between *e1–e2*. Setae *f3*, *h1*, *h2* inserted ventrally. Lateral dorsal setae strongly spatulate, with significantly expanded tips, tips often plumose on lateral setae (*sc2*, *c3*, *d3*, *e3*); dorsal setae barbed along entire length. Dorsal setal measurements: *v2* 68–76, *sc1* 46–51, *sc2* 81–87, *c1* 38–43, *c2* 41–48, *c3* 80–87, *d1* 33–40, *d2* 45–50, *d3* 82–92, *e1* 34–38, *e2* 40–46, *e3* 91–97, *f2* 40–56, *f3* 23–33, *h1* 21–24, *h2* 18–22.

Palps. (Fig. 86a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6) and one eupathidium with tapered forked tip (11–12) distally, and one dorsal seta (10–11); palp femorogenu with one seta (25–26).

Venter. (Fig. 86b) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on posterior margin of genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1c*, *3b*, *4b* present. Setae *ag*, *g1*, *g2*, *ps2*, *ps3* barbed. Setal measurements: *1a* 51–86, *1b* 16–22, *1c* 12–17, *2b* 12–20, *3a* 11–13, *3b* 11–12, *4a* 64–81, *4b* 11–12, *ag* 11–12, *g1* 12–13, *g2* 12, *ps2* 11–12, *ps3* 9–11.

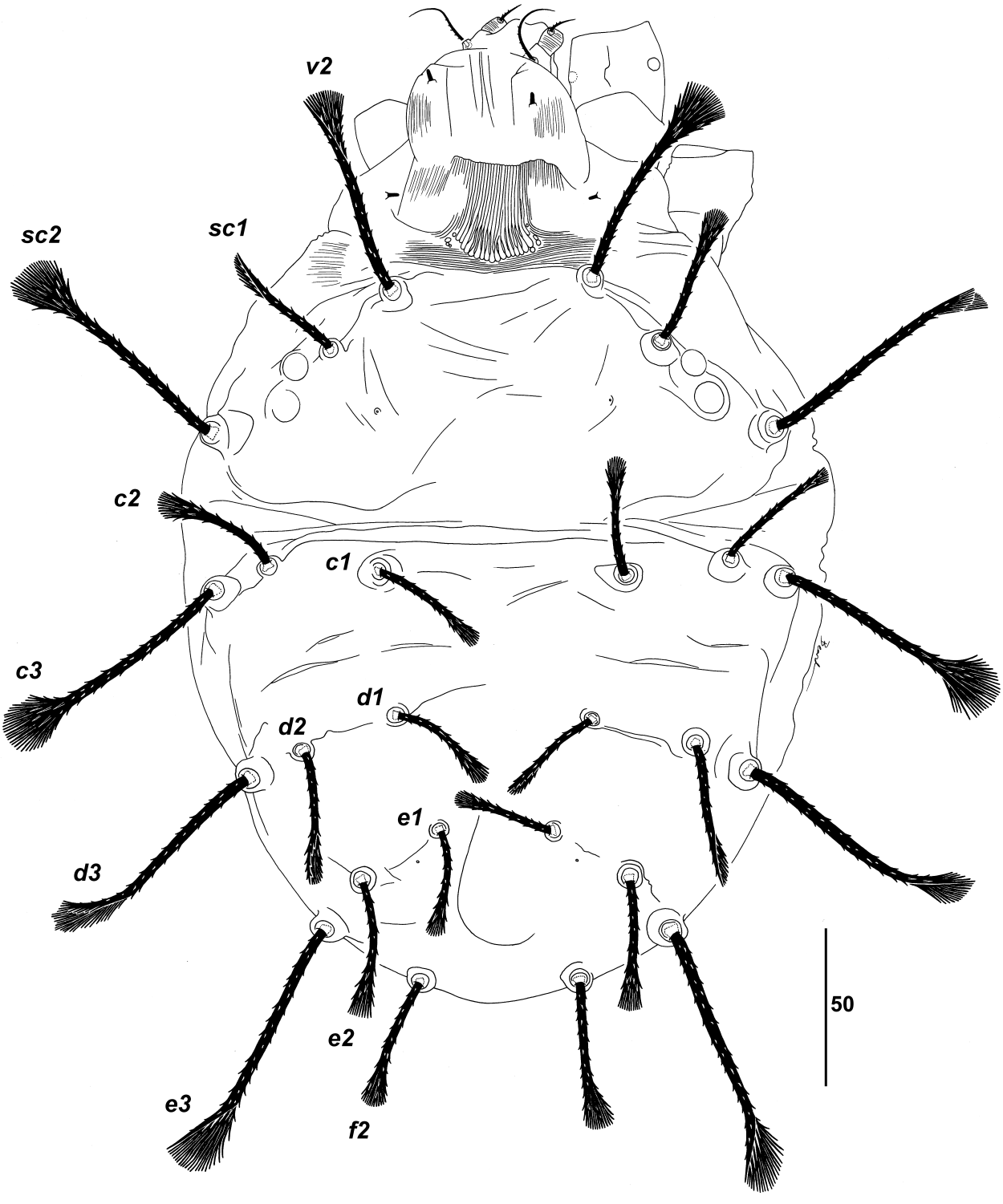


FIGURE 85. *Raoiella eugeniae* (Mohanasundaram), adult female: dorsal habitus.

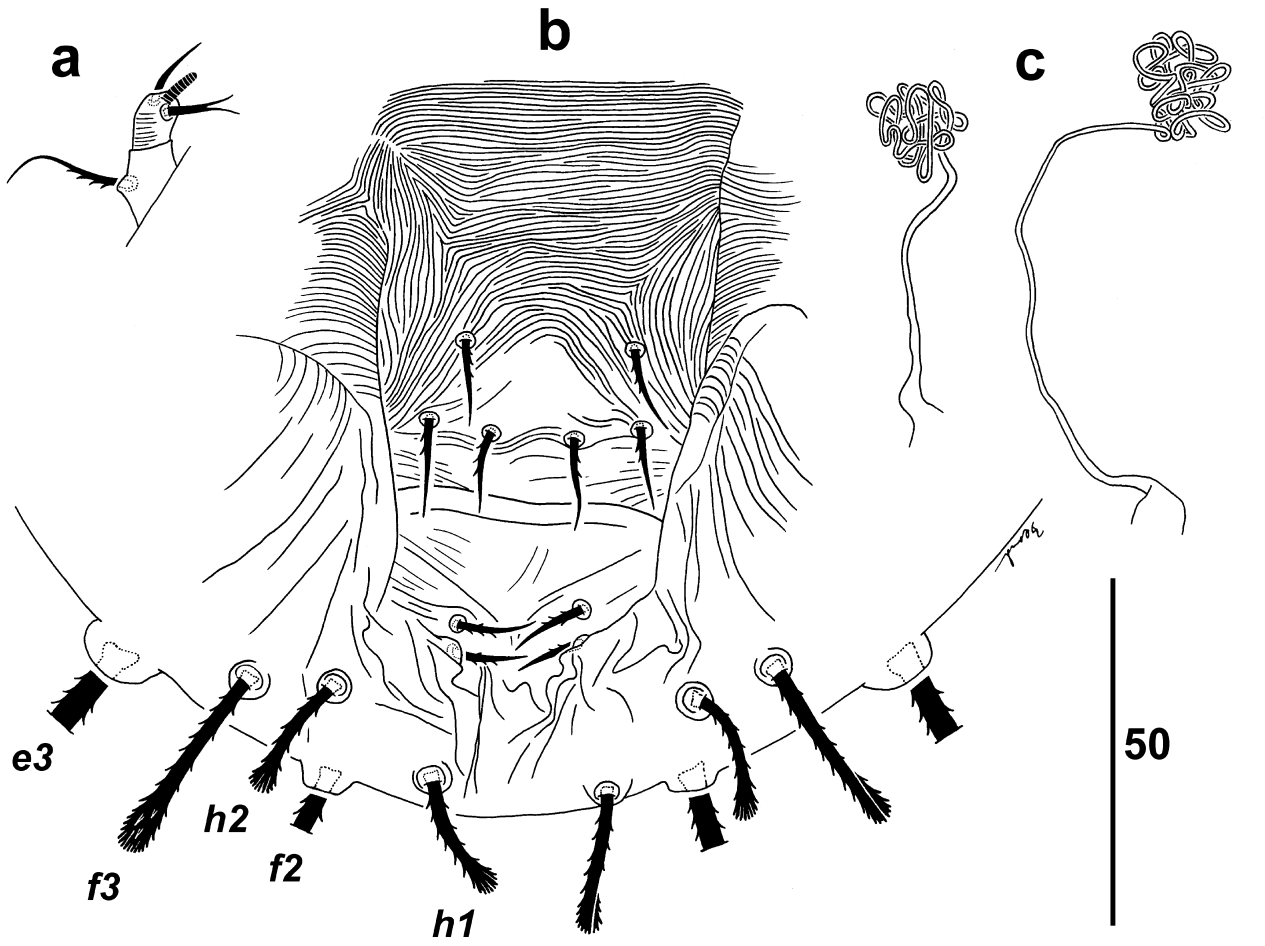


FIGURE 86. *Raoiella eugeniae* (Mohanasundaram), adult female: a. detail of palp; b. posterior venter; c. detail of spermatheca.

Spermatheca. (Fig. 86c) Elongate, fine membranous tube, tightly coiled distally.

Legs. (Fig. 87) Setal formula for legs I–IV (coxae to tarsi): 2-1-4-3-4-9(1), 1-1-4-3-4-9(1), 1-1-2-1-3-5, 1-1-2-0-3-5 respectively. Female femora I–II with four setae (*d*, *l′*, *v′*, *bv″*) and genua I–II with three setae (*d*, *l′*, *l″*). Variations in setal counts: one specimen with both cx I–II with 1 seta on one side and two setae on the other side; one specimen with cx II with 0 setae. Tarsi I and II each with one abaxial solenidion (ta I 17–19; ta II 12–13) and two eupathidia distally (ta I 10–11, 10–11; ta II 10, 10–11). Barbed companion seta *ft″* on tarsus I 35–42 and tarsus II 9–13, inserted adjacent to solenidion *ω″*. Dorsal seta on tibiae I spatulate distally; dorsal seta on tibiae II thick to slightly spatulate, not tapered. Claw I 15–16.

Male. ***Dorsum.*** Body measurements (3): length between setae *v2–h1* 157–160, *v2–f2* 149–154, width between setae *sc2–sc2* 122–126, *c3–c3* 123–125, *f2–f2* 47–50, *f3–f3* 55–63. As in female, dorsal cuticle weakly sclerotised to membranous, smooth; with transverse striae between setae *d1* and *f2*. Lateral dorsal setae strongly spatulate, barbed along entire length; seta *h1* and *h2* weakly spatulate; setae *h2*, *f3* often inserted ventrally. Dorsal setae measurements: *v2* 32–36, *sc1* 36–37, *sc2* 63–69, *c1* 29–31, *c2* 39–40, *c3* 77–82, *d1* 31–33, *d2* 38–41, *d3* 74–77, *e1* 24–26, *e2* 34–40, *e3* 88–91, *f2* 24–31, *f3* 23–25, *h1* 18–19, *h2* 18–20.

Palps. (Fig. 88a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5) and one eupathidium with tapered forked tip (9–10) distally, one dorsal seta (8–9); palp femorogenu with one seta (20–22).

Venter. (Fig. 88b) Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and a distinct patch of smooth cuticle on either side of setae *ag*. Setae *1c*, *3b*, *4b* present. Setae *ps3* modified as accessory genital stylets into stout spurs. Setal measurements: *1a* 57–62, *1b* 16–18, *1c* 11–16, *2b* 9–11, *3a* 9–13, *3b* 8–9, *4a* 47–61, *4b* 8–10, *ag* 10–11, *g1* 10–11, *g2* 10–11, *ps2* 9–10, *ps3* 11–13.

Aedeagus. (Fig. 88c) Aedeagus narrow, elongate and sclerotised (50–52), tapering to a blunt point distally (at genital opening).

Legs. Setal formula for legs I–IV (coxae to tarsi): 2-1-4-3-4-10(2), 1-1-4-3-4-10(2), 1-1-2-1-3-5, 1-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 11–14, abaxial 16–17; ta II adaxial 10–11, abaxial 11–12), and two eupathidia distally (ta I 10–11, 10–11; ta II 9, 8–9). Barbed companion seta *ft″* on tarsus I 23–28 and tarsus II 9–10, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta weakly spatulate. Claw I 13.

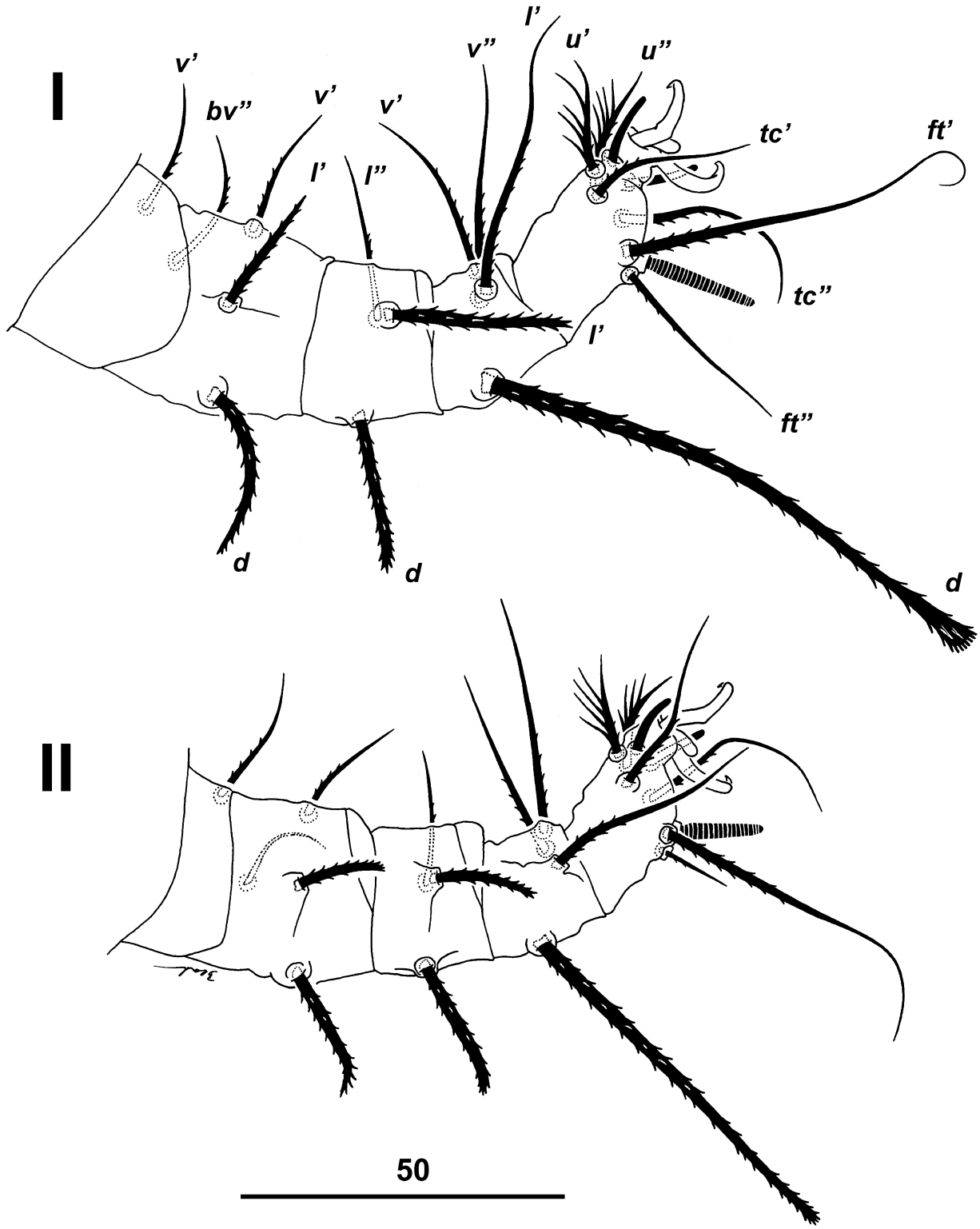


FIGURE 87. *Raoiella eugeniae* (Mohanasundaram), adult female: legs I–II (right side, adaxial aspect).

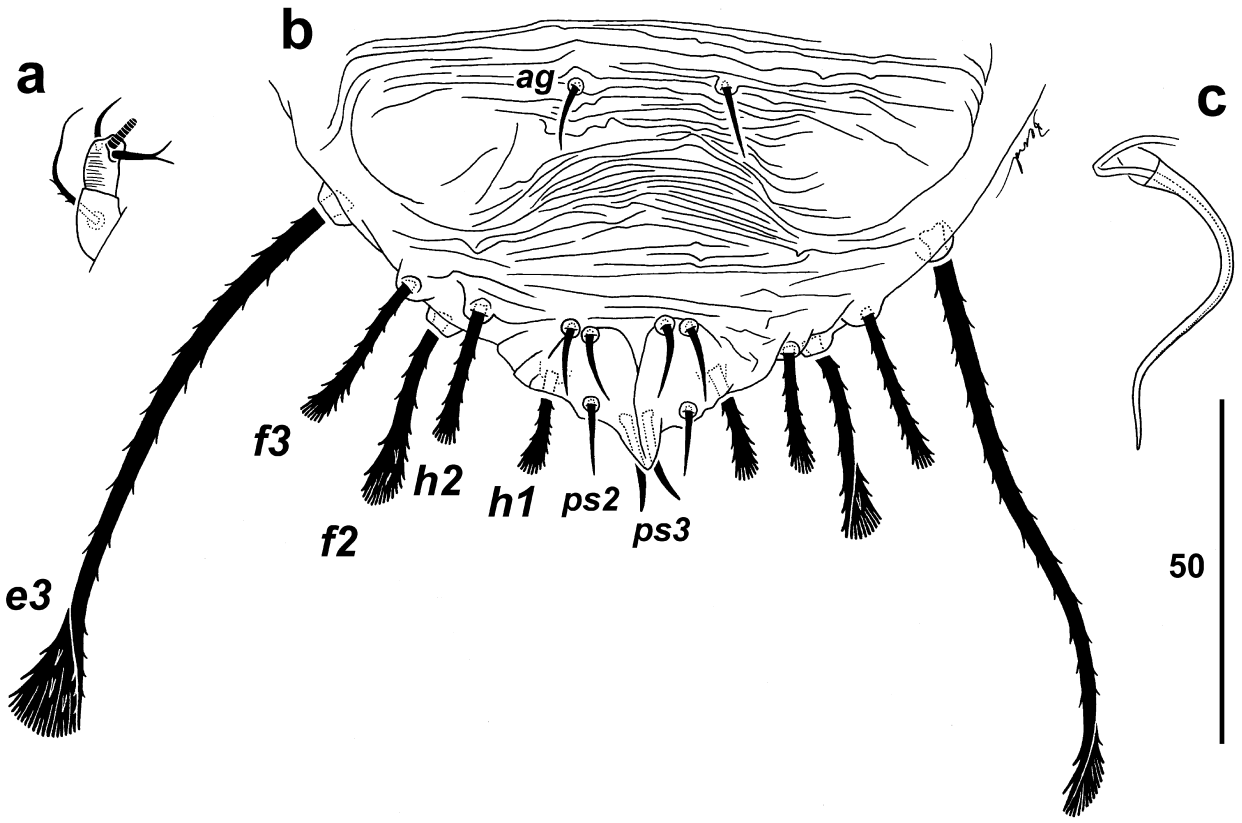


FIGURE 88. *Raoiella eugeniae* (Mohanasundaram), adult male: a. detail of palp; b. posterior venter; c. detail of aedeagus.

Immatures. Egg. Unknown. Mohanasundaram & Parameswaran (1991) states that, as with other species in the genus, the eggs of this species (identified as *R. macfarlanei*) are oval and red and laid in groups on the lower side of the leaves, and the nymphs are gregarious.

Host. *Eugenia* sp., *Syzygium* spp., *S. jambos* (L.) (Myrtaceae).

Distribution. INDIA: Mangalore and Bangalore, Karnataka.

Remarks. Mohandasundaram (1996) erected a new genus to accommodate this species based on the presence of "a clear semi-circular" propodosomal shield over the base of the infracapitulum. There is no shield present in the specimens that we examined, and we believe that the author misinterpreted the anterior part of the hypostome and/or the ribbed collar. We were unable to borrow the holotype despite repeated requests. The type depository is listed as Department of Agricultural Entomology Collection, Tamil Nadu Agricultural University, Coimbatore, India.

Mohanasandarum (1996) provided the following descriptive details for the female: prodorsum with three pairs of fairly long, serrate, clavate setae on prominent tubercles; all 13 pairs of opisthosomal setae are serrate and clavate; dorsal setal measurements: *v2* 65, *sc1* 50, *sc2* 75, *c1* 40, *c2* 42, *c3* 80, *d1* 35, *d2* 40, *d3* 70, *e1* 30, *e2* 44, *e3* 65, *f2* 70, *f3* 30, *h1* 22, *h2* 24.

As we have not examined the types, we are reluctant at this point to describe our material as a new species based on length differences of a few setae—setae *f2* 70 in the original description vs 40–56 in our material, setae *d3* 70 vs 82–92 and setae *e3* 65 vs 91–97. Mohanasandarum's material was collected on 18.i.1994 from Mangalore (called Mangaluru) and possibly Putur, which are 375 km and 320 km, respectively, west of the city where our material was collected, Bangalore (called Bangaluru) in 1970. Both sets of material were collected from the state of Karnataka (formerly Mysore) in southern India, and from a species of either of the genera *Eugenia* Linnaeus or *Syzygium* Gaertner (both Myrtaceae). It should be noted that the genus *Eugenia* was recently split into the genera *Eugenia* and *Syzygium*, with the majority of Indian species now placed in the latter genus (Byng *et al*. 2015).

The situation has another layer of complexity, however, in that both Nageshachandra & Channabasavanna (1974) and Mohanasundaram & Parameswaran (1991) originally identified *R. eugeniae* as *R. macfarlanei*. This is

understandable as *R. macfarlanei* females have seta *f2* much longer than *f3,* as also illustrated for *R. eugeniae* females by Mohanasandarum (1996). As both the original description and the original identifications all indicate that seta *f2* is obviously longer than *f3* on *eugeniae*, this circumstantially supports the possibility that our *eugeniae* material, with *f2* setae subequal in length with *f3* (Fig. 85), could represent a new species. Additional circumstantial evidence for a new species comes from the fact that males usually have setae of similar lengths to those of the female of the same species, relative to body size. In their description, Nageshachandra & Channabasavanna (1974) only illustrated the male and immatures, as *R. macfarlanei* females had already been described and illustrated by Pritchard & Baker. The male they illustrated has setae *f2* and *f3* subequal and short, whereas the male should have setal lengths that match those of the female, i.e. setae *f2* obviously longer than *f3* (Fig. 157). Based on this, it appears that there could indeed be two species on *Eugenia*/*Syzygium* in India, but this is not determinable until the types are thoroughly examined. It is unfortunate that Mohanasandaram (1996) did not fully describe the male in the original description and that we were unsuccessful in borrowing the types, to confirm this possibility.

According to Mohanasundaram & Parameswaran (1991) and Mohanasundaram (1996), individuals of this species were found on the lower surface of their host plant, and the feeding by this mite causes yellowing to the host leaves. They also state that while the eggs are laid in clusters and the nymphs are gregarious, adults appear to be solitary and migratory. As previously stated, both Nageshachandra & Channabasavanna (1974) and Mohanasundaram & Parameswaran (1991) misidentified this species as *R. macfarlanei*, but later Mohansundaram (1996) must have realised the error and described these mites as a new species in a new genus, *Neoraoiella eugeniae*; however, Mesa *et al.* (2009) later made *Neoraoiella* a junior synonym of genus *Raoiella*.

We feel that the record of *R. macfarlanei* feeding on *Jambosa vulgaris* (Myrtaceae) by Gupta (1985) (now *Syzygium vulgaris*) is also a misidentification, and most likely represents *R. eugeniae*.

Raoiella eugeniae is morphologically similar to *R. macfarlanei*, but can be separated by the following: *Re* setae *f2* 40–56, setae *f3* 22–33 vs *Rm* setae *f2* 68–79, setae *f3* 31–33; *Re* setae *d* on femora I–II are subequal in length to setae *d* on genua I–II vs *Rm* setae *d* on femora I-II are longer than setae *d* on genua I–II.

Specimens of *R. eugeniae* were not included in molecular analyses by Dowling *et al.* (2012).

Raoiella goyderi **sp. nov. Ochoa & Beard**

(Figs 89–104)

Material examined. Holotype. ♀**. Australia**, ex. milky box, *Lophostemon lactifluus* (F.Muell.) Peter G.Wilson & J.T.Waterh. (Myrtaceae), Berry Springs Nature Park, Litchfield Shire, south of Darwin, Northern Territory, 12º42'14"S 130º59'59"E, 18.v.08, R. Ochoa & J. J. Beard (MAGNT).

Paratypes. 12 ♀, 6 ♂, 7 deutonymphs, 7 protonymphs, 7 larvae, 2 eggs, same data as holotype (all on separate slides, QM, USNM).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* spatulate. Adult femora I–II with four setae (*d*, *l'*, *v'*, *bv"*); genua I–II with two seta (*d*, *l'* present; seta *l"* absent); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft"*) obviously shorter than solenidion. Dorsal setae on tibiae I–II tapered. Eupathidium on palp tibiotarsus blunt. Larva with setae *h2* short tapered or blunt.

Description. Female. ***Dorsum.*** (Figs 89–90, 104) Body measurements (7): length between setae *v2–h1* 225–238 [233], width between setae *sc2–sc2* 172–178 [176], *c3–c3* 161–168 [168], *f3–f3* 92–102 [97]. Lightly sclerotised prodorsal and opisthonotal shields evident; shields finely punctate. Prodorsum with pair large pores mesally, pair large pores on posterior margin (often in folded cuticle between prosoma and opisthosoma). Dorsal opisthosoma with two pairs of large pores between setae *c1–d2*; pair slit pores between setae *d1–d2*; pair of minute pores between *e1–e1* and *e1–f2*. Dorsal setae spatulate, barbed along entire length. Dorsal setal measurements: *v2* 69–76 [69], *sc1* 61–68 [68], *sc2* 64–69 [68], *c1* 12–17 [15], *c2* 46–54 [54], *c3* 62–74 [67], *d1* 9–16 [13], *d2* 35–40 [35], *d3* 63–69 [66], *e1* 9–15 [12], *e2* 34–39 [34], *e3* 58–66 [63], *f2* 43–56 [47], *f3* 60–67 [61], *h1* 53–64 [64], *h2* 29–35 [30].

Palps. (Fig. 91a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) [5–6] and one blunt eupathidium with small tapered tip (8–10) [8–9] distally, one dorsal seta; palp femorogenu with one seta (26–32) [26]. Stylets with 13–15 small rounded lateral teeth distally (Fig. 92).

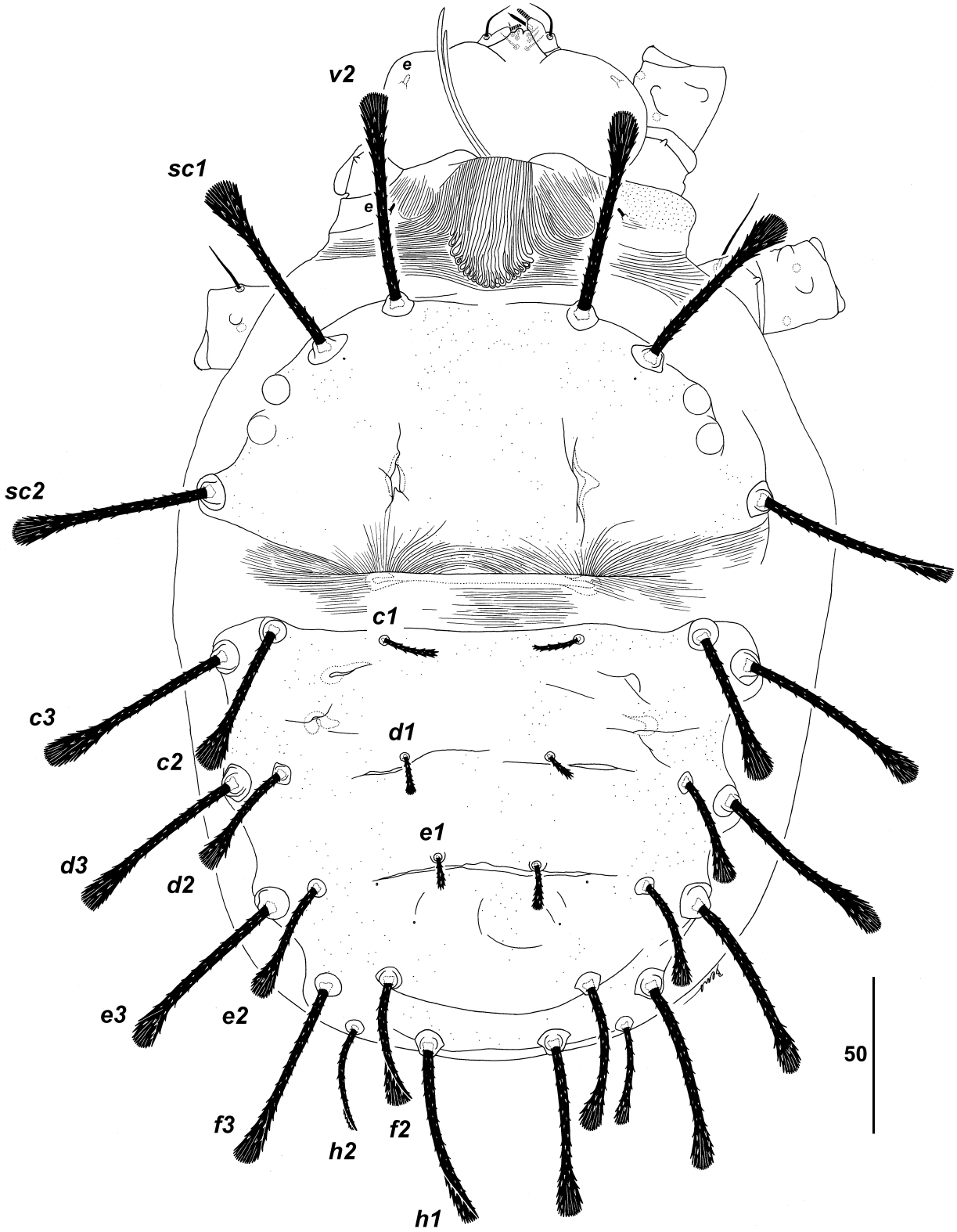


FIGURE 89. *Raoiella goyderi* Ochoa & Beard, adult female: dorsal habitus.

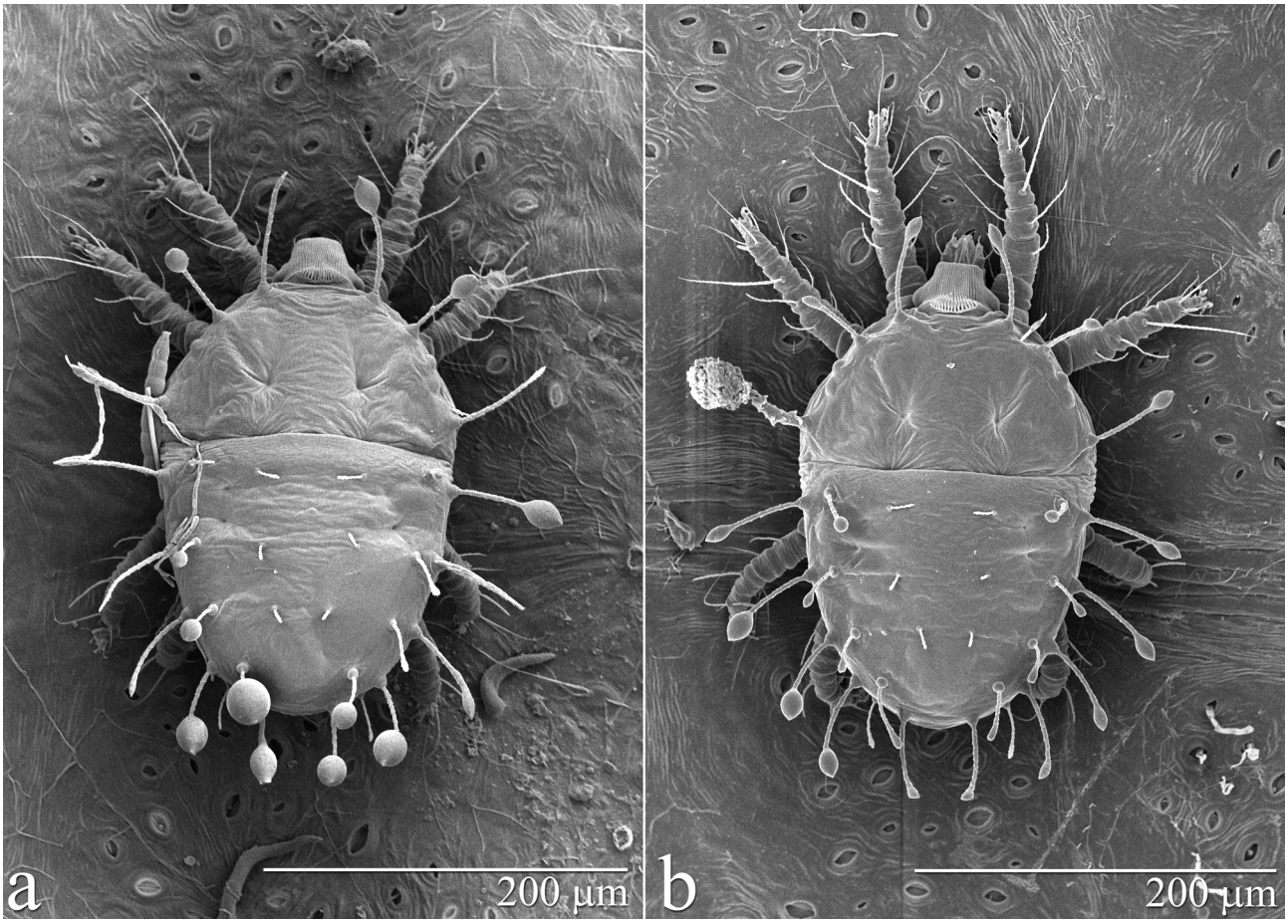


FIGURE 90. *Raoiella goyderi* Ochoa & Beard, adult female: dorsal habitus on host plant (two different individuals).

Venter. (Figs 93–94) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *ag*, *g1*, *g2*, *ps2*, *ps3* barbed. Setal measurements: *1a* 76–122 [76], *1b* 26–30 [30], *2b* 14–20 [18], *3a* 13–18 [16], *4a* 58–93 [79], *ag* 11–14 [14], *g1* 13–18 [15], *g2* 13–17 [17], *ps2* 13–16 [13], *ps3* 9–14 [14].

Spermatheca. (Fig. 91b) Elongate, fine membranous tube.

Legs. (Figs 95–96) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-9(1), 1-1-4-2-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Variations in setal counts: cx II with 1/0 setae, fe II with 3/4 setae. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 9–11 [9–10]; ta II 9–10 [9]) and two eupathidia *pζ′*–*pζ″* distally (ta I 14–15 [15], 14 [14]; ta II 13–14 [14], 13–14 [14]). Short barbed companion seta *ft″* on tarsus I 7–9 [7] and tarsus II 7–8 [7], inserted adjacent to solenidion *ω″* (Fig. 96). Tibiae I–II with dorsal seta with finely tapered tip. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*), genua I–II with two seta (*d*, *l′* present; *l″* absent). Tenent hairs on claws with four attachment points. Claws short (13–14).

Male. ***Dorsum.*** (Fig. 97) Body measurements (6): length between setae *v2–h1* 158–181, width between setae *sc2–sc2* 129–135, *c3–c3* 119–126, *f3–f3* 59–67. Prodorsum with pair large pores mesally, pair large pores on posterior margin (often in folded cuticle between prosoma and opisthosoma). Opisthosoma with three pairs of large pores between setae *c1–d2*; pair of minute pores mesad setae *f2*; with transverse striae between setae *d1* and *f2*. Dorsal setae spatulate, barbed along entire length, seta *h1* weakly spatulate. Dorsal setae measurements: *v2* 20–27, *sc1* 37–45, *sc2* 48–52, *c1* 11–18, *c2* 34–40, *c3* 50–59, *d1* 11–12, *d2* 25–30, *d3* 49–57, *e1* 10–15, *e2* 27–31, *e3* 46–54, *f2* 28–32, *f3* 42–49, *h1* 25–29, *h2* 29–32.

Palps. (Fig. 97) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one blunt eupathidium (8–10) distally, one dorsal seta; palp femorogenu with one seta (23–25).

Venter. Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and

a distinct patch of smooth cuticle on either side of setae *ag*. Setal measurements: *1a* 69–83, *1b* 20–25, *2b* 12–15, *3a* 10–14, *4a* 46–69, *ag* 11–13, *g1* 14–16, *g2* 13–15, *ps2* 14–16, *ps3* 18–21. Pseudanal setae *ps3* modified as accessory genital stylets into elongate, thickened spurs.

Aedeagus. (Fig. 97) Aedeagus narrow, elongate and sclerotised (63–67), tapering to a blunt point distally (at genital opening).

Legs. (Fig. 98) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-10(2), 1-1-4-2-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 6–7, abaxial 8–10; ta II adaxial 6–7, abaxial 8–10), and two eupathidia distally (ta I 12–13, 12–13; ta II 11–13, 11–12). Short, barbed companion seta *ft″* on tarsus I 6–8 and tarsus II 6–8, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta finely tapered. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*), genua I–II with two seta (*d*, *l′* present; seta *l″* absent). Tenent hairs on claws with four attachment points. Claws short (11).

Deutonymph. ***Dorsum.*** Body measurements (5): length between setae *v2–h1* 191–211, width between setae *sc2–sc2* 152–163, *c3–c3* 155–165, *f2–f2* 33–45. Prodorsum mostly smooth with some oblique striae laterally; often with weakly developed pore sublaterally. Dorsal opisthosoma with weak, widely spaced transverse folds between *c1–d1*; slit like pore between *d1–d2*. Dorsal setae barbed along entire length; seta *h2* short, weakly spatulate, barbed. Dorsal setae measurements: *v2* 57–63, *sc1* 57–60, *sc2* 48–54, *c1* 15–29, *c2* 57–59, *c3* 48–51, *d1* 12–35, *d2* 49–57, *d3* 35–46, *e1* 17–34, *e2* 46–54, *e3* 27–37, *f2* 46–51, *f3* 26–30, *h1* 23–28, *h2* 16–19.

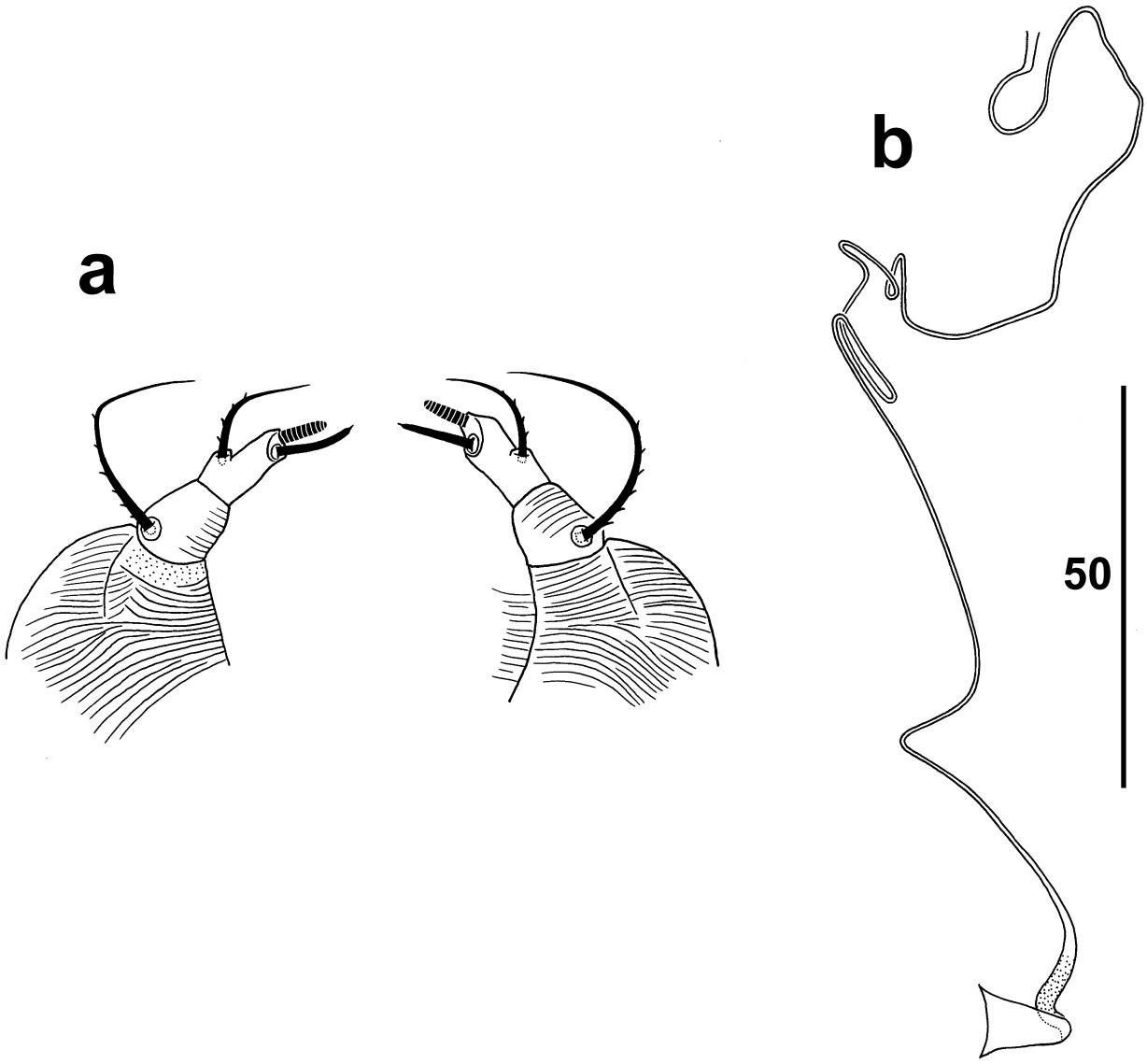


FIGURE 91. *Raoiella goyderi* Ochoa & Beard, adult female: a. detail of palps; b. detail of spermatheca.

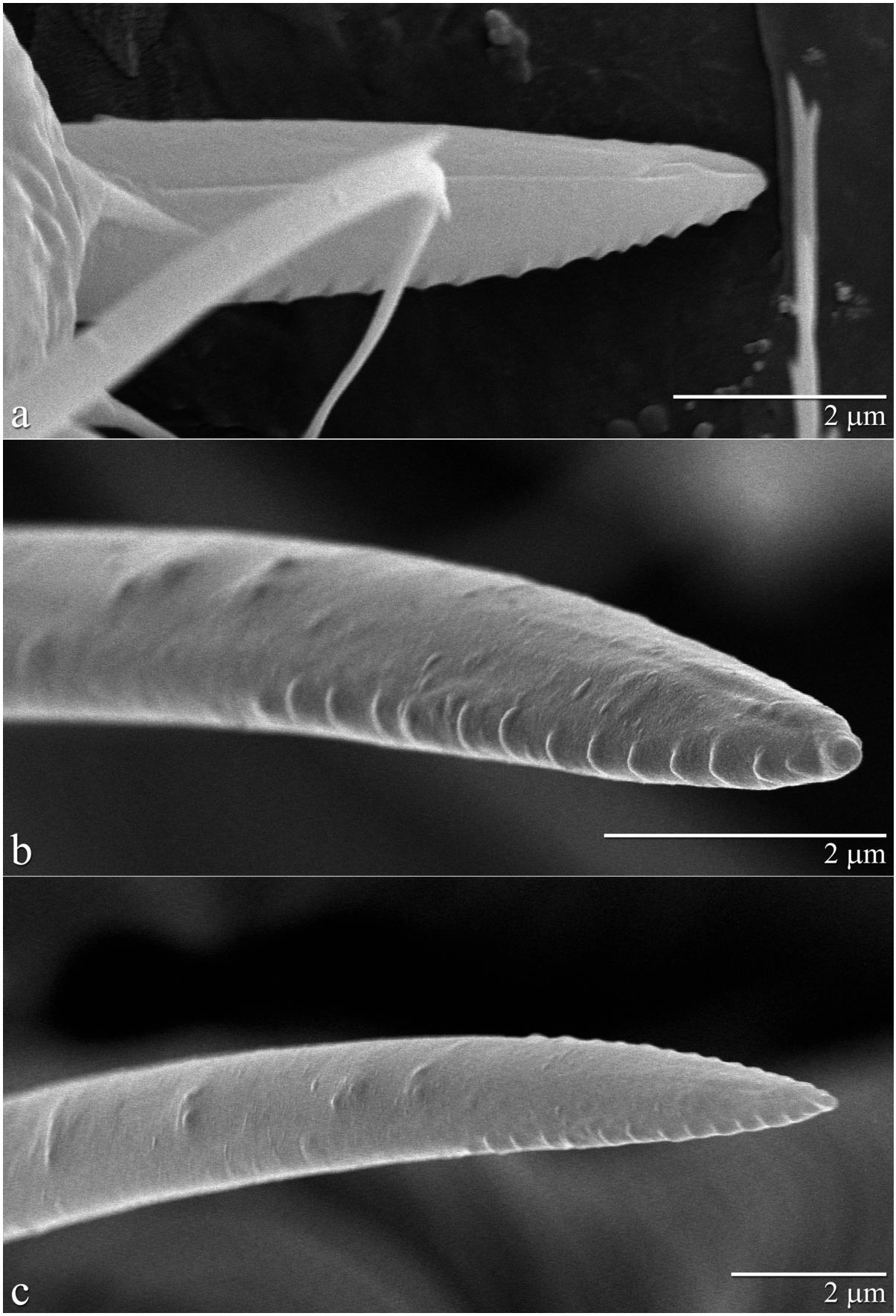


FIGURE 92. *Raoiella goyderi* Ochoa & Beard, dorsal and lateral views of joined stylets, detail of stylet tips with lateral serrations.

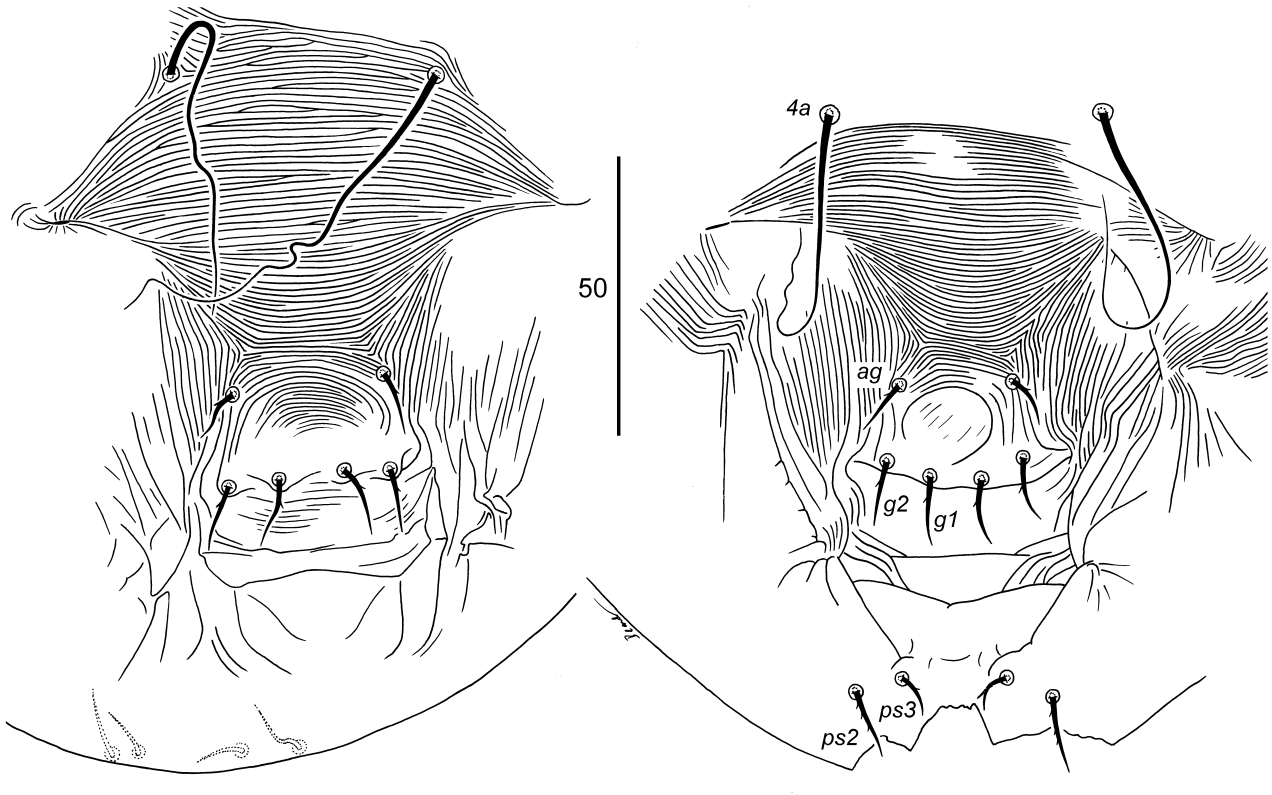


FIGURE 93. *Raoiella goyderi* Ochoa & Beard, adult female: posterior venter (two different individuals).

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–5) and one blunt eupathidium (7–8) distally, one dorsal seta; palp femorogenu with one seta (19–23).

Venter. Cuticle almost completely plicate, with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 71–86, *1b* 14–22, *3a* 8–11, *4a* 42–51, *ag* 6–8, *g1* 4–6, *ps2* 6–7, *ps3* 5–7.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 7–8; ta II 6–7) and two eupathidia distally (ta I 11, 10–11; ta II 9–11, 10–11). Companion seta *ft″* on tarsus I 4–5 and tarsus II 4–5, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with two setae (*d*, *l′* present; *l″* absent). Tarsus I claw 10–11.

Protonymph. *Dorsum.* Body measurements (3): length between setae *v2–h1* 151–163, width between setae *sc2–sc2* 119–137, *c3–c3* 123–141, *f2–f2* 24–26. Prodorsum mostly smooth, with weak longitudinal creases. Dorsal opisthosoma with weak widely spaced transverse striae between *c1–d1*. Dorsal setae strongly spatulate, barbed along entire length; setae *h2* short, blunt, barbed. Dorsal setae measurements: *v2* 44–52, *sc1* 49–55, *sc2* 30–38, *c1* 23–30, *c2* 46–47, *c3* 28–33, *d1* 26–32, *d2* 41–45, *d3* 20–22, *e1* 28–30, *e2* 33–35, *e3* 13–21, *f2* 21–26, *f3* 11–13, *h1* 11–15, *h2* 8–11.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (3–4) and one blunt eupathidium (6–7) distally, one dorsal seta; palp femorogenu with one seta (18–20).

Venter. Cuticle almost completely finely plicate, with mostly transverse striae, except coxal fields smooth; patch of longitudinal striae between *ag–ps* setae, some longitudinal striae around coxal fields. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 49–73, *1b* 14–19, *3a* 9–11, *ag* 4–7, *ps2* 4–8, *ps3* 3–8.

Legs. (Fig. 99) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 5–6; ta II 5) and two eupathidia distally (ta I 8, 8–9; ta II 8, 7–8). Companion seta *ft″* on tarsus I 4 and tarsus II 4, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with one seta (*l′* present; *d*, *l″* absent). Tarsus I claw 8–9.

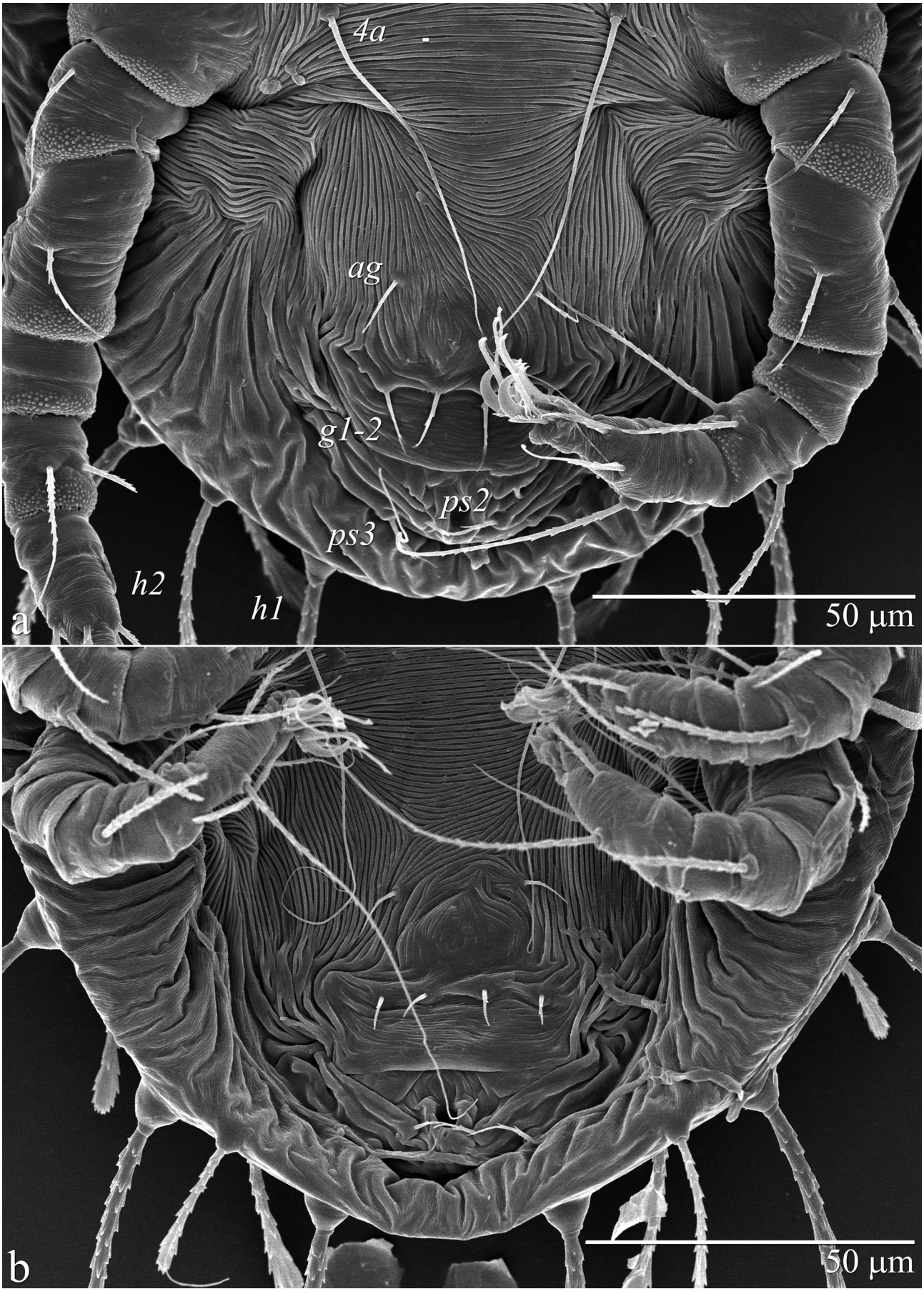


FIGURE 94. *Raoiella goyderi* Ochoa & Beard, adult female: posterior venter (two different individuals).

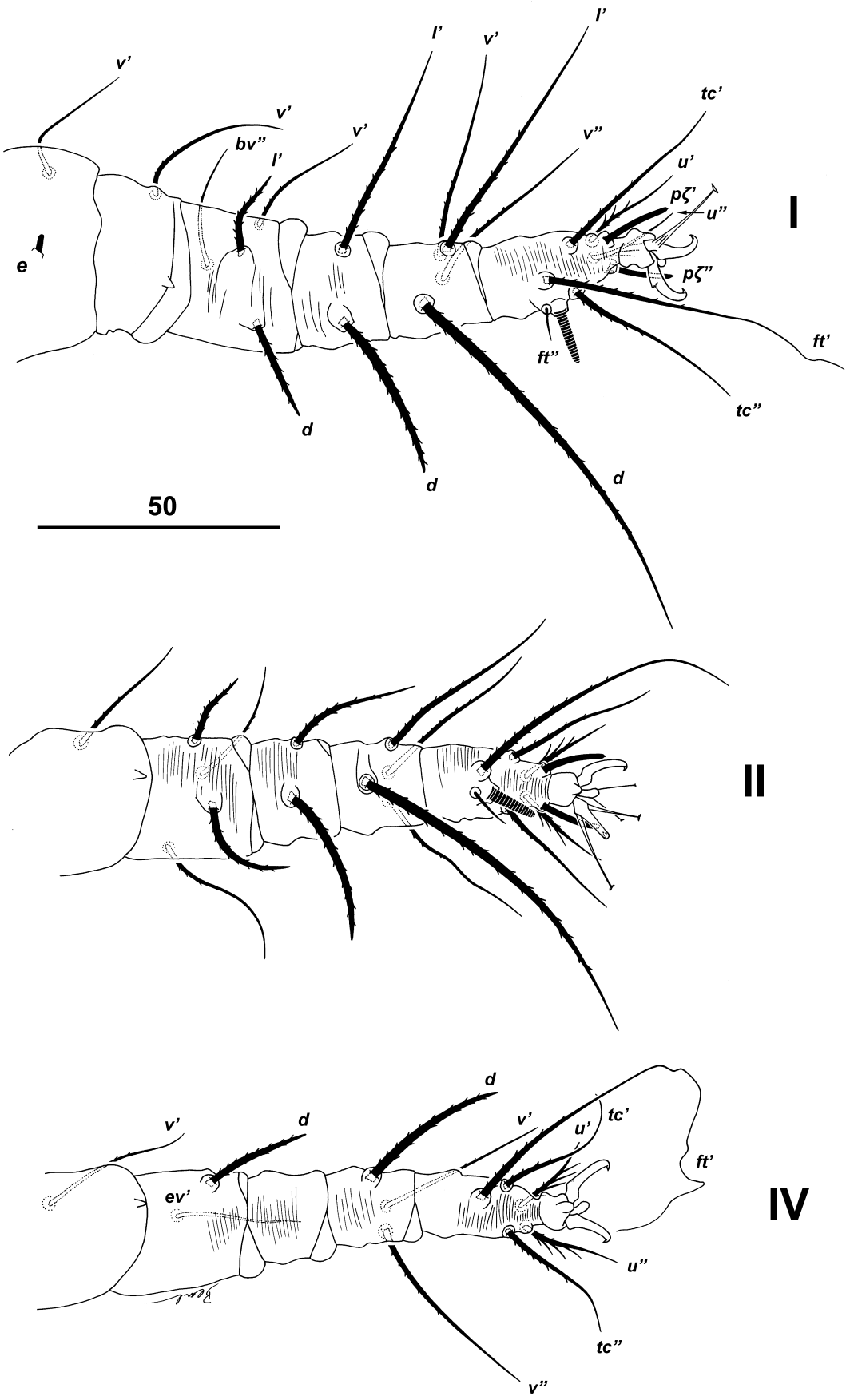


FIGURE 95. *Raoiella goyderi* Ochoa & Beard, adult female: legs I–II, IV (right side, dorsal aspect).

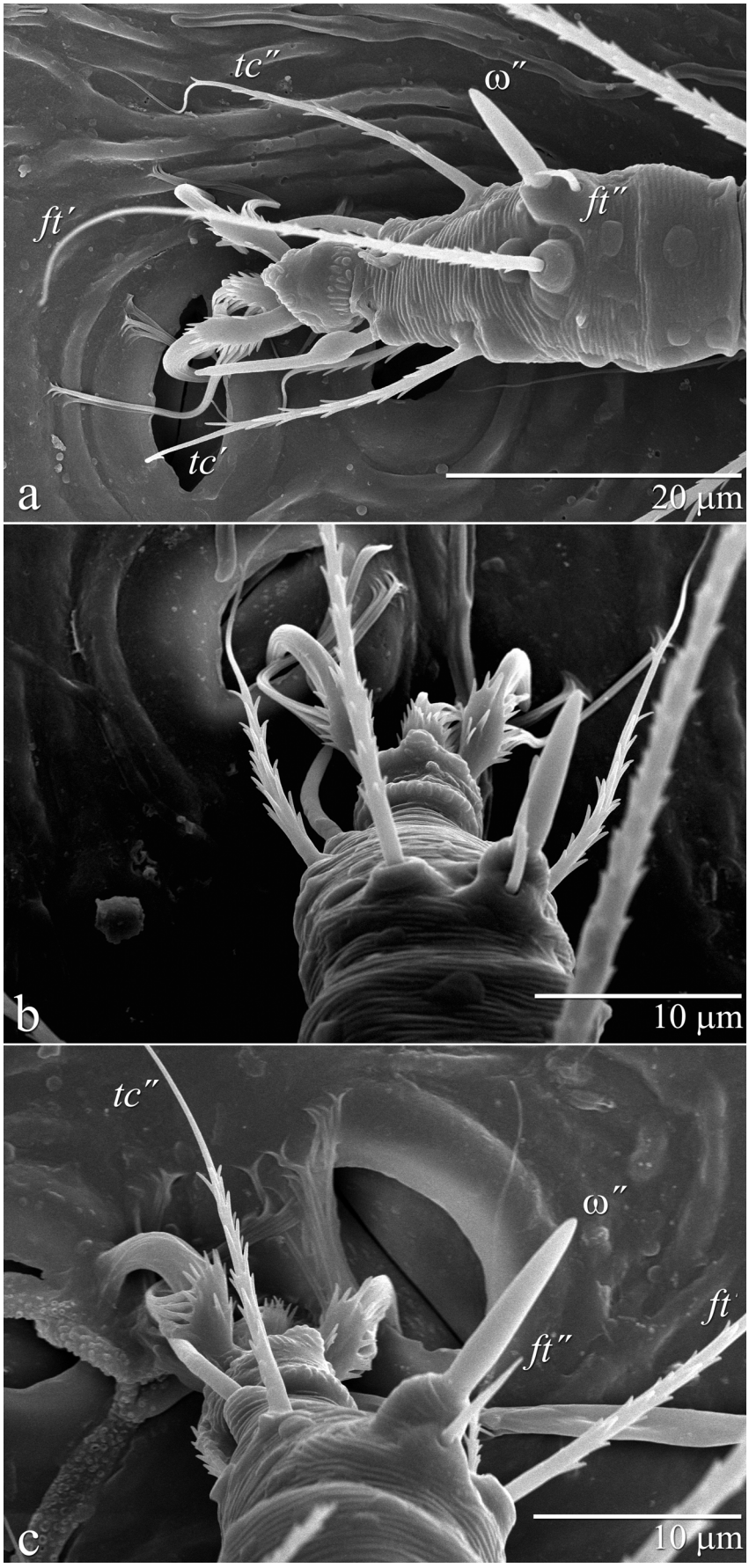


FIGURE 96. *Raoiella goyderi* Ochoa & Beard, adult female: a., b. detail of tarsus I indicating solenidion (*ω″*) and companion seta (*ft″*); c. detail of tarsus II. Note how the mite uses the stomatal lip for anchorage.

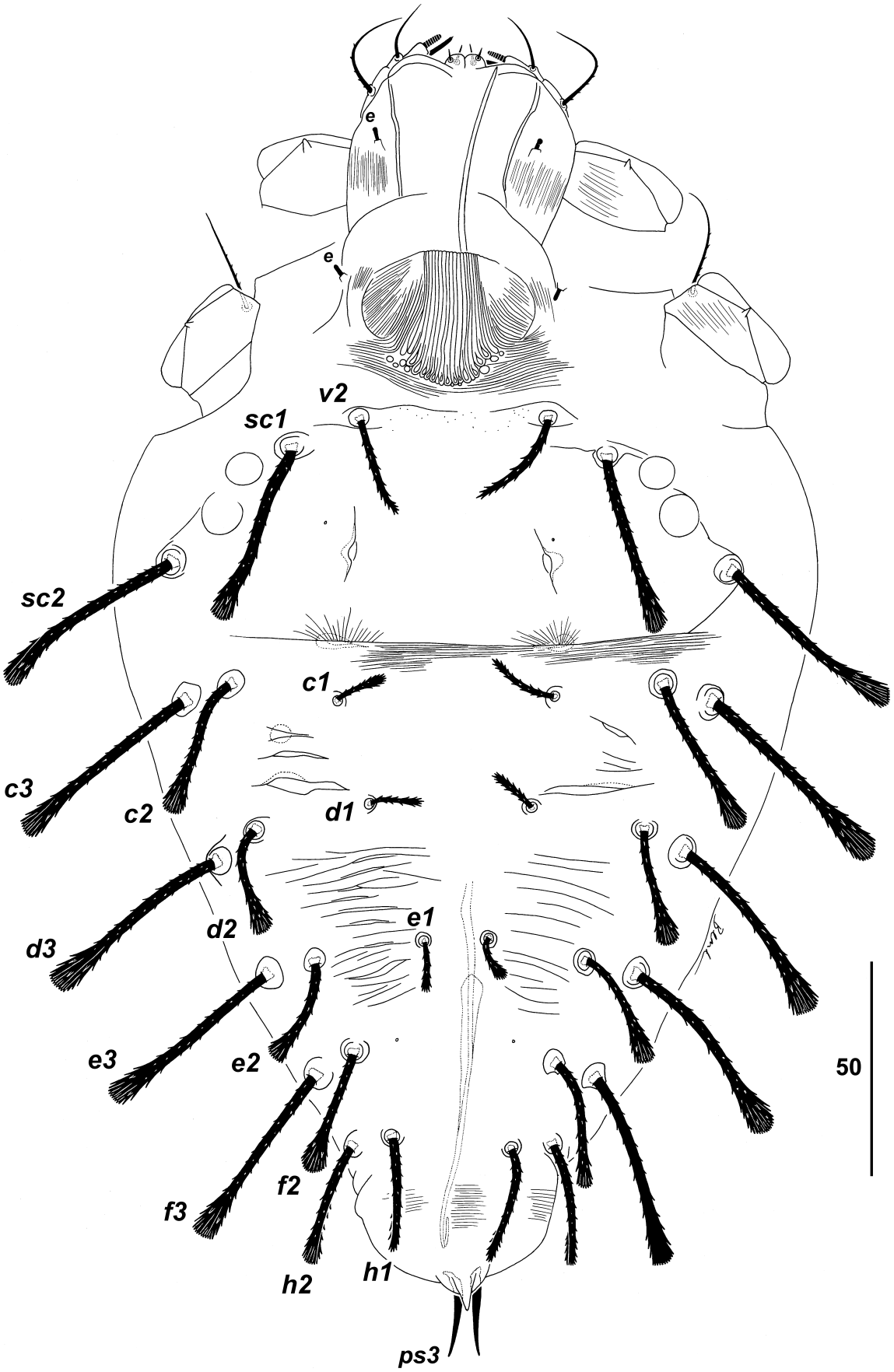


FIGURE 97. *Raoiella goyderi* Ochoa & Beard, adult male: dorsal habitus with detail of palps, aedeagus and setae *ps3*.

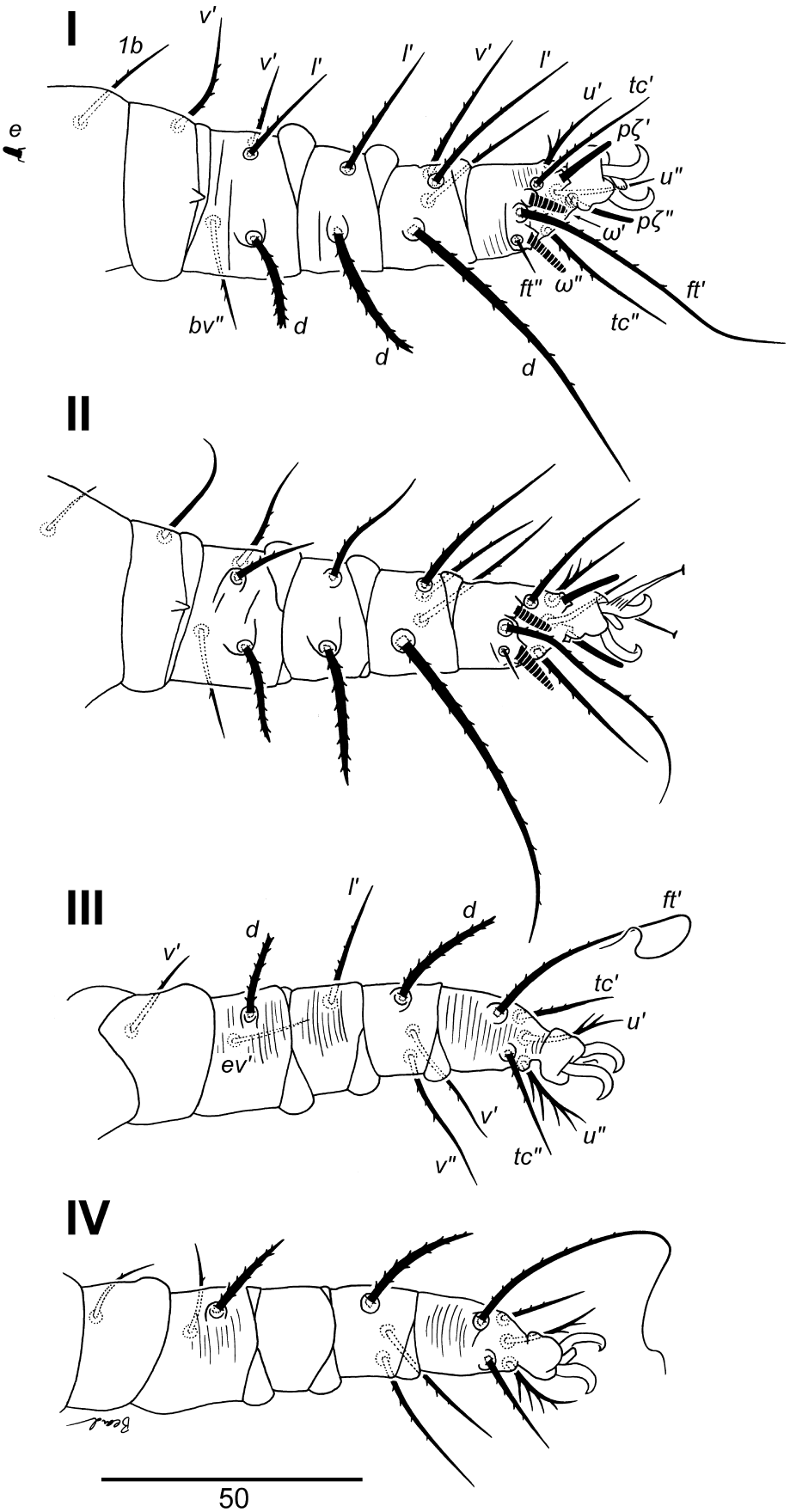


FIGURE 98. *Raoiella goyderi* Ochoa & Beard, adult male: legs I–IV (right side; legs I–II dorsal aspect, legs III–IV abaxial aspect).

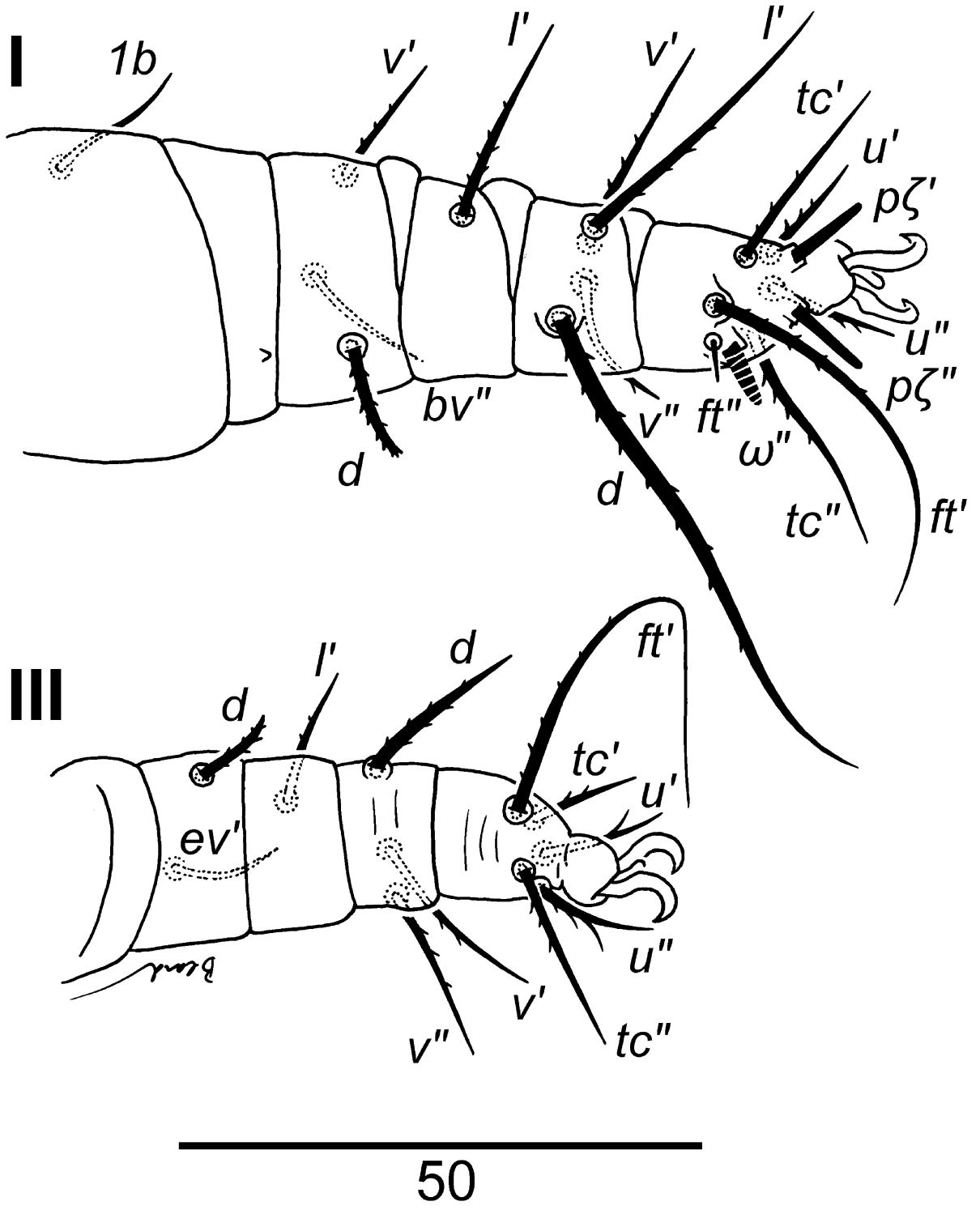


FIGURE 99. *Raoiella goyderi* Ochoa & Beard, protonymph: legs I and III (right side, dorsal to abaxial aspect).

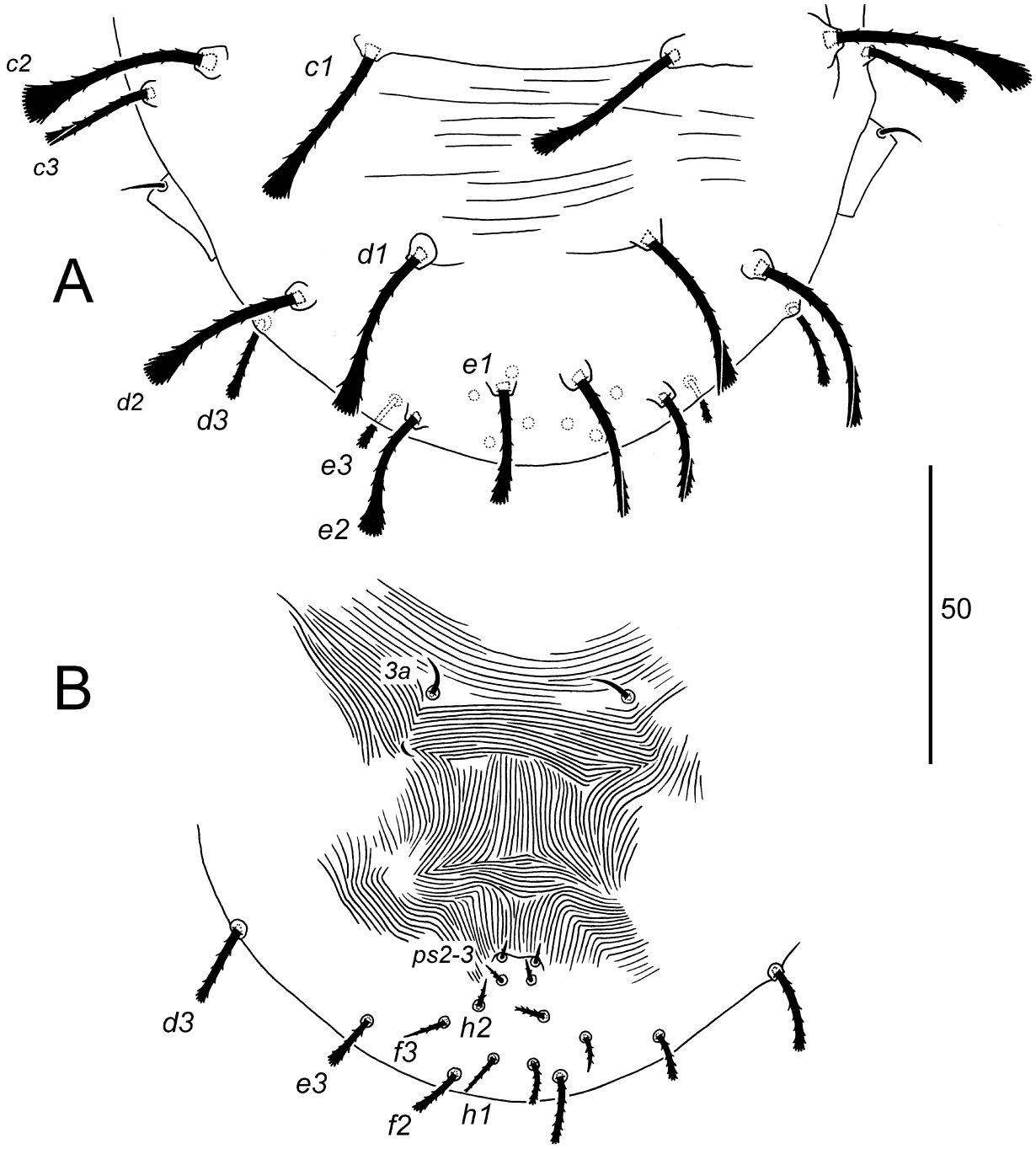


FIGURE 100. *Raoiella goyderi* Ochoa & Beard, larva: a. dorsal opisthosoma; b. posterior venter.

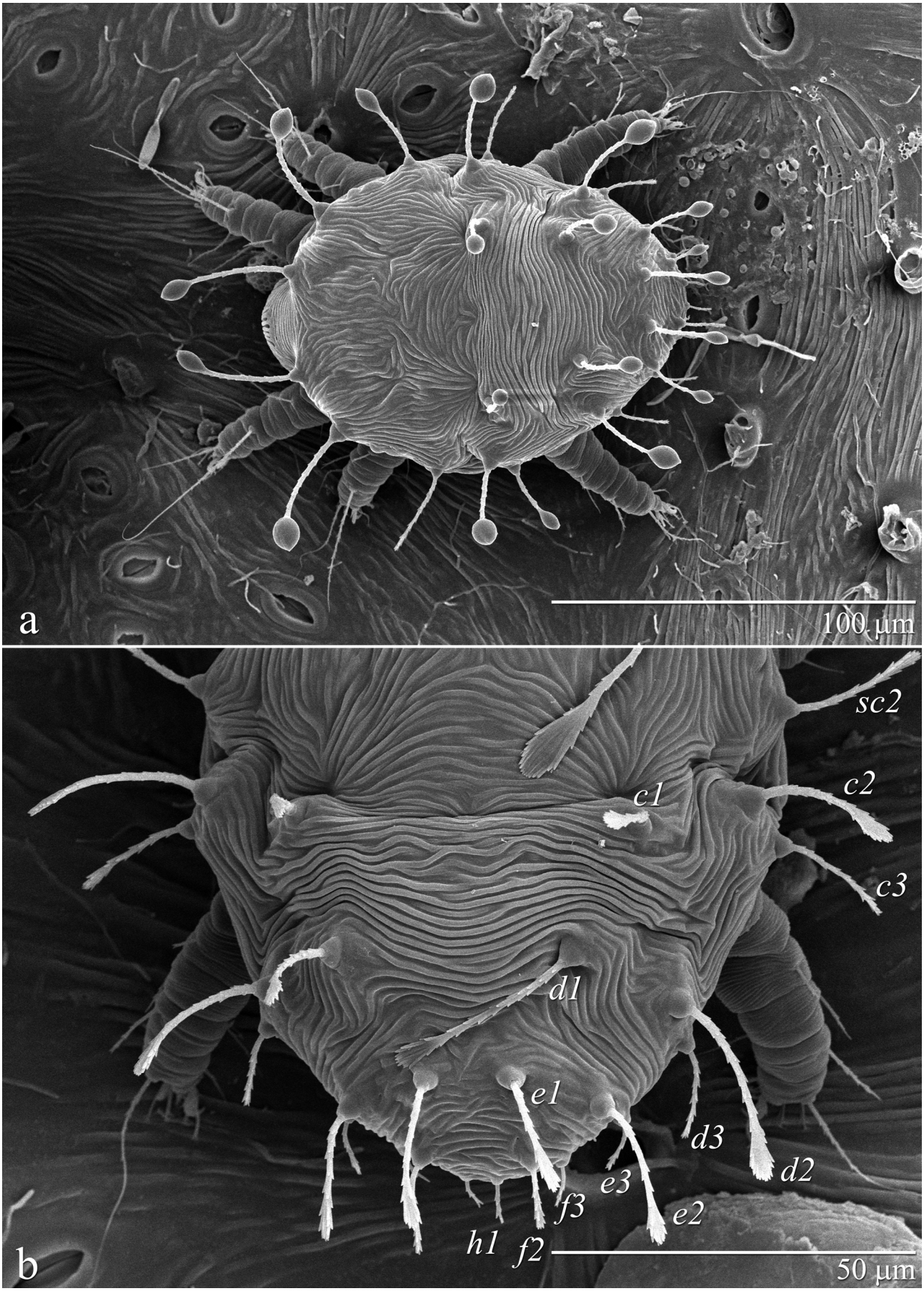


FIGURE 101. *Raoiella goyderi* Ochoa & Beard, larva: a. dorsal habitus on host plant; b. detail of posterior dorsum.

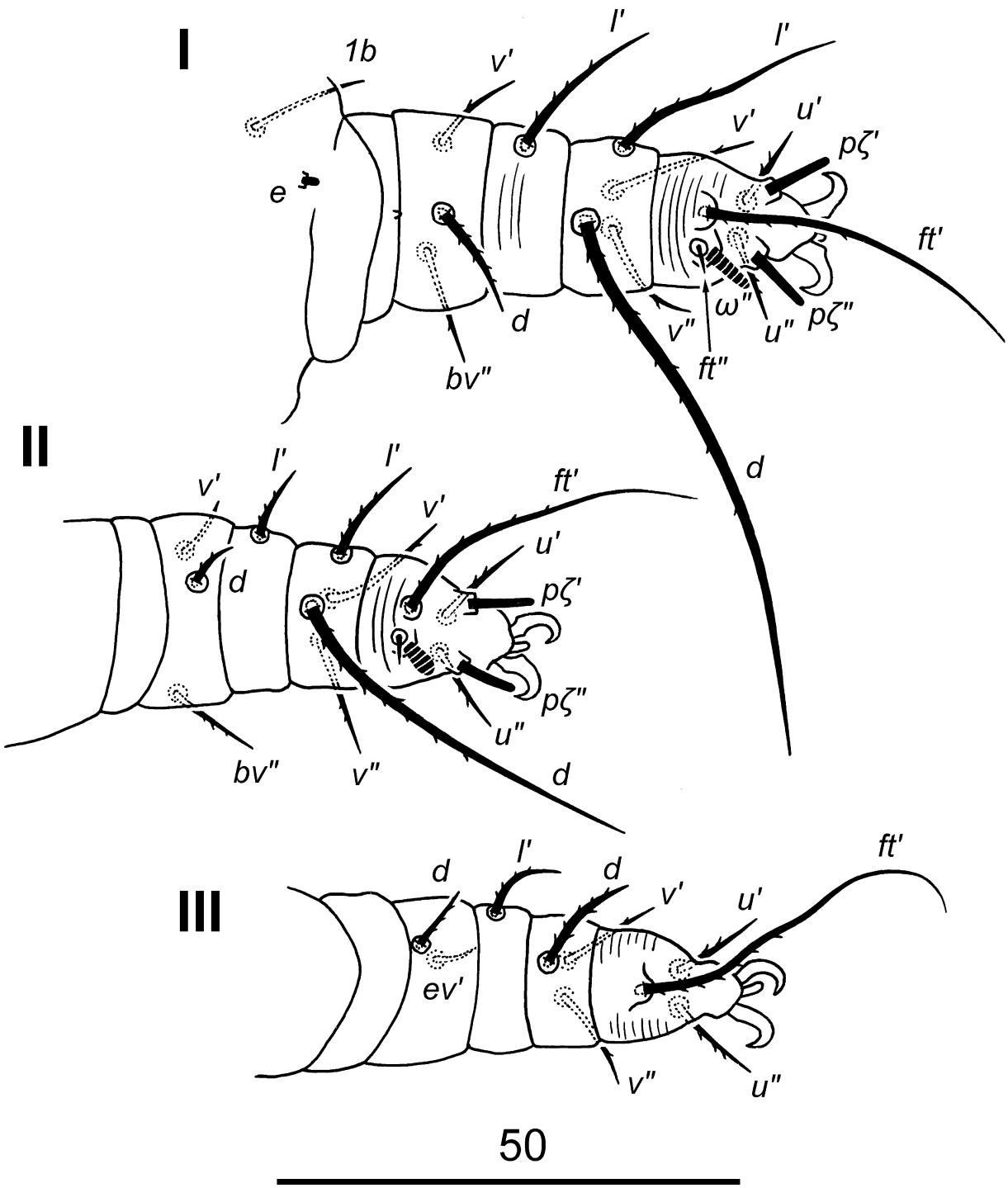


FIGURE 102. *Raoiella goyderi* Ochoa & Beard, larva: legs I–III (right side, dorsal aspect).

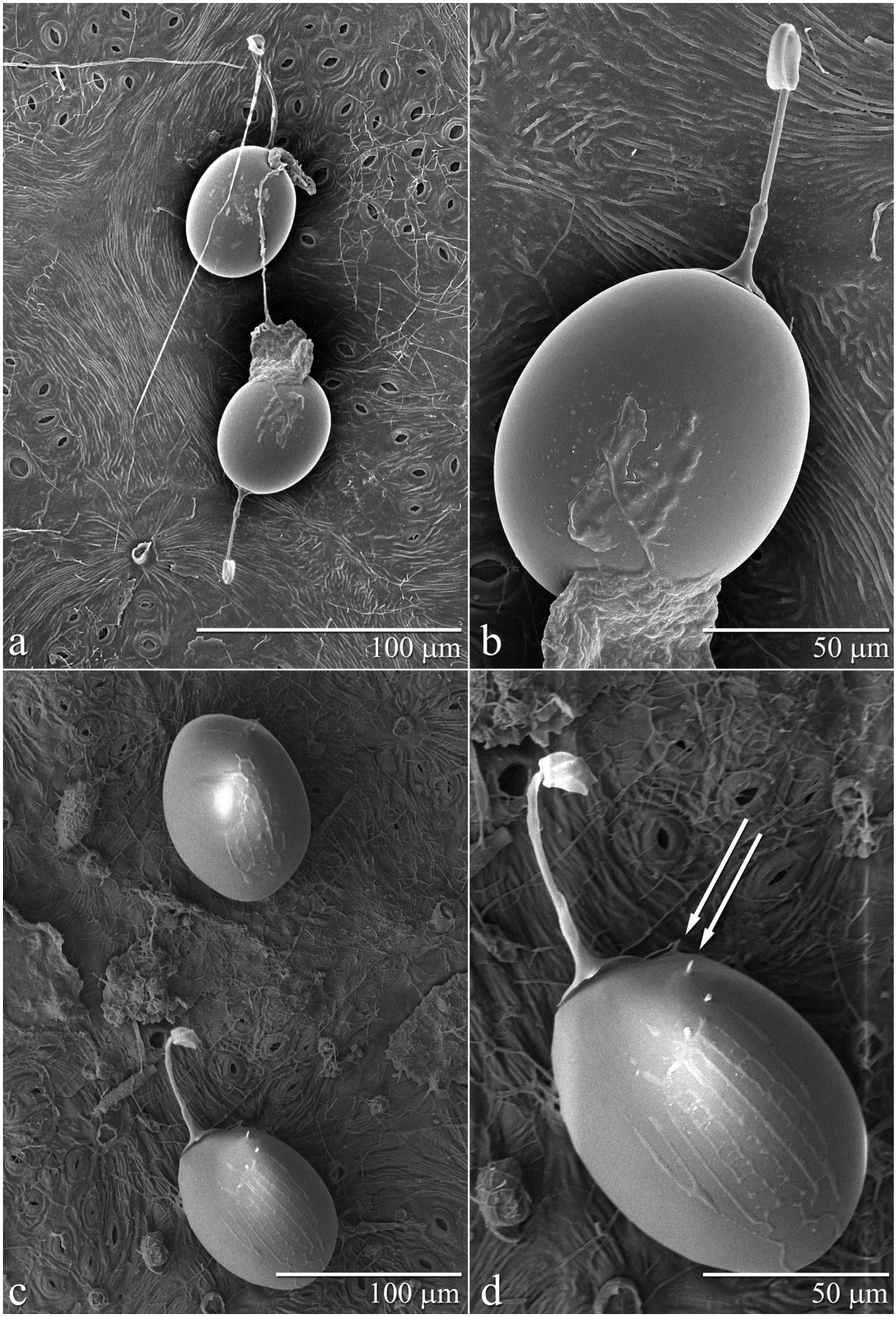


FIGURE 103. *Raoiella goyderi* Ochoa & Beard, a.–d. eggs on host plant (c.–d. note pair of minute spines indicated by arrows, enlarged in 103d).

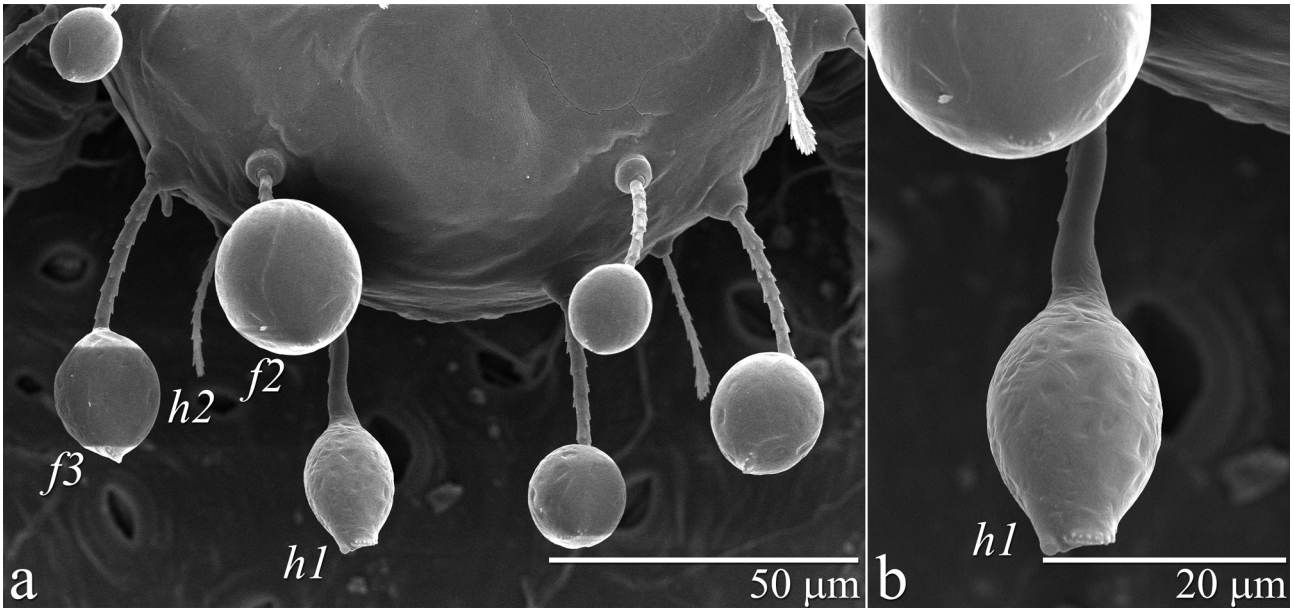


FIGURE 104. *Raoiella goyderi* Ochoa & Beard, adult female: a. detail of posterior dorsal setae, indicating droplet formation; b. detail of droplet on seta *h1* (note the texture of the droplet surface and the tip of the seta protruding from the droplets).

Larva. ***Dorsum.*** (Figs 100a, 101) Body measurements (3): length between setae *v2–e1* 115–120, width between setae *sc2–sc2* 113–117, *c3–c3* 118–122, *e2–e2* 42–47. Prodorsum with smooth with some weak transverse striae mesally. Dorsal opisthosoma with widely spaced transverse striae between setae *c1–d1*. Dorsal setae weakly spatulate, barbed along entire length; setae *e3*, *f2*, *f3*, *h1*, *h2* appear ventral; setae *h1*, *h2* short, tapered or blunt, barbed. Dorsal setae measurements: *v2* 39–42, *sc1* 46–52, *sc2* 21–27, *c1* 29–31, *c2* 34–37, *c3* 18–23, *d1* 31–35, *d2* 29–35, *d3* 13–16, *e1* 24–26, *e2* 20–24, *e3* 8–11, *f2* 11–15, *f3* 6–8, *h1* 7–8, *h2* 5–6.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (3–4) and one blunt eupathidium (8) distally, one dorsal seta; palp femorogenu with one seta (15–18).

Venter. (Fig. 100b) Cuticle almost completely plicate, with mostly transverse striae, except coxal fields smooth; cuticle between setae *3a–ps* with two patches of longitudinal striae separated by patch of transverse striae. Setal measurements: *1a* 51–54, *1b* 11–18, *3a* 7–9, *ps2* 4, *ps3* 3–4.

Legs. (Fig. 102) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 5; ta II 4–5) and two eupathidia distally (ta I 7–8, 7–8; ta II 7–8, 7–8). Companion seta *ft″* on tarsus I 3–4 and tarsus II 3, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with one seta (*l′* present; *d*, *l″* absent). Claw 8.

Egg. (Fig. 103) Red to orange in colour, ellipsoid, 85–110 long 75–80 wide, with a strong stipe 80–100 long, and with two small recurved spines near the stipe base 2.5–3.5 long (Fig. 103). Often with a series of fine longitudinal stripes on the surface (Figs 103c,d); and 10–20 eggs were found with a single female. Several predators were present with this species, including Phytoseiidae (Acari: Mesostigmata) and syrphid larvae (Diptera: Syrphidae).

Host. Milky box, *Lophostemon lactifluus* (F.Muell.) Peter G.Wilson & J.T.Waterh. (Myrtaceae).

Distribution. AUSTRALIA: Litchfield Shire, 47 km south of Darwin, Northern Territory.

Etymology. This species is named in honour of Surveyor-General George W. Goyder, who was the first to survey the region in which this mite was collected, including Berry Springs, located within the south western Litchfield Shire. Berry Springs got its name from 'Berry Creek' which was named by Goyder, in 1870, in honour of his Chief Draftsman, Edwin S. Berry, a member of Goyder's 1869 Survey Expedition to Port Darwin. Berry and Goyder went ashore on the first boat from his chartered vessel, the Moonta.

Remarks. *Raoiella goyderi* **sp. nov.** was listed as *Raoiella* sp. 5 (DNA code RaIn46) in Dowling *et al.* (2012; Table 1 and Figs 1, 2) and in Beard *et al.* (2013), and is a sister taxon to *R. bauchani* (and *R. pooleyi*), but separated by more than 8% divergence. *Raoiella goyderi* is morphologically similar to the other species in the *R. bauchani*

species group, *R. bauchani* and *R. pooleyi*, but can be separated by the following: *Rb* setae *f2* subequal in length to *f3*, *Rp* and *Rg* setae *f2* shorter than *f3*; *Rb* palp tibiotarsus elongate, *Rp* and *Rg* with palp segments of regular length; *Rb* with dorsal setae *c1* > *d1* > *e1*, *Rp* with setae *c1*, *d1*, *e1* minute, *Rg* with setae *c1*, *d1*, *e1* short.

The host plant was identified by botanists at the Queensland Herbarium (BRI), but no voucher specimen was retained.

***Raoiella hallingi* sp. nov. Beard**
(Figs 105–109)

Material examined. Holotype. ♀. **Australia,** ex. *Eucalyptus* sp. (Myrtaceae), Broome, northwest Western Australia, 29.x.2006, L. Halling (QMS 108802).

Paratypes. ♀, 2 ♂, 4 deutonymphs (3 pharate ♀), protonymph, larva, same data as holotype. (NAQS Cairns; all on separate slides, except ♂ and protonymph on same slide (slide in poor condition)).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* spatulate. Adult femora I with four setae (*d*, *l′*, *v′*, *bv″*), femur II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with three seta (*d*, *l′*, *l″*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft″*) slightly longer than solenidion, sometimes subequal. Dorsal setae on tibiae I–II thick, weakly spatulate to blunt. Eupathidium on palp tibiotarsus tapered.

Description. Female. ***Dorsum.*** (Fig. 105) Body measurements (2): length between setae *v2–h1* 228–246 [230], width between setae *sc2–sc2* 179–188 [181], *c3–c3* 177–181 [177], *f3–f3* 101–104 [104]. Prodorsum with pair of pores on posterior margin (often hidden in folds of soft cuticle); opisthosoma with three pairs of large pores between setae *c2–d2*, pair pores between *d2–e2*. Dorsal setae thick, spatulate, barbed along entire length. Dorsal setae measurements: *v2* 59–62 [59–62], *sc1* 37–39 [37–39], *sc2* 56–62 [56–57], *c1* 27–28 [27–28], *c2* 30–31 [31], *c3* 60–61 [60], *d1* 19–21 [19–20], *d2* 28–30 [28–30], *d3* 63–65 [63–65], *e1* 23–26 [23–24], *e2* 31–33 [31–32], *e3* 67–71 [67–70], *f2* 38–39 [38–39], *f3* 79–84 [79–82], *h1* 56–60 [56–58], *h2* 33–37 [33].

Palps. (Fig. 105) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (8–9) [8] and one finely tapered eupathidium distally (12–13) [12–13], one dorsal seta (12–14); palp femorogenu with one seta (24–27).

Venter. (Fig. 106) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setal measurements: *1a* 36–56 [36–38], *1b* 16–22 [22], *2b* 16–18 [18], *3a* 13 [13], *4a* 42–44 [44], *ag* 10–11 [10], *g1* 13–14 [14], *g2* 13–15 [15], *ps2* 12–16 [16], *ps3* 12 [12].

Spermatheca. Short membranous tube visible.

Legs. (Fig. 107) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-3-3-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 13–15 [13]; ta II 11–12 [11]) and two eupathidia distally (ta I 12–13 [12], 13–14 [13]; ta II 12 [12], 12 [12]). Companion seta *ft″* on tarsus I 20–23 [20–21] and tarsus II 16–18 [16], inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta with blunt tip, not finely tapered. Femora I with four setae (*d*, *l′*, *v′*, *bv″*), femur II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with three seta (*d*, *l′*, *l″*). Tenent hairs on claws with three attachment points.

Male. ***Dorsum.*** (Fig. 108) Body measurements (2): length between setae *v2–h1* 149–169, width between setae *sc2–sc2* 132–146, *c3–c3* 127–136, *f3–f3* 55–59. Prodorsum smooth with pair of pores on posterior margin (often hidden in folds of soft cuticle); opisthosoma with pair slit pores between setae *c2–d2*. Opisthosoma with transverse striae between setae *d1–f2*. Dorsal setae spatulate, barbed along entire length, narrower than female. Dorsal setae measurements: *v2* 30–32, *sc1* 30–31, *sc2* 40–46, *c1* 20, *c2* 22–23, *c3* 45–50, *d1* 17, *d2* 21, *d3* 42–47, *e1* 17, *e2* 21–23, *e3* 45–52, *f2* 24–27, *f3* 46–55, *h1* 22–23, *h2* 19–23.

Palps. (Fig. 108) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–7) and one finely tapered eupathidium (8–10) distally, one dorsal seta (12–13); palp femorogenu with one seta.

Venter. Cuticle with mostly finely transverse plicae. Setae *ps3* modified as accessory genital stylets into short thick spines. Setal measurements: *1a* 44–48, *1b* 16–18, *2b* 13–15, *3a* 11, *4a* 29, *ag* 10, *g1* 11–13, *g2* 10–12, *ps2* 8–10, *ps3* 9–11.

Aedeagus. (Fig. 108) Aedeagus narrow, elongate and sclerotised (66–71), tapering to a blunt point distally.

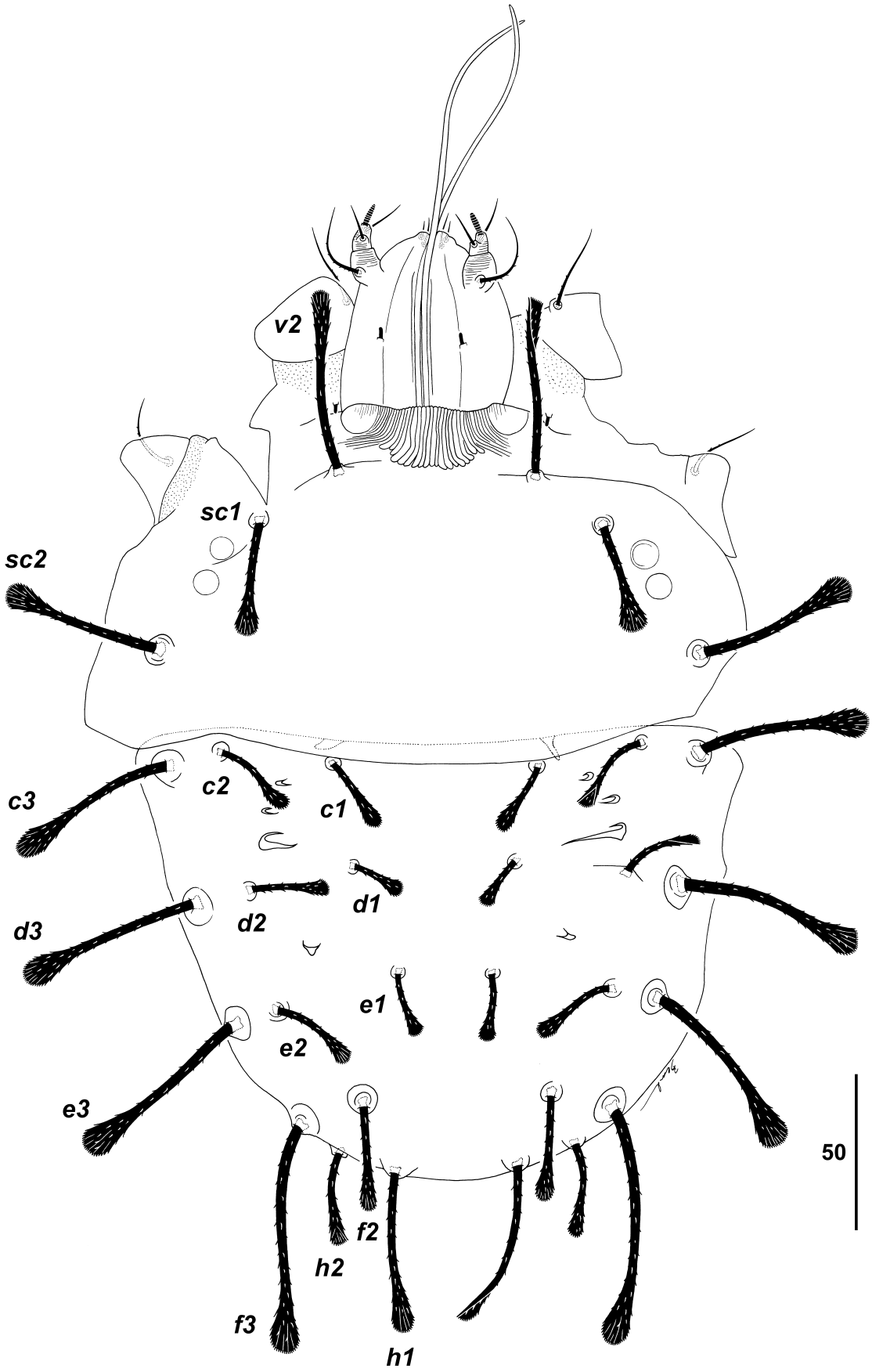


FIGURE 105. *Raoiella hallingi* Beard, adult female: dorsal habitus with details of palps.



FIGURE 106. *Raoiella hallingi* Beard, adult female: posterior venter.

Legs. (Fig. 109) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-3-3-4-10(2), 0-1/0-2-1-3-5, 0-1/0-2-0-3-5 respectively (trochanters III–IV are not clearly visible and the pattern of expression of seta *v′* remains uncertain). Tarsi I and II each with two solenidia (ta I adaxial 13–15, abaxial 14; ta II adaxial 12–15, abaxial 12–13), and two eupathidia distally (ta I 11, 10; ta II 10, 9). Companion seta *ft″* on tarsus I 16–20 (finely tapered) and tarsus II 12–13, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta finely tapered. Femur I with four setae (*d*, *l′*, *v′*, *bv″*), femur II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with three seta (*d*, *l′*, *l″*). Tenent hairs on claws with three attachment points.

Deutonymph. ***Dorsum.*** Body measurements (3): length between setae *v2–h1* 180–200, width between setae *sc2–sc2* 146–152, *c3–c3* 148–153, *f3–f3* 60–65. Prodorsum smooth; dorsal opisthosoma mostly smooth with light transverse striations; pores not visible. Dorsal setae barbed along entire length. Dorsal setae measurements: *v2* 51–52, *sc1* 36–38, *sc2* 48–49, *c1* 20–21, *c2* 26, *c3* 47–51, *d1* 17–21, *d2* 23–27, *d3* 48–55, *e1* 18–21, *e2* 24–29, *e3* 50–53, *f2* 30–33, *f3* 49–51, *h1* 25–30, *h2* 13–16.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–7) and one finely tapered eupathidium (8–9) distally, one dorsal seta (9–10); palp femorogenu with one seta.

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 35–54, *1b* 13–17, *3a* 9–11, *4a* 30–47, *ag* 7–8, *g1* 6–8, *ps2* 6–7, *ps3* 5–8.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 9–10; ta II 9–10) and two eupathidia distally (ta I 9, 9–10; ta II 9, 9–10). Companion seta *ft″* on tarsus I 8–11 and tarsus II 6–7, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta spatulate. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with two seta (*d*, *l′* present; *l″* absent).

Protonymph. ***Dorsum.*** Body measurements (1): length between setae *v2–h1* 161, width between setae *sc2–sc2* 133, *c3–c3* 129, *f3–f3* 38. Dorsal setae spatulate, barbed along entire length; setae *h2* tapered. Dorsal setae measurements: *v2* 42, *sc1* 33, *sc2* 41, *c1* -, *c2* 26–28, *c3* 40–43, *d1* 18, *d2* 23, *d3* 38–39, *e1* -, *e2* 23–28, *e3* 35–36, *f2* 27, *f3* -, *h1* 10–11, *h2* 11–12.

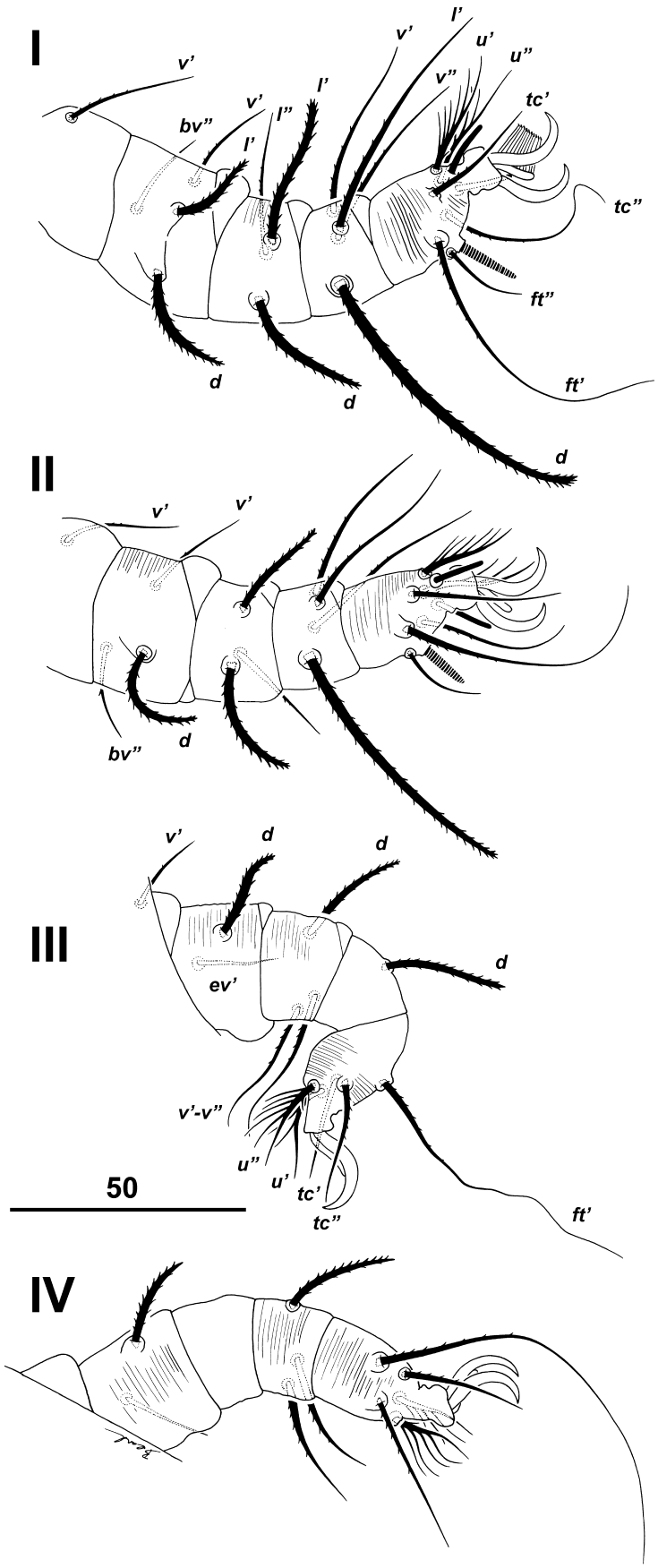


FIGURE 107. *Raoiella hallingi* Beard, adult female: legs I–IV (right side; legs I–II adaxial to dorsal aspect, legs III–IV abaxial aspect).

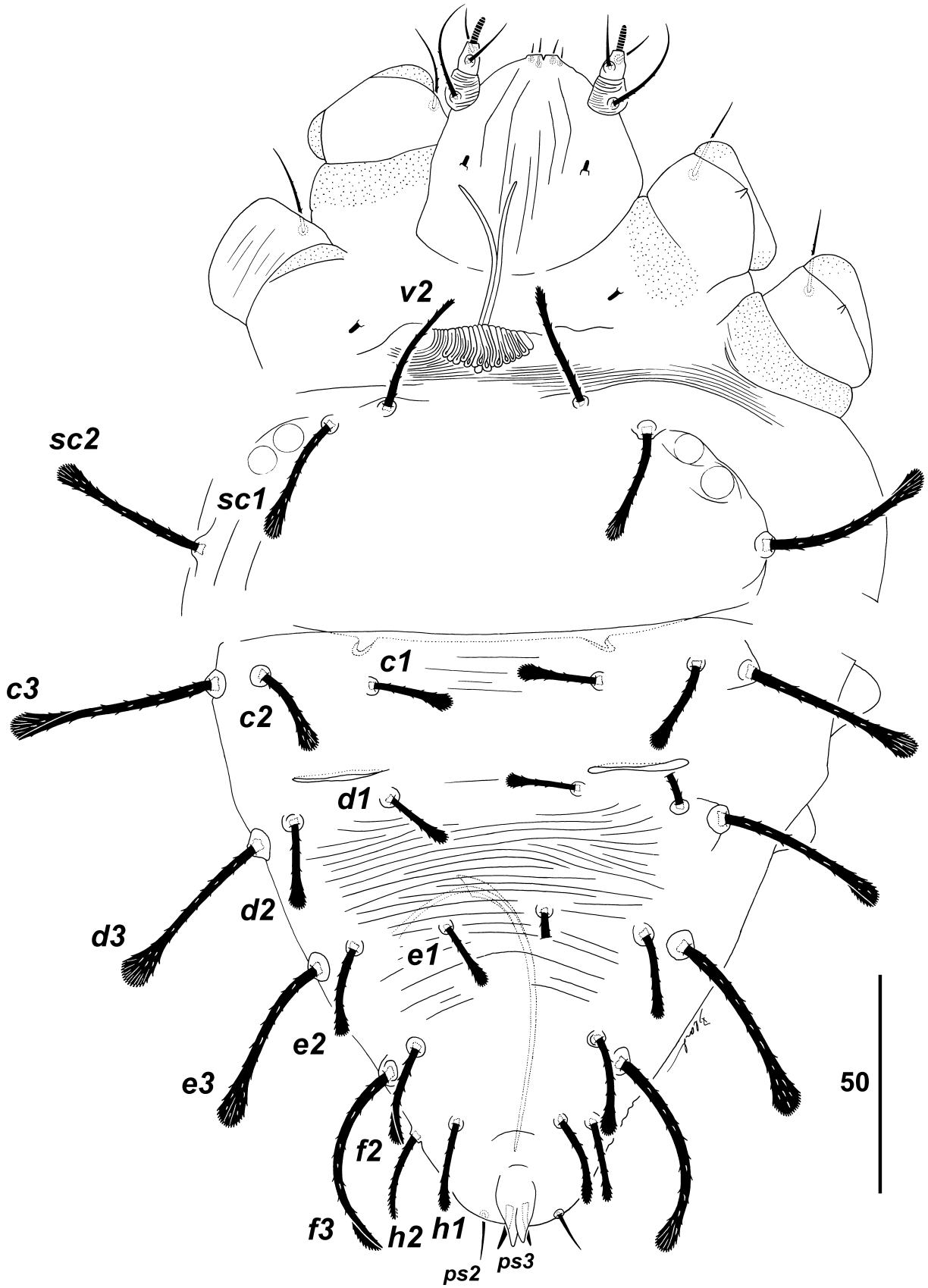


FIGURE 108. *Raoiella hallingi* Beard, adult male: dorsal habitus with details of palps, aedeagus and setae *ps3*.

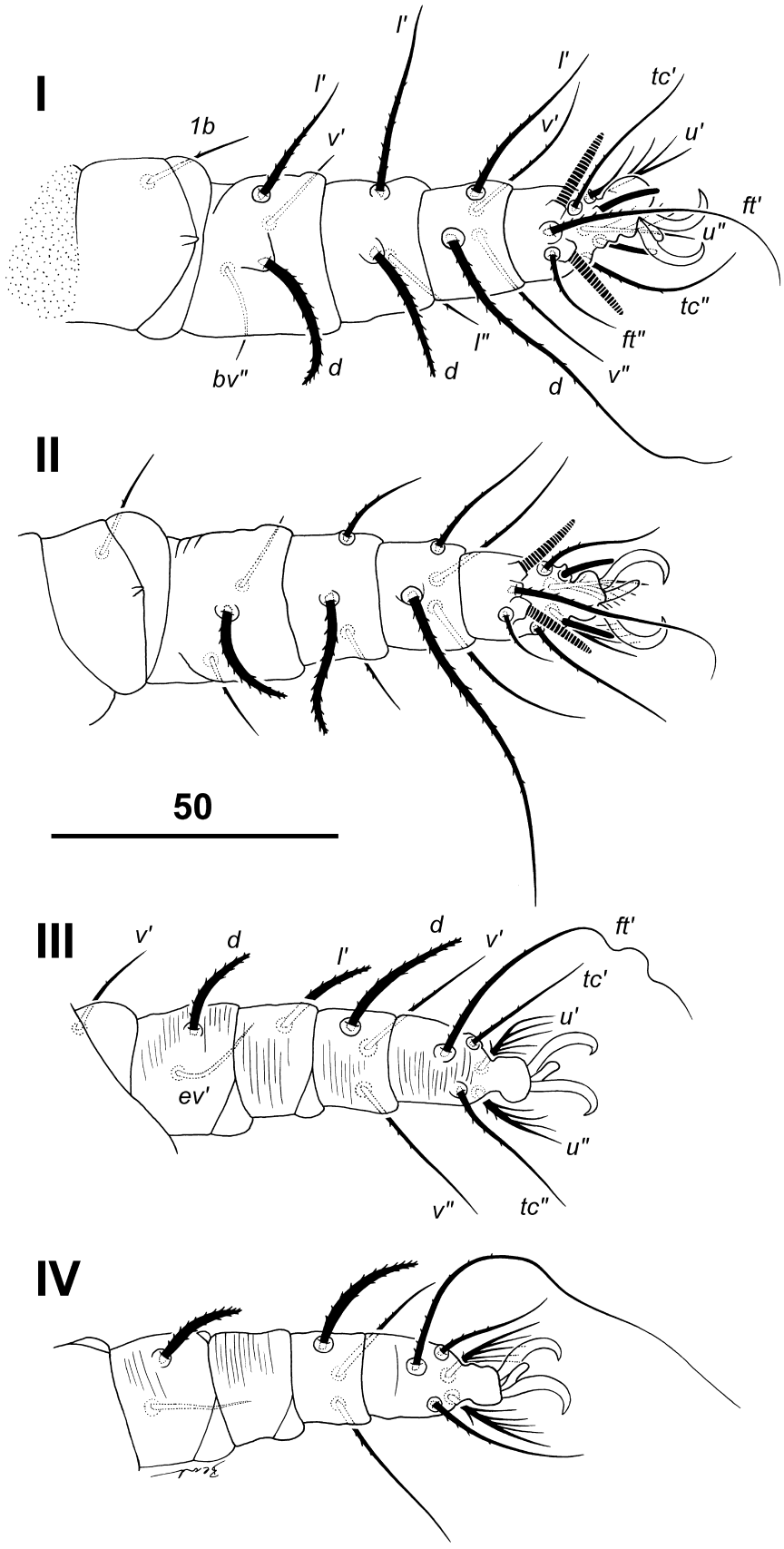


FIGURE 109. *Raoiella hallingi* Beard, adult male: legs I–IV (right side; legs I–II dorsal aspect, legs III–IV abaxial aspect).

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one tapered eupathidium (7) distally, one dorsal seta (8); palp femorogenu with one seta.

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements (most setae obscured): *3a* 11, *ag* 9, *ps2* 3–4, *ps3* 3–4.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 9; ta II 7–8) and two eupathidia distally (ta I 7, 7; ta II 7, 7). Companion seta *ft″* on tarsus I 6 and tarsus II 7, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta spatulate. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with one seta (*l′* present; *d*, *l″* absent).

Larva. Unknown.

Host. *Eucalyptus* sp. (Myrtaceae).

Distribution. AUSTRALIA: northwest Western Australia.

Etymology. This species is named for its collector, Luke Halling.

Remarks. *Raoiella hallingi* was listed as *Raoiella* sp. 11 in Beard *et al*. (2013), and is morphologically similar to *R. calgoa*, *R. crebra* and *R. illyarrie*—see Remarks section for *R. calgoa* for characters for separation. *Raoiella illyarrie* is considered here to have males with trochanter IV nude (although seta *v′* is occasionally expressed), and it is possible that male *R. hallingi* have a nude trochanter IV (not confirmed as trochanters are somewhat obscured), while the males of *R. calgoa* and *R. crebra* clearly have one seta present on trochanter IV. Specimens of *R. hallingi* were not included in molecular analyses by Dowling *et al.* (2012).

Raoiella illyarrie sp. nov. Beard & Ochoa

(Figs 110–115)

Material examined. Holotype. ♀. **Australia**, ex. illyarrie *Eucalyptus erythrocorys* (Myrtaceae), along road to entrance of Yanchep National Park, 51 km N Perth via Wanneroo Road, Western Australia, 31°33’02”S 115°41’12”E, 22.iv.2009, J. J. Beard (WAM).

Paratypes. 11 ♀, 4 ♂, 4 deutonymphs, 3 protonymphs, 2 larvae, same data as holotype (WAM, QM, USNM).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* spatulate. Adult femora I with four setae (*d*, *l′*, *v′, bv″*), femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with three setae (*l′*, *d*, *l″*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsus I with companion setae (*ft″*) finely tapered, longer than solenidion, often broken and appearing subequal to solenidion. Tarsus II with companion seta (*ft″*) slightly longer than or subequal to solenidion. Dorsal setae on tibiae I–II tapered distally, but sometimes with weakly spatulate tip. Eupathidium on palp tibiotarsus tapered. Larva with setae *h2* elongate, filiform.

Description. Female. ***Dorsum.*** (Fig. 110a) Body measurements (9): length between setae *v2–h1* 256–278 [258], width between setae *sc2–sc2* 177–193 [177], *c3–c3* 178–191 [182], *f3–f3* 98–111 [109]. Lightly sclerotised posteromesally and opisthonotal shields often well developed. Prodorsum smooth with some fine arching folds posteromesally, one pair large round pores mesally and three pairs of minute pores sublaterally, with pair large pores on posterior margin (often under fold in sejugal region). Opisthosoma mostly smooth with fine punctations and a few fine sublateral folds; with two pairs of large transversely elongate slit pores and three minute pores between setae *c1–c2* and *d1–d2*; with two pairs large pores between *d1–d2* and *e1–e2*; with pair large pores between *e2–f2*. All dorsal setae spatulate, barbed along entire length. Dorsal setae measurements: *v2* 55–70 [59], *sc1* 30–47 [35], *sc2* 52–64 [56], *c1* 26–32 [27], *c2* 26–32 [32], *c3* 53–62 [53], *d1* 17–20 [20], *d2* 21–27 [26–27], *d3* 59–65 [61], *e1* 18–23 [19–20], *e2* 24–30 [28], *e3* 60–69 [63], *f2* 27–34 [34], *f3* 75–83 [75], *h1* 47–57 [48], *h2* 27–36 [28].

Palps. (Fig. 110b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one distal solenidion (8–10) [8–9] and one finely tapered eupathidium (11–14) [12], and one seta dorsally (14–16) [15–16]; palp femorogenu with one seta (26–31) [28].

Venter. (Fig. 111a) Cuticle almost completely plicate, covered with mostly transverse striae; cuticle between *1b–1b* transverse, longitudinal *1b–1a*, transverse *1a–g1*, with oblique to longitudinal striae flanking genital region,

coxal fields smooth. Setae *g1* and *g2* inserted in more or less transverse line on membranous genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *g1*, *g2*, *ps2*, *ps3* barbed. Setal measurements: *1a* 67–102 [67–72], *1b* 17–25 [17], *2b* 14–26 [14], *3a* 12–13 [12], *4a* 49–93 [71], *ag* 9–14 [13], *g1* 13–14 [13], *g2* 13–17 [13], *ps2* 14–18 [17–18], *ps3* 12–13 [12–13].

Spermatheca. (Fig. 111b) A coiled membranous duct > 100 in length.

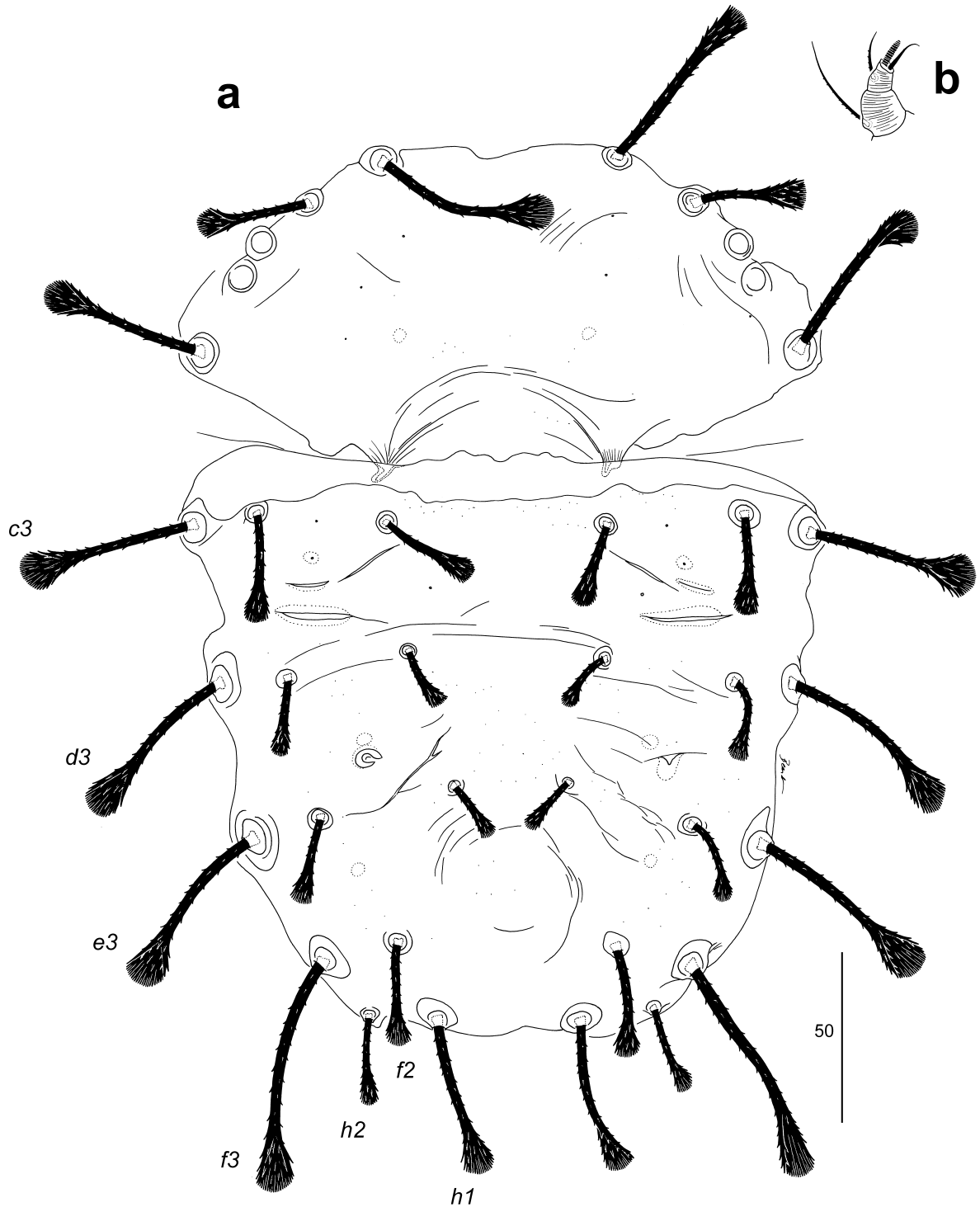


FIGURE 110. *Raoiella illyarrie* Beard & Ochoa, adult female: a. dorsal habitus; b. detail of palp.

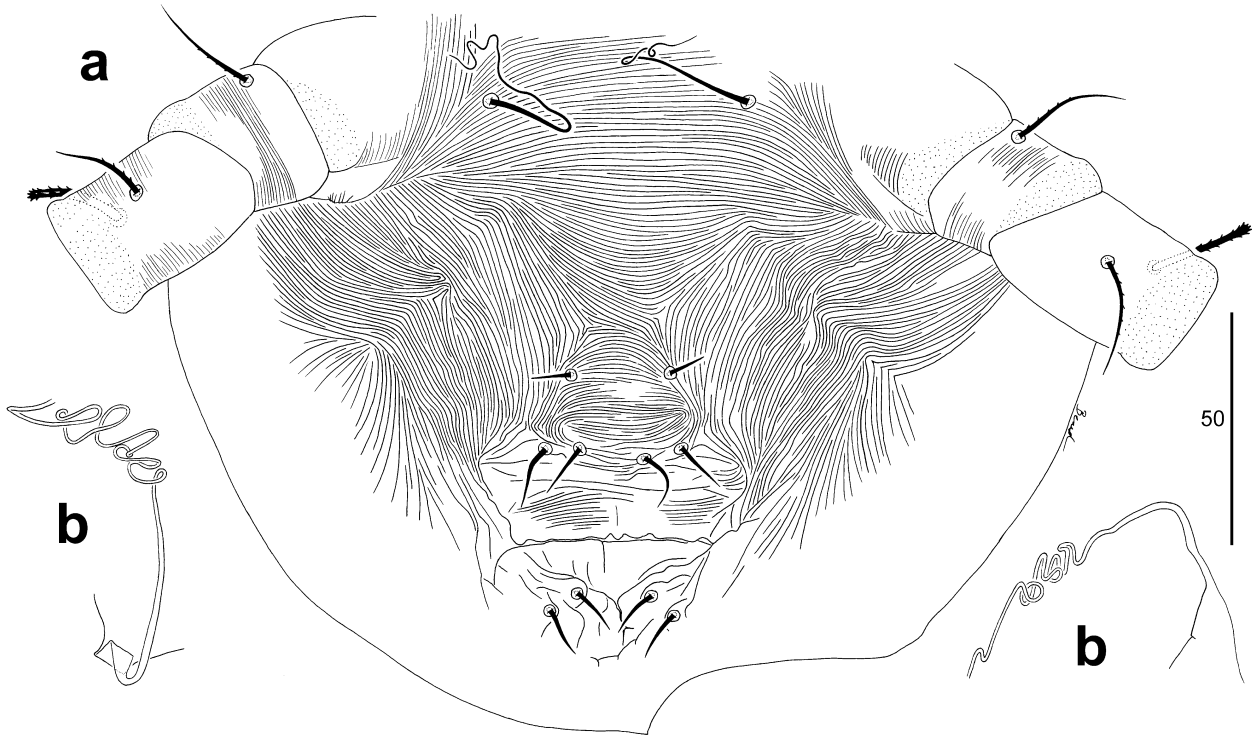


FIGURE 111. *Raoiella illyarrie* Beard & Ochoa, adult female: a. posterior venter; b. detail of spermatheca.

Legs. (Fig. 112) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-3-3-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Femora I with four setae (*d*, *l′*, *v′*, *bv″*), femora II with three setae (*d*, *v′*, *bv″*; *l′* absent). Genua I–II with three setae (*l′*, *d*, *l″*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 13–16 [15]; ta II 11–16 [13–14]) and two eupathidia distally *pζ″*–*pζ″* (ta I 12–14 [12–13], 12–14 [12–13]; ta II 12–13 [12–13], 12–13 [12–13]). Finely tapered, barbed companion seta *ft″* on tarsus I 17–29 [17–20] and tarsus II 11–21 [13], inserted adjacent to solenidion *ω″*. The tips of the companion setae are extremely fine and often broken, making the seta appear shorter (and hence the large range in length). Dorsal seta, *d*, on tibiae I–II most commonly tapered blunt (Fig. 112), but sometimes weakly spatulate (ti I 74–81 [74–75], ti II 65–69 [65–69]). Claw I 20–21.

Male. ***Dorsum.*** (Fig. 113a) Body measurements (4): length between setae *v2–h1* 172–192, width between setae *sc2–sc2* 131–145, *c3–c3* 127–137, *f3–f3* 53–68. Prodorsum smooth, with pair large pores on posterior margin (under fold in sejugal region). Opisthosoma mostly smooth with band of transverse striae between *d1* and *e1*; a pair of large transverse pores between *c2–d2*. Weakly developed pygidial shield present between *f1* and *h1*, with finely punctate cuticle; with band of fine transverse striae at posterior tip of opisthosoma between *h1* and *ps3*. Setae *h1*, *h2* blunt to weakly spatulate. Dorsal setae measurements: *v2* 28–34, *sc1* 24–26, *sc2* 31–41, *c1* 16–20, *c2* 19–23, *c3* 38–42, *d1* 14–18, *d2* 16–24, *d3* 38–45, *e1* 13–18, *e2* 17–22, *e3* 41–50, *f2* 16–25, *f3* 43–48, *h1* 20–23, *h2* 16–23.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–9) and one finely tapered eupathidium (10–12) distally, and one seta dorsally (12–15); palp femorogenu with one seta (19–23).

Venter. Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and a distinct patch of smooth cuticle on either side of setae *ag*. Setae *1a*, *4a* elongate, finely tapered (difficult to determine full length); setae *ag*, *g1*, *g2* lightly barbed; setae *ps3* modified as accessory genital stylets into thickened spurs (Fig. 113). Setal measurements: *1a* 53–83, *1b* 13–24, *2b* 12–15, *3a* 12–14, *4a* 36–66, *ag* 9–12, *g1* 11–14, *g2* 11–13, *ps2* 9–11, *ps3* 9–10.

Aedeagus. (Fig. 113b) Aedeagus narrow, elongate and sclerotised (86–92), tapering to a blunt point distally.

Legs. (Fig. 114 114) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-3-3-4-10(2), 0-1-2-1-3-5, 0-0-2-0-3-5 respectively. Seta *v′* is symmetrically absent on tr IV of 2/4 males examined, asymmetrically absent on 1/4 males, and present on both trochanters of 1/4 males, and based on this data, seta *v′* is considered to be absent on trochanter IV for the male of this species. Femora I with four setae (*d*, *l′*, *v′*, *bv″*), femora II with three setae (*d*,

v′, *bv″* present; *l′* absent). Genua I–II with three setae (*l′*, *d*, *l″*). Tarsi I and II each with two solenidia (ta I *ω′* adaxial 11–15, *ω″* abaxial 13–15; ta II adaxial 10–13, abaxial 14–15), and two eupathidia *pζ′–pζ″* distally (ta I 13–14, 12–13; ta II 11–12, 11–12). Finely tapered, barbed companion seta *ft″* laterad solenidion *ω″* on tarsus I 15–27 and tarsus II 11–18. Companion setae are often broken, and may appear shorter (Fig. 114). Tibiae I–II with dorsal seta, *d*, tapered, sometimes with a blunt tip or weakly spatulate (dtiI 66–68, dtiII 57–66). Claw I 16–17.

Deutonymph (female and male). ***Dorsum.*** Sexually dimorphic. Body measurements (1 female, 3 males in parentheses): length between setae *v2–h1* female 220 (male 180–188), width between setae *sc2–sc2* 148 (123–130), *c3–c3* 151 (122–129), *f3-f3* 70 (44–53). Prodorsum mostly smooth with weak arching transverse striae posteriorly. Opisthosoma with transverse striae between *c1–d1*, sometimes to *e1*. All dorsal setae spatulate; *h2* sometimes weakly spatulate to blunt. Lateral opisthosomal setae (*c3*, *d3*, *e3*, *f3*) longer than central setae (*c1–2*, *d1–2*, *e1–2*, *f2*). Male dorsal setae slightly finer than female dorsal setae. Dorsal setae measurements: *v2* 43 (28–33), *sc1* 27 (23–25), *sc2* 40 (29–32), *c1* 21 (16–20), *c2* 23 (17–22), *c3* 46 (32–35), *d1* 19 (13–16), *d2* 23 (14–20), *d3* 41 (32–35), *e1* 19 (14–17), *e2* 22 (17–20), *e3* 43 (31–34), *f2* 29 (18–25), *f3* 38 (20–28), *h1* 23 (10–16), *h2* 14–17 (10–18).

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (f 6–7; m 5–6) and one finely tapered eupathidium (9–11) distally, and one seta dorsally (9–12); and femorogenu with one seta 16–18.

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth; striae between *1b–1b* transverse (oblique in male); *1b–1a* longitudinal; female with *1a–ag* transverse and *ag–g1* weakly oblique; male with *1a–g1* transverse; both sexes with oblique striae flanking genital region (see also Figs 20a–b, 128a–b, 234a–b). Seta *1a* elongate, fine (difficult to determine full length); setae *2b* absent. Setae smooth to weakly barbed. Setal measurements: *1a* 35–47, *1b* 14–16, *3a* 8–10, *4a* 24–42, *ag* 7–10, *g1* 7–10, *ps2* 7–8, *ps3* 7–10.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Femora I–II with three setae (*d*, *v′*, *bv″*; *l′* absent). Genua I–II with two setae (*l′*, *d*; *l″* absent). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 9–12); ta II 8–9) and two eupathidia *pζ′–pζ″* distally (ta I 8–10, 8–10; ta II 8–9, 8–9). Fine, barbed companion seta *ft″* on tarsus I 11–12 and tarsus II 7–9, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta, *d*, spatulate to weakly spatulate or sometimes blunt (dtiI 53–59, dtiII 46–53). Claw I 13–15.

Protonymph. ***Dorsum.*** Body measurements (4): length between setae *v2–f2* 148–151, width between setae *sc2–sc2* 119–120, *c3–c3* 115–123, *f3–f3* 36–42. Prodorsum mostly smooth, sometimes with weak transverse striae posteriorly. Opisthosoma with transverse striae between setae *c1–d1*. All setae spatulate. Lateral setae *c3*, *d3*, *e3* much longer than *c1–c2*, *d1–d2*, *e1–e2*; other setae more or less subequal, except *h1–h2* short; setae *f3* often inserted ventrally with *h1*, *h2*; setae *h1* blunt to weakly spatulate, barbed; setae *h2* tapered, barbed. Dorsal setae measurements: *v2* 29–33, *sc1* 23–26, *sc2* 27–29, *c1* 16–19, *c2* 19–21, *c3* 26–29, *d1* 14–16, *d2* 17–21, *d3* 26–28, *e1* 15–16, *e2* 19–20, *e3* 19–26, *f2* 16–20, *f3* 13–17, *h1* 8–11, *h2* 11–23.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one finely tapered eupathidium (8–9) distally, and one seta dorsally (10–11); palp femorogenu with one seta (15–16).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setae smooth to weakly barbed. Setal measurements: *1a* 29–34, *1b* 9–10, *3a* 7–9, *ag* 7–10, *ps2* 4–5, *ps3* 4–5.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Femora I–II with three setae (*d*, *v′*, *bv″*; *l′* absent). Genua I–II with one seta (*l′*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 8; ta II 7–8) and two eupathidia *pζ′–pζ″* distally (ta I 8–9, 7–8; ta II 7, 7–8). Barbed, tapered companion seta *ft″* on tarsus I 7–10 and tarsus II 5–8, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta, *d*, blunt to weakly spatulate (dtiI 43–47, dtiII 39–41). Claw I 11–12.

Larva. ***Dorsum.*** (Fig. 115a) Body measurements (2): length between setae *v2–f2* 142–144, width between setae *sc2–sc2* 110–15, *c3–c3* 114–120, *f3–f3* 23–28. Prodorsum with some longitudinal to oblique striations; setae spatulate, barbed, subequal in length. Opisthosoma with transverse striae between setae *c1–d1*. Most dorsal opisthosomal setae subequal in length and spatulate, with setae *f2*, *f3*, *h1* being the shortest and weakly spatulate to tapered; *h2* fine, elongate, flagellate; setae *e3*, *f2*, *f3*, *h1*, *h2* inserted ventrally. Dorsal setae measurements: *v2* 25–28, *sc1* 21–26, *sc2* 21–23, *c1* 17, *c2* 19–21, *c3* 18–24, *d1* 19–21, *d2* 20, *d3* 16–19, *e1* 20–21, *e2* 20–21, *e3* 9–19, *f2* 12–16, *f3* 7–10, *h1* 7–9, *h2* 34–37.

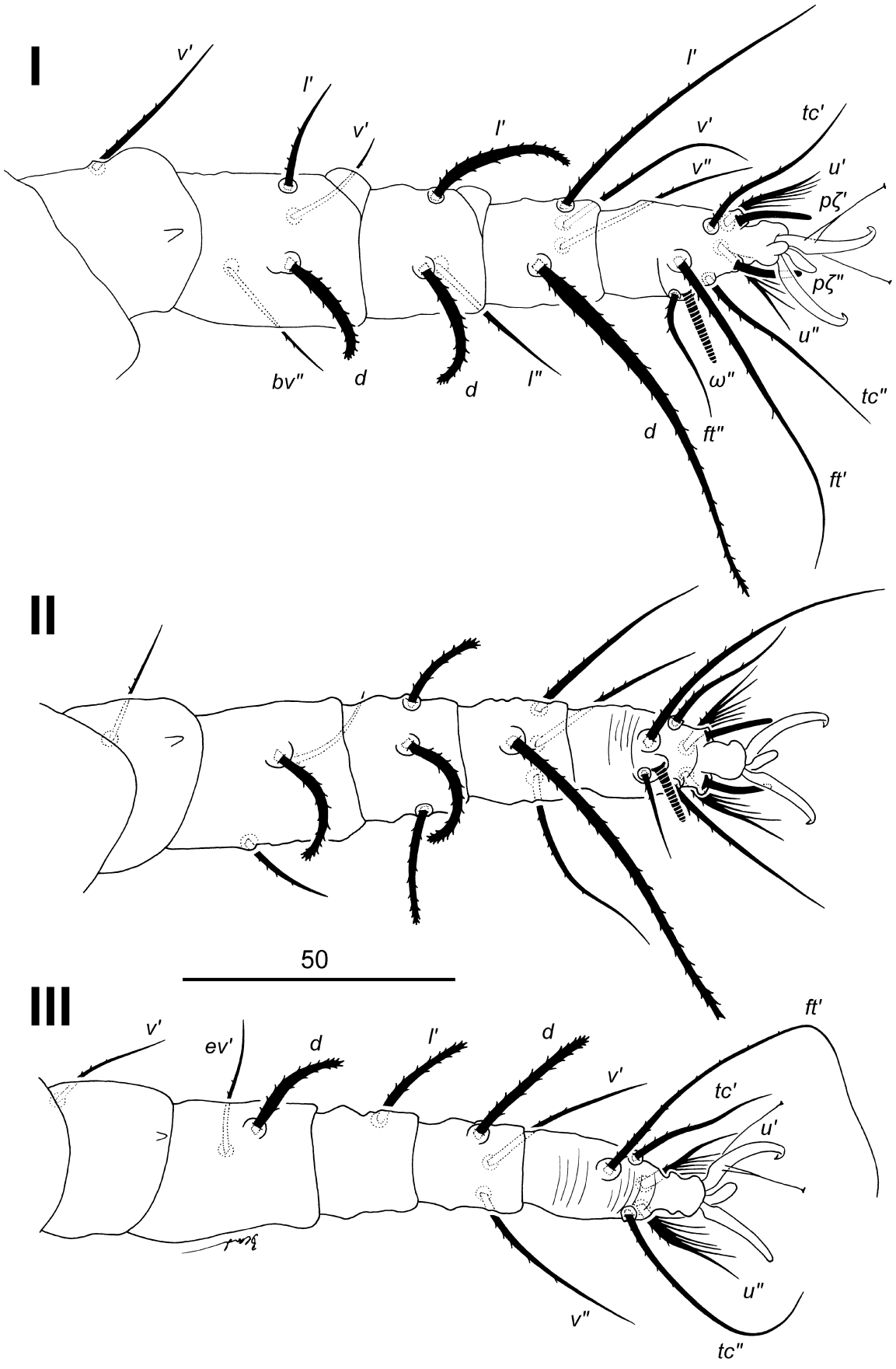


FIGURE 112. *Raoiella illyarrie* Beard & Ochoa, adult female: legs I–III (right side, dorsal aspect).

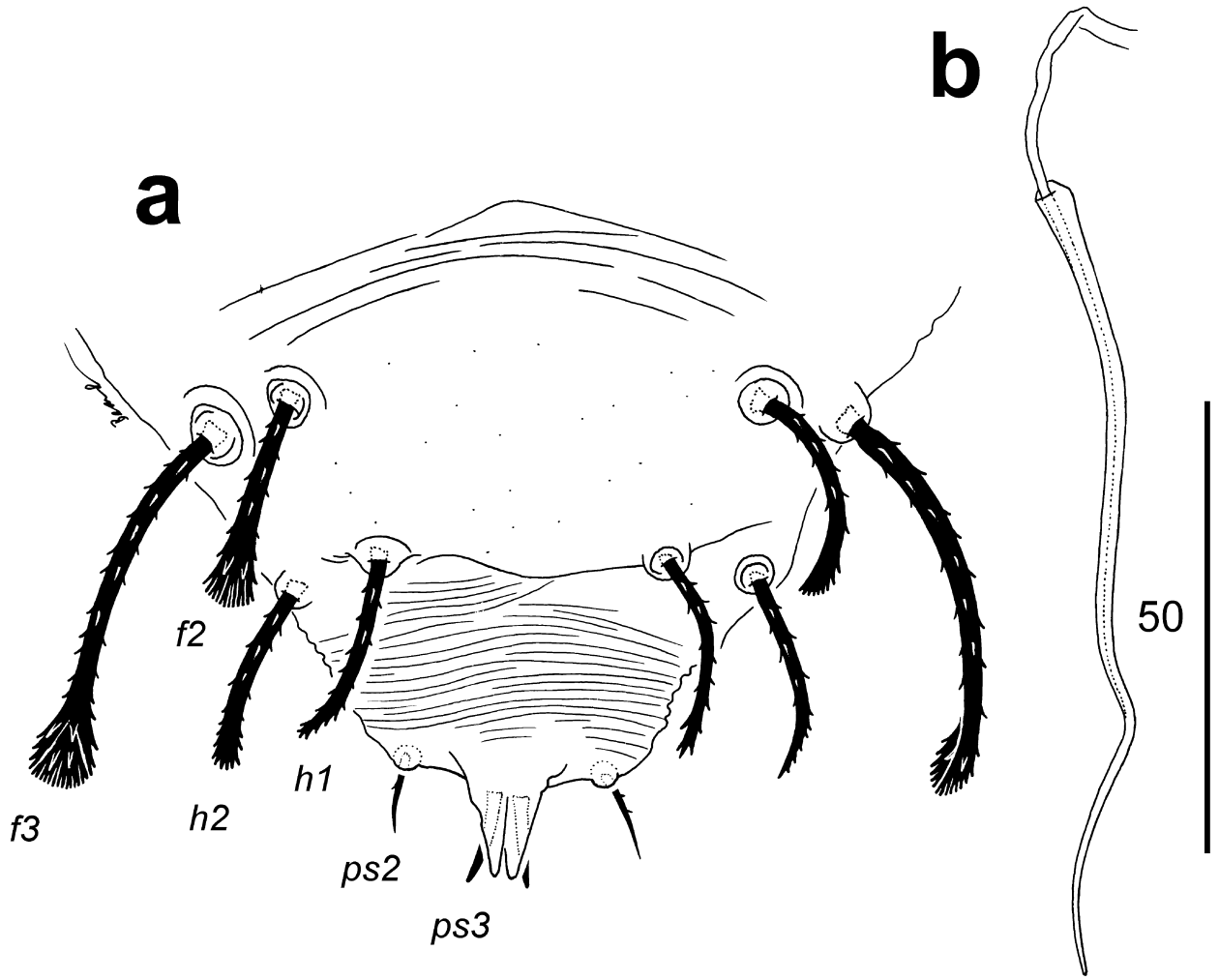


FIGURE 113. *Raoiella illyarrie* Beard & Ochoa, adult male: a. posterior dorsum, with detail of *ps3* setae; b. detail of aedeagus.

***Palps*.** Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5) and one finely tapered eupathidium (10) distally, and one seta dorsally (7–9); palp femorogenu with one seta (12–13).

***Venter*.** (Fig. 115b) Cuticle almost completely strongly plicate, except coxal fields smooth; striae transverse *1b–1b*, oblique to longitudinal *1b–1a*, transverse between *1a–3a*, with transverse, longitudinal and oblique striae *3a–ps3*, striae forming a diamond anterior to *ps2–ps3* (Fig. 115b) (see also Figs 23, 44, 56, 70, 100, 129a, 146, 161b, 178, 191b, 238, 268). Setal measurements: *1a* 38–57, *1b* 12–13, *3a* 7–8, *ps2* 5–6, *ps3* 5–6.

***Legs*.** Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Femora I–II with three setae (*d*, *v′*, *bv″*; *l′* absent). Genua I–II with one seta (*l′*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 7; ta II 5–6) and two eupathidia *pζ′–pζ″* distally (ta I 7, 7; ta II 6–7, 6–7). Barbed tapered companion seta *ft″* on tarsus I 7–9 and tarsus II 5–7, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta finely tapered. Claw I 12.

Host. Illyarrie, *Eucalyptus erythrocorys* (Myrtaceae).

Distribution. AUSTRALIA: southwestern Western Australia.

Etymology. This species is named for the local indigenous name of its host plant *E. erythrocorys*, illyarrie, which is also used as the common name for the plant.

Remarks. *Raoiella illyarrie* **sp. nov.** was listed as *Raoiella* sp. 4 (DNA code RaIn 66) along with a specimen labelled RaIn45, which we consider here to be a separate species, *R. crebra* **sp. nov.**, and was listed as *Raoiella* sp. 4B in Beard *et al*. (2013) The two populations considered as species 4 in the Dowling *et al.* (2012) study were

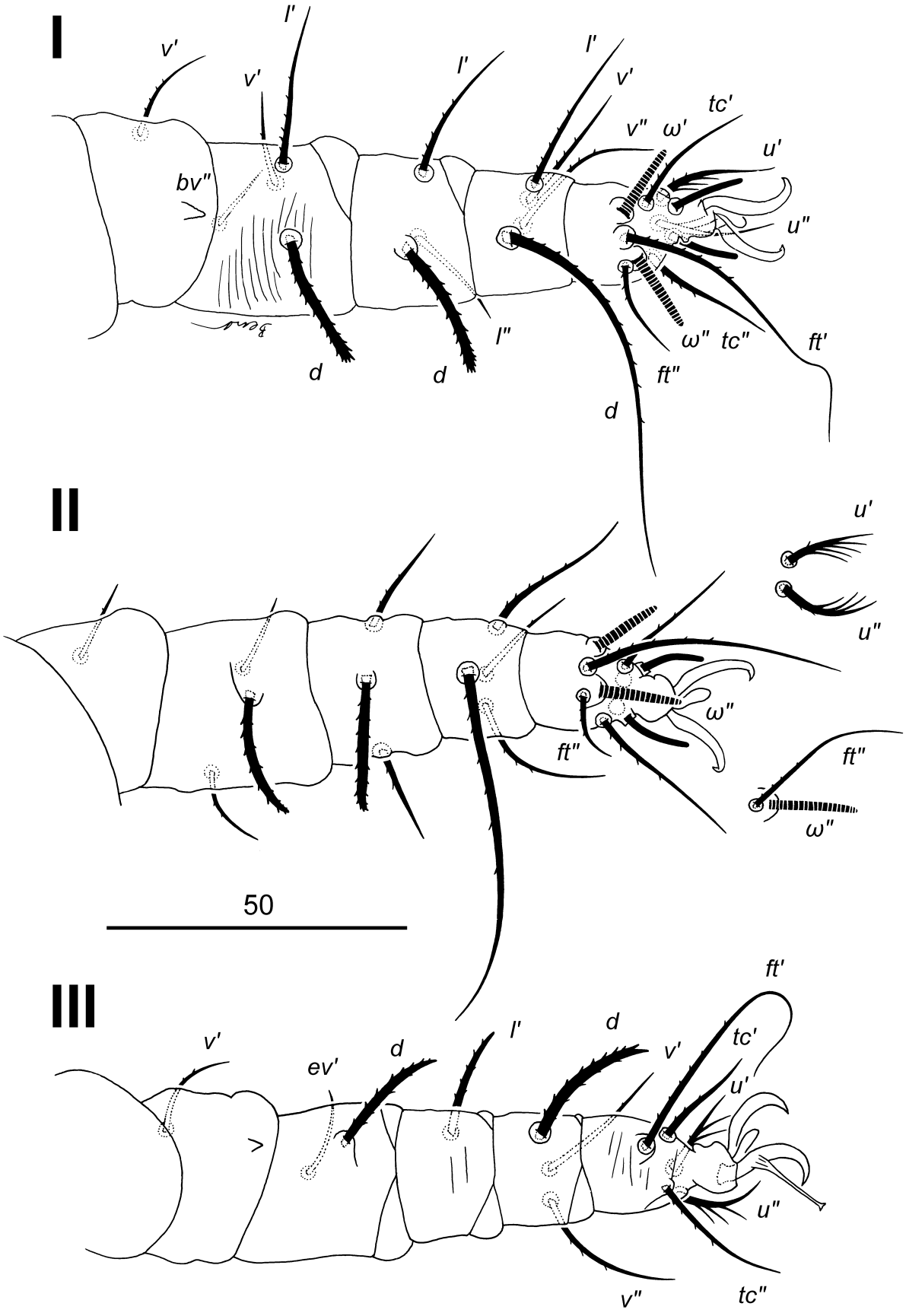


FIGURE 114. *Raoiella illyarrie* Beard & Ochoa, adult male: legs I–III (right side, dorsal aspect); leg II with variation of adaxial solenidion (*ω″*) and companion seta (*ft″*) on tarsus and unguinal setae illustrated separately.

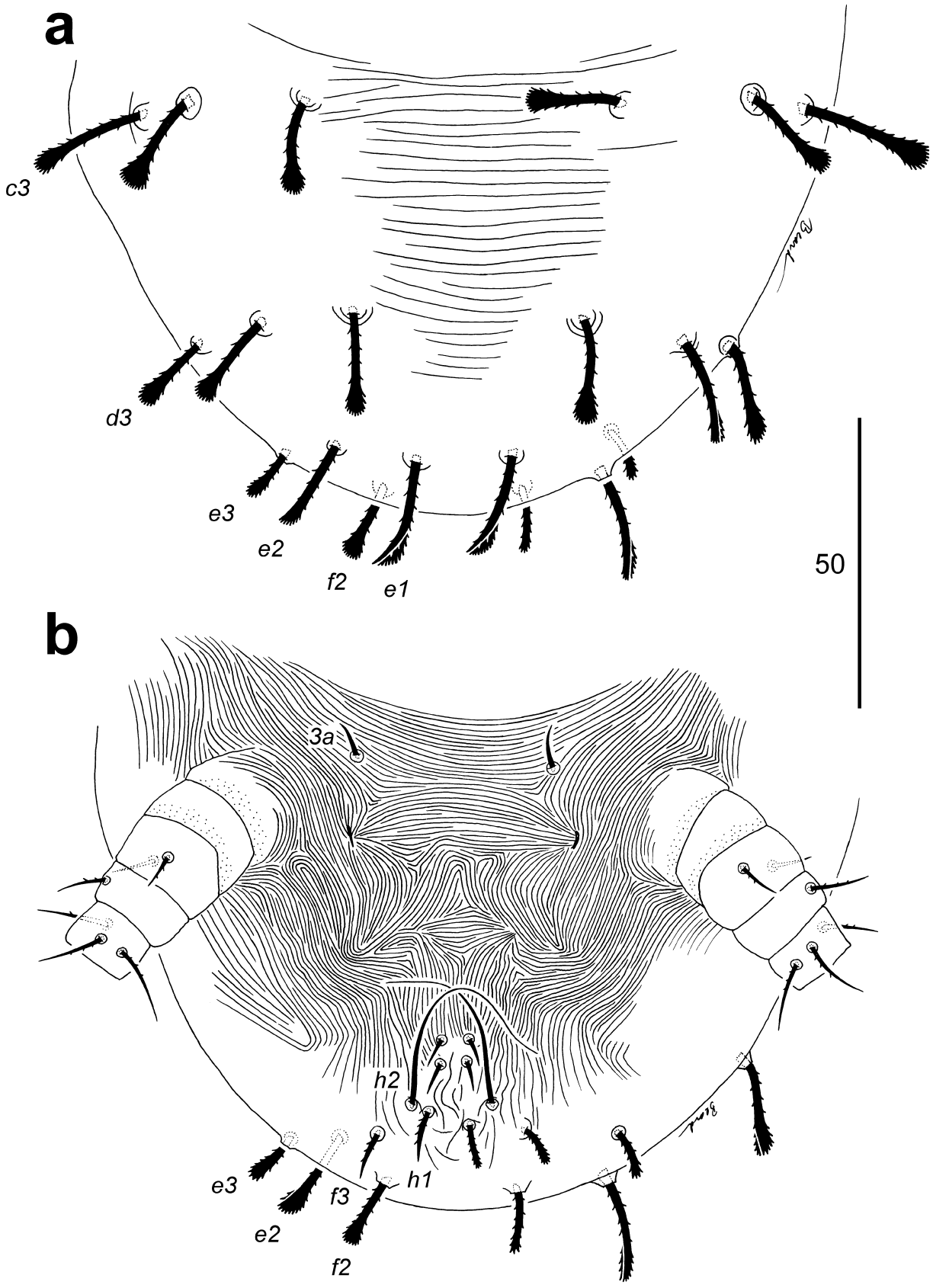


FIGURE 115. *Raoiella illyarrie* Beard & Ochoa, larva: a. dorsal opisthosoma; b. posterior venter.

shown to exhibit 2.81% sequence divergence, which greatly exceeds the intraspecific variation seen in species 1 (0.6–0.1%), but is still a low amount of interspecies divergence in *Raoiella*. Our subsequent morphological analysis has shown that the two populations, collected from different host plants and from opposite sides of the Australian continent, do actually represent two distinct species, *R. crebra* and *R. illyarrie*.

Raoiella illyarrie differs from *R. crebra* in the following manner: *Ri* with setae *sc1* 30–47 vs *Rc* setae *sc1* 28–31; *Ri* seta *d* on tibiae I 74–81 and tibiae II 65–69 vs *Rc* seta *d* on tibiae I 58–65 and tibiae II 58–61; *Ri* companion seta on tarsus I longer than solenidion vs *Rc* companion seta on tarsus I subequal or shorter than solenidion. *Raoiella illyarrie* is also similar to *R. hallingi* but can be separated by femur I with seta *l′* tapered and genu II with seta *l″* thick (Fig. 112) on *R. illyarrie*, and femur I with seta *l′* thick and genu II with seta *l″* tapered (Fig. 107) on *R. hallingi*.

Raoiella indica **Hirst**

(Figs 116–131)

Raoiella indica Hirst, 1924: 522
Rarosiella cocosae Rimando, 1996: 3—synonymy Mesa *et al.* (2009).
Raoiella camur Chaudhri & Akbar, 1985: 18—new synonymy
Raoiella camur Akbar, 1990: 78—objective synonymy Mesa *et al.* (2009).
Raoiella empedos Chaudhri & Akbar, 1985: 16—new synonymy
Raoiella empedos Akbar, 1990: 75—objective synonymy Mesa *et al.* (2009).
Raoiella neotericus Chaudhri & Akbar, 1985: 19—new synonymy
Raoiella neotericus Akbar, 1990: 78—objective synonymy Mesa *et al.* (2009).
Raoiella obelias Hasan & Akbar, 2000: 11—new synonymy
Raoiella phoenica Meyer, 1979: 114—new synonymy
Raoiella rahii Akbar & Chaudhri, 1987: 42—new synonymy

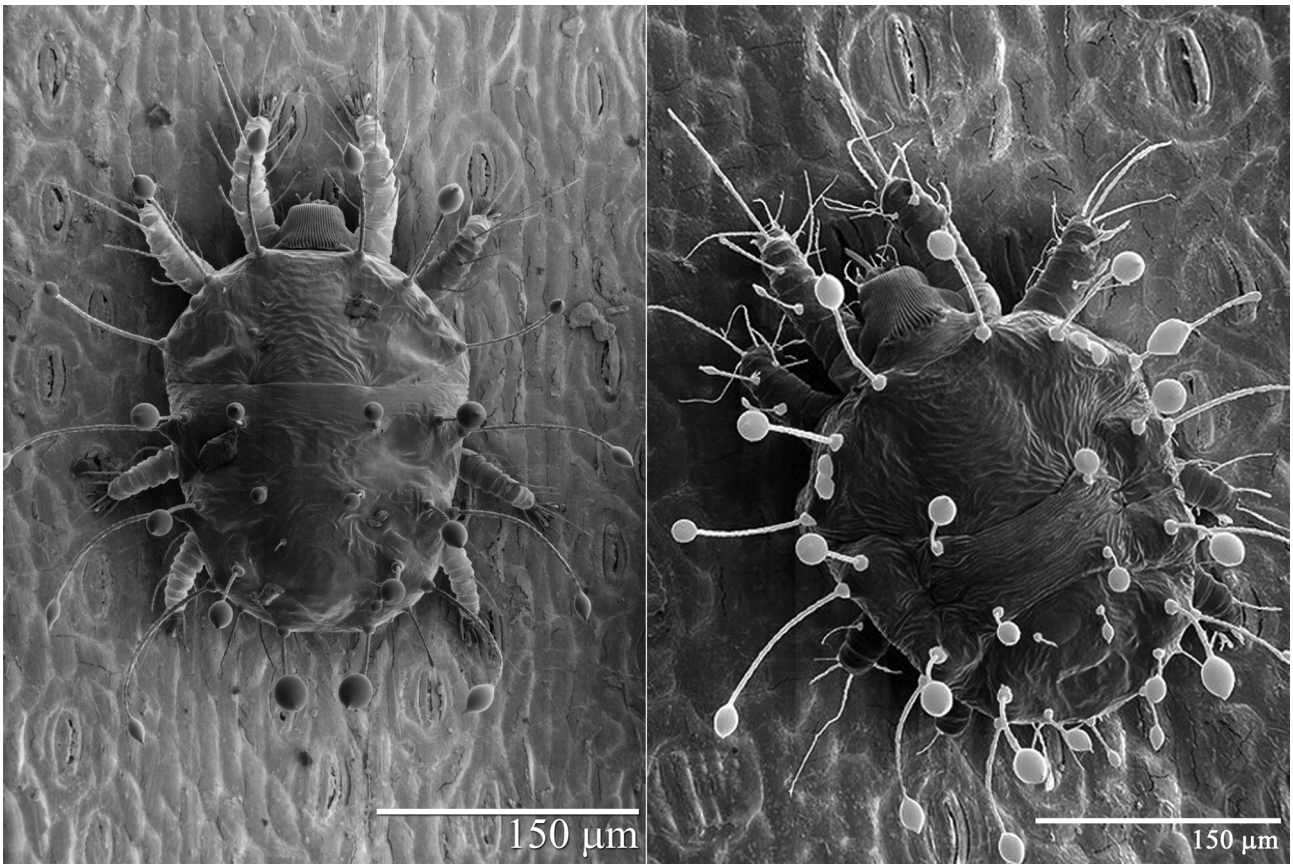


FIGURE 116. *Raoiella indica* Hirst, adult female: dorsal habitus on host plant (two different individuals).

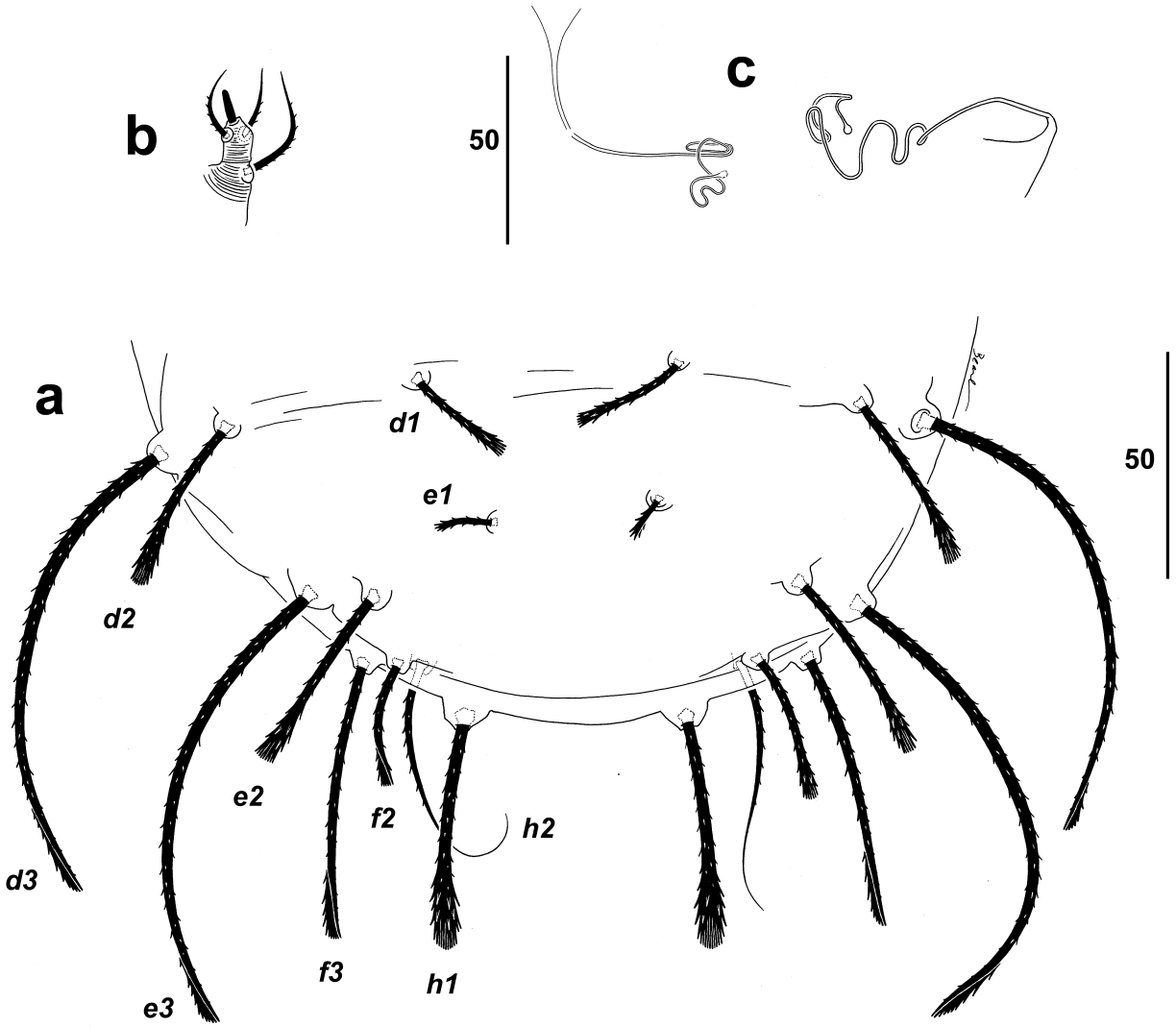


FIGURE 117. *Raoiella indica* Hirst, adult female: a. posterior dorsal opisthosoma (Paratype, India, ex. *Cocos nucifera*); b. detail of palp (The Philippines, *Rarosiella cocosae* Rimando Paratype); c. details of spermatheca (left, USA ex. *C. nucifera*; right, Pakistan, ex. *Phoenix dactylifera*).

Material examined. Paratypes. ♀, **India,** pharate ♀, deutonymph, Coimbatore, Tamil Nadu, ex. coconut *Cocos nucifera* (Arecaceae), 4.ix.1923 (no collector indicated on slide) (one slide, NHM).

Other material examined. **Antigua**, ♀, ♂, ex. coconut *Cocos nucifera* (Arecaceae), 3.vi.2007, J. Perez, intercepted in USA (USNM). **Aruba**, 2 ♀, ex. Arecaceae, 23.viii.2010, intercepted in USA (USNM). **Barbados**, 2 ♀, ex. Arecaceae, 22.vii.2007, S. Jackson, intercepted in USA (USNM). **Cambodia**, 2 ♀, pharate ♀, ♂, 2 deutonymphs, protonymph, ex. "Le Cocotier" coconut, *C. nucifera*, Kok Patry Station, Siem Reap Province, 07.vi.1962, J.L. Nickel, 62-28782 (one slide, OSAL). **Dominica**, 2 ♀, 052392, intercepted in USA (USNM). **Pakistan**, 2 ♀, 2 miles east of Sargodha, Punjab Province, ex. date palm *Phoenix dactylifera* L. (Arecaceae), 29.xi.1969, Chaudhri (one slide; USNM). **Republic of the Philippines**, 6 ♀, ♂, Camiguin Island, ex. coconut seedling *C. nucifera*, 9.x.1995, Philippine Coconut Authority Staff (= paratypes 1–3, 15–17 of *Rarosiella cocosae* Rimando) (two slides, UPLBMNH); 2 ♀, ex. guava *Psidium guajava* (Myrtaceae), 4.v.1998, M. Batchelor, SF026241 (USNM). **Puerto Rico**, 4 ♀, ex. *C. nucifera*, Ponce, 07.xii.2006, W. Ojeda and N. Nieves (RPM-011-PCE-12/07/06) (one slide, USNM); 1 ♀, 3 deutonymphs, ex. *C. nucifera* (Arecaceae), Peñuelas, 13.xii.2006, W. Ojeda and N. Nieves (RPN-014-PÑA-12/13/06) (one slide, USNM); 2 ♀, 2 ♂, ex. *C. nucifera* (Arecaceae), Ponce, 15.xii.2006, W. Ojeda and N. Nieves (RPM-017-PCE-12/5/06) (one slide, USNM). **Saint Thomas**, 2 ♀, protonymph, ex. *C. nucifera*, 3.vi.2007, G. Montero, intercepted in USA (USNM). **Singapore**, ♀, ex. leaf of

Rhapis palm *Rhapis* sp. (Arecaceae), intercepted by Australian Quarantine and Inspection Service (AQIS) in Brisbane from Singapore, 12.i.2006 (BIN94159, STH QLD AQIS). **Sudan**, ♀, 3 deutonymphs, protonymph, Nuri (45.F.), ex. date palm *Ph. dactylifera*, 18.xii.1938, J.W. Cowland (= holotype and paratypes of *Raoiella phoenica* Meyer) (one slide; NHM). **Thailand**, 3 ♀, 1 pharate ♀, ♂, 3 larvae, ex. leaves of coconut palm, *C. nucifera*, Kanchanaburi, 27.iv.2009, Manita (QM); 3 ♀, pharate ♀, 2 deutonymphs, ex. leaves of coconut palm *C. nucifera*, 21.vii.1974, coll. unknown (one slide, USNM). **Republic of Trinidad and Tobago**, 5 ♀, ♂, deutonymph, ex. leaves of banana *Musa* sp. (Musaceae), main road, Guayguayare, Mayaro Region, 10.v.2006, F. Hoseiun (one slide, USNM); 14 ♀, ex. leaves of *Heliconia* sp. (Heliconiaceae), Los Gallos Road, Cedros, 10.v.2006, R. Ochoa & E. Kane (one slide, USNM); 3 ♀, 4 ♂, 1 deutonymph, ex. *C. nucifera*, St Quentin Estate, Icacos, 10.v.2006, R. Ochoa and E. Kane (one slide, USNM); 9 ♀, 3 ♂, ex. *C. nucifera*, Agostini Plantation, Constrance Estate, Icacos, 10.v.2006, R. Ochoa (one slide, USNM); 6 ♀, 3 ♂, ex. banana *Musa* sp., Los Gallos Road, Icacos, 10.v.2006, M. Ram and Dhanie (one slide, USNM). **United States of America**, 16 ♀, 6 ♂, 10 deutonymphs, 3 protonymphs, 8 larvae, ex. leaves of coconut palm, *C. nucifera*, Palm Beach Gardens, Palm Beach County, Florida, 04.xii.2007, B.M. Clark & R. Buchholz, sample number E2007-9061 (QM).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* subequal in length with *h2*. Setae *h2* finely tapered, often broken. Adult femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with three setae (*d*, *l′*, *l″*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft″*) obviously longer than solenidion, barbed. Dorsal setae on tibiae I–II tapered. Eupathidium on palp tibiotarsus finely tapered, barbed. Palp supracoxal seta *e* with a forked tip. Larva with setae *h2* short, tapered.

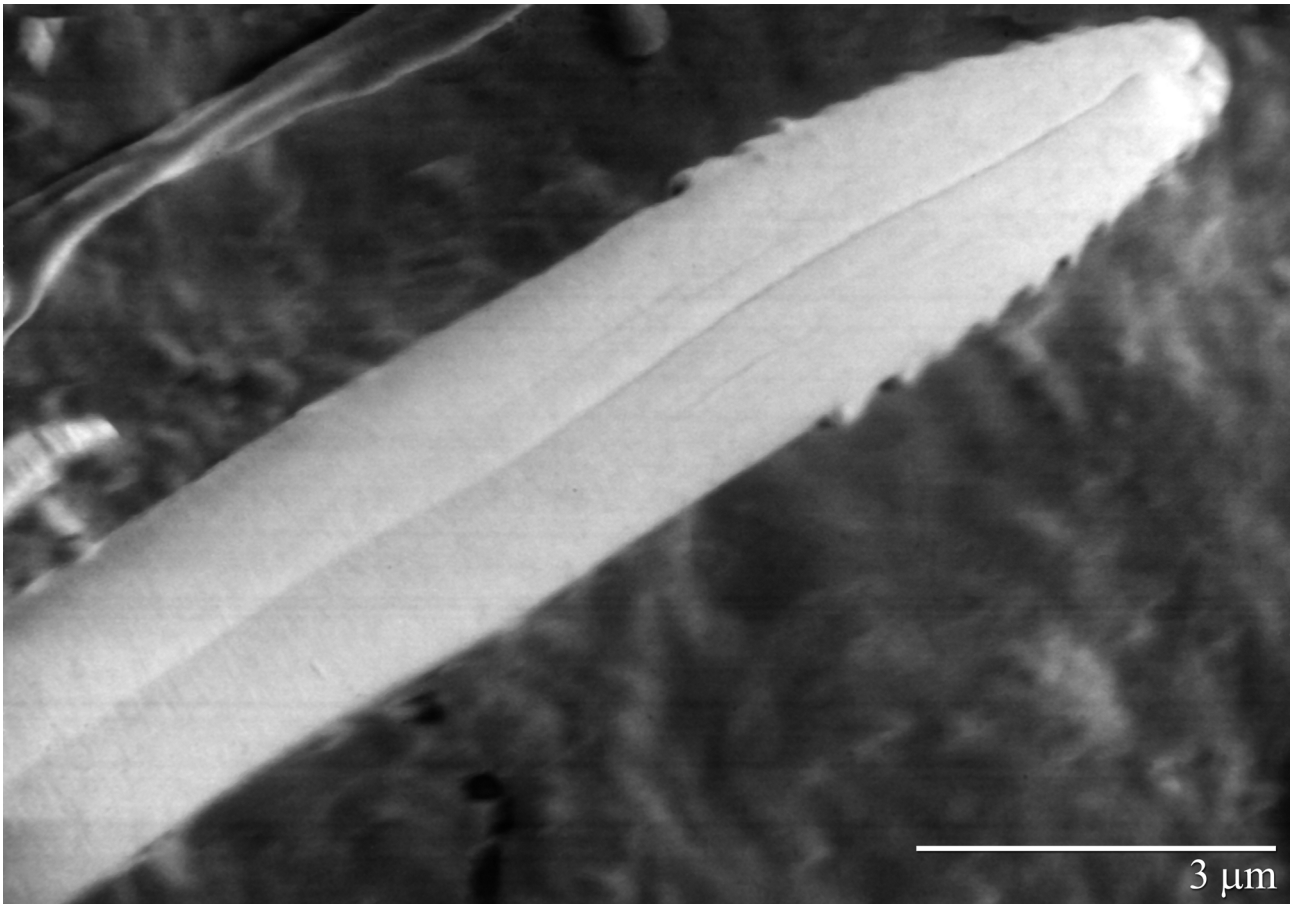


FIGURE 118. *Raoiella indica* Hirst, adult female: dorsal view of joined stylets, detail of stylet tip with lateral serrations.

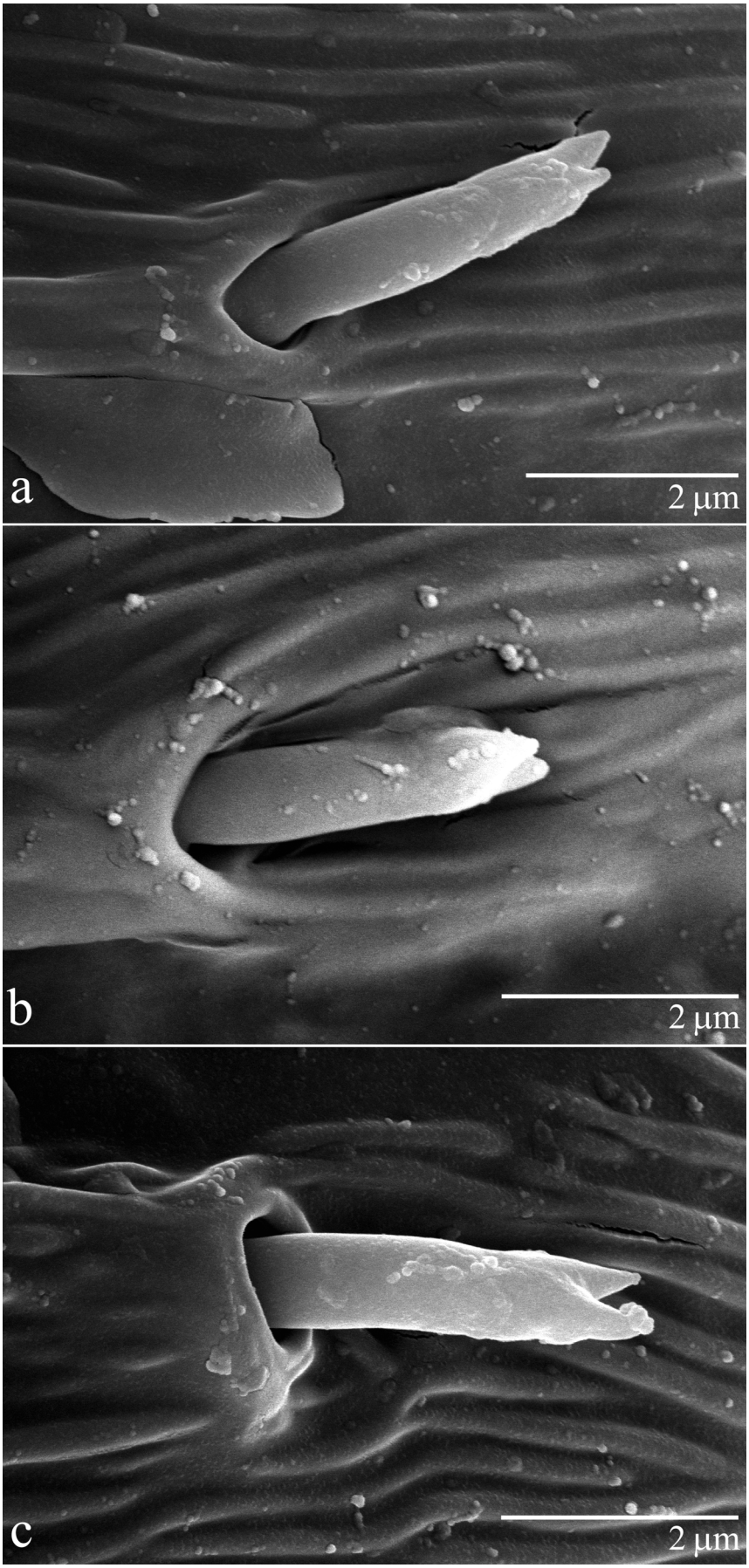


FIGURE 119. *Raoiella indica* Hirst, adult female: detail of forked palp supracoxal setae, *e*.

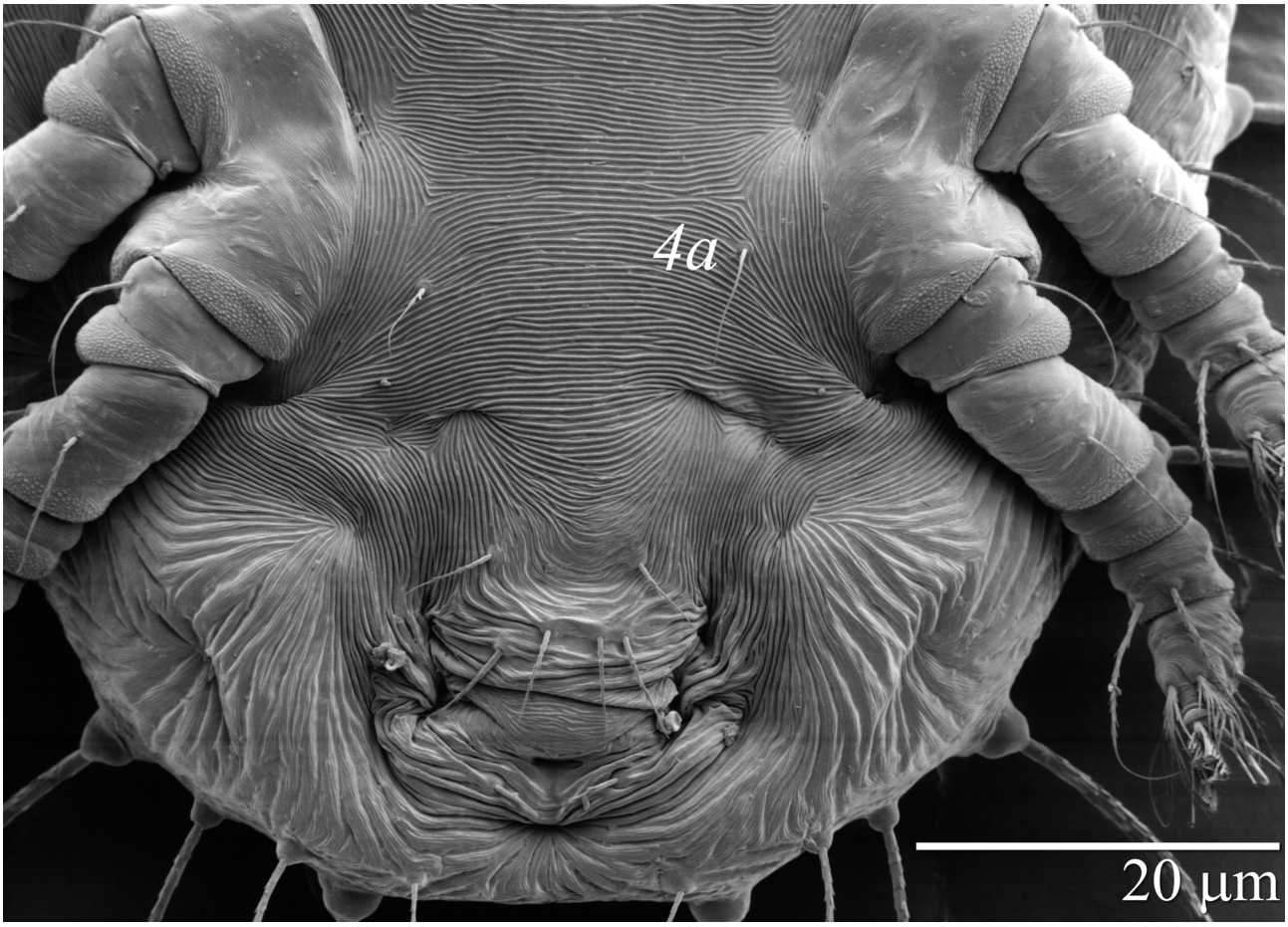


FIGURE 120. *Raoiella indica* Hirst, adult female: posterior venter.

Description. Female. ***Dorsum.*** (Figs 116, 117a) Body measurements (30): length between setae *v2–h1* 225–266 [232], width between setae *sc2–sc2* 183–215 [183], *c3–c3* 194–219 [200], *f2–f2* 78–85 [85], *f3–f3* 100–110 [105]. Dorsum mostly smooth. Prodorsum with four pairs of small pores sublaterally, pair large pores on posterior margin (often hidden in fold of sejugal furrow). Opisthosoma with pair small pores between *c1–c2*. Dorsal setae, long, arching, narrowly spatulate, barbed along entire length. Setae *c1*, *d1*, *e1* tapered to weakly spatulate; setae *h2* finely tapered, elongate. Dorsal setae measurements: *v2* 65–92 [83–85], *sc1* 71–110 [92–95], *sc2* 58–103 [87–91], *c1* 38–67 [47–48], *c2* 43–82 [53–55], *c3* 93–132 [118–119], *d1* 23–43 [30–31], *d2* 38–74 [46–48], *d3* 83–135 [122–126], *e1* 7–31 [12–16], *e2* 38–73 [51–53], *e3* 93–141 [122–124], *f2* 22–47 [33–39], *f3* 42–80 [71–72], *h1* 49–85 [61–62], *h2* 48–72 [60–66].

Palps. (Fig. 117b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–9) [8–9] and one finely tapered, barbed eupathidium (13–17) [14–15] distally, one seta dorsally (12–14) [12–13]; palp femorogenu with one dorsal seta (24–28) [26]. Combined stylets form a broad flat tube with a series of 10–12 small recurved lateral teeth distally (Fig. 118). Supracoxal seta *e* on dorsal infracapitulum and coxa I with a forked tip (Fig. 119).

Venter. (Fig. 120) Cuticle almost completely plicate, covered with mostly transverse striae; striae longitudinal between *1b–1a*, transverse *1a–ag*, longitudinal striae laterad genital region, coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *g1*, *g2*, *ps2, ps3* barbed; seta *ps3* sometimes appearing forked, or with long barbs. Setal measurements: *1a* 69–126 [80], *1b* 26–40 [30–31], *2b* 15–33 [15–20], *3a* 14–24 [18–20], *4a* 17–49 [20–23], *ag* 17–23 [19–20], *g1* 17–27 [19–21], *g2* 22–36 [27–32], *ps2* 13–22 [18–20], *ps3* 8–14 [10–11].

Spermatheca. (Fig. 117c) Narrow membranous tube, shorter than most other species, ending in a small rounded vesicle.

Legs. (Figs 121, 122) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-4-3-4-9(1), 0-1-2-1-3-5,

0-1-2-0-3-5 respectively. Some specimens with variations such as tr III 0, tr IV 0, ge II 2, ti III 2. Tarsi I and II each with one abaxial solenidion *ω"* (ta I 12–18 [18]; ta II 11–16 [16]) and two eupathidia *pζ'–pζ"* distally (ta I 11–16 [15], 13–16 [14–15]; ta II 11–16 [14], 12–16 [14–15]). Companion seta *ft"* barbed, elongate, on tarsus I 57–72 [63] and tarsus II 50–66 [60–62], inserted adjacent to solenidion *ω"*. Tibiae I and II with dorsal seta finely tapered. Femora I–II with four setae (*d*, *l'*, *v'*, *bv"*); genua I–II with three setae (*d*, *l'*, *l"*). Claws of medium length (15–18) [16]. Tenent hairs on claws with four attachment points.

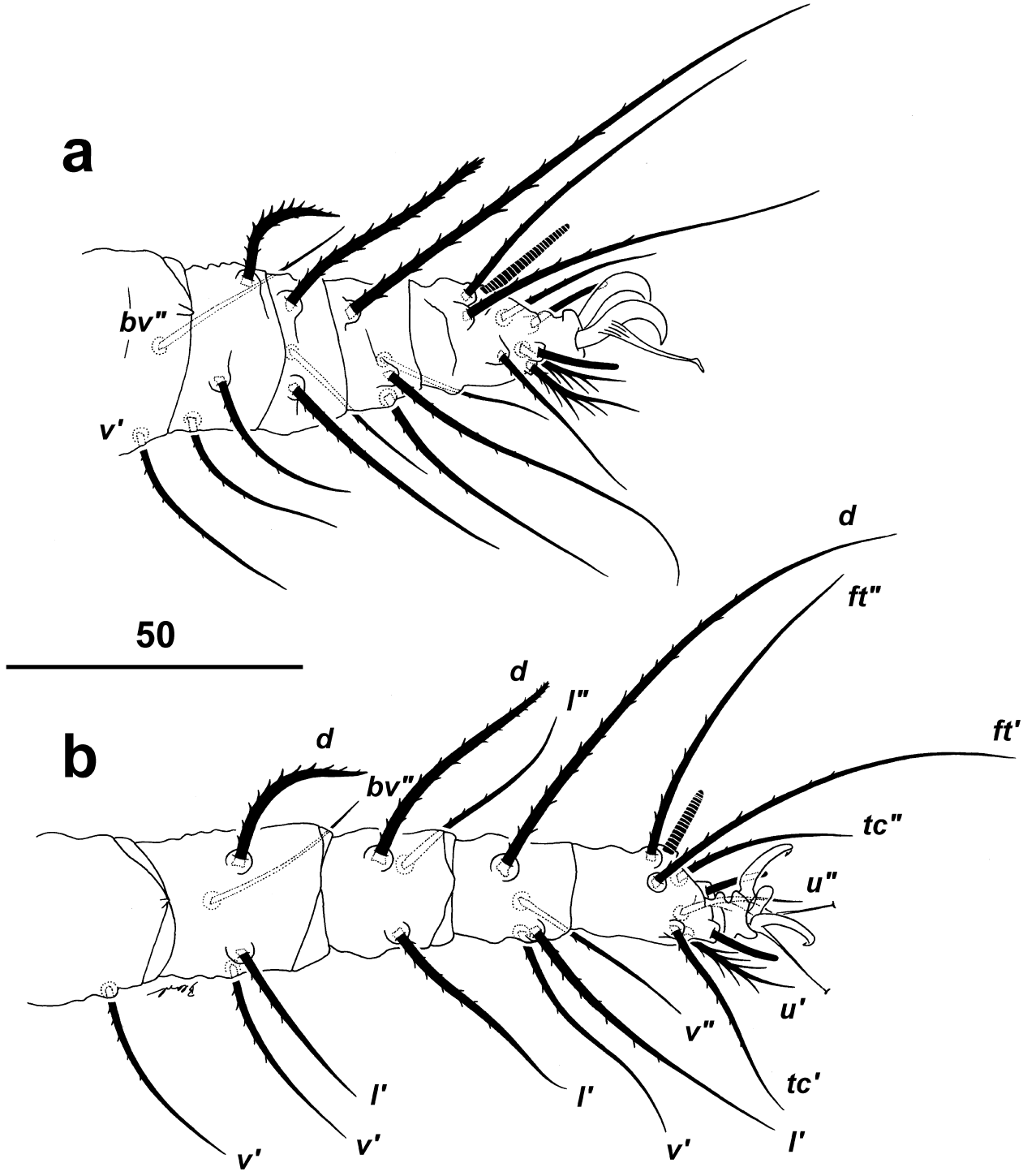


FIGURE 121. *Raoiella indica* Hirst, adult female, leg I (left side, dorsal aspect): a. paratype India, ex. *Cocos nucifera* (note that due to specimen being unexpanded, femoral ventral seta *bv"* appears to be inserted on the trochanter with seta *v'*); b. Pakistan ex. *Phoenix dactylifera*.

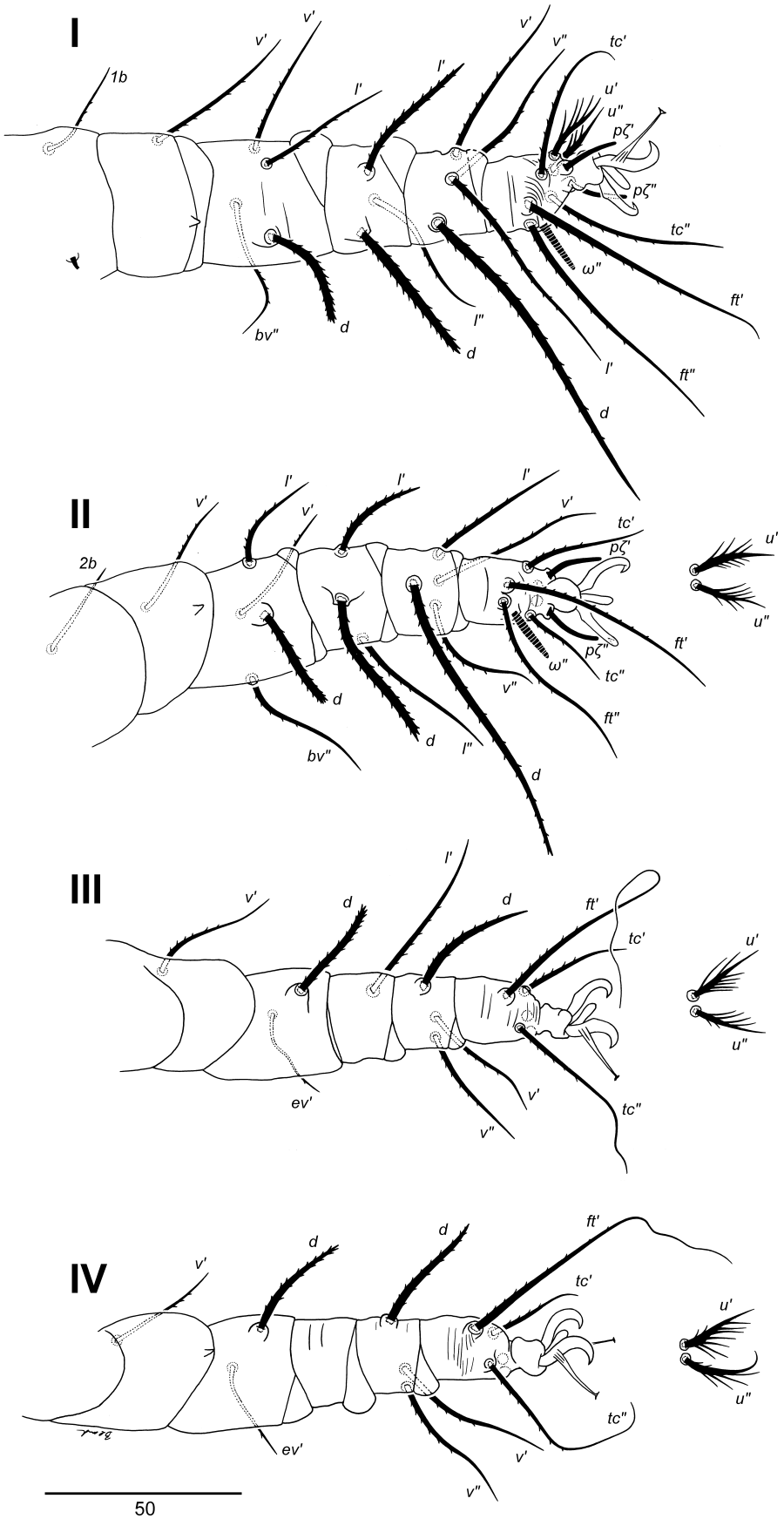


FIGURE 122. *Raoiella indica* Hirst, adult female (from Thailand): legs I–IV (right side; leg I–II dorsal aspect, legs III–IV abaxial aspect; unguinal setae illustrated separately).

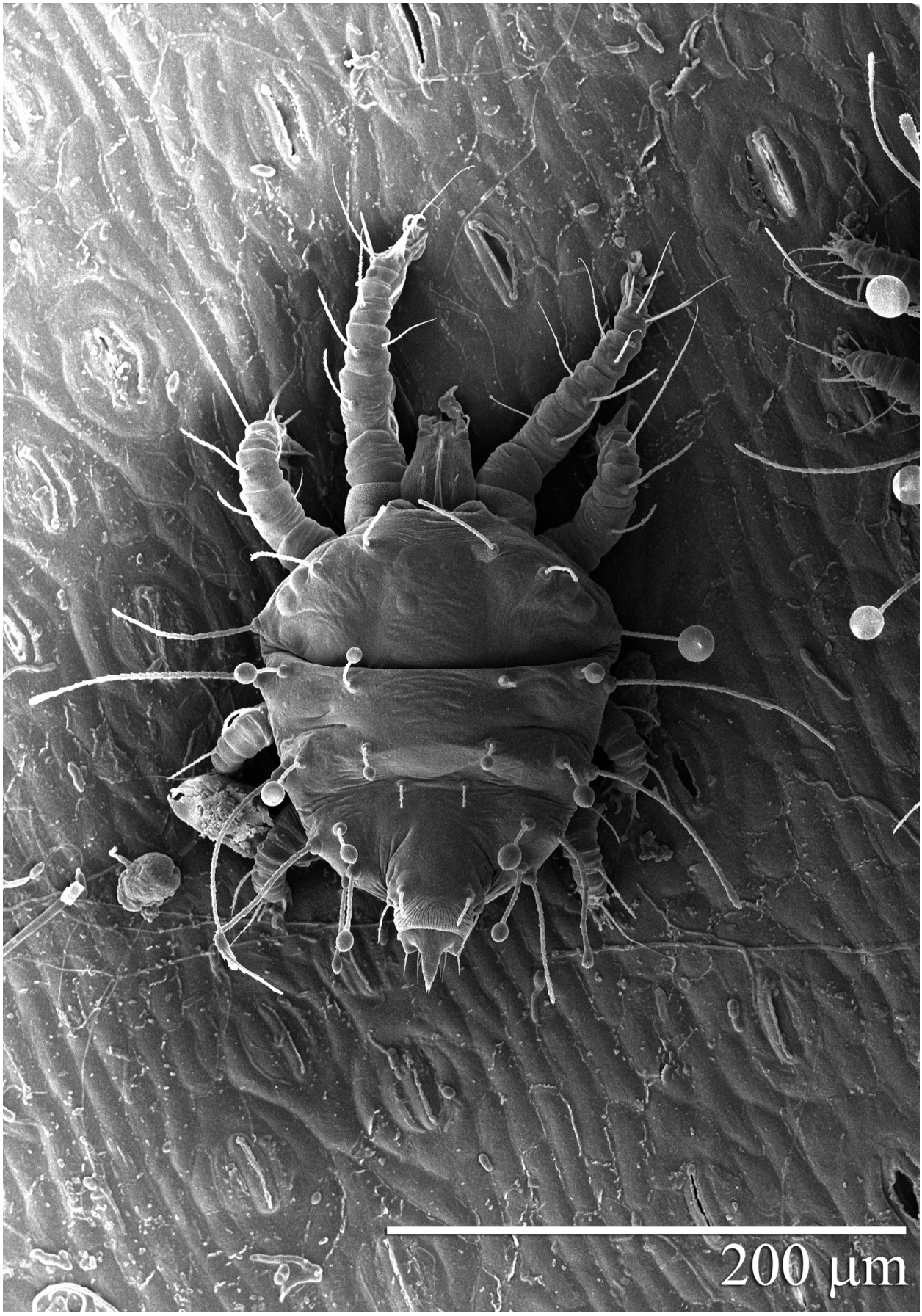


FIGURE 123. *Raoiella indica* Hirst, adult male: dorsal habitus on host plant.

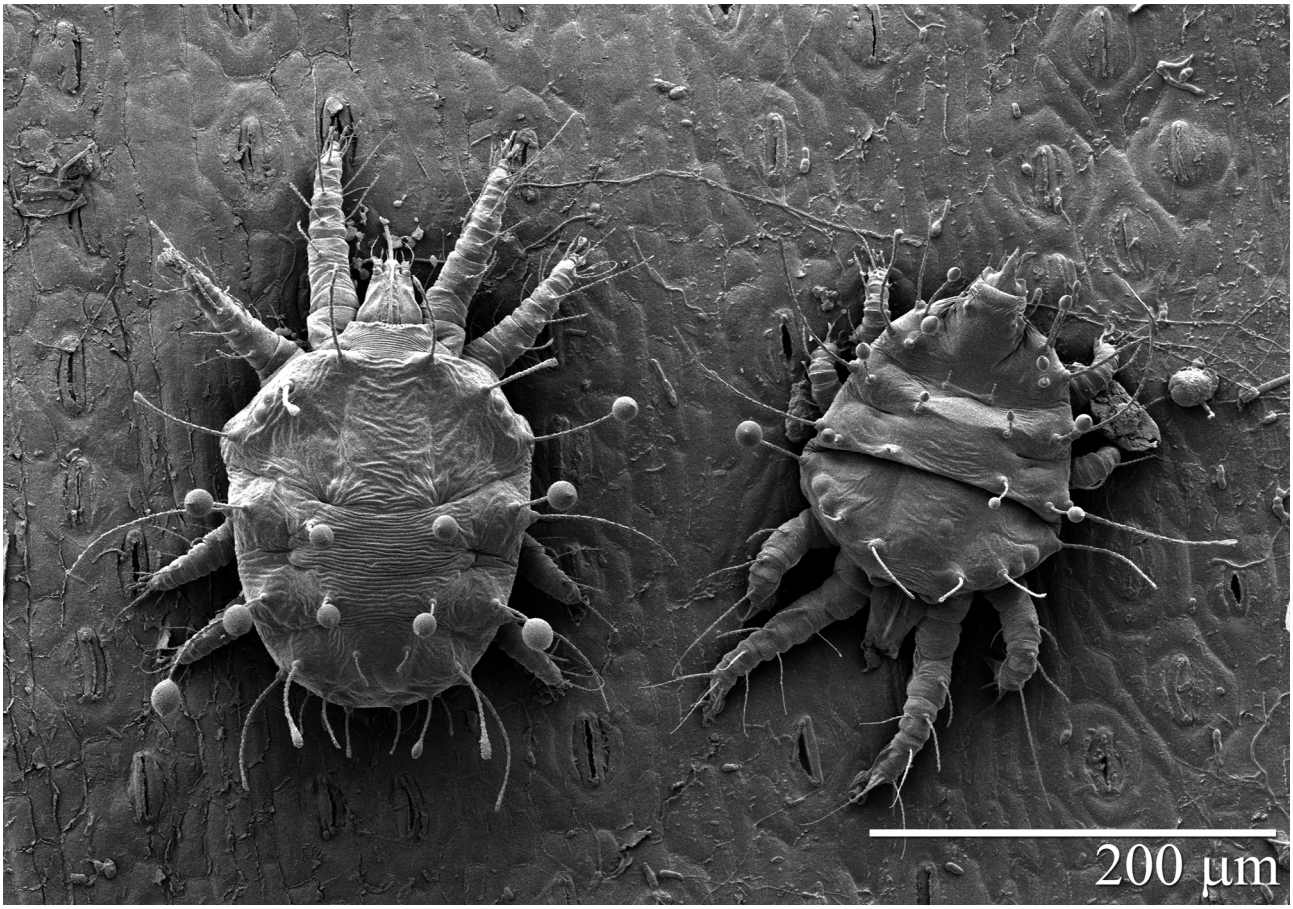


FIGURE 124. *Raoiella indica* Hirst, dorsal habitus on host plant: adult male (right) and female deutonymph (left).

Male. ***Dorsum.*** (Figs 123–126a) Body measurements (14): length between setae *v2–h1* 155–166, width between setae *sc2–sc2* 146–157, *c3–c3* 139–149, *f3–f3* 71–81. Prodorsum smooth. Opisthosoma mostly smooth with weak transverse striae between setae *d1* and *e1*; two pairs of pores between *c2–d2*. Dorsal setae narrowly spatulate, barbed along entire length. Setae *c1*, *d1*, *e1*, *h1* weakly spatulate; setae *h2* finely tapered. Setae *f3*, *h2* sometimes inserted ventrally. Setae *h1*, *h2*, *ps2*, *ps3* inserted on posterior conical (retractable) projection of body. Dorsal setae measurements: *v2* 46–72, *sc1* 66–78, *sc2* 63–81, *c1* 30–42, *c2* 36–45, *c3* 85–104, *d1* 22–34, *d2* 34–47, *d3* 86–103, *e1* 12–18, *e2* 32–51, *e3* 71–97, *f2* 46–56, *f3* 37–57, *h1* 21–28, *h2* 23–30.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–9) and one tapered, barbed eupathidium (12–14) distally, and one seta dorsally (12–14); palp femorogenu with a dorsal seta (23–26).

Venter. (Fig. 126b) Ventral cuticle almost completely plicate, covered in mostly transverse striae; striae transverse between *1b–1b*, longitudinal striae *1b–1a*, transverse striae *1a–4a*; transverse broadly separated striae *4a–g1–2*; coxal fields smooth and distinct patch of smooth cuticle on either side of setae *ag*. Setae *ps3* modified as accessory genital stylets into short, stout spurs. Setae *g1*, *g2* lightly barbed or smooth; setae *g1*, *g2*, *ps2*, *ps3* inserted on posterior conical projection of body. Setal measurements: *1a* 59–102, *1b* 25–37, *2b* 19–26, *3a* 15–19, *4a* 16–23, *ag* 14–20, *g1* 15–17, *g2* 15–21, *ps2* 10–13, *ps3* 8–10. Setae *3b*, *4b* absent.

Aedeagus. (Fig. 125) Aedeagus narrow, elongate, finely tapered (68–85).

Legs. (Fig. 127) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-4-3-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 11–14, abaxial 16–20; ta II adaxial 10–13, abaxial 15–19), and two eupathidia distally (ta I 13–15, 13–15; ta II 12–13, 11–14). Companion seta *ft″* barbed, elongate, on tarsus I 51–61 and tarsus II 39–53, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered. Tenent hairs on claws with four attachment points. Claws short (13–14).

Deutonymph. ***Dorsum.*** (Fig. 124) Body measurements (11): length between setae *v2–h1* 181–217, width between setae *sc2–sc2* 147–170, *c3–c3* 155–177, *f2–f2* 50–54, *f3–f3* 63–72. Dorsum mostly smooth with light transverse striations. Large pore between setae *c1–d2*; minute pore between setae *d1–d2* and *e1–e2*. Dorsal setae

narrowly spatulate; dorsal setae barbed along entire length; setae *h2* tapered. Dorsal setae measurements (male deutonymphs represent the lower range, female deutonymphs represent the upper range): *v2* 63–81, *sc1* 63–93, *sc2* 60–86, *c1* 35–59, *c2* 47–74, *c3* 72–101, *d1* 30–49, *d2* 47–73, *d3* 60–97, *e1* 18–23, *e2* 53–76, *e3* 57–88, *f2* 37–48, *f3* 20–28, *h1* 23–33, *h2* 22–31.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–7), one tapered, barbed eupathidium (12–13) distally, and one dorsal seta (12–13); palp femorogenu with one dorsal seta (17–22).

Venter. (Fig. 128) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Female venter (Fig. 128a) with striae forming circular pattern around setae *g1*, with setae *g1*, *ps2–3* evenly spaced (see also Figs 20a–b, 190a–b, 234a–b); male venter (Fig. 128b) with transverse striae in region of setae *g1*, with setae *g1* distant to setae *ps2–3* (see also Figs 20a–b, 190a–b, 234a–b). Seta *1a* elongate, fine (difficult to determine full length). Setae *ag*, *g1*, *ps2*, *ps3* barbed. Setal measurements: *1a* 54–91, *1b* 14–28, *2b* 11–22, *3a* 10–16, *4a* 10–19, *ag* 9–14, *g1* 8–12, *ps2* 7–16, *ps3* 8–10.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-1-3-2-4-9(1), 1-1-3-2-4-9(1), 0-1-2-1-3-5, 0-0-2-0-3-5 respectively. One specimen with cx II nude. Tarsi I and II each with one abaxial solenidion (ta I 10–13; ta II 9–12) and two eupathidia distally (ta I 10–12, 10–12; ta II 10–12, 10–12). Companion seta *ft″* elongate, on tarsus I 48–59 and tarsus II 35–52, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta slightly spatulate. Tenent hairs on claws with four attachment points. Claws short (13–14).

Protonymph. *Dorsum.* Body measurements (10): length between setae *v2–h1* 163–176, width between setae *sc2–sc2* 155–164, *c3–c3* 166–170, *f2–f2* 37–42. Dorsal setae spatulate, barbed along entire length except setae *h1* blunt to slightly spatulate, setae *f3* blunt, setae *h2* tapered. Dorsal setae measurements: *v2* 57–64, *sc1* 76–81, *sc2* 59–61, *c1* 54–56, *c2* 59–69, *c3* 58–60, *d1* 42–44, *d2* 61–62, *d3* 42–43, *e1* 19–22, *e2* 52–57, *e3* 32–38, *f2* 26–29, *f3* 8–11, *h1* 14–15, *h2* 11–12.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6) and one tapered, barbed eupathidium (12–13) distally, and one tapered barbed seta (10–11) dorsally; palp femorogenu with one barbed seta (18–21).

Venter. (Fig. 129b) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 69–87, *1b* 18–19, *3a* 8, *ag* 6–7, *ps2* 4–6, *ps3* 4–7.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 7–9; ta II 7) and two eupathidia distally (ta I 9–10, 10; ta II 8–9, 9). Companion seta *ft″* on tarsus I 37–41 and tarsus II 36–39, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta tapered. Tenent hairs on claws with three attachment points. Claws short (10–11).

Larva. *Dorsum.* (Fig. 130b) Body measurements (10): length between setae *v2–h1* 132–146, width between setae *sc2–sc2* 123–131, *c3–c3* 127–139, *f2–f2* 22–24. Prodorsum smooth; opisthosoma with pair large slit-like pores anterad seta *c1*; with some mesal transverse striae between setae *c1–c1*. Dorsal setae spatulate, barbed along entire length; setae *e3*, *f2* slightly spatulate to blunt; setae *e3*, *f2*, *f3*, *h1*, *h2* may be ventral; setae *f3*, *h1*, *h2* short, tapered. Dorsal setae measurements: *v2* 41–50, *sc1* 64–71, *sc2* 42–47, *c1* 37–45, *c2* 39–47, *c3* 28–32, *d1* 39–43, *d2* 38–43, *d3* 17–22, *e1* 31–39, *e2* 29–38, *e3* 13–18, *f2* 10–17, *f3* 9–10, *h1* 8–9, *h2* 6–7.

Palps. (Fig. 130a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–7) and one tapered, barbed eupathidium (11–12) distally, and one barbed seta (9–10) dorsally; femorogenu with one tapered barbed seta (9–12).

Venter. (Fig. 129a) Cuticle almost completely strongly plicate, except coxal fields smooth. Setal measurements: *1a* 38–61, *1b* 10–16, *3a* 7–12, *ps2* 4–5, *ps3* 3–4.

Legs. (Fig. 130b) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 6–7; ta II 5–7) and two eupathidia distally (ta I 8, 7; ta II 8, 8–9). Companion seta *ft″* on tarsus I 31–44 and tarsus II 31–39, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta tapered. Supracoxal setae *e* on coxae I forked (Fig. 130b). Tenent hairs on claws with three attachment points. Claws short (10).

Egg. (Fig. 131) Red, ellipsoid, 95–120 long 90–90 wide; stipe long, fine 140–170 long, with basal attachment point thicker than rest of stipe, as noted by Kane *et al.* (2012); and with pair of minute recurved spines (Fig. 131d; see arrow).

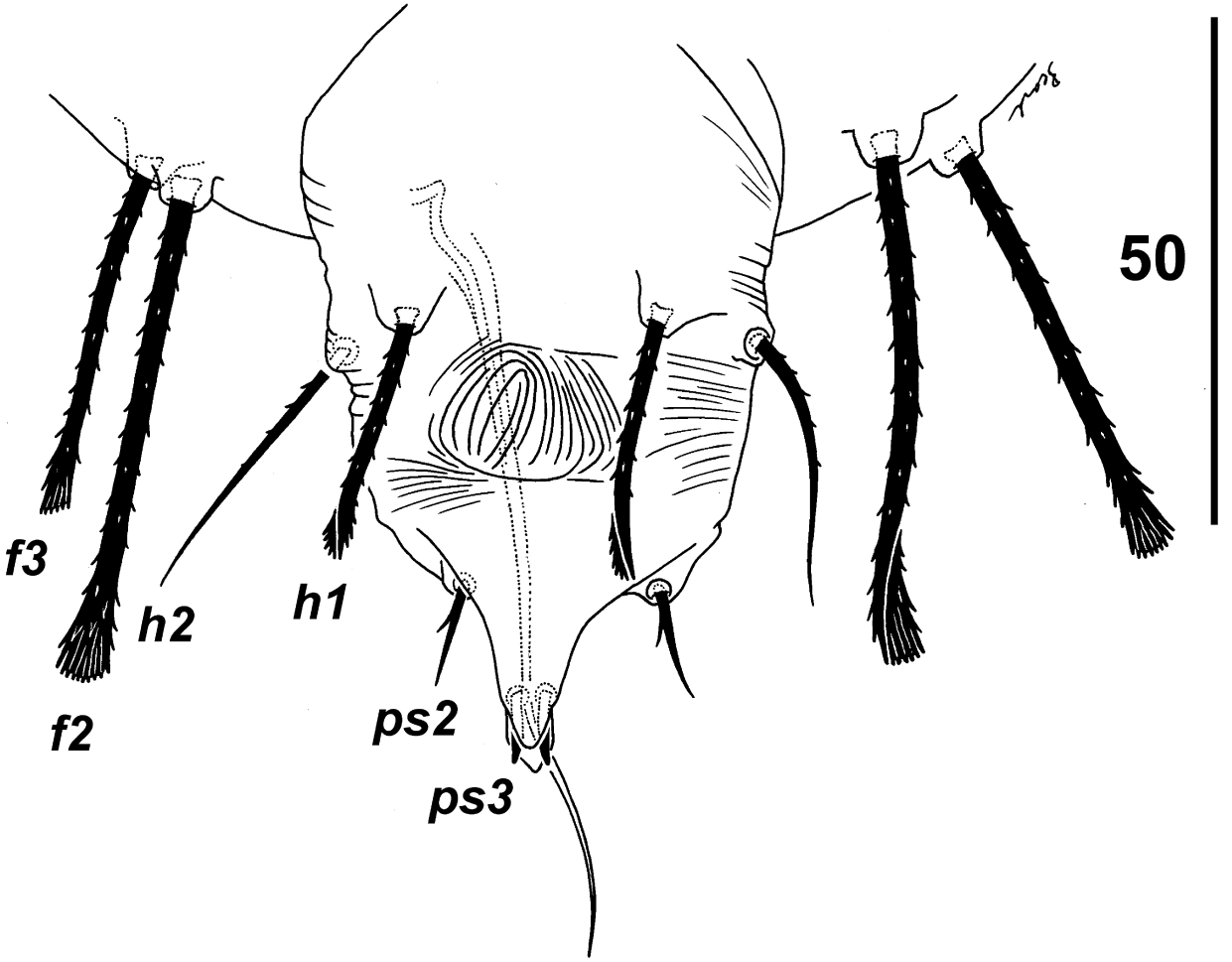


FIGURE 125. *Raoiella indica* Hirst, adult male: posterior dorsal opisthosoma with detail of aedeagus and setae *ps3* (The Philippines, *Rarosiella cocosae* Paratype).

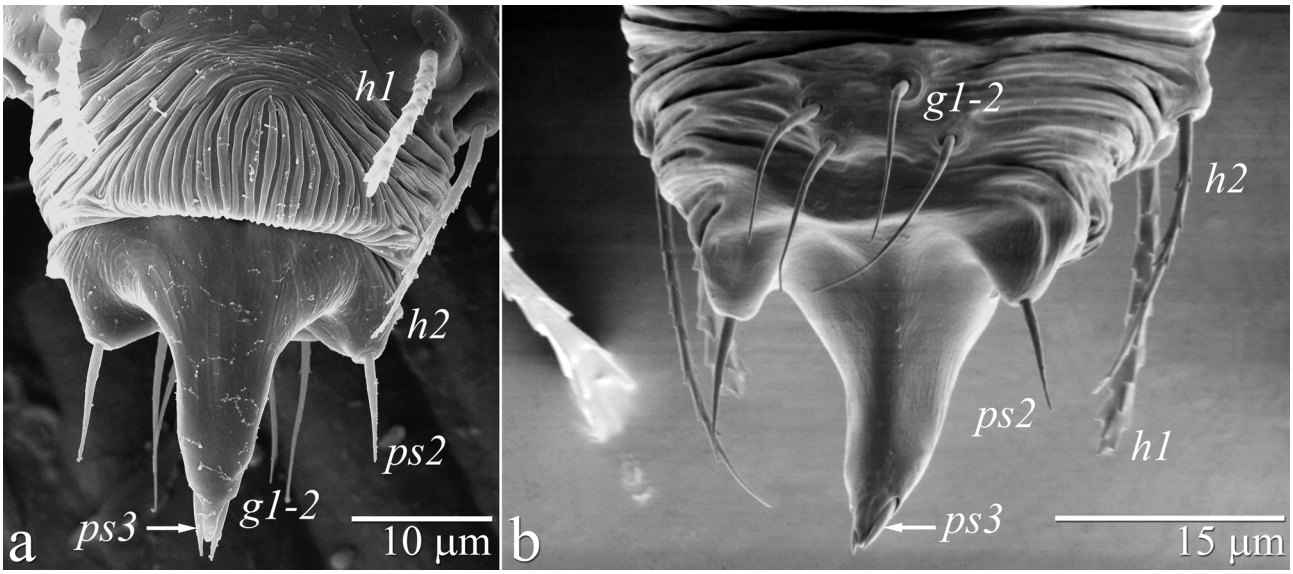


FIGURE 126. *Raoiella indica* Hirst, adult male: posterior dorsal opisthosoma indicating setae *ps3*, a. dorsal aspect; b. ventral aspect.

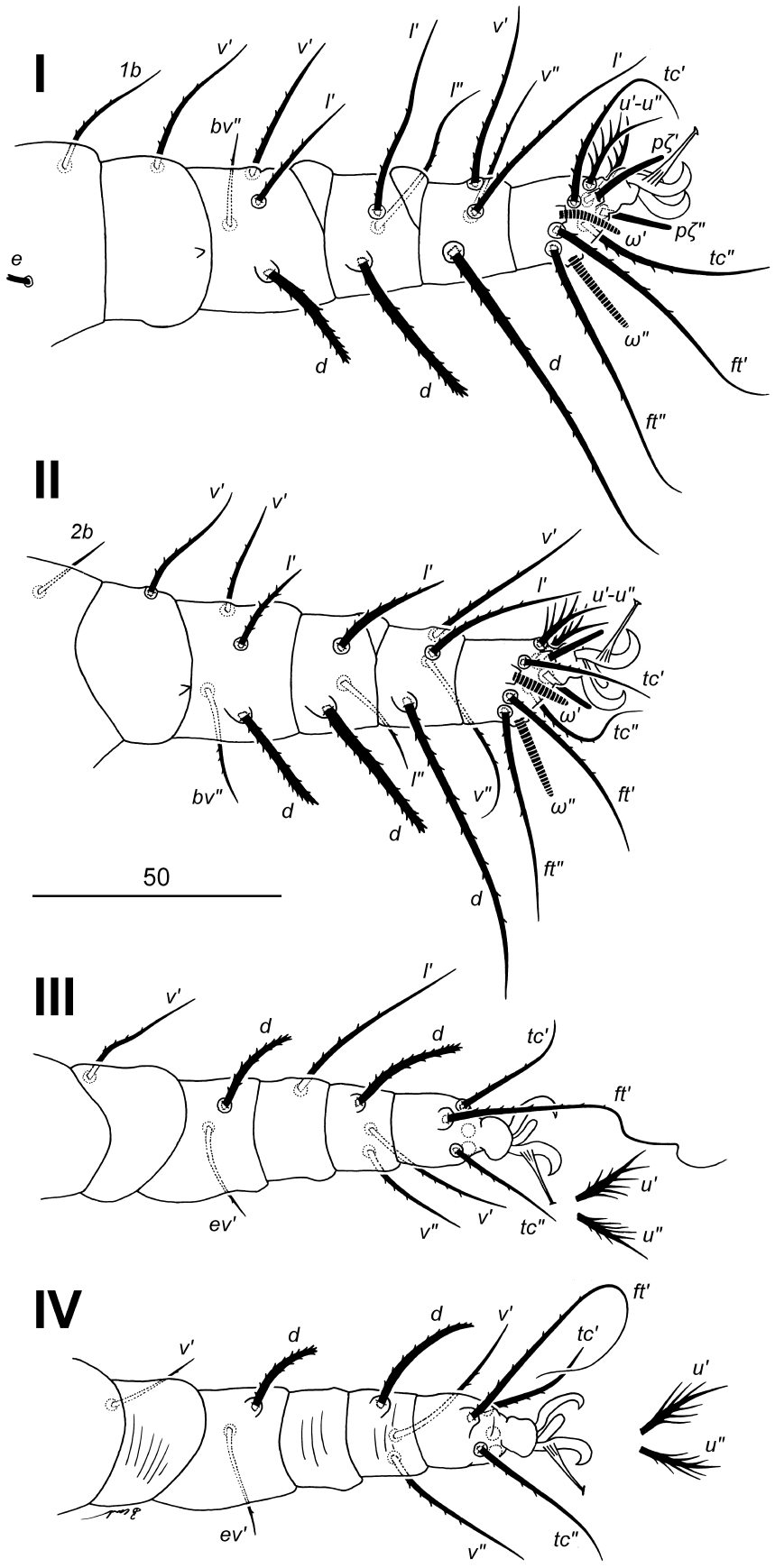


FIGURE 127. *Raoiella indica* Hirst, adult male (from Thailand): legs I–IV (right side, dorsal aspect; proral setae, *pζ'–pζ''*, not labelled on tarsus II).

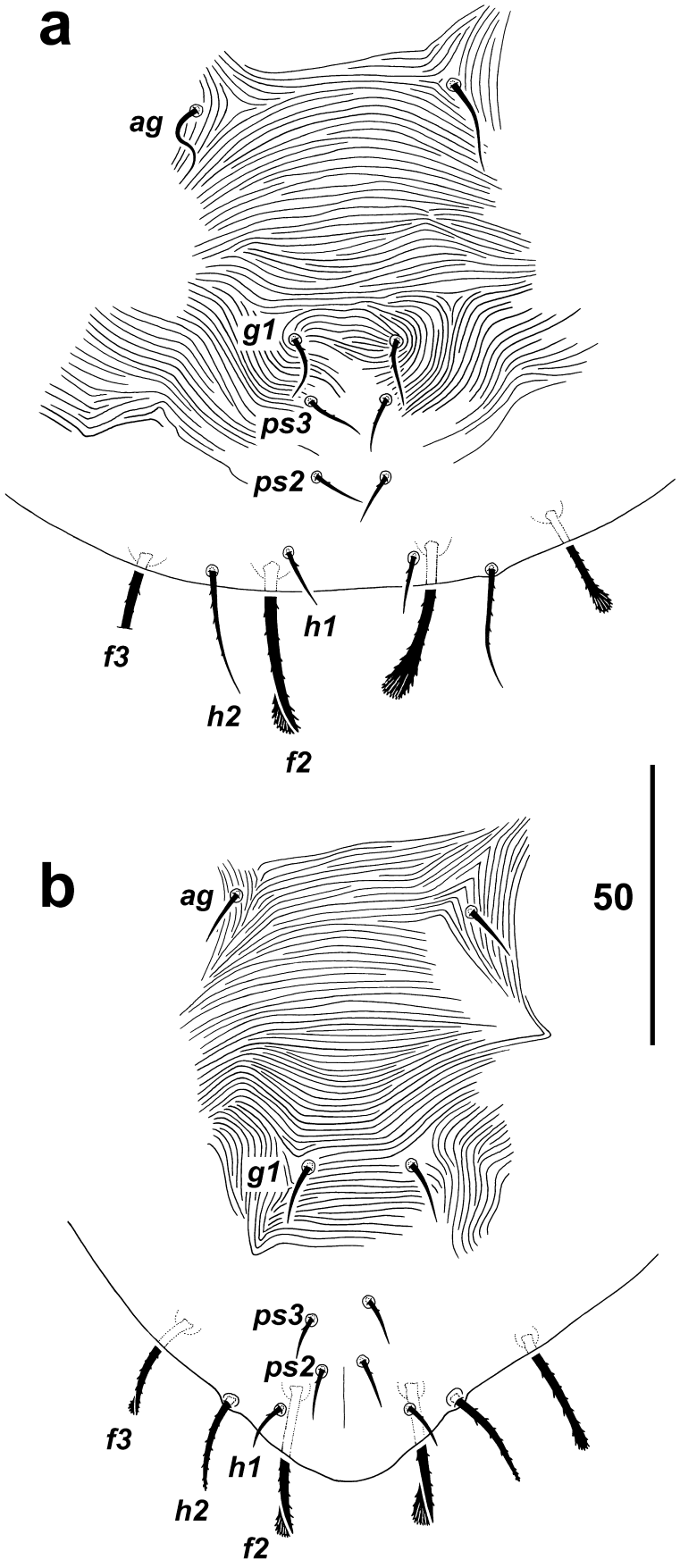


FIGURE 128. *Raoiella indica* Hirst, deutonymph posterior venter: a. female deutonymph; b. male deutonymph.

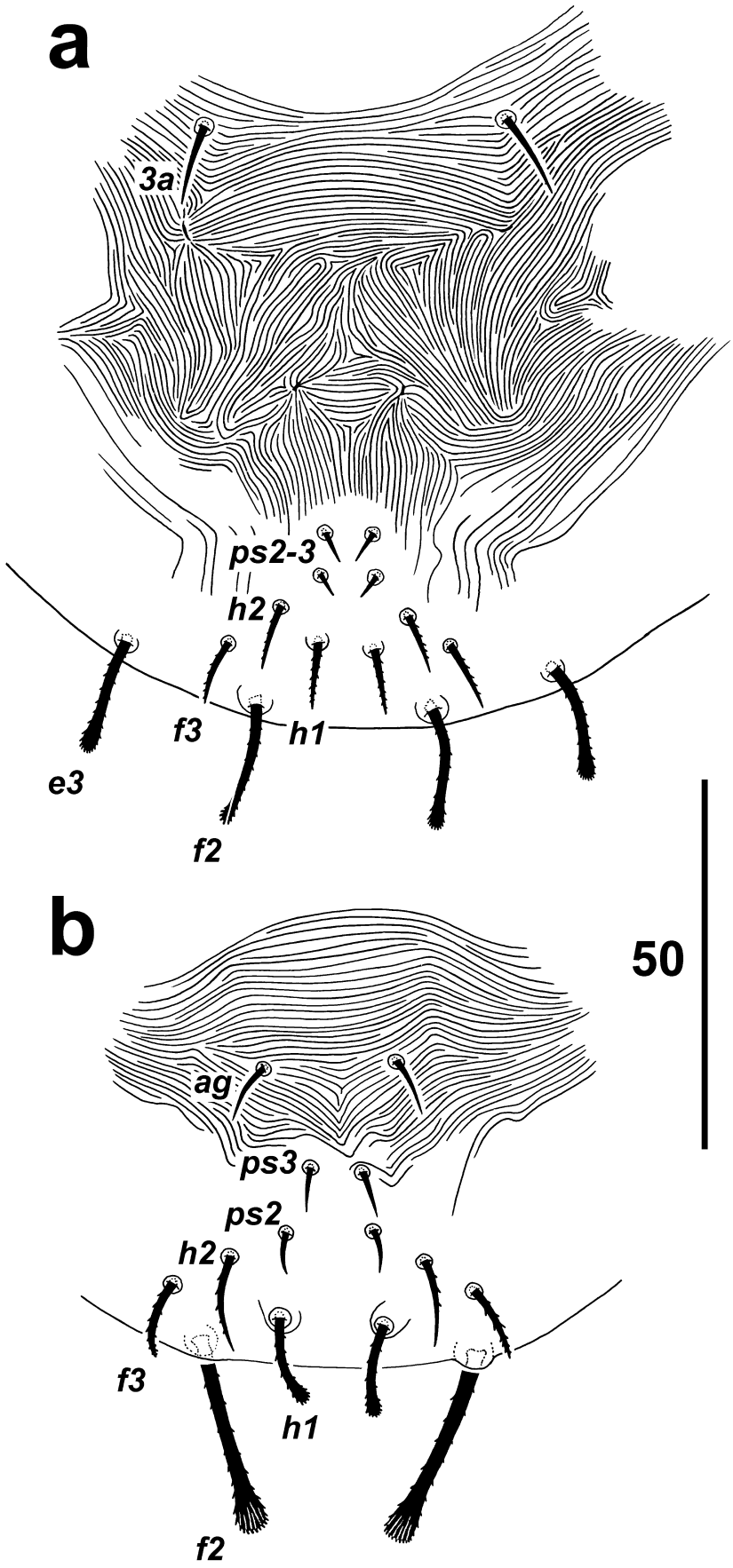


FIGURE 129. *Raoiella indica* Hirst, posterior venter: a. larva; b. protonymph.

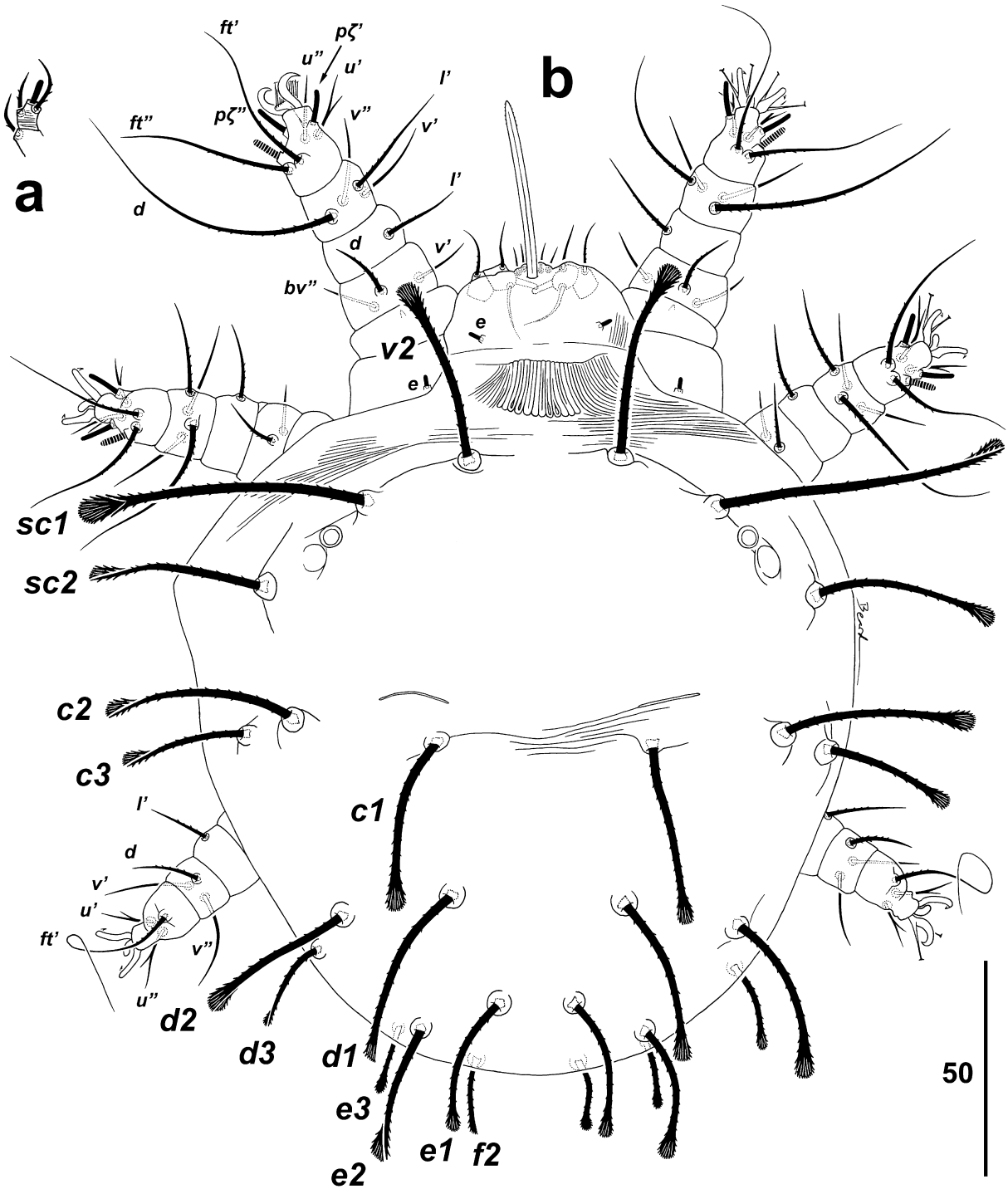


FIGURE 130. *Raoiella indica* Hirst, larva: a. detail of palp; b. dorsal habitus with detail of legs I–III.

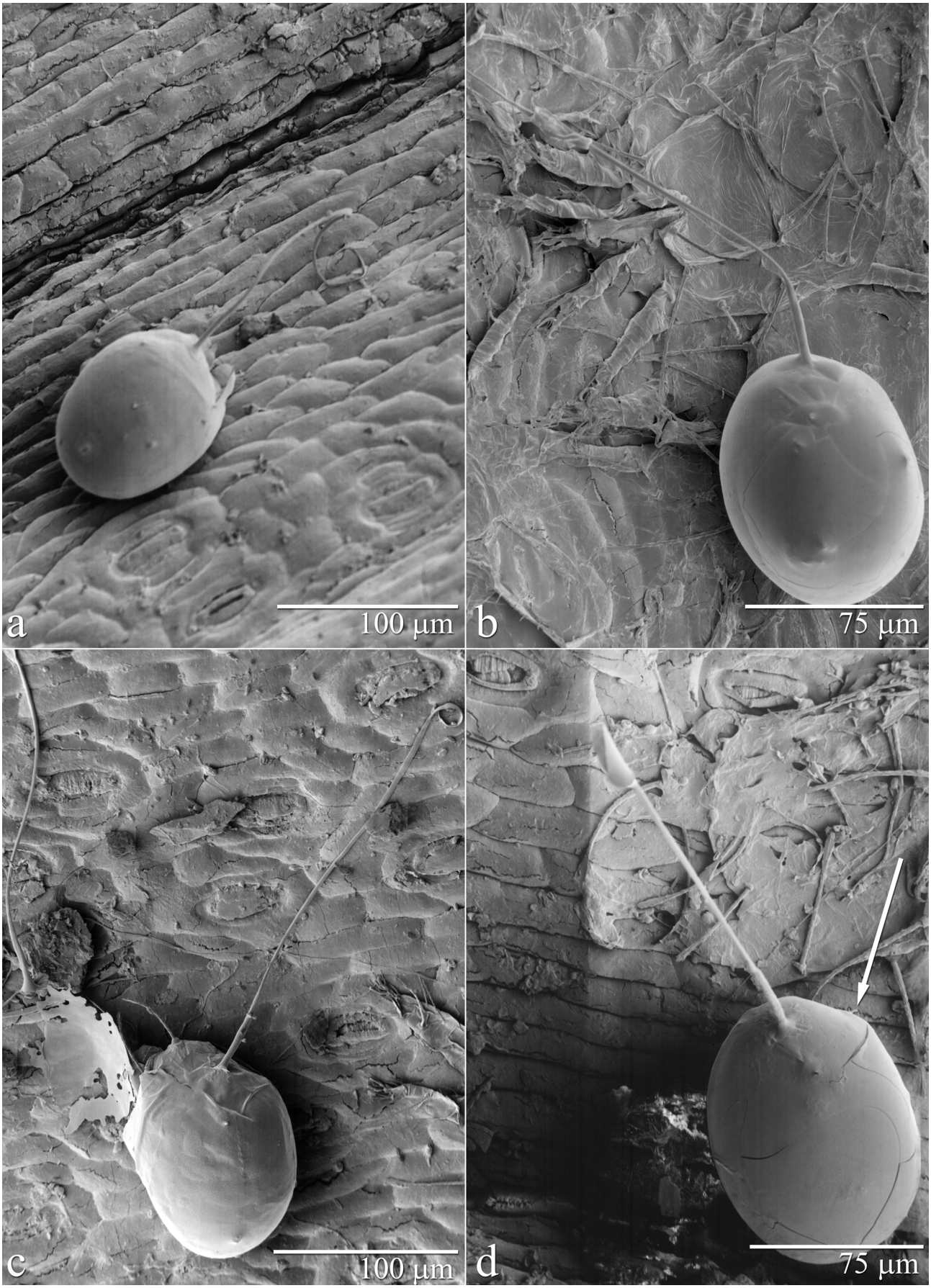


FIGURE 131. *Raoiella indica* Hirst, a.–d. eggs on host plant (d. note pair of minute spines indicated by arrow).

Hosts. Arecaceae: *Cocos nucifera* L., *Dictyosperma album* (Borg.), *Phoenix dactylifera* L., *Rhapis* spp., *Veitchia merrillii* (Becc.); **Heliconiaceae**: *Heliconia* spp.; **Lamiaceae**: *Ocimum basilicum* L.; **Musaceae**: *Musa* spp.; **Pandanaceae**: *Pandanus* spp. (unconfirmed host). See Dowling *et al*. (2008), Kane *et al.* (2012), Carillo *et al.* (2012), Otero-Colina *et al.* (2016) and Taylor (2017) for further details.

Distribution. WESTERN ASIAN REGION: India, Pakistan, Sri Lanka; SOUTH EAST ASIA: Cambodia Indonesia, The Philippines, Singapore, Thailand; AFRICAN REGION: Kenya, Mauritius, Namibia, La Reunion Island, Sudan, South Africa; MIDDLE EASTERN / NORTH AFRICAN REGION: Egypt, Iran, Iraq, Israel, Jordan, Morocco, Saudi Arabia, Tunisia, United Arab Emirates; MEDITERRANEAN REGION: Greece, Turkey; CARIBBEAN REGION: Antigua, Aruba, Barbados, St Croix, Cuba, Dominica, Dominican Republic, Guadeloupe, Haiti, Jamaica, Martinique, Puerto Rico, Saint Lucia West Indies, Saint Martin, Saint Thomas, Trinidad, Turks & Caicos Islands; CENTRAL AMERICA: Belize, El Salvador, Guatemala, Honduras, Nicaragua, Panama; SOUTH AMERICA: Brazil, Colombia, Guayana, Venezuela; NORTH AMERICA: Mexico, USA—Florida. See Dowling *et al*. (2008, 2012), Ramos & Aguilar (2014), Giliomee & Ueckermann (2016), Otero-Colina *et al.* (2016), Taylor (2017) and García Ochaeta (2018) for further distribution details.

Remarks. A special issue of *Experimental & Applied Acarology* Volume 57 (2012) was dedicated to presenting research on the biology and control of the red palm mite, *Raoiella indica*, edited by Pena, Bruin & Sabelis.

Due to the extent of damage caused by its feeding and the characteristic pattern of leaf yellowing, the red palm mite is the first plant feeding mite to have its distributional changes and geographic spread studied and mapped using satellite technology (Lubkin *et al.* 2016). Lubkin *et al.* (2016) used multispectral imagery and calculated spectral vegetation indices to track the geographic spread of this mite from 2002 to 2016 in Puerto Rico. The tracking methodology presented and the tools that were established can be applied to other geographical areas in an effort to mitigate current mite infestations and prepare for and prevent future invasions.

Raoiella karri **sp. nov. Ochoa & Beard**

(Figs 132–147)

Material examined. Holotype. ♀**. Australia**, ex. leaves of immature *Eucalyptus* sp. (Myrtaceae), "Westwood Cottage", 64 Karri Loop, Margaret River, Western Australia, 33°57'20"S 115°03'27"E, R. Ochoa & J.J. Beard (WAM).

Paratypes. 12 ♀, 2 ♂, 5 deutonymphs, 5 protonymphs, same data as Holotype, (all on separate slides; WAM, QM, USNM).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* spatulate. Adult femora I with four setae (*d*, *l′*, *v′*, *bv″*); femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with three setae (*l′*, *d*, *l″*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsus I with companion setae (*ft″*) longer than solenidion; tarsus II with companion seta (*ft″*) subequal in length with solenidion. Dorsal setae *d* on tibiae I–II tapered. Eupathidium on palp tibiotarsus blunt.

Description. Female. ***Dorsum.*** (Figs 132–134) Body measurements (7): length between setae *v2–h1* 266–285 [266], width between setae *sc2–sc2* 173–195 [192], *c3–c3* 188–200 [200], *f3–f3* 101–119 [119]. Prodorsum with pair large pores on posterior margin (often in folded cuticle between prodorsum and opisthosoma); opisthosoma with pair large pores between setae *c2* and *d2*. Central setae on dorsal opisthosoma obviously shorter than lateral setae; dorsal setae barbed along entire length. Setae *h2* spatulate. Dorsal setae measurements: *v2* 63–73 [71–72], *sc1* 51–56 [55–56], *sc2* 63–70 [67–70], *c1* 20–25 [23], *c2* 23–28 [27], *c3* 62–69 [64], *d1* 15–18 [15], *d2* 19–23 [22], *d3* 68–73 [73], *e1* 15–21 [18], *e2* 23–28 [24], *e3* 69–77 [77], *f2* 29–43 [43], *f3* 78–88 [83], *h1* 48–56 [52], *h2* 25–35 [28].

Palps. (Figs 132, 134) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (8–9) [8–9] and one blunt eupathidium (10–11) [10–11] distally, one dorsal seta (12–15) [15]; palp femorogenu with one seta (22–24) [23–24]. The stylets are narrow and strongly tapered (Fig. 135b), with 14–15 small rounded lateral teeth distally (Fig. 135).

Venter. (Figs 136a,b, 137) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* and *g2* inserted in more or less transverse row on posterior margin of genital flap

(Figs 136a,b, 137). Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *3a*, *g1*, *g2*, *ps2*, *ps3* barbed. Setal measurements: *1a* 58–91 [76], *1b* 20–24 [22], *2b* 14–17 [16], *3a* 11–16 [15], *4a* 53–90 [66], *ag* 10–12 [12], *g1* 10–13 [12], *g2* 11–15 [15], *ps2* 11–14 [13], *ps3* 9–12 [11].

Spermatheca. (Fig. 136c) Highly convoluted narrow tube, indistinct distally.

Legs. (Figs 138–140) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-3-3-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 13–16 [14]; ta II 11–13 [11–12]) and two eupathidia distally *pζ′–pζ″* (ta I 12–13 [12], 12–13 [12]; ta II 11–13 [11], 12–13 [12]). Femur I with four setae (*d*, *l′*, *v′*, *bv″*); femur II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with three setae (*d*, *l′*, *l″*). Companion seta *ft″* on tarsus I finely tapered 18–22 [18–20] (Figs 138, 139) and tarsus II 10–16 [12–15] (Fig. 140), inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta with tapered tip (not finely tapered). Tenent hairs on claws with three attachment points.

Male. ***Dorsum.*** (Figs 141–142, 147a) Body measurements (2): length between setae *v2–h1* 187–200, width between setae *sc2–sc2* 153–171, *c3–c3* 143–157, *f3–f3* 77–78. Prodorsum smooth; opisthosoma with transverse striae, strongest between setae *d1* and *f2*. Prodorsum with pair of minute sublateral pores, and pair large pores on posterior margin (often in folds of cuticle); opisthosoma with pair large slit pores between setae *c1* and *d2*; pair of minute pores between *c2–c3* and *e1–e2*. Dorsal setae spatulate, barbed along entire length, narrower than female. Seta *h1* and *h2* weakly spatulate. Dorsal setae measurements: *v2* 31–32, *sc1* 26–30, *sc2* 37–39, *c1* 17–18, *c2* 17–18, *c3* 39–45, *d1* 15, *d2* 16–17, *d3* 41–47, *e1* 16, *e2* 16–18, *e3* 44–47, *f2* 20–22, *f3* 43–46, *h1* 20–22, *h2* 16–18.

Palps. (Fig. 141) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (8–9) and one blunt eupathidium (9–10) distally, one dorsal seta (11–13); palp femorogenu with one seta (19–23).

Venter. Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and a distinct patch of smooth cuticle on either side of setae *ag*. Setae *ps3* modified as accessory genital stylets into short stout spurs (Figs 141, 142b). Setal measurements: *1a* 61–77, *1b* 17, *2b* 15–16, *3a* 10–11, *4a* 62, *ag* 8–9, *g1* 12, *g2* 12, *ps2* 8–9, *ps3* 7–9.

Aedeagus. (Fig. 141) Aedeagus narrow, elongate and sclerotised (52–55), tapering to a blunt point distally (at genital opening).

Legs. (Figs 143–144) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-3-3-4-10(2), 0-1-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I (Figs 143, 144a) and tarsi II (Figs 143, 144b) each with two solenidia (ta I adaxial 12–15, abaxial 14–15; ta II adaxial 12–13, abaxial 14–15), and two eupathidia distally (ta I 12, 11; ta II 12–13, 14–15). Femur I with four setae (*d*, *l′*, *v′*, *bv″*); femur II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with three setae (*d*, *l′*, *l″*). Companion seta *ft″* on tarsus I finely tapered 15–19 (Fig. 144a) and tarsus II 12–13 (Fig. 144b), inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered. Tenent hairs on claws with three attachment points.

Deutonymph. ***Dorsum.*** Body measurements (4 female, 1 male): length between setae *v2–h1* female 212–231 (male 186), width between setae *sc2–sc2* 157–166 (133), *c3–c3* 152–162 (133), *f3–f3* 63–67 (48). Prodorsum mostly smooth; dorsal opisthosoma with some weak transverse folds between *c1–d1*; one pair large slit pores between setae *c1–d2*. Dorsal setae barbed along entire length; setae *h1* spatulate, setae *h2* tapered. Dorsal setae measurements: *v2* 49–54 (36), *sc1* 36–41 (27), *sc2* 48–53 (28), *c1* 19–21 (17), *c2* 22–24 (17), *c3* 50–55 (35), *d1* 14–18 (13), *d2* 18–21 (16), *d3* 49–55 (37), *e1* 16–19 (15), *e2* 22–25 (16), *e3* 44–58 (37), *f2* 27–34 (21), *f3* 31–46 (29), *h1* 17–21 (10–12), *h2* 13–15 (8–9).

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion 6–8 (6–7) and one blunt eupathidium 8–10 (6–7) distally, one dorsal seta 10–13 (9–11); palp femorogenu with one seta 15–18 (13–16).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except with some longitudinal striae between coxae I. Female: area of longitudinal striae between *g1–ps2* and coxal fields smooth (see also Figs 20a, 128a, 234a). Male: covered with mostly transverse striae, with coxal fields smooth (see also Figs 20b, 128b, 234b). Setae *1a* and *4a* elongate, fine (difficult to determine full length). Setal measurements (both sexes): *1a* 42–55, *1b* 12–18, *3a* 8–10, *4a* 32–68, *ag* 6–9, *g1* 7–10, *ps2* 7–8, *ps3* 5–6.

Legs. (Fig. 145a) Both sexes. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I (Fig. 145a) and II each with one abaxial solenidion (ta I 9–10; ta II 7–10) and two eupathidia distally (ta I 8–9, 8–10; ta II 7–8, 7–8). Companion seta *ft″* on tarsus I 7–9 and tarsus II 5–7, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta tapered. Tenent hairs on claws with three attachment points.

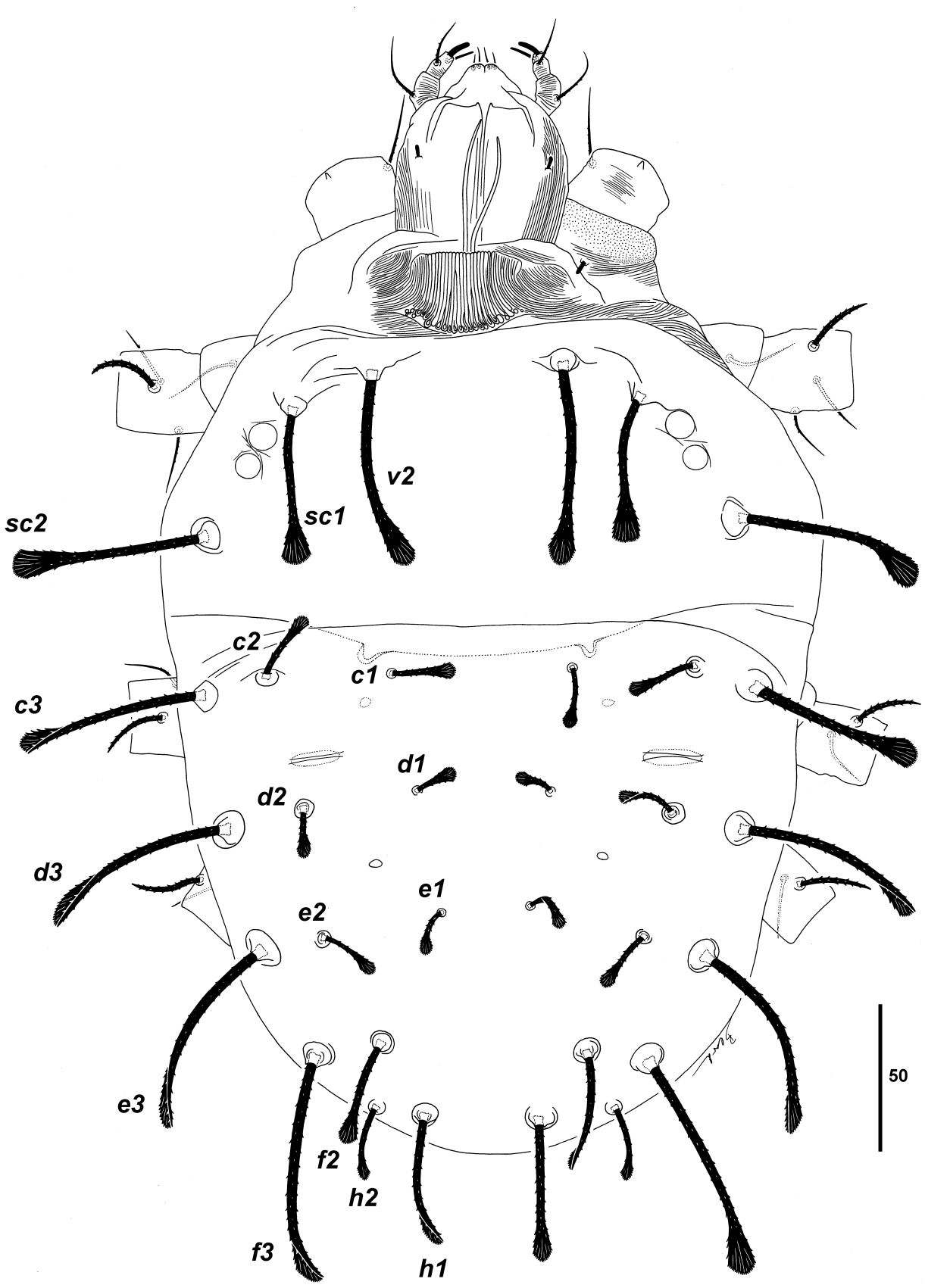


FIGURE 132. *Raoiella karri* Ochoa & Beard, adult female: dorsal habitus with details of the palps.

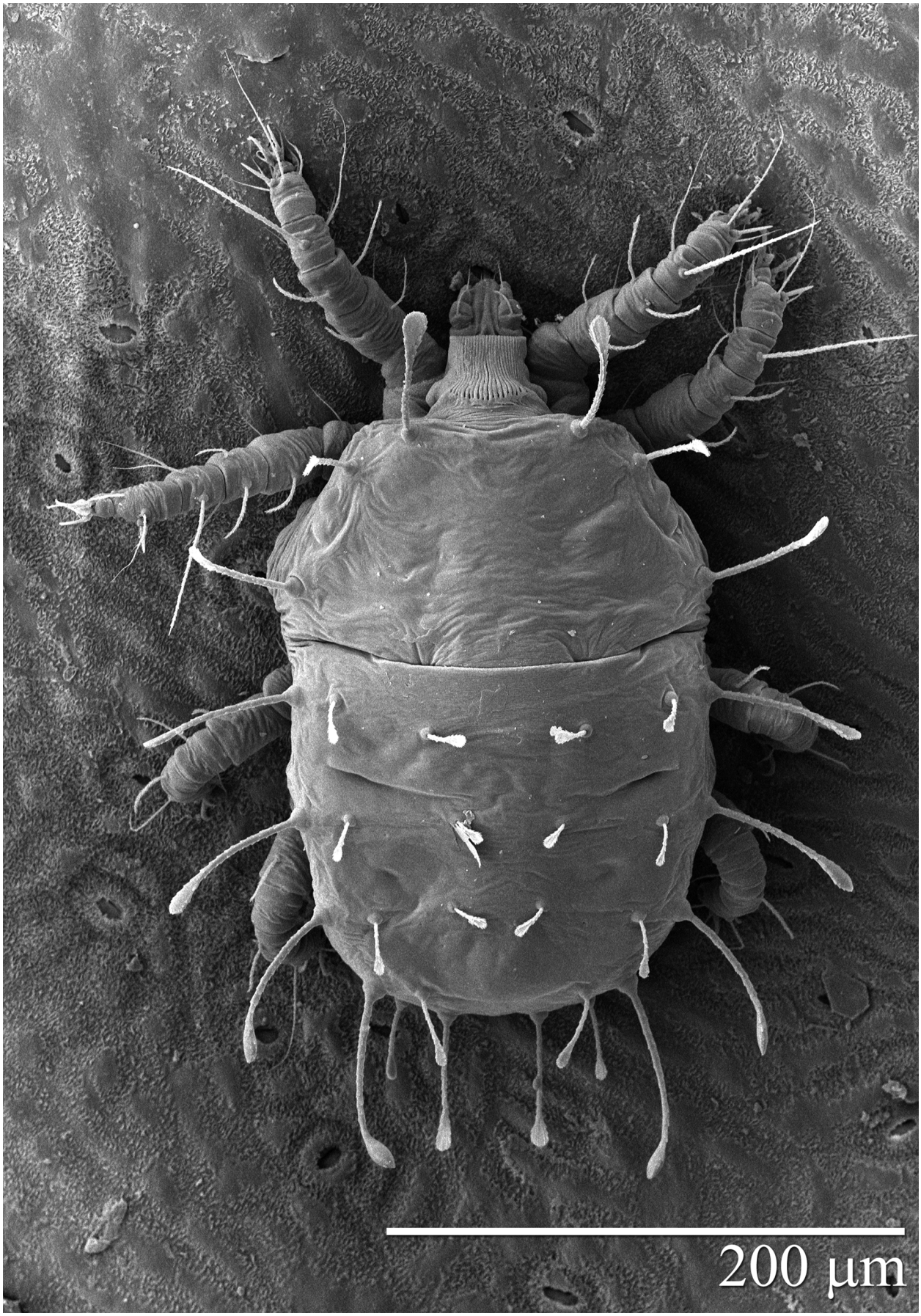


FIGURE 133. *Raoiella karri* Ochoa & Beard, adult female: dorsal habitus on host plant.

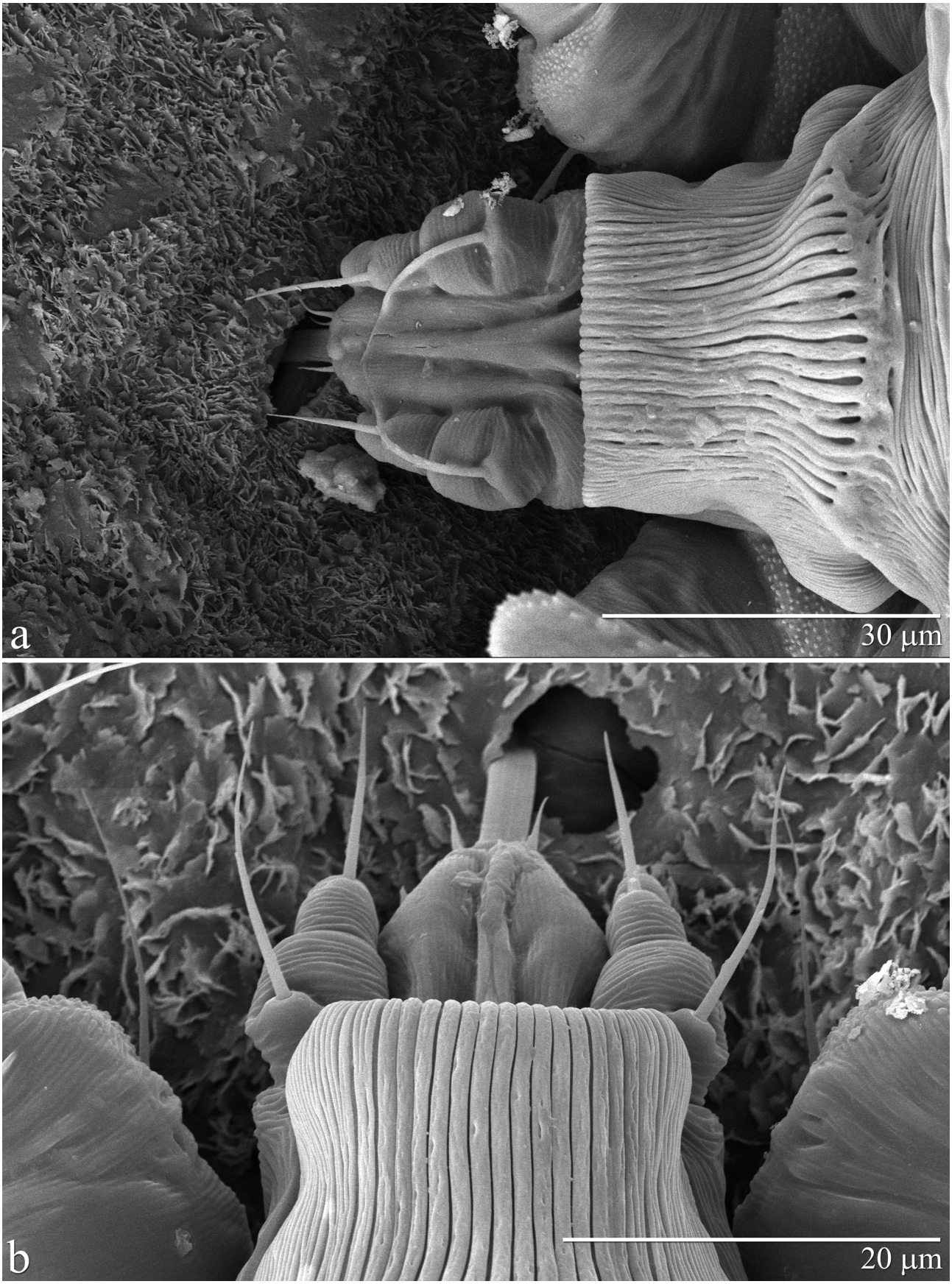


FIGURE 134. *Raoiella karri* Ochoa & Beard, feeding via the stomata: a. adult female; b. adult male.

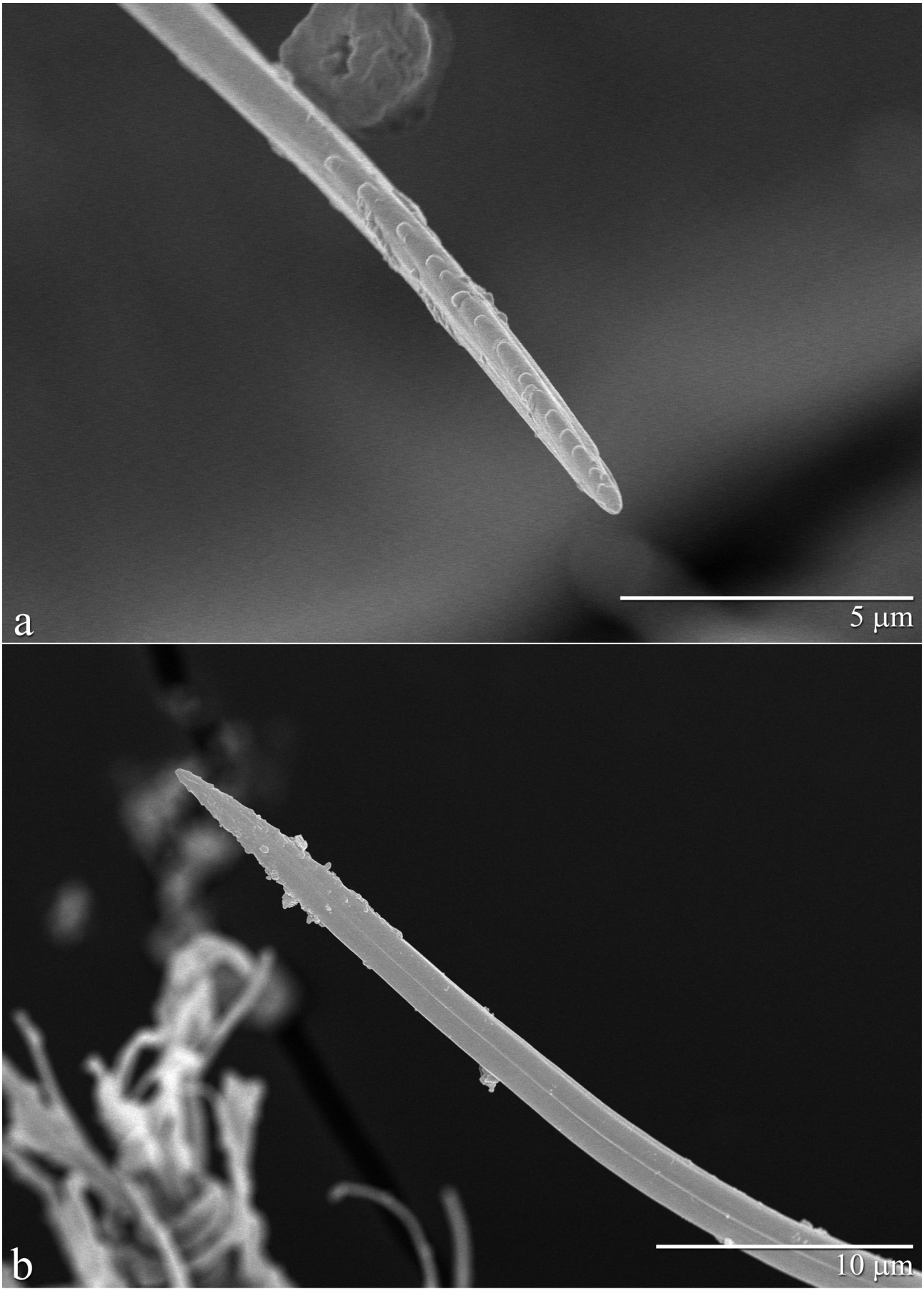


FIGURE 135. *Raoiella karri* Ochoa & Beard, dorsal and lateral view of joined stylets, detail of stylet tip with lateral serrations.

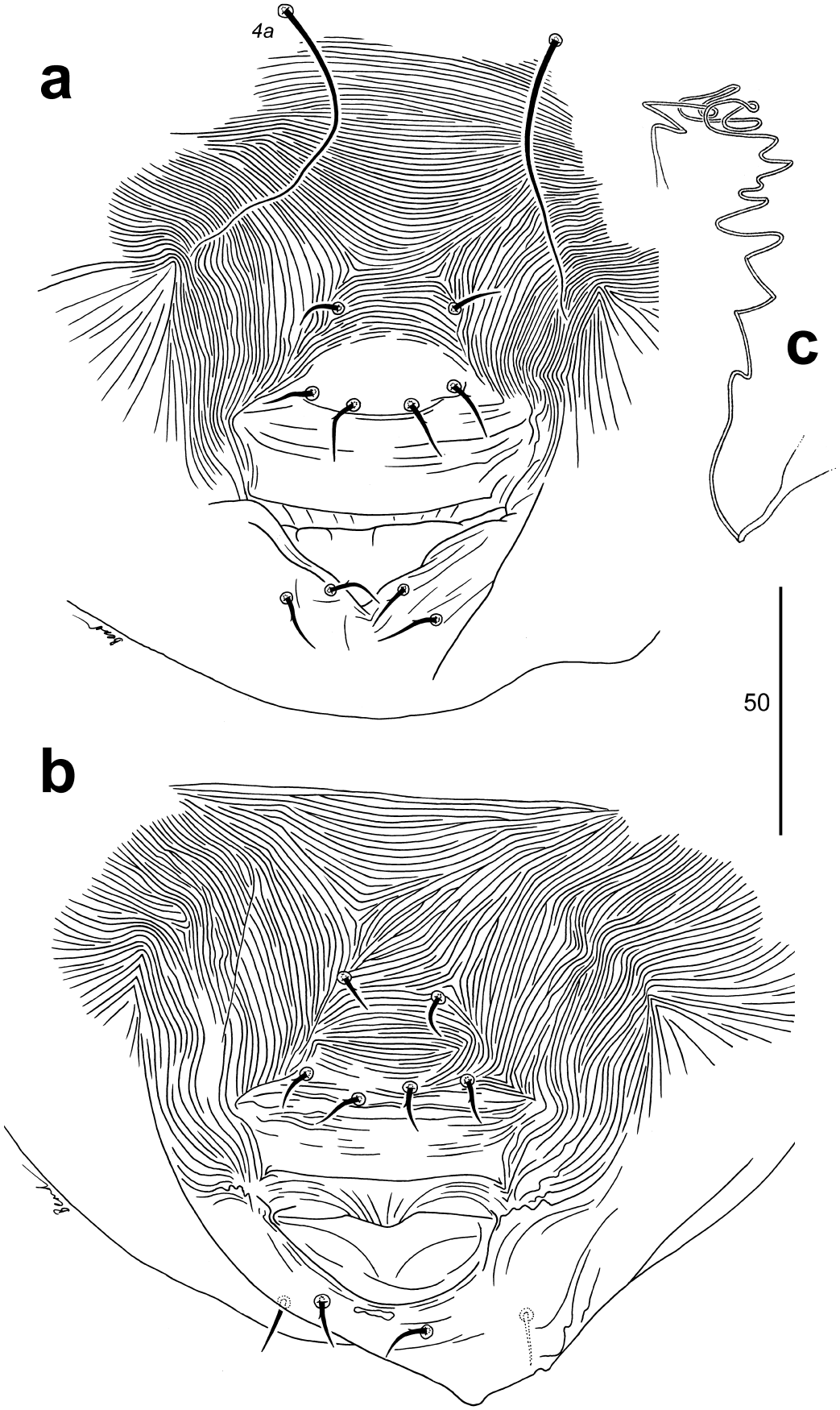


FIGURE 136. *Raoiella karri* Ochoa & Beard, adult female: a., b. posterior venter (two different individuals); c. detail of spermatheca.

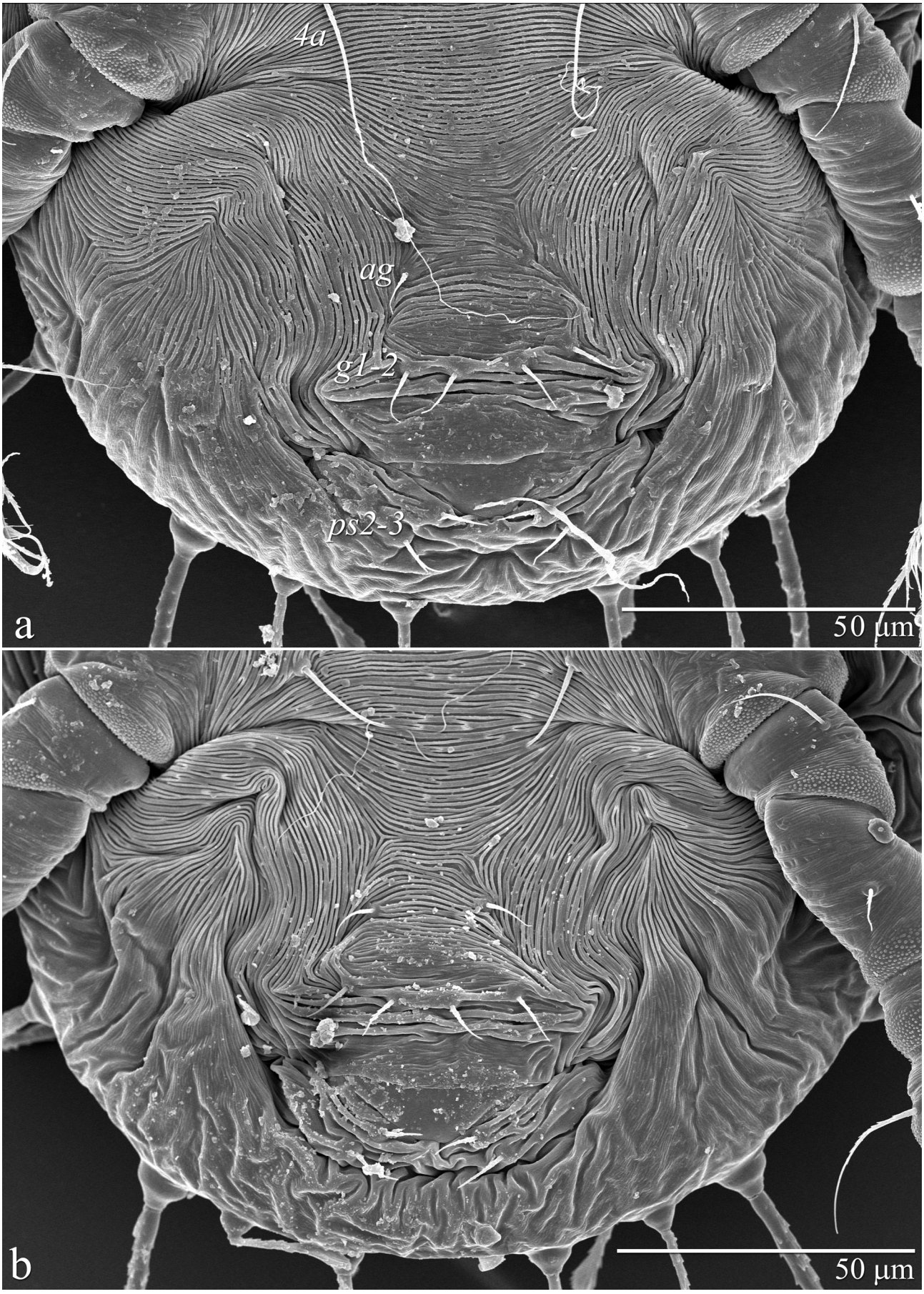


FIGURE 137. *Raoiella karri* Ochoa & Beard, adult female: posterior venter (two different individuals).

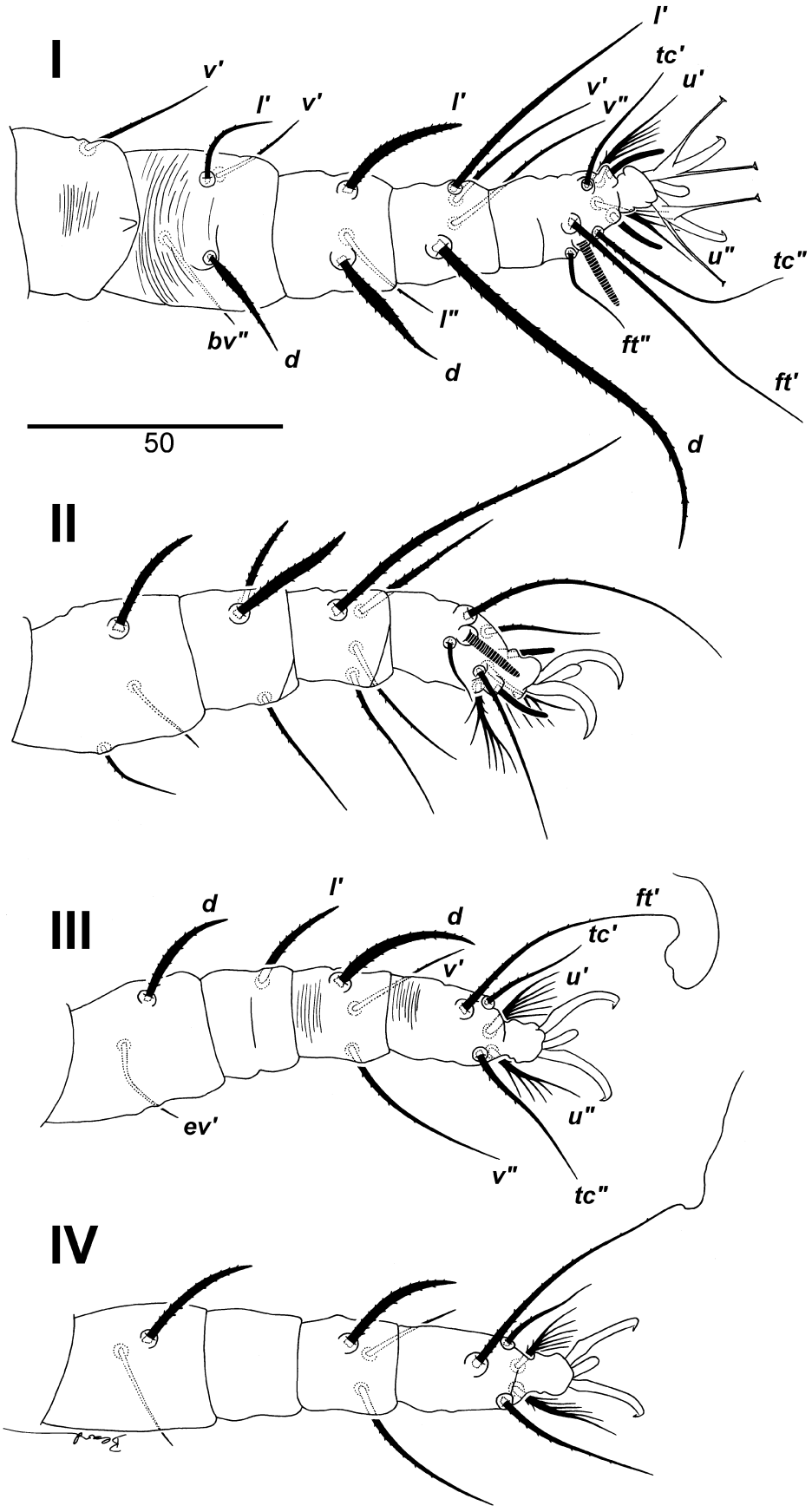


FIGURE 138. *Raoiella karri* Ochoa & Beard, adult female: legs I–IV (right side; leg I dorsal aspect, legs II–IV dorsal to abaxial aspect).

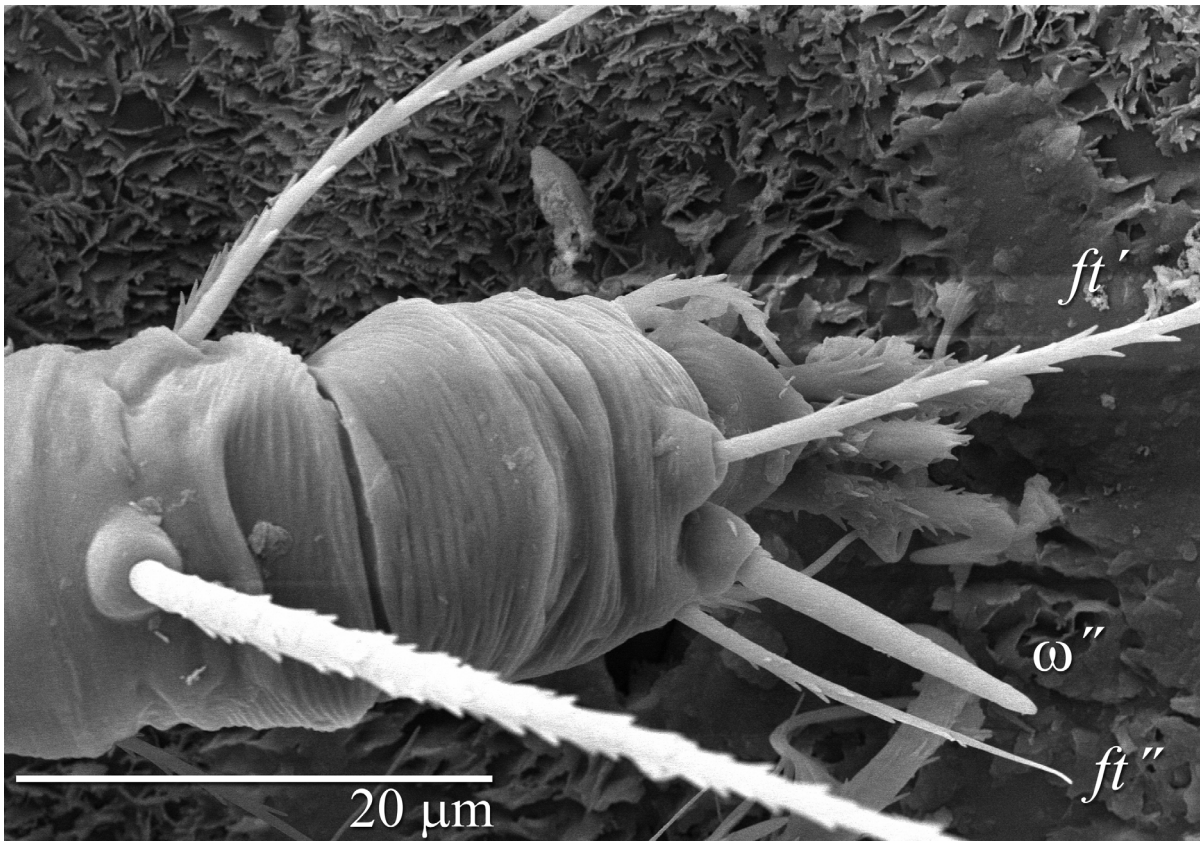


FIGURE 139. *Raoiella karri* Ochoa & Beard, adult female: detail of tarsus I, indicating the solenidia (*ω″*) and companion setae (*ft″*) (two different individuals).

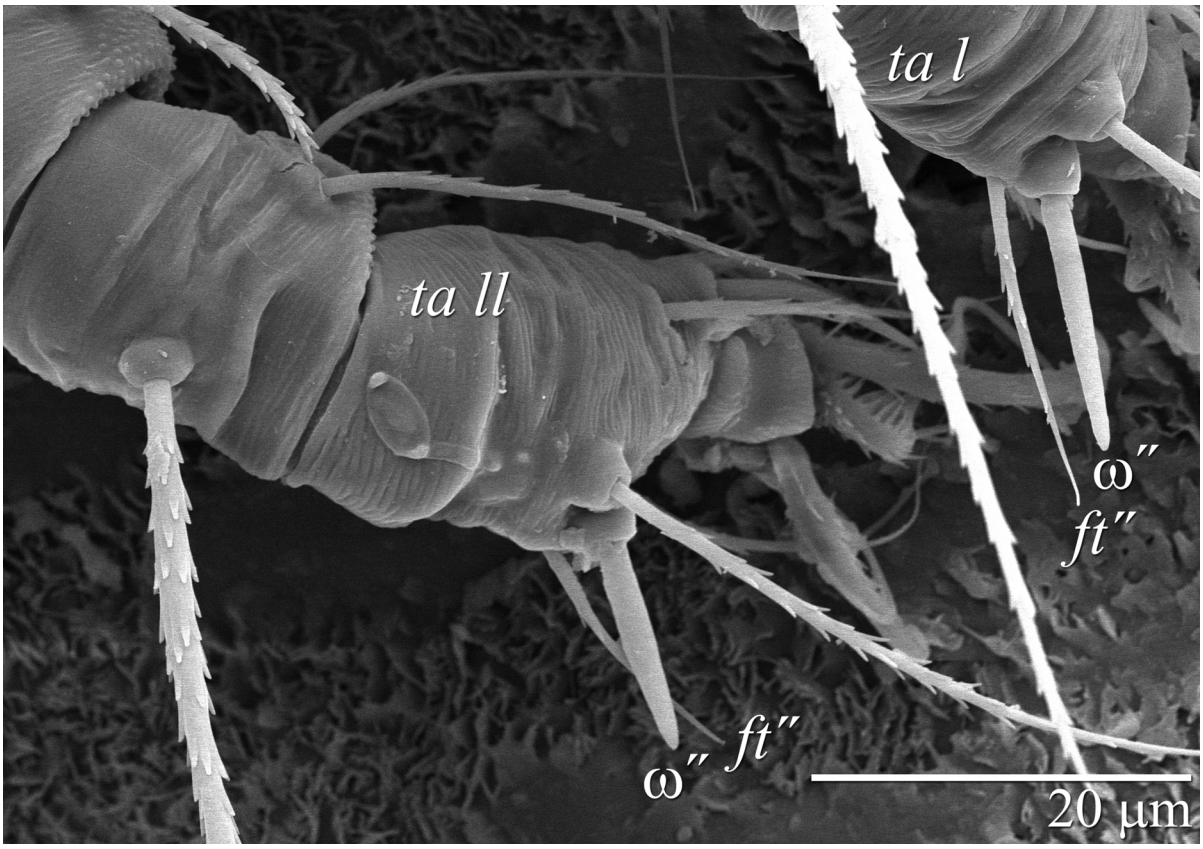


FIGURE 140. *Raoiella karri* Ochoa & Beard, adult female: detail of tarsus II (with part of tarsus I), indicating the solenidia (*ω″*) and companion setae (*ft″*).

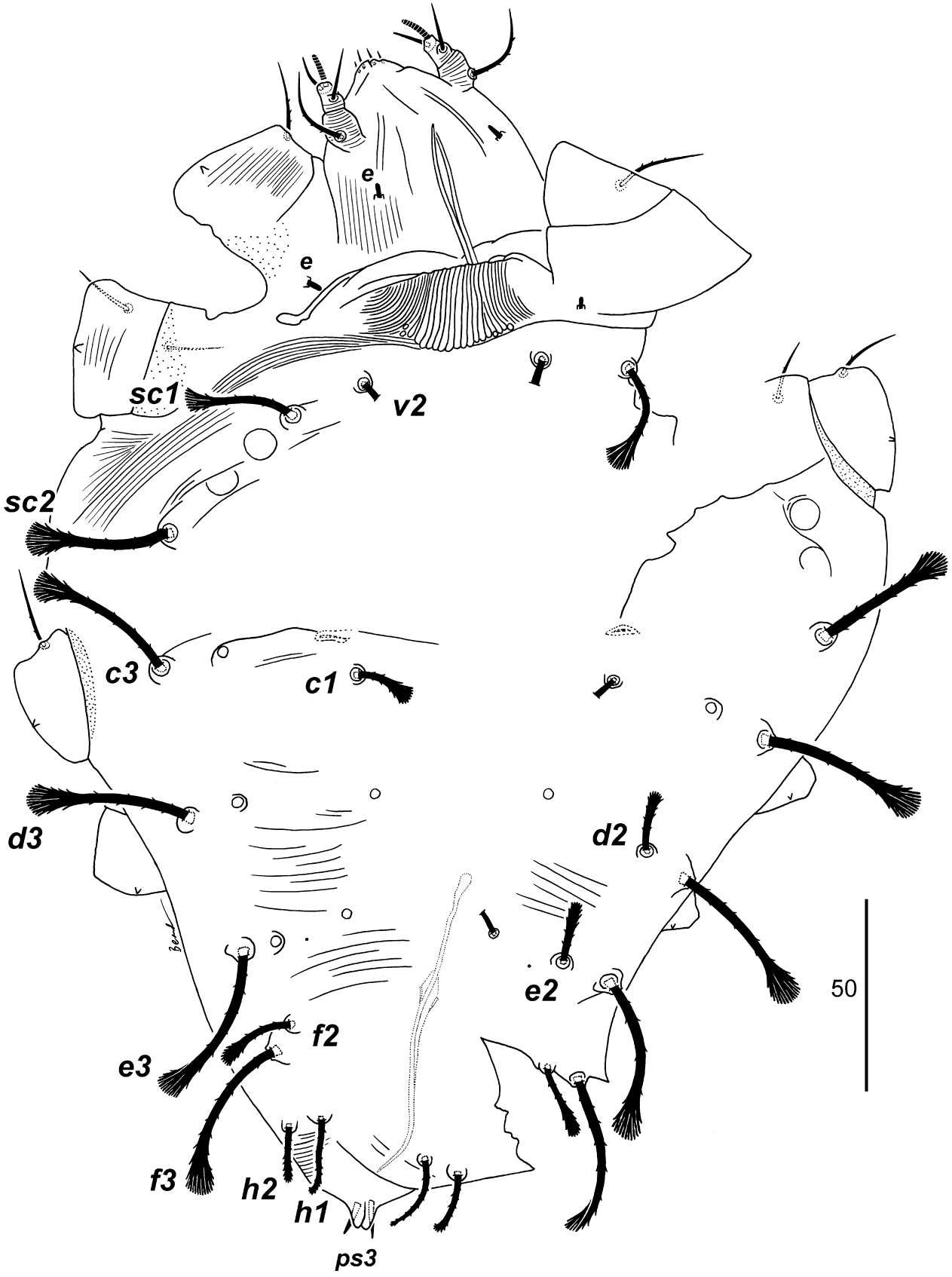


FIGURE 141. *Raoiella karri* Ochoa & Beard, adult male: dorsal habitus with details of palps, setae *ps3* and aedeagus.

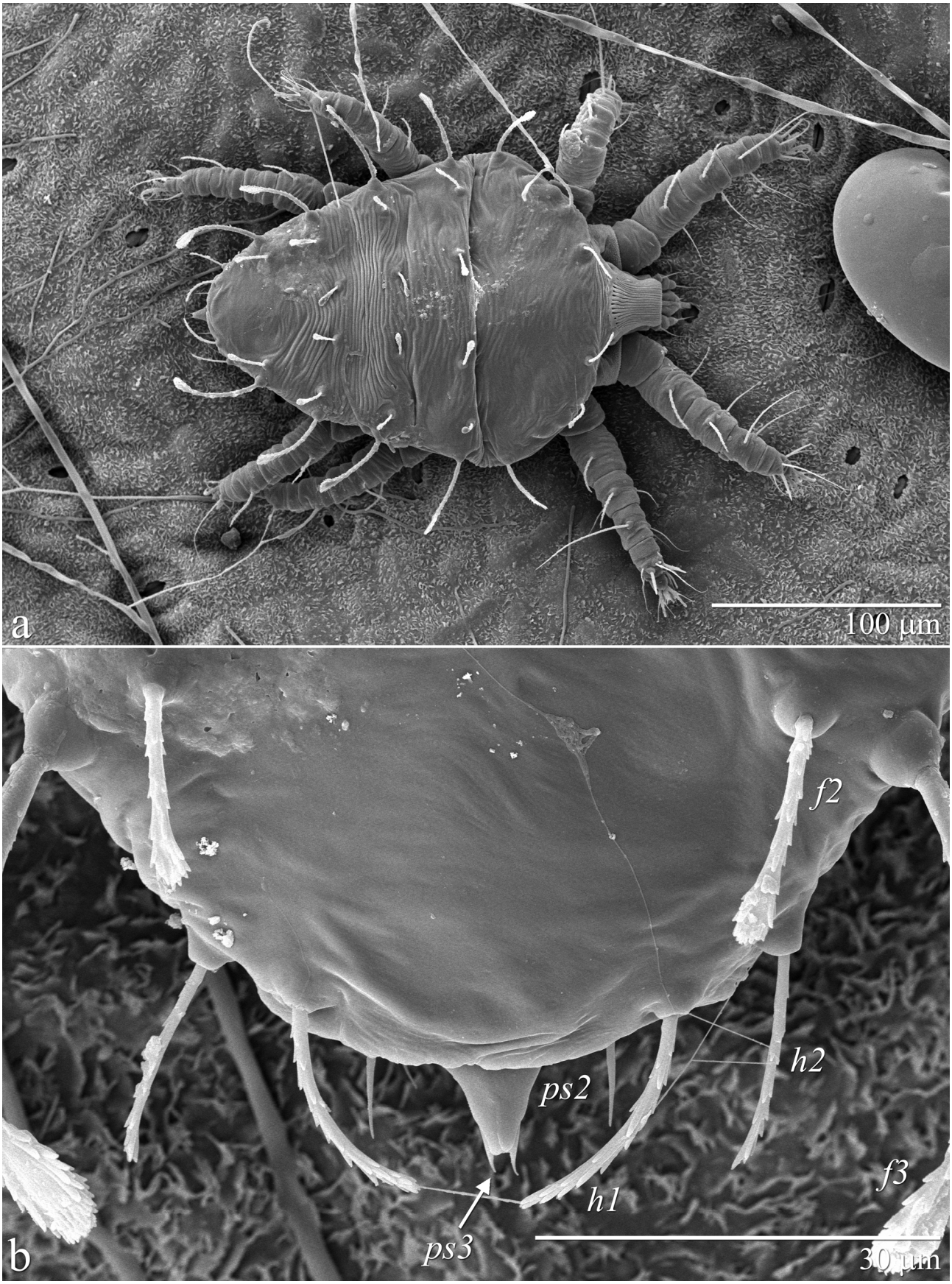


FIGURE 142. *Raoiella karri* Ochoa & Beard, adult male, a. dorsal habitus on host plant; b. detail of posterior dorsum with details of *ps3* setae.

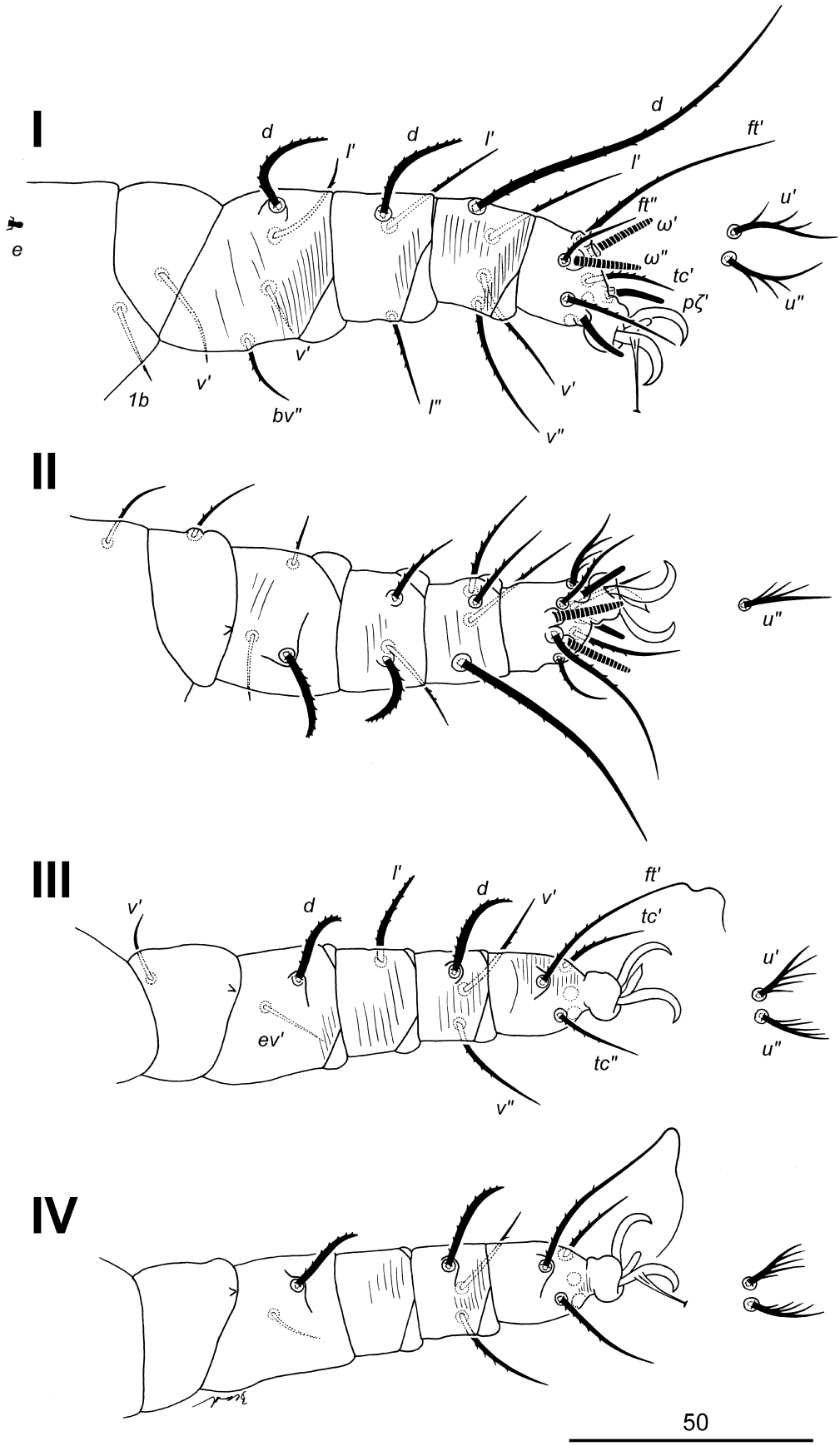


FIGURE 143. *Raoiella karri* Ochoa & Beard, adult male: legs I–IV (right side; leg I abaxial aspect, legs II-IV dorsal aspect; unguinal setae illustrated separately).

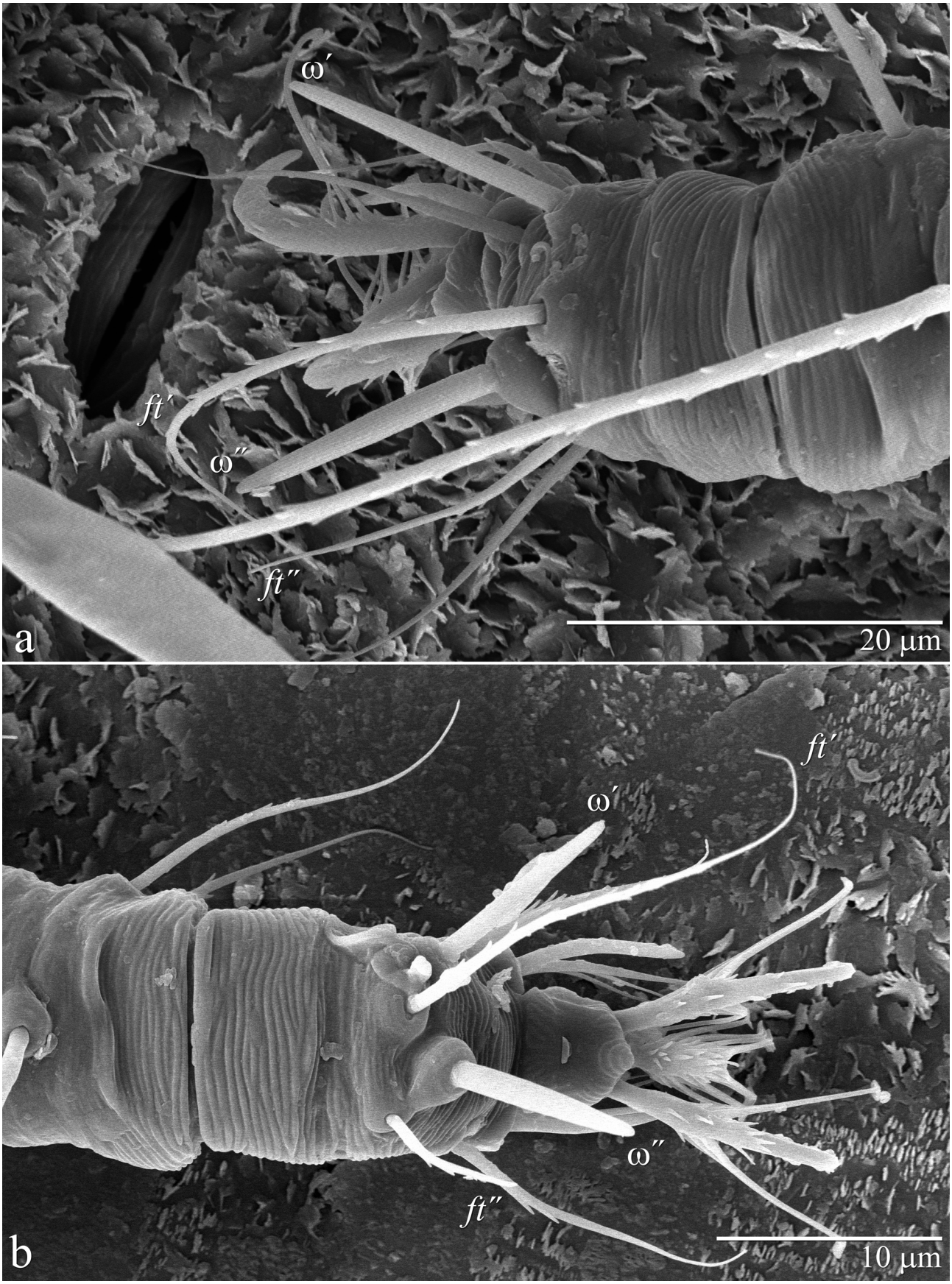


FIGURE 144. *Raoiella karri* Ochoa & Beard, adult male: a. detail of tarsus I; b. detail of tarsus II.

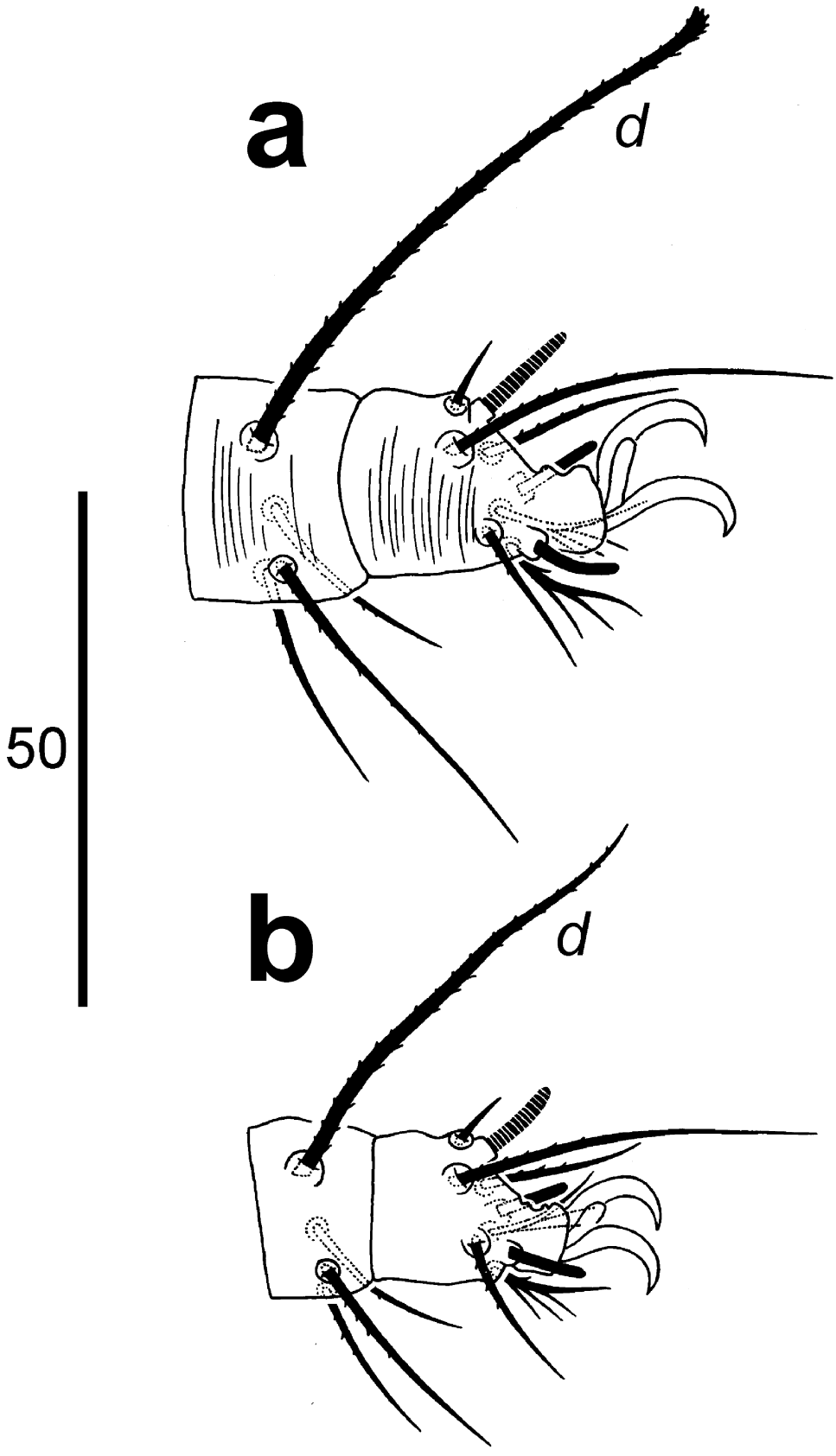


FIGURE 145. *Raoiella karri* Ochoa & Beard, tibia-tarsus I: a. deutonymph I (left side, adaxial aspect); b. protonymph (left side, adaxial aspect).

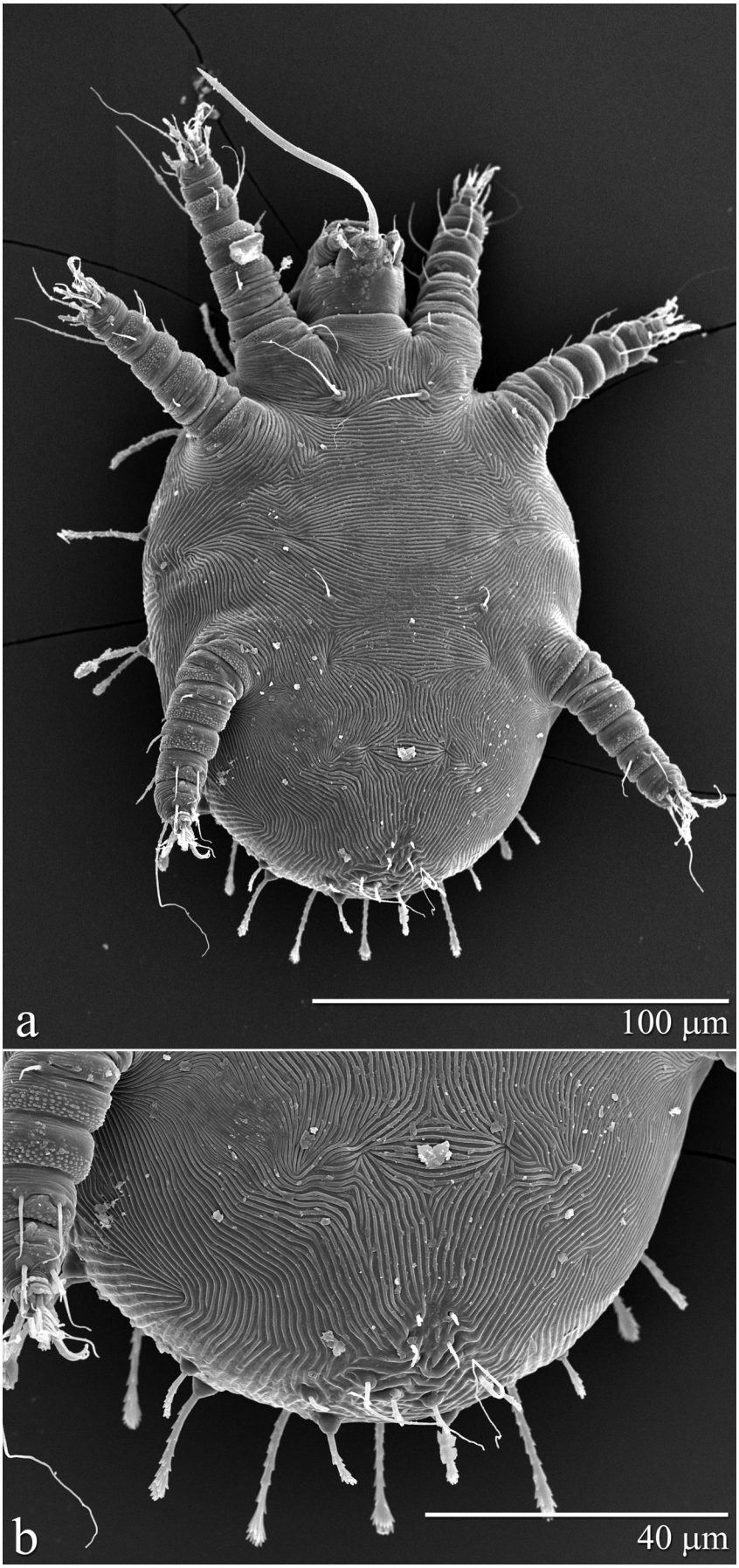


FIGURE 146. *Raoiella karri* Ochoa & Beard, larva: a. ventral habitus; b. detail of posterior venter.

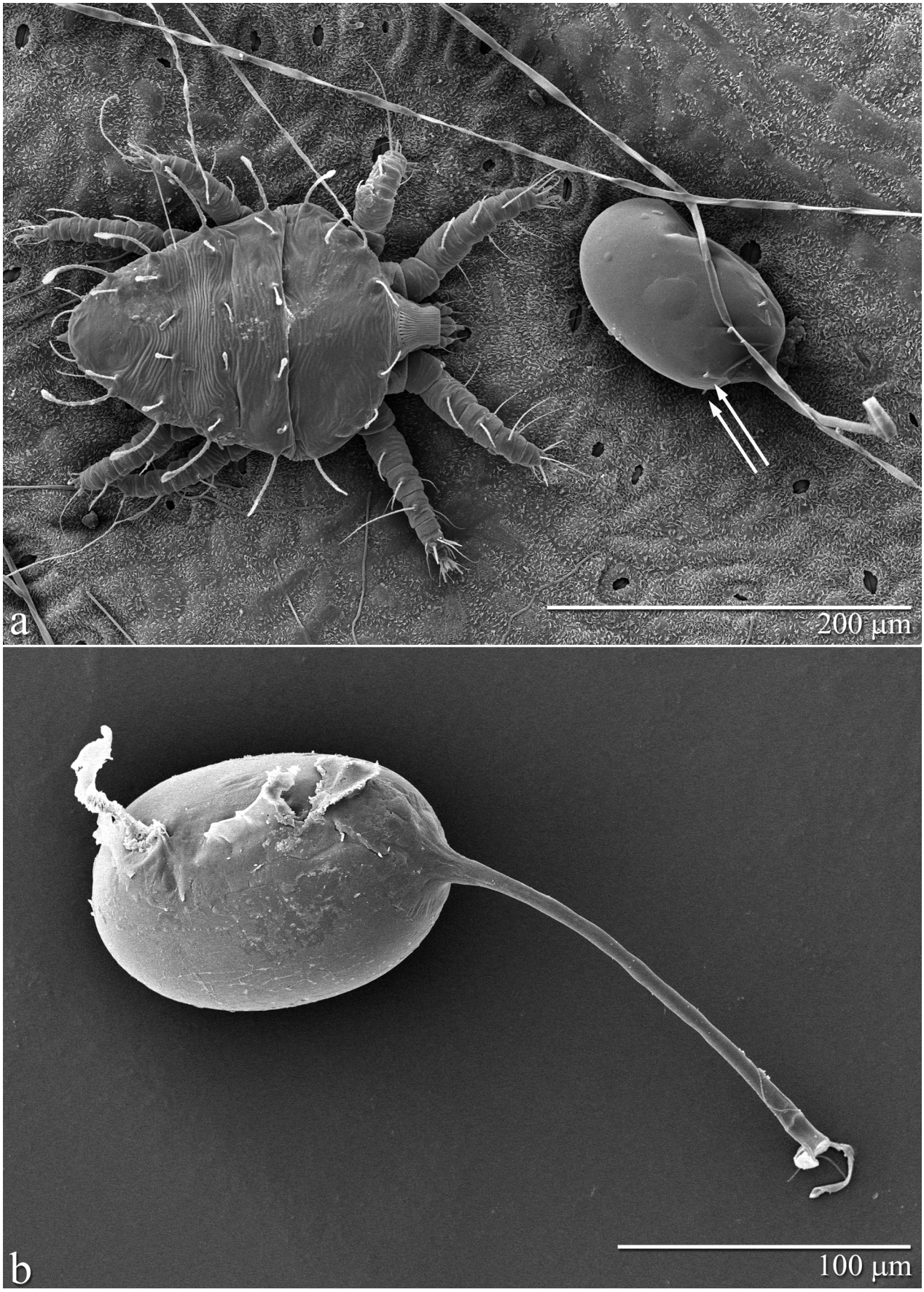


FIGURE 147. *Raoiella karri* Ochoa & Beard, a. adult male with egg on host plant (note pair of minute spines indicated by arrow); b. egg removed from host plant.

Protonymph. *Dorsum.* The ranges presented in the following description are relatively large as the lower values represent a male protonymph specimen. Body measurements (4): length between setae *v2–h1* 170–186, width between setae *sc2–sc2* 116–137, *c3–c3* 116–139, *f3–f3* 43–50. Prodorsum mostly smooth; dorsal opisthosoma with some weak transverse folds between *c1–d1*; pair of minute pores between *d1–d2*. Dorsal setae spatulate, barbed along entire length; setae *h1* short, thick; setae *h2* tapered. Dorsal setae measurements: *v2* 33–44, *sc1* 25–37, *sc2* 28–40, *c1* 17–23, *c2* 17–25, *c3* 32–42, *d1* 14–21, *d2* 18–24, *d3* 28–40, *e1* 17–23, *e2* 18–29, *e3* 22–32, *f2* 18–26, *f3* 10–17, *h1* 6–12, *h2* 8–17.

Palps. (Fig.) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one blunt eupathidium (6–8) distally, one dorsal seta (8–11); palp femorogenu with one seta (12–15).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 33–68, *1b* 12–13, *3a* 7–9, *ag* 6–7, *ps2* 4–5, *ps3* 3–5.

Legs. (Fig. 145b) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I (Fig. 145b) and II each with one abaxial solenidion (ta I 6–8; ta II 6–7) and two eupathidia distally (ta I 7–8, 7–8; ta II 6–7, 6–7). Companion seta *ft″* on tarsus I 5–7 (Fig. 145b) and tarsus II 4–6, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta tapered. Tenent hairs on claws with two attachment points.

Larva. The larva was imaged using low temperature SEM (Fig. 146), however no specimens were prepared for slide mounting.

Egg. (Fig. 147) Red, ellipsoid, smooth, 115–125 long, 75–80 wide; stipe long 150–165.

Host. *Eucalyptus* sp. (Myrtaceae).

Distribution. AUSTRALIA: southwest Western Australia.

Etymology. ***Raoiella karri* sp. nov.** is named for the street on which it was collected. The name karri is a local indigenous word for a type of *Eucalyptus* tree, *E. diversicolour*, from southwestern Western Australia, the third tallest tree in the world.

Remarks. ***Raoiella karri* sp. nov.** (DNA code RaIn42; Dowling *et al.* 2012; Table 1 and Fig. 1, 2) was listed as *Raoiella* sp. 2 along with a specimen labelled RaIn58, which we consider here to be a separate species, ***R. todtiana* sp. nov.**, and was listed as *Raoiella* sp. 2A in Beard *et al*. (2013). The two populations considered as species 2 in the Dowling *et al.* (2012) study were shown to exhibit 3.2% sequence divergence, which greatly exceeds the intraspecific variation seen in species 1 (0.6–1.0%), but is still a low amount of interspecific divergence in *Raoiella*. Our subsequent morphological analysis has shown that the two populations can be easily distinguished. *Raoiella karri* can be separated from *R. todtiana* in the following manner: *Rk* setae *v2* 63–73, *sc1* 51–61, *sc2* 63–70, *f2* 29–43; setae *d* on femora I–III and genu I with tapered tips vs *Rt* setae *v2* 55–65, *sc1* 32–42, *sc2* 48–60, *f2* 26–32; setae *d* on femora I–III and genu I with broad blunt tips.

***Raoiella macfarlanei* Pritchard & Baker**
(Figs 148–164)

Material examined. Holotype. ♀. **Greece**, ex. Olive (*Olea* sp., Oleaceae), Rasel Hila, Cyrenaica, i.1956, U.N.F.A.O., C.I.E. 14628 (one slide, NHM, 1957.9.2.4-5; holotype on right-hand side of slide, paratype on left). **Paratype.** ♀, same data as Holotype (NHM).

Other material examined. **Greece,** 25 ♀, 3 ♂, 16 deutonymphs, 1 larva, ex. olive, *Olea europaea* (Oleaceae), Elia Prefecture, west Peloponnese, 4.v.2012, G. Papadoulis (USNM, QM).

Diagnosis. Opisthosomal setae *f2* longer than *f3*; setae *h1* and *h2* subequal in length. Dorsal setae with plumose spatulate tips. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with three setae (*d*, *l′*, *l″*); coxae I with one seta present (*1b*); coxae III–IV with one seta (*3b*, *4b* present). Tarsus I with companion setae (*ft″*) finely tapered, obviously longer than solenidia; tarsus II with companion seta (*ft″*) obviously shorter than solenidion. Tibiae I–II with dorsal seta *d* with weakly to obviously spatulate tip, often plumose distally. Eupathidium on palp tibiotarsus forked distally, finely tapered. Larva with setae *h2* short, tapered or blunt.

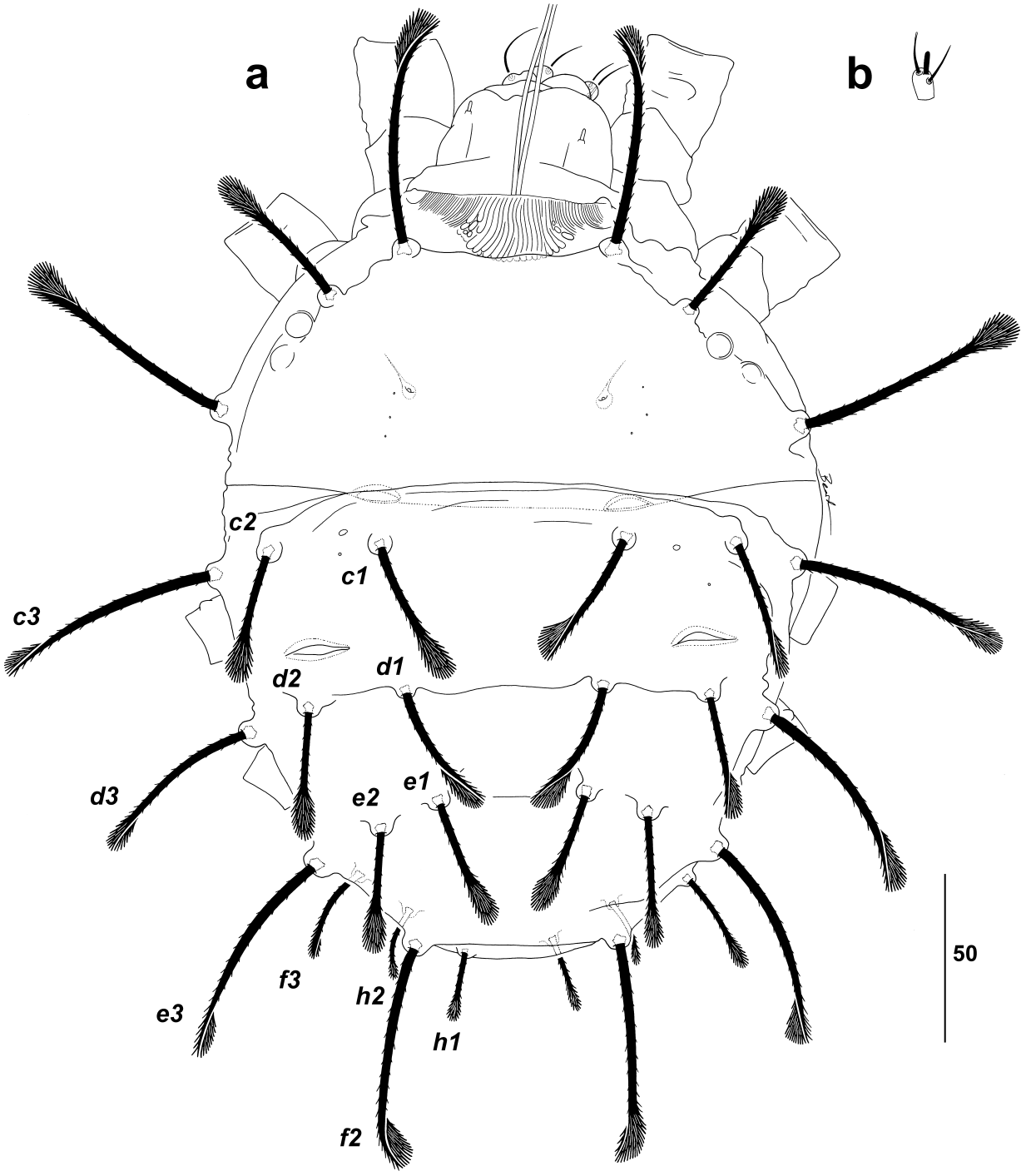


FIGURE 148. *Raoiella macfarlanei* Pritchard & Baker, adult female (holotype): a. dorsal habitus; b. detail of palp.

Description. Female. ***Dorsum.*** (Figs 148a, 149a, 150b) Body measurements (12; [holo + para]): length between setae *v2–h1* 212–235 [215–228], *v2–f2* 207–227; width between setae *sc2–sc2* 177–193 [181–193], *c3–c3* 178–194 [180–194], *f3–f3* 82–104 [63]. Lightly sclerotised prodorsal shield apparent. Prodorsum with pair sclerotised pores and four pairs of minute pores mesally; pair large pores on posterior margin of shield (often concealed in folded soft cuticle of sejugal region). Opisthosoma with two small pores between setae *c1–c2*; pair large slit pores between setae *c2–d2*; and several minute pores near *d3*, *e2* and *e3*. Dorsal setae barbed along entire length, with plumose spatulate tips. Setae *h1* spatulate, *h2* weakly spatulate to blunt. Dorsal setae measurements: *v2* 63–79 [69–73], *sc1* 40–53 [47–48], *sc2* 69–83 [73], *c1* 39–47 [45–47], *c2* 37–45 [43–44], *c3* 68–76 [68–71], *d1*

35–45 [44–45], *d2* 34–42 [41–42], *d3* 58–75 [58–68], *e1* 35–42 [41–42], *e2* 35–43 [39–43], *e3* 66–75 [70–71], *f2* 68–79 [68–70], *f3* 26–37 [31–33], *h1* 22–28 [22–23], *h2* 20–28 [20–22].

Palps. (Figs 148b, 149b,c) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–7) [7] and one finely tapered eupathidium with forked tip (11–14) [13–14] distally, one dorsal seta (10–13) [11]; palp femorogenu with one seta (21–26) [23–24]. Stylets narrow with 10–11 small lateral teeth distally (Fig. 151).

Venter. (Figs 152a, 153, 154) Cuticle almost completely plicate, covered with mostly transverse fine striae, except coxal fields smooth to finely pustulate; transverse striae on ventral infracapitulum and between *1b–1b*; smooth between *1b–1a*; transverse striae *1a–ag*; genital flap smooth *ag–g1*, with band of transverse striae, often broken, along posterior margin of flap; with longitudinal striae flanking the genital region. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 63–102 [83–94], *1b* 20–27 [25], *2b* 10–17 [10–14], *3a* 8–11 [11], *3b* 8–10 [8], *4a* 52–101 [52], *4b* 7–12 [7], *ag* 8–10 [8], *g1* 10–13 [10], *g2* 10–12 [10], *ps2* 8–9 [9], *ps3* 9–10 [10].

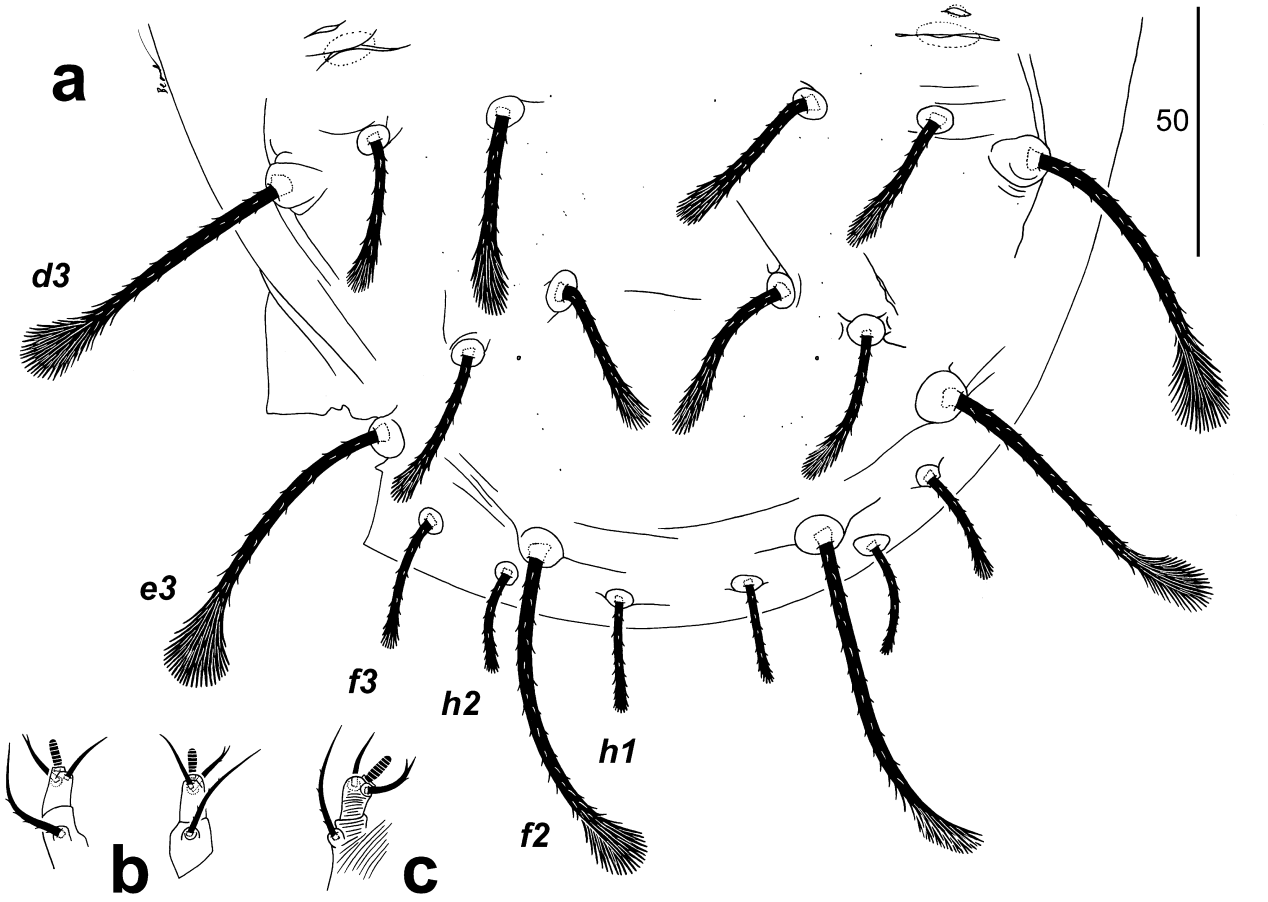


FIGURE 149. *Raoiella macfarlanei* Pritchard & Baker, adult female (non-type): a. posterior dorsum, showing variation in form of setal tips; b. detail of palps in dorsal aspect; c. detail palp in ventral aspect.

Spermatheca. (Fig. 152b) Membranous tube only visible for a short distance from genital opening.

Legs. (Figs 155, 156) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-4-3-4-9(1), 1-1-2-1-3-5, 1-1-2-0-3-5 respectively. Femora I–II with 4 setae (*d*, *l′*, *v′*, *bv″*); genua I–II with 3 setae (*d*, *l′*, *l″*). Seta *l′* on femur I-II sometimes asymmetrically absent. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 14–18 [14–15]; ta II 11–12 [11]) and two eupathidia distally *pζ′–pζ″* (ta I 11–12 [12], 11–12 [11]; ta II 11–12 [11], 11–12 [12]). Companion setae *ft″* inserted adjacent to solenidion *ω″*; *ft″* on ta I finely tapered with minute barbs, much longer than solenidion 29–44 [29–33] (Fig. 156a); on ta II short with a few barbs 6–10 [6], much shorter than solenidion (one female with *ft″* on ta II 12) (Fig. 156b). Dorsal seta on tibiae I and II with weakly to obviously spatulate tip, often plumose. Outer tenent hairs on claws with four attachment points; claw I 12–13, claw IV 11–12.

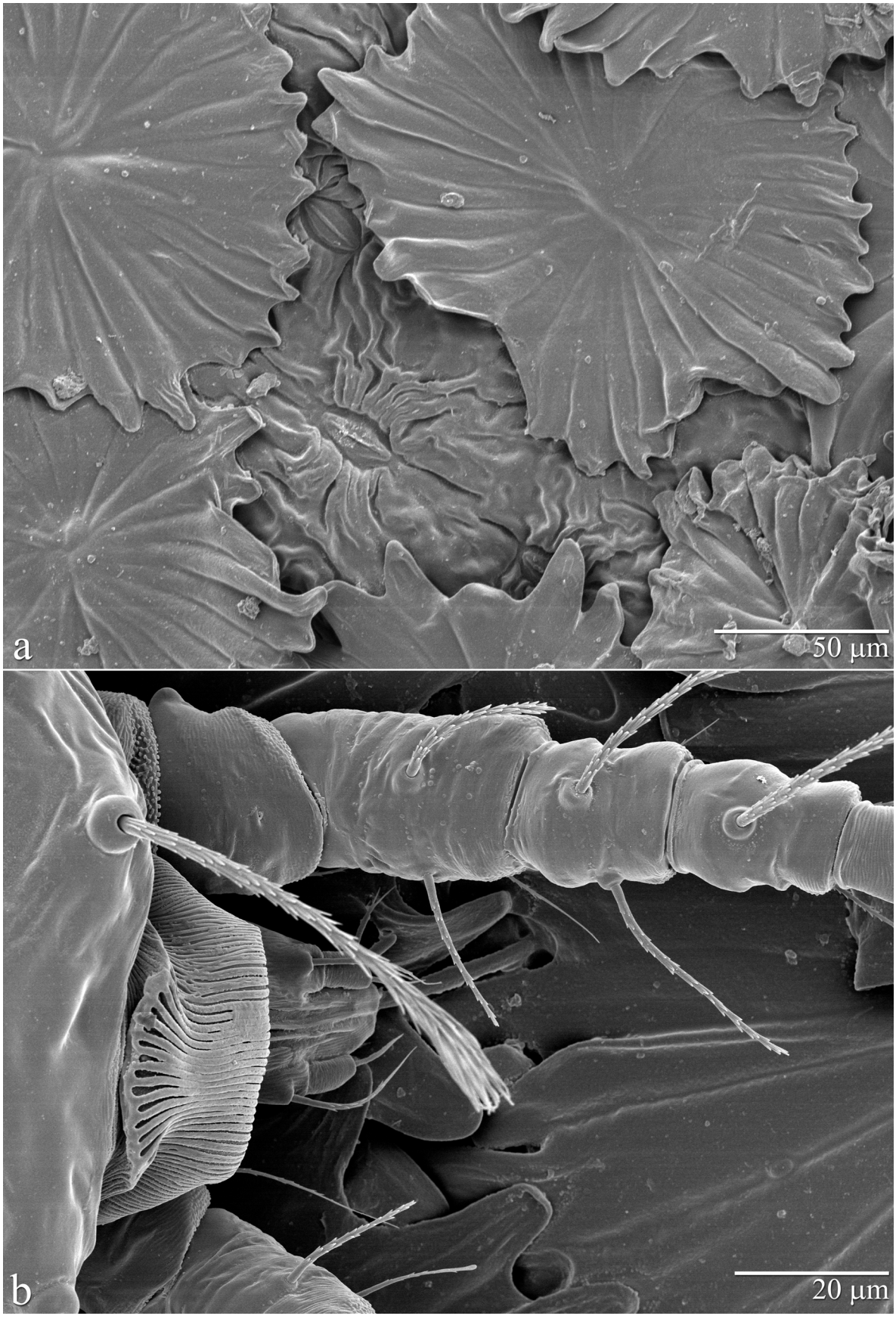


FIGURE 150. *Raoiella macfarlanei* Pritchard & Baker, a. host plant olive leaf surface, with detail of a stomatal opening, and the characteristic peltate trichomes that overlap each other to cover the leaf surface and protect the stomata; b. adult female feeding between the trichomes, possibly through the stomata as other *Raoiella* species are known to do.

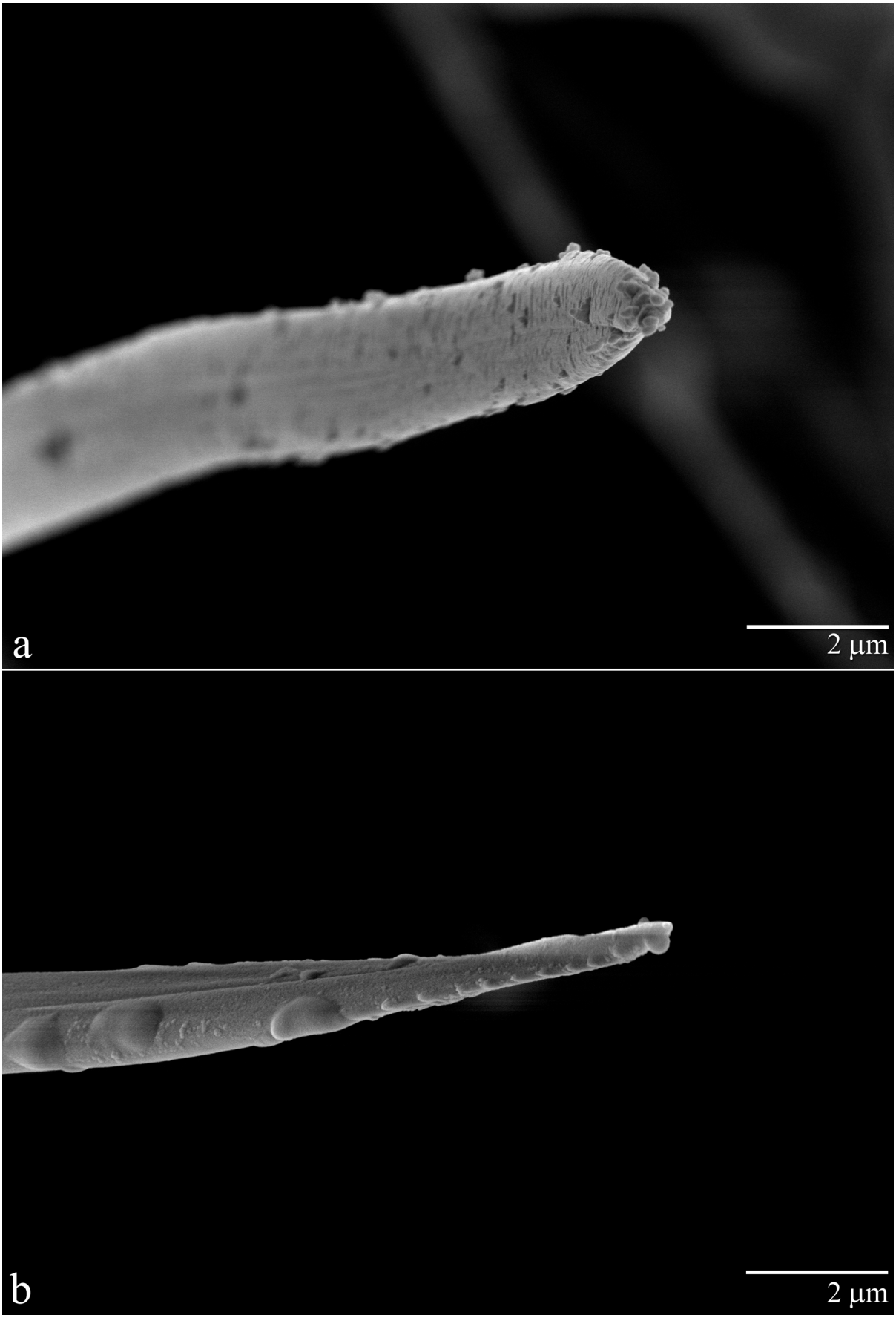


FIGURE 151. *Raoiella macfarlanei* Pritchard & Baker, dorsal and lateral view of joined stylets, detail of stylet tip with lateral serrations.

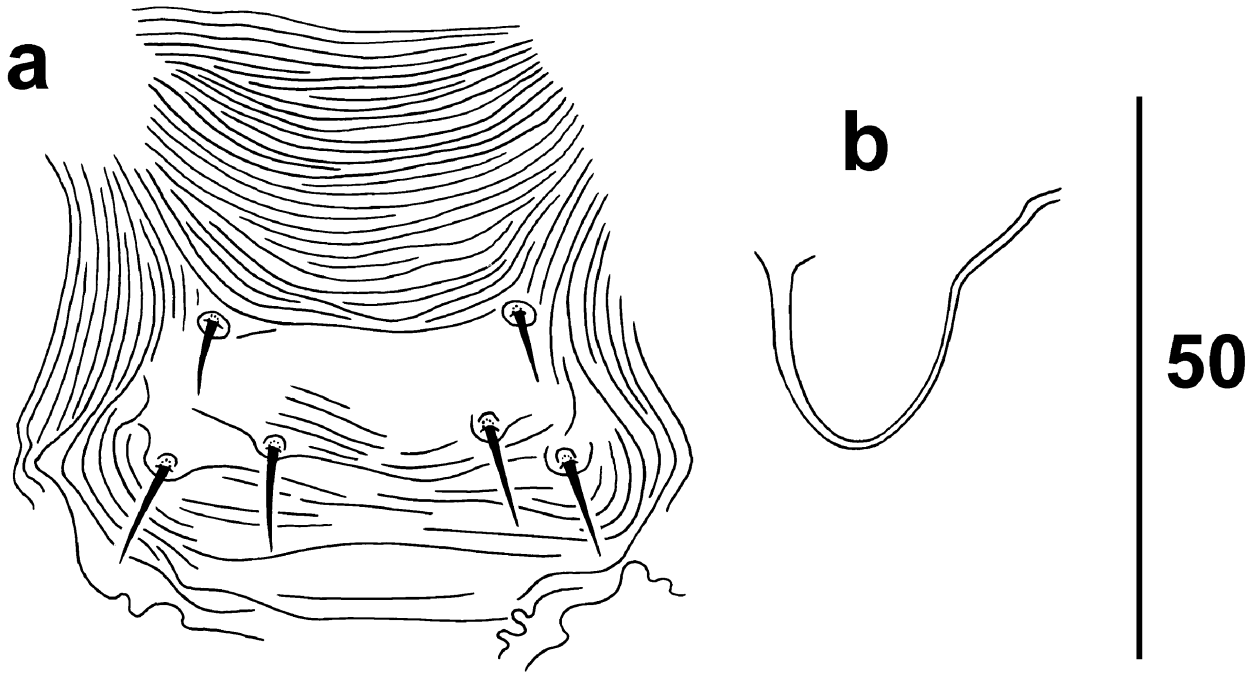


FIGURE 152. *Raoiella macfarlanei* Pritchard & Baker, adult female (holotype): a. genital region; b. detail of spermatheca.

Male. ***Dorsum.*** (Figs 157a, 158) Body measurements (3): length between setae *v2–h1* 151–158, *v2–f2* 142–146, width between setae *sc2–sc2* 117–133, *c3–c3* 118–126, *f3–f3* 53–64. Prodorsum mostly smooth, with some weak folds mesad eyes; pair large weakly developed pores on posterior margin (under fold in sejugal region). Opisthosoma with two regions of smooth cuticle (between setal rows C–D and posterior to setal row E) separated by band of transverse striae between *d1* and *e1*. Central and sublateral opisthosomal setae subequal in length (*c1*, *c2*, *d1*, *d2*, *e1*, *e2*); lateral opisthosomal setae (*c3*, *d3*, *e3*, *f3*) much longer, strongly spatulate (spatulae not plumose); setae *f2* strongly spatulate, obviously longer than *f3*, weakly spatulate; setae *h1* and *h2* weakly spatulate to blunt. Dorsal setae measurements: *v2* 46–51, *sc1* 32–33, *sc2* 58–67, *c1* 28–32, *c2* 32–35, *c3* 61–67, *d1* 27–31, *d2* 29–32, *d3* 60–66, *e1* 24–29, *e2* 28–31, *e3* 58–68, *f2* 37–43, *f3* 20–27, *h1* 16–20, *h2* 19–22.

Palps. (Fig. 157b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–5) and one finely tapered eupathidium with forked tip (10–11) distally, and one seta dorsally (9–11); palp femorogenu with one seta (18–19).

Venter. (Fig. 159a) Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and a large distinct patch of smooth cuticle on either side of setae *ag*. Setae *1a*, *4a* elongate, finely tapered (difficult to determine full length); setae *ag*, *g1*, *g2* smooth; setae *ps3* modified as accessory genital stylets into short, thickened, tapered spines (Figs 158b, 159a). Setal measurements: *1a* 54–57, *1b* 18–19, *2b* 10–11, *3a* 7–10, *3b* 7–10, *4a* 53–67, *4b* 7–10, *ag* 7–11, *g1* 11–12, *g2* 10–11, *ps2* 8–10, *ps3* 9–10.

Aedeagus. (Fig. 159b) Aedeagus narrow, elongate and sclerotised (60–61), tapering to a blunt point distally.

Legs. (Fig. 160) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-4-3-4-10(2), 1-1-2-1-3-5, 1-1-2-0-3-5 respectively. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with three setae (*d*, *l′*, *l″*). Tarsi I and II each with two solenidia (ta I *ω′* adaxial 10–12, *ω″* abaxial 16; ta II adaxial 7–9, abaxial 10–11), and two eupathidia *pζ″*–*pζ″* distally (ta I 10–11, 9–10; ta II 9–10, 9–10). Companion seta *ft″* on tarsus I finely tapered with minute barbs 24–28 and short with few minute barbs on tarsus II 7–9, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta, *d*, with thick barbed tip, not tapered or spatulate. Outer tenent hairs on claws with four attachment points; claw I 10, claw IV 9–10.

Deutonymph. ***Dorsum.*** Body measurements (6 female, 3 male): length between setae *v2–h1* female 175–186 (male 146–154), *v2–f2* 170–184 (136–145), width between setae *sc2–sc2* 153–164 (121–131), *c3–c3* 152–169 (126–134), *f3–f3* 59–70 (48–61). Prodorsal cuticle mostly smooth, with some weak oblique folds mesad setae *sc1* and eyes. Dorsal opisthosoma with widely spaced transverse striations between *c1–d1*, sometime to *e1*. Pore in

sejugal fold is weakly developed. Dorsal setae with spatulate tips (spatulae not plumose), barbed along entire length; *v2* spatulate on both male and female deutonymphs; setae *f3, h1*, *h2* subequal in length, weakly spatulate to blunt, usually inserted ventrally or ventrolaterally. Dorsal setae measurements: *v2* 61–69 (46–54), *sc1* 42–45 (32–35), *sc2* 64–69 (55–60), *c1* 34–39 (27–31), *c2* 40–44 (30–36), *c3* 58–70 (45–53), *d1* 36–39 (27–29), *d2* 41–44 (31–36), *d3* 56–62 (44–52), *e1* 33–38 (24–28), *e2* 41–49 (30–40), *e3* 49–61 (39–50), *f2* 51–60 (39–46), *f3* 15–19 (13–17), *h1* 13–16 (12–16), *h2* 14–16 (13–14).

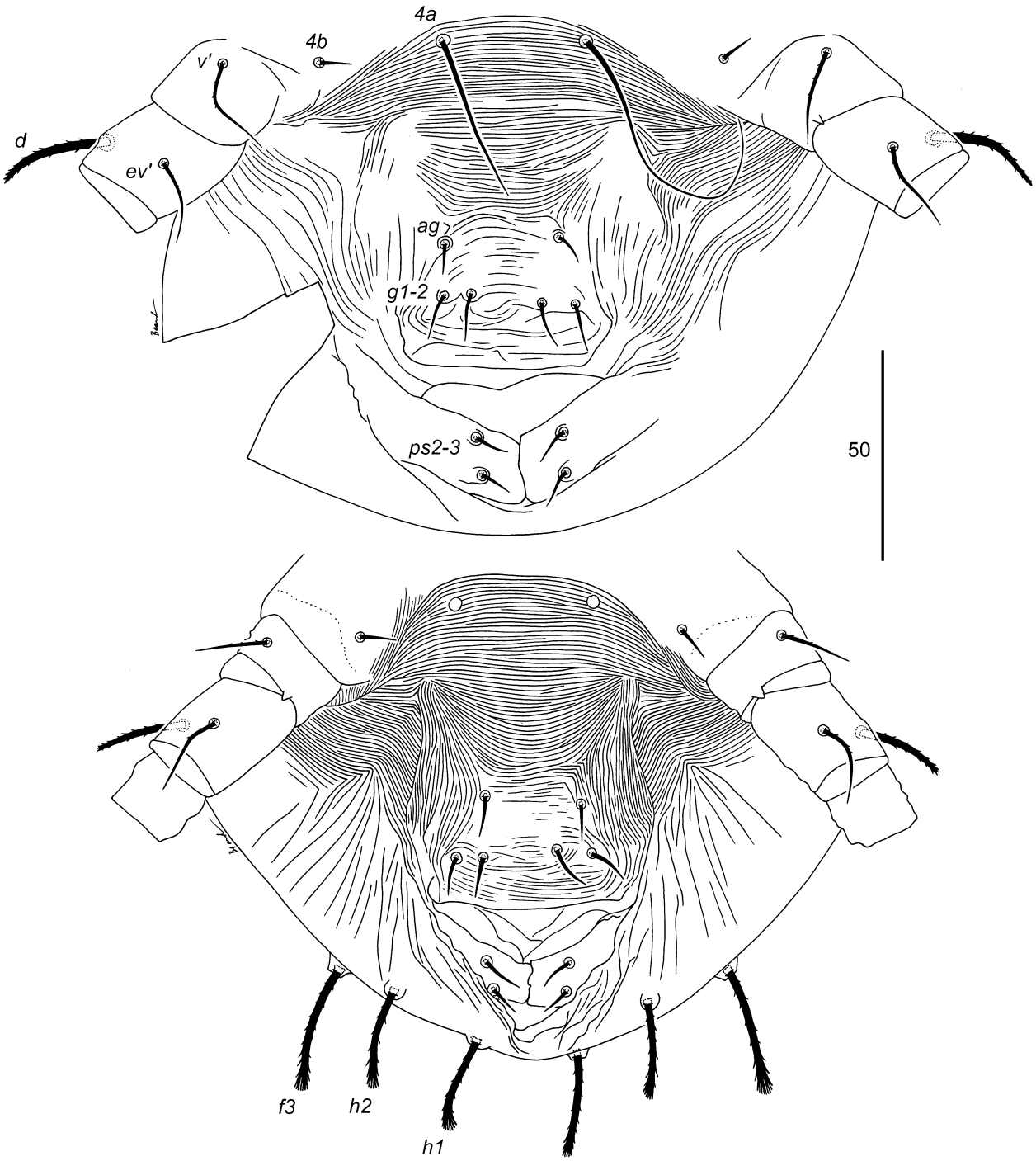


FIGURE 153. *Raoiella macfarlanei* Pritchard & Baker, adult female (non-type): posterior venter (two different individuals).

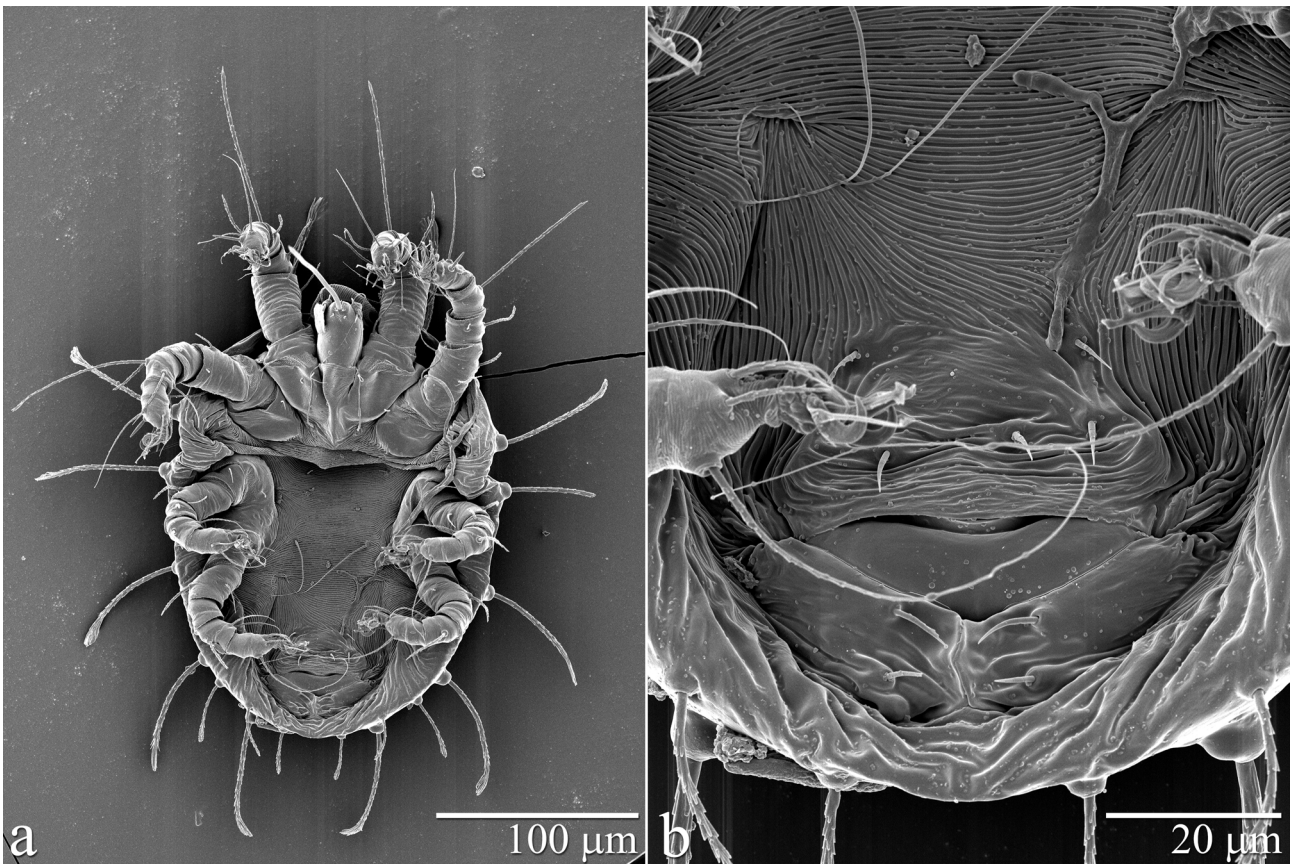


FIGURE 154. *Raoiella macfarlanei* Pritchard & Baker, adult female: a. ventral habitus; b. detail of posterior venter.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion 4–5 (3–4) and one finely tapered eupathidium with forked tip 10–11 (9) distally, one dorsal seta 9–10 (8–9); palp femorogenu with one seta 19–20 (15).

Venter. (Fig. 161a) Cuticle almost completely plicate, covered with mostly transverse striae. Female venter: transverse striae ventral infracapitulum and between *1b–1b*; longitudinal striae between *1b–1a*, transverse striae *1a–g1*; oblique striae between *ag–ps3* with transverse folds laterad *ps* setae; with oblique folds surrounding the genital region (see also Figs 20a, 128a, 234a). Female posterior opisthosoma broadly rounded (Fig. 161a); posterior margin of genital flap beginning to form posterior to setae *g1*. Male posterior opisthosoma tapered; with mixed striae between setae *ag–ag*; *ps3* slightly thicker than *ps2* (see also Figs 20b, 128b, 234b). Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 51–79 (37–44), *1b* 15–18 (12–13), *3a* 6–9 (5–6), *3b* 6–8 (5–6), *4a* 32–59 (23–39), *4b* 6–8 (5–6), *ag* 7–8 (6–7), *g1* 7–9 (7), *ps2* 6–7 (4–6), *ps3* 7–8 (6–7).

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-1-3-2-4-9(1), 0-0/1-3-2-4-9(1), 1-1-2-1-3-5, 0/1-0-2-0-3-5 respectively. Coxal setae *2b* absent on female deutonymphs, and asymmetrically present on 2/3 male deutonymphs examined; coxal setae *4b* was absent on one female deutonymph. Tarsi I and II each with one abaxial solenidion (both sexes: ta I 9–10; ta II 6–8) and two eupathidia distally (ta I 8–10, 8–10; ta II 8, 7–8). Short smooth companion seta *ft″* on tarsus I 19–28 (20–21) and tarsus II 5–7 (both sexes), adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta, *d*, weakly spatulate. Femora I–II with three setae (*d*, *v′*, *bv″* present; seta *l′* absent (*l′* normally added in deutonymph)); genua I–II with two setae (*d*, *l′* present; *d* assumed to be added in deutonymph). Outer tenent hairs on claws with four attachment points; claw I 10 (9); claw IV 9 (8).

Protonymph. Unknown.

Larva. *Dorsum.* (Figs 162, 164c) Body measurements (1): length between setae *v2–f2* 118, width between setae *sc2–sc2* 107, *c3–c3* 107, *f3–f3* 31. Prodorsum smooth. Opisthosoma with transverse striae between setae *c1–d1*; central and sublateral setae (*c1*, *c2*, *d1*, *d2*, *e1*, *e2*) longer than lateral setae (*c3*, *d3*, *e3*); *f2* short, spatulate; posterior lateral setae (*f2*, *h1*, *h2*) short, tapered and blunt to weakly spatulate; setae *e3*, *f2*, *f3*, *h1*, *h2* often inserted posteroventrally. Dorsal setae measurements: *v2* 40–42, *sc1* 40–44, *sc2* 42–43, *c1* 29–30, *c2* 33, *c3* 19–20, *d1* 34–36, *d2* 27–29, *d3* 14, *e1* 30, *e2* 28, *e3* 12–13, *f2* 17–18, *f3* 9, *h1* 7–9, *h2* 6.

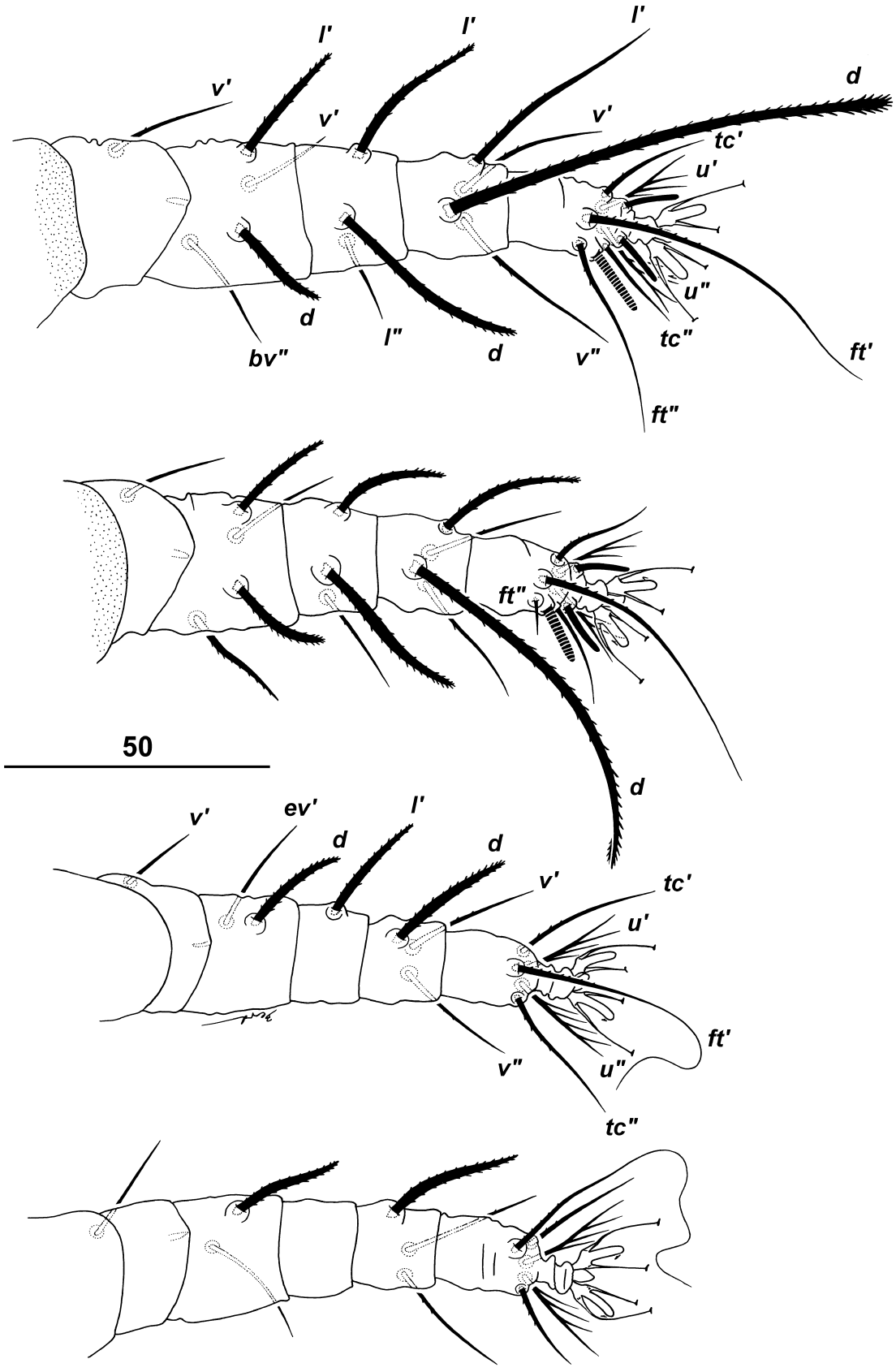


FIGURE 155. *Raoiella macfarlanei* Pritchard & Baker, adult female (holotype): legs I–IV (right side; legs I–II dorsal aspect, legs III–IV dorsal to abaxial aspect).

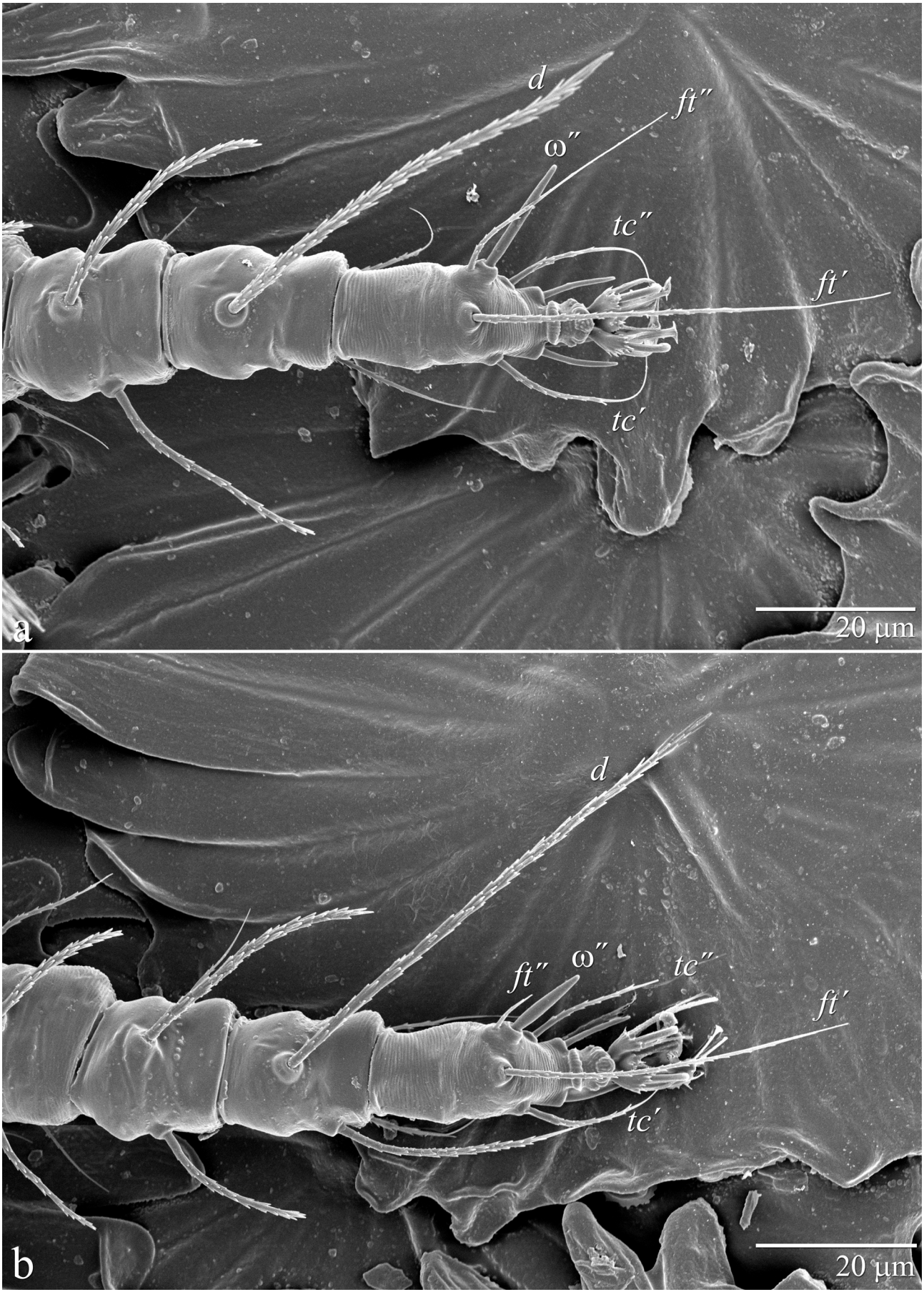


FIGURE 156. *Raoiella macfarlanei* Pritchard & Baker, adult female, genu-tibia-tarsus: a. leg I; b. leg II.

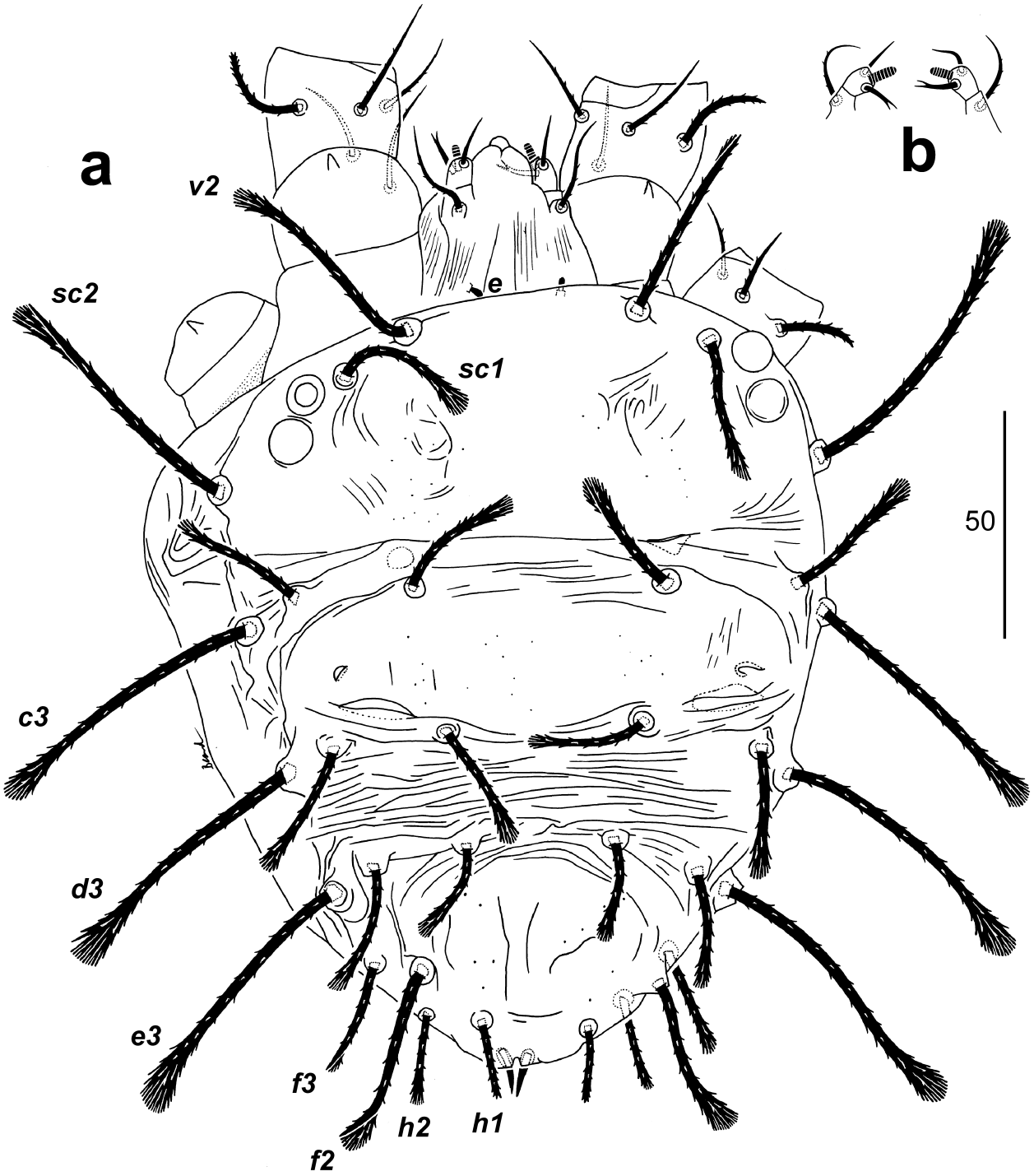


FIGURE 157. *Raoiella macfarlanei* Pritchard & Baker, adult male: a. dorsal habitus; b. detail of palps (dorsal aspect).

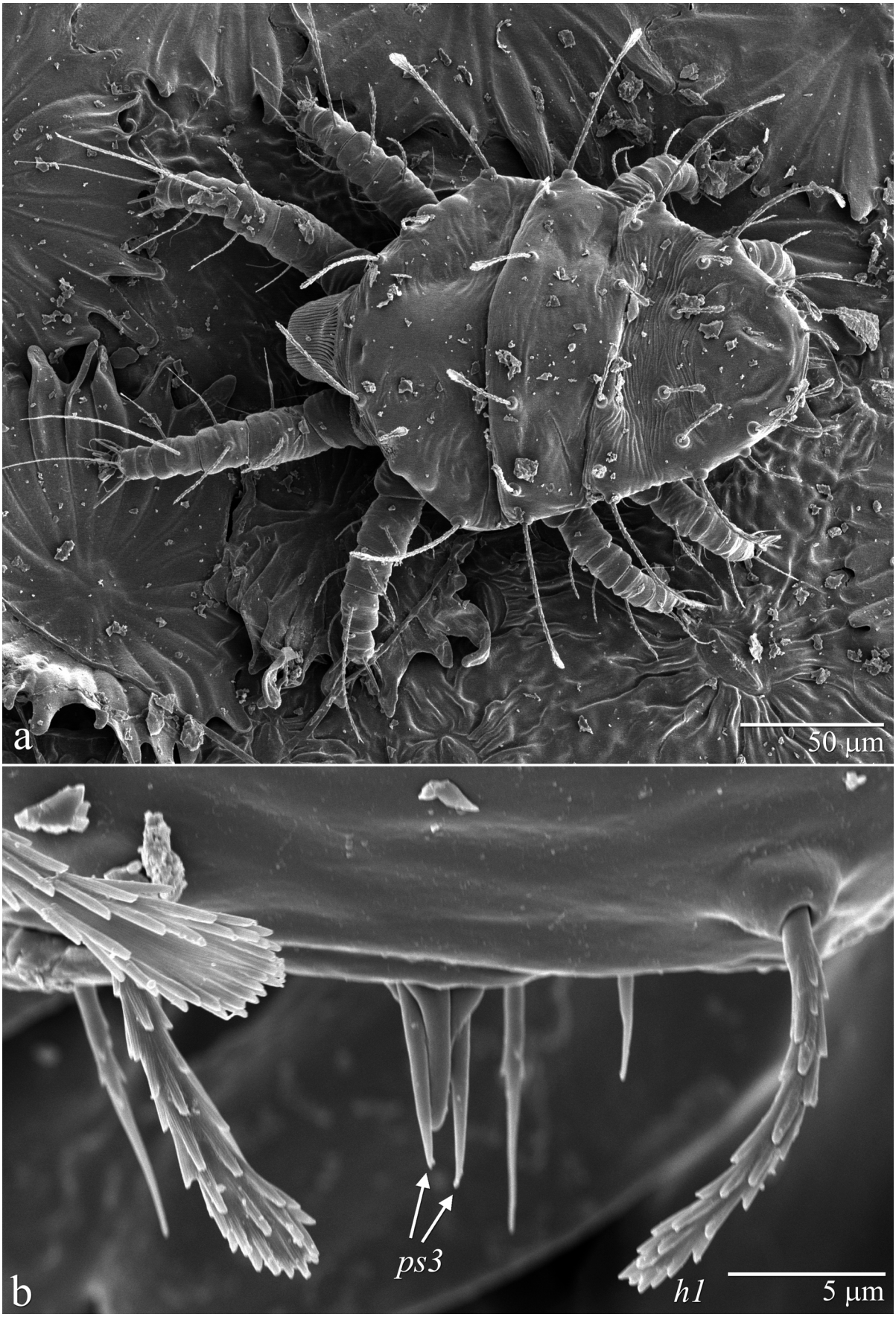


FIGURE 158. *Raoiella macfarlanei* Pritchard & Baker, adult male: a. dorsal habitus on host plant; b. detail of posterior dorsum, indicating setae *ps3*.

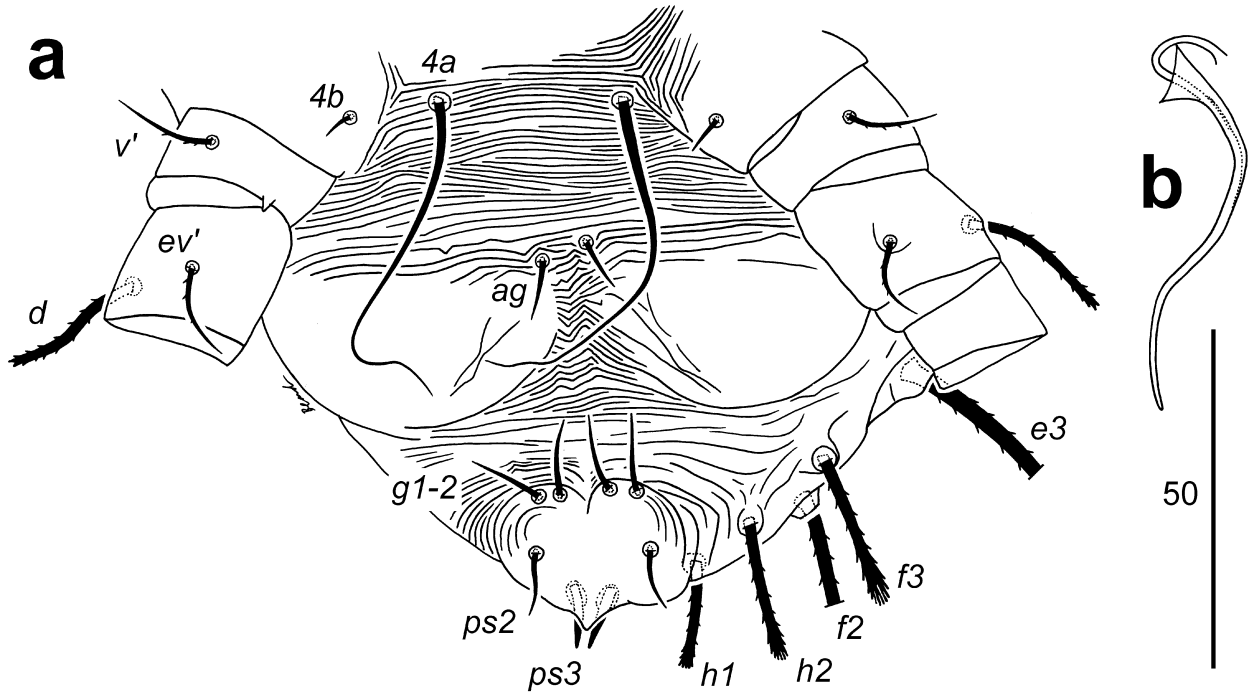


FIGURE 159. *Raoiella macfarlanei* Pritchard & Baker, adult male: a. posterior venter with detail of setae *ps3*; b. detail of aedeagus.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4) and one eupathidium with tapered forked tip (10) distally, and one seta dorsally (6); palp femorogenu with one seta (11).

Venter. (Fig. 161b) Cuticle almost completely strongly plicate, except coxal fields smooth; striae transverse *1b–1b*; striae longitudinal *1b–1a*; striae transverse *1a–3a*; with a band of longitudinal, narrow band of transverse striae forming a small central diamond or triangle, and band of longitudinal striae to *ps* setae. Setal measurements: *1a* 31, *1b* 7–8, *3a* 5–6, *ps2* 2–3, *ps3* 2–3.

Legs. Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Genua I–II with one seta (*l'*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 4; ta II 4) and two eupathidia *pζ′–pζ″* distally (ta I 6, 7; ta II 7, 6). Companion seta *ft″* on tarsus I 12 and tarsus II 5, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta, *d*, finely tapered, and tibia I *d* much longer than tibia II. Claw I 7; outer tenent hairs with three attachment points.

Egg. (Figs 163–164) Ellipsoid to globose, smooth, 85–100 long, 75–85 wide, with a long fine stipe 110–120 with distal portion usually curled back on itself forming a distal loop (Figs 163–164); with pair of minute recurved spines (Figs 164a,b; see arrows).

Host. Olive, *Olea* sp. and *O. europaea* (Oleaceae). Other hosts in literature include *Ceratonia siliqua* (Fabaceae), *Olea europaea* var *europaea* and *Olea europaea* var. *sylvestris*.

Distribution. GREECE: Rasel Hila; Peloponnese.

Remarks. The *Raoiella macfarlanei* species group is unusual within the genus in having ventral coxal setae *3b* and *4b* present, and a forked eupathidium on the palp. Some setae are mistakenly omitted in the original illustration by Pritchard & Baker (1958:258; Fig. 48), we interpret these setae to be seta *e1* on the left side and seta *h2* on the right side.

Raoiella macfarlanei is morphologically similar to *R. eugeniae*, but can be separated by several character states, including the following: **female:** *Rm* setae *e3* (66–75) and *f2* (68–79) subequal in length vs *Re* setae *e3* (91–97) much longer than *f2* (40–56); *Rm* setae *f2* (68–79) much longer than *Re* setae *f2* (40–56); *Rm* setae *d* on femora I–II are longer than setae *d* on genua I–II vs *Re* setae *d* on femora I–II are subequal in length to setae *d* on genua I–II; **male:** *Rm* setae *f2* (37–43) longer than *f3* (20–27) vs *Re* setae *f2* (24–31) subequal to *f3* (23–25).

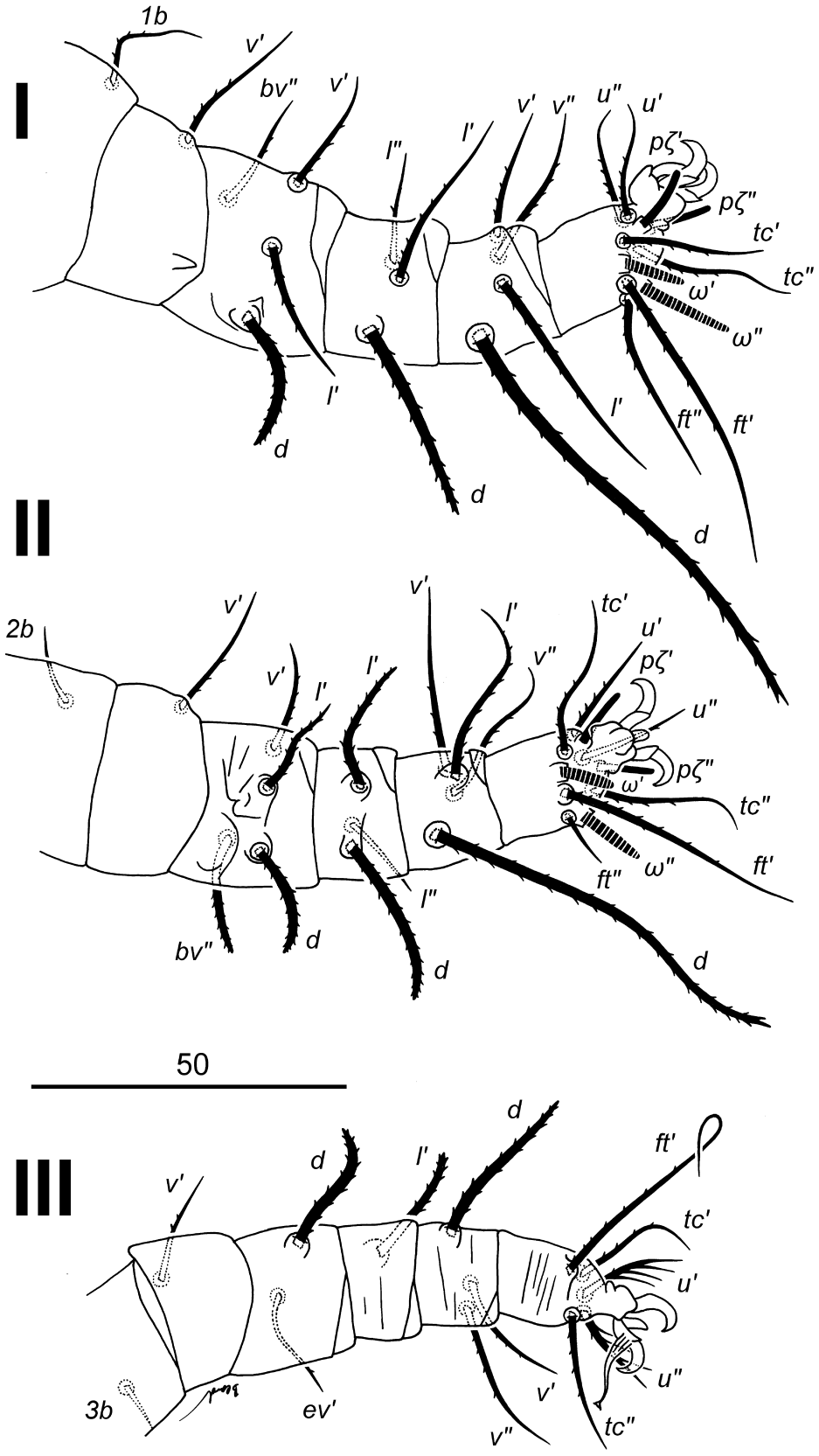


FIGURE 160. *Raoiella macfarlanei* Pritchard & Baker, adult male: legs I–III (right side; leg I adaxial aspect, leg II dorsal aspect, leg III abaxial aspect).

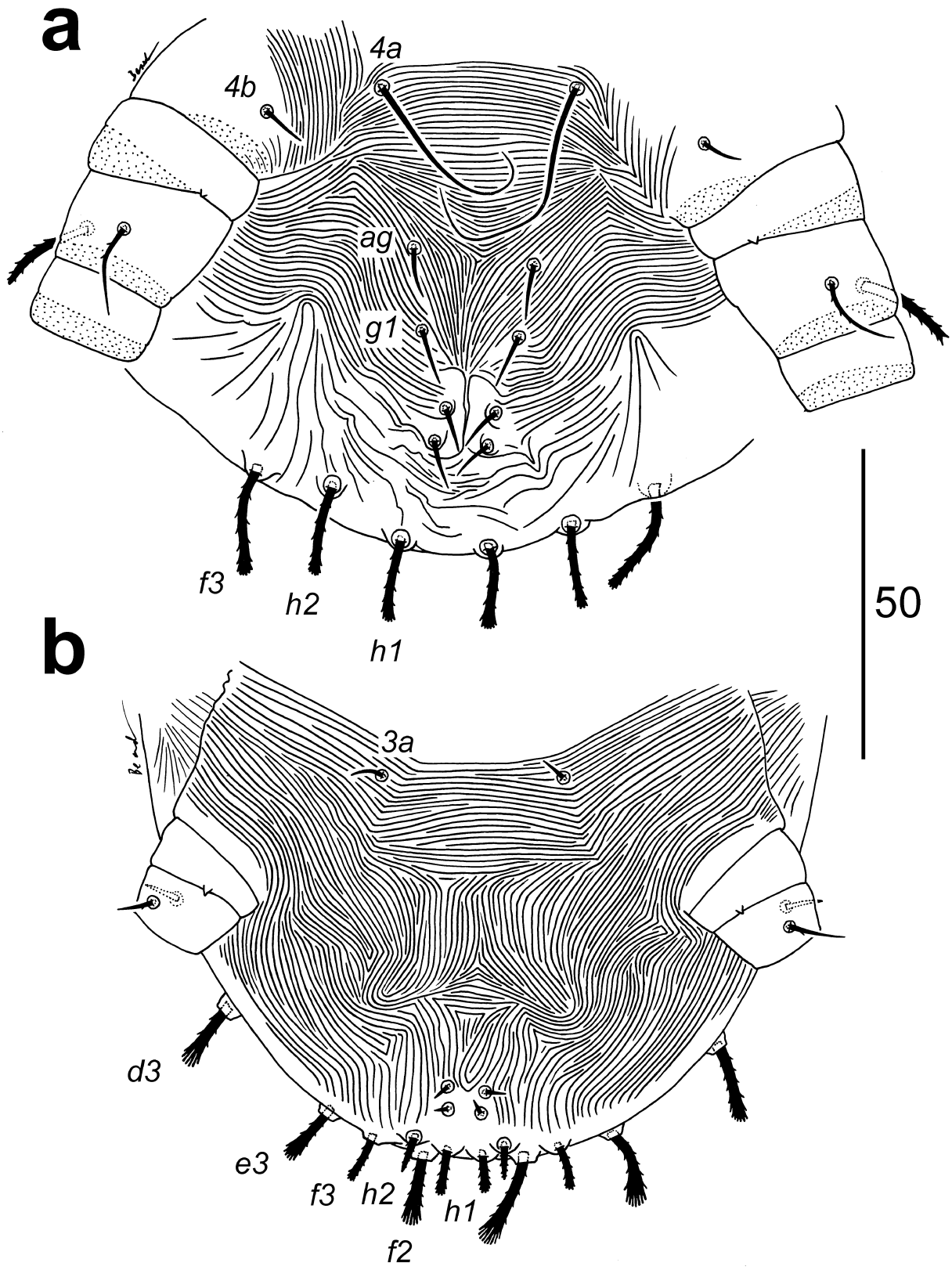


FIGURE 161. *Raoiella macfarlanei* Pritchard & Baker, posterior venter: a. female deutonymph; b. larva.

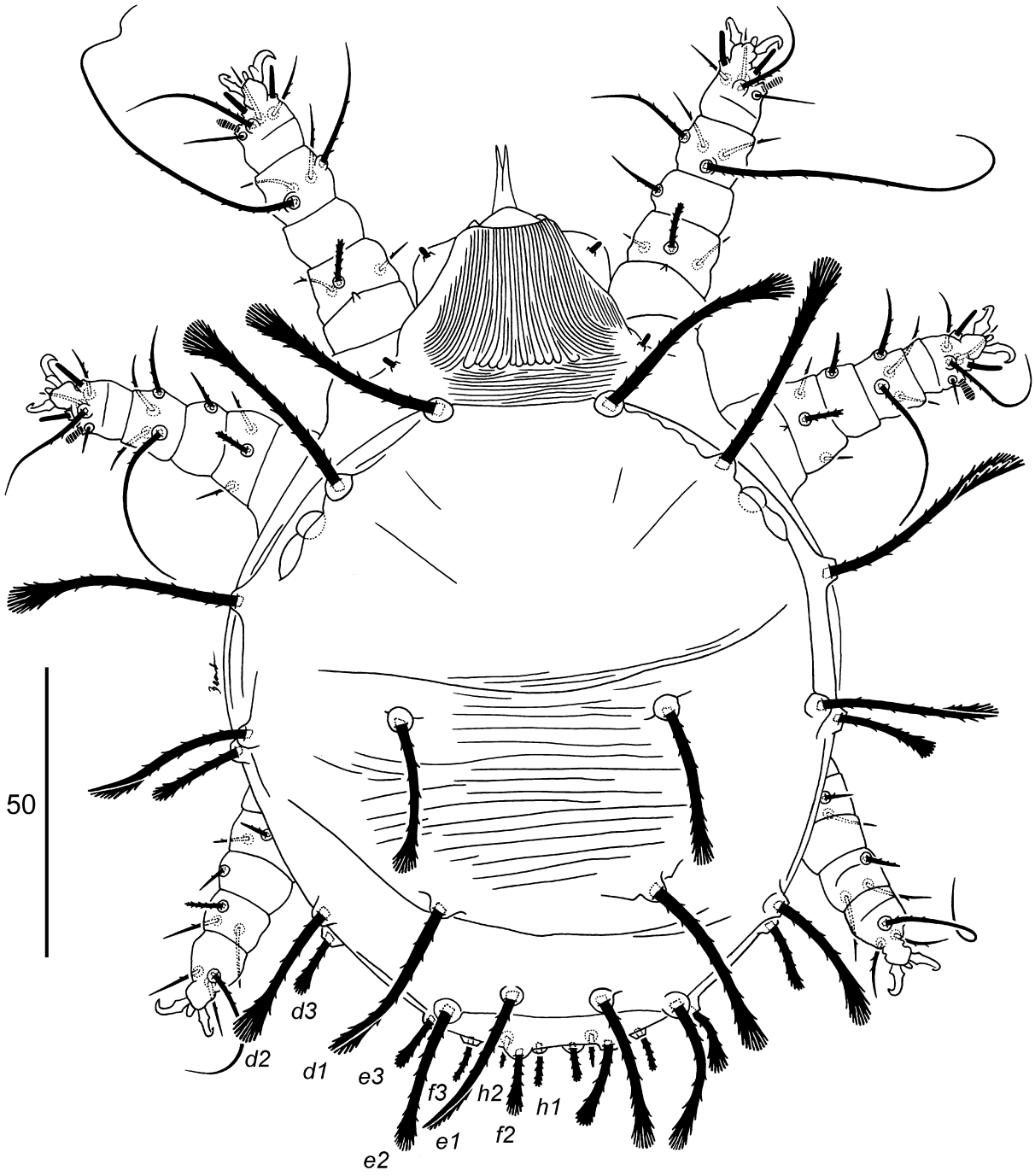


FIGURE 162. *Raoiella macfarlanei* Pritchard & Baker, larva: dorsal habitus, with details of legs.

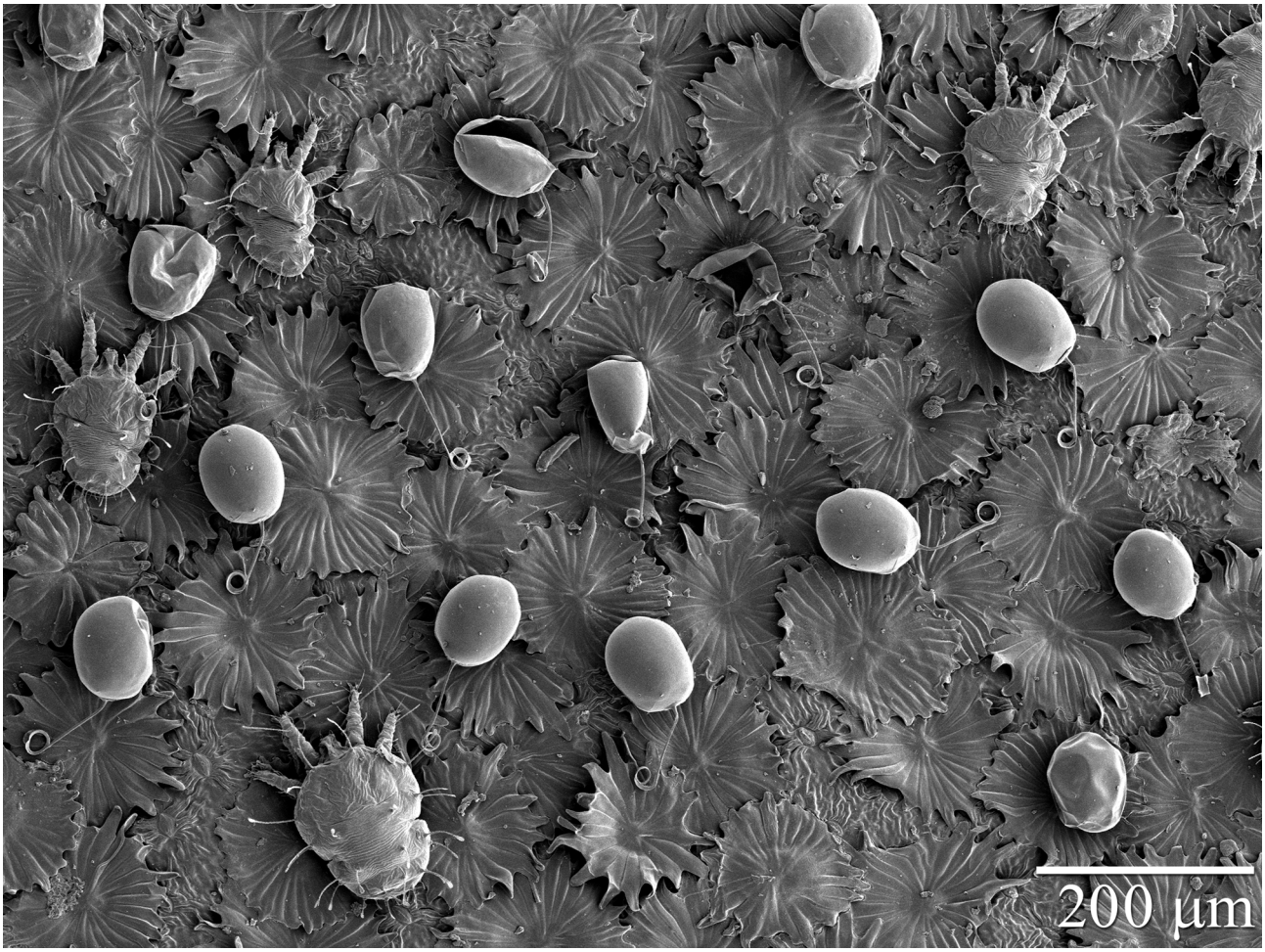


FIGURE 163. *Raoiella macfarlanei* Pritchard & Baker, eggs and caste skins on host plant.

Using SEM, we imaged *R. macfarlanei* feeding with their gnathosomas positioned between the characteristic peltate trichomes of the host leaf surface (Fig. 150b), which is also where the stomata are located on the leaf surface (Fig. 150a). Based on our previous observations on feeding in this mite genus (Ochoa *et al.* 2011; Beard *et al.* 2012), we assume that these mites are also using the stomatal openings as access points for feeding.

We feel that the record of *R. macfarlanei* feeding on the carob tree *Ceratonia siliqua* (Fabaceae) by Hatzinikolus (1987:57) should be re-assessed. Gupta (1985) recorded *R. macfarlanei* attacking mango in India, but this record is not confirmed.

Raoiella marri **sp. nov. Beard & Ochoa**
(Figs 165–183)

Material examined. Holotype. ♀**. Australia**, ex. marri, *Corymbia calophylla* (Lindl.) K.D. Hill & L.A.S. Johnson (Myrtaceae) (host plant voucher with BRI—AQ814931), Wellington National Park, between Bunbury and Collie, along road to Wellington Dam, inside park on a ridge, Western Australia, 33°20’25”S 115°57’21”E, 20.iv.2009, J.J. Beard (WAM).

Paratypes. 5 ♀, 2 ♂, 1 deutonymph, 1 protonymph, 3 larvae, same data as Holotype (WAM, QM, ANIC); 9 ♀, 2 ♂, 5 deutonymphs, 3 protonymphs, 2 larvae, ex. marri, *C. callophylla*, Wellington National Park, Bunbury-Collie Road, Western Australia, 33°19’27”S 115°59’26”E, 20.iv.2009, J.J. Beard (WAM, QM, ANIC, USNM).

Other material examined. **Australia,** 4 ♀, 6 deutonymphs, 2 larvae, ex. jarrah, *Eucalyptus marginata* Sm. (Myrtaceae) growing as undergrowth in a marri forest, *Corymbia callopylla*, John Forrest National Park, on rocky slope with granite boulders, 28 km E Perth, 31°53’30”S 116°05’18”E, Western Australia, 21.iv.2009, J.J. Beard (QM, USNM).

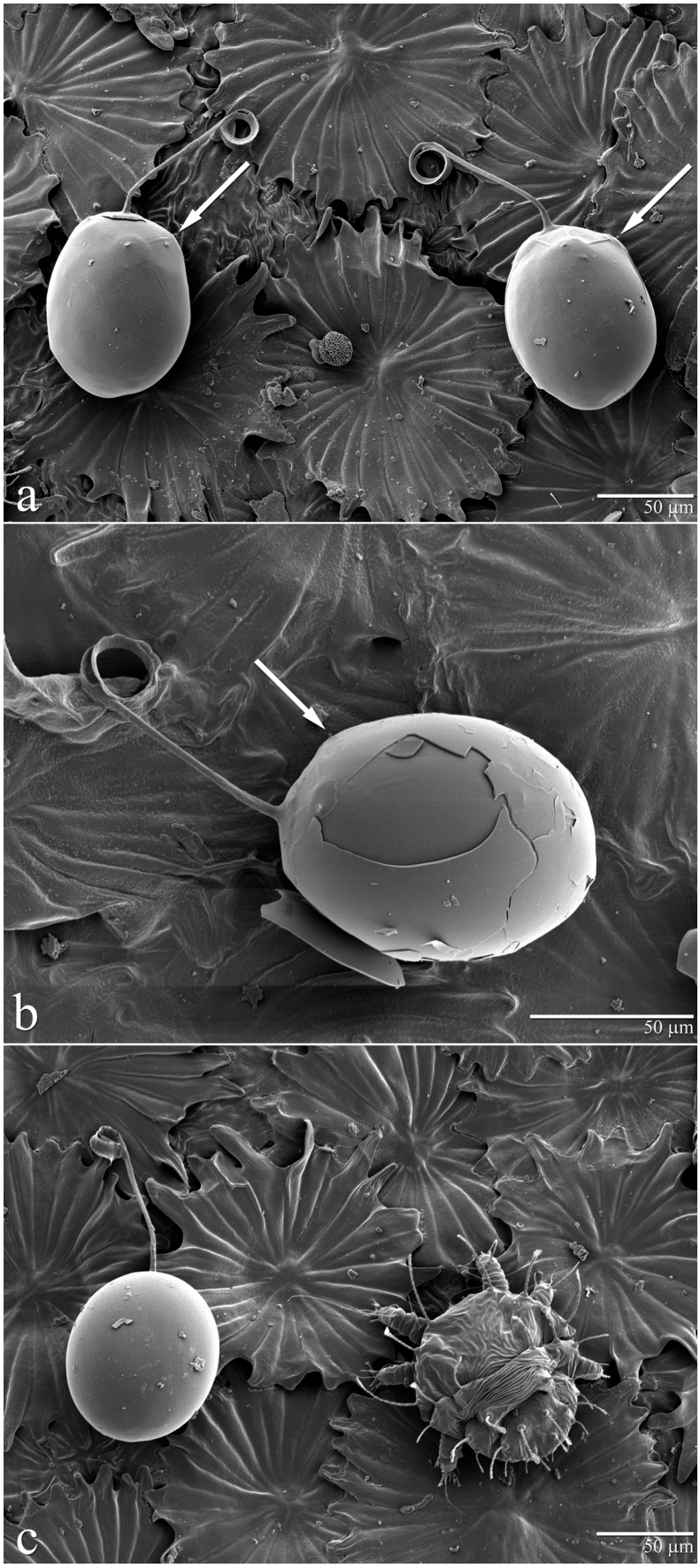


FIGURE 164. *Raoiella macfarlanei* Pritchard & Baker, egg on host plant: a., b. eggs (note pair of minute spines indicated by arrows); c. egg with larva.

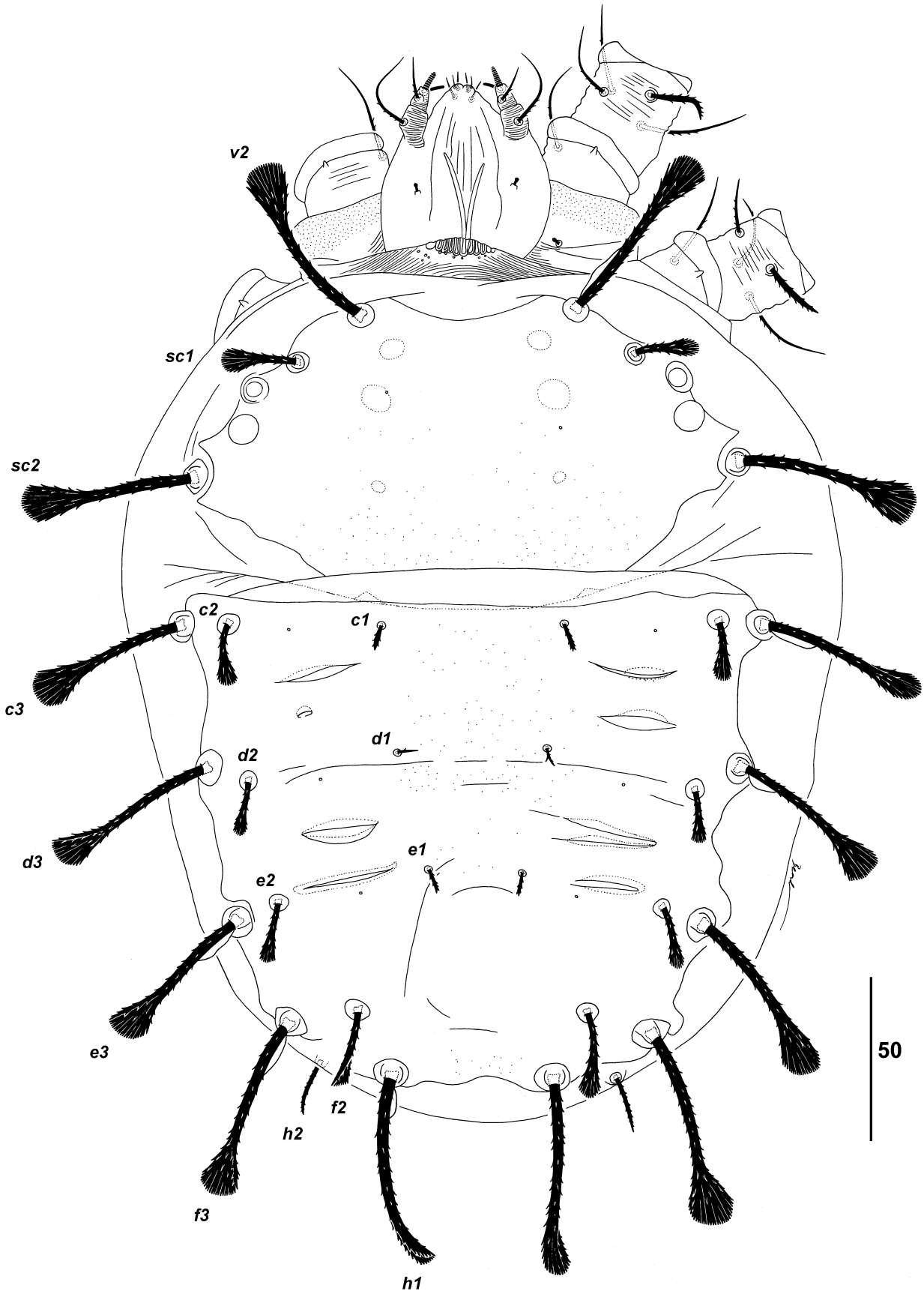


FIGURE 165. *Raoiella marri* Beard & Ochoa, adult female: dorsal habitus with details of palps.

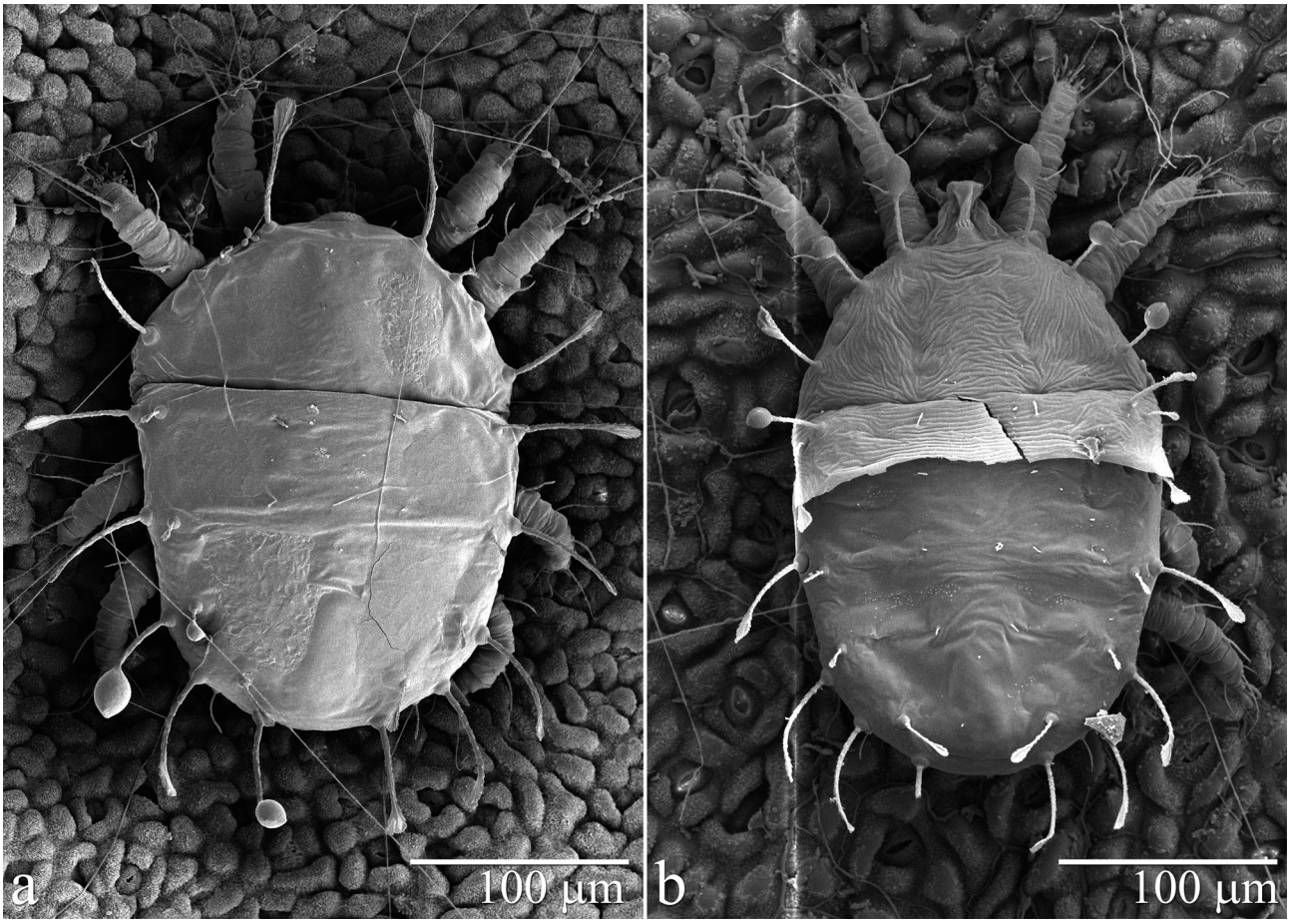


FIGURE 166. *Raoiella marri* Beard & Ochoa, adult female: a. dorsal habitus on host plant; b. moulting deutonymph, exposing female dorsum.

Diagnosis. Opisthosomal setae *c1*, *d1*, *e1* minute; setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* short, tapered, not spatulate. Adult femora I–II with four setae (*d*, *l'*, *bv''*, *v'*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Adult female genua I–II with two setae (*l'*, *l''* present; *d* absent); adult male genua I–II with three setae (*d*, *l'*, *l''*). Tarsus I–II with companion setae (*ft''*) subequal in length with solenidia. Dorsal setae on tibiae I–II finely tapered. Eupathidium on palp tibiotarsus blunt. Larva with setae *h2* elongate, filiform. Egg without a stipe.

Description. Female. ***Dorsum.*** (Figs 165–166) Body measurements (8): length between setae *v2–h1* 233–260 [233], width between setae *sc2–sc2* 171–183 [171], *c3–c3* 177–194 [190], *f3–f3* 95–117 [107]. Lightly sclerotised prodorsal and opisthonotal shields obviously developed. Prodorsum smooth with some fine punctations posteriorly, with pair large pores on posterior margin (under fold in sejugal region), one pair of minute pores mesally; *sc1* much shorter than *v2* and *sc2*. Opisthosoma smooth with fine punctations anteromesally between *c1–c1* and *e1–e1*; with four pairs of large transversely elongate slit pores and three pairs of minute pores sublaterally, aligned longitudinally between setae *c1–c2* and *e1–e2*. Lateral opisthosomal setae (*c3*, *d3*, *e3*, *f3*, *h1*) thick, strongly spatulate, barbed along entire length; sublateral setae (*c2*, *d2*, *e2*, *f2*) much shorter than lateral setae, weakly spatulate; central setae (*c1*, *d1*, *e1*) short, not spatulate, blunt to tapered. Setae *h2* short, not spatulate, tapered. Dorsal setae measurements: *v2* 53–71 [62], *sc1* 20–31 [22], *sc2* 53–63 [61], *c1* 8–12 [9], *c2* 19–25 [21], *c3* 50–61 [56], *d1* 6–8 [7], *d2* 17–21 [19], *d3* 49–60 [55], *e1* 7–9 [7], *e2* 18–22 [22], *e3* 55–62 [60], *f2* 25–34 [29], *f3* 56–67 [65], *h1* 57–72 [63], *h2* 16–21 [17].

Palps. (Fig. 165) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one distal solenidion (6–7) [6–7] and one distal blunt eupathidia (7–10) [7], and one seta dorsally; palp femorogenu with one seta (22–27) [24]. Stylets broad with 8–11 small rounded lateral teeth distally (Fig. 167).

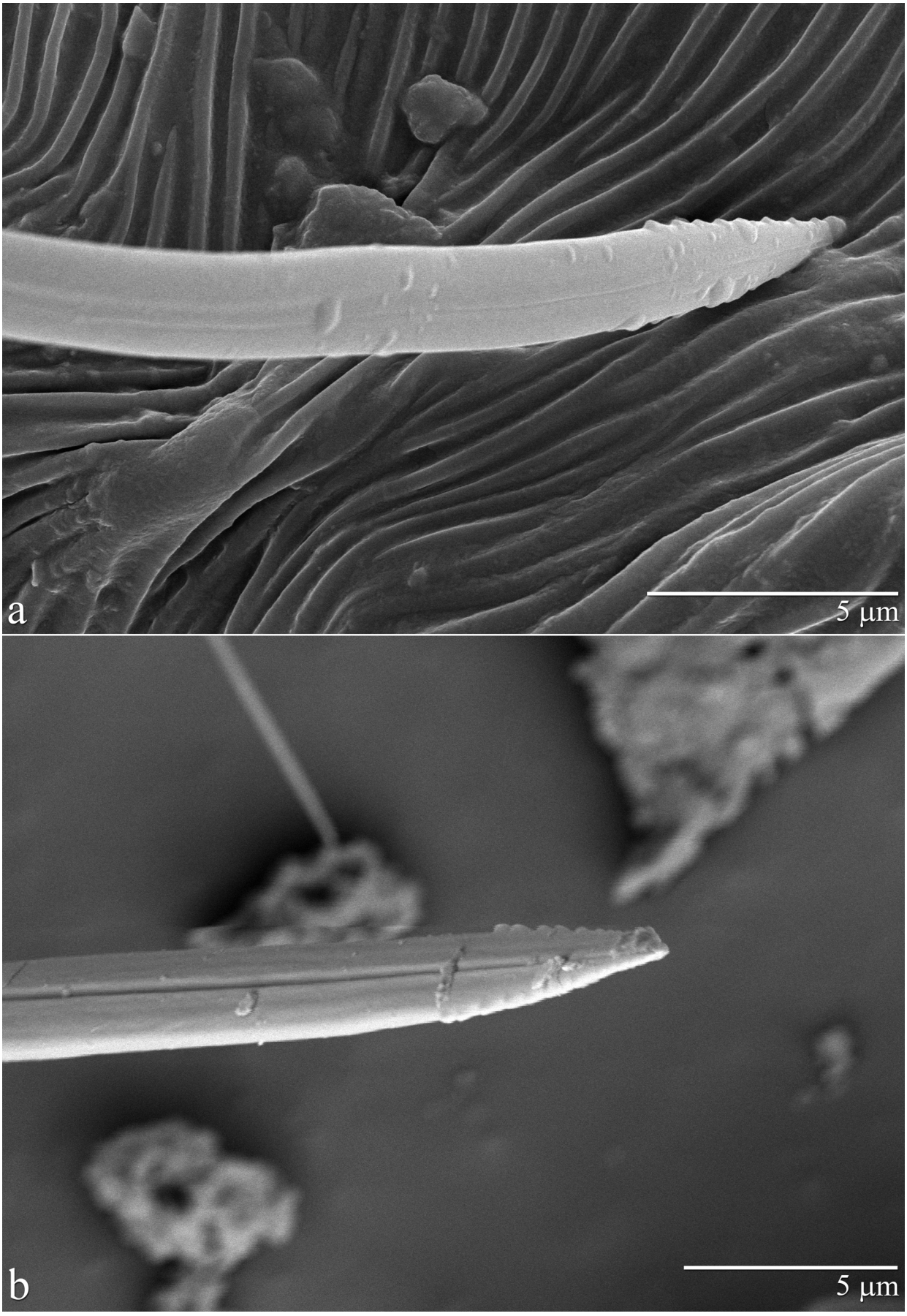


FIGURE 167. *Raoiella marri* Beard & Ochoa, dorsal view of joined stylets, detail of stylet tip with lateral serrations.

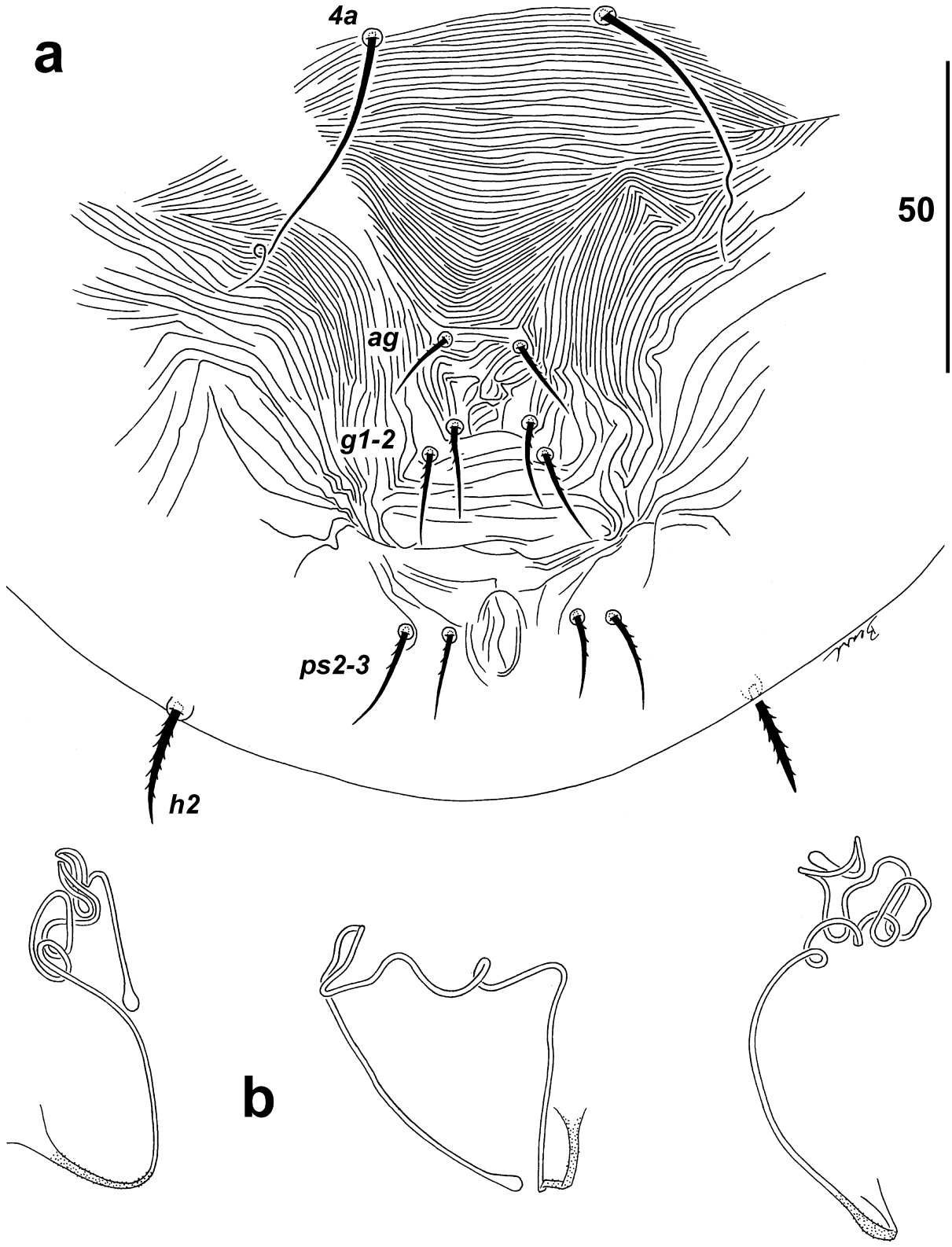


FIGURE 168. *Raoiella marri* Beard & Ochoa, adult female: a. posterior venter; b. details of spermatheca.

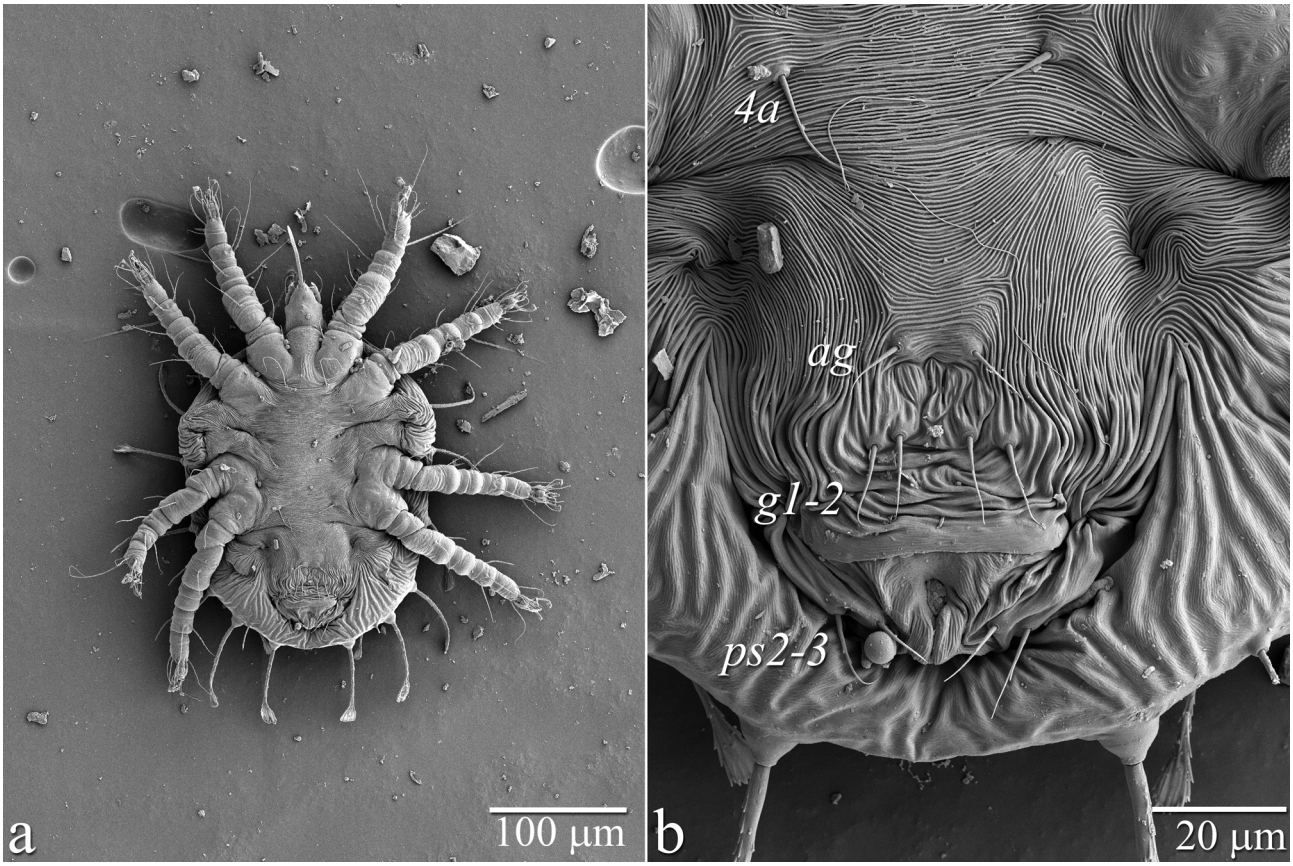


FIGURE 169. *Raoiella marri* Beard & Ochoa, adult female: a. ventral habitus; b. detail of posterior venter.

Venter. (Figs 168–169) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* inserted slightly anterior to *g2* on membranous genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *g1*, *g2*, *ps2*, *ps3* barbed. Setal measurements: *1a* 48–81 [75], *1b* 21–26 [21], *2b* 12–17 [13], *3a* 12–15 [12], *4a* 43–73 [43–59], *ag* 10–15 [10], *g1* 12–15 [14], *g2* 14–16 [16], *ps2* 15–19 [15], *ps3* 12–15 [14].

Spermatheca. (Fig. 168b) A coiled membranous duct ending in a small membranous bulb; basal region of duct, at the genital opening, has a granular appearance.

Legs. (Figs 170–171) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-9(1), 1-1-4-2-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with two setae (*l′*, *l″*; seta *d* absent). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 9–11 [9–10]; ta II 9–10 [10]) and two eupathidia distally *pζ′–pζ″* (ta I 12–14 [12–13], 12–14 [12–13]; ta II 12–13 [12–13], 12–13 [12–13]). Barbed companion seta *ft″* on tarsus I 12–19 [13] and tarsus II 9–12 [9], inserted adjacent to solenidion *ω″*. Dorsal seta, *d*, on tibiae I and II with finely tapered tip. Claw I 17–19.

Male. ***Dorsum.*** (Fig. 172) Body measurements (4): length between setae *v2–h1* 181–195, width between setae *sc2–sc2* 137–145, *c3–c3* 142–150, *f3–f3* 84–87. Prodorsum smooth, with pair large pores on posterior margin (under fold in sejugal region). Opisthosoma mostly smooth with band of transverse striae between *d1* and *e1*; posterior cuticle between *h1–h1* with distinct longitudinally striate and rugose pattern (Fig. 172). Lateral opisthosomal setae (*c3*, *d3*, *e3*, *f3*) thick, strongly spatulate, barbed along entire length; sublateral setae (*c2*, *d2*, *e2*, *f2*, *h1*) much shorter than lateral setae, weakly spatulate; central setae (*c1*, *d1*, *e1*) short, not spatulate, blunt to tapered. Seta *h2* not spatulate, tapered. Dorsal setae measurements: *v2* 22–27, *sc1* 23–32, *sc2* 46–52, *c1* 7–9, *c2* 16–20, *c3* 39–46, *d1* 5–8, *d2* 13–18, *d3* 43–45, *e1* 6–8, *e2* 15–18, *e3* 40–46, *f2* 16–24, *f3* 37–48, *h1* 15–18, *h2* 17–22.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–7) and one blunt eupathidium (6–9) distally, and one seta dorsally; palp femorogenu with one seta (21–26).

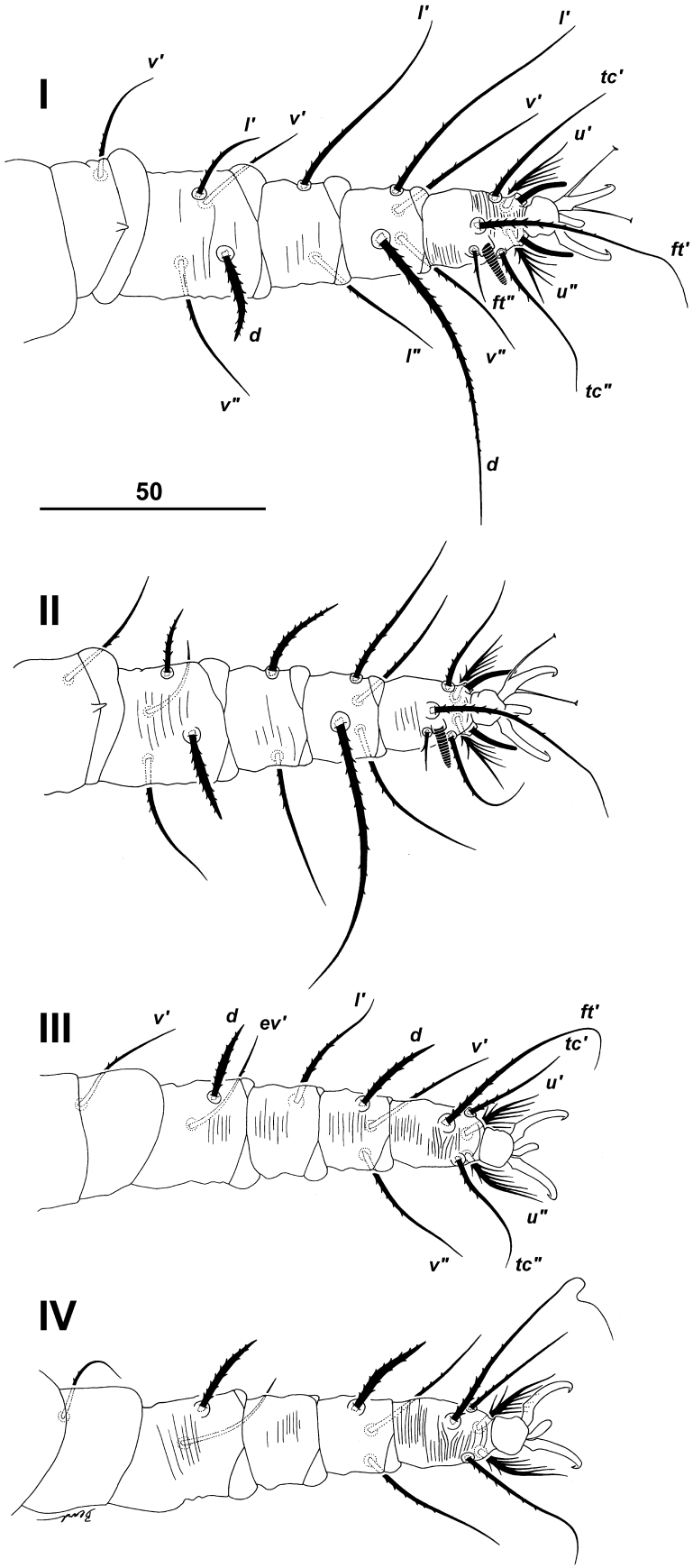


FIGURE 170. *Raoiella marri* Beard & Ochoa, adult female: legs I–IV (right side; legs I–II dorsal aspect, legs III–IV dorsal to abaxial aspect).

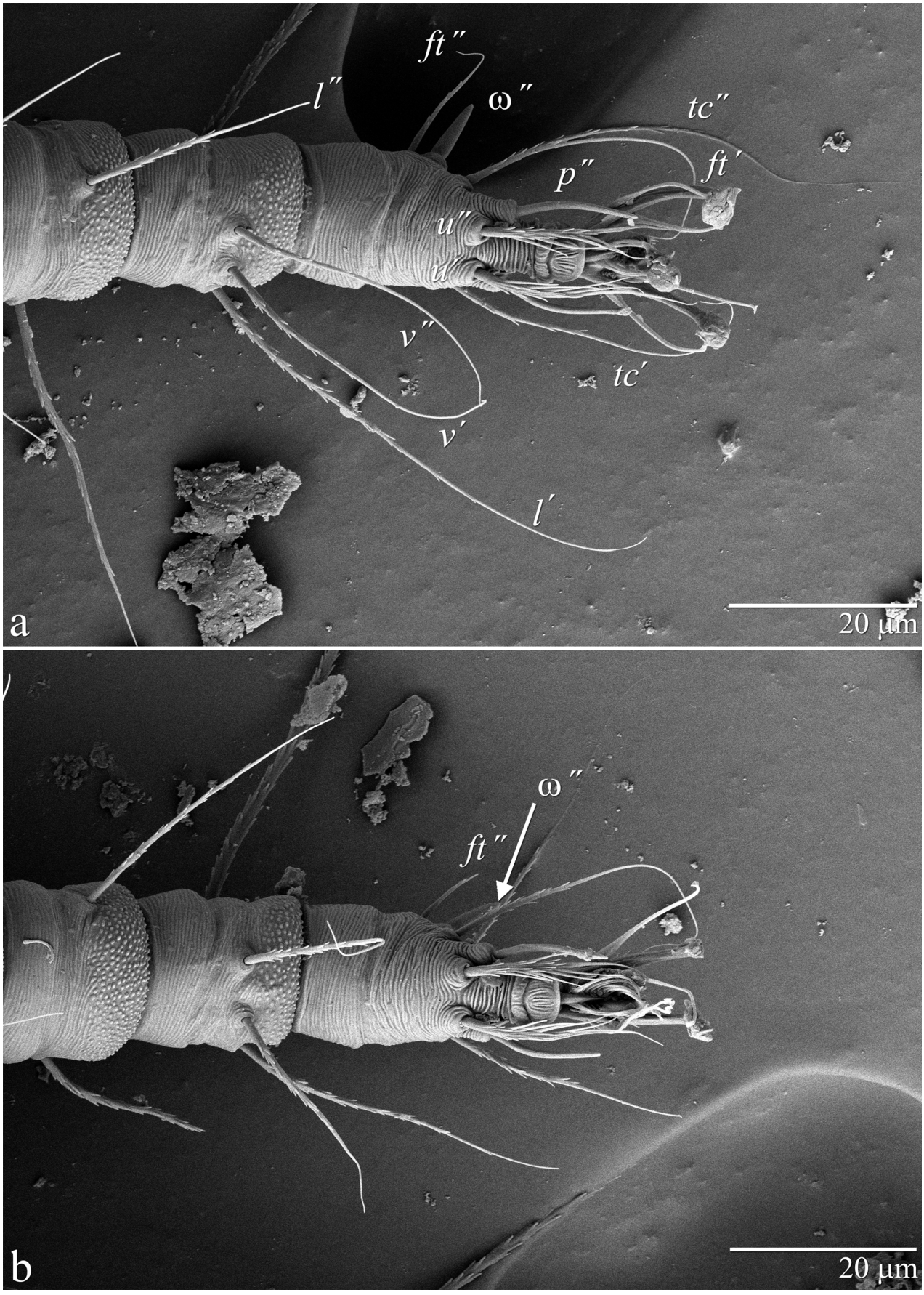


FIGURE 171. *Raoiella marri* Beard & Ochoa, adult female: a. ventral view tibia-tarsus I (right); b. ventral view tibia-tarsus II (right).

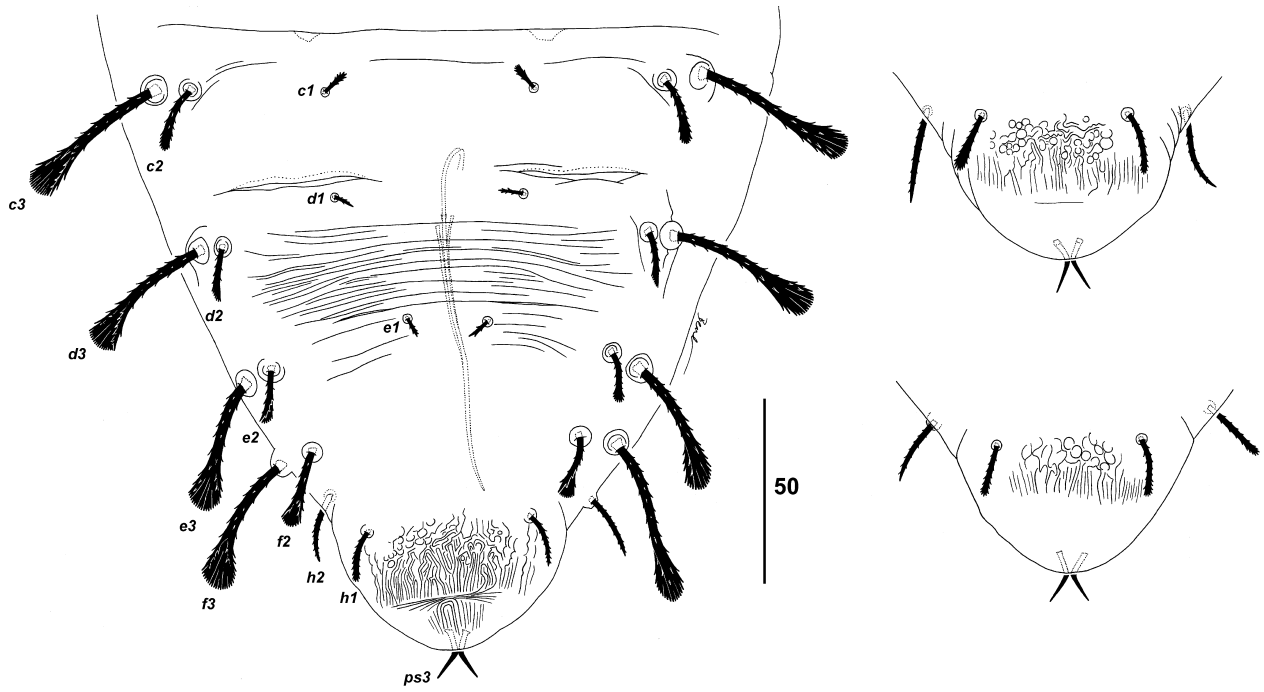


FIGURE 172. *Raoiella marri* Beard & Ochoa, adult male: dorsal opisthosoma with detail of aedeagus and setae *ps3*; with variation in cuticle pattern on posterior dorsal opisthosoma.

Venter. Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and a distinct patch of smooth cuticle on either side of setae *ag*. Setae *1a*, *4a* elongate, finely tapered (difficult to determine full length); setae *ag*, *g1*, *g2* lightly barbed; setae *ps3* modified as accessory genital stylets, elongate, thickened, with distinct curved shape. Setal measurements: *1a* 52–94, *1b* 18–22, *2b* 13–14, *3a* 11–14, *4a* 52–70, *ag* 8–11, *g1* 8–10, *g2* 8–10, *ps2* 10–11, *ps3* 13–15.

Aedeagus. (Fig. 172) Aedeagus narrow, elongate and sclerotised (72–75), tapering to a blunt point distally.

Legs. (Fig. 173) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-4-3-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Genua I–II with three setae (*d*, *l′*, *l″*). Tarsi I and II each with two solenidia (ta I *ω′* adaxial 8–10, *ω″* abaxial 8–10; ta II adaxial 7–9, abaxial 8–10), and two eupathidia *pζ′–pζ″* distally (ta I 11–13, 12–13; ta II 11–13, 11–12). Companion seta *ft″* on tarsus I 15–16 and tarsus II 10–12, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta finely tapered. Tenent hairs on claws with three attachment points.

Deutonymph. *Dorsum.* (Figs 174–175) Body measurements (5 female, 3 male): length between setae *v2–h1* female 215–224 (male 177–183), width between setae *sc2–sc2* 155–162 (134–138), *c3–c3* 171–177 (141–146), *f2–f2* 42–55 (42–43), *f3–f3* 86–93 (67–73). Dorsum mostly smooth with light transverse striations. Lateral opisthosomal setae (*c3*, *d3*, *e3*, *f3*) thick, strongly spatulate, barbed along entire length; sublateral setae (*c2*, *d2*, *e2*, *f2*, *h1*) much shorter than lateral setae, spatulate to weakly spatulate; central setae (*c1*, *d1*, *e1*) short, not spatulate; seta *h1* thick, tapered to blunt, barbed; female with seta *h2* thick, tapered to blunt, barbed; male with seta *h2* tapered, fine, barbed. Dorsal setae measurements: *v2* 47–53 (31–37), *sc1* 41–47 (31–38), *sc2* 35–40 (31–35), *c1* 7–9 (7–9), *c2* 47–54 (32–44), *c3* 17–20 (13–18), *d1* 7–8 (5–7), *d2* 43–50 (31–41), *d3* 15–19 (15–20), *e1* 6–7 (6–7), *e2* 45–49 (29–37), *e3* 15–19 (15–17), *f2* 40–44 (22–29), *f3* 16–21 (16–19), *h1* 15–22 (13–14), *h2* 11–14 (12–15).

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion 6–7 (5) and one blunt eupathidium 6–8 (5–6) distally, and one seta dorsally; and femorogenu with one seta 21–25 (18–21).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length); setae *2b* absent. Setae smooth to weakly barbed. Male with seta *ps3* thickened. Setal measurements: *1a* 37–57 (48–51), *1b* 18–20 (16–18), *3a* 7–10 (10–12), *4a* 22–40 (34–44), *ag* 7–8 (6–7), *g1* 6–8 (5–6), *ps2* 7–8 (8–9), *ps3* 5–7 (7–8).

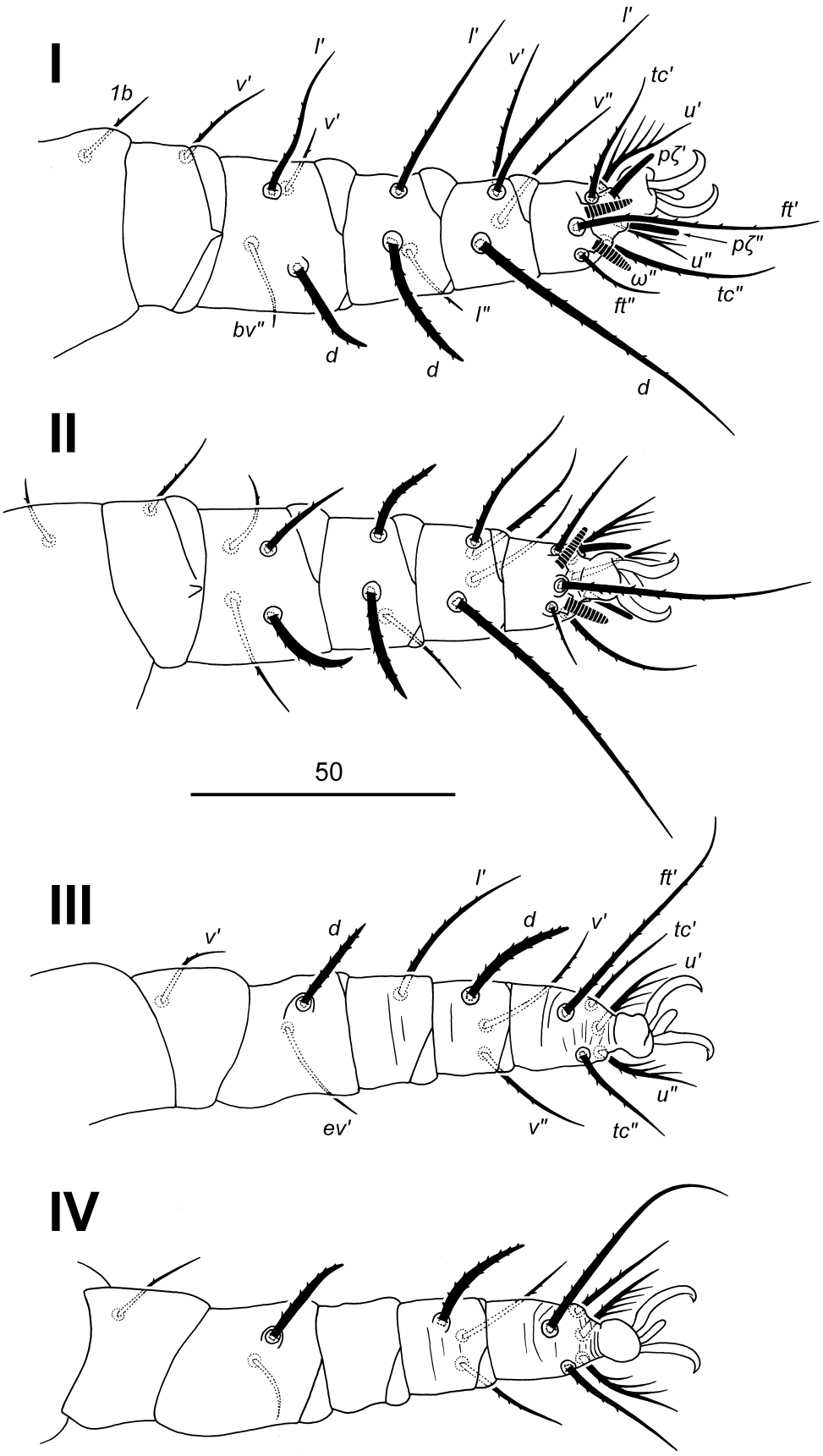


FIGURE 173. *Raoiella marri* Beard & Ochoa, adult male: legs I–IV (right side; legs I–II dorsal aspect, legs III–IV dorsal to abaxial aspect).

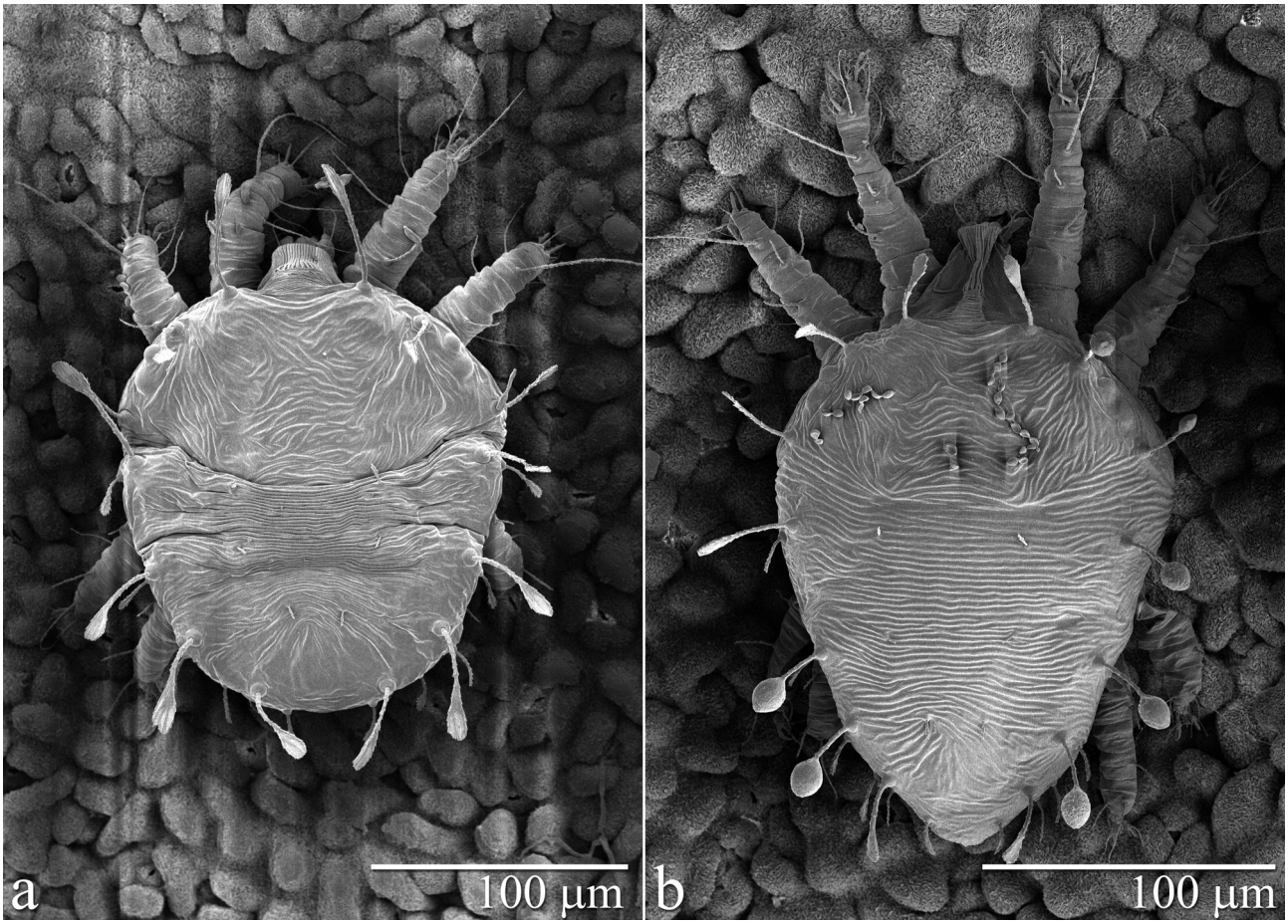


FIGURE 174. *Raoiella marri* Beard & Ochoa, deutonymph: a. female dorsal habitus (unfed); b. male dorsal habitus.

Legs. (Fig. 174) Female setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Female genua I–II with one seta (seta *l′* present; seta *d* absent). Male genua I–II with two setae (*d*, *l′* present). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 7–8 (6–7); ta II 7–8 (6–7)) (see Fig. 175—tarsus I is visible) and two eupathidia *pζ′–pζ″* distally (ta I 10–11, 9–10 (8–10, 8–9); ta II 10, 9–10 (8–9, 8–9)). Both sexes companion seta *ft″* barbed, on tarsus I 6–9 and tarsus II 4–7, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta *d* with finely tapered tip, however when broken does not appear fine. Claw I 13–15 (both sexes).

Protonymph. ***Dorsum.*** Body measurements (4): length between setae *v2–h1* 171–172, *v2–f2* 161–168, width between setae *sc2–sc2* 127–136, *c3–c3* 139–144, *f2–f2* 30–34, *f3–f3* 51–55. Opisthosoma with sublateral setae (*c2*, *d2*, *e2*, *f2*) much longer than other setae, thick, barbed along entire length, broadly spatulate; lateral setae (*c3*, *d3*, *e3*, *f3*) and central setae (*c1*, *d1*, *e1*) short, weakly spatulate to blunt or tapered, barbed; setae *f3*, *h1* blunt to weakly spatulate, or tapered, barbed; setae *h2* tapered. Dorsal setae measurements: *v2* 33–44, *sc1* 34–37, *sc2* 17–20, *c1* 7–9, *c2* 34–41, *c3* 11–14, *d1* 7–8, *d2* 33–40, *d3* 10–12, *e1* 7–10, *e2* 30–37, *e3* 10–12, *f2* 16–31, *f3* 10–12, *h1* 7–9, *h2* 11–12.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one tapered eupathidium (6–9) distally, and one seta dorsally; palp femorogenu with one seta (16–19).

Venter. (Fig. 180a) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setae smooth to weakly barbed. Setal measurements: *1a* 37–47, *1b* 14–17, *3a* 9, *ag* 6–9, *ps2* 4–5, *ps3* 2–3.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Genua I–II with one seta (*l′*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 6–7; ta II 6–7) and two eupathidia *pζ′–pζ″* distally (ta I 8–9, 8–9; ta II 7–9, 7–9). Companion seta *ft″* on tarsus I 4–5 and tarsus II 3–4, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta *d* with finely tapered tip, however when broken does not appear fine. Claw I 11–13.

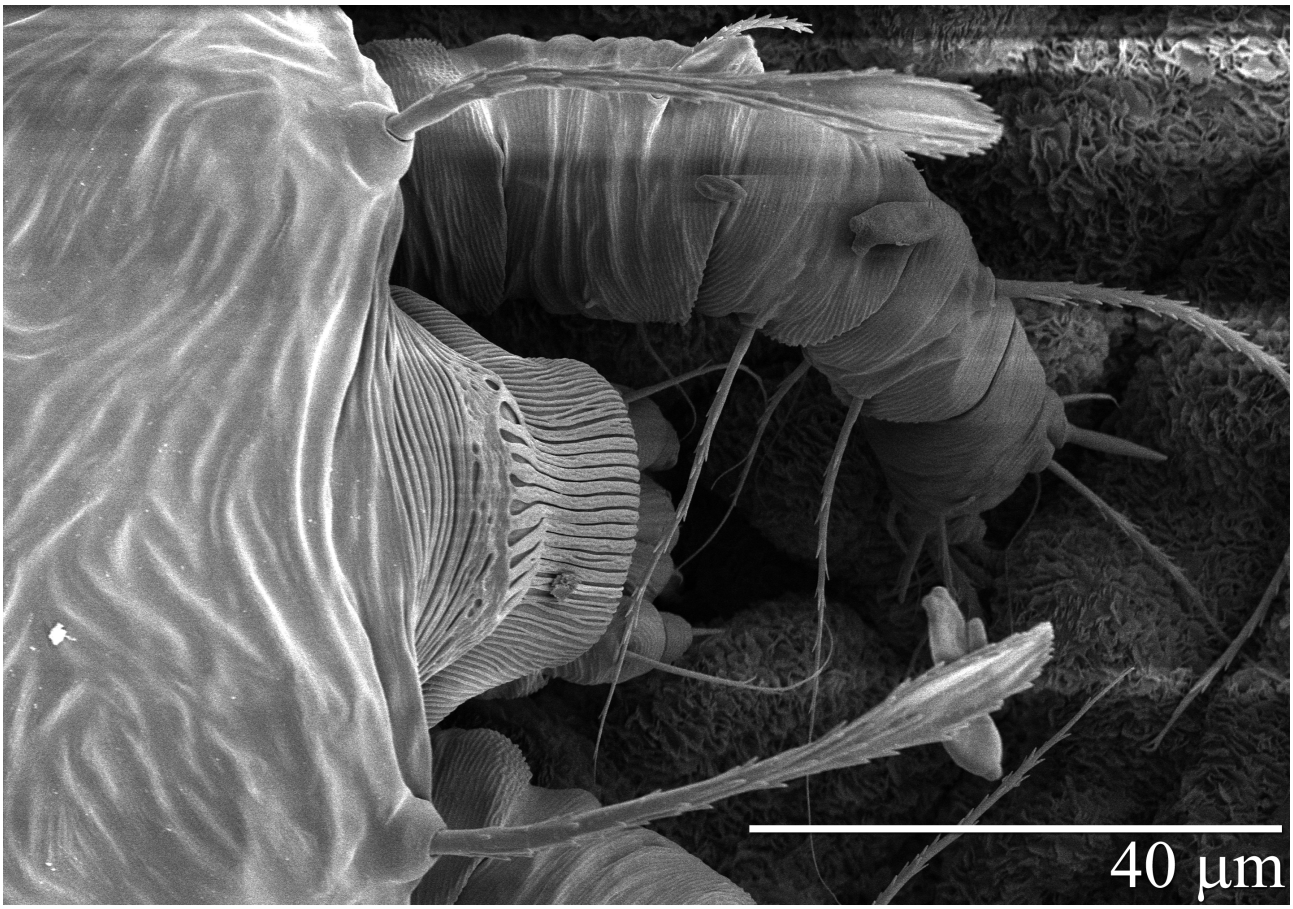


FIGURE 175. *Raoiella marri* Beard & Ochoa, deutonymph feeding via stomatal opening.

Larva. *Dorsum.* (Figs 176–177) Body measurements (3): length between setae *v2–f2* 125–141, width between setae *sc2–sc2* 107–113, *c3–c3* 111–119, *f2–f2* 14–20, *f3–f3* 19–35. Prodorsum with longitudinal to oblique striations; *v2*, *sc1* long, strongly spatulate, barbed; *sc2* short, weakly spatulate to blunt, barbed. Opisthosoma with transverse striae between setae *c1–d1*. Setae *c2*, *d2*, *e1*, *e2* longer than other opisthosomal setae, thick, strongly spatulate, barbed; lateral setae *c3*, *d3*, *e3* short, blunt to tapered, barbed; setae *c1*, *d1* short, weakly spatulate to blunt, barbed; setae *f2* weakly spatulate to blunt, barbed; *f3* short, tapered, barbed; *h1* short, thick, tapered; *h2* fine, elongate, filiform; setae *f2*, *f3*, *h1*, *h2* inserted ventrally. Dorsal setae measurements: *v2* 25–29, *sc1* 32–36, *sc2* 11–13, *c1* 8–12, *c2* 29–33, *c3* 9–11, *d1* 10–13, *d2* 26–31, *d3* 8–11, *e1* 16–21, *e2* 24–26, *e3* 7–10, *f2* 11–14, *f3* 8–11, *h1* 7–11, *h2* 26–65.

Palps. (Fig. 176) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–5) and one tapered eupathidium (8–9) distally, and one seta dorsally; palp femorogenu with one seta (12–14).

Venter. (Figs 178–180b) Cuticle almost completely strongly plicate, except coxal fields smooth; striae transverse *1a–3a*, with longitudinal and oblique striae *3a–ps3*. Setal measurements: *1a* 28–44, *1b* 13–14, *3a* 7–8, *ps2* 4–6, *ps3* 4–5.

Legs. (Fig. 176) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Genua I–II with one seta (*l′*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 4–6; ta II 4–5) and two eupathidia *pζ′–pζ″* distally (ta I 7–8, 7–8; ta II 8, 7). Companion seta *ft″* on tarsus I 3–4 and tarsus II 2–3, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta *d* long, finely tapered. Claw I 11–12.

Egg. (Fig. 181) Weakly ellipsoid to globose, smooth, 95–110 long, 70–80 wide, without a stipe (Fig. 181). A pair of minute recurved spines are present (Fig. 181a; see arrow), though not always visible.

Host. Marri, *Corymbia calophylla* (Myrtaceae).

Distribution. AUSTRALIA: southwest Western Australia.

Etymology. *Raoiella marri* **sp. nov.** is named for common name, marri, given to the host plant *Corymbia calophylla*, by the local indigenous people.

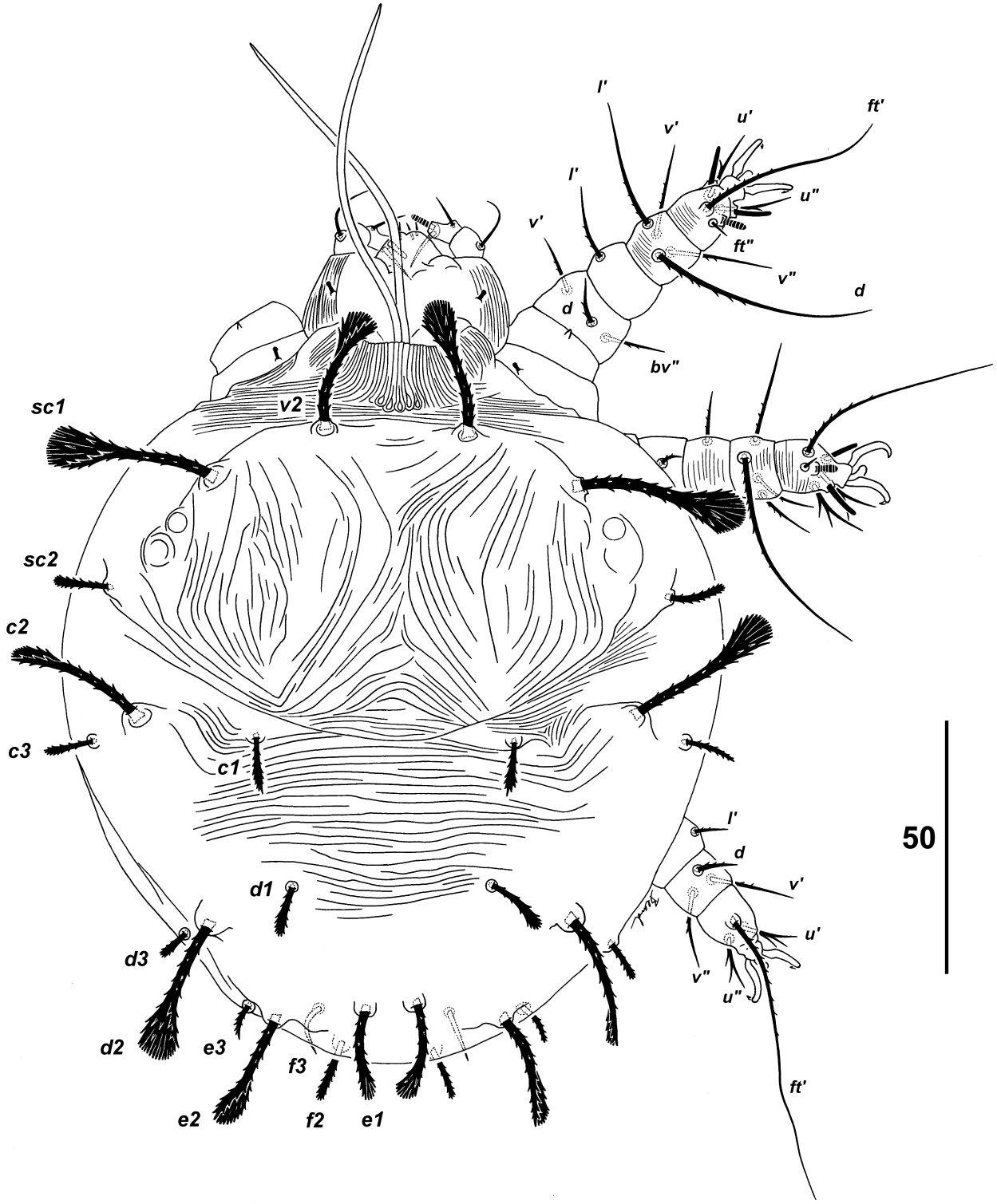


FIGURE 176. *Raoiella marri* Beard & Ochoa, larva: dorsal habitus with details of legs I–III and palps.

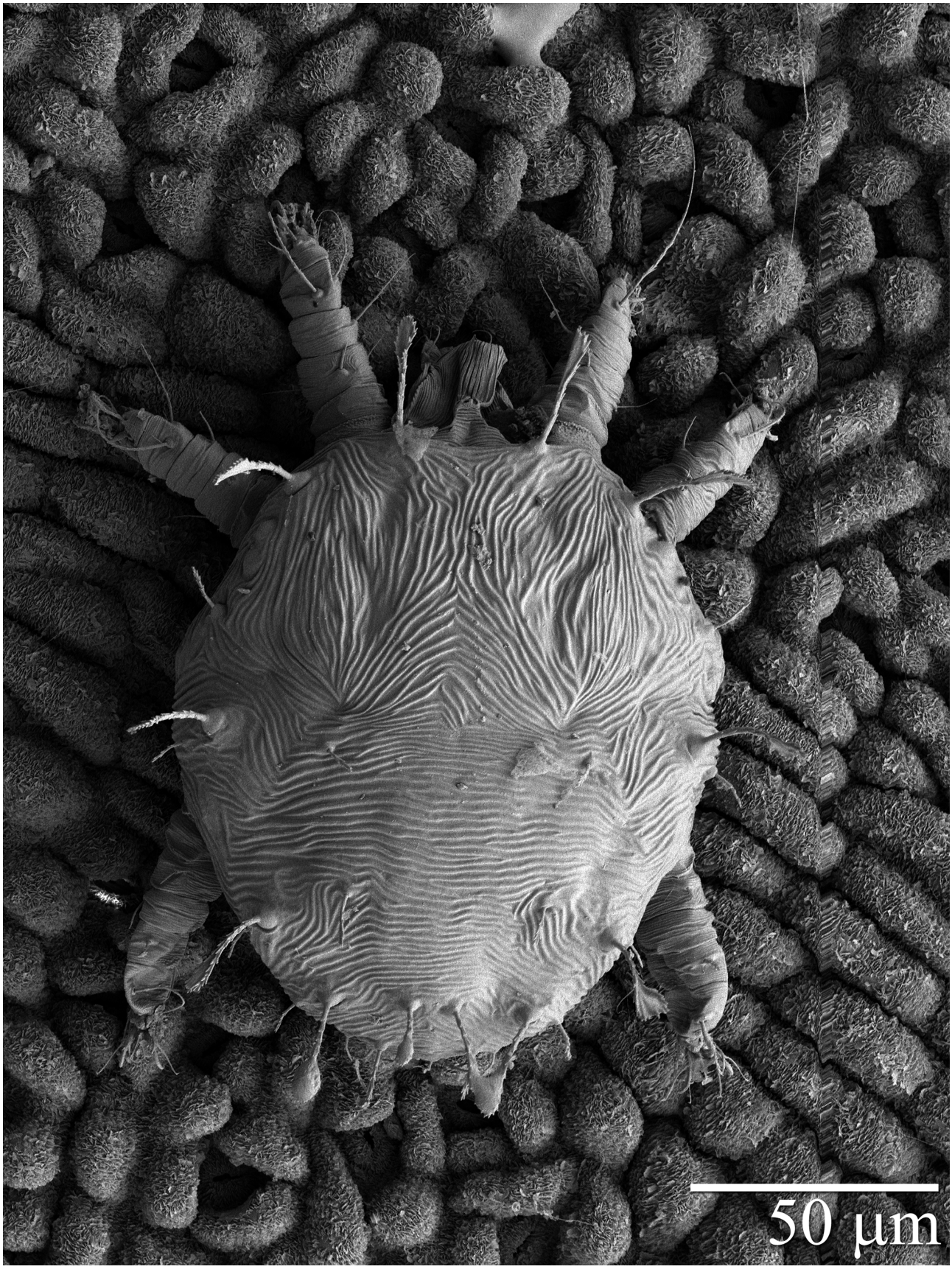


FIGURE 177. *Raoiella marri* Beard & Ochoa, larva: dorsal habitus on host plant.

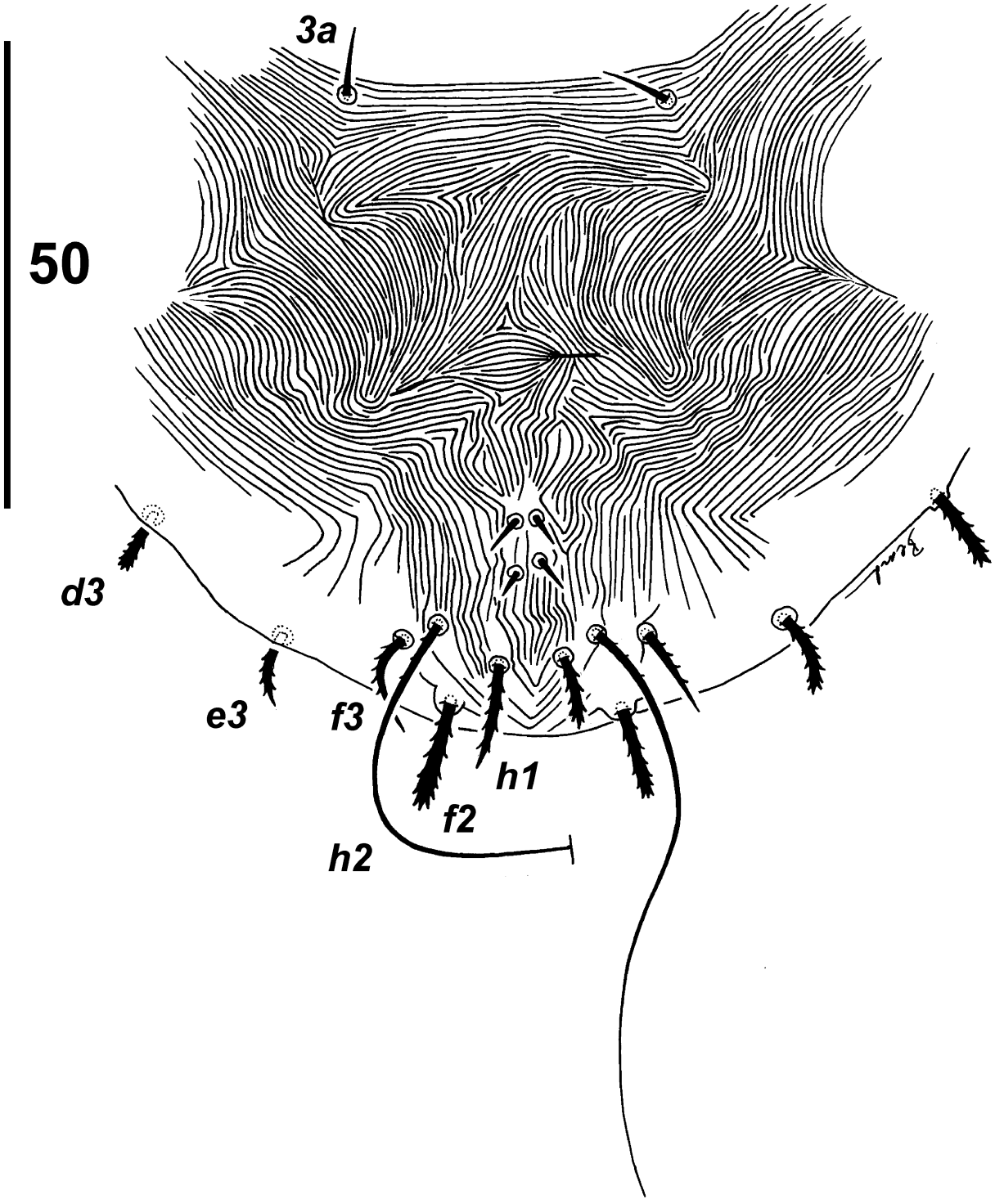


FIGURE 178. *Raoiella marri* Beard & Ochoa, larva: posterior venter.

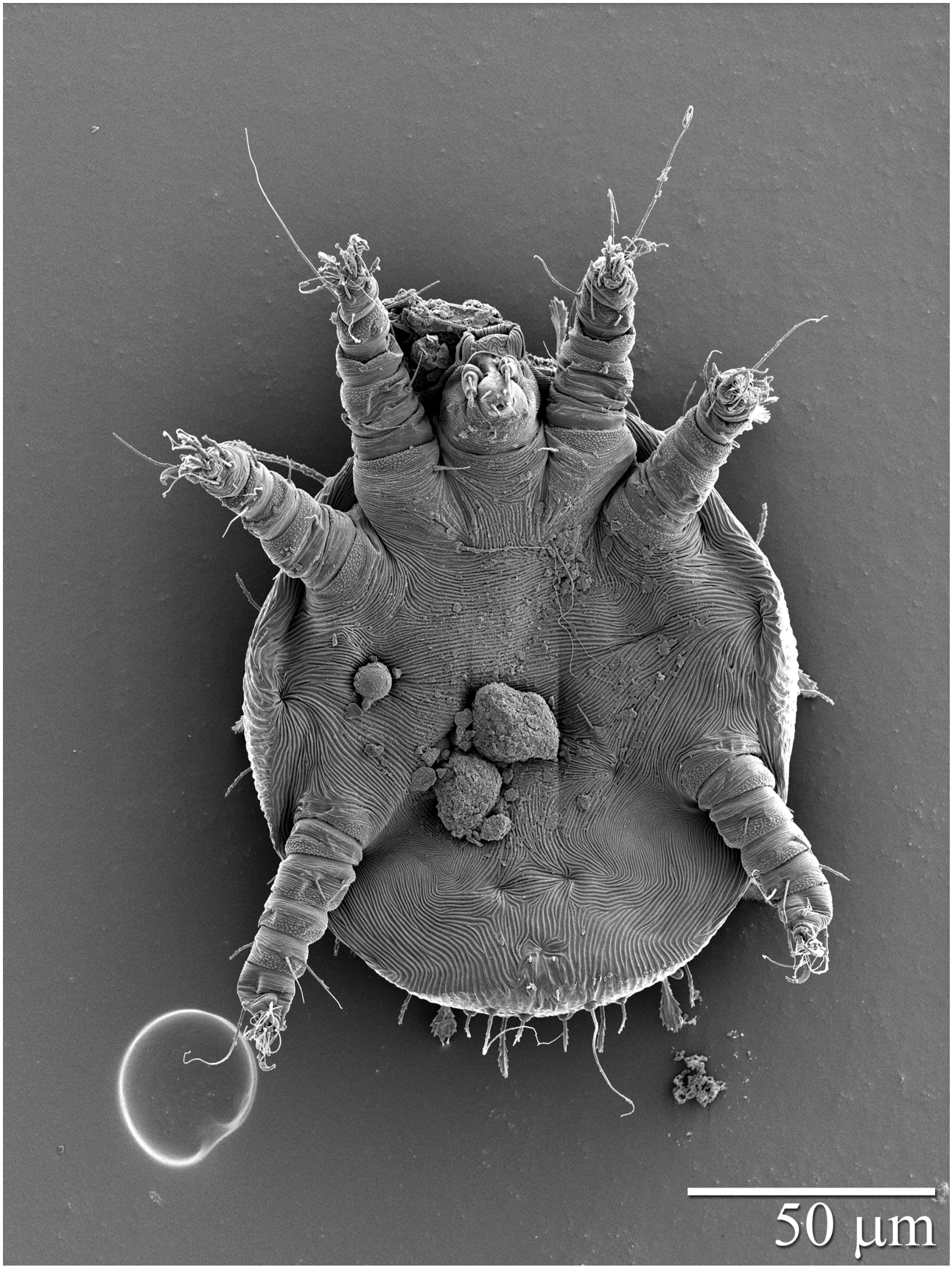


FIGURE 179. *Raoiella marri* Beard & Ochoa, larva: ventral habitus.

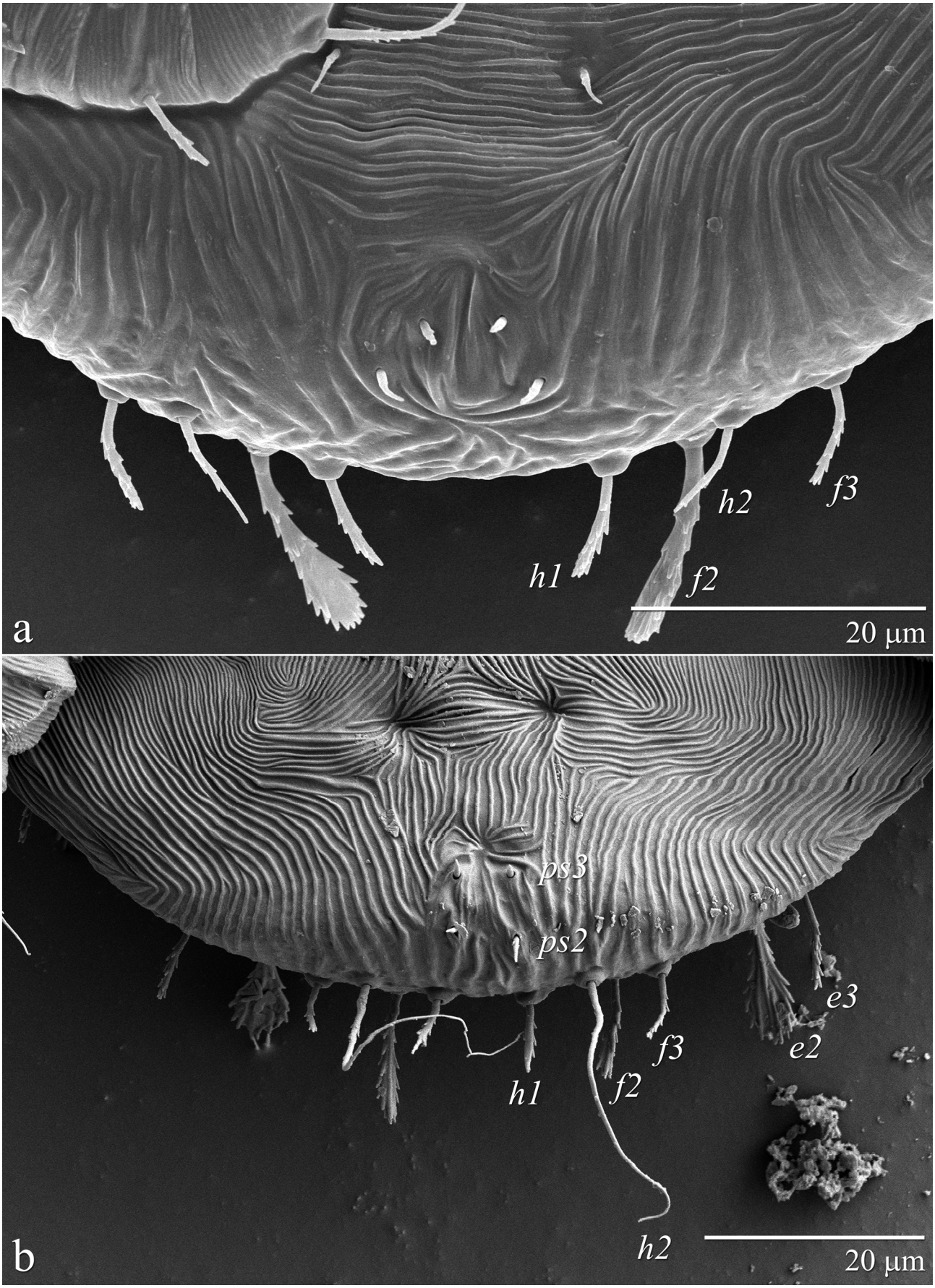


FIGURE 180. *Raoiella marri* Beard & Ochoa, posterior venter: a. protonymph; b. larva.

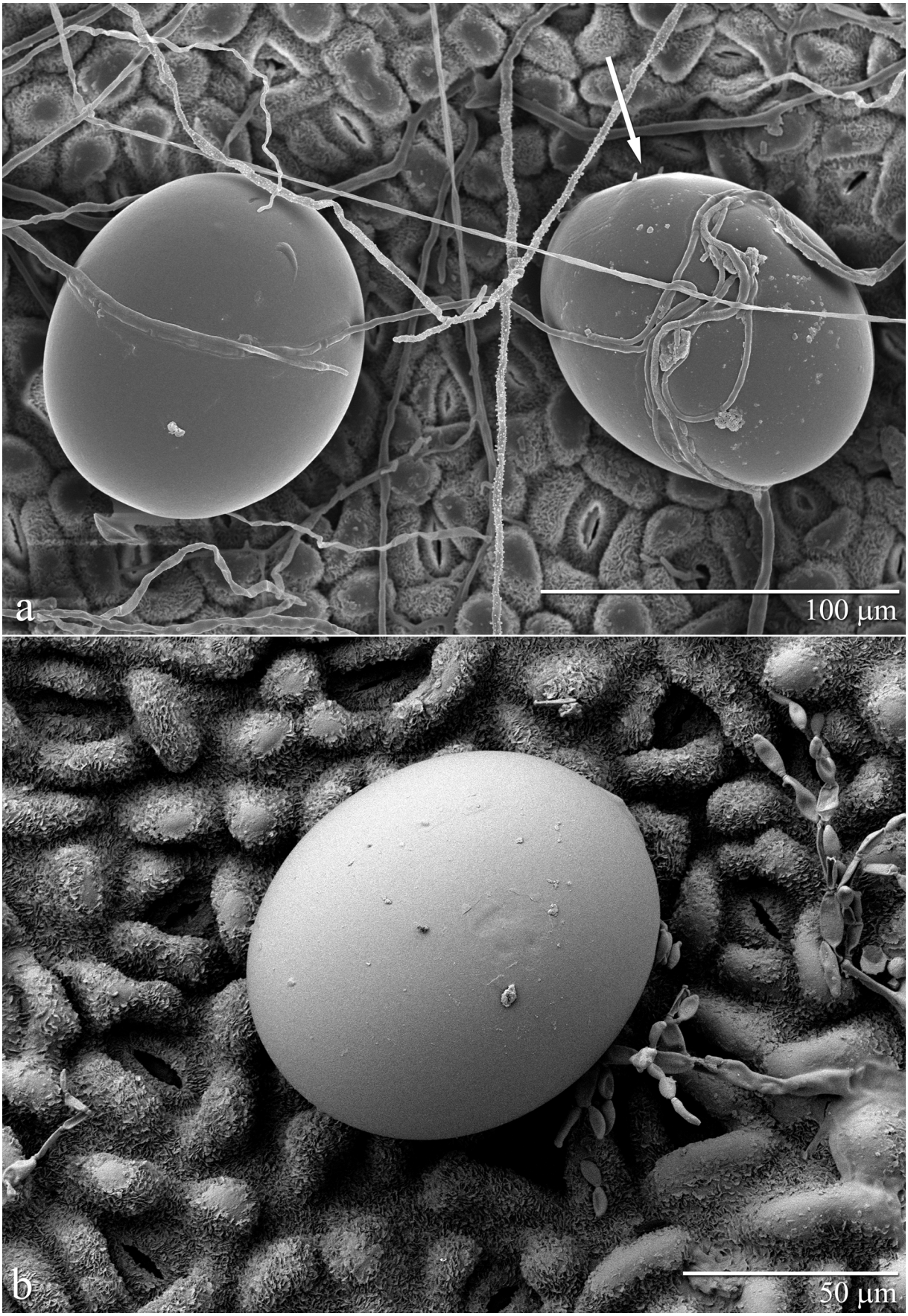


FIGURE 181. *Raoiella marri* Beard & Ochoa, a.–b.eggs on host plant. Note absence of stipe, and pair of minute recurved spines (indicated by arrow in a.).

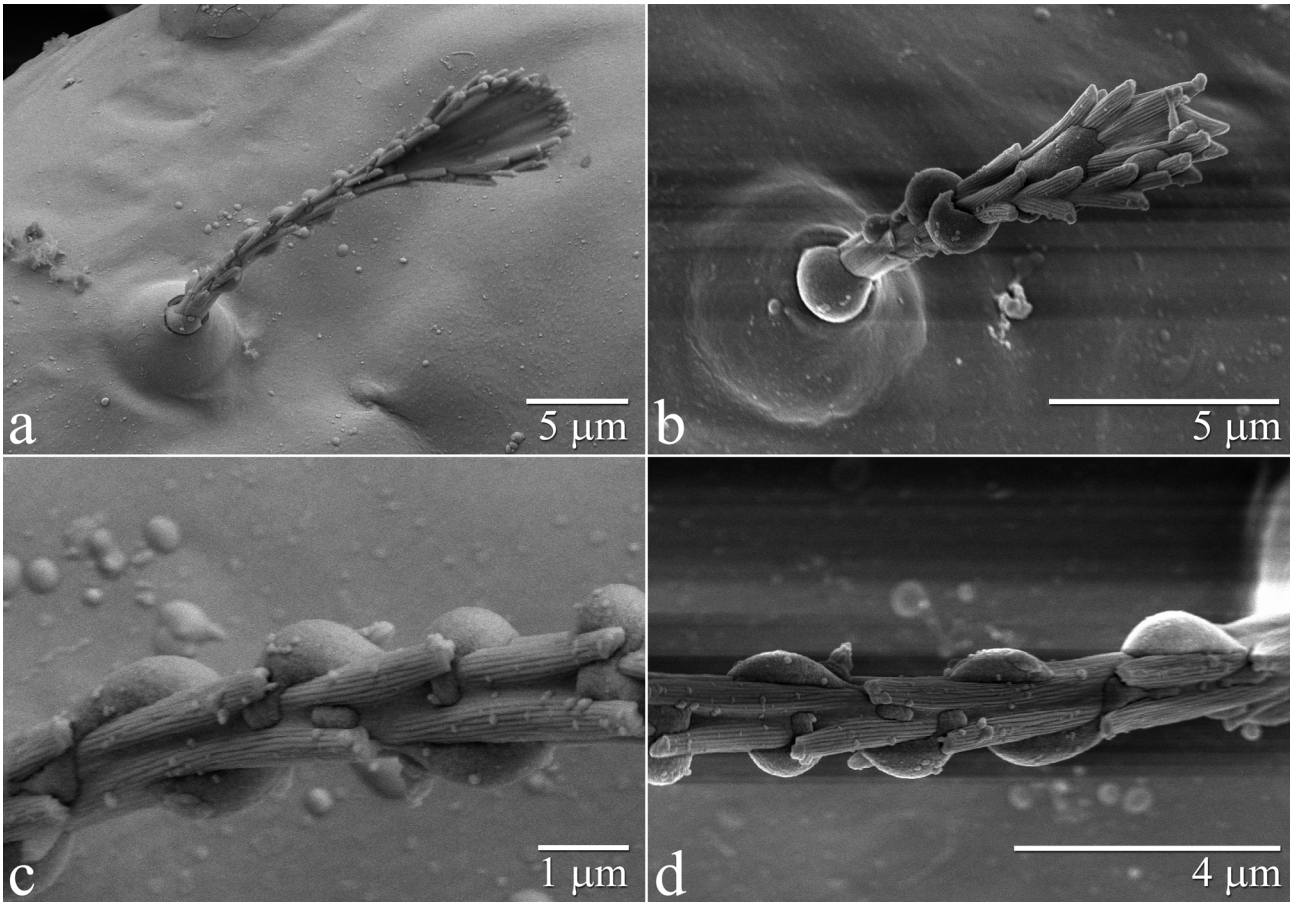


FIGURE 182. *Raoiella marri* Beard & Ochoa, adult female: a.–d. detail of dorsal setae indicating formation of droplets.

Remarks. *Raoiella marri* **sp. nov.** was listed as *Raoiella* sp. 7 (DNA codes RaIn59, RaIn60, RaIn 69) in Dowling *et al.* (2012; Table 1 and Figs 1, 2), and in Beard *et al*. (2013). This species was considered genetically distinct from the two other species in the clade, *R. australica* (species 6 in Dowling *et al.* 2012) and *R. taronga* (species 8 in Dowling *et al.* 2012).

Raoiella marri can be separated from *R. australica* by the following: *Rm* (both sexes) with setae *d* on femora II–IV and tibiae III–IV with tapered tips vs *Ra* (both sexes) with blunt tips; *Rm* male prodorsal setae *sc2* > 45 µm vs *Ra* male *sc2* < 45; *Rm* male cuticle between setae *h1–h1* with longitudinal striae mixed with rugose or rounded reticulate pattern vs *Ra* male cuticle between setae *h1–h1* with band of longitudinal striae. *Raoiella marri* can be separated from *R. taronga* by the following: *Rm* (both sexes) setae *c1*, *d1*, *e1* are all minute vs *Rt* larger and weakly spatulate; *Rm* setae *g1* inserted anterior to *g2* vs *Rt* setae *g1–g2* inserted in transverse row on genital flap; *Rm* genua I with setae *l′* very thin, finely tapered vs *Rt* genua I with setae *l′* thickened; *Rm* femora I–IV and tibiae III–IV with setae *d* with tapered tips vs *Rt* femora I–IV and tibiae III–IV with setae *d* with blunt tips; *Rm* male prodorsal setae *v2* < 30 vs *Rt v2* > 40 µm.

The immature stages have dorsal opisthosomal lateral setae *c3*, *d3*, *e3* are much shorter than the sublateral setae *c2*, *d2*, *e2*. In contrast, the adult stages have the lateral setae much longer than the sublateral setae. The larva and protonymph each have one seta on genu I–II (*l′*). The female deutonymph does not add any setae, but the male deutonymph adds *l″* (*l′*, *l″* present), thus making the deutonymphs sexually dimorphic. The adult female adds *l″* (*l′*, *l″* present), and the adult male adds *d* (*d*, *l′*, *l″* present), resulting in sexually dimorphic adult leg setation. A host plant voucher has been deposited with Queensland Herbarium, BRI—AQ814931.

The collection made from jarrah *E. marginata* (listed as *Other Material Examined*) is considered here to be accidental, and this plant is not considered to be a host for *R. marri*. The mites collected from jarrah were found in low numbers from young jarrah trees that were growing as an understorey in a forest of the true host, marri *Corymbia calophylla*.

***Raoiella pandanae* Mohanasundaram**
Taxonomic status uncertain

Raoiella pandanae Mohanasundaram 1985: 31

Diagnosis (based on literature). Opisthosomal setae *f2* shorter than *f3*; setae *h2* finely tapered. Adult femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with three setae (*l′*, *d*, *l″*); coxae I with one seta; coxae III–IV nude. Tarsi I–II with companion setae (*ft″*) apparently longer than solenidion, barbed. Eupathidium on palp tibiotarsus finely tapered, barbed.

Description (based on literature). Female. *Dorsum.* Body measurements: length 245, width 200. Dorsum smooth with few wrinkles on the hysterosoma. Dorsal lateral setae, long, curved, weakly spatulate, barbed along entire length; all dorsal setae weakly spatulate except setae *h2* apparently tapered. Dorsal setae measurements: *v2* 70, *sc1* 80, *sc2* 75, *c1* 33, *c2* 38, *c3* 90, *d1* 20, *d2* 30, *d3* 90, *e1* 14, *e2* 35, *e3* 100, *f2* 22, *f3* 55, *h1* 50, *h2* -.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus distally with one short solenidion, a possible finely tapered eupathidium and one seta; palp femorogenu with one long dorsal seta, nearly three times as long as segment.

Venter. Fine striae medially, with more widely separated striae laterally. Setae *1a*, *3a*, *4a* present; one pair of aggenital *ag* setae; two pairs of genital *g* setae; one pair of pseudanal *ps* setae ("anal" in description) (we feel that there should be two pairs of *ps* setae, as no other species has only one pair). "One pair of caudal setae and one pair of long, caudo-lateral setae projecting beyond the caudal end and seen along with the posterior dorsal setae; this seta can be differentiated from the dorsal setae by its thinner form"—we interpret the caudal seta as being seta *h1*, and the long thin setae as being *h2*, with a form similar to that seen in *R. indica* (Fig. 117a).

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-6(1), 1-1-4-3-4-6(1), 0-1-2-1-3-4, 0-1-2-0-3-4 respectively. We believe the tarsal setal counts are incorrect. Such counts are not seen in any other species known so far. We assume the tarsi to match the same as all other species in being 9(1)-9(1)-5-5. Based on the illustration, there are two long setae dorsally on tarsi I–II that we interpret to be the *ft′–ft″* setae, indicating that the companion seta *ft″* is elongate as seen in *R. indica*.

Male. *Dorsum.* Body measurements: length 260, width 150. Opisthosoma tapered posteriorly.

Palps. Palps assumed to be two-segmented.

Egg. Dark red in colour. No mention of a stipe was made.

Hosts. Screw palm, *Pandanus* spp. (Pandanaceae).

Distribution. INDIA: Tamil Nadu: South Arcot, Vadalur.

Remarks. The type material is listed in Mohanasundaraum (1985) as: **Holotype, 4 Paratypes.** ♀ ♂, **India**, South Arcot, Tamil Nadu, ex. screw pine *Pandanus* sp. (Arecaceae), 5.viii.1981 (collector M. Mohanasundaram) (N0. 68, TNAU). The repeated requests to borrow the type material have not been answered.

Mohanasundaram (1985) discussed a severe infestation of these mites on *Pandanus* plants that were being grown in an area surrounded by coconut palms that were apparently free from mite infestation, but because of the coconut palms these mites were initially thought to be *R. indica*. Mesa *et al.* (2009) indicated that *R. pandanae* was a suspected junior synonym of *R. indica*. However, there are apparent key differences in the lengths of the lateral dorsal setae and host plant records that indicate that this could be a valid species. This species is in need of an updated and detailed description, including the immatures. Based on what could be seen of the leg chaetotaxy in the original description, the elongate companion setae *ft″*, and the description of setae *h2*, *R. pandanae* is tentatively placed in the *R. indica* group.

Many of the setal counts listed in the original description are most likely inaccurate, as for example, no species known to date has 6(1) setae on tarsi I–II.

Specimens of *R. pandanae* were not included in the molecular analyses by Dowling *et al.* (2012).



FIGURE 183. *Raoiella marri* Beard & Ochoa, deutonymph: detail of dorsal setae *v2* (and part of *sc1*) with a frozen droplet held at the setal tip; note the texture of the droplet surface, and tip of spatula emerging from top of droplet.

***Raoiella pooleyi* sp. nov. Beard & Ochoa**
(Figs 184–193)

Material examined. Holotype. ♀. **Australia,** ex. brush box *Lophostemon confertus* (Myrtaceae), Serpentine Creek Historical Cemetery, Redland Bay, Queensland, 27º40'10"S 153º18'05"E, 24.ix.2015, P.I. Forster, G. Leiper and J.J. Beard (QMS 108803).

Paratypes. 18 ♀, 16 ♂, 9 deutonymphs, 4 protonymphs, 10 larvae, same data as Holotype (QM, USNM).

Other material examined. **Australia,** 16 ♀, 1 ♂, 4 deutonymphs, 1 protonymph, same data as Holotype except 22.ix.2016; 19 ♀, 7 ♂, 7 deutonymphs, 3 protonymphs, 3 larvae, Gap Creek Reserve, Gap Creek Road, Mt Coottha, Brisbane, Queensland, 27º28'44.5"S 152º55'42.5"E, 19.xii.2004, ex. *L. confertus* (Myrtaceae), J.J. Beard & P.I. Forster (mounted in PVA; slides starting to degrade); 10 ♀, 10 ♂, 1 pharate male, 16 deutonymphs, 5 protonymphs, 10 larvae, same data except 22.ix.2016 (BRI voucher PIF44553). All specimens in QM and USNM.

Diagnosis. Opisthosomal setae *c1*, *d1*, *e1* minute; *f2* obviously shorter than *f3*; setae *h1* obviously longer than *h2*. Setae *h2* spatulate to weakly spatulate. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with two setae (*d*, *l′* present; *l″* absent); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft″*) moderately shorter than solenidion. Dorsal setae on tibiae I–II tapered to fine tip. Eupathidium on palp tibiotarsus tapered to thick tip. Larva with setae *h2* short, blunt or tapered.

Description. Measurements are presented as the full range of all specimens measured, followed by the holotype and paratype measurements in square brackets [holotype; paratypes]. See Remarks for explanation of measurements presented below.

Female. *Dorsum.* (Fig. 184a) Body measurements (20): length between setae *v2–h1* 235–278 [268; 250–268], width between setae *sc2–sc2* 186–206 [202; 200–206], *c3-c3* 174–198 [193; 185–194], *f3–f3* 106–125 [123; 117–125]. Prodorsal and dorsal opisthosomal shields weakly developed, with smooth cuticle (although shields appear strongly developed in some specimens). Prodorsum with a pair of large pores and one pair of minute pores mesally, and pair of large pores on posterior margin (often hidden in fold of sejugal region). Dorsal opisthosoma with four pairs of pores between *c1–d2*, and one pair of minute pores between *e1–e2*. Lateral setae (*c3*, *d3*, *e3*, *f3*) much longer than sublateral setae (*c2*, *d2*, *e2*, *f2*); central setae (*c1*, *d1*, *e1*) minute. All dorsal setae barbed along entire length (central setae with few barbs); all dorsal setae, except central setae, spatulate. Dorsal setae measurements: *v2* 62–74 [70–72; 68–74], *sc1* 51–70 [62–65; 56–65], *sc2* 59–72 [68–69; 62–72], *c1* 6–11 [7–8; 7–11], *c2* 38–56 [45–46; 39–49], *c3* 58–75 [67–71; 66–75], *d1* 3–8 [6; 4–6], *d2* 19–31 [22–27; 19–27], *d3* 56–71 [71; 66–71], *e1* 5–9 [6–7; 5–7], *e2* 17–31 [22–23; 17–27*], *e3* 53–71 [66–68; 62–71], *f2* 33–45 [41–45; 33–45], *f3* 55–68 [65; 63–68], *h1* 52–71 [66–67; 61–71], *h2* 28–36 [33–35; 28–35]. * = one female had an abnormally long *e2* seta, 45 long (not included in range), while other seta in pair was 24.

Palps. (Fig. 184b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–7) [5] and one eupathidium tapered to thick tip (8–10) [8] distally, one dorsal barbed seta (13–18) [13–14]; palp femorogenu with one barbed seta (29–36) [33–34].

Venter. (Figs 185a,b) Cuticle almost completely plicate, covered with mostly transverse striae; transverse striae between *1b–1b*, longitudinal striae between *1b–1a*, transverse between *1a–ag*, with mixed transverse to oblique striae *ag–ag*, with coxal fields smooth. Setae *g1* and *g2* inserted in more-or-less transverse row on posterior margin of genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *g1*, *g2* slightly barbed; setae *ps2*, *ps3* barbed. Setae *3b*, *4b* absent. Setal measurements: *1a* 66–120 [76–84], *1b* 16–27 [16–18], *2b* 10–13 [12–13], *3a* 6–11 [7–8], *4a* 64–103 [84–96], *ag* 9–16 [9–10], *g1* 13–17 [14–15], *g2* 12–15 [13–15], *ps2* 17–20 [19], *ps3* 10–12 [10–11].

Spermatheca. (Fig. 185c) An elongate, narrow, weakly convoluted duct. The basal section of the duct broadens abruptly towards external opening, and basal section of narrow duct has a granular texture.

Legs. (Fig. 186) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-9(1), 1-1-4-2-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 10–13 [11]; ta II 9–11 [9]) and two eupathidia *pζ′–pζ″* distally (ta I 11–13 [12], 11–12 [12]; ta II 11–12 [11–12], 11–12 [11–12]). Short, smooth companion seta *ft″* on tarsus I 6–9 [7–9] and tarsus II 6–8 [7], inserted adjacent to solenidion *ω″* on a shared tubercle. Tibiae I–II with dorsal seta thick, barbed, tapered to fine tip. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″* present; *l′* added in adult, delayed from deutonymph; genua I–II with two setae (*d*, *l′*) (*d* added in deutonymph). Claw I 12–13 [12–13] long; tenent hairs with four attachment points. Claw IV 11–12 [12] long; tenent hairs with five attachment points.

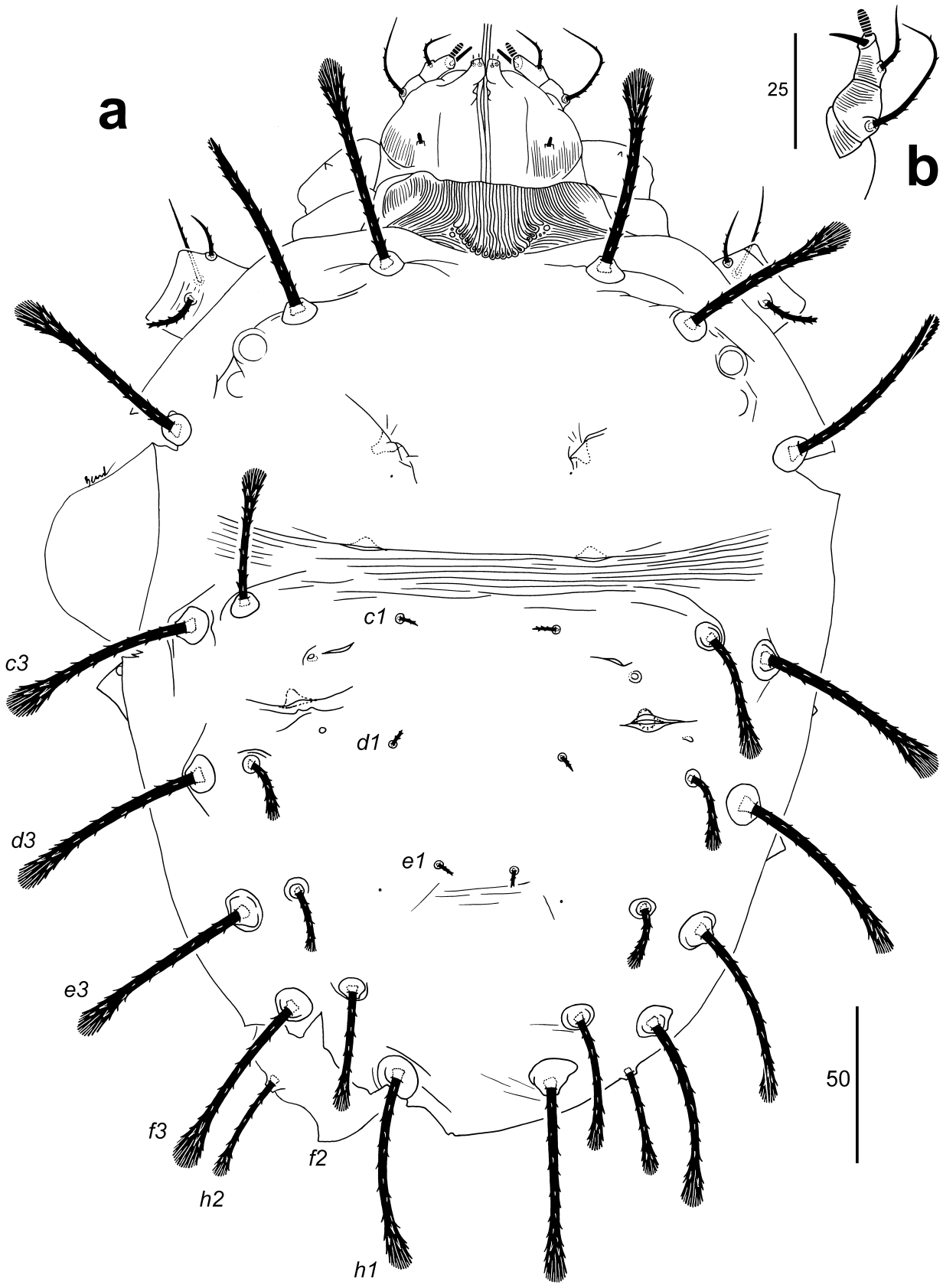


FIGURE 184. *Raoiella pooleyi* Beard & Ochoa, adult female: a. dorsal habitus; b. detail of palp.

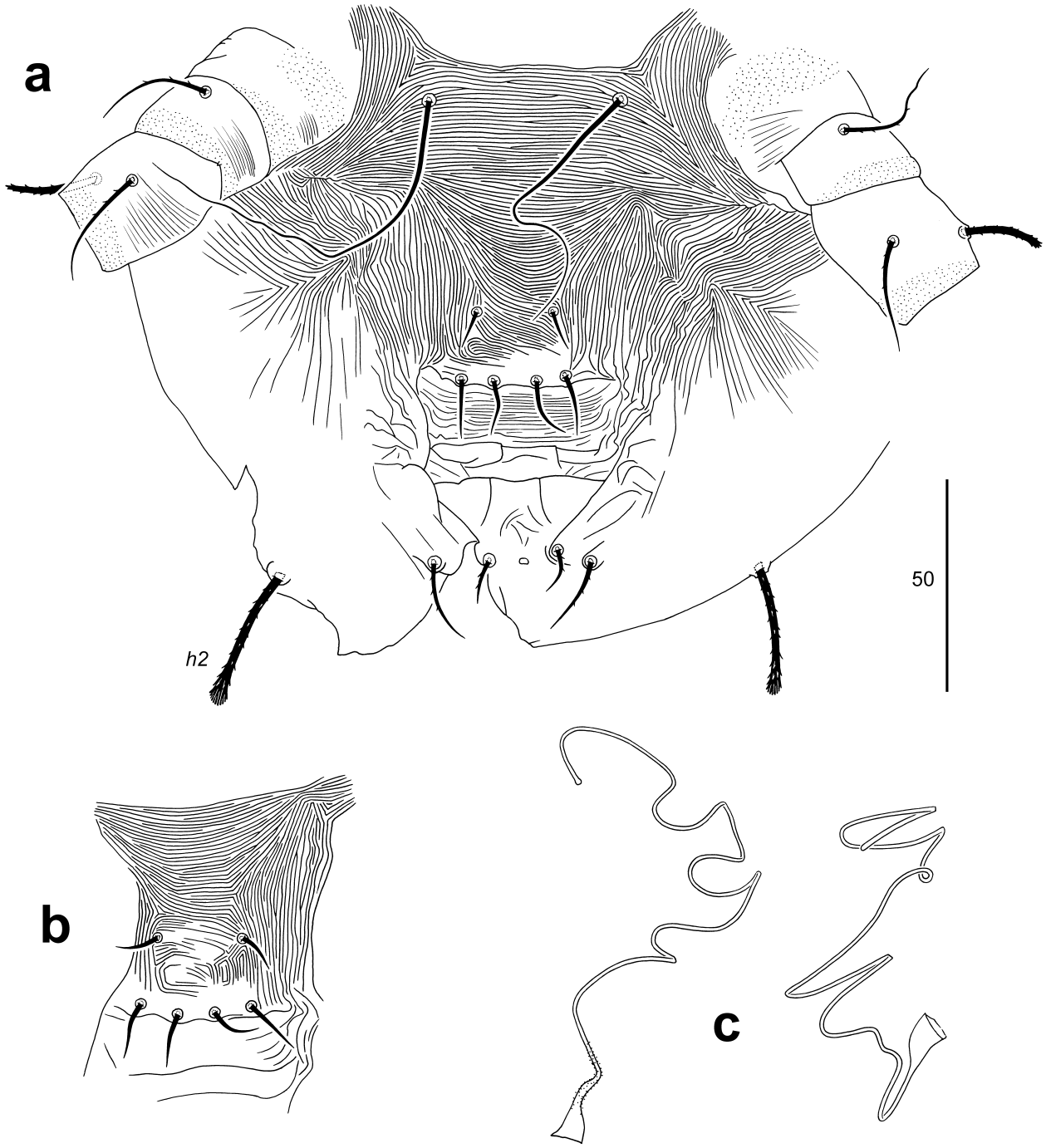


FIGURE 185. *Raoiella pooleyi* Beard & Ochoa, adult female: a. posterior venter; b. variation in striae in genitoanal region; c. detail of spermatheca.

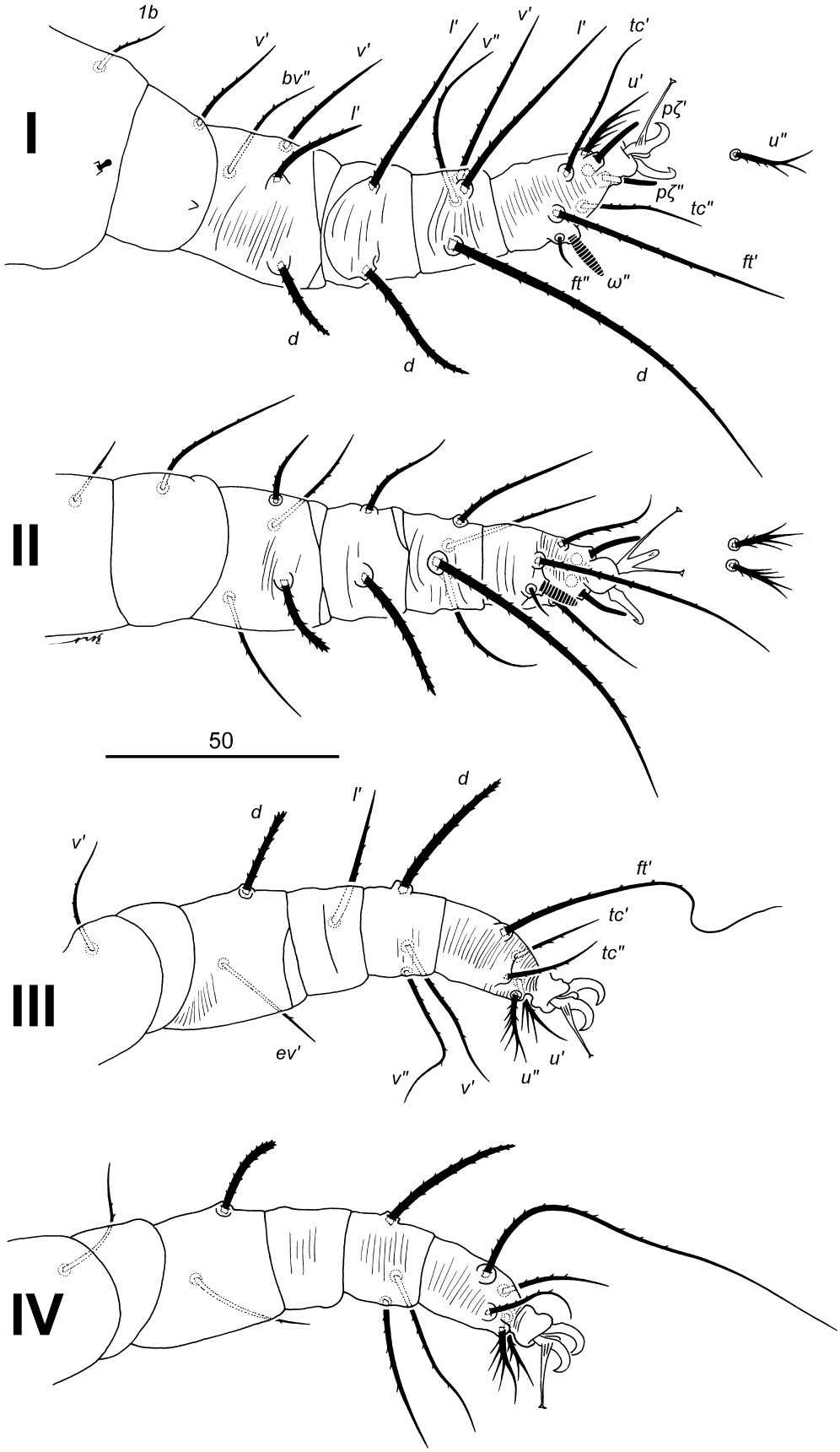


FIGURE 186. *Raoiella pooleyi* Beard & Ochoa, adult female: legs I–IV (right side; leg I dorsal to adaxial aspect, leg II dorsal aspect, legs III–IV abaxial aspect).

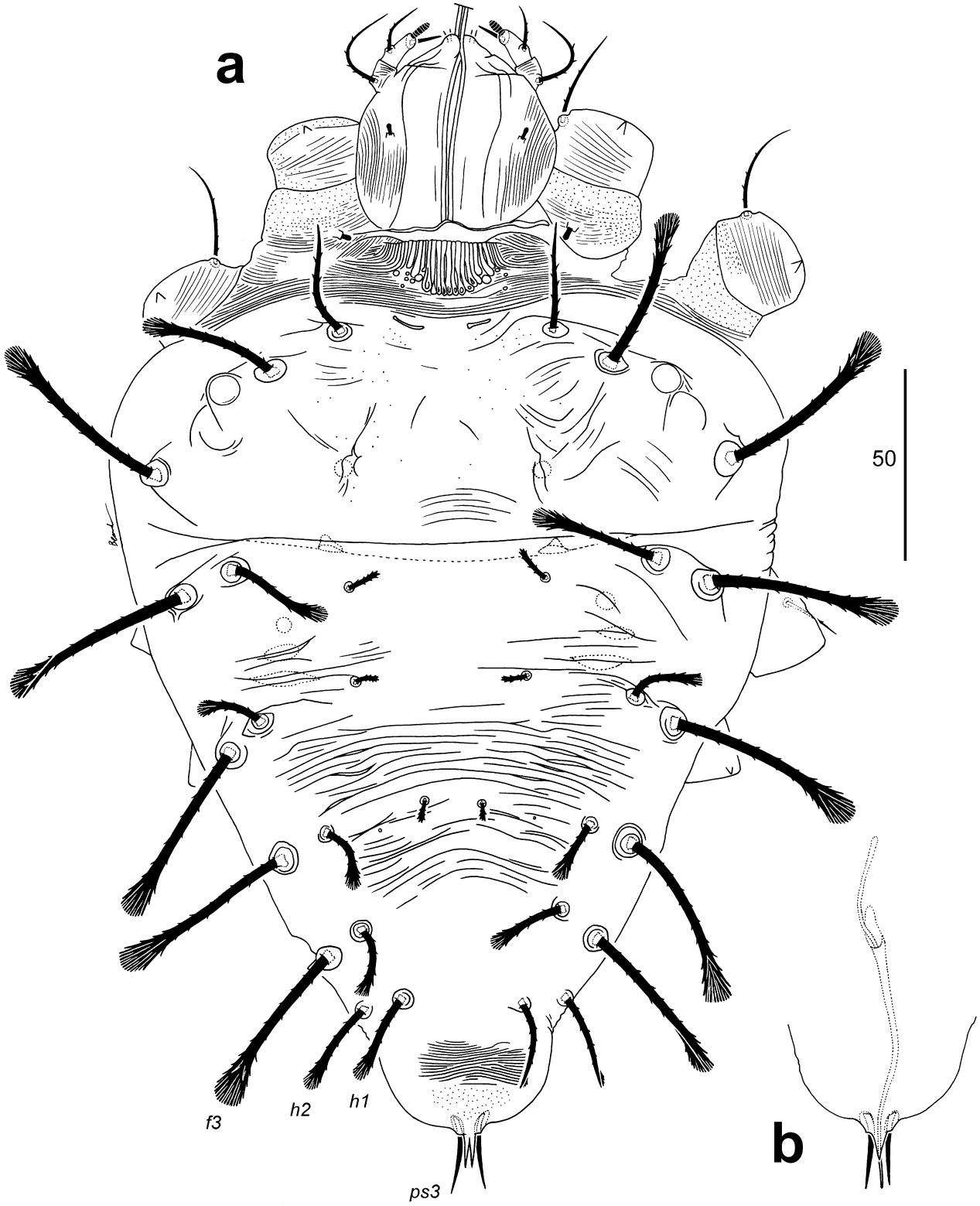


FIGURE 187. *Raoiella pooleyi* Beard & Ochoa, adult male: a. dorsal habitus with detail of palps and setae *ps3*; b. detail of aedeagus and setae *ps3* (dorsal aspect; aedeagus emerging from under a small, dorsal, posteromedial extension (note: extension divided in a. and Fig. 188)).

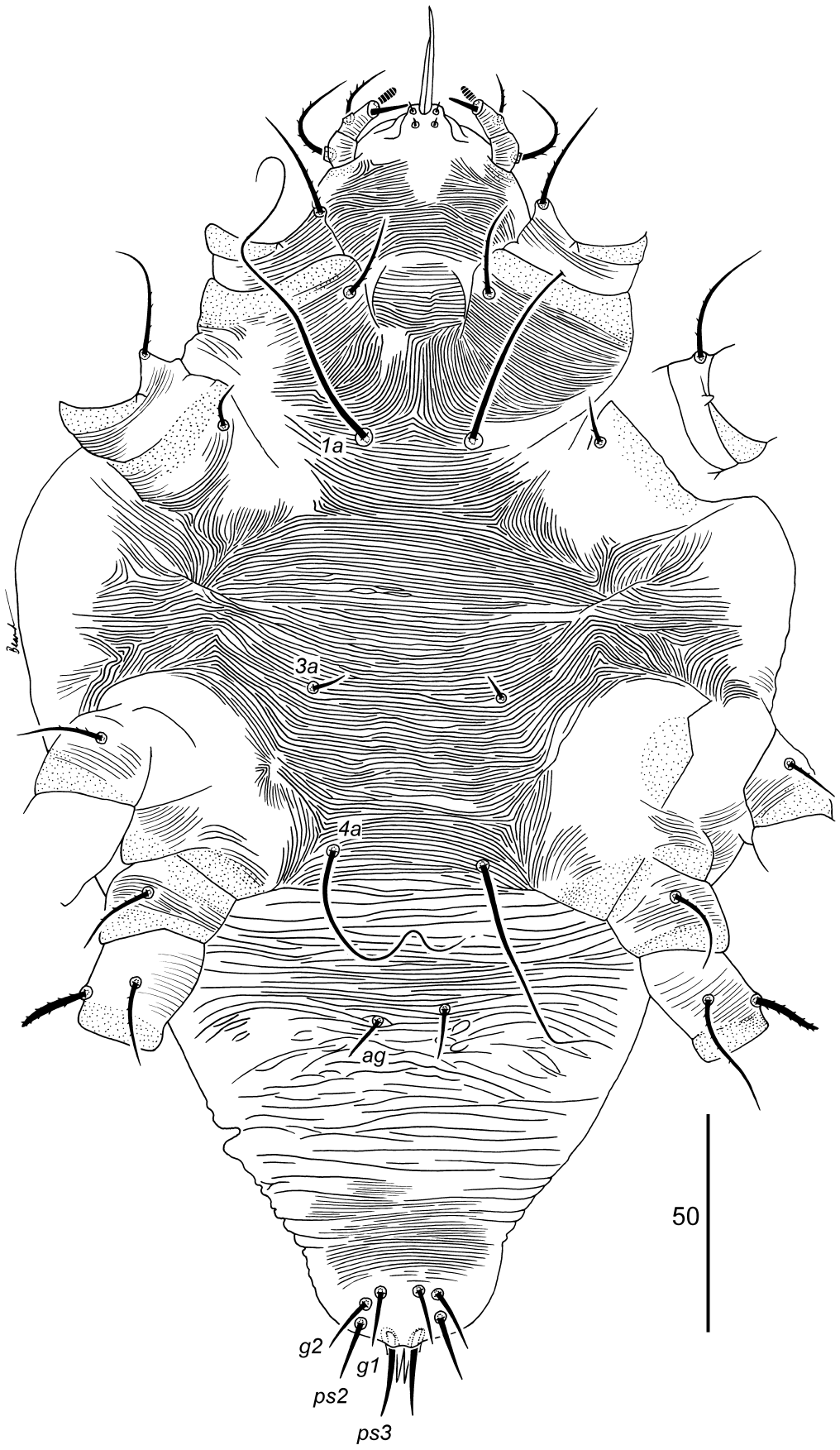


FIGURE 188. *Raoiella pooleyi* Beard & Ochoa, adult male: ventral habitus, with detail of setae *ps3*.

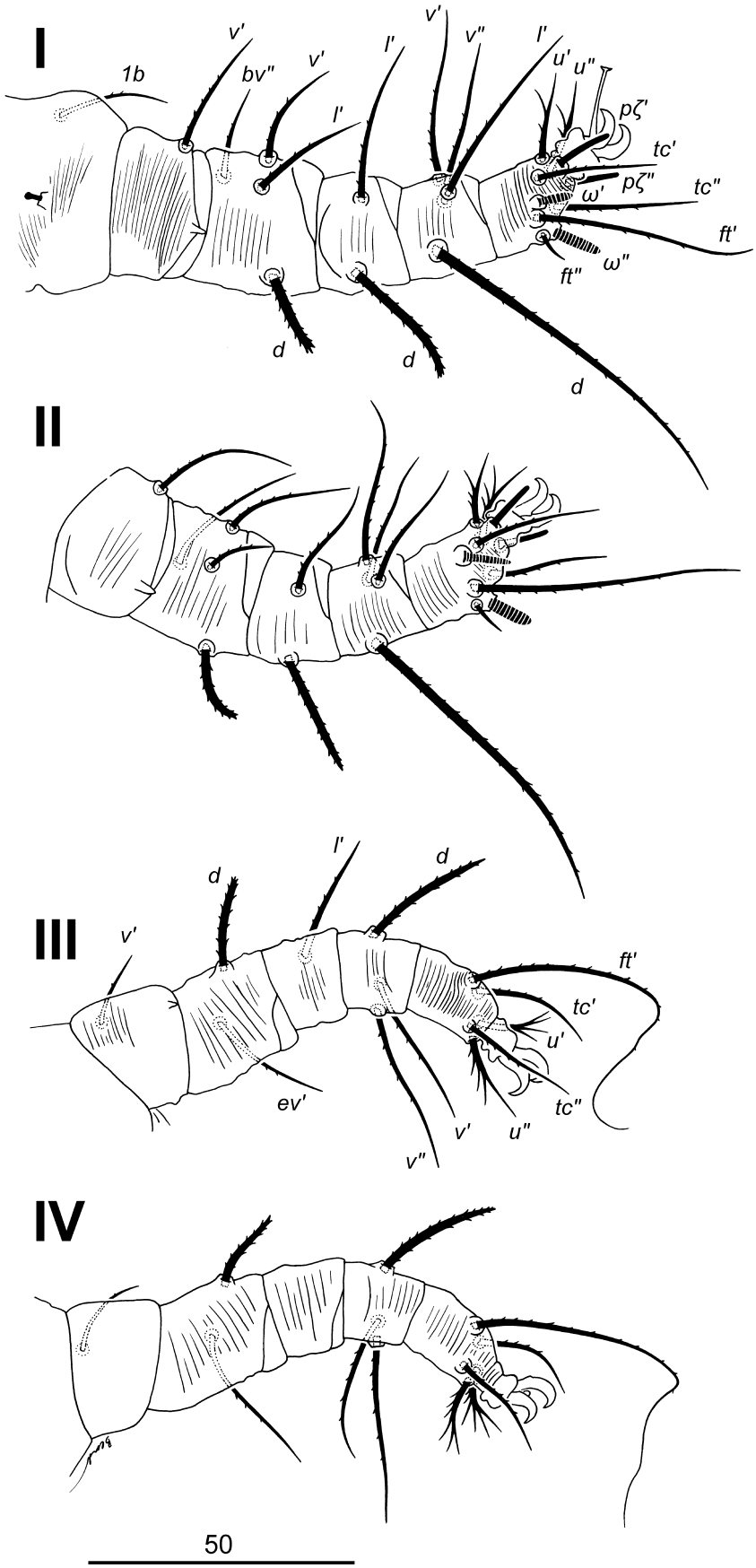


FIGURE 189. *Raoiella pooleyi* Beard & Ochoa, adult male: legs I–IV (right side; legs I–II dorsal to adaxial aspect, legs III–IV abaxial aspect).

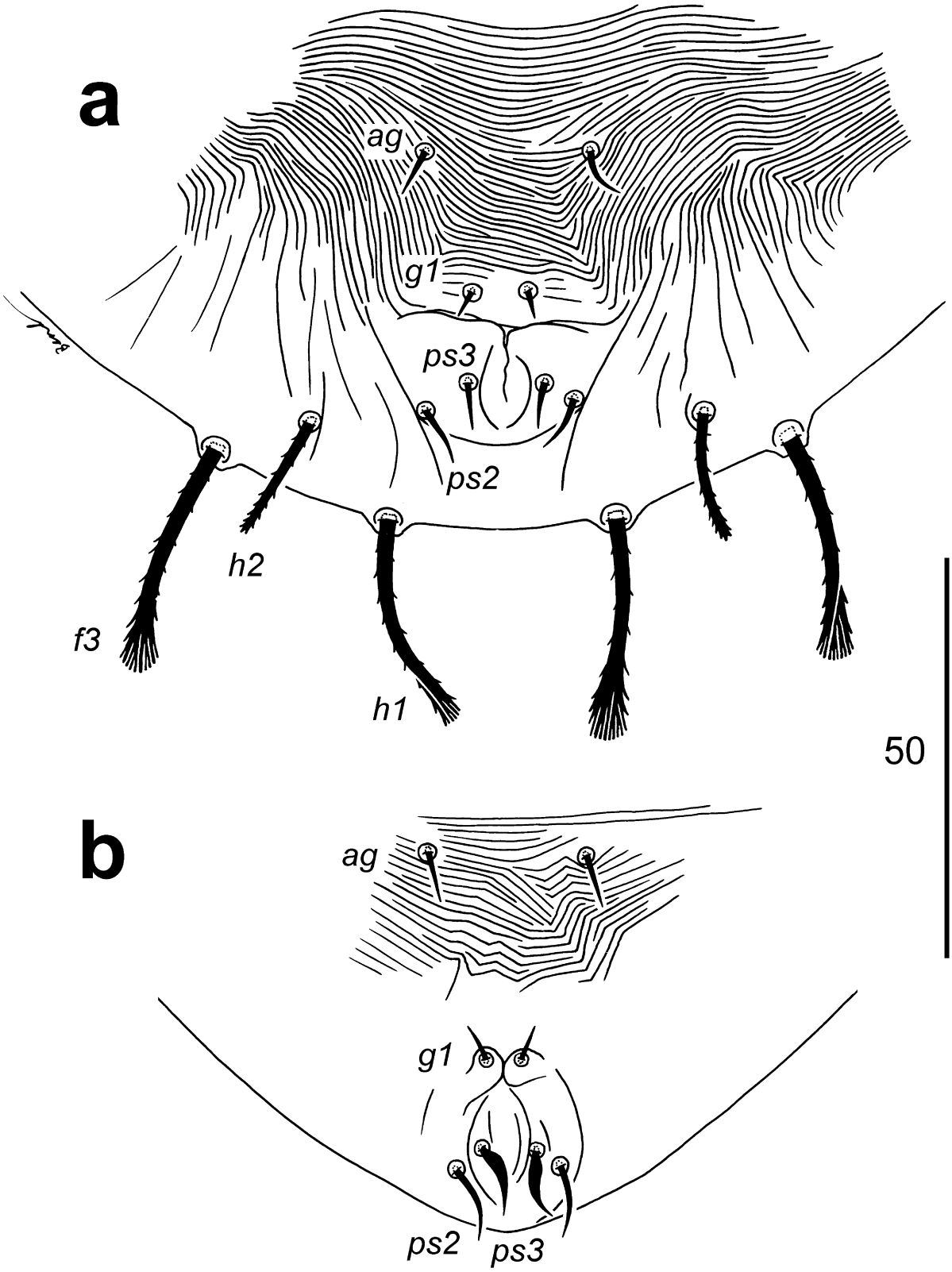


FIGURE 190. *Raoiella pooleyi* Beard & Ochoa, deutonymph posterior venter: a. female deutonymph; b. male deutonymph (with detail of modified *ps3* setae).

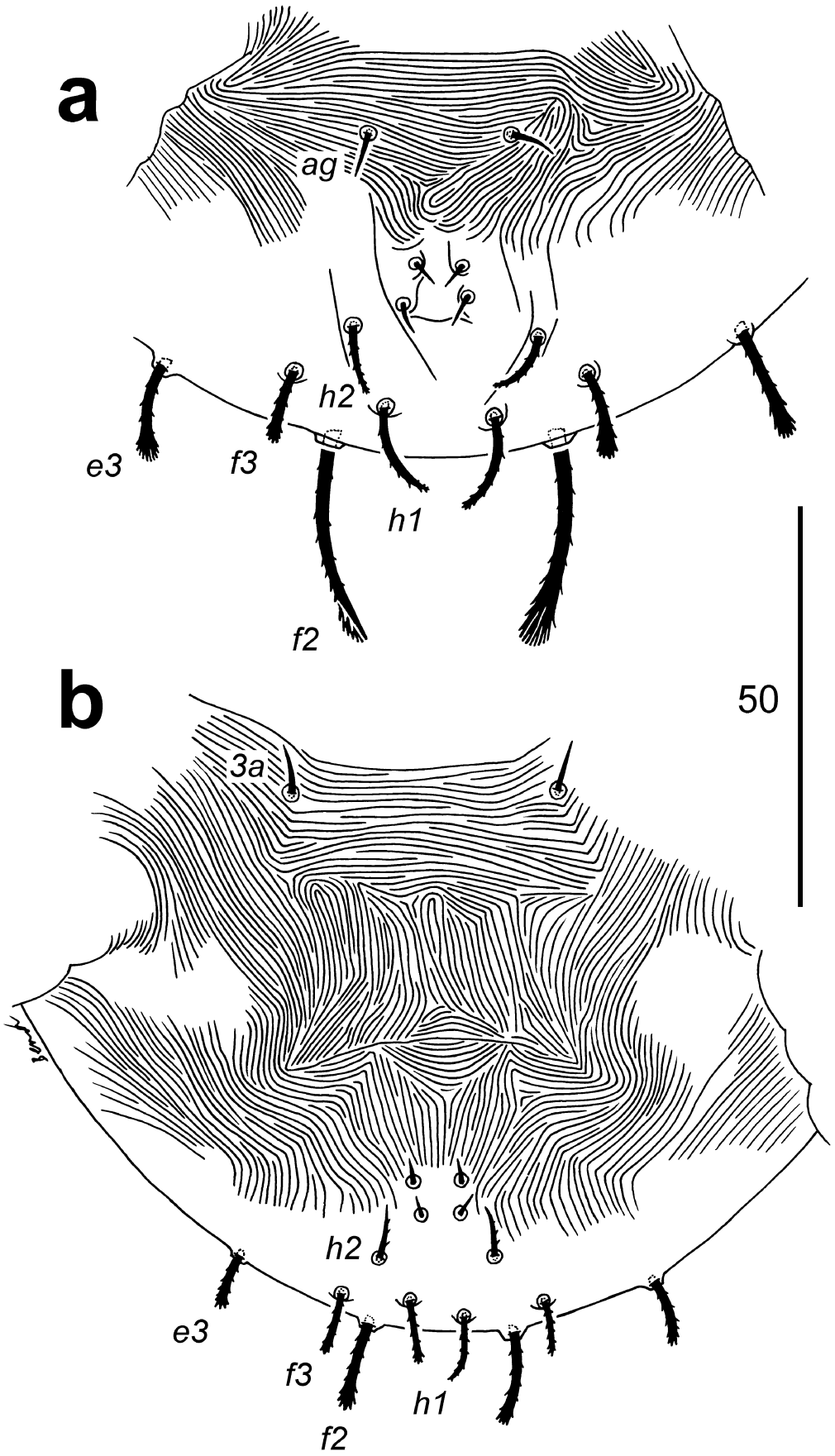


FIGURE 191. *Raoiella pooleyi* Beard & Ochoa, posterior venter: a. protonymph; b. larva.



FIGURE 192. *Raoiella pooleyi* Beard & Ochoa, larva: a. dorsal habitus; b. detail of palp.

Male. ***Dorsum.*** (Figs 187, 193) Body measurements (18): length between setae *v2–h1* 157–182, width between setae *sc2–sc2* 135–152, *c3–c3* 126–138, *f3–f3* 62–72. Prodorsum smooth with a few scattered punctations and fine plicae; with a large pore mesally and a large pore on the posterior margin (often hidden in fold of sejugal region). Dorsal opisthosoma with some transverse plicae between setae *d1* and *e1*; with three pairs large slit pores between *c1–d2*, pair of minute pores between *e1–e2*. Dorsal cuticle posterior to *h1–h1* (weak pygidial shield) with band of fine transverse striae, and finely pustulate near posterior margin; posterior margin with pair cuticular, elongate triangular projections, associated with genital stylets (setae *ps3*) (Figs 187a,b, 188). All dorsal setae barbed along entire length, and all dorsal setae spatulate, except *v2* tapered, and central opisthosomal setae (*c1*, *d1*,

e1) weakly spatulate to blunt distally; setae *h1*, *h2* often only weakly spatulate. Dorsal setae measurements: *v2* 22–33, *sc1* 31–47, *sc2* 42–59, *c1* 9–12, *c2* 24–36, *c3* 43–62, *d1* 6–11, *d2* 16–26, *d3* 42–58, *e1* 5–10, *e2* 17–22, *e3* 41–56, *f2* 18–28, *f3* 41–52, *h1* 22–31, *h2* 24–31.

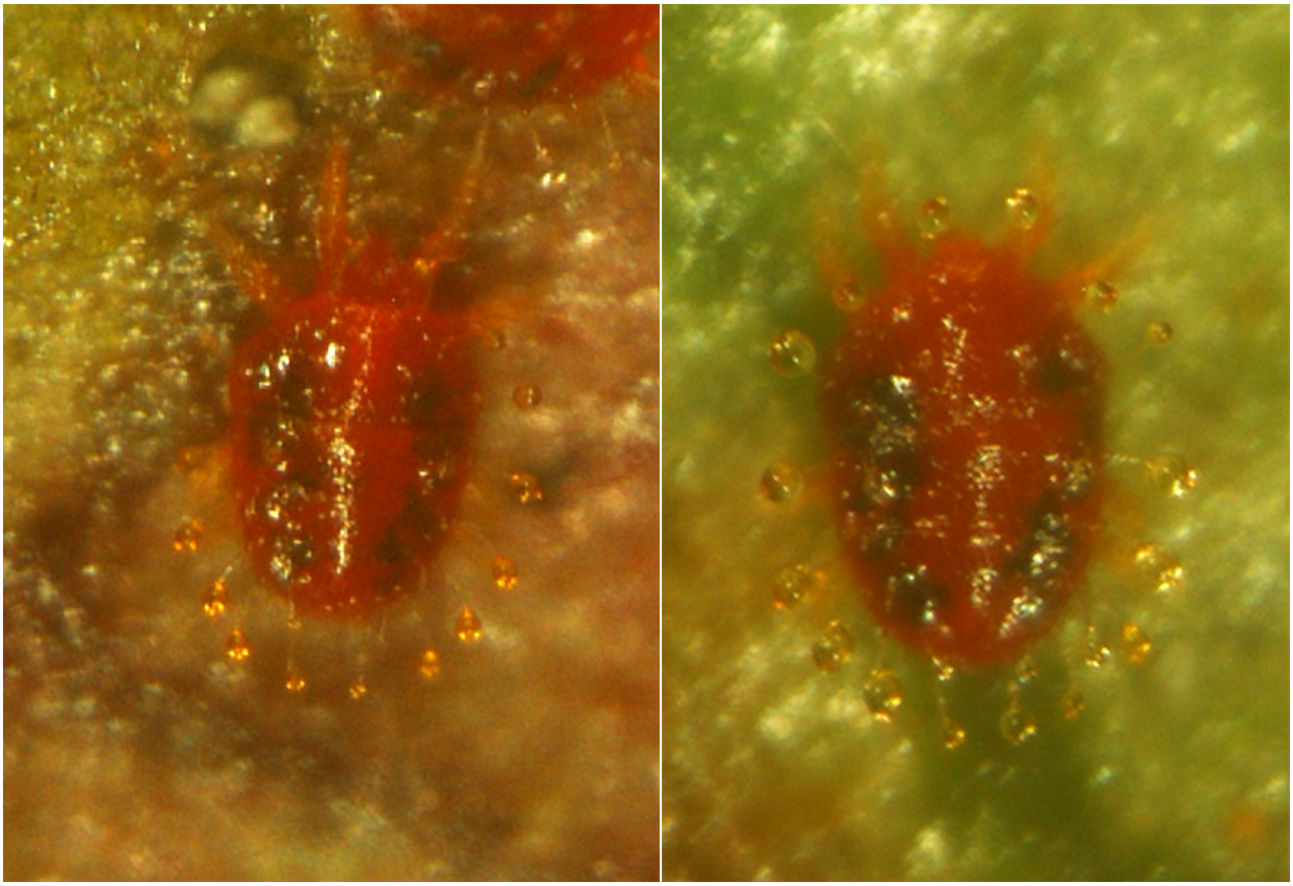


FIGURE 193. *Raoiella pooleyi* Beard & Ochoa, live individuals: adult females on host plant; note the orange droplets.

Palps. (Fig. 187a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one narrow blunt eupathidium (6–9) distally, one barbed dorsal seta (11–13); palp femorogenu with one barbed seta (22–28).

Venter. (Fig. 188) Ventral cuticle almost completely plicate, covered in mostly transverse striae; anterior striae finely and narrowly spaced, striae posterior to *4a–4a* widely spaced; coxal fields smooth. Ventral infracapitulum with fine transverse striae; striae transverse, stronger, between setae *1b–1b*; striae longitudinal between *1b–1a*; striae transverse *1a–g1*. Setae *3b*, *4b* absent. Setae *ag*, *g1*, *g2*, *ps2* smooth; setae *ps2* slightly thicker than *g1–g2*. Setae *ps3* modified as accessory genital stylets, into thickened, slightly curved, tapered spines (Figs 187–188). Setal measurements: *1a* 53–96, *1b* 17–28, *2b* 9–13, *3a* 6–10, *4a* 43–74, *ag* 9–13, *g1* 13–16, *g2* 11–16, *ps2* 14–18, *ps3* 19–22.

Aedeagus. (Fig. 187b) Aedeagus narrow, elongate and sclerotised (60–70; 65–80 including basal membranous expansion (Fig. 187b)), tapering to a fine yet blunt point distally (towards genital opening).

Legs. (Fig. 189) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-10(2), 1-1-4-2-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial *ω′* 6–8, abaxial *ω″* 9–10; ta II adaxial *ω′* 6–8, abaxial *ω″* 8–10), and two eupathidia *pζ′–pζ″* distally (ta I 11–12, 10–11; ta II 10–11, 10–11). Short smooth companion seta *ft″* on tarsus I 6–10 and tarsus II 5–9, inserted adjacent to solenidion *ω″*, sharing the same tubercle. Tibiae I–II with dorsal seta finely tapered. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″* present; *l′* added in adult delayed from deutonymph); genua I–II with two setae (*d*, *l′*) (*d* added in deutonymph). Claw I 10–11 long; tenent hairs with four attachment points. Claw IV 9–11; tenent hairs with four–five attachment points.

Deutonymph. *Dorsum.* Body measurements (11 female, 4 male): length between setae *v2–h1* female 196–231 (male 148–172), *v2–f2* 186–208 (138–156), width between setae *sc2–sc2* 164–188 (124–141), *c3–c3* 164–182

(122–136), *f2–f2* 45–51 (37–39), *f3–f3* 65–78 (51–54). Prodorsal cuticle smooth. Dorsal opisthosoma with widely spaced transverse striations between *c1–e1*; no pores visible. Lateral setae (*c3*, *d3*, *e3*, *f3*) shorter than sublateral setae (*c2*, *d2*, *e2*, *f2*). Dorsal setae with spatulate tips, barbed along entire length; *v2* spatulate on both male and female deutonymphs (tapered on adult male); setae *f3, h1*, *h2* weakly spatulate, barbed, often inserted ventrally. Dorsal setae measurements: *v2* 53–65 (39–47), *sc1* 53–65 (41–49), *sc2* 43–56 (30–42), *c1** 8–19 (8–23), *c2* 51–63 (36–44), *c3* 37–49 (24–42), *d1** 6–26 (5–16), *d2* 47–60 (35–44), *d3* 34–42 (23–34), *e1** 7–26 (7–19), *e2* 40–57 (30–39), *e3* 25–36 (17–29), *f2* 40–55 (28–38), *f3* 22–31 (15–25), *h1* 23–35 (17–24), *h2* 12–21 (12–18) (* = most deutonymphs measured have *c1* and *d1* 8–10 and *e1* 7–13, but two female deutonymphs have *c1* 16–19, *d1* 19–26, *e1* 23–26 and one male deutonymph has *c1* 22–23, *d1* 16, *e1* 15–19. These measurements are close to those of the protonymph stage, and most likely represent developmental mistakes. An additional three female deutonymphs (measurements not included) had abnormally long *c1*, *d1*, *e1* setae.)

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion, both sexes 4–5, and one narrow, blunt eupathidium 8–9 (6–7) distally; both sexes one dorsal seta 9–13; palp femorogenu with one seta 23–27 (19–23).

Venter. (Fig. 190) Cuticle almost completely plicate, covered with mostly transverse striae; longitudinal striae between *1b–1a*, transverse striae *1a–g1*, with longitudinal and oblique striae laterad genital region. Female posterior opisthosoma broadly rounded (Fig. 190a); with transverse to slightly oblique striae between *ag–ag*; posterior margin of genital flap beginning to form posterior to setae *g1*; setae *ps2* longer than, but not of different form to, setae *ps3* (Fig. 190a); *ps2–3* barbed in female (see also Figs 20a, 128a, 234a). Male posterior opisthosoma tapered (Fig. 190b); with mixed striae between setae *ag–ag*; setae *ps3* beginning to modify, of different form to *ps2*, with bulbous base and tapered tip, often curved (Fig. 190b) (see also Figs 20b, 128b, 234b). Setae *1a* and *4a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 47–93 (38–82), *1b* 13–21 (11–17), *3a* 7–9 (6–8), *4a* 34–58 (22–32), *ag* 6–8 (5–7), *g1* 4–7 (4–6), *ps2* 6–8 (8–9), *ps3* 6–7 (9–10).

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 7–8 (6–7); ta II 7–8 (6)) and two eupathidia distally (ta I 9–10, 8–9 (7–8, 7–8); ta II 9, 8–9 (8, 8)). Short smooth companion seta *ft″* on tarsus I 4–6 (3–4) and tarsus II 4–5 (4), adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; seta *l′* absent (*l′* normally added in deutonymph); genua I–II with two setae (*d*, *l′* present; *d* added in deutonymph). Claw I 9–10 in both sexes; tenent hairs with three attachment points. Claw IV 8–9 in both sexes; tenent hairs with four attachment points.

Protonymph. ***Dorsum.*** Body measurements (10): length between setae *v2–h1* 139–161, *v2–f2* 135–165, width between setae *sc2–sc2* 117–146, *c3–c3* 118–153, *f2–f2* 26–31, *f3–f3* 38–46. Prodorsum with well developed shield, wrinkled, with weak longitudinal to oblique striae. Dorsal opisthosoma with widely spaced transverse striae between *c1–e1*. Dorsal setae spatulate, barbed along entire length; setae *f3* blunt to weakly spatulate inserted ventrolaterally; setae *h1*, *h2* tapered to blunt, tapered and inserted ventrally. Lateral setae (*c3*, *d3*, *e3*, *f3*) shorter than sublateral setae (*c2*, *d2*, *e2*, *f2*). Dorsal setae measurements: *v2* 37–55, *sc1* 39–58, *sc2* 23–39, *c1* 9–13, *c2* 36–54, *c3* 20–32, *d1* 6–19, *d2* 32–53, *d3* 18–25, *e1** 9–25, *e2* 26–42, *e3* 12–17, *f2* 21–35, *f3* 10–13, *h1* 11–15, *h2* 9–12 (* = two individuals with setal pair *e1* measuring 9–18 and 23–25).

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–6) and one narrow, blunt eupathidium (6–7) distally, one dorsal seta (8–11); palp femorogenu with one seta (17–22).

Venter. (Fig. 191a) Cuticle almost completely plicate, covered with mostly transverse striae; striae transverse between setae *1b–1b*; striae weak, transverse between *1a*–ag; striae mixed and oblique *ag–ps3*; with longitudinal striae around coxal fields III–IV. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 38–66, *1b* 12–14, *3a* 7–8, *ag* 4–7, *ps2* 3–7, *ps3* 3–7.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 5–6; ta II 5–6) and two eupathidia distally (ta I 7–8, 7–8; ta II 6–7, 6–7). Smooth companion seta *ft″* on tarsus I 3–4 and tarsus II 3–4, adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta, *d*, tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; seta *l′* absent); genua I–II with one seta (*l′* present; *d* absent). Claw I 8–9 long; claw IV 7–8 long; tenent hairs with three attachment points.

Larva. ***Dorsum.*** (Fig. 192a) Body measurements (11): length between setae *v2–f2* 117–139, *v2–e1* 105–125, width between setae *sc2–sc2* 100–121, *c3–c3* 105–126, *e3–e3* 50–56, *f2–f2* 16–22, *f3–f3* 26–33. Prodorsum with longitudinal crescent shaped striations mesally, with transverse crescent striations posteromedially; *v2*, *sc1* long,

strongly spatulate, barbed; *sc2* short, weakly spatulate to blunt, barbed. Opisthosoma with transverse striae between setae *c1–d1*. Anterior opisthosomal setae spatulate, posterior setae weakly spatulate to blunt; setae *d3* and *e3* short, weakly spatulate to blunt, barbed; setae *f2* weakly spatulate, barbed; setae *f3* short, blunt, barbed; setae *h1* short, blunt or tapered, barbed; *h2* short, tapered, barbed; setae *e3*, *f2*, *f3* often inserted ventrolaterally; setae *h1*, *h2* inserted ventrally. Dorsal setae measurements: *v2* 31–41, *sc1* 41–52, *sc2* 16–23, *c1* 23–32, *c2* 31–39, *c3* 12–20, *d1* 26–33, *d2* 26–31, *d3* 9–16, *e1* 21–29, *e2* 18–23, *e3* 7–11, *f2* 9–15, *f3* 6–9, *h1* 5–10, *h2* 5–9.

Palps. (Fig. 192b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (3–5) and one tapered, seta-like eupathidium (8–10) distally, and one seta dorsally (7–9); palp femorogenu with one seta (12–16).

Venter. (Fig. 191b) Cuticle almost completely plicate, except coxal fields smooth; striae transverse *1a–3a*; striae between *3a–ps3* with band of longitudinal striae and a small area of transverse striae forming a diamond within the longitudinal striae (Fig. 191b) (see also Figs 23, 44, 56, 70, 100, 115b, 129a, 146, 161b, 178, 238, 268). Setal measurements: *1a* 27–43, *1b* 9–14, *3a* 5–8, *ps2* 3–4, *ps3* 3–4.

Legs. Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Genua I–II with one seta (*l′*). Tarsi I and II each with one abaxial solenidion *ω″* (ta I 4–6; ta II 4–5) and two eupathidia *pζ″–pζ″* distally (ta I 6–7, 6–7; ta II 6–7, 6–7). Companion seta *ft″* on tarsus I 3–5 and tarsus II 3–4, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta finely tapered. Claw I 7–8, claw IV 7–8, tenent hairs with three attachment points.

Egg. Red, ellipsoid in shape to slightly globose, and a distal stipe approximately twice as long as egg.

Host. Brush Box, *Lophostemon confertus* (Myrtaceae).

Distribution. AUSTRALIA: Brisbane, Queensland.

Etymology. This species is named in honour of Mr Chris Pooley, our collaborator and imaging specialist, for his dedication and continued contributions to our acarological research.

Remarks. *Raoiella pooleyi* has distinctly orange-tinted droplets on the tips of the dorsal setae (Fig. 193). *Raoiella pooleyi* is morphologically similar to the other species in the *R. bauchani* species group, *R. bauchani* and *R. goyderi*, but can be separated by the following: *Rb* setae *f2* subequal in length to *f3*, *Rp* and *Rg* setae *f2* shorter than *f3*; *Rb* palp tibiotarsus elongate, *Rp* and *Rg* with palp segments of regular length; *Rb* with dorsal setae *c1* > *d1* > *e1*, *Rp* with setae *c1*, *d1*, *e1* minute, *Rg* with setae *c1*, *d1*, *e1* short.

The measurements for the type material are presented separately in the description above for the following reasons. The original collection of this species was made from Gap Creek Reserve and specimens were mounted in PVA. A second collection was made from a separate site in Redland Bay, and these specimens were mounted in Hoyer's medium. This series of slides became the type series. A third collection was later made from the original site for species confirmation, and these specimens were also mounted in Hoyer's medium. The original PVA material has begun to degrade and the specimens are somewhat wrinkled, shrivelled and distorted. The measurements for the original material represent the lower end of the range presented above, while the Hoyer's mounted material represents the upper end of the range. For this reason, we have presented the full ranges of measurements for both populations, which is followed by the measurements for the holotype and paratypes in square brackets. Such a phenomenon should be considered by acarologists when dealing with specimens in different media and of different ages.

Specimens of *R. pooleyi* were not included in molecular analyses by Dowling *et al.* (2012).

Raoiella shimpana **Meyer**

(Figs 194–199)

Material examined. Holotype. ♀, **South Africa**, Ngwanetsi River, Kruger National Park, ex. *Cassine transvaalensis* (Celastraceae), 27.ix.1963, M.K.P. Meyer (NCD).

Paratypes. 3 ♀, ♂, pharate ♀, deutonymph, same data as Holotype (AcY: 77/833) (one slide, NHM).

Diagnosis. Female. Opisthosomal setae *f2* longer than *f3*; setae *h1* subequal in length with *h2*. Setae *h2* spatulate. Dorsal setae with plumose spatulate tips. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*); genua I–II with three setae (*d*, *l′*, *l″* present); coxae I with two setae (*1b*, *1c* present); coxae III–IV with one seta (setae *3b*, *4b* present). Tarsus I with companion setae (*ft″*) obviously longer than solenidia; tarsus II with companion seta obviously shorter than solenidion. Dorsal setae on tibiae I–II tapered. Eupathidium on palp tibiotarsus thick, with tapered forked tip.

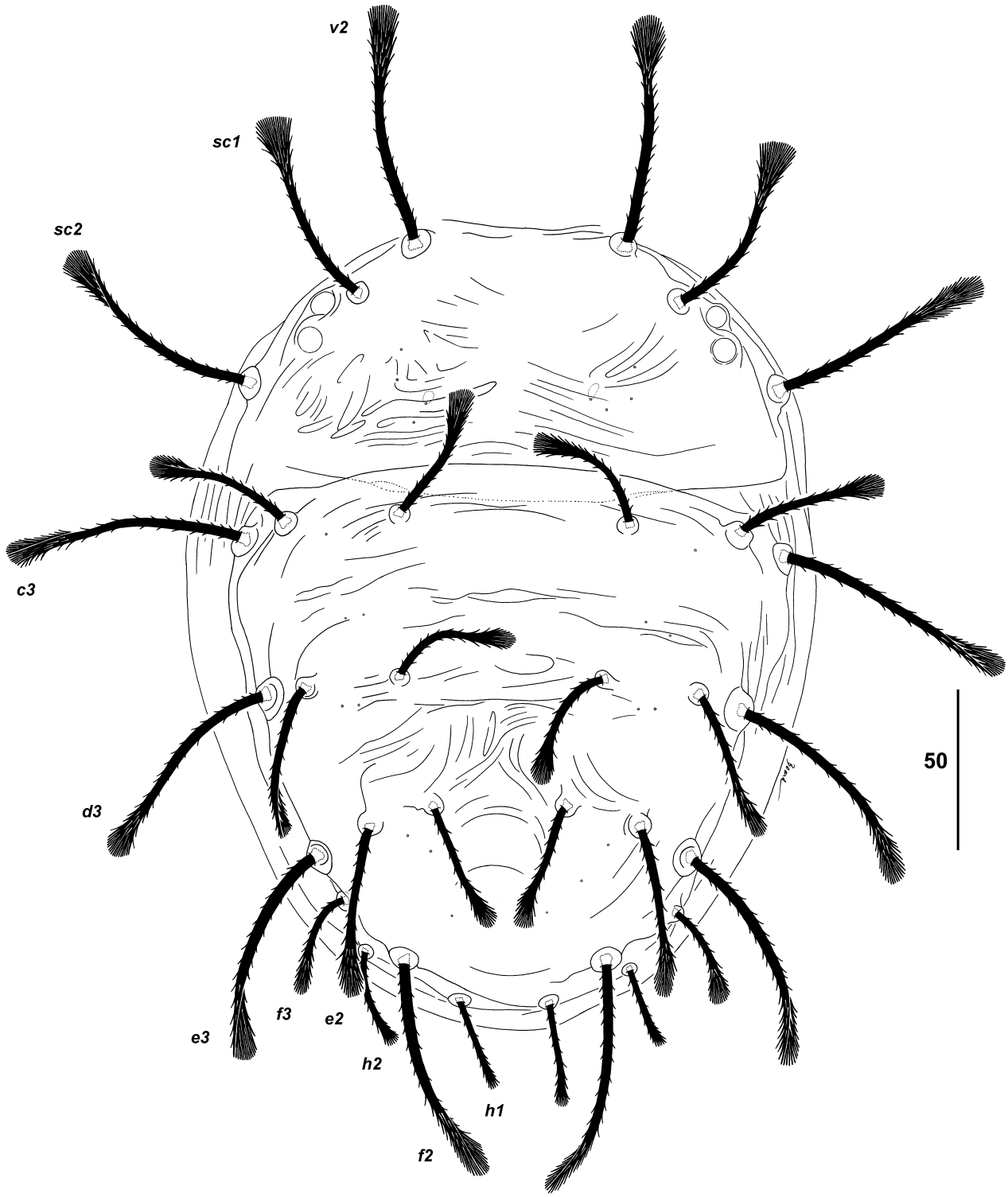


FIGURE 194. *Raoiella shimpana* Meyer, adult female: dorsal habitus.

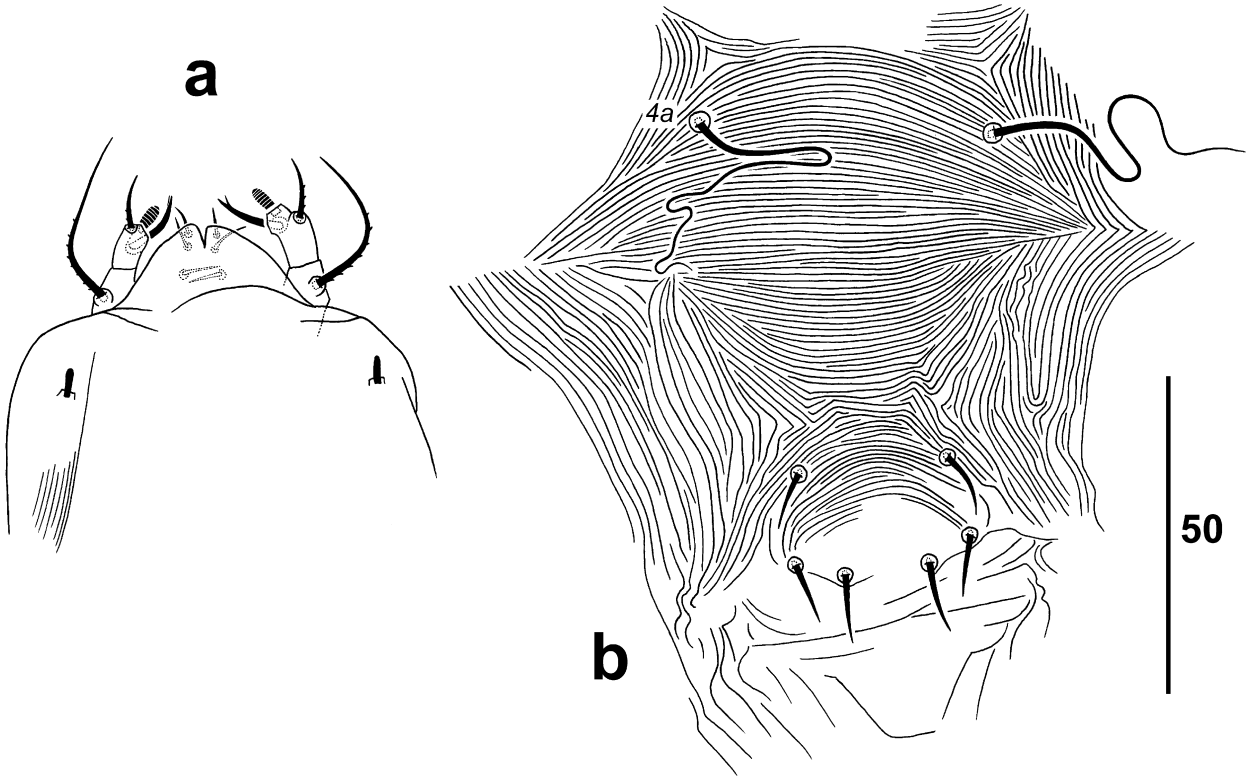


FIGURE 195. *Raoiella shimpana* Meyer, adult female: a. details of palps (dorsal view of infracapitulum); b. detail of genital region (posterior venter).

Description. Female. ***Dorsum.*** (Fig. 194) Body measurements (4): length between setae *v2–h1* 242–246, width between setae *sc2–sc2* 165–169, *c3–c3* 169–176, *f2–f2* 60–63, *f3–f3* 101–103. Lightly sclerotised prodorsal and opisthonotal shields evident. Prodorsum with four pairs small pores sublaterally, pair pores on posterior margin of the prodorsal shield (hidden within folds of sejugal region); opisthosoma with pair of minute pores between *c1–c2*, two pairs minute pores between *c2–d2*, two pairs minute pores between *d1–d2*, and three pairs minute pores between *e1–f2*. All dorsal setae spatulate, often with plumose tips, barbed along entire length. Dorsal setae measurements: *v2* 73–77 [75], *sc1* 57–66 [59], *sc2* 75–79 [84], *c1* 46–47 [46], *c2* 50–52 [51], *c3* 74–83 [81], *d1* 42–45 [42], *d2* 50–54 [54], *d3* 76–80 [79], *e1* 41–48 [43], *e2* 50–57 [53], *e3* 76–80 [80], *f2* 76–81 [81], *f3* 34–38 [37], *h1* 31–39 [33], *h2* 27–35 [35].

Palps. (Fig. 195a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6), one thick eupathidium with a tapered forked tip (10–11) (Fig. 195a), one dorsal seta; palp femorogenu with one dorsal seta (19–26).

Venter. (Fig. 195b) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on posterior margin of genital flap. Setae *1a*, *4a* often elongate, fine (difficult to determine full length). Setal measurements: *1a* 86–111, *1b* 20–23, *1c* 10–12, *2b* 8–10, *3a* 10–12, *3b* 9–10, *4a* 68–89, *4b* 8–9, *ag* 10–11, *g1* 11–13, *g2* 11–13, *ps2* 9–10, *ps3* 10–11.

Spermatheca. A narrow membranous tube is visible.

Legs. (Fig. 196) Setal formula for legs I–IV (coxae to tarsi): 2-1-4-3-4-9(1), 1-1-4-3-4-9(1), 1-1-2-1-3-5, 1-1-2-0-3-5 respectively. Tarsi I and II each with one adaxial solenidion (ta I 12–13; ta II 11–12) and two eupathidia distally (ta I 11–12, 11–12; ta II 11–12, 11–12). Companion seta *ft″* on tarsus I elongate, tapered 47–49 and on tarsus II short 8–9, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta tapered, sometimes not finely tapered distally. Claw I 13.

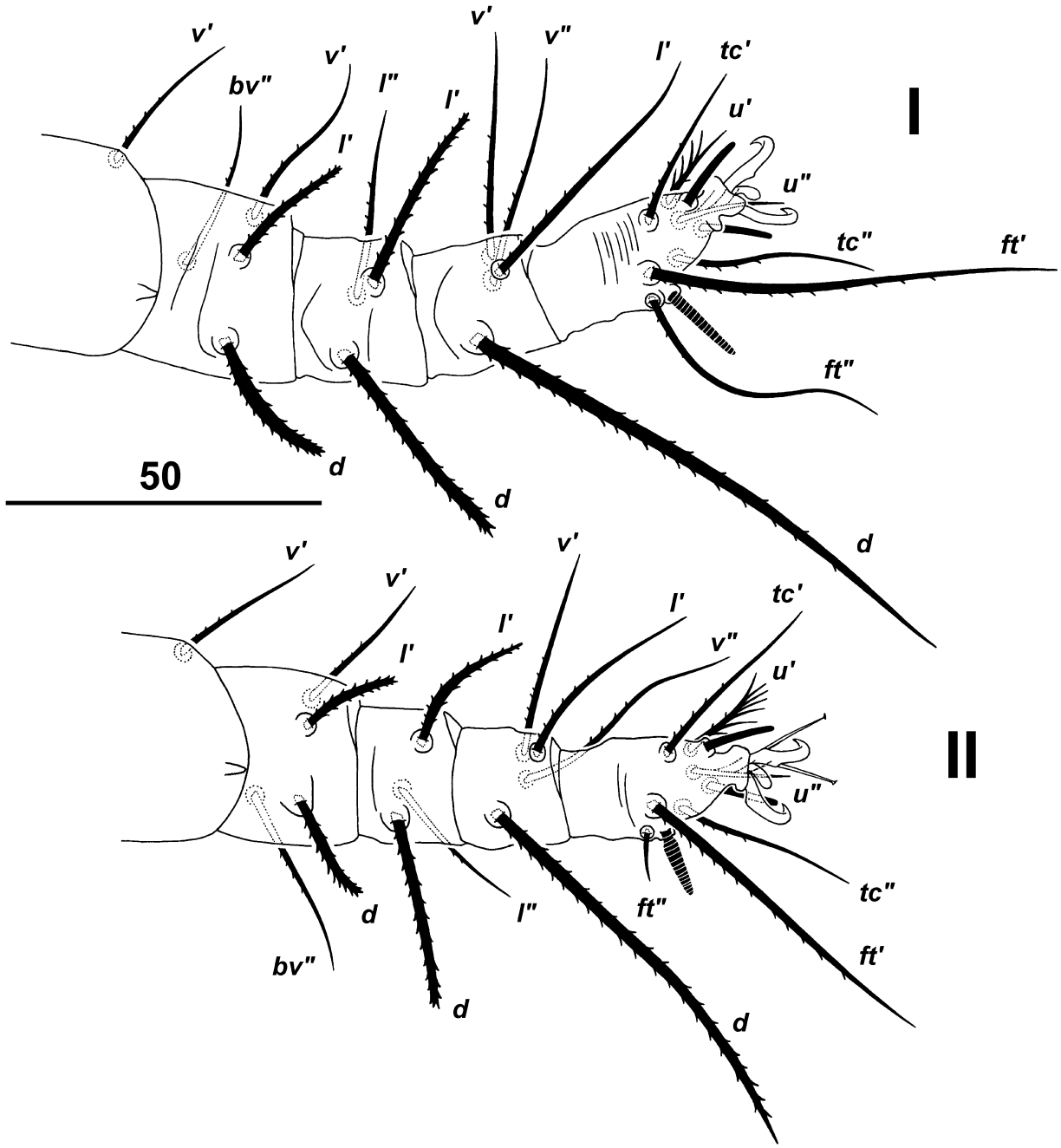


FIGURE 196. *Raoiella shimpana* Meyer, adult female: legs I–II (right side, dorsal to adaxial aspect).

Male. ***Dorsum.*** (Fig. 197a) Body measurements (2): length between setae *v2–h1* 161, width between setae *sc2–sc2* 126, *c3–c3* 128, *f2–f2* 46, *f3–f3* 72. Lightly sclerotised prodorsal shield evident. Prodorsum mostly smooth with some weak transverse folds. Opisthosoma with transverse folds between *c1–e1*; smooth cuticle between *e1–h1*; with a pair of transverse slit pores anterior to *d1–d2*. Dorsal setae spatulate, barbed along entire length, narrower than female. Setae *f2* and *f3* inserted in transverse row; *h1–h2* weakly spatulate to broadly blunt. Dorsal setae measurements: *v2* 40–49, *sc1* 30–40, *sc2* 66–67, *c1* 34–35, *c2* 39–41, *c3* 63–68, *d1* 33–36, *d2* 36–45, *d3* 63–72, *e1* 29–30, *e2* 34–37, *e3* 61–66, *f2* 31–33, *f3* 27–30, *h1* 18–21, *h2* 20–26.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–5), one eupathidium (10–11), one dorsal seta; palp femorogenu with one dorsal seta (19).

Venter. Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and a distinct patch of smooth cuticle on either side of setae *ag*. Setae *ps3* modified as accessory genital stylets, into

short stout spurs (Fig. 197a). Setal measurements: *1a* 68–76, *1b* 16–18, *1c* 8–11, *2b* 7–8, *3a* 9–10, *3b* 7–8, *4a* 51, *4b* 9–10, *ag* 11, *g1* 10–11, *g2* 11–12, *ps2* 8–9, *ps3* 11.

Aedeagus. (Fig. 197b) Aedeagus narrow, elongate, tapering (60).

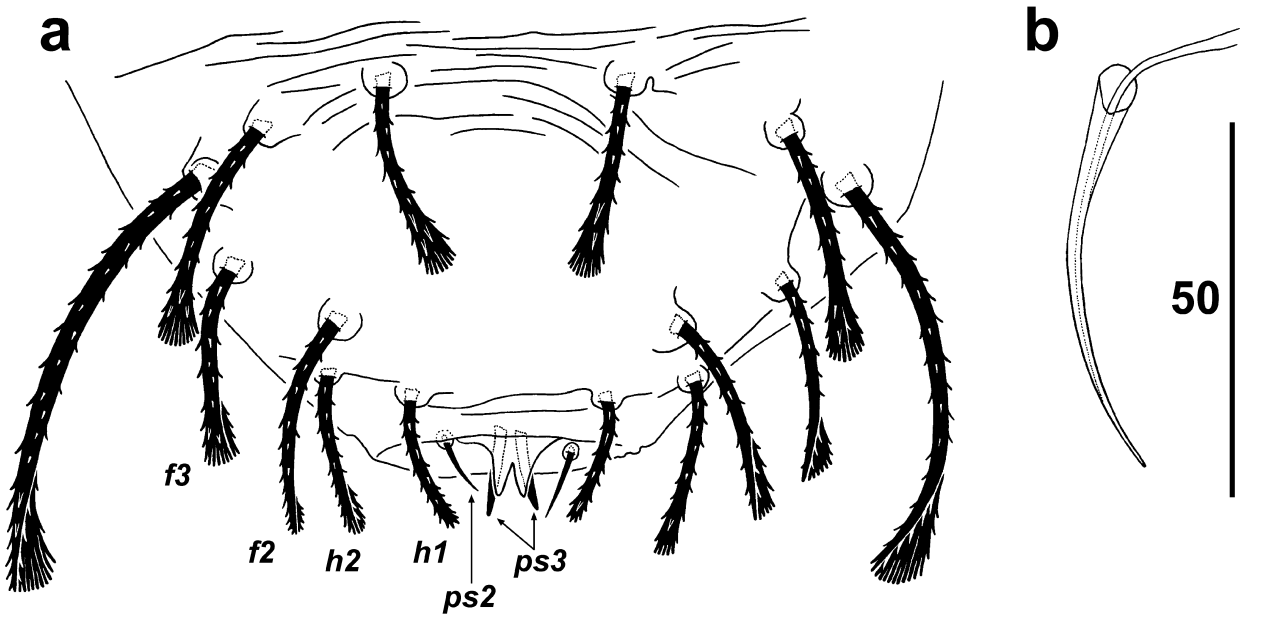


FIGURE 197. *Raoiella shimpana* Meyer, adult male: a. posterior dorsal opisthosoma with detail of setae *ps3*; b. detail of aedeagus.

Legs. (Fig. 198) Setal formula for legs I–IV (coxae to tarsi): 2-1-4-3-4-10(2), 1-1-4-3-4-10(2), 1-1-2-1-3-5, 1-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I paraxial 9–11, abaxial 13–14; ta II adaxial 9, antiaxial 11), and two eupathidia distally (ta I 11–12, 10–11; ta II 10, 9). Companion seta *ft″* on tarsus I elongate, tapered 37–39 and on tarsus II short 9, inserted adjacent to solenidion *ω″*. Tibia I–II with dorsal seta weakly tapered. Claw I 11.

Deutonymph. *Dorsum.* (Fig. 199) Body measurements (2): length between setae *v2–h1* 191–217, width between setae *sc2–sc2* 142–143, *c3–c3* 145–160, *f2–f2* 40, *f3–f3* 59–67. Dorsum mostly smooth with light transverse striations. Dorsal setae spatulate, barbed along entire length. Setae *h1*, *h2* inserted ventrally. Dorsal setae measurements: *v2* 62–68, *sc1* 56–62, *sc2* 67–72, *c1* 46–49, *c2* 58–62, *c3* 57–63, *d1* 46–50, *d2* 59–62, *d3* 55–56, *e1* 42–51, *e2* 62–66, *e3* 50–53, *f2* 46–51, *f3* 19–22, *h1* 11–21, *h2* 13–18.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4), one eupathidium (10–11), one dorsal seta; palp femorogenu with one dorsal seta (17–20).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 71–81, *1b* 15–18, *1c* 7–8, *2b* 6–9, *3a* 7–8, *3b* 7–8, *4a* 32–38, *4b* 7–8, *ag* 8, *g1* 7, *ps2* 6–8, *ps3* 7.

Legs. Setal formula for legs I–IV (coxae to tarsi): 2-1-3-2-4-9(1), 1-1-3-2-4-9(1), 1-1-2-1-3-5, 1-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 8–10; ta II 7–8) and two eupathidia distally (ta I 9, 8; ta II 8, 8). Companion seta *ft″* on tarsus I elongate, tapered 32–37 and on tarsus II short 5–6, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta slightly spatulate. Tenent hairs on claws with four attachment points. Claw I 10.

Protonymph, Larva, and Egg. Unknown.

Hosts. *Cassine transvaalensis* (Celastraceae).

Distribution. SOUTH AFRICA: Ngwanetsi River region, Kruger National Park.

Remarks. *Raoiella shimpana* is morphologically similar to *Raoiella argenta*, but can be separated by the following: *Rs* setae *f2* 76–81 vs *Ra* setae *f2* 62–68; *Rs* setae *d* on femora I, tibiae I and setae *l′* on tibia I with broad blunt tips vs *Ra* with tapered tips.

Specimens of *R. shimpana* were not included in molecular analyses by Dowling *et al.* (2012).

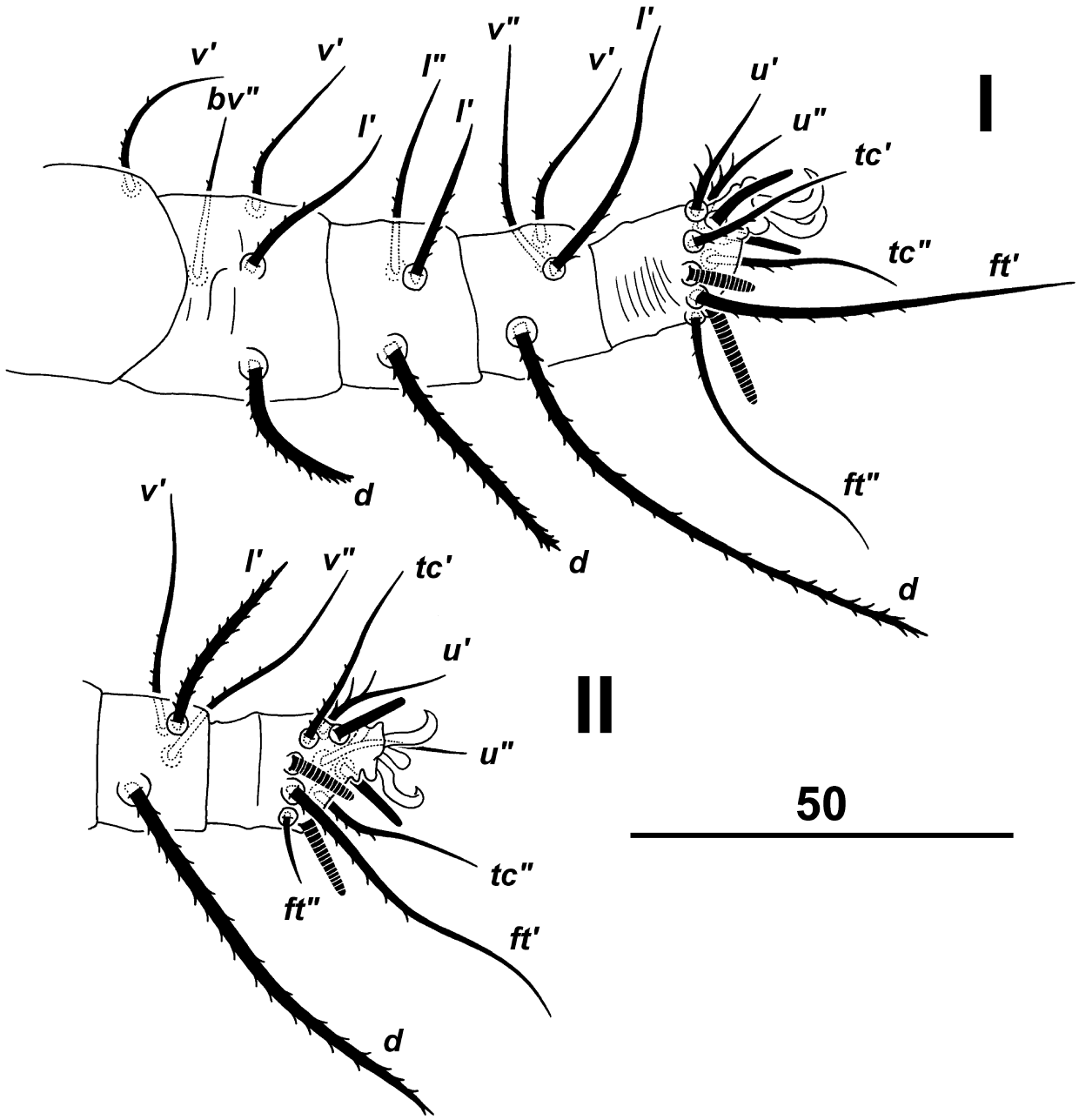


FIGURE 198. *Raoiella shimpana* Meyer, adult male: leg I and tibia-tarsus II (right side, dorsal to adaxial aspect).

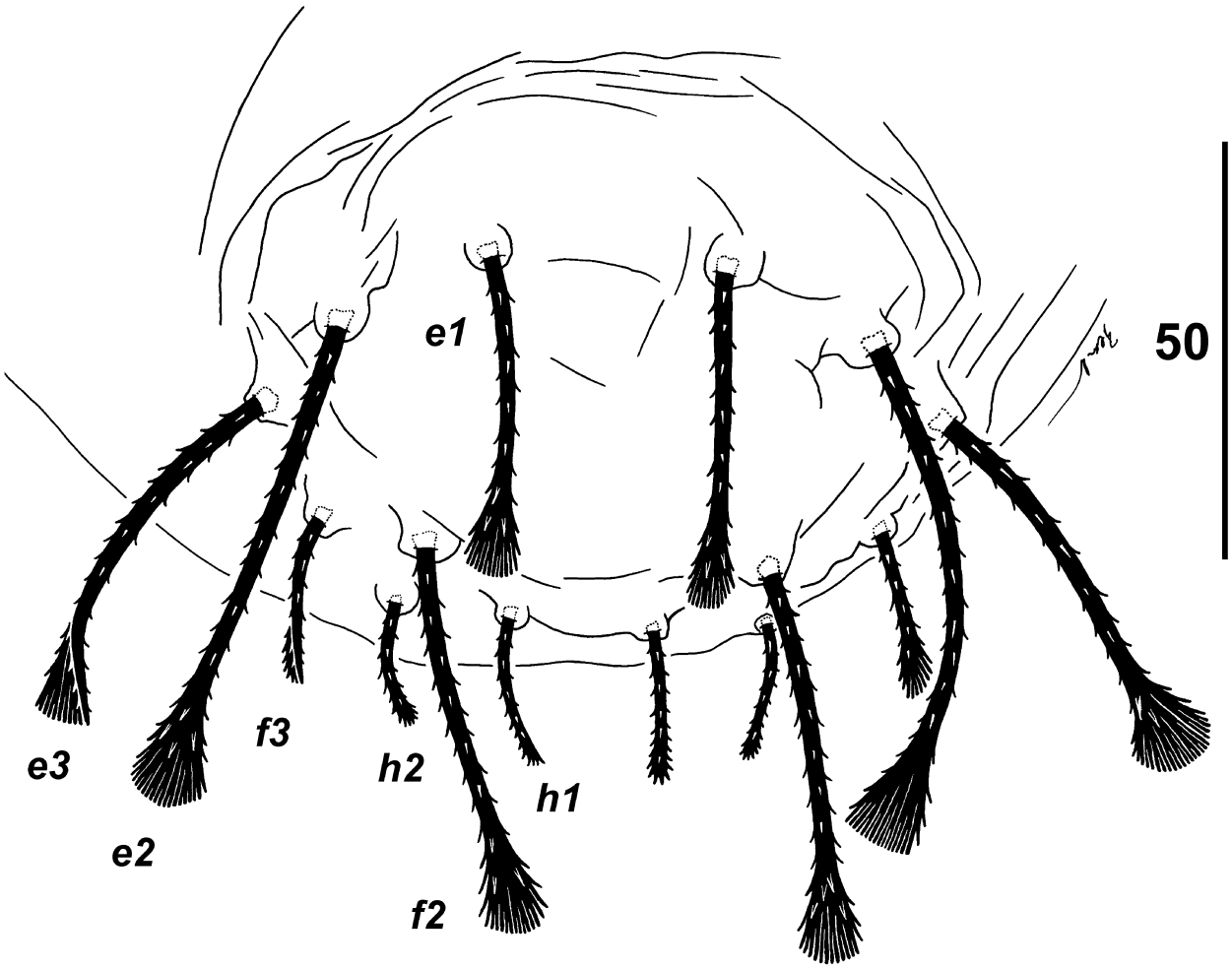


FIGURE 199. *Raoiella shimpana* Meyer, deutonymph: posterior dorsal opisthosoma.

***Raoiella tallerack* sp. nov. Beard & Ochoa**
(Figs 200–214)

Material examined. Holotype. ♀. **Australia,** Western Australia, Coorow-Green Head Road, nr Alexander Morrison National Park, 30°02'55"S 115°21'42"E, 16.iv.2009, ex. tallerack, *Eucalyptus pleurocarpa* (Myrtaceae), J. J. Beard (WAM).

Paratypes. 8 ♀, 7 ♂, 4 deutonymphs, 5 protonymphs, 3 larvae, same data as holotype (WAM, QM, USNM).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* short, spatulate. Adult femora I with four setae (*d*, *l'*, *v'*, *bv"*), femora II with three setae (*d*, *v'*, *bv"* present; *l'* absent), genua I–II with three setae (*d*, *l'*, *l"*); coxae I with one seta (*1b* present; *1c* absent); coxa II with setae *2b* delayed until adult; coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft"*) longer than solenidia. Dorsal setae on tibiae I–II tapered. Eupathidium on palp tibiotarsus finely tapered. Larva with setae *h2* elongate, filiform. Egg with stipe five times the total egg length.

Description. Female. ***Dorsum.*** (Figs 200–203) Body measurements (9): length between setae *v2–h1* 230–264 [256], width between setae *sc2–sc2* 163–176 [170], *c3–c3* 172–188 [174], *f3–f3* 100–117 [108]. Prodorsal and dorsal opisthosomal shields evident. Prodorsum with paired series of pores aligned posteriorly to *v2*—two pairs small pores, pair large pores, pair small pores, pair large pores on posterior margin of shield; additional minute punctae scattered over shield. Dorsal opisthosoma with many pores—three–four pairs pores between *c1–c2* and *d1–d2* (one small pore, two–three larger slit pores); two pores between *d1–d2* and *e1–e2* (one small, one large convoluted pore) (Figs 202–203); three small pores between *e1–e2* and *f2*; several additional minute pores and

punctae scattered over shield. Dorsal setae barbed with large spatulate tips. Dorsal setae measurements: *v2* 57–67 [57–62], *sc1* 35–41 [37], *sc2* 53–67 [59–61], *c1* 25–29 [27–29], *c2* 32–36 [32–33], *c3* 57–69 [57–61], *d1* 21–26 [24–26], *d2* 33–37 [34–35], *d3* 63–71 [63–70], *e1* 24–28 [25–27], *e2* 32–38 [37–38], *e3* 65–77 [65–71], *f2* 35–43 [39–43], *f3* 84–96 [84–85], *h1* 52–61 [55–59], *h2* 30–38 [31–33].

Palps. (Fig. 200) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (9–10) [9] and one finely tapered eupathidium (12–16) [12–13] distally, one dorsal finely tapered seta (17–20) [18–20]; palp femorogenu with one tapered barbed seta (26–32) [26–31]. Stylets with 8–12 minute lateral teeth distally (Fig. 204).

Venter. (Fig. 205) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *g1*, *g2*, *ps2*, *ps3* barbed. Setae *3b*, *4b* absent. Setal measurements: *1a* 43*–103 [52–62], *1b* 22–31 [27], *2b* 21–25 [22], *3a* 18–24 [23], *4a* 41*–89 [89], *ag* 11–16 [16], *g1* 12–16 [15–16], *g2* 12–20 [16], *ps2* 16–22 [16–22], *ps3* 14–17 [15–17]. * = broken.

Spermatheca. (Fig. 206) An elongate (> 100 μm), narrow, highly convoluted duct ending in a small oval vesicle. Duct broadens slightly towards external opening.

Legs. (Fig. 207) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-3-3-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 13–15 [14–15]; ta II 10–11 [11]) and two eupathidia *pζ′–pζ″* distally (ta I 14–16 [15], 13–16 [15]; ta II 13–15 [14], 14–16 [15]). Weakly barbed to smooth companion seta *ft″* on tarsus I 17–24 [20–24] and tarsus II 12–18 [15], inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta thick, tapered. Femora I with four setae (*d*, *l′*, *v′*, *bv″* present; seta *l′* added in adult, delayed from deutonymph), femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with three setae (*d*, *l′*, *l″*). Tenent hairs on claws with three attachment points. Claws long (21–22).

Male. ***Dorsum.*** (Fig. 208) Body measurements (7): length between setae *v2–h1* 176–192, width between setae *sc2–sc2* 123–133, *c3–c3* 120–130, *f3–f3* 60–66. Prodorsum smooth with scattered punctations posteriorly; with pair round pores mesally. Dorsal opisthosoma with transverse striae, strongest between setae *d1* and *f2*; with pair large pores between *d1–d2*, between *d1–e1*, with some scattered punctations anterad *d1*. Pygidial shield weakly developed between setae *f2–h1*; cuticle posterior *h1* with band of transverse striae, often with narrow band of longitudinal striae between transverse striae. Dorsal setae with large spatulate tips, barbed along entire length; setae *h1*, *h2* short, with reduced spatulate tips. Dorsal setae measurements: *v2* 25–32, *sc1* 24–29, *sc2* 34–39, *c1* 19–22, *c2* 21–24, *c3* 40–43, *d1* 19–20, *d2* 22–24, *d3* 39–42, *e1* 17–21, *e2* 22–25, *e3* 44–48, *f2* 23–27, *f3* 46–52, *h1* 20–24, *h2* 19–21.

Palps. (Fig. 208) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (8–9) and one finely tapered eupathidium (11–14) distally, one finely tapered dorsal seta (14–16); palp femorogenu with one tapered barbed seta (20–25).

Venter. Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth. Setae *g1*, *g2*, *ps2* weakly barbed; setae *ps3* modified as accessory genital stylets into short thickened spines (Fig. 208). Setae *3b*, *4b* absent. Setal measurements: *1a* 42–66, *1b* 18–25, *2b* 10–17, *3a* 12–17, *4a* 28–63, *ag* 9–12, *g1* 14–18, *g2* 12–14, *ps2* 8–10, *ps3* 9–12.

Aedeagus. (Fig. 208) Aedeagus narrow, elongate and sclerotised (67–77), tapering to a blunt point distally (towards genital opening).

Legs. (Fig. 209) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-3-3-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 10–12, abaxial 12–13; ta II adaxial 9–11, abaxial 12–14), and two eupathidia distally (ta I 14–15, 14–15; ta II 12–13, 12–13). Smooth to weakly barbed companion seta *ft″* laterad solenidion *ω″* on tarsus I 18–22 and tarsus II 11–15. Tibiae I–II with dorsal seta finely tapered. Femora I with four setae (*d*, *l′*, *v′*, *bv″* present; seta *l′* added in adult, delayed from deutonymph), femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with three setae (*d*, *l′*, *l″*). Tenent hairs on claws with two attachment points.

Deutonymph. ***Dorsum.*** (Fig. 214) Body measurements (4): length between setae *v2–h1* 194–221, width between setae *sc2–sc2* 146–152, *c3–c3* 148–157, *f3–f3* 65–75. Prodorsum mostly smooth with weak transverse striations mesally, with some oblique striations laterally; with two–three pairs minute pores sublaterally. Dorsal opisthosoma with weak widely spaced transverse striations between *c1–d1*; no pores visible. Most dorsal setae with broadly spatulate tips, barbed along entire length; setae *f3* broadly spatulate, barbed; *h1* spatulate, barbed; *h2* thick, weakly spatulate, barbed. Dorsal setae measurements: *v2* 43–49, *sc1* 30–32, *sc2* 41–45, *c1* 23–26, *c2* 26–29, *c3* 45–48, *d1* 21–24, *d2* 25–28, *d3* 47–50, *e1* 23–26, *e2* 27–29, *e3* 48–50, *f2* 30–33, *f3* 51–59, *h1* 22–27, *h2* 15–19.

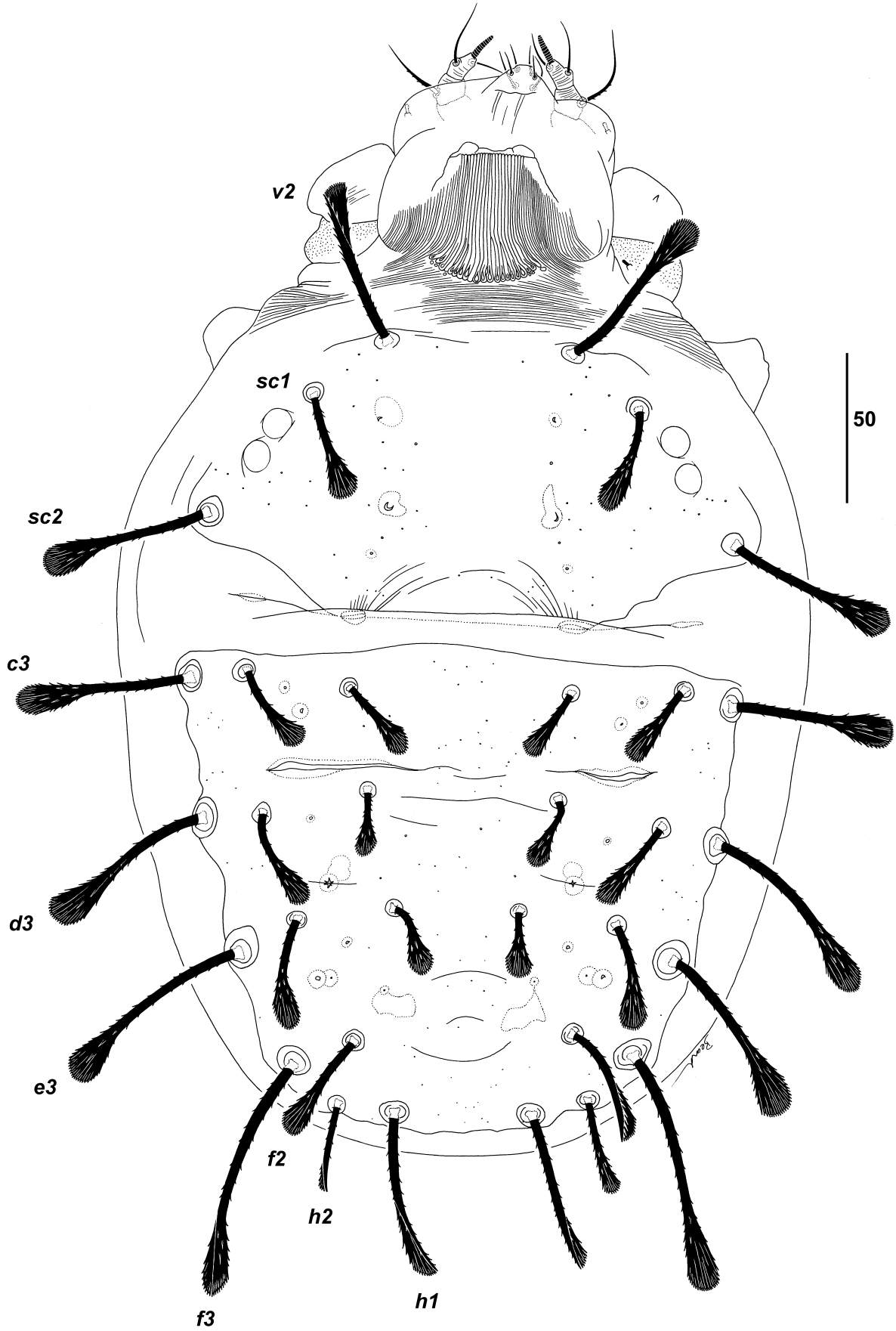


FIGURE 200. *Raoiella tallerack* Beard & Ochoa, adult female: dorsal habitus with detail of palp.

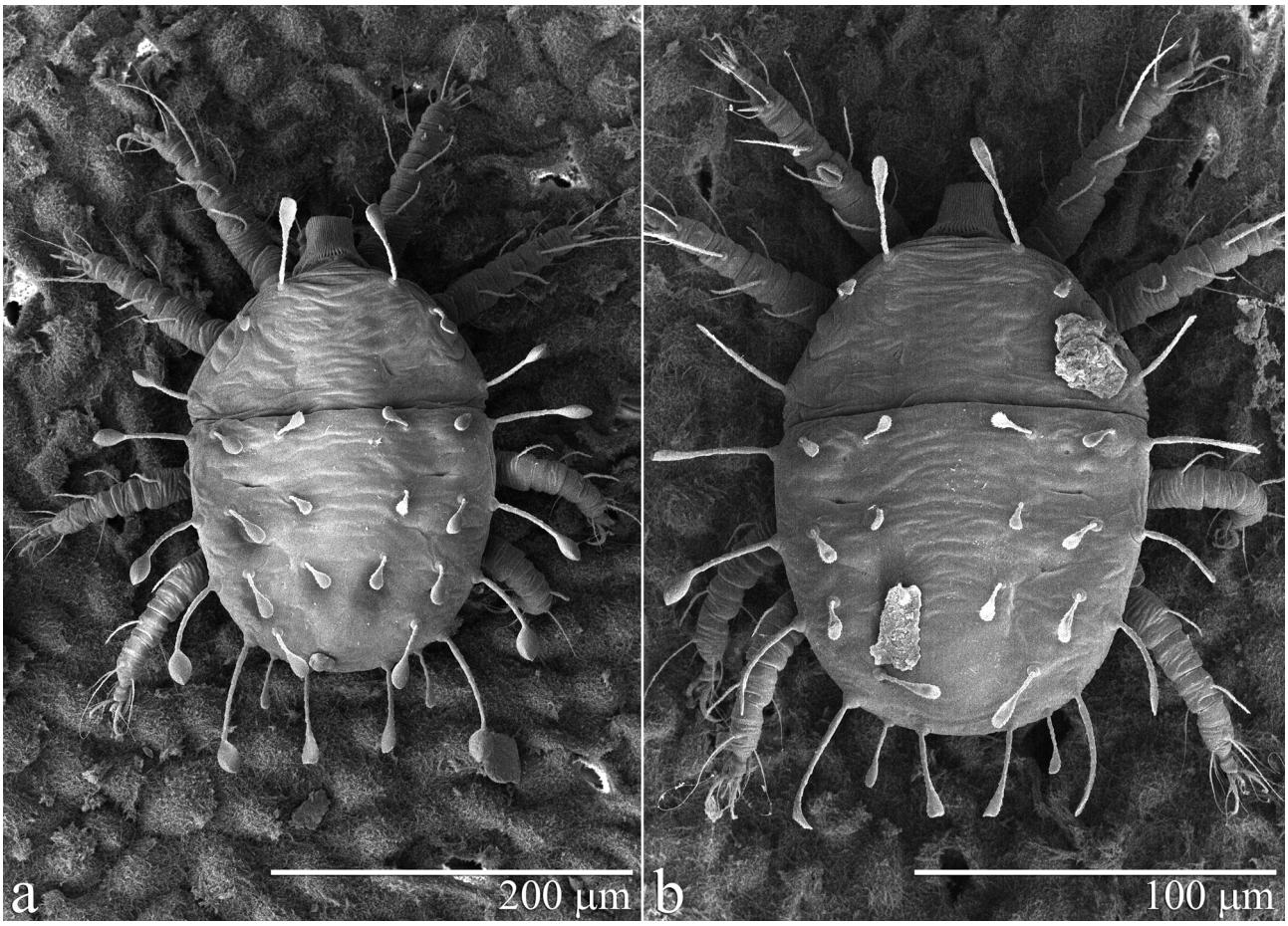


FIGURE 201. *Raoiella tallerack* Beard & Ochoa, adult female: dorsal habitus on host plant (two different individuals).

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–8) and one tapered eupathidium (10–12) distally, one tapered dorsal seta (13–14); palp femorogenu with one tapered barbed seta (21–23).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth; patch of v-shaped striae between *ag–g1* (see also Figs 20a, 128a, 190a, 234a). Seta *1a* elongate, fine (difficult to determine full length); setae *2b*, *3b*, *4b* absent. Most ventral setae smooth; setae *ps2*, *ps3* weakly barbed. Setal measurements: *1a* 48–81, *1b* 16–21, *3a* 12–15, *4a* 48–84, *ag* 10–11, *g1* 8–10, *ps2* 9–10, *ps3* 8–10.

Legs. (Fig. 210) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 9–10; ta II 7–8) and two eupathidia distally (ta I 10–11, 10–11; ta II 10–11, 10–11). Weakly barbed to smooth companion seta *ft″* on tarsus I 7–9 and tarsus II 6–8, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta weakly spatulate to blunt. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent, usually added in deutonymph); genua I–II with two setae (*d*, *l′* present; *l″* absent; *d* added in deutonymph). Tenent hairs on claws with two attachment points. Claws long (16–17).

Protonymph. *Dorsum.* Body measurements (5): length between setae *v2–h1* 164–190, width between setae *sc2–sc2* 114–135, *c3–c3* 122–138, *f3–f3* 40–51. Prodorsum mostly smooth, with weak transverse striae medially and oblique striae laterally. Dorsal opisthosoma with widely spaced transverse striae between *c1–d1*. Dorsal setae spatulate, barbed along entire length; setae *f3* spatulate to weakly spatulate, barbed; *h1* thick, weakly spatulate, barbed; *h2* tapered, barbed. Dorsal setae measurements: *v2* 21–37, *sc1* 21–29, *sc2* 24–35, *c1* 18–23, *c2* 20–24, *c3* 23–36, *d1* 19–23, *d2* 21–25, *d3* 22–34, *e1* 19–25, *e2* 21–26, *e3* 20–35, *f2* 19–27, *f3* 18–27, *h1* 7–15, *h2* 12–18.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (6–7) and one tapered eupathidium (8–11) distally, one fine dorsal seta (11–12); palp femorogenu with one finely tapered seta (15–22).

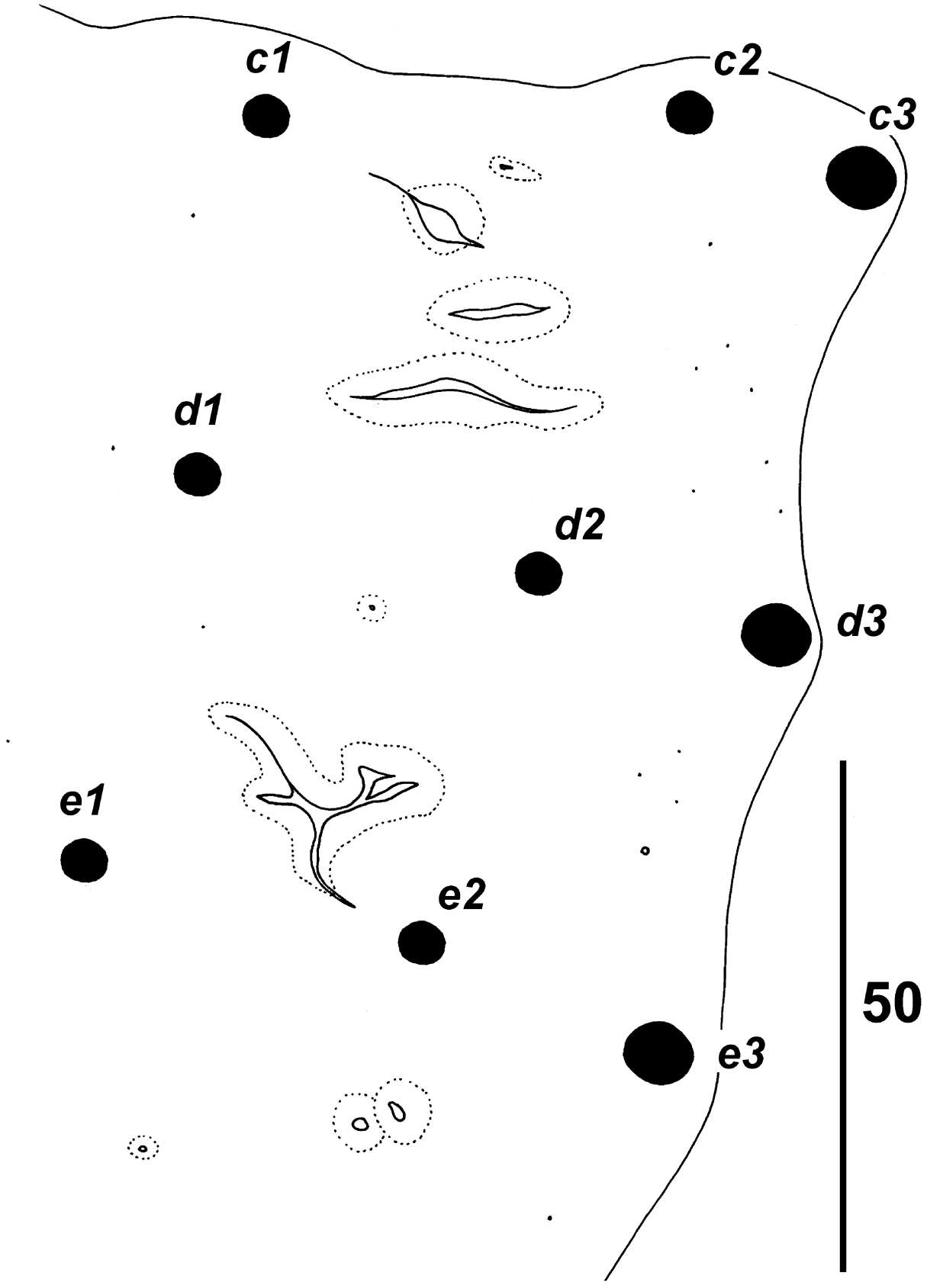


FIGURE 202. *Raoiella tallerack* Beard & Ochoa, adult female: detail of pores on anterior lateral region of dorsal opisthosomal shield (large black spots represent setal positions).

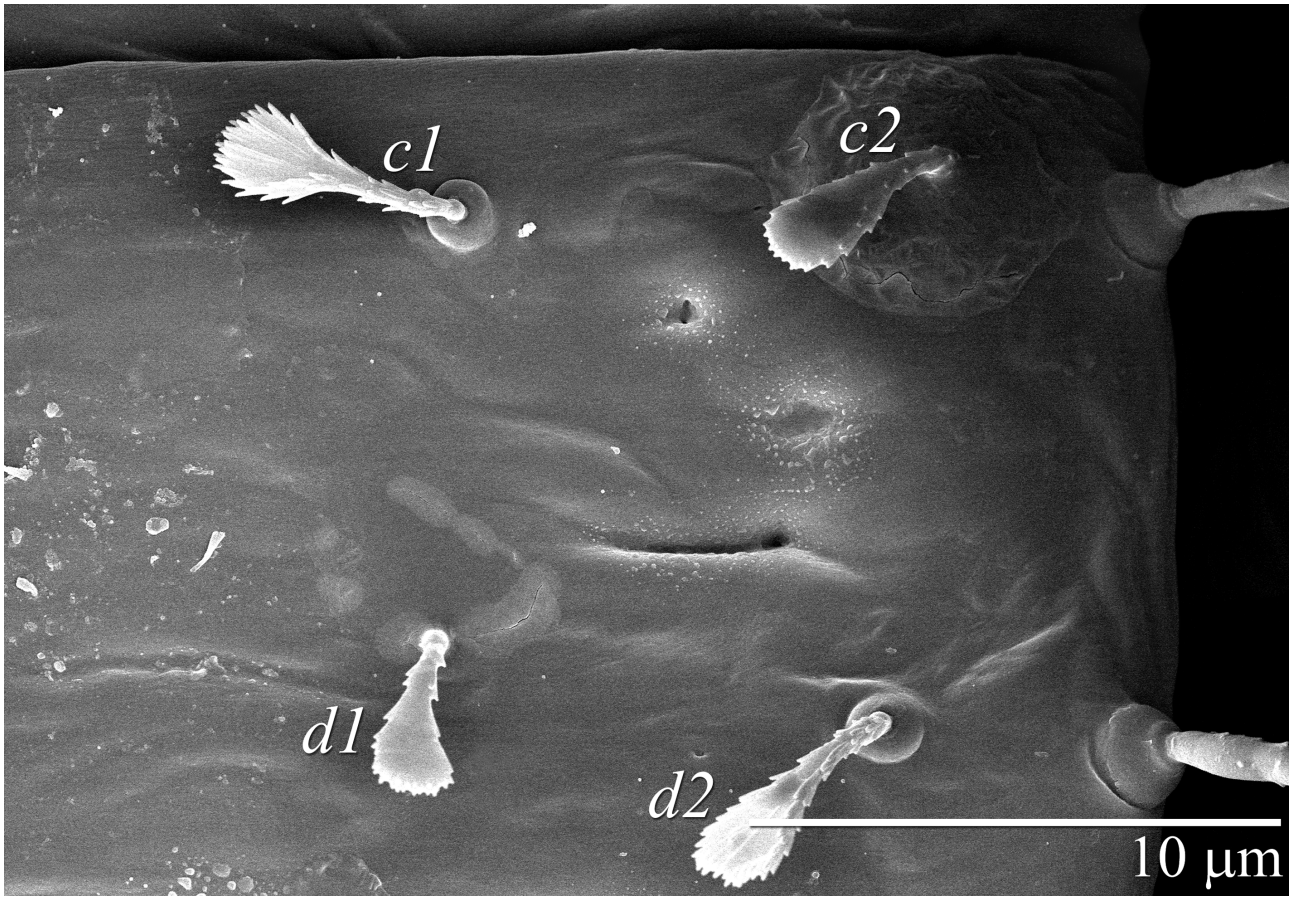


FIGURE 203. *Raoiella tallerack* Beard & Ochoa, adult female: detail of pores on anterior lateral region of dorsal opisthosomal shield.

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields smooth; with patch of longitudinal striae between *ag–ps3* setae. Protonymph ventral setae *2b*, *3b* absent. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 61–91, *1b* 13–16, *3a* 10–16, *ag* 8–10, *ps2* 6–8, *ps3* 5–8.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 8–9; ta II 6–7) and two eupathidia distally (ta I 8–9, 8–9; ta II 8–9, 8–9). Smooth companion seta *ft″* on tarsus I 6–7 and tarsus II 4–6, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered to slightly spatulate. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with one seta (*l′* present; *d*, *l″* absent). Tenent hairs on claws with two attachment points. Claws short (12–14).

Larva. ***Dorsum.*** (Figs 211–213a) Body measurements (3): length between setae *v2–f2* 131–147, width between setae *sc2–sc2* 103–111, *c3–c3* 109–115, *f3–f3* 24–28. Prodorsum with longitudinal striations. Dorsal opisthosoma with some mesal transverse striae between setae *c1–e1*. Dorsal setae spatulate, barbed along entire length; setae *f2*, *f3*, *h1*, *h2* may be ventral; setae *f3*, *h2* tapered to blunt, barbed; setae *h1* elongate, tapered; *h2* fine, elongate, filiform. Dorsal setae measurements: *v2* 21–24, *sc1* 24–25, *sc2* 18–20, *c1* 16–18, *c2* 18–21, *c3* 15–17, *d1* 19–20, *d2* 17–20, *d3* 12–14, *e1* 22–25, *e2* 19–21, *e3* 13–16, *f2* 18–20, *f3* 10–11, *h1* 11, *h2* 36–52.

Palps. (Fig. 211) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5) and one tapered eupathidium (9–11) distally, on fine dorsal seta (10–13); palp femorogenu with one fine dorsal seta (13–15).

Venter. Cuticle almost completely plicate, except coxal fields smooth; cuticle *1b–1b* with transverse striae, *1b–1a* becoming longitudinal, *1a–3a* transverse, cuticle posterior to *3a* with two regions of longitudinal striae separated by small diamond region of transverse striae (see also Figs 23, 44, 56, 70, 100, 115b, 129a, 146, 161b, 178, 191b, 238, 268). Setae *1a* elongate, finely tapered. Setal measurements: *1a* 21–44, *1b* 10–12, *3a* 9, *ps2* 4–5, *ps3* 4–5.

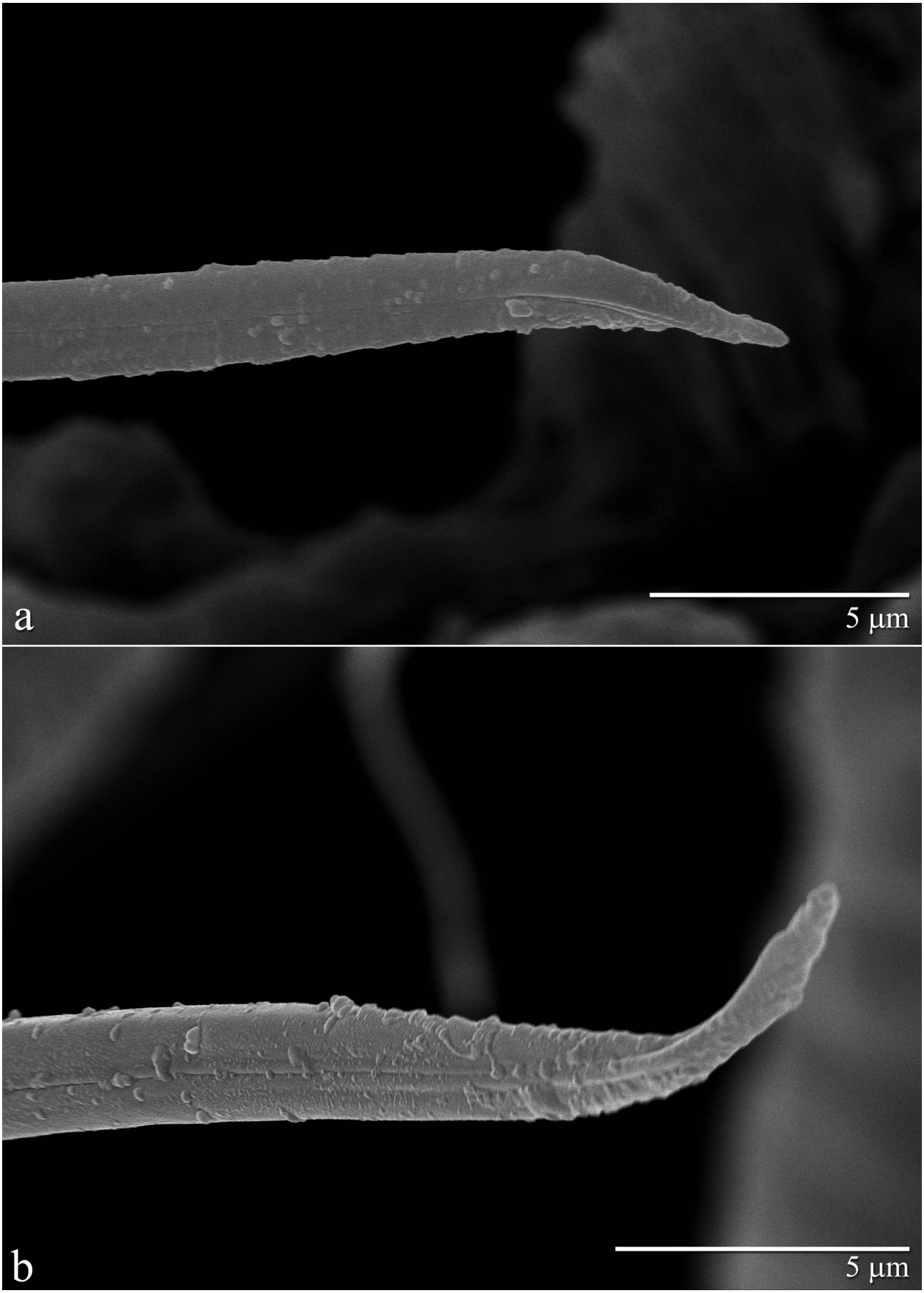


FIGURE 204. *Raoiella tallerack* Beard & Ochoa, dorsal view of joined stylets, detail of stylet tip with lateral serrations.

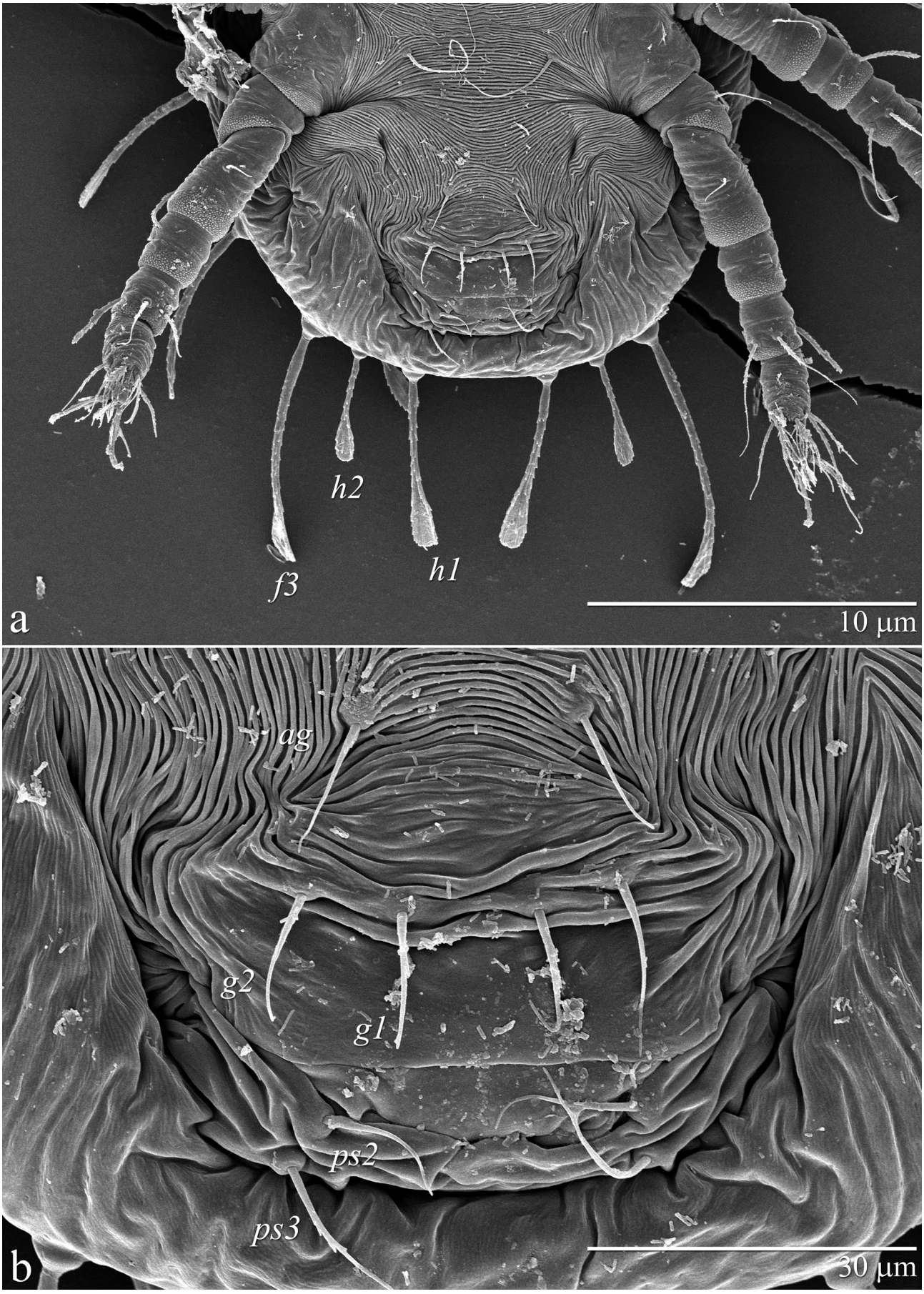


FIGURE 205. *Raoiella tallerack* Beard & Ochoa, adult female: a. posterior venter; b. detail of genital region.

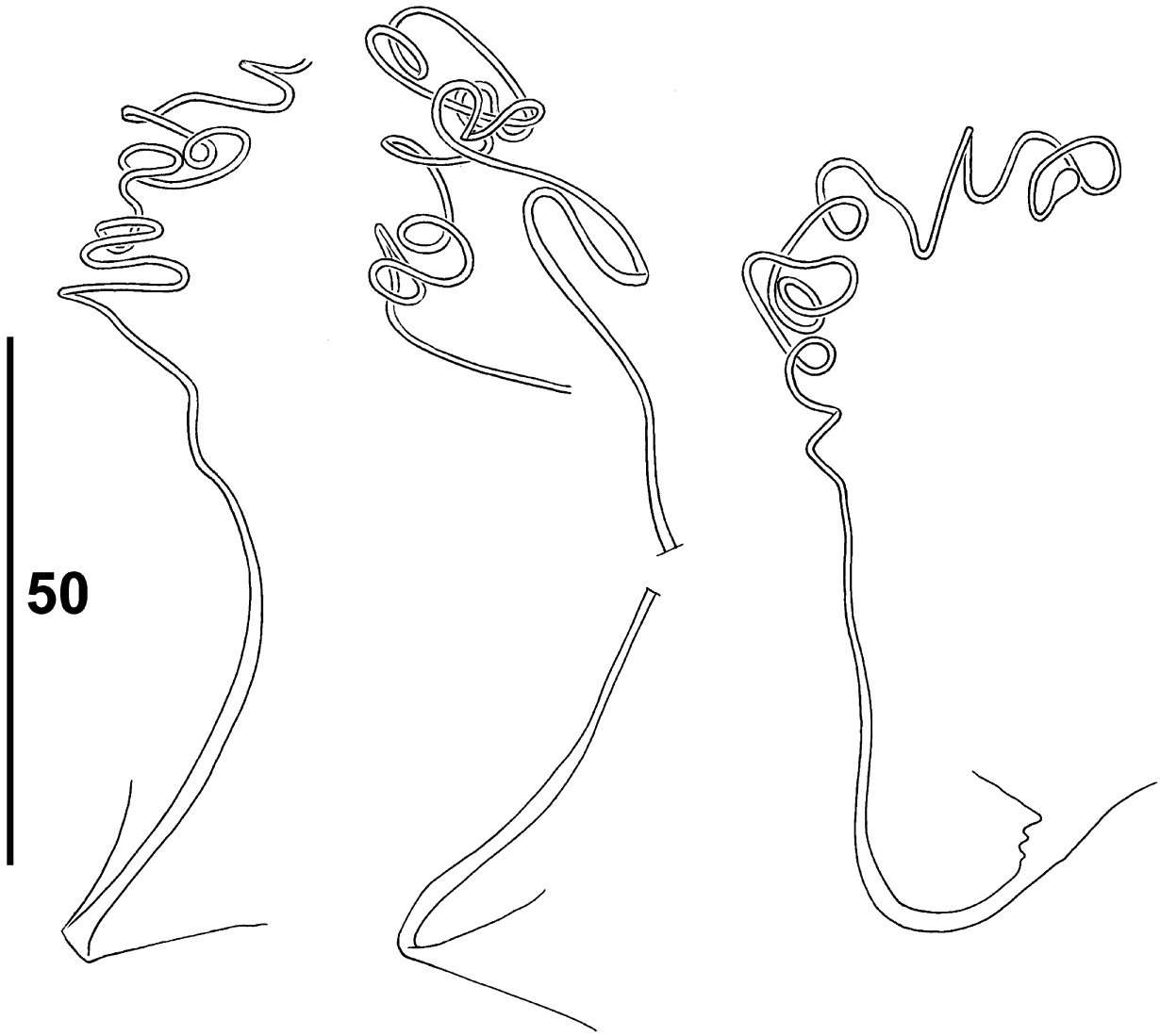


FIGURE 206. *Raoiella tallerack* Beard & Ochoa, adult female: detail of spermatheca.

Legs. (Fig. 211) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 6; ta II 5–6) and two eupathidia distally (ta I 8, 7–8; ta II 8, 7–8). Companion seta *ft″* on tarsus I 5–8 and tarsus II 4–6, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta finely tapered. Femora I–II with three setae (*l′*, *v′*, *bv″* present; *d* absent); genua I–II with one seta (*l′* present; *d*, *l″* absent). Tenent hairs on claws with two attachment points. Claws short (12–13).

Egg. (Fig. 213) Red, ellipsoid in shape, 110–120 long 75–80 wide, with some weak longitudinal bands on surface (Fig. 213a), a long distal stipe approximately 400–500 long (4–5 X length of egg) (Figs 213b,c), and a pair of minute recurved spines (Figs 213a,b; see arrows).

Host. Tallerack, *Eucalyptus pleurocarpa* Schauer. (Myrtaceae).

Distribution. AUSTRALIA: Central southwest coast of Western Australia, approximately 250 km north of Perth, 65km east of Greenhead, in the sandplain region of the Alexander Morrison National Park.

Etymology. *Raoiella tallerack* **sp. nov.** is named for the common name given to its host plant by the local indigenous people, tallerack.

Remarks. *Raoiella tallerack* **sp. nov.** (DNA code RaIn67) was listed with specimens RaIn43 and RaIn44 (wandoo population) and RaIn68 (jarrah population) as *Raoiella* sp. 3 in Dowling *et al.* (2012; Table 1 and Figs 1, 2), and this species was listed as *Raoiella* sp. 3B in Beard *et al*. (2013). However, based on morphological characteristics, geography, and host plant, we have chosen to name *R. tallerack* as a separate species to the species represented by the other three specimens, which is described here as *Raoiella* wandoo **sp. nov.**

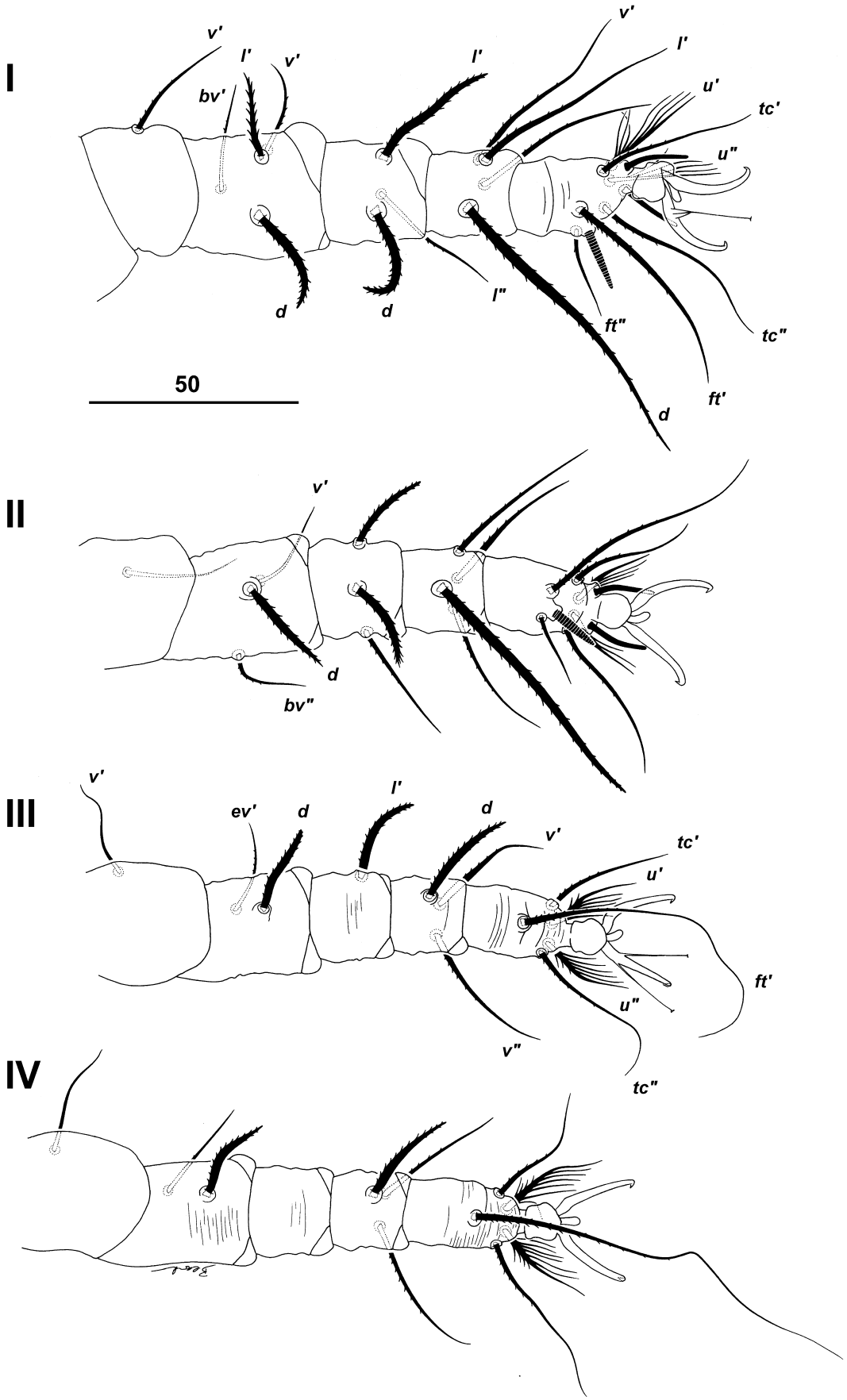


FIGURE 207. *Raoiella tallerack* Beard & Ochoa, adult female: legs I–IV (right side, dorsal aspect; leg I slightly adaxial).

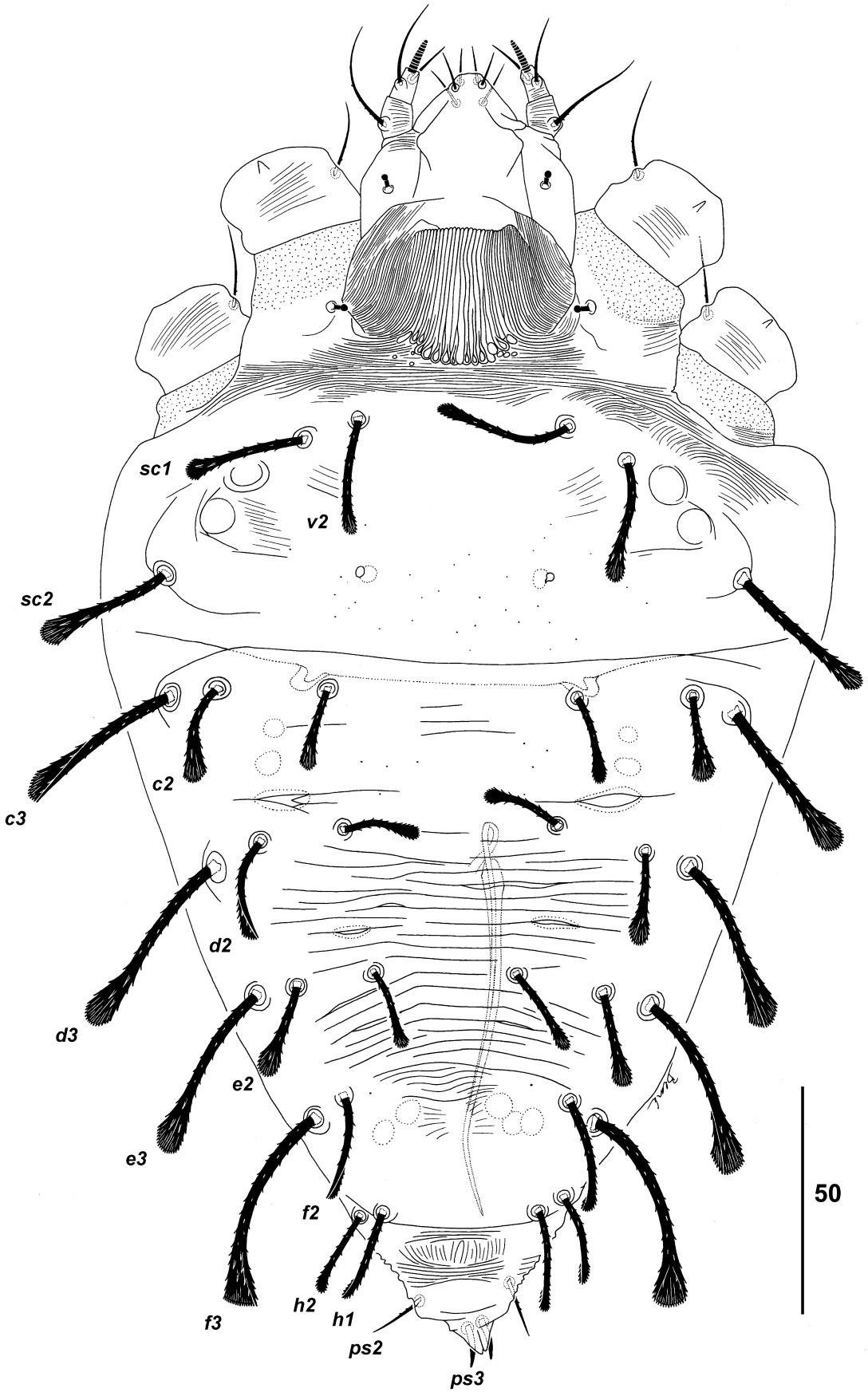


FIGURE 208. *Raoiella tallerack* Beard & Ochoa, adult male: dorsal habitus with details of palp, aedeagus and setae *ps3*.

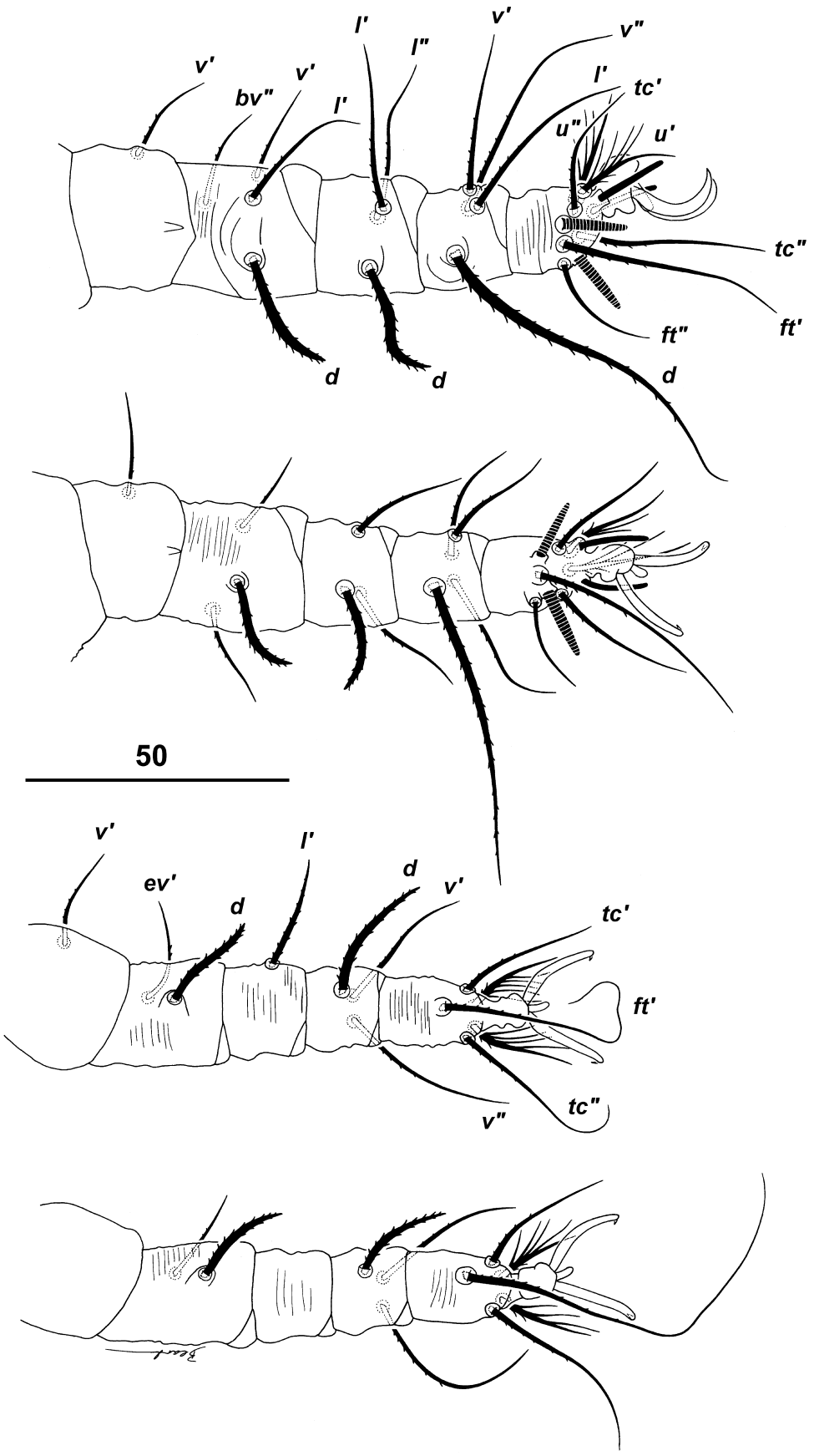


FIGURE 209. *Raoiella tallerack* Beard & Ochoa, adult male: legs I–IV (right side, dorsal aspect; leg I slightly adaxial).

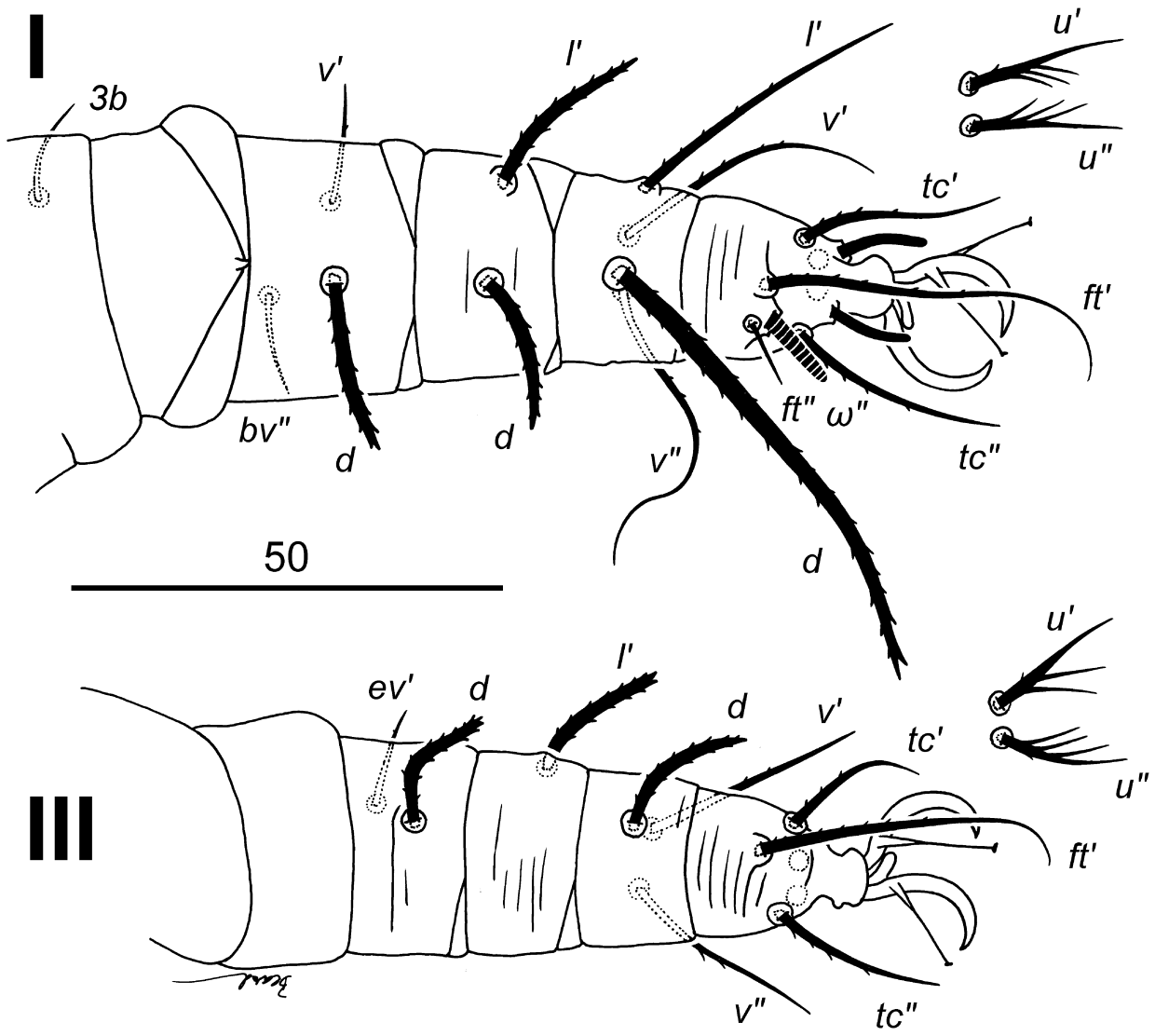


FIGURE 210. *Raoiella tallerack* Beard & Ochoa, deutonymph: legs I and III (right side, dorsal aspect).

Raoiella tallerack can be separated from *R.* wandoo by the following: *Rt* eggs with a stipe 4–5X the length of the egg; *c1* 25–29, *c2* 32–36, *f2* 35–43, *h2* 30–38, *sc2–sc2* 163–176 vs *Rw* eggs with a stipe 1–2X the length of the egg; *c1* 18–23, *c2* 25–31, *f2* 31–36, *h2* 22–34, *sc2–sc2* 178–202.

As in *R.* wandoo, coxae II is nude in immature stages, i.e. the expression of setae *2b*, normally added in the protonymph, is unusually delayed until the adult stage. Setae *3b* (protonymph seta) and *4b* (deutonymph seta) are absent.

***Raoiella taronga* sp. nov. Beard & Ochoa**
(Figs 215–224)

Material examined. Holotype. ♀**. Australia**, New South Wales, Taronga Park Zoo, Bradleys Head Road, Mosman, Sydney, 35°50'39"S 151°14'28"E, 10.xii.2009, ex. immature *Eucalyptus* sp. (Myrtaceae), J. J. Beard (QMS 108800).

Paratypes. 16 ♀, 4 ♂, 1 deutonymph, same data as Holotype (QM; USNM).

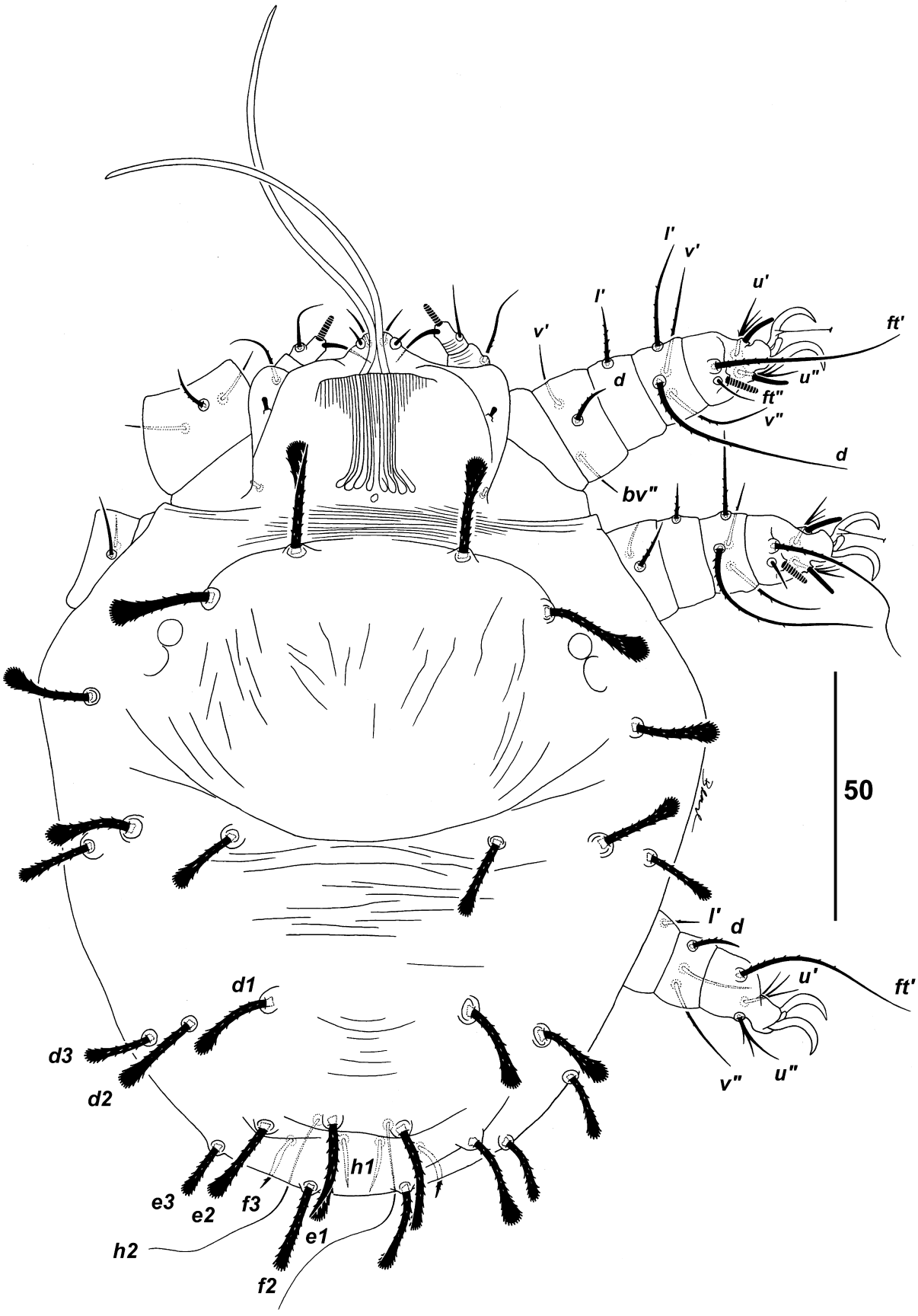


FIGURE 211. *Raoiella tallerack* Beard & Ochoa, larva: dorsum with details of legs I–III, palp and setae *h2*.

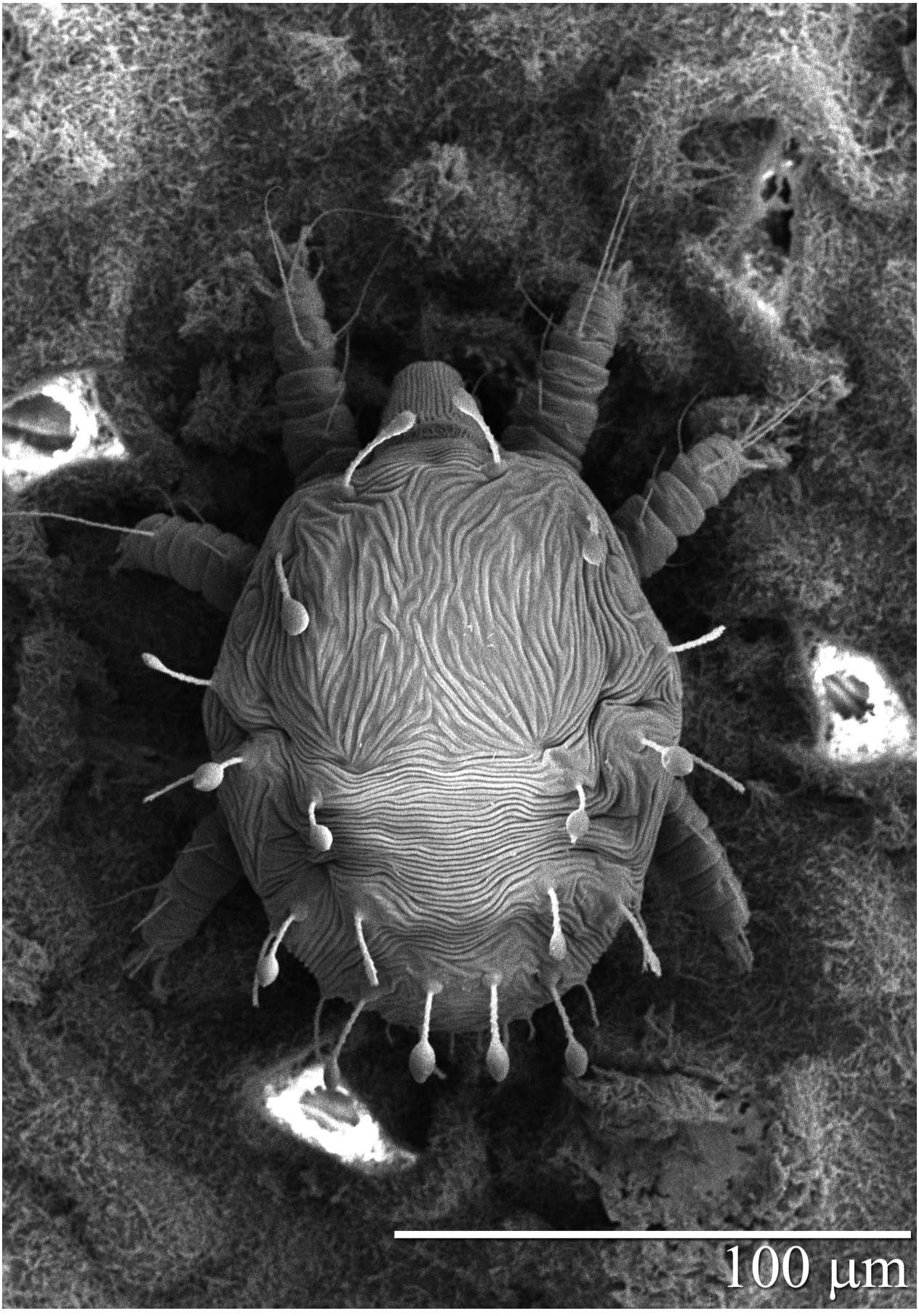


FIGURE 212. *Raoiella tallerack* Beard & Ochoa, larva: dorsal habitus on host plant.

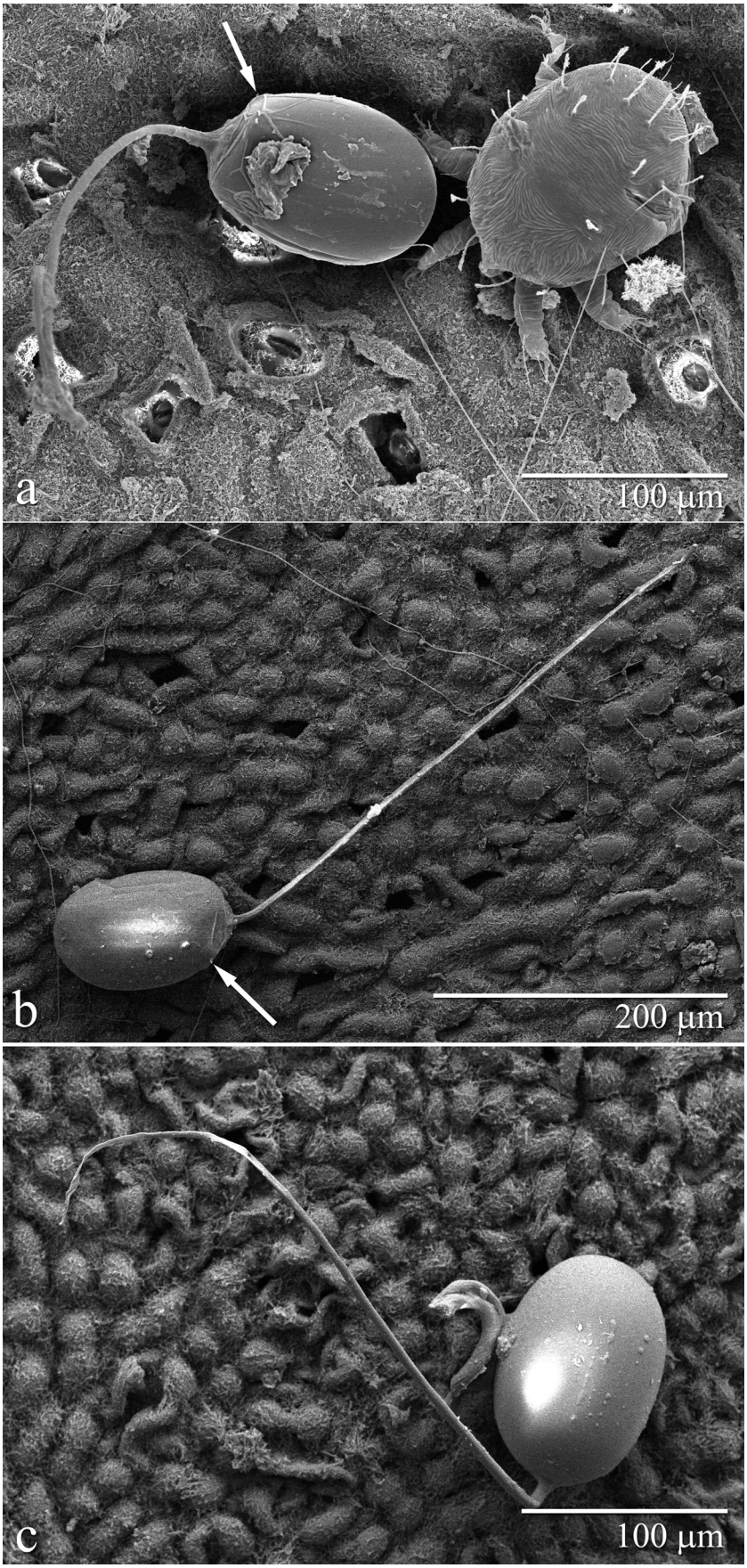


FIGURE 213. *Raoiella tallerack* Beard & Ochoa, a. egg with larva on host plant; b.,c. egg on host plant. Note paired minute spines on egg in a. and b., indicated by arrows.

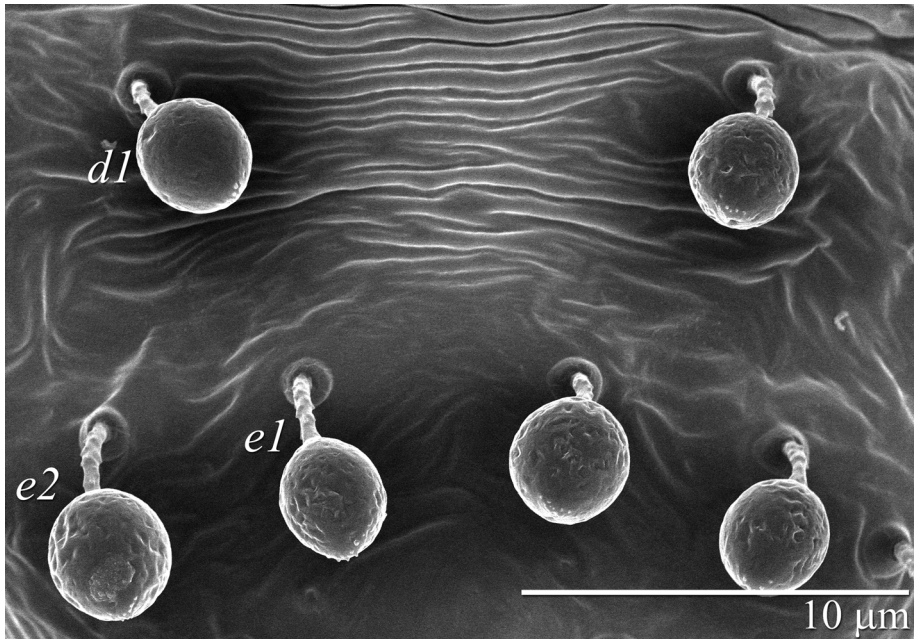


FIGURE 214. *Raoiella tallerack* Beard & Ochoa, deutonymph: detail of frozen droplets on dorsal setae; note texture of droplet surface, and tips of spatulae emerging from droplets.

Diagnosis. Prodorsal setae *sc1* shorter than setae *v2* and *sc2*. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* tapered. Adult femora I–II with four setae (*d*, *l′*, *bv″*, *v′*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Adult female genua I–II with two setae (*l′*, *l″* present; *d* absent); adult male genua I–II with three setae (*d*, *l′*, *l″*). Tarsi I–II with companion setae (*ft″*) slightly longer than solenidion. Dorsal setae on tibiae I–II tapered, with blunt tip. Eupathidium on palp tibiotarsus blunt.

Description. Female. ***Dorsum.*** (Figs 215, 224) Body measurements (7): length between setae *v2–h1* 227–258 [245], width between setae *sc2–sc2* 180–189 [189], *c3–c3* 185–193 [190], *f3–f3* 105–118 [112]. Prodorsum smooth, with a series of minute pores sublaterally in more-or-less longitudinal row posterior to *v2*, with pair large pores on posterior margin (often in folded cuticle of sejugal region). Dorsal opisthosoma smooth; with pair of minute pores and two pairs of large slit pores between setae *c1–c2* and *d1–d2*, pair of minute pores and pair slit pores and between *d1–d2* and *e1–e2*, pair of minute pores between *e1* and *e2*. Setae *c1* weakly spatulate; *d1*, *e1* tapered to blunt; *h2* tapered, short; other dorsal setae strongly spatulate, barbed along entire length. Dorsal setae often with hyaline sheaths present at their bases (Figs 215–216), which is presumed to be the fluid that makes up the droplets on the setae tips. Dorsal setal measurements: *v2* 54–61 [54–56], *sc1* 27–32 [30–32], *sc2* 52–59 [52–53], *c1* 10–15 [12–14], *c2* 21–28 [26–28], *c3* 50–60 [50–51], *d1* 7–10 [8–10], *d2* 20–25 [23–25], *d3* 49–60 [51–52], *e1* 7–10 [7–10], *e2* 22–30 [27–30], *e3* 50–59 [50–52], *f2* 27–36 [33–36], *f3* 54–62 [54–55], *h1* 50–61 [50–53], *h2* 13–17 [15–16].

Palps. (Figs 215, 217a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–8) [7] and one blunt eupathidium (10–12) [10–11] distally, one dorsal seta (10–15) [13–15]; palp femorogenu with one seta (26–31) [26–27].

Venter. (Fig. 216) Cuticle almost completely plicate; with transverse setae between *1b–1b*, longitudinal striae *1b–1a*, transverse striae *1a*–ag; striae longitudinal laterad genital region and coxae III–IV; striae transverse on genital flap; cuticle in coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *ag*, *g1*, *g2*, *ps2*, *ps3* barbed. Setal measurements: *1a* 47–85 [53–68], *1b* 18–26 [22–26], *2b* 14–20 [14–17], *3a* 12–13 [12–13], *4a* 54–78 [63–66], *ag* 10–14 [10–11], *g1* 11–15 [11–12], *g2* 13–16 [13–14], *ps2* 9–13 [10–11], *ps3* 10–14 [10–11].

Spermatheca. (Fig. 217b) Elongate, fine, tightly coiled membranous tube.

Legs. (Fig. 218) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-2-4-9(1), 1-1-4-2-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*), genua I–II with two setae (*l′*, *l″*; *d* absent). Tarsi I and II each with one abaxial solenidion (ta I 10–12 [10–11]; ta II 8–10 [8–9]) and two eupathidia distally (ta I

13–15 [14–15], 13–14 [13–14]; ta II 12–14 [14], 12–13 [13]). Weakly barbed, fine companion seta *ft″* on tarsus I 14–17 [16–17] and tarsus II 12–15 [12–14] (if fine tip broken, companion setae can appear to be 9–10 long), inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered, but not finely tapered (dtiI 72–78 [72–76], dtiII 65–75 [68–70]). Claw IV 18–19 [18].

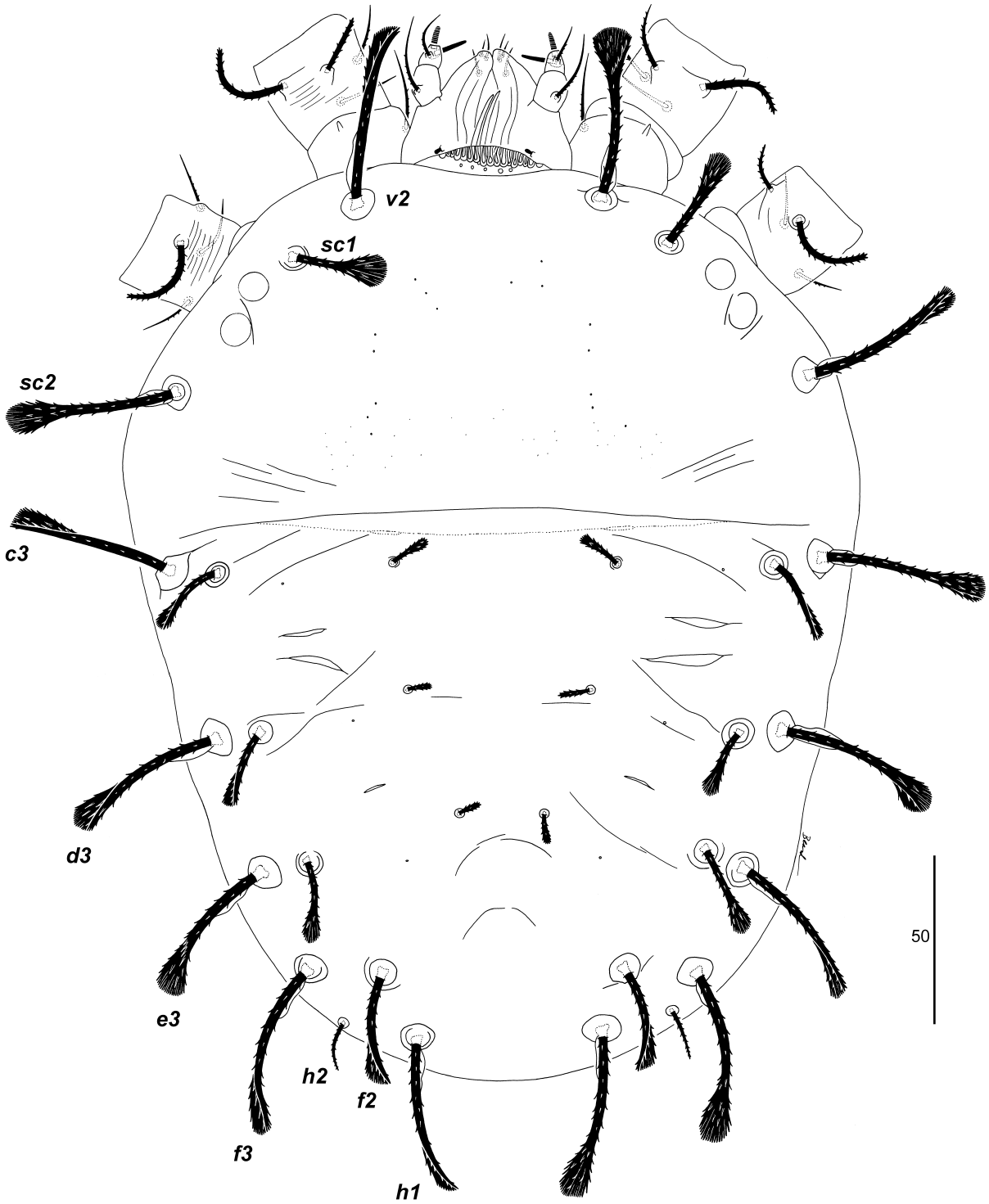


FIGURE 215. *Raoiella taronga* Beard & Ochoa, adult female: dorsal habitus with details of palp; note "sheaths" of liquid at bases of lateral setae.

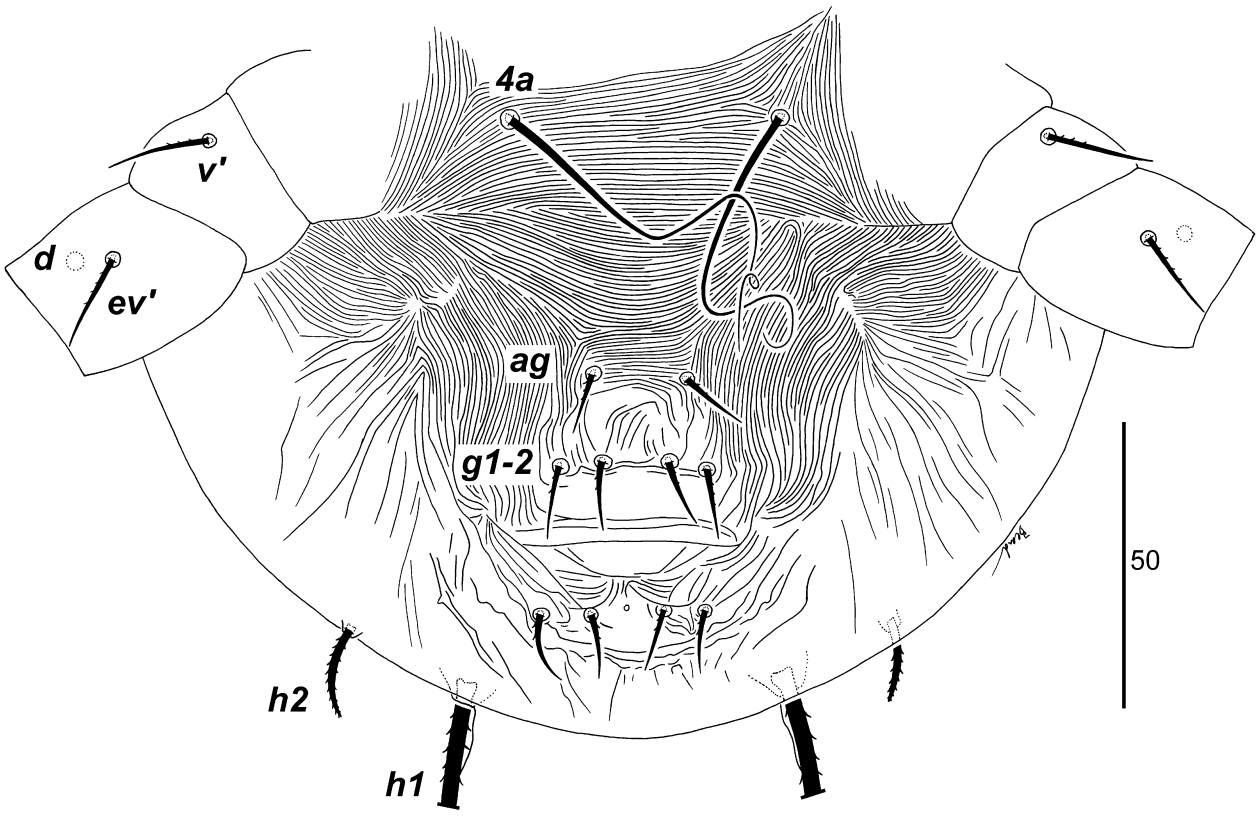


FIGURE 216. *Raoiella taronga* Beard & Ochoa, adult female: posterior venter.

Male. ***Dorsum.*** (Figs 219, 220a, 224) Body measurements (3): length between setae *v2–h1* 180–215, width between setae *sc2–sc2* 151–157, *c3–c3* 145–151, *f3–f3* 75–86. Prodorsum usually smooth, sometimes weak, mostly transverse striae visible posteriorly; pair large pores on posterior margin weakly developed (often in folded cuticle between prosoma and opisthosoma). Opisthosoma with two pairs of large slit pores between setae *c1–d2* and one pair of minute pores between *c1–c2*; with strong transverse striae between setae *d1* and *f2*; weak transverse and longitudinal striae posterior *h1*. Dorsal setae spatulate, barbed along entire length; setae *v2* tapered to weakly spatulate; setae *h1* weakly spatulate; *h2* tapered. Dorsal setae measurements: *v2* 42–54, *sc1* 32–36, *sc2* 45–48, *c1* 12–16, *c2* 22–26, *c3* 42–47, *d1* 8–10, *d2* 21–23, *d3* 45–48, *e1* 8–12, *e2* 22–25, *e3* 43–49, *f2* 27–29, *f3* 47–48, *h1* 27–31, *h2* 15–17.

Palps. (Fig. 220b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–8) and one tapered eupathidium (9–10) distally, one dorsal seta (13–14); palp femorogenu with one seta (23–25).

Venter. (Fig. 221) Ventral cuticle almost completely plicate with mostly transverse striae; cuticle with longitudinal striae between *1b–1a*, striae transverse *1a–g1*; striae fine between *1a–4a*, broadly separated *4a* to posterad *ag*; cuticle with pair of distinct smooth regions laterad *ag*; cuticle with some longitudinal striae mesad coxae III–IV. Setal measurements: *1a* 42–66, *1b* 16–23, *2b* 13–19, *3a* 9–13, *4a* 37–68, *ag* 10–11, *g1* 9–10, *g2* 9–10, *ps2* 11–12, *ps3* 13–14. Pseudanal setae *ps3* thickened, tapered, modified as accessory genital stylets into thickened spines (Figs 220a, 221).

Aedeagus. (Fig. 220c) Aedeagus narrow, elongate and sclerotised (56–62), tapering to a fine blunt tip distally (at genital opening).

Legs. (Fig. 222) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-4-3-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Femora I–II with four setae (*d*, *l′*, *v′*, *bv″*), genua I–II with three setae (*d*, *l′*, *l″*). Tarsi I and II each with two solenidia (ta I adaxial 7–8, abaxial 11–12; ta II adaxial 7–9, abaxial 8–10), and two eupathidia distally (ta I 12–13, 12–13; ta II 12–13, 12–13). Finely tapered, weakly barbed companion seta *ft″* on tarsus I 15–21 (tip often difficult to see, or broken) and tarsus II 14–15, inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal setae tapered with blunt tip. Claw IV 15.

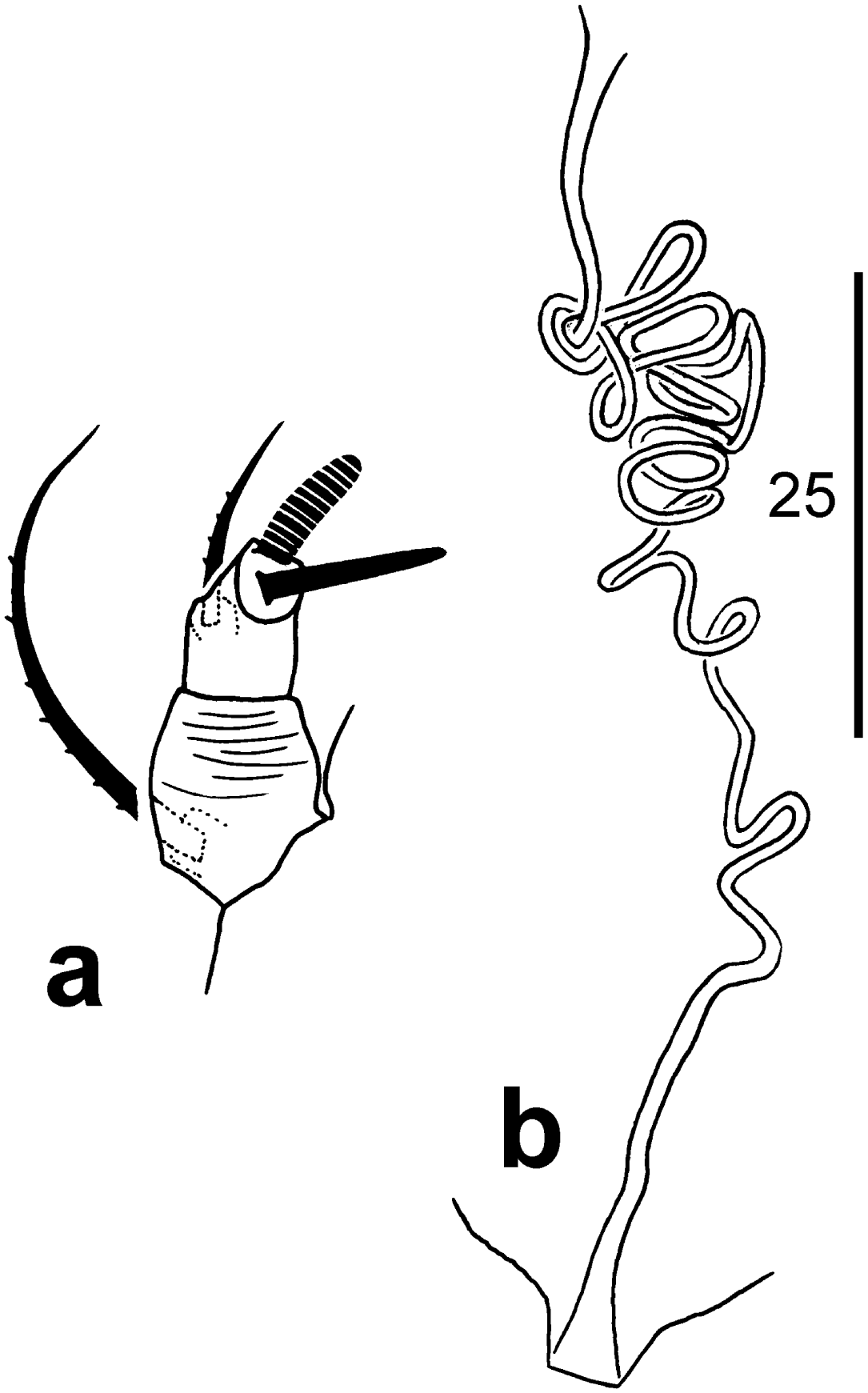


FIGURE 217. *Raoiella taronga* Beard & Ochoa, adult female: a. detail of palp; b. detail of spermatheca.



FIGURE 218. *Raoiella taronga* Beard & Ochoa, adult female: legs I–III (right side, dorsal aspect).

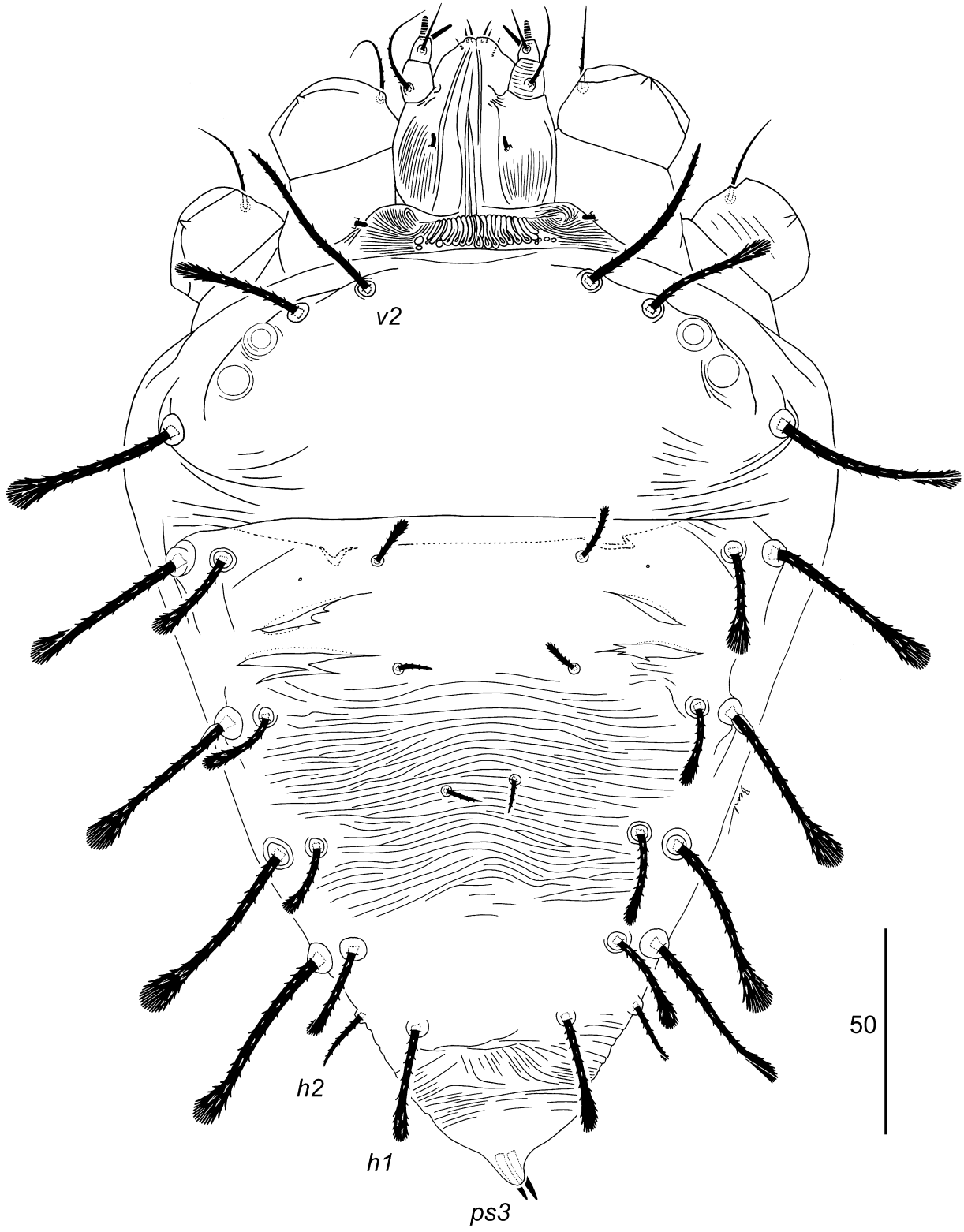


FIGURE 219. *Raoiella taronga* Beard & Ochoa, adult male: dorsal habitus, with detail of palps and setae *ps3*.

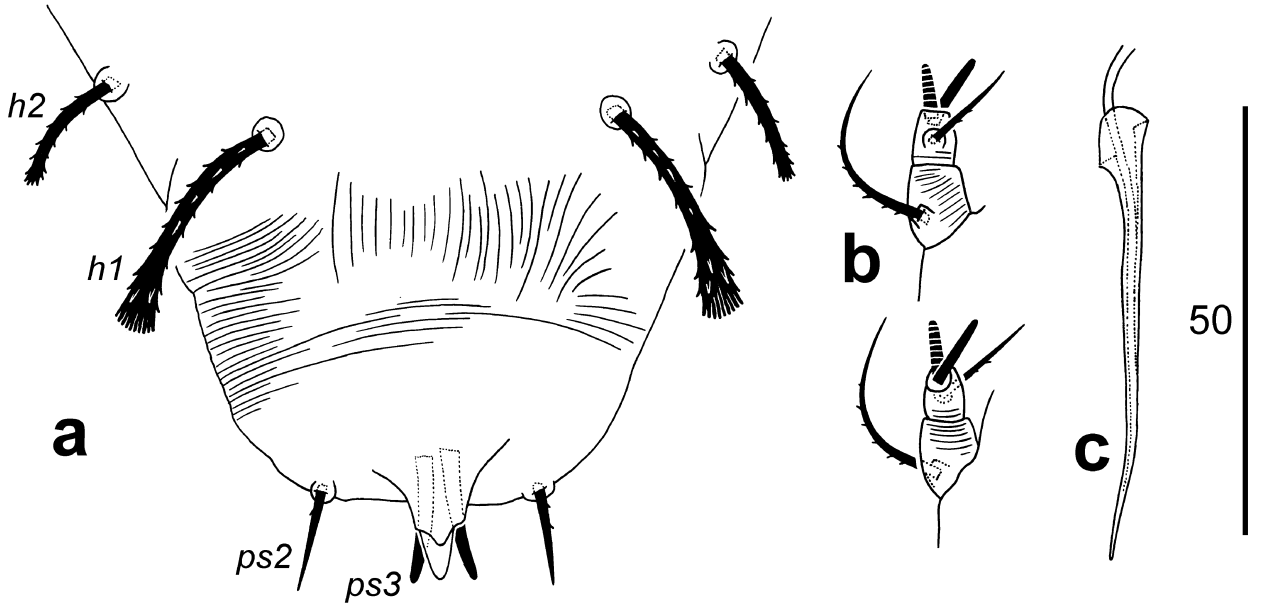


FIGURE 220. *Raoiella taronga* Beard & Ochoa, adult male: a. variation in posterior dorsal opisthosoma; b. detail of palp (dorsal and ventral aspects); c. detail of aedeagus.

Deutonymph (male). ***Dorsum.*** Body measurements (1): length between setae *v2–h1* 178, width between setae *sc2–sc2* 139, *c3–c3* 144, *f3–f3* 61. Prodorsum mostly smooth with some arching transverse striae mesally. Dorsal opisthosoma with widely spaced transverse folds between *c1–f2*; slit like pore anterior to *d2* appears weakly developed or absent. Dorsal setae barbed along entire length; seta *v2* spatulate, seta *h2* tapered. Dorsal setae measurements: *v2* 37–41, *sc1* 33–34, *sc2* 32–33, *c1* 15–16, *c2* 33–36, *c3* 25–27, *d1* 8–10, *d2* 33–34, *d3* 21–22, *e1* 9–11, *e2* 33, *e3* 18, *f2* broken, *f3* 19–22, *h1* 18–19, *h2* 12–18.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one tapered eupathidium (8–9) distally, one dorsal seta (11); palp femorogenu with one seta (21).

Venter. Cuticle almost completely plicate; transverse striae between *1b–1b*, becoming longitudinal striae between *1b–1a*, fine transverse striae *1a–g1*, coxal fields smooth (see also Figs 20b, 128b, 190b, 234b). Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 33–43, *1b* 18, *3a* 8–9, *4a* 32–34, *ag* 9–10, *g1* 8–9, *ps2* 7, *ps3* 7–8. Seta *2c* is aberrantly present on coxa II on one side of the body.

Legs. (Fig. 223) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Femora I–II with three setae (*d*, *v′*, *bv″*; seta *l′* absent), genua I–II with two seta (*d*, *l′*; seta *l″* absent). Tarsi I and II each with one abaxial solenidion (ta I 7–8; ta II 5–6) and two eupathidia distally (ta I 10, 10; ta II 9–10, 9). Companion seta *ft″* on tarsus I 9–10 and tarsus II 8–9, inserted adjacent to solenidion *ω″*. Tibiae I–II dorsal seta with blunt tip (dtiI 62, dtiII 48–52). Claw IV 12.

Protonymph and Larva. Unknown.

Egg. Bright red, ellipsoid, with moderately long stipe (Fig. 224).

Host. *Eucalyptus* sp. (Myrtaceae).

Distribution. AUSTRALIA: Sydney, New South Wales.

Etymology. This species is named for its collection site, Taronga, which is an indigenous word meaning "water view".

Remarks. *Raoiella taronga* was listed as *Raoiella* sp. 8 (DNA code RaIn70) in Dowling *et al.* (2012; Table 1 and Figs 1, 2), and in Beard *et al*. (2013). This species is morphologically similar to the other members of its clade, *R. australica* and *R. marri* (species 6 and species 7 in Dowling *et al.* 2012, respectively).

Raoiella taronga can be separated from *R. australica* by the following: *Rt* (both sexes) setae *c1*, *d1*, *e1* are weakly spatulate and larger vs *Ra* (both sexes) *c1*, *d1*, *e1* all minute; *Rt* setae *h2* narrow, tapered vs *Ra* setae *h2* thicker and blunt tipped; *Rt ps2–ps3* subequal in length vs *Ra ps2* longer than *ps3*; *Rt* genua I with setae *l′* thickened

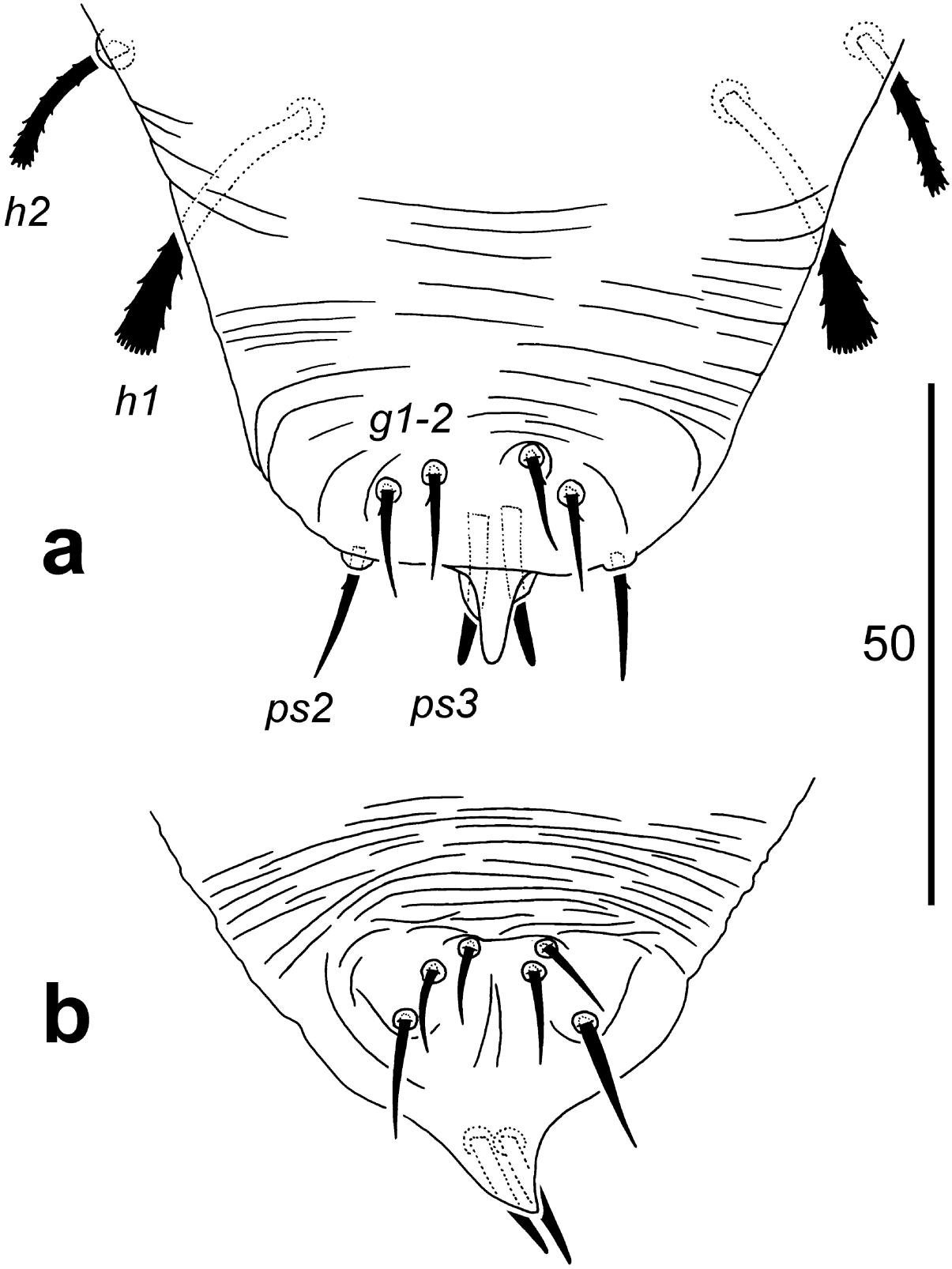


FIGURE 221. *Raoiella taronga* Beard & Ochoa, adult male: a. posterior venter with genital region retracted; b. posterior venter with genital region protracted.

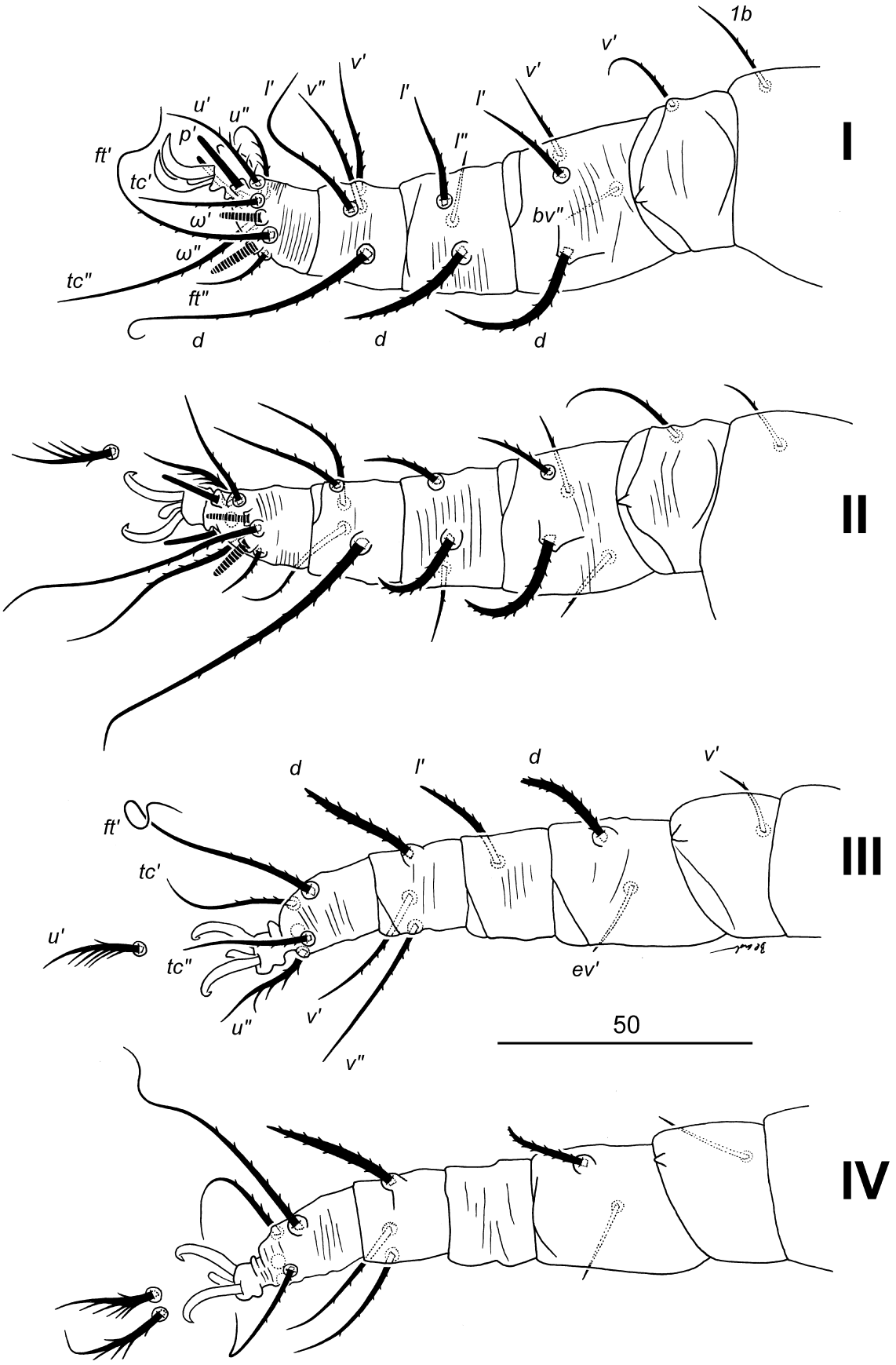


FIGURE 222. *Raoiella taronga* Beard & Ochoa, adult male: legs I–IV (left side; leg I dorsal to adaxial aspect, leg II dorsal aspect, legs III–IV abaxial aspect; unguinal setae illustrated separately).

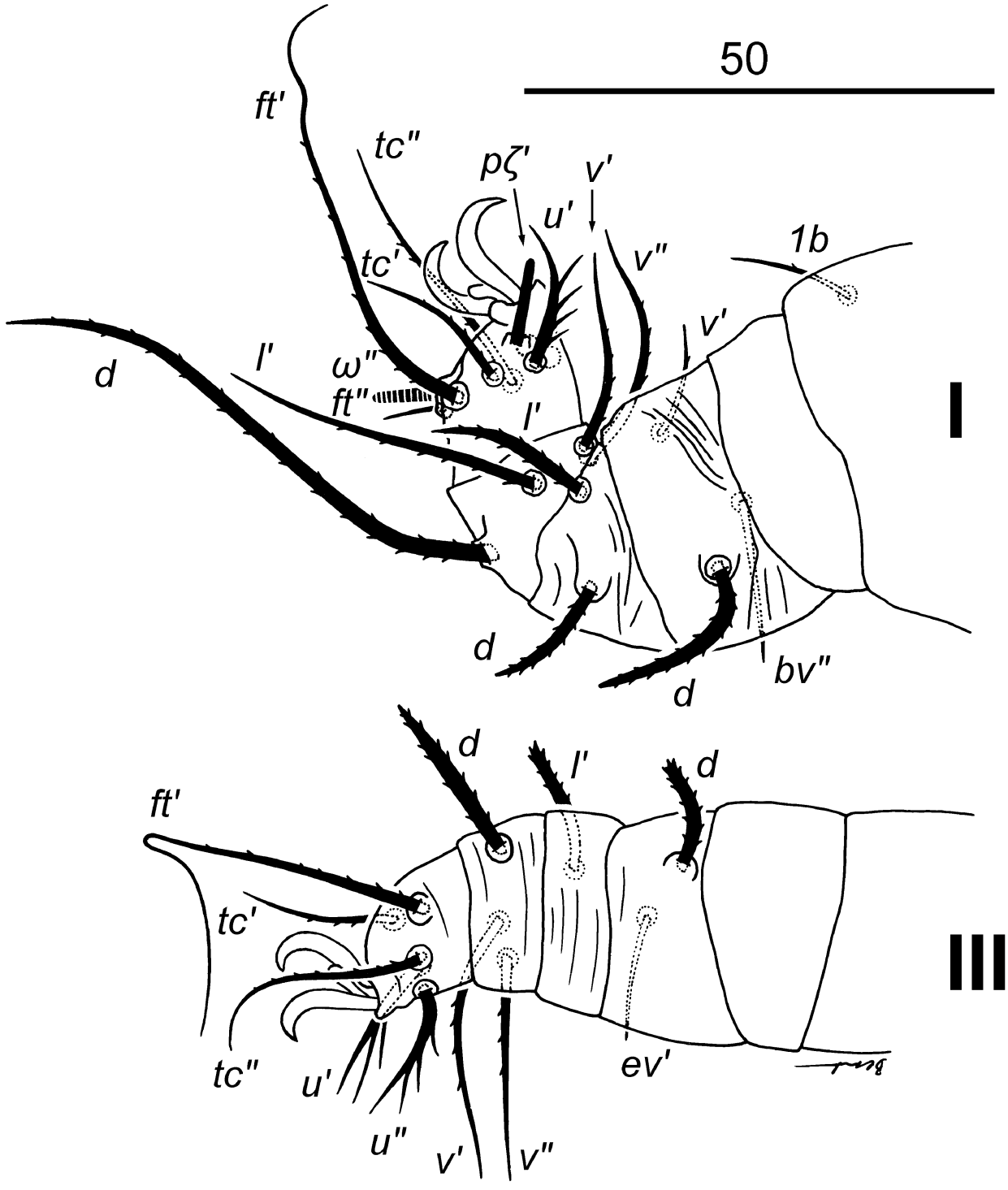


FIGURE 223. *Raoiella taronga* Beard & Ochoa, deutonymph: legs I and III (left side; leg I abaxial aspect, leg III adaxial aspect).

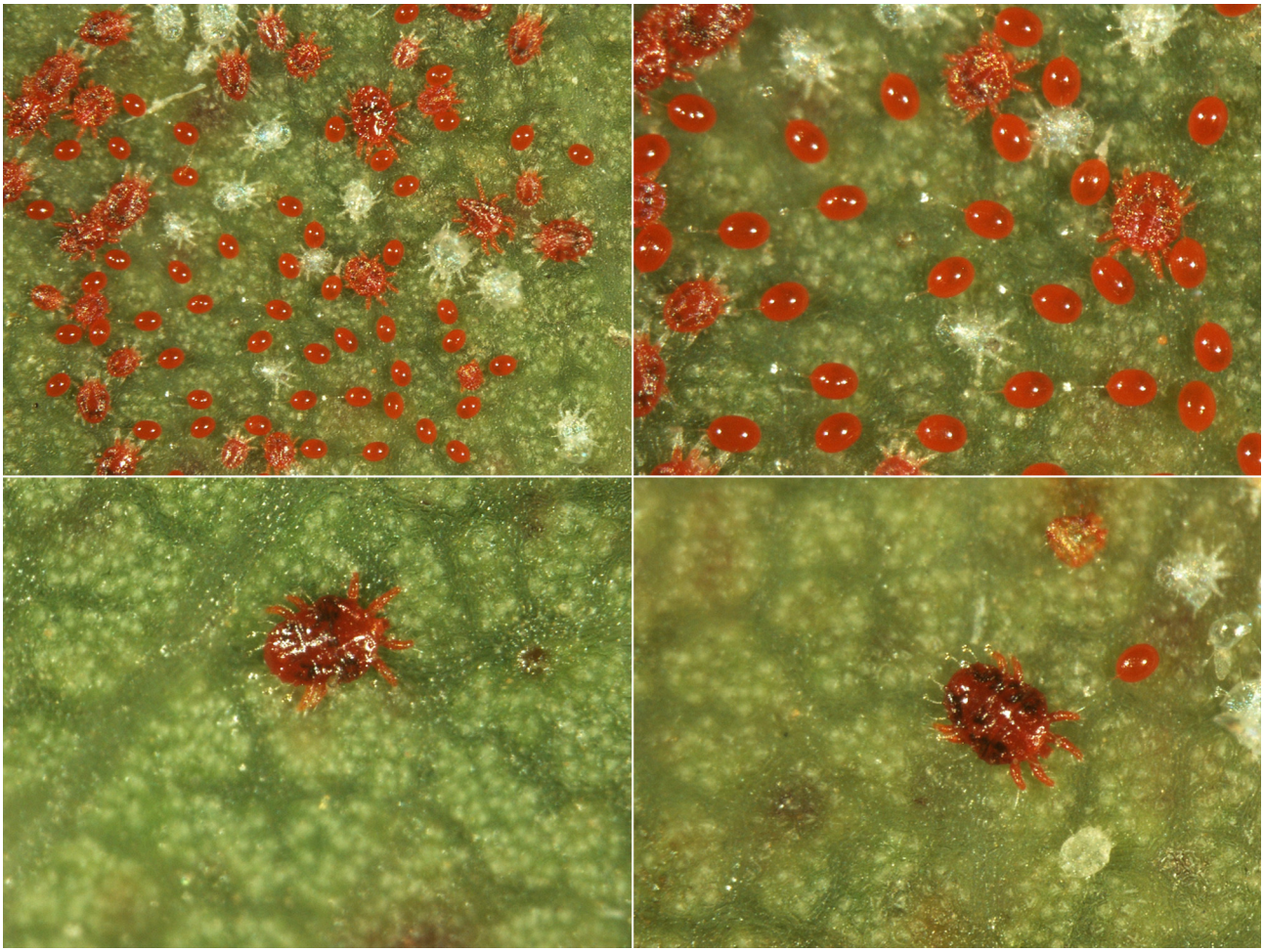


FIGURE 224. *Raoiella taronga* Beard & Ochoa, live individuals on host plant: eggs, immatures and adults.

vs *Ra* genua I with setae *l′* thin, finely tapered; *Rt* male with setae *h1* obviously longer than *h2* vs *Ra* setae *h1* marginally shorter than *h2*; *Rt* male prodorsal setae *v2* > 40 µm vs *Ra v2* < 30. *Raoiella taronga* can be separated from *R. marri* by the following: *Rt* (female and male) setae *c1*, *d1*, *e1* are weakly spatulate and larger than those on *Rm* (all minute); *Rt* setae *g1–g2* inserted in transverse row on genital flap vs *Rm* setae *g1* inserted anterior to *g2*; *Rt* genua I with setae *l′* thickened vs *Rm* genua I with setae *l′* very thin, finely tapered; *Rt* femora I–IV and tibiae III–IV with setae *d* with blunt tips vs *Rm* femora I–IV and tibiae III–IV with setae *d* with tapered tips; *Rt* male prodorsal setae *v2* > 40 µm vs *Rm v2* < 30.

The presence of seta *d* on genua I–II of the deutonymph is an indicator that the specimen is a male, as seta *d* is present on genua I–II of the adult male but absent on the adult female (a character state for the *australica* species group).

Raoiella todtiana **sp. nov. Beard & Ochoa**

(Figs 225–240)

Material examined. Holotype, ♀. Australia, ex. coastal blackbutt *Eucalyptus todtiana* (Myrtaceae) (host plant voucher BRI—AQ814932), approx 3 km E Cataby, on Cataby-Dandaragan Road, 30°43’58”S 115°33’12”E, 15.iv.2009, J.J. Beard (WAM).

Paratypes. 5 ♀, 3 ♂, 5 deutonymphs, 3 protonymphs, 4 larvae same data as holotype; 4 ♀, 3 ♂, 2 larvae, ex. *E. todtiana*, Alexander Morrison National Park, Coorow-Green Head Road, 30°03’33”S 115°28’09”E, 16.iv.2009, J.J. Beard; 4 ♀, 2 ♂, 2 deutonymphs, 3 protonymphs, ex. *E. todtiana*, Yanchep National Park, 51 km N Perth via Wanneroo Road, 31°32’34”S 115°41’50”E, 22.iv.2009, J.J. Beard. All paratypes in WAM, QM.

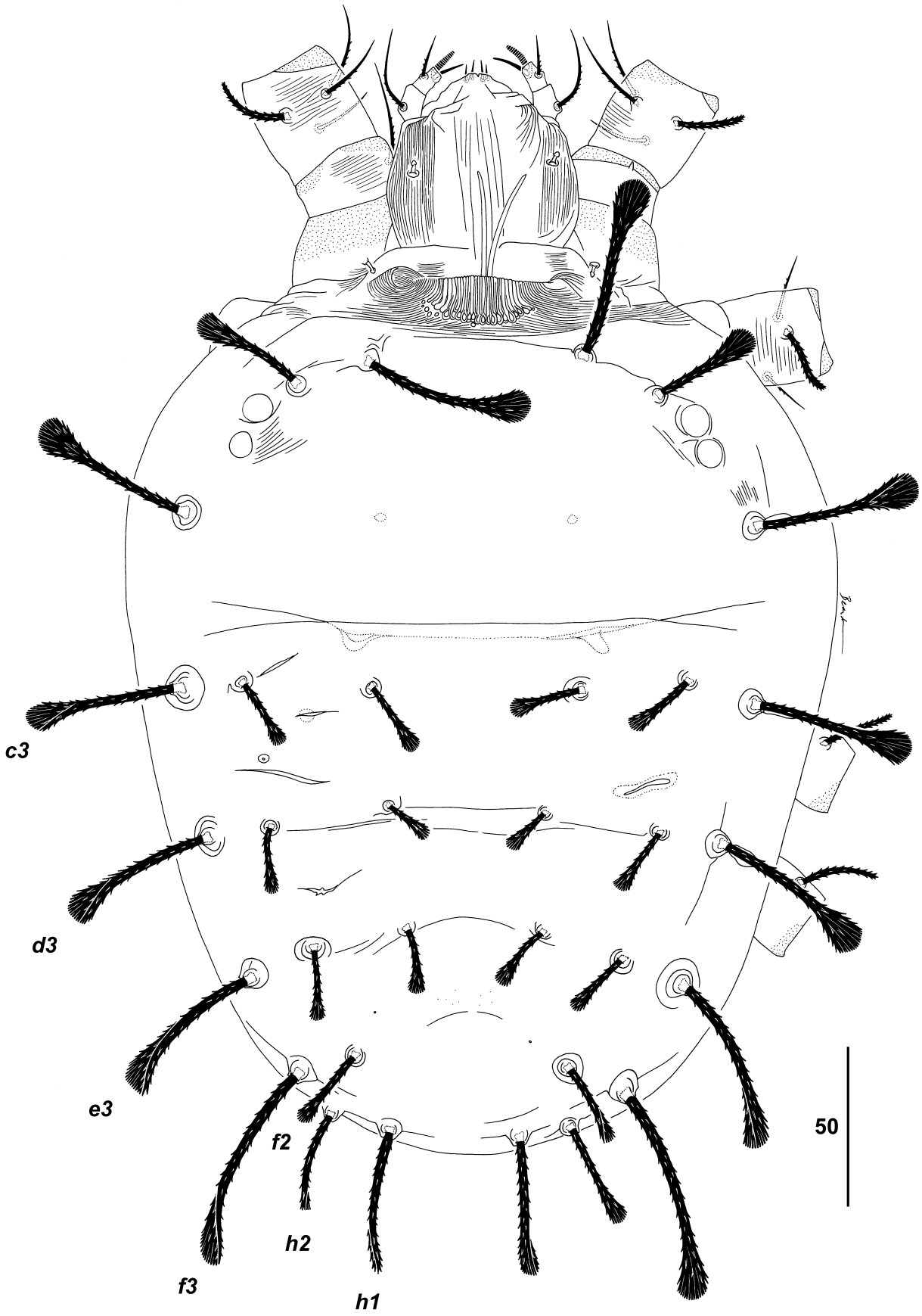


FIGURE 225. *Raoiella todtiana* Beard & Ochoa, adult female: dorsal habitus with details of palp.

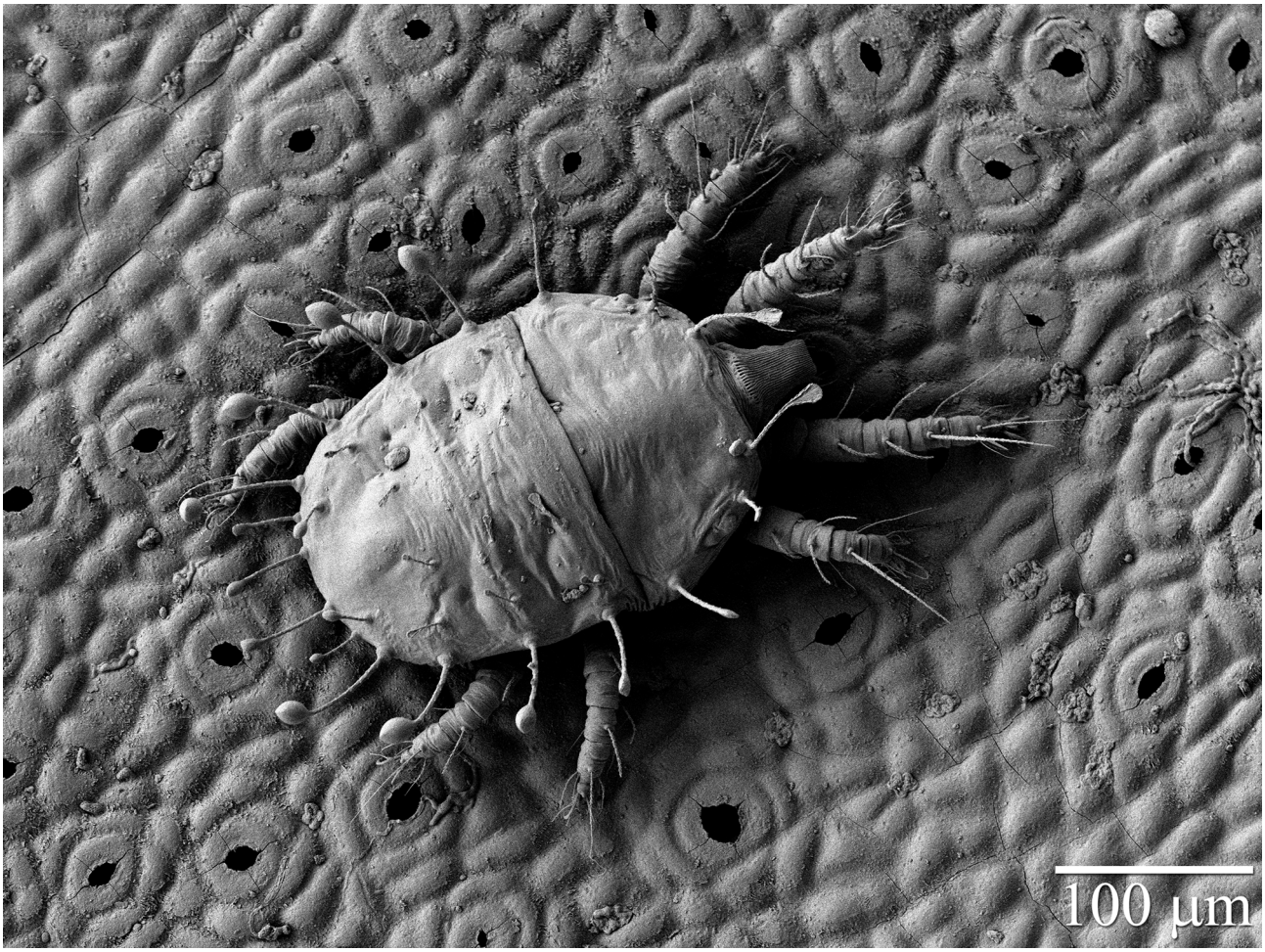


FIGURE 226. *Raoiella todtiana* Beard & Ochoa, adult female: dorsal habitus on host plant.

Other material examined. **Australia,** 9 ♀, 7 ♂, 4 deutonymphs, 2 protonymphs, 13 larvae, same data as holotype; 2 ♀, 5 ♂, 1 protonymph, ex. *E. todtiana*, Yanchep National Park, 51 km N Perth via Wanneroo Road, Western Australia, 31°32'34"S 115°41'50"E, 22.iv.2009, J.J. Beard. All other material in QM.

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* slightly longer than *h2*. Setae *h2* short, spatulate. Adult femora I with four setae (*d*, *l'*, *v'*, *bv"*); femora II with three setae (*d*, *v'*, *bv"* present; *l'* absent); genua I–II with three setae (*d*, *l', l"*); coxae I with one seta (*1b* present; *1c* absent); coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft"*) longer than solenidia. Dorsal setae on tibiae I–II tapered to finely tapered. Eupathidium on palp tibiotarsus tapered, finely blunt. Larva with setae *h2* elongate, filiform.

Description. Female. ***Dorsum.*** (Figs 225–227) Body measurements (14): length between setae *v2–h1* 240–260 [244], width between setae *sc2–sc2* 172–182 [175], *c3–c3* 171–187 [177], *f2–f2* 57–68, *f3–f3* 92–107 [99]. Lightly sclerotised prodorsal and opisthonotal shields evident; shields finely punctate. Prodorsum smooth, with pair large pores on posterior margin (often in folded cuticle between prosoma and opisthosoma); one–three pairs of minute pores and pair of large pores mesally not always visible. Dorsal opisthosoma with a pair of minute pores and one–three pairs of slit pores between setae *c2–d2*; pair large pores between *d2–e2*; some minute pores between *e1–f2* often visible. Dorsal setae spatulate, barbed along entire length; setal measurements: *v2* 55–65 [55–58], *sc1* 32–42 [35–37], *sc2* 48–60 [50–53], *c1* 22–30 [24–26], *c2* 24–28 [24–25], *c3* 51–60 [51–52], *d1* 15–21 [16–17], *d2* 20–24 [22–23], *d3* 52–65 [52–54], *e1* 18–23 [22–23], *e2* 22–26 [23–25], *e3* 53–67 [53–58], *f2* 26–32 [28–29], *f3* 70–82 [70–71], *h1* 43–56 [46–47], *h2* 26–36 [33–35].

Palps. (Fig. 225) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (8–10) [9] and one tapered, blunt eupathidium (9–13) [11–12] distally, one dorsal seta (11–15)[12–14]; palp femorogenu with one seta (22–28) [24–26]. Stylet tip not imaged with SEM.

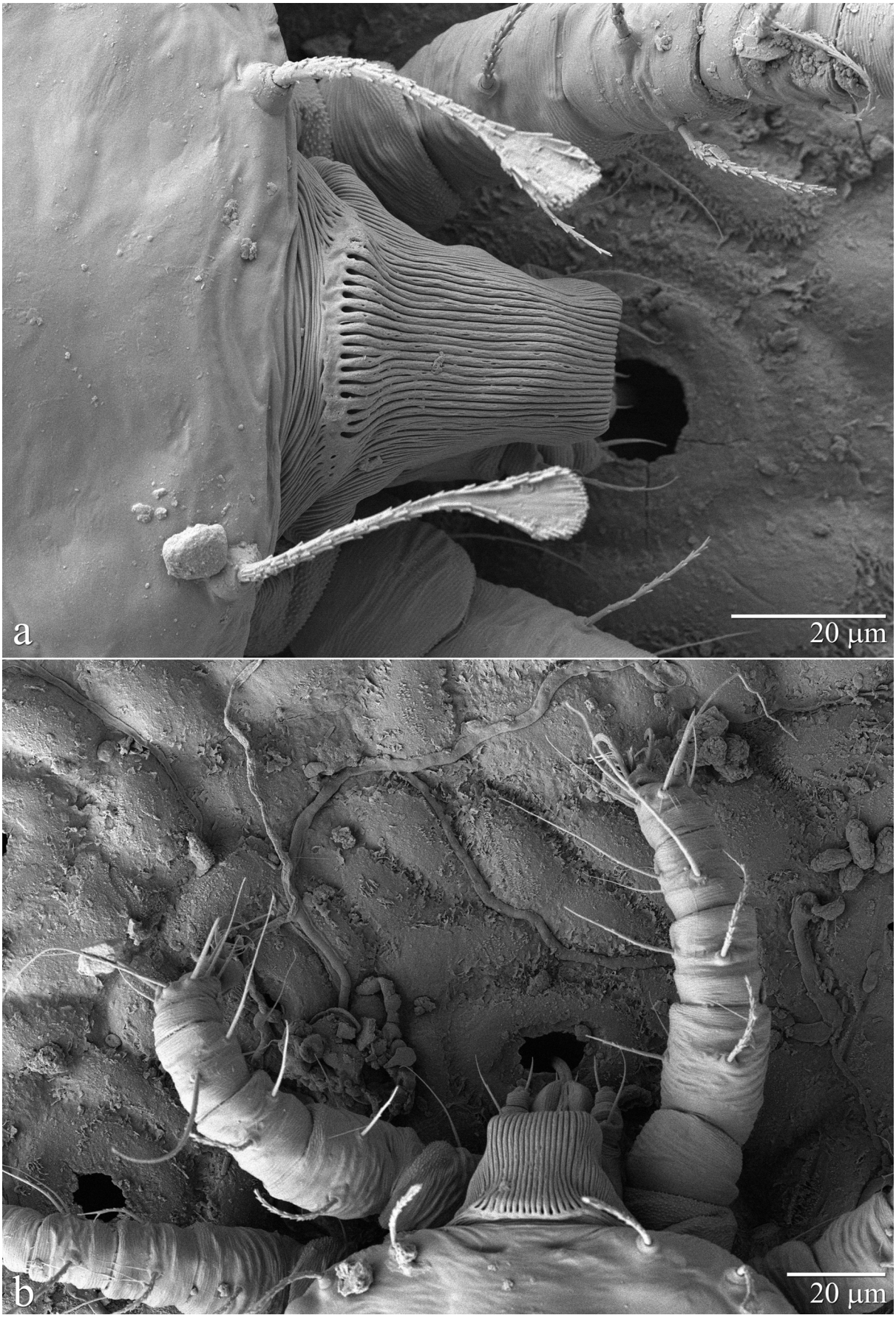


FIGURE 227. *Raoiella todtiana* Beard & Ochoa, adults feeding via the stomata: a. female; b. male.

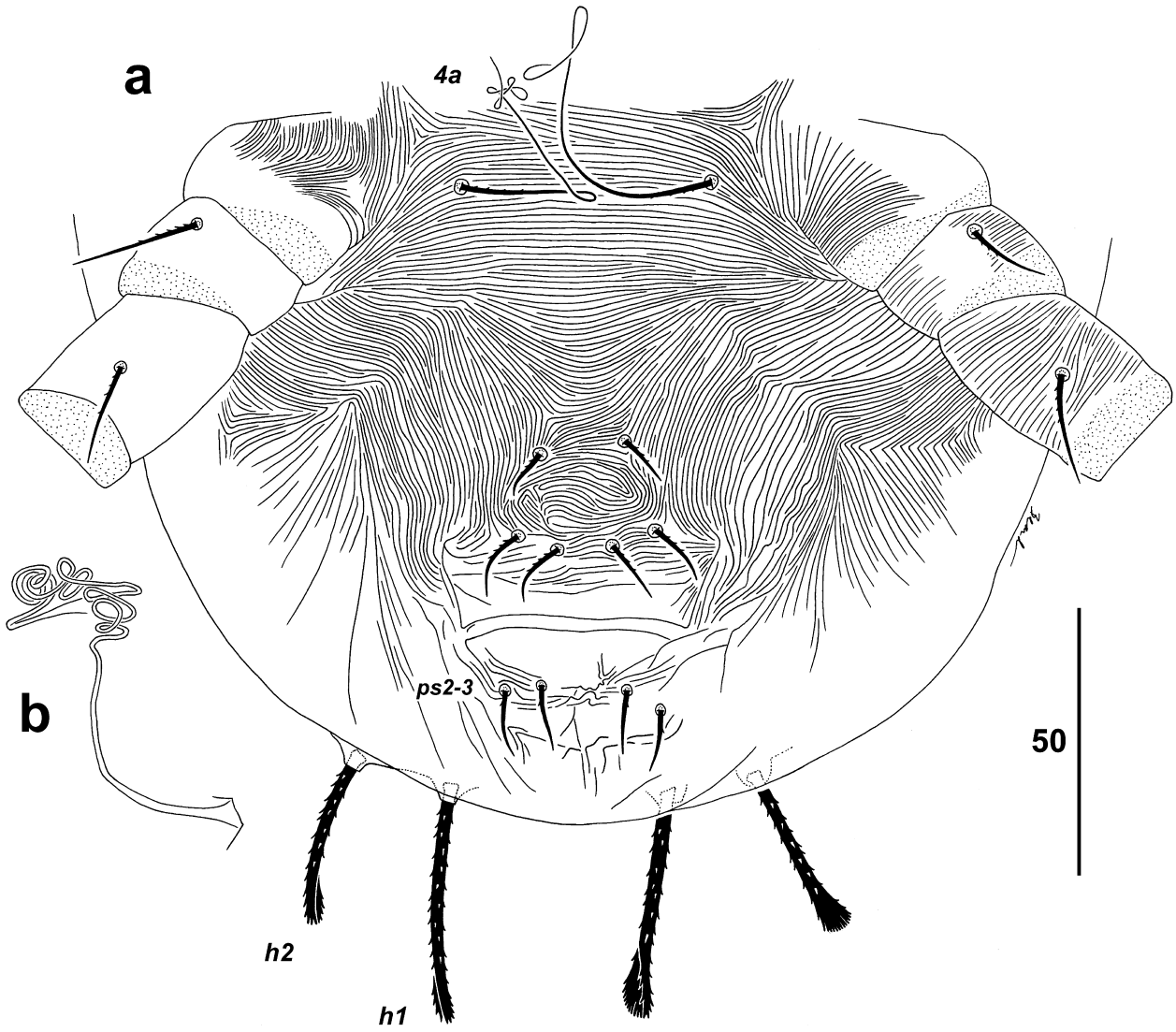


FIGURE 228. *Raoiella todtiana* Beard & Ochoa, adult female: a. posterior venter; b. detail of spermatheca.

Venter. (Fig. 228a) Cuticle almost completely plicate; with longitudinal striae between *1b–1a*, transverse striae *1a–g1*; striae longitudinal laterad genital region and coxae III–IV; striae transverse on genital flap; cuticle in coxal fields smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *ag*, *g1*, *g2*, *ps2*, *ps3* barbed. Setal measurements: *1a* 58–101 [87–92], *1b* 18–27 [23–27], *2b* 13–19 [13], *3a* 12–15 [13–14], *4a* 58–85 [63–81], *ag* 8–11 [11], *g1* 12–14 [13–14], *g2* 12–14 [14], *ps2* 11–15 [15], *ps3* 10–12 [11].

Spermatheca. (Fig. 228b) Elongate, fine, tightly coiled membranous tube, appears to terminate in a membranous bulb.

Legs. (Figs 227b, 229–230) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-3-3-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Variations in setal counts: ge I with 2/3 setae. Tarsi I and II each with one abaxial solenidion (ta I 12–16 [14]; ta II 11–14 [12]) and two eupathidia distally (ta I 12–13 [12–13], 12–14 [13–14]; ta II 11–13 [13], 11–13 [13]). Weakly and finely barbed, fine companion seta *ft″* on tarsus I 17–27 [21–25] (Fig. 230a) and tarsus II 15–19 [17] (Fig. 230b), inserted adjacent to solenidion *ω″*. Tibiae I–II with dorsal seta tapered but not finely tapered. Femora I with four setae (*d*, *l′*, *v′*, *bv″*), femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with three setae (*d*, *l′*, *l″*). Claw IV 17–19 [17].

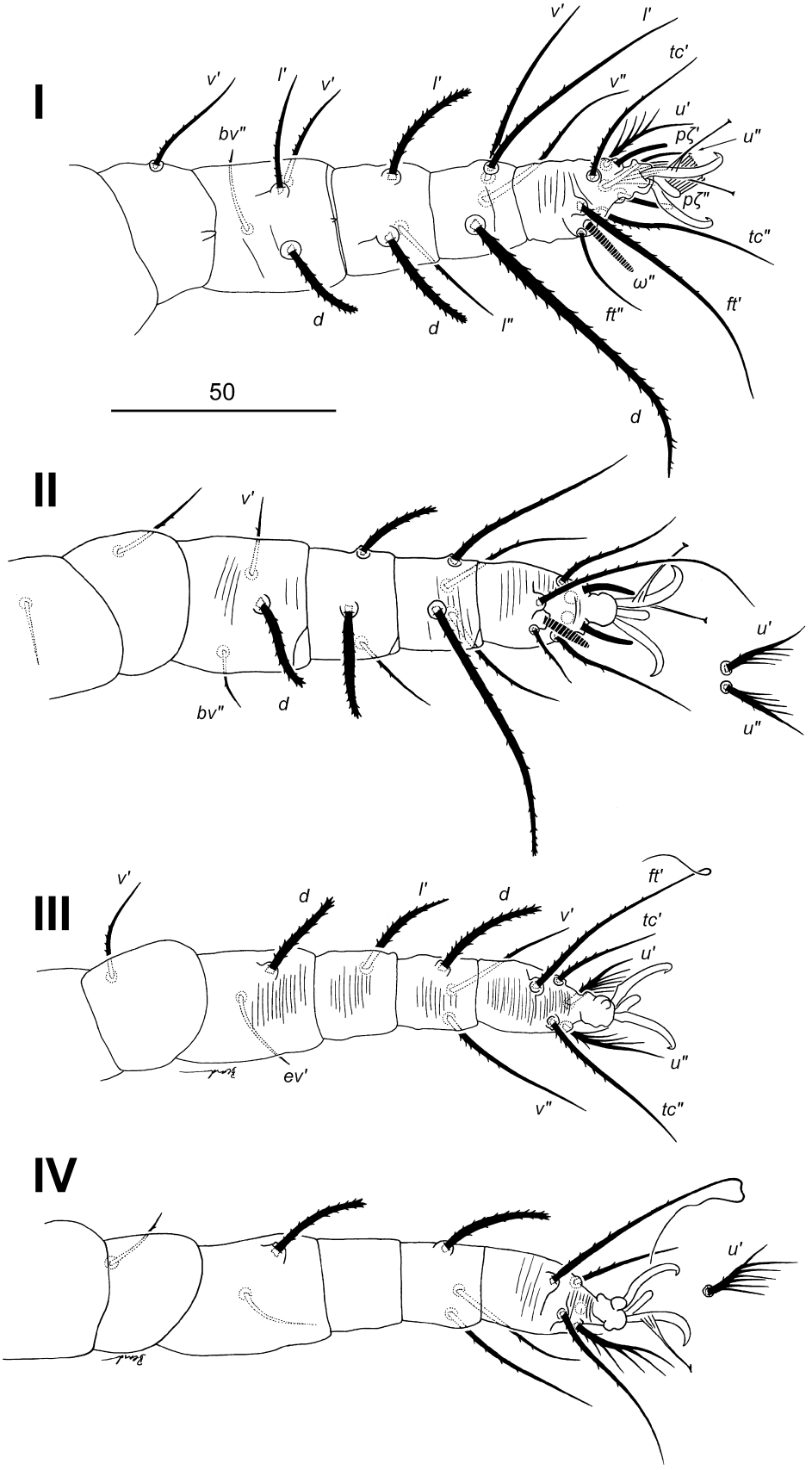


FIGURE 229. *Raoiella todtiana* Beard & Ochoa, adult female: a. legs I–IV (right side; legs I–II dorsal aspect, legs III–IV abaxial aspect).

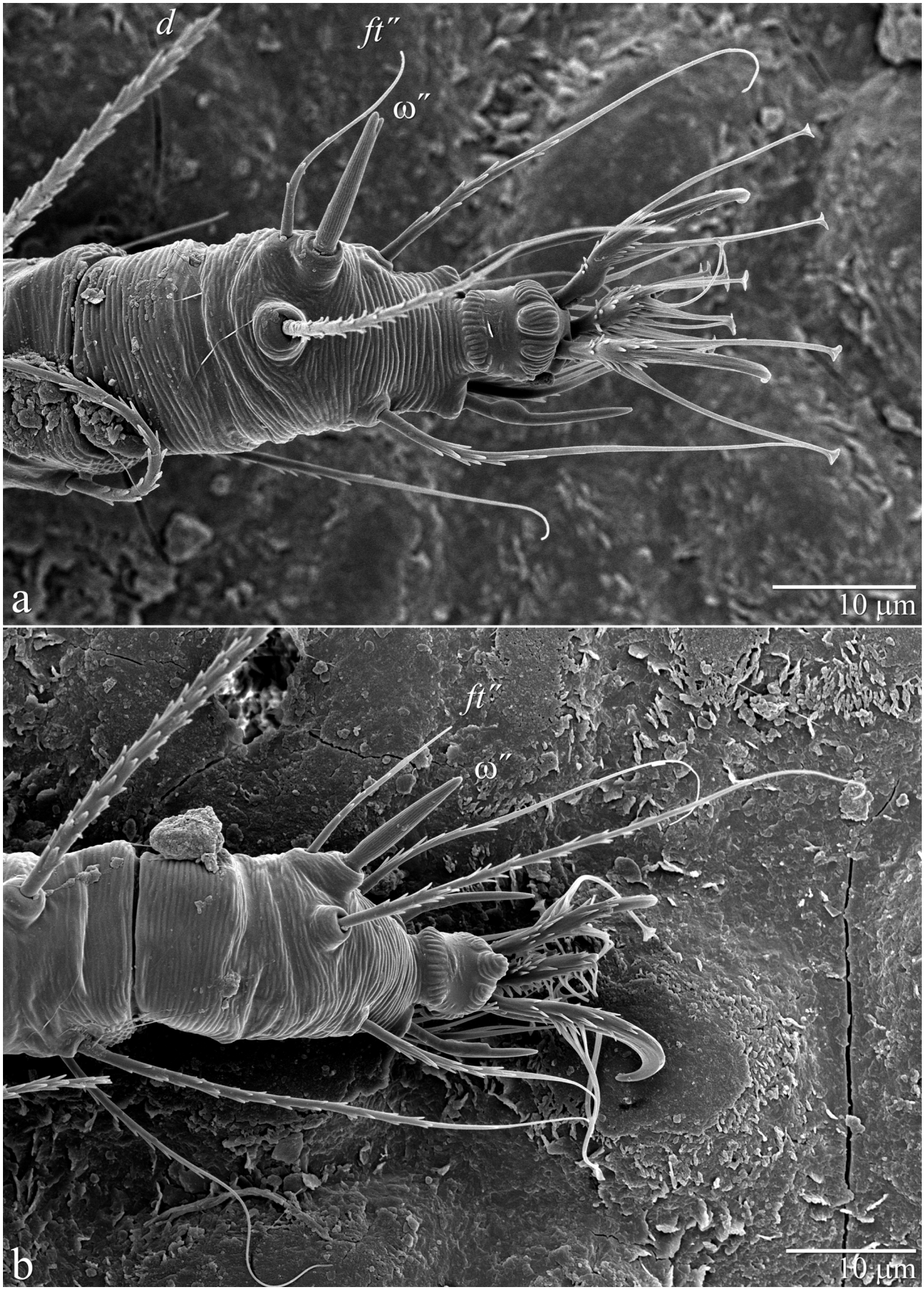


FIGURE 230. *Raoiella todtiana* Beard & Ochoa, adult female: a. detail of tarsus I indicating solenidion (*ω″)* and companion seta (*ft″*) (left side); b. detail of tarsus II (left side).

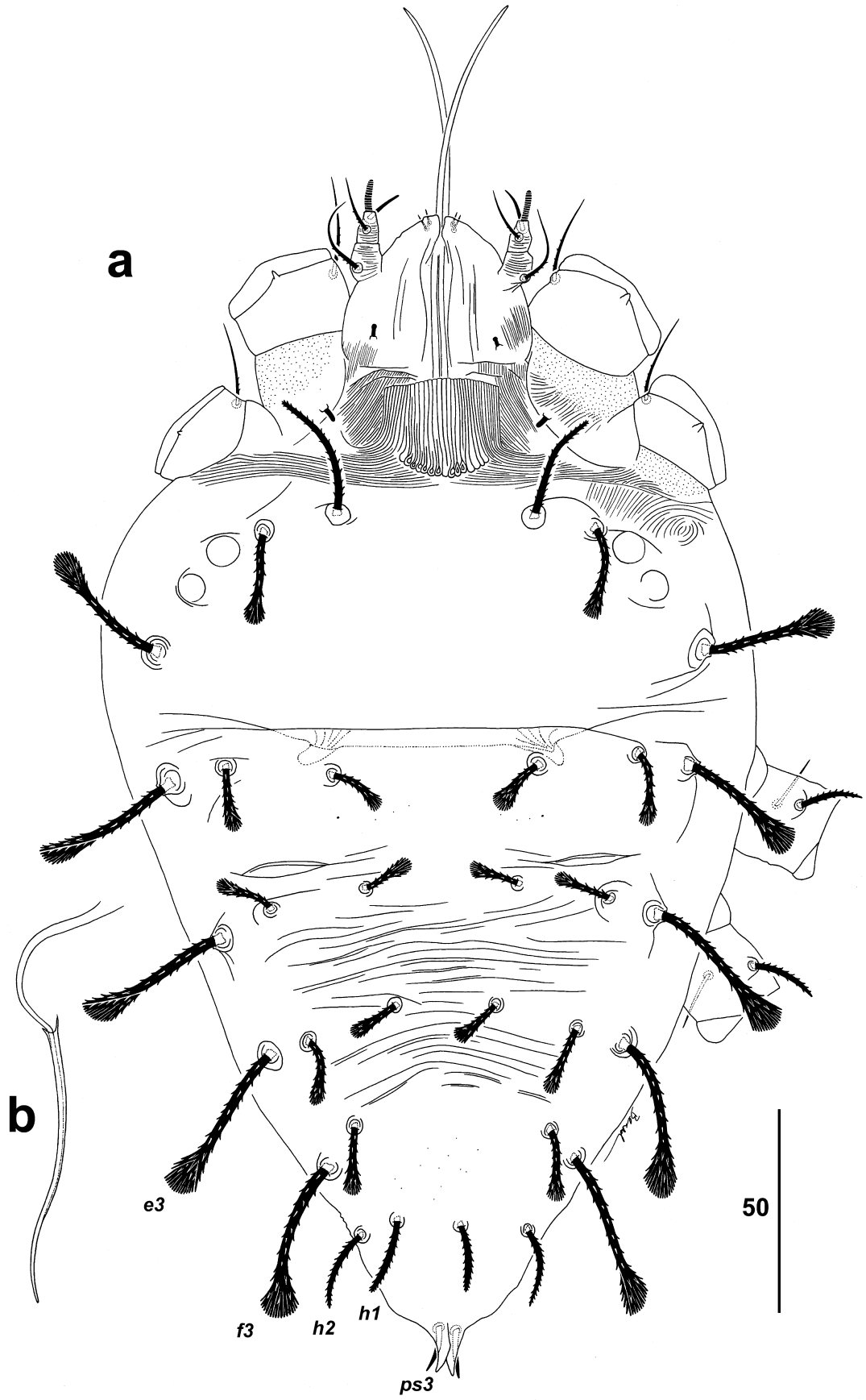


FIGURE 231. *Raoiella todtiana* Beard & Ochoa, adult male: a. dorsal habitus with detail of palps and setae *ps3*; b. detail of aedeagus.

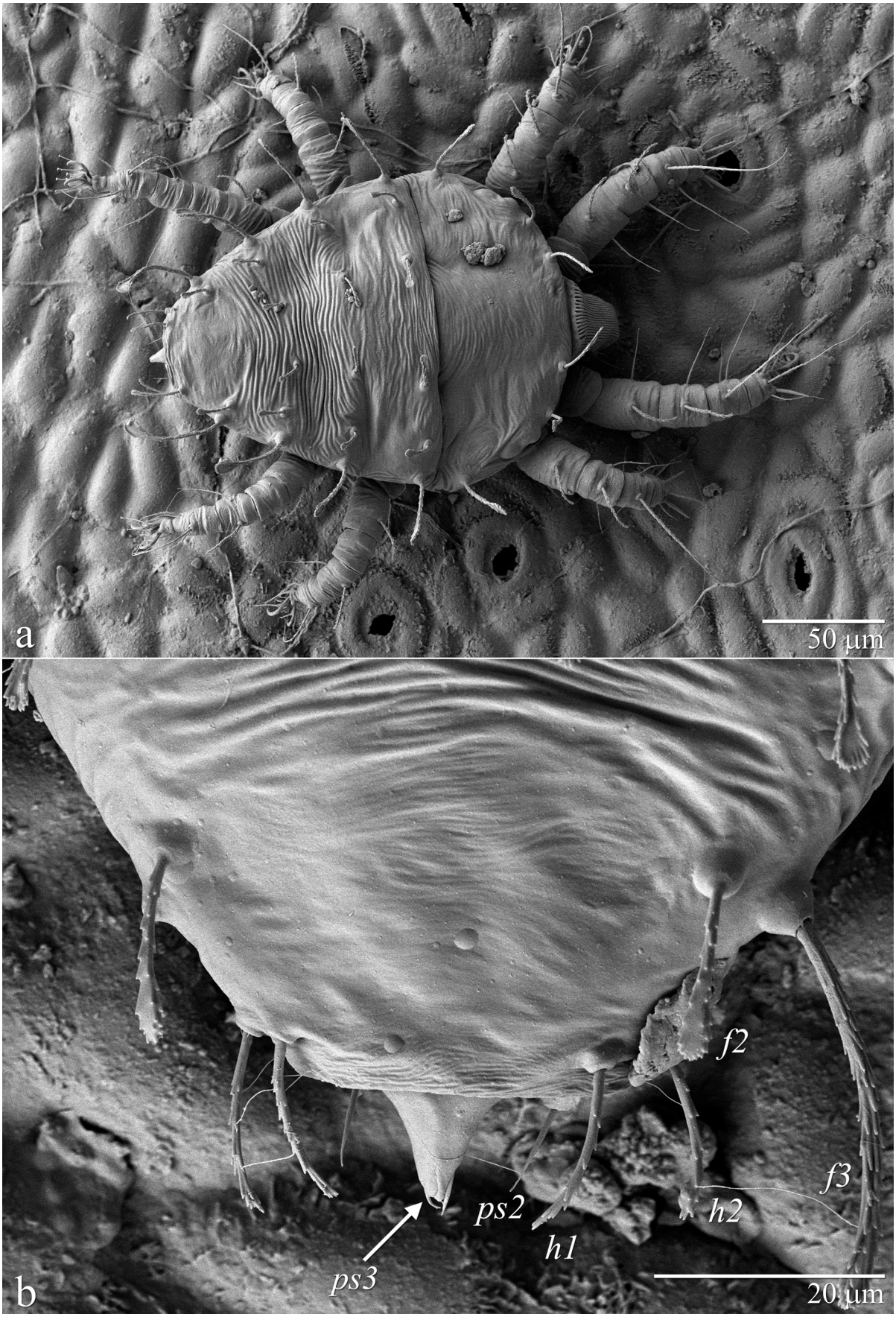


FIGURE 232. *Raoiella todtiana* Beard & Ochoa, adult male: a. dorsal habitus on host plant; b. detail of posterior dorsum, indicating setae *ps3*.

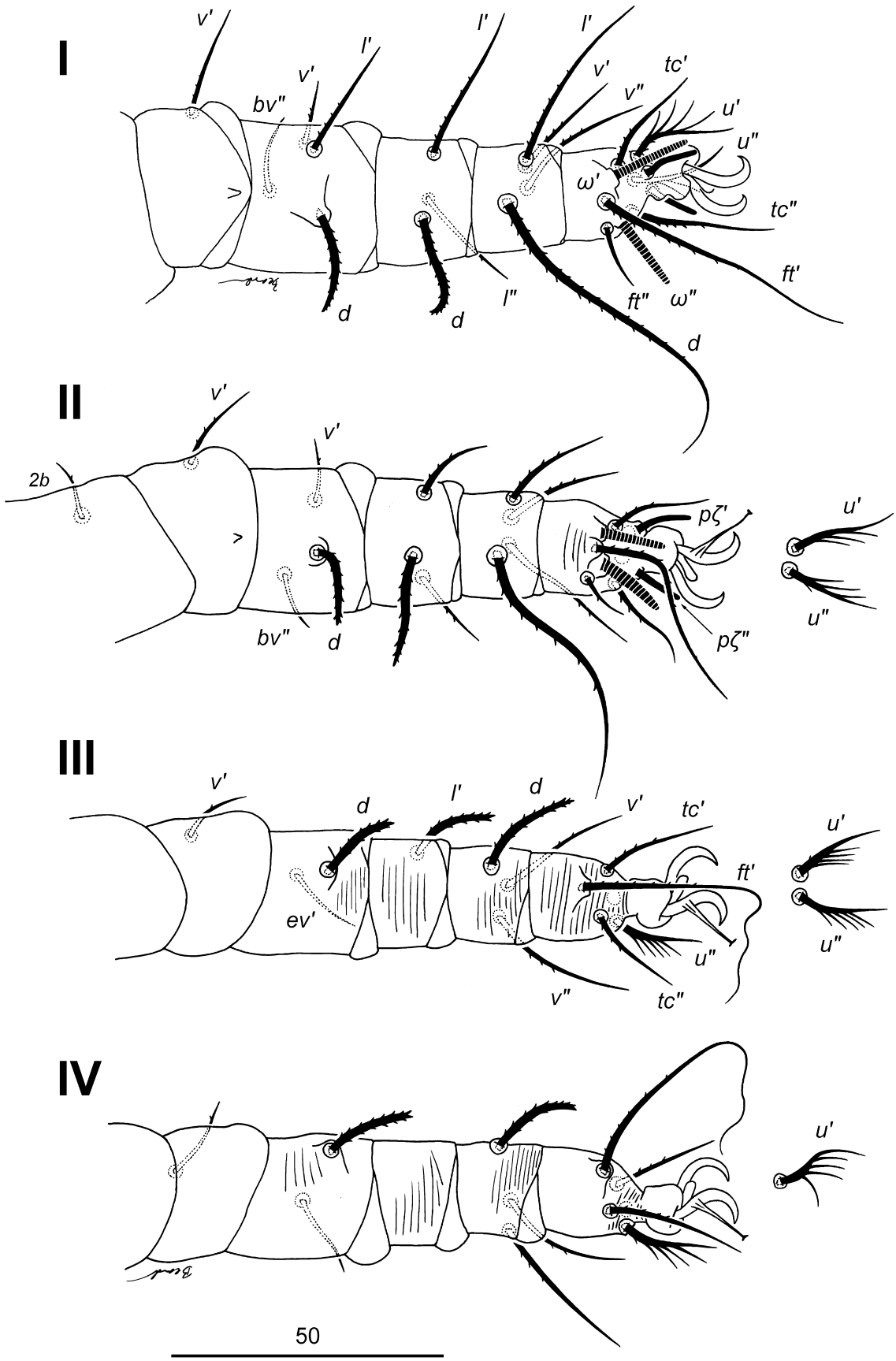


FIGURE 233. *Raoiella todtiana* Beard & Ochoa, adult male: a. legs I–IV (right side; legs I–II dorsal aspect, legs III–IV abaxial aspect; unguinal setae illustrated separately).

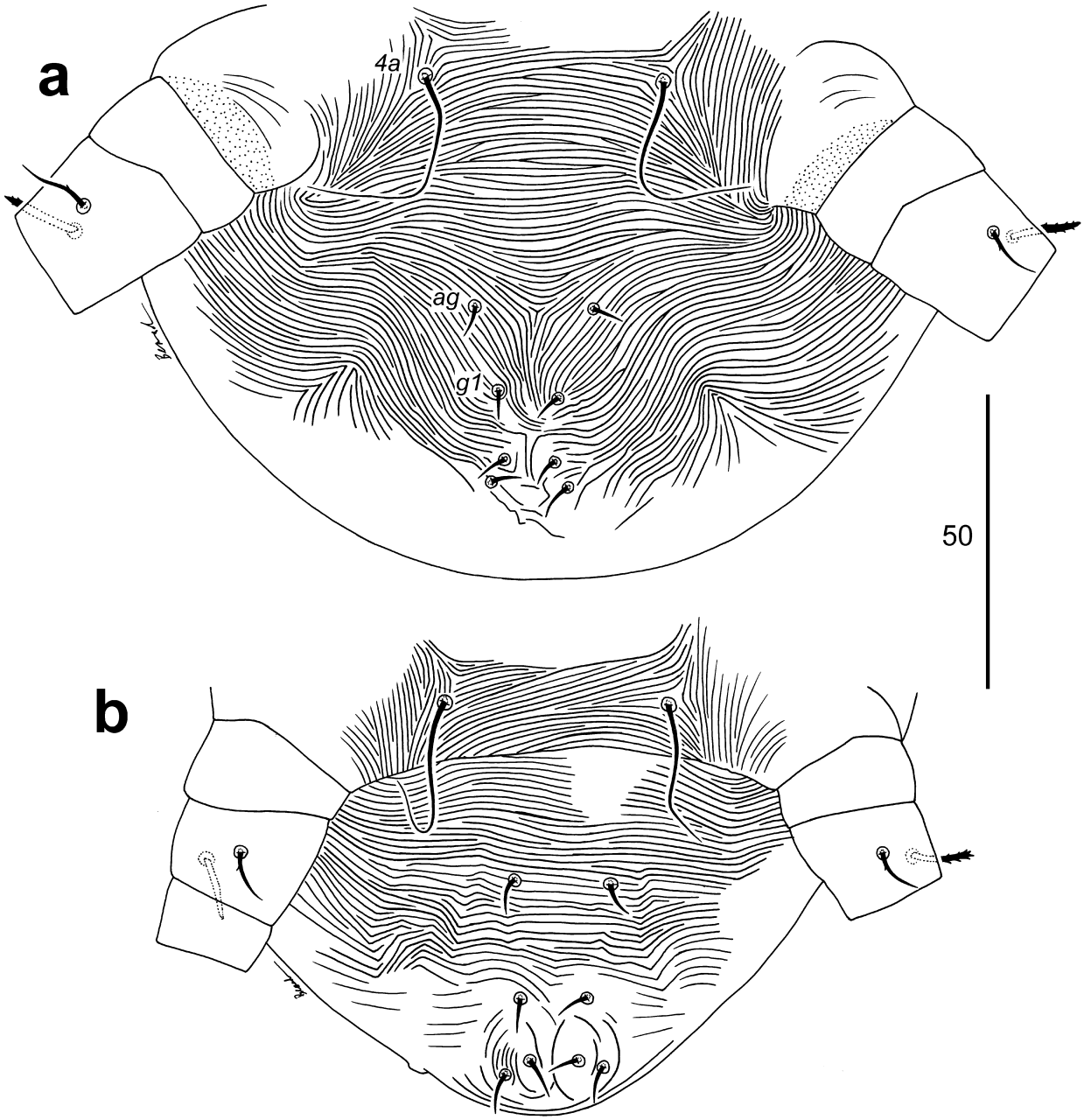


FIGURE 234. *Raoiella todtiana* Beard & Ochoa, deutonymph posterior venter: a. female deutonymph; b. male deutonymph.

Male. ***Dorsum.*** (Figs 231a–232) Body measurements (8): length between setae *v2–h1* 170–186, width between setae *sc2–sc2* 132–144, *c3–c3* 127–140, *f2–f2* 46–50, *f3–f3* 57–61. Prodorsum with pair large pores mesally often visible, pair large pores on posterior margin (often in folded cuticle between prosoma and opisthosoma). Opisthosoma with pair of large slit pores between setae *c2–d2*; with strong transverse striae between setae *d1* and *f2*; weakly puncate pygidial shield between F–H row setae. Dorsal setae spatulate, barbed along entire length; setae *v2* tapered to weakly spatulate; setae *h1*, *h2* tapered to weakly spatulate. Dorsal setae measurements: *v2* 27–34, *sc1* 23–28, *sc2* 32–39, *c1* 15–20, *c2* 18–21, *c3* 30–42, *d1* 13–17, *d2* 15–19, *d3* 38–46, *e1* 14–16, *e2* 15–19, *e3* 36–45, *f2* 13–21, *f3* 43–50, *h1* 16–21, *h2* 15–21.

Palps. (Fig. 231a) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (8–9) and one tapered, blunt eupathidium (8–10) distally, one dorsal seta (11–15); palp femorogenu with one seta (18–21).

Venter. Ventral cuticle almost completely plicate with mostly transverse striae; cuticle with longitudinal striae

between *1b–1a*, striae transverse *1a–g1*; striae fine between *1a–4a*, broadly separated *4a* to posterad *ag*; cuticle with pair of distinct smooth regions laterad *ag*; cuticle with some longitudinal striae mesad coxae III–IV. Setal measurements: *1a* 53–72, *1b* 17–23, *2b* 12–16, *3a* 8–13, *4a* 37–58, *ag* 7–10, *g1* 11–14, *g2* 11–14, *ps2* 8–11, *ps3* 9–11. Pseudanal setae *ps3* thickened, modified as accessory genital stylets into thickened spines (Figs 231a, 232b).

Aedeagus. (Fig. 231b) Aedeagus narrow, elongate and sclerotised (68–72), tapering to a blunt point distally (at genital opening).

Legs. (Figs 232a, 233) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-3-3-4-10(2), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 12–16, abaxial 14–15; ta II adaxial 11–14, abaxial 12–15), and two eupathidia distally (ta I 11–12, 11–12; ta II 10–11, 10–11). Finely tapered, weakly barbed companion seta *ft″* on tarsus I 14–23 (tip often difficult to see) and tarsus II 11–15, inserted adjacent to solenidion *ω″*. Tibiae I with dorsal setae finely tapered, tibiae II with dorsal seta tapered but not finely tapered. Femora I with four setae (*d*, *l′*, *v′*, *bv″*), femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with three setae (*d*, *l′*, *l″*). Aberrant setal counts: genua I–II with 2/3 (*l″* absent). Claw IV 14–15.

Deutonymph. ***Dorsum.*** Body measurements (6 females, 1 male): length between setae *v2–h1* female 197–217 (male 175), width between setae *sc2–sc2* 143–150 (122), *c3–c3* 143–156 (122), *f2–f2* 36–44 (30), *f3–f3* 56–63 (43). Prodorsum mostly smooth with some weak transverse folds. Dorsal opisthosoma with weak, widely spaced transverse folds between *c1–d1*; slit like pore anterior to *d2*. Dorsal setae barbed along entire length; seta *h2* blunt to weakly spatulate, barbed (blunt in male). Dorsal setae measurements: *v2* 45–50 (36), *sc1* 27–33 (23), *sc2* 40–49 (31), *c1* 19–22 (17), *c2* 21–24 (18), *c3* 41–47 (32), *d1* 14–18 (13), *d2* 17–22 (15), *d3* 43–48 (36), *e1* 17–20 (16), *e2* 18–23 (19), *e3* 42–49 (33), *f2* 22–27 (20), *f3* 36–45 (29), *h1* 14–20 (15), *h2* 9–13 (10).

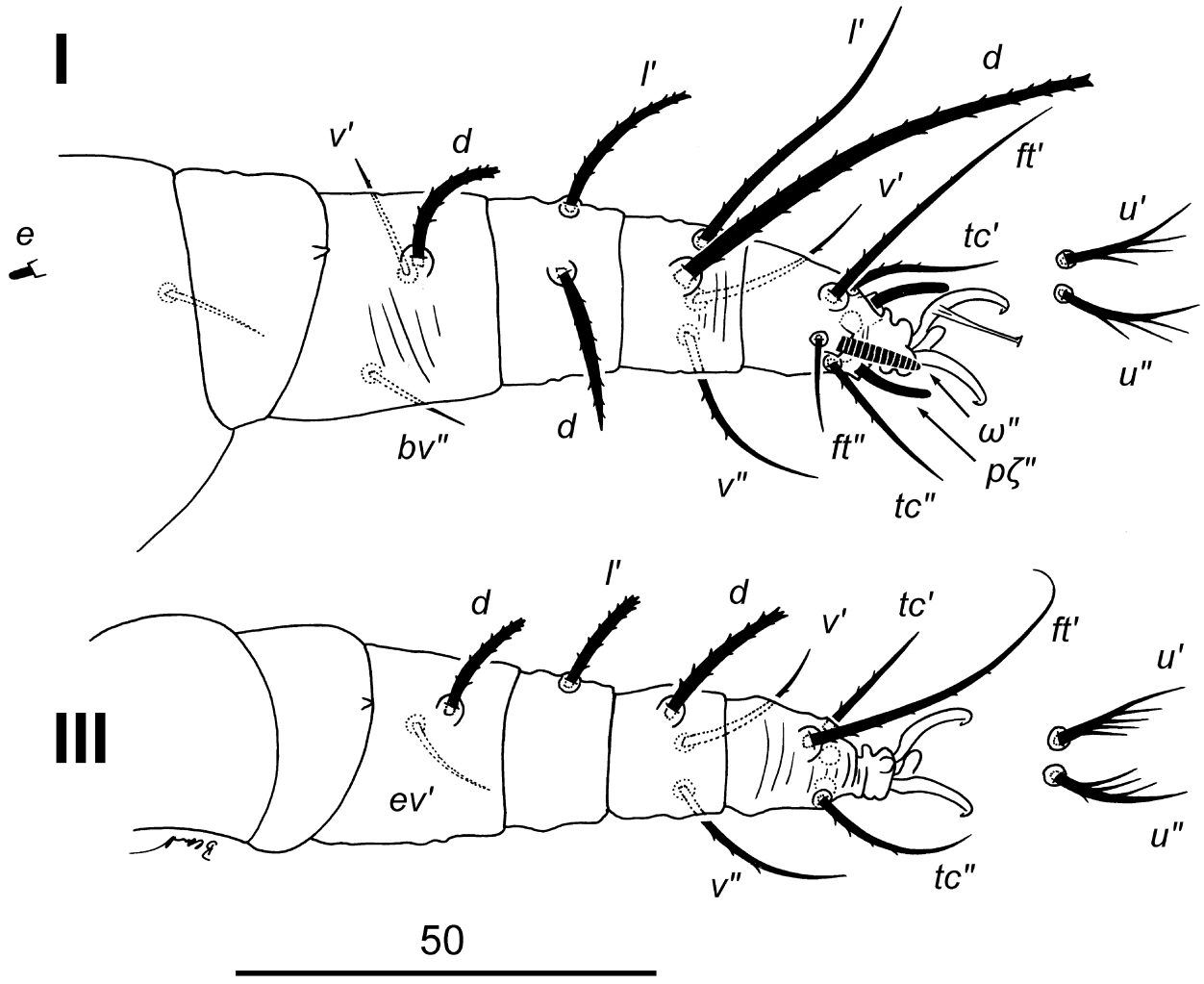


FIGURE 235. *Raoiella todtiana* Beard & Ochoa, deutonymph: legs I and III (right side, dorsal aspect).

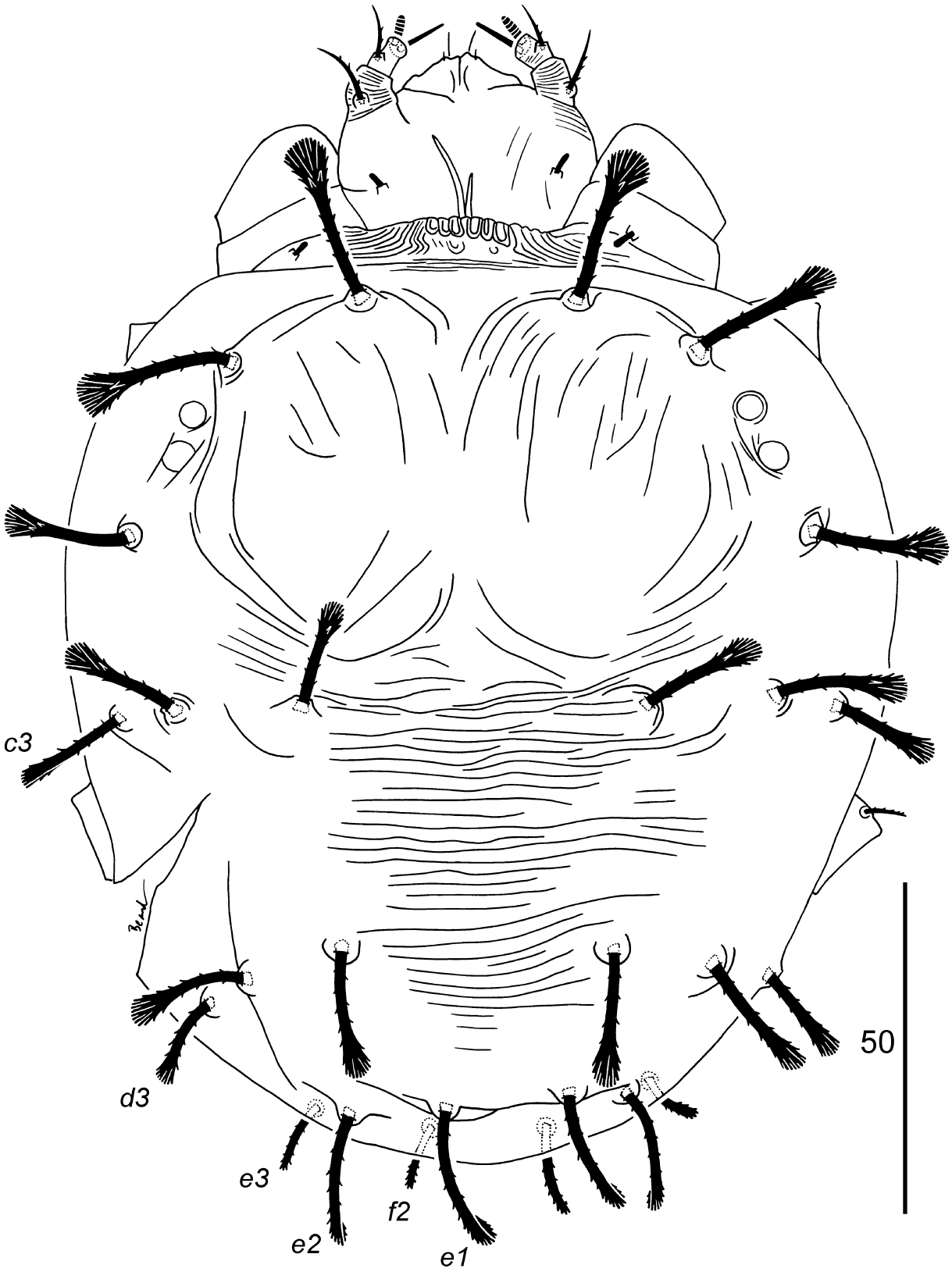


FIGURE 236. *Raoiella todtiana* Beard & Ochoa, larva: dorsal habitus with detail of palps.

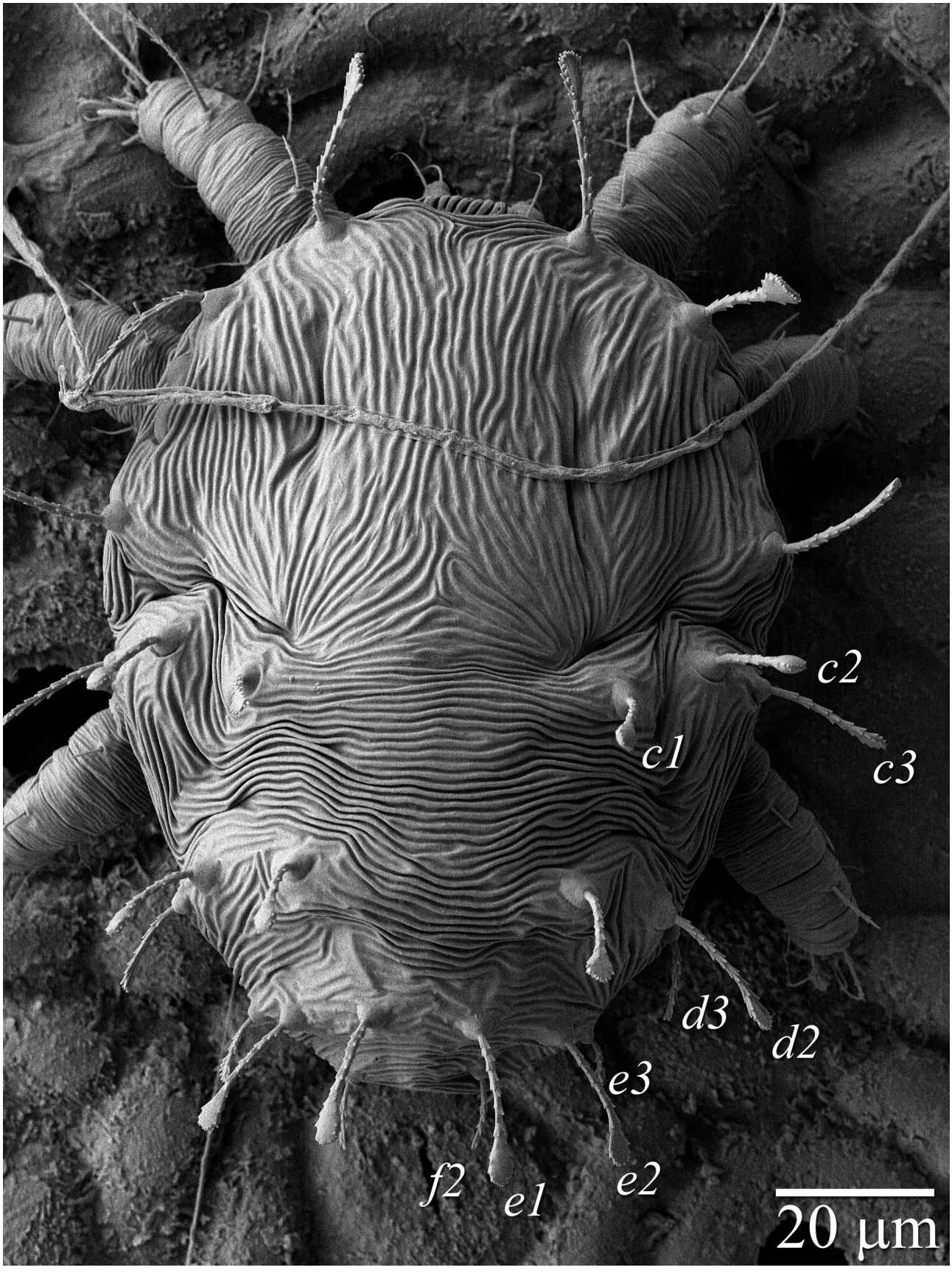


FIGURE 237. *Raoiella todtiana* Beard & Ochoa, larva: dorsal habitus on host plant.

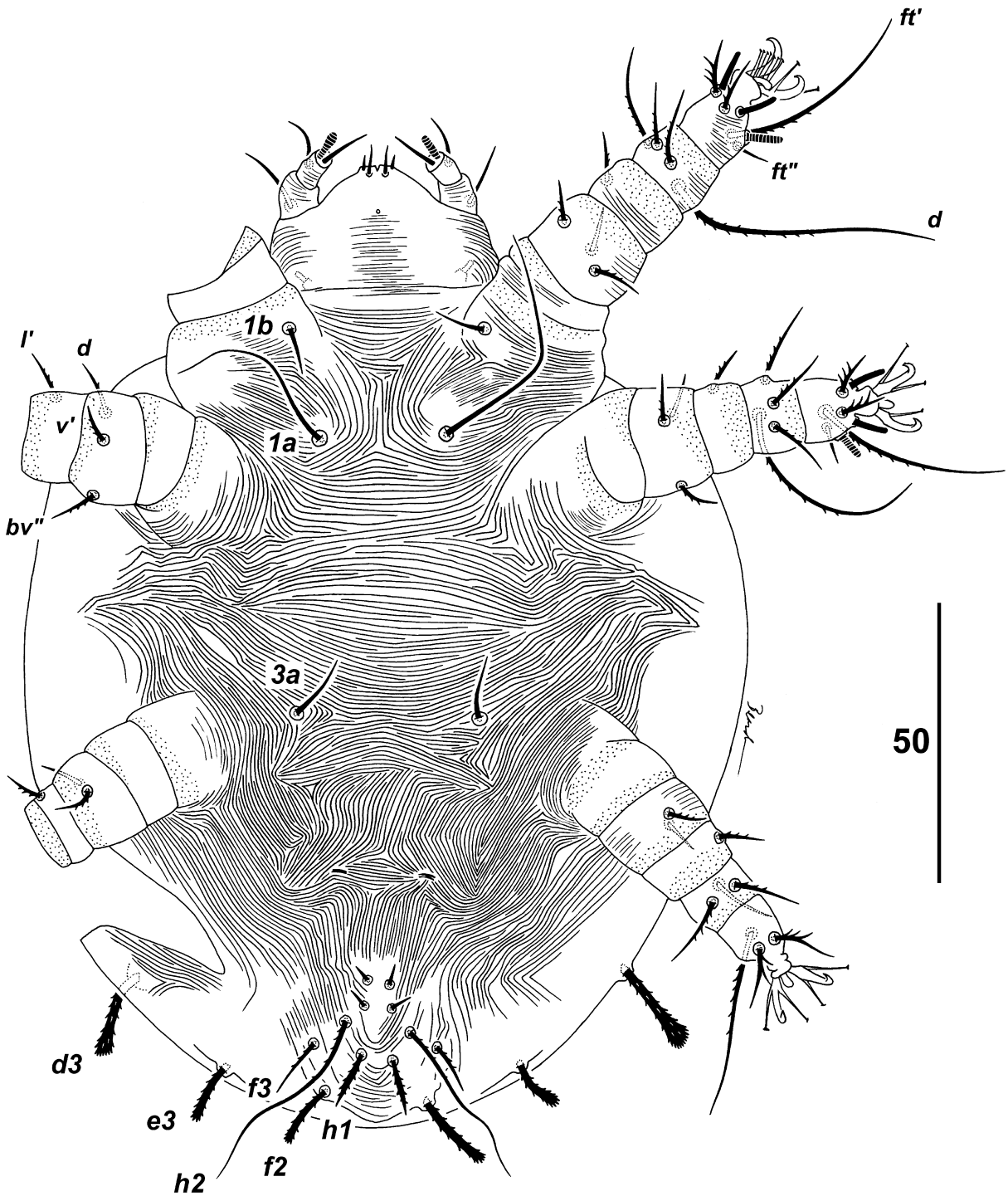


FIGURE 238. *Raoiella todtiana* Beard & Ochoa, larva: ventral habitus with detail of legs I–III and palps.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (7–8) and one tapered eupathidium (7–10) distally, one dorsal seta (7–11); palp femorogenu with one seta (17–21).

Venter. (Fig. 234) Female (Fig. 234a): cuticle almost completely plicate; longitudinal striae between *1b–1a*, fine transverse striae *1a–ag*, longitudinal to oblique striae *ag–g1*, coxal fields smooth. Male (Fig. 234b): cuticle almost completely plicate; transverse striae *1b–1b*, longitudinal striae *1b–1a*, transverse striae *1a–ag*, wavy striae *ag–g1*; male with *ps2–3* inserted in transverse line on weakly developed platelets. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 51–62 (43), *1b* 12–17 (17), *3a* 6–10 (8), *4a* 35–54 (36), *ag* 6–9 (8), *g1* 7–10 (7–9), *ps2* 5–8 (7–8), *ps3* 5–8 (8).

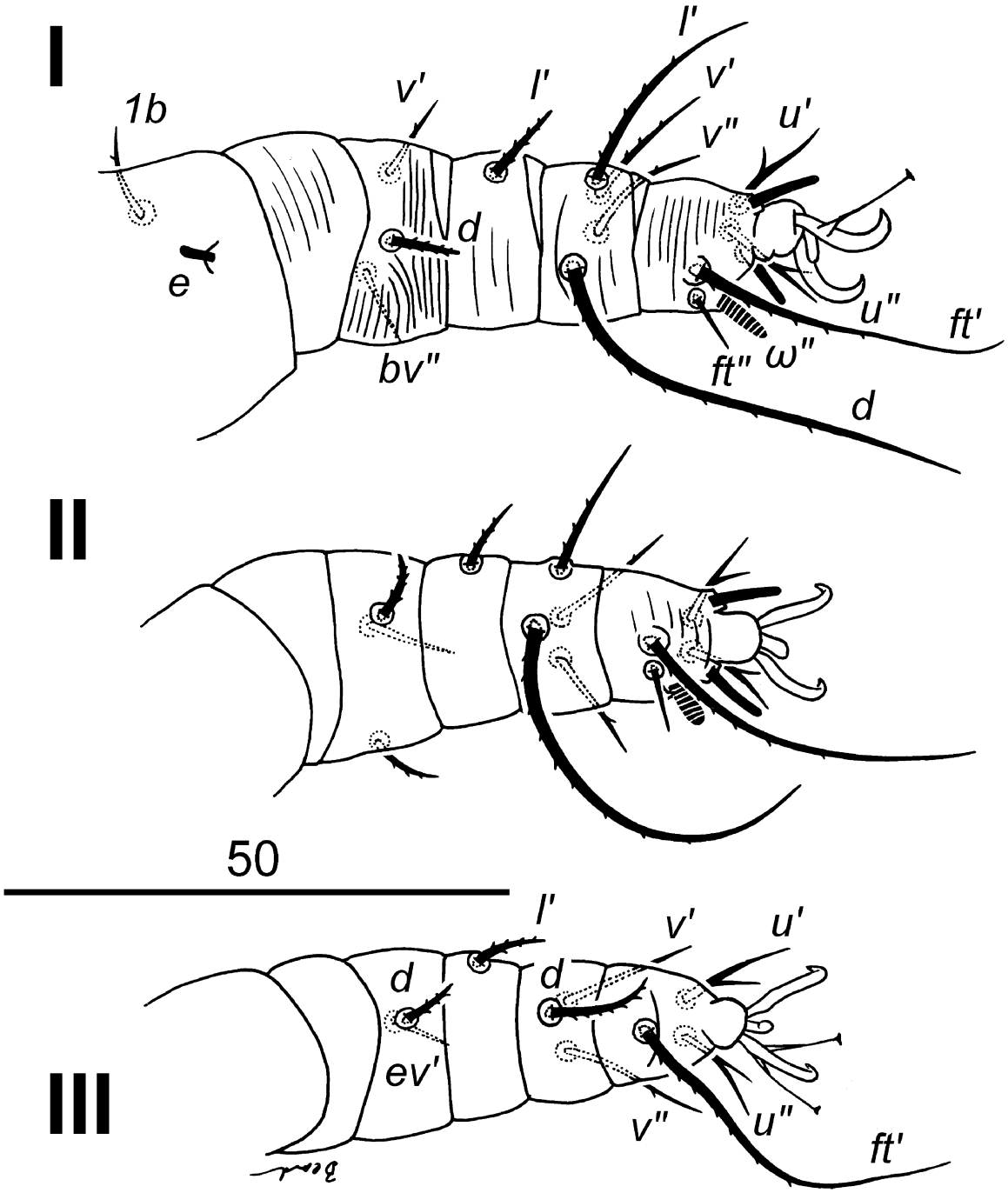


FIGURE 239. *Raoiella todtiana* Beard & Ochoa, larva: legs I–III (right side, dorsal aspect).

Legs. (Fig. 235) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (ta I 9–11; ta II 7–9) and two eupathidia distally (ta I 8–9, 8–10; ta II 7–10, 7–9). Weakly barbed to smooth companion seta *ft″* on tarsus I 9–11 and tarsus II 6–8, inserted adjacent to solenidion *ω″*. Tibiae I–II dorsal seta with blunt tip. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with two seta (*d*, *l′* present; *l″* absent). Claw IV 11–13.

Protonymph. *Dorsum.* Body measurements (6): length between setae *v2–h1* 156–181, *v2–f2* 145–170, width between setae *sc2–sc2* 114–125, *c3–c3* 116–130, *f2–f2* 25–31, *f3–f3* 41–45. Prodorsum mostly smooth, with weak

transverse folds. Dorsal opisthosoma with weak widely spaced transverse striae between *c1–d1*. Dorsal setae strongly spatulate, barbed along entire length; setae *h1* lanceolate; *h2* tapered, inserted ventrally; *f3* often inserted ventrally. Dorsal setae measurements: *v2* 32–43, *sc1* 24–32, *sc2* 32–40, *c1* 18–21, *c2* 20–23, *c3* 30–39, *d1* 15–18, *d2* 17–22, *d3* 27–38, *e1* 15–22, *e2* 19–3, *e3* 23–32, *f2* 17–21, *f3* 10–14, *h1* 7–9, *h2* 6–9.

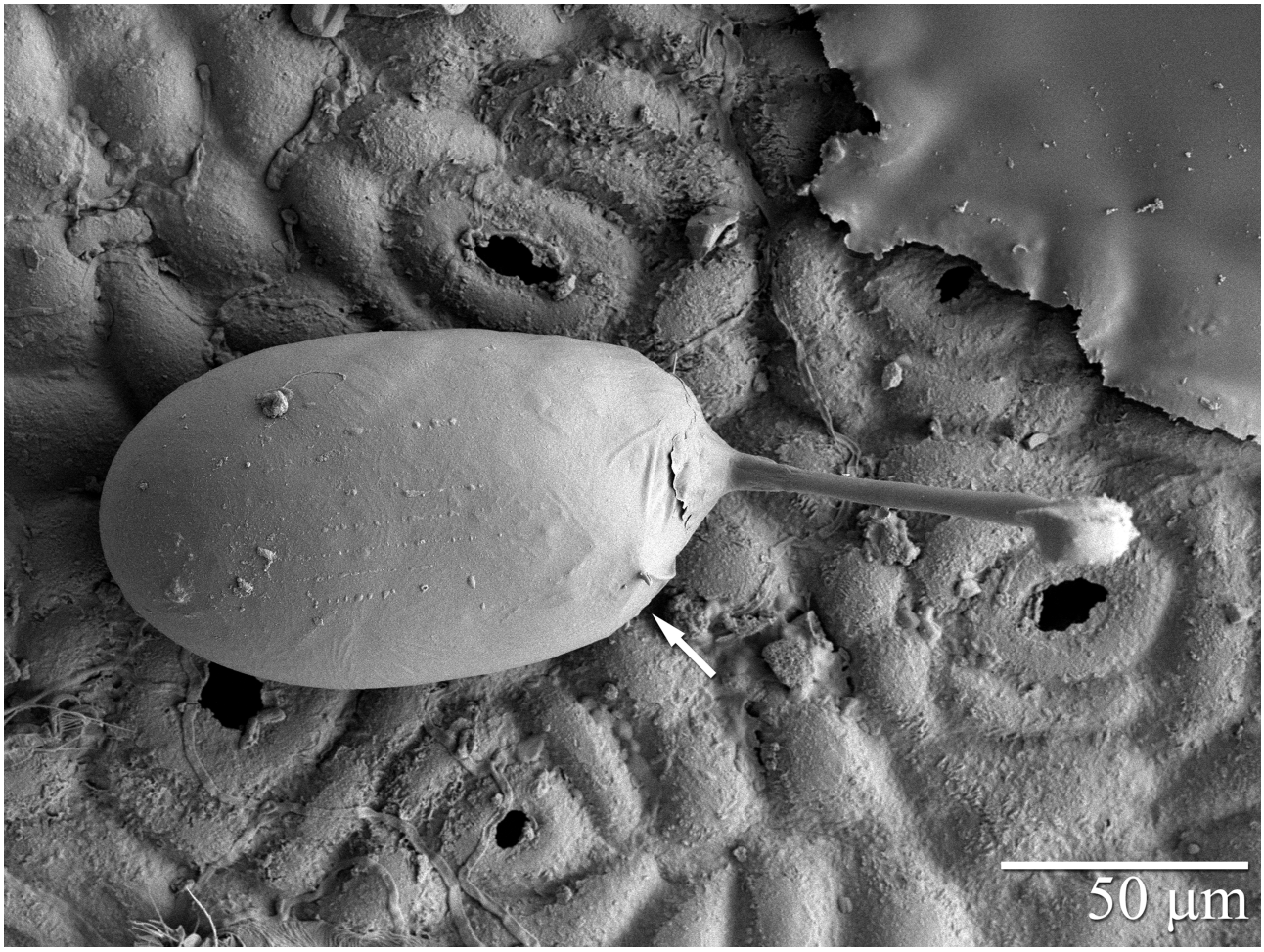


FIGURE 240. *Raoiella todtiana* Beard & Ochoa, egg on host plant, hatched (note minute recurved spine, indicated by arrow).

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one tapered eupathidium (7–9) distally, one dorsal seta (8–10); palp femorogenu with one seta (13–18).

Venter. Cuticle almost completely finely plicate; with transverse striae between *1b–1b*, longitudinal striae *1b–1a*, transverse striae *1a–ag*, oblique or V-shaped striae *ag–ps3*; coxal fields smooth. Seta *1a* elongate, fine (difficult to determine full length). Setal measurements: *1a* 38–84, *1b* 9–14, *3a* 7–10, *ag* 5–8, *ps2* 3–5, *ps3* 3–5.

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 7–8; ta II 6–7) and two eupathidia distally (ta I 7–8, 7–8; ta II 7–8, 6–8). Smooth companion seta *ft″* on tarsus I 5–8 and tarsus II 4–5, inserted adjacent to solenidion *ω″*. Tibiae I–II dorsal seta with blunt tip. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with one seta (*l′* present; *d*, *l″* absent). Claw IV 9–11.

Larva. ***Dorsum.*** (Figs 236–237) Body measurements (6): length between setae *v2–f2* 130–145, *v2–e1* 117–132, width between setae *sc2–sc2* 100–111, *c3–c3* 106–116, *f2–f2* 14–18, *f3–f3* 18–23. Prodorsum with weak widely spaced longitudinal folds. Dorsal opisthosoma with widely spaced transverse striae between setae *c1–e1*. Dorsal setae weakly spatulate, barbed along entire length; setae *f3* fine, tapered; setae *h1* stout, tapered; *h2* elongate, filiform. Setae *e3*, *f2*, *f3* inserted ventrally or on margin; *h1*, *h2* inserted ventrally. Dorsal setae measurements: *v2* 26–31, *sc1* 23–27, *sc2* 20–24, *c1* 17–21, *c2* 16–23, *c3* 14–22, *d1* 17–23, *d2* 19–23, *d3* 13–18, *e1* 21–25, *e2* 19–22, *e3* 9–12, *f2* 12–15, *f3* 7–11, *h1* 6–9, *h2* 29–39.

Palps. (Fig. 236) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (4–5) and one tapered eupathidium (7–10) distally, one dorsal seta (7–9); palp femorogenu with one seta (10–12).

Venter. (Fig. 238) Cuticle almost completely plicate; with transverse striae between *1b–1b*, longitudinal and oblique striae *1b–1a*, transverse striae *1a–3a*, mixed striae *3a–ps3* with small diamond-shaped region of transverse striae surrounded by longitudinal to oblique striae (Fig. 238) (see also Figs 23, 44, 56, 70, 100, 115b, 129a, 146, 161b, 178, 191b, 268); coxal fields smooth. Setal measurements: *1a* 28–37, *1b* 7–13, *3a* 8–10, *ps2* 4–5, *ps3* 3–5.

Legs. (Figs 237–239) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 6–7; ta II 4–5) and two eupathidia distally (ta I 6–7, 6–7; ta II 6–7, 6–7). Smooth companion seta *ft″* on tarsus I 5–8 and tarsus II 4–7, inserted adjacent to solenidion *ω″*. Dorsal seta on tibiae I–II finely tapered. Femora I–II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with one seta (*l′* present; *d*, *l″* absent). Claw IV 9–11.

Egg. (Fig. 240) Red, elongate ellipsoid in shape, 140–150 long 70–75 wide (Fig. 240); a strong, distal stipe approximately 120–130 long, usually curled back on itself forming a distal loop; with a pair of minute recurved spines (Fig. 240; see arrows).

Host. Coastal blackbutt *Eucalyptus todtiana* F. Muell. (Myrtaceae).

Distribution. AUSTRALIA: southwest Western Australia.

Etymology. This species is named for its host plant's specific name, "todtiana". Botanist Ferdinand von Mueller named *Eucalyptus todtiana* for his illustrator Emil Todt.

Remarks. *Raoiella todtiana* **sp. nov.** (DNA code RaIn58; Dowling *et al.* 2012, Table 1 and Figs 1, 2) was listed as *Raoiella* sp. 2 along with a specimen labelled RaIn42, which we consider here to be a separate species, *R. karri* **sp. nov.**, and was listed as *Raoiella* sp. 2B in Beard *et al*. (2013). The two populations considered as species 2 in the Dowling *et al.* study were shown to exhibit 3.2% sequence divergence, which greatly exceeds the intraspecific variation seen in species 1 (0.6–1.0%), but is still a low amount of interspecific divergence in *Raoiella*. Our subsequent morphological analysis has shown that the two populations can be easily distinguished.

Raoiella todtiana can be separated from *R. karri* by the following: *Rt* setae *v2* 55–65, *sc1* 32–42, *sc2* 48–60 vs *Rk* setae *v2* 63–73, *sc1* 51–61, *sc2* 63–70; *Rt* setae *f2* 26–32, *h2* 26–36 vs *Rk* setae *f2* 29–43, *h2* 25–35; *Rt* setae *d* on femora I–III and genu I with broad blunt tips vs *Rk* setae *d* on femora I–III and genu I with tapered tips.

A host plant voucher has been deposited with Queensland Herbarium, BRI—AQ814932.

Raoiella wandoo **sp. nov. Beard & Ochoa**
(Figs 241–270)

Material examined. Holotype. ♀. **Australia**, Western Australia, near Caernarvon Hills, NW of Narrogin, 32°47'35"S 116°54'15"E, 8.x.2004, ex. wandoo *Eucalyptus* wandoo Blakely (Myrtaceae), J. J. Beard (WAM, UQIC #59997).

Paratypes. 4 ♀, 5 ♂, 5 deutonymphs, 2 protonymphs, larva, same data as Holotype (QM, UQIC #59991, 59995, 60001-3, 60005-8, 60014-15, 60019-23, 60026); 9 ♀, 3 ♂, 2 deutonymphs, 4 protonymphs, 2 larvae, same data as Holotype except 32°48'08"S 116°53'52"E (QM, USNM; UQIC #59954–59989).

Other material examined (multiple specimens for each set of data). same data as Holotype except 32°47'35"S 116°54'15"E (QM; UQIC #59991–60028); same data except 32°47'31"S 116°54'19"E (QM; UQIC #60096–60128); ex. *E*. wandoo (Myrtaceae), Northam, Western Australia, 31°38'39"S 116°40'31"E, 1.x.2004, J. J. Beard (QM; UQIC #59911–59915; 59917–27; 59929–59953); ex. *E*. wandoo (Myrtaceae), Dryandra Nature Reserve, 27 km north Narrogin along Narrogin-Wandering Road, Western Australia, 32º46'49"S 116º59'57"E, 9.v.2008, J.J. Beard & R. Ochoa (QM, USNM); same data except 32º47'02"S 116º59'48"E, J. J. Beard & R. Ochoa (QM; USNM); same data except 32°47'07"S 116°57'54"E, 8.xi.2006, J. J. Beard (QM); same data except 32°47'35"S 116°54'14"E (QM); same data except 32°47'34"S 116°54'16"E, 20.xi.2006 (QM); same data except 32°48'18"S 116°53'45"E, 20.xi.2006 (QM); 7 ♀, 4 ♂, 4 deutonymphs, 3 protonymphs, ex. leaves of jarrah *E. marginata* Sm. (Myrtaceae) growing in a forest of mixed wandoo *Eucalyptus* wandoo, jarrah *E. marginata* and marri *Corymbia callophylla* (all Myrtaceae), John Forrest National Park, 28 km E Perth, Western Australia, 31º53'07"S 116º04'37"E, 21.iv.09, J.J. Beard (QM).

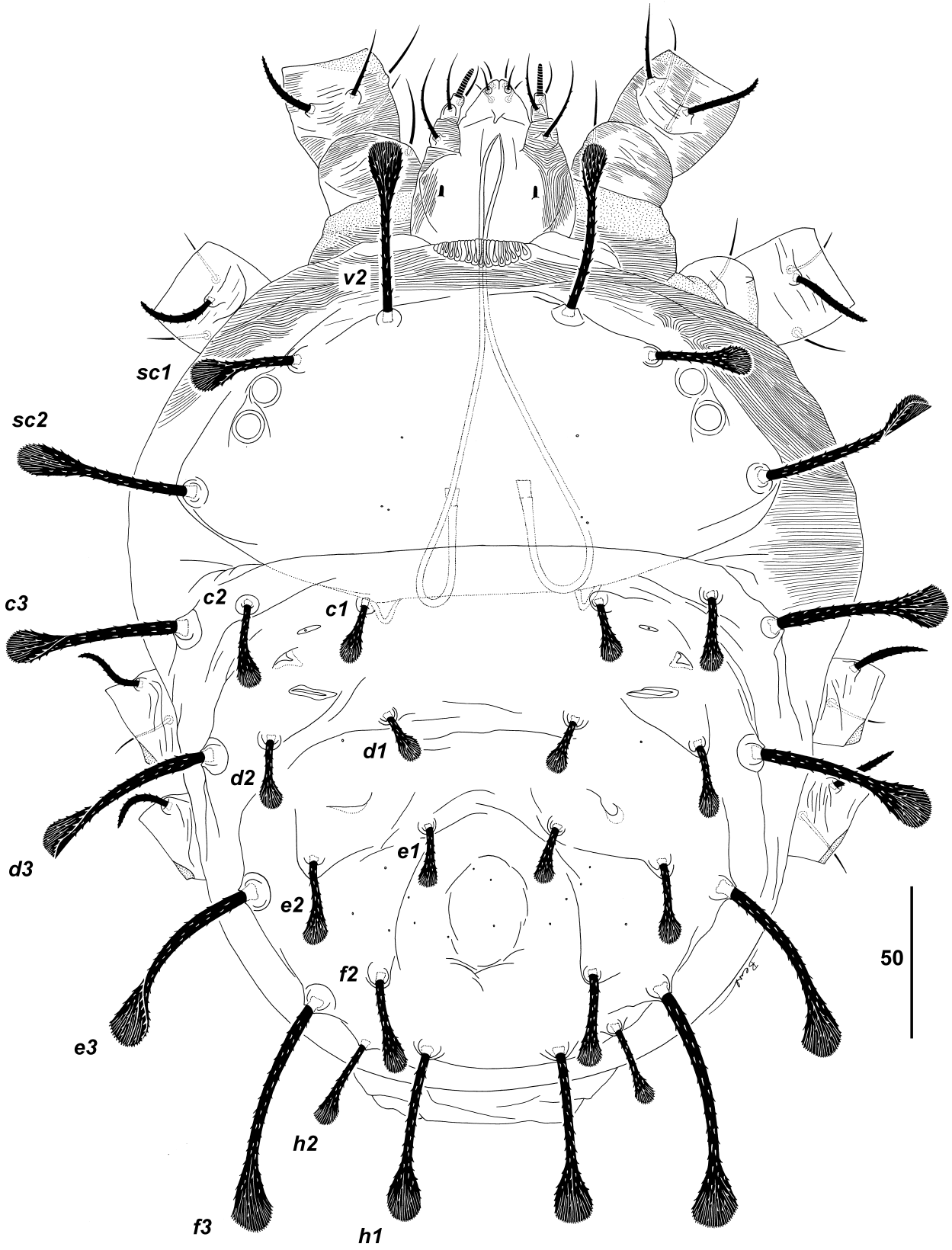


FIGURE 241. *Raoiella* wandoo Beard & Ochoa, adult female (wandoo population): dorsal habitus with details of palp.

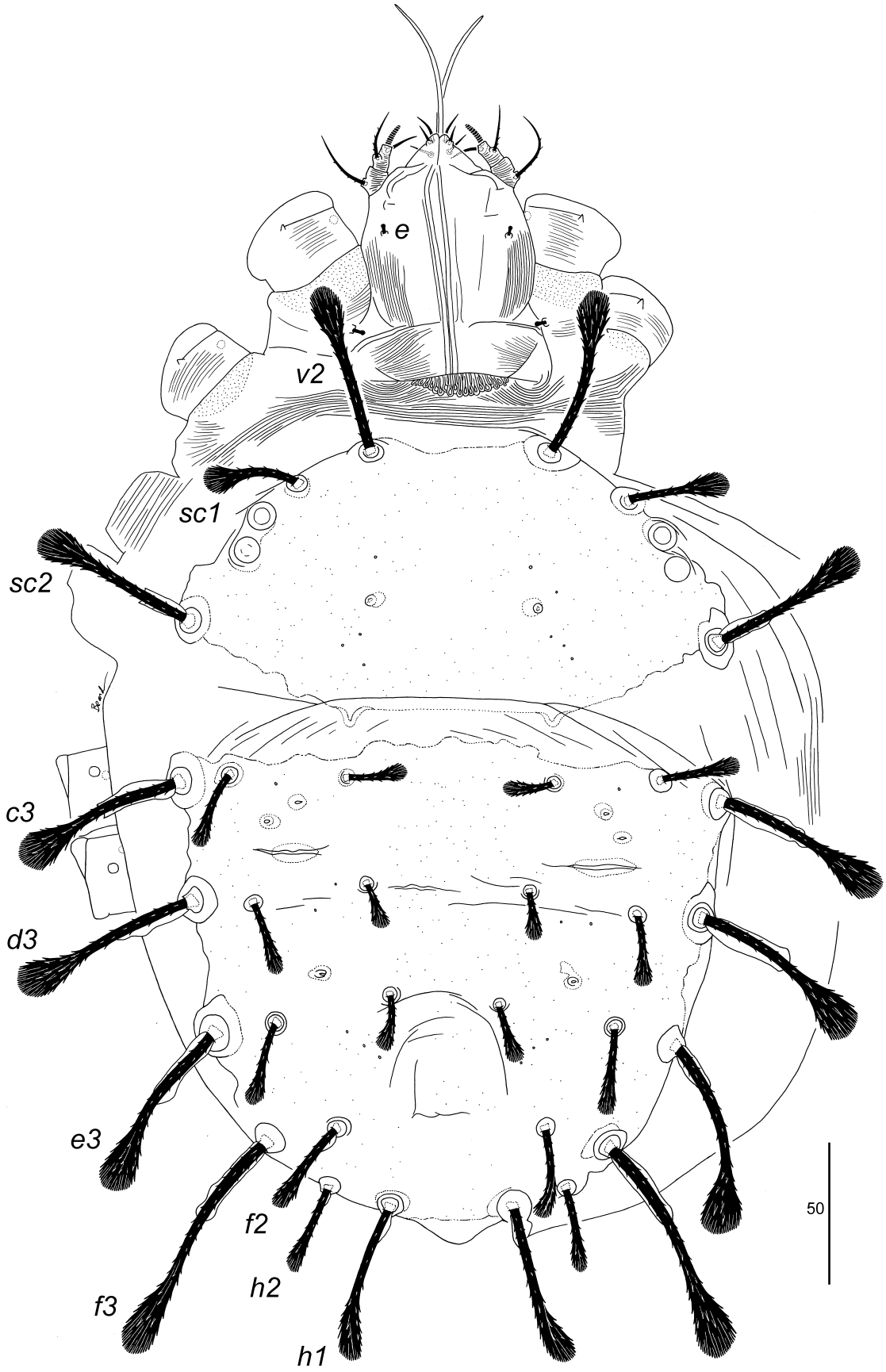


FIGURE 242. *Raoiella* wandoo Beard & Ochoa (jarrah population), adult female: dorsum with details of palps.

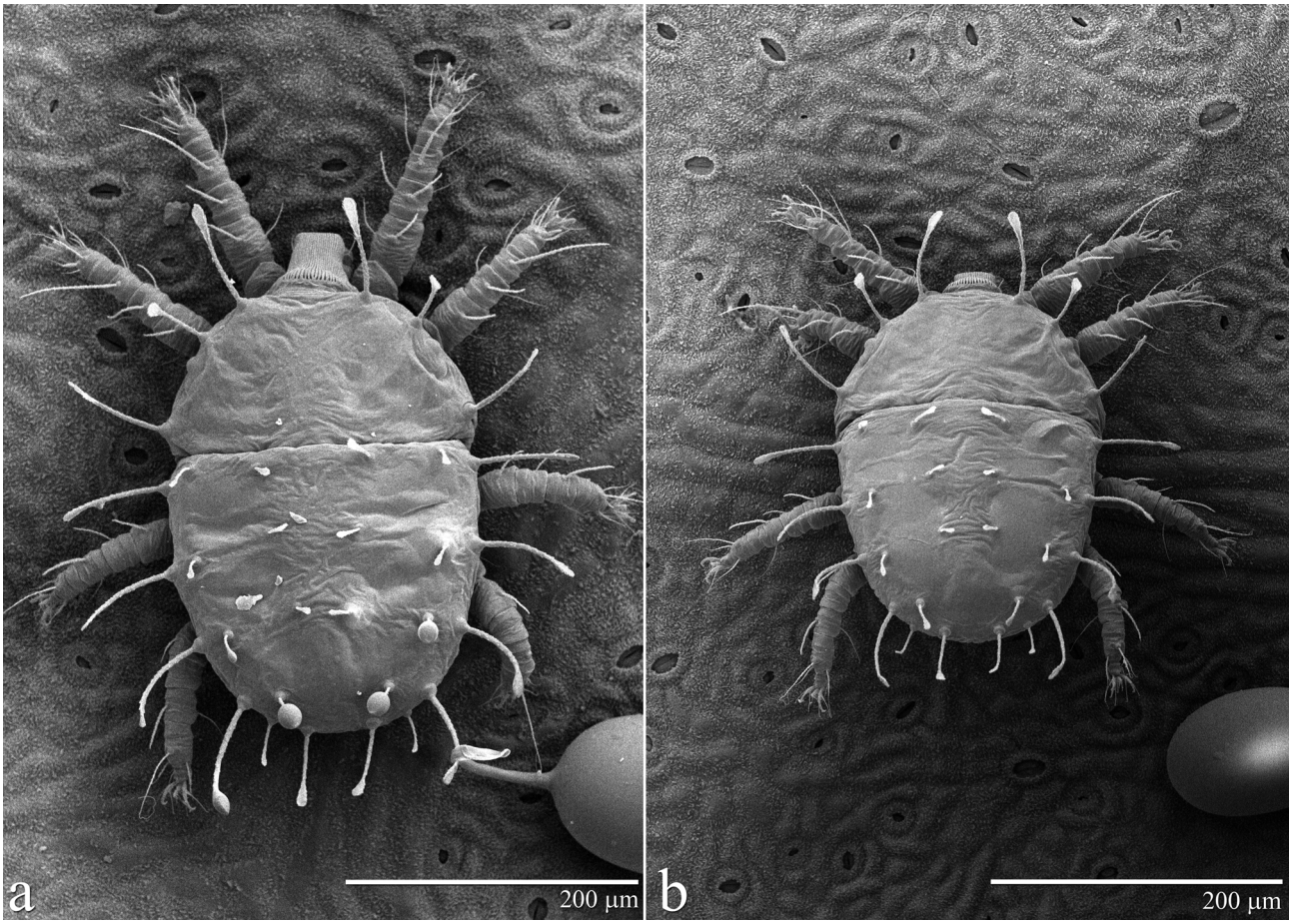


FIGURE 243. *Raoiella* wandoo Beard & Ochoa, adult female (wandoo population): dorsal habitus on host plant (two different individuals).

Diagnosis. Opisthosomal setae *f2* shorter than *f3*; setae *h1* longer than *h2*. Setae *h2* short, spatulate. Adult femora I with four setae (*d*, *l′*, *v′*, *bv″*); femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent); genua I–II with three setae (*d*, *l′*, *l″*); coxae I with one seta (*1b* present; *1c* absent); coxae II with one seta (*2b*) delayed to adult stage, coxae II nude in immature stages; coxae III–IV nude (setae *3b*, *4b* absent). Tarsi I–II with companion setae (*ft″*) slightly longer than, or subequal to, solenidia. Dorsal setae on tibiae I–II tapered to blunt. Larva with setae *h2* elongate, filiform.

Description. Female. ***Dorsum.*** (Figs 241–246) Body measurements (17): length between setae *v2–h1* 239–274 [241], width between setae *sc2–sc2* 178–202 [187], *c3–c3* 179–203 [190], *f2–f2* 63–75 [69], *f3–f3* 99–123 [113]. Lightly sclerotised prodorsal and opisthonotal shields evident, often strongly developed. Prodorsum with pair large round pores and up to five pairs of minute pores mesally, and pair of large pores on posterior margin (often hidden in fold of sejugal furrow). Dorsal opisthosoma with three pairs of large pores and pair of minute pores between setae *c1–d2*; two pairs minute pores between *d1–d2* and pair large pores between setae *d1–e2*; and up to three pairs of minute pores between *e1–e2*. Lateral setae (*c3*, *d3*, *e3*, *f3*) longer than sublateral setae (*c2*, *d2*, *e2*, *f2*); central setae (*c1*, *d1*, *e1*) shorter than all dorsal setae (can be somewhat subequal in length with sublateral setae). Dorsal setae thick, strongly spatulate, barbed along entire length. Setae *h2* spatulate. A hyaline sheath is often visible at the bases of the lateral setae, extending for approximately half the setal length (Fig. 242), which is assumed to be the fluid that makes up the droplets on the tips of the setae. Dorsal setae measurements: *v2* 53–65 [58–59], *sc1* 31–39 [35–37], *sc2* 56–65 [60], *c1* 18–23 [22], *c2* 25–31 [27–28], *c3* 58–70 [60–63], *d1* 16–21 [19–21], *d2* 26–30 [26], *d3* 63–73 [64–66], *e1* 18–23 [20], *e2* 27–36 [28–30], *e3* 63–75 [70–71], *f2* 31–39 [34–35], *f3* 77–92 [81–84], *h1* 51–66 [58–59], *h2* 22–35 [29–33].

Palps. (Figs 241–242, 248) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (8–11) [11] and one finely tapered eupathidium (11–18) distally, and one seta dorsally (15-20); palp femorogenu with one seta (22-31). Stylet with 9–14 small lateral teeth distally (Fig. 247).



FIGURE 244. *Raoiella* wandoo Beard & Ochoa, adult female (jarrah population): dorsal habitus on host plant.

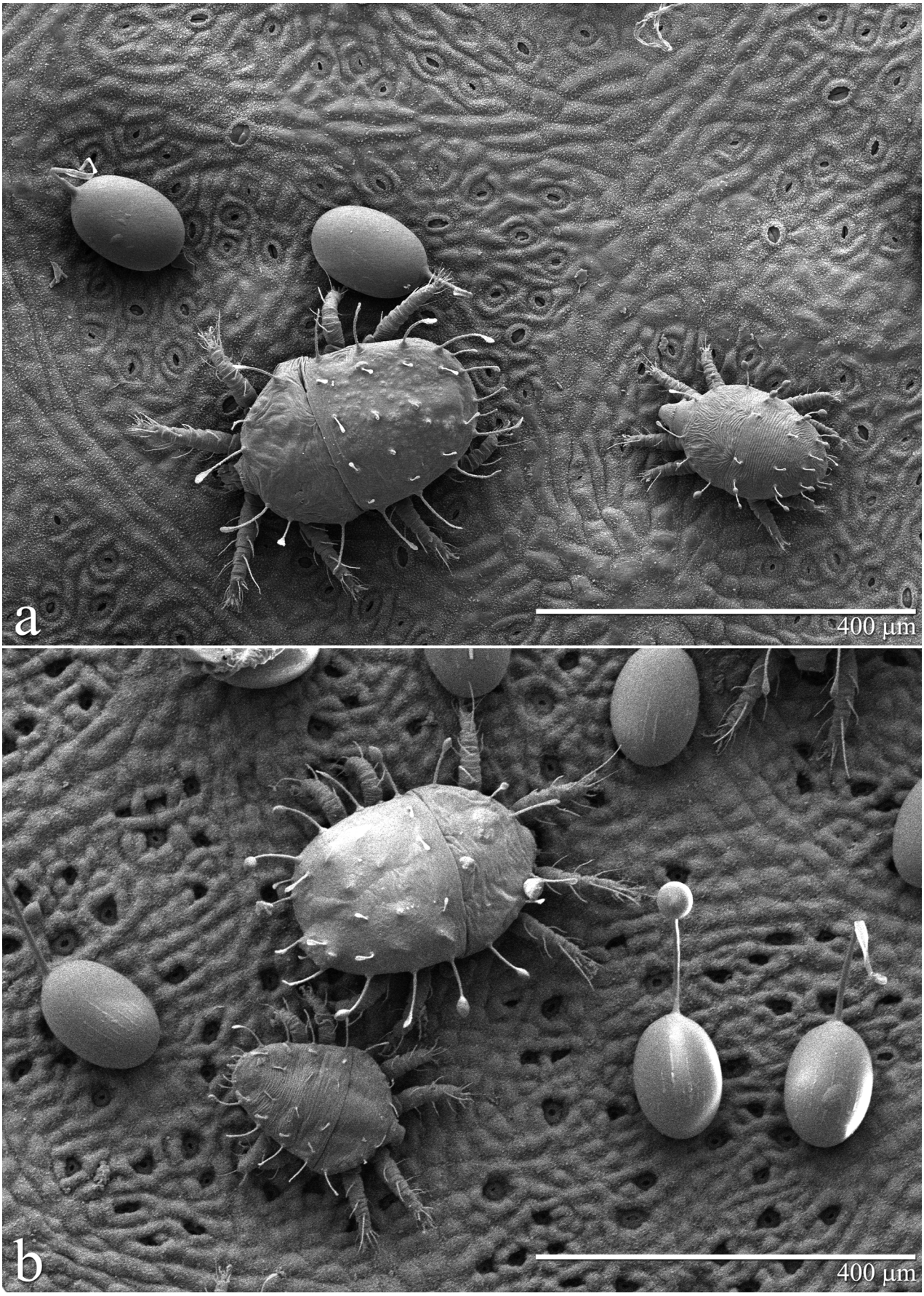


FIGURE 245. *Raoiella* wandoo Beard & Ochoa, detail of colonies on host plant (wandoo population): a. female, protonymph, eggs; b. female, male, eggs.

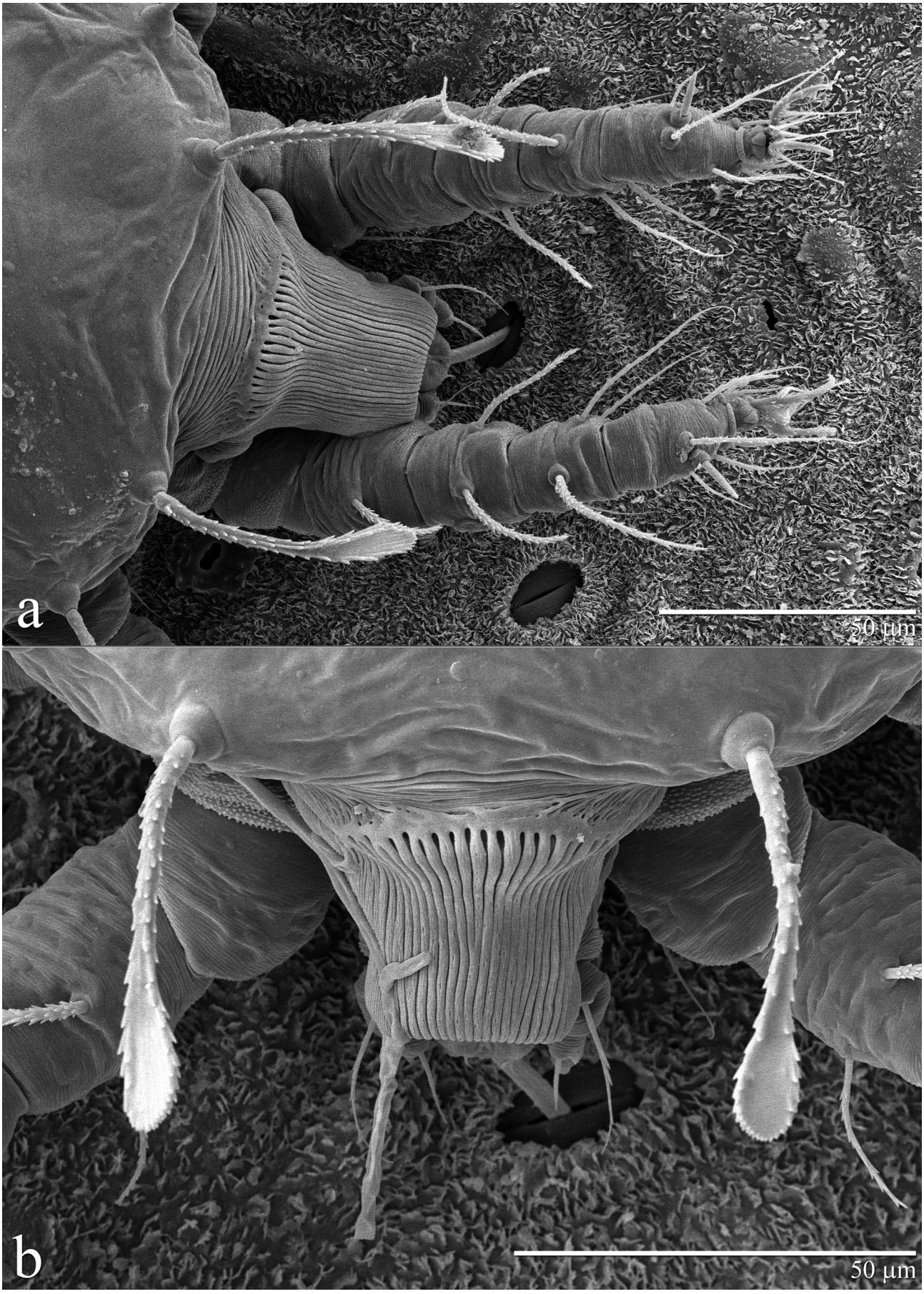


FIGURE 246. *Raoiella* wandoo Beard & Ochoa, adult female: feeding via the stomatal opening (on wandoo).

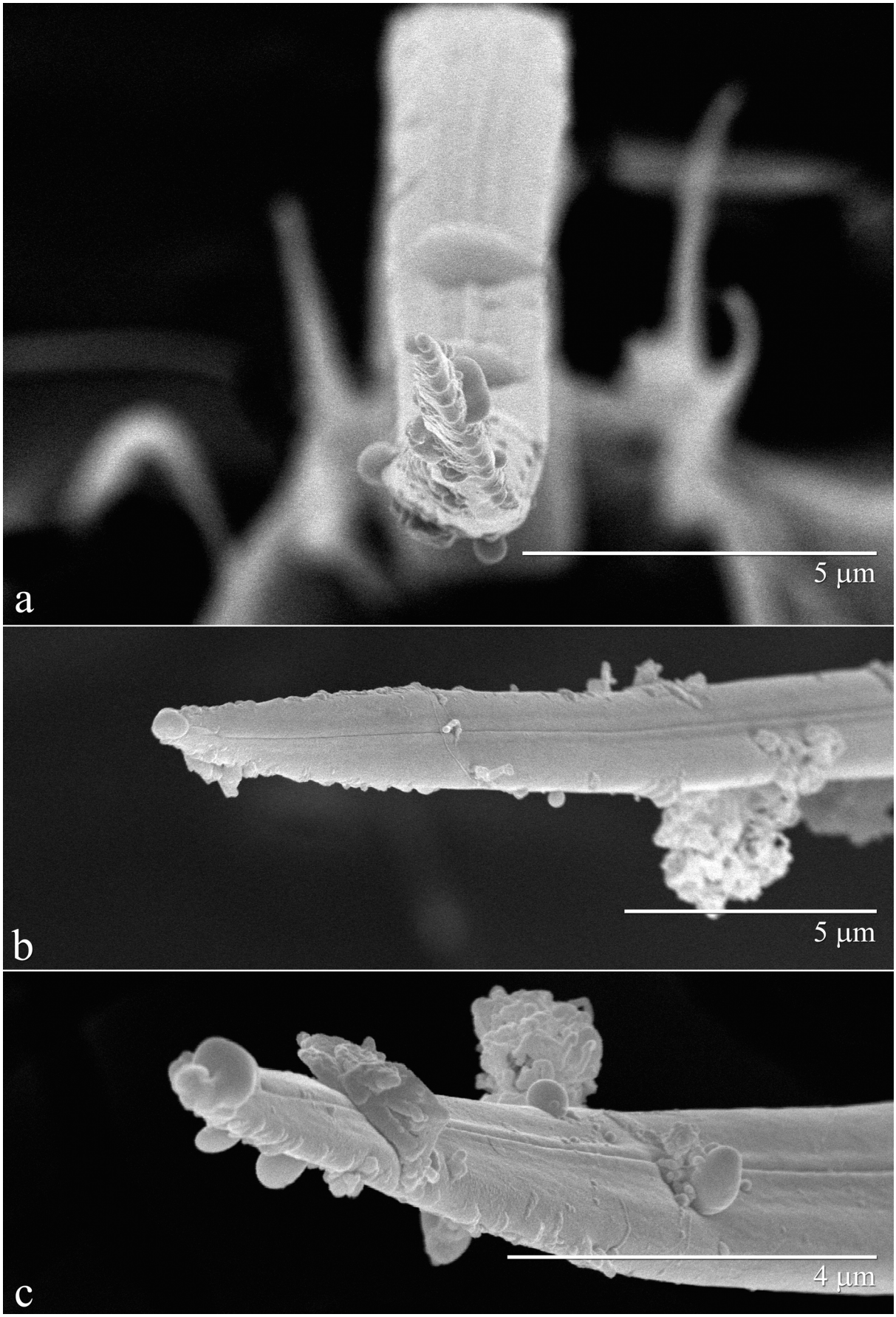


FIGURE 247. *Raoiella* wandoo Beard & Ochoa, various aspects of joined stylets, detail of stylet tip with lateral serrations.

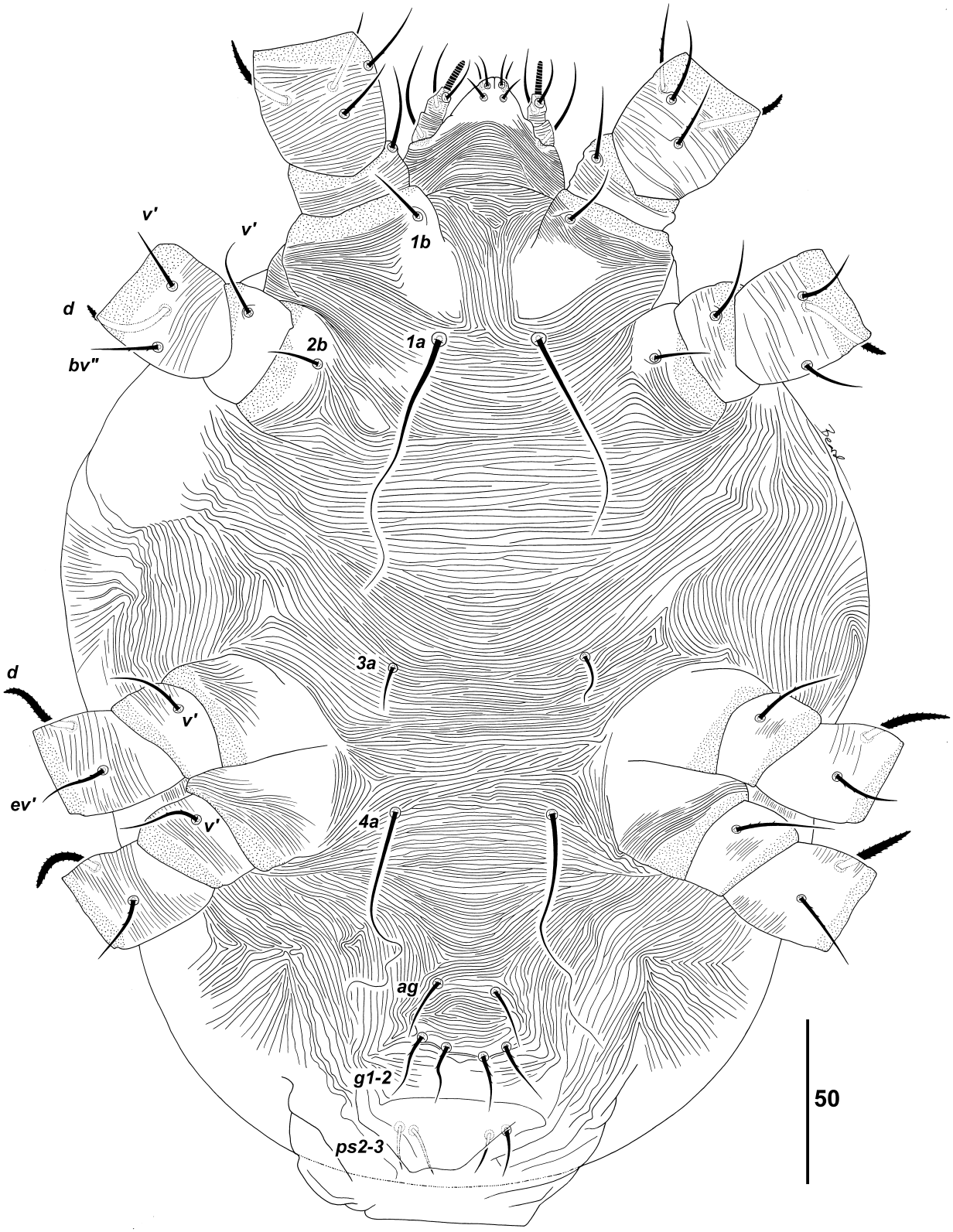


FIGURE 248. *Raoiella* wandoo Beard & Ochoa, adult female (wandoo population): ventral habitus with detail of palps.

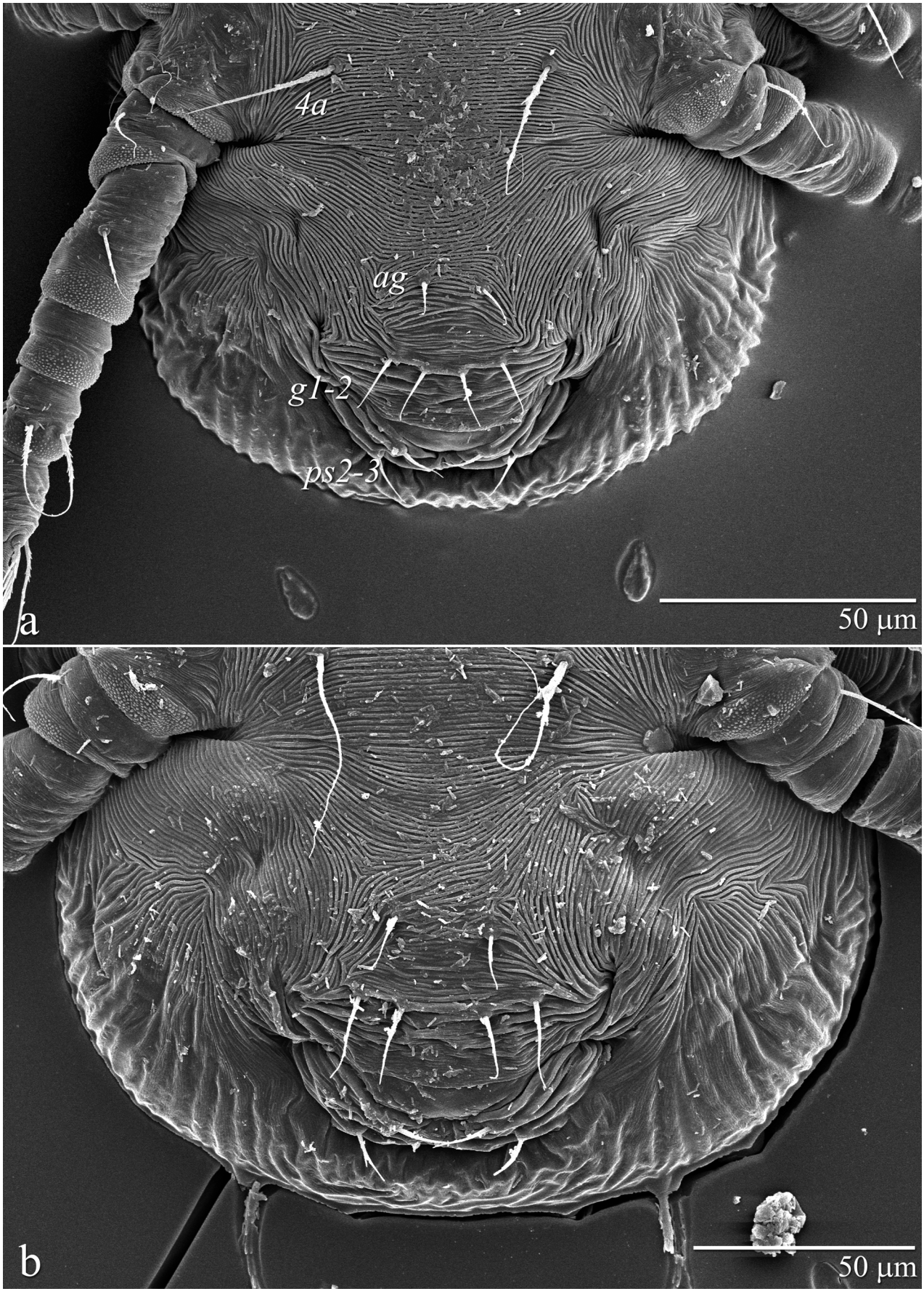


FIGURE 249. *Raoiella* wandoo Beard & Ochoa, adult female (wandoo population): posterior venter (two different individuals).

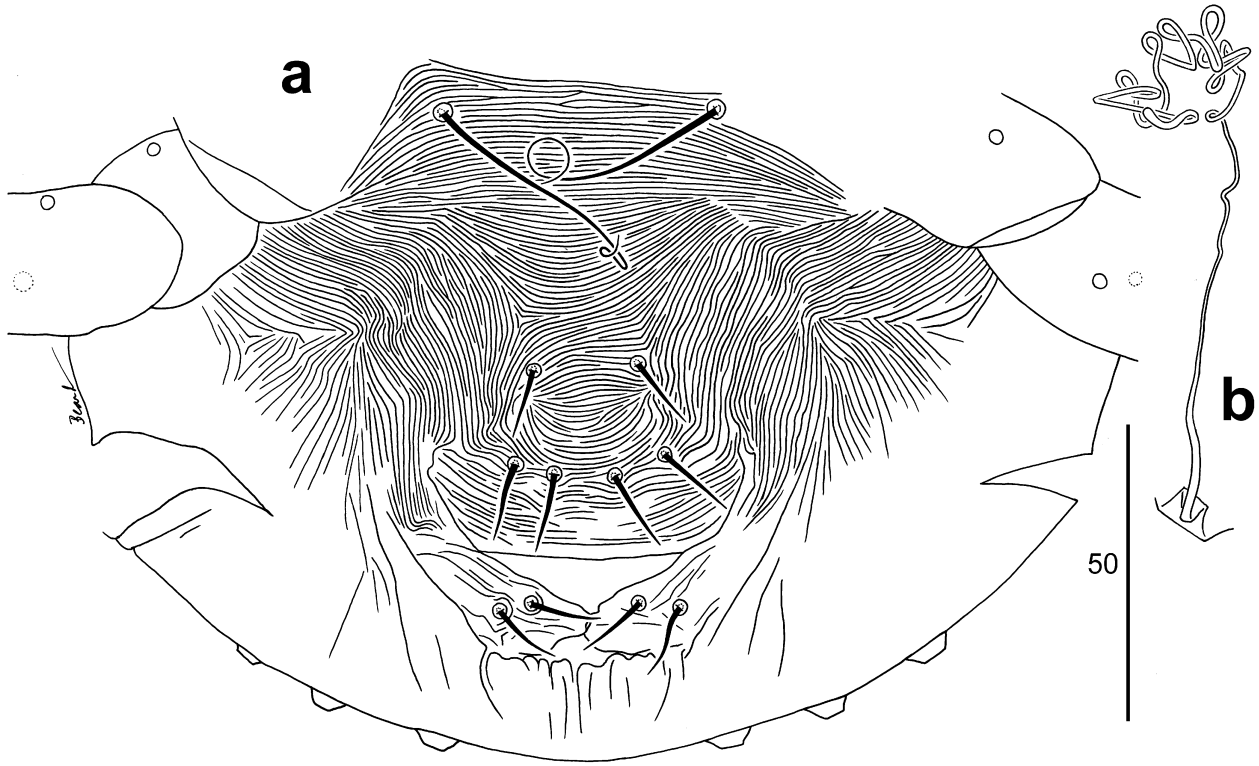


FIGURE 250. *Raoiella* wandoo Beard & Ochoa, adult female (jarrah population): a. posterior venter; b. detail of spermatheca.

Venter. (Figs 248–251) Cuticle almost completely plicate, covered with mostly transverse striae, except coxal fields mostly smooth. Setae *g1* and *g2* inserted in transverse row on genital flap. Setae *1a*, *4a* elongate, fine (difficult to determine full length). Setae *1b*, *2b*, *g1*, *g2*, *ps2*, *ps3* barbed. Setal measurements: *1a* 52–108 [53–78], *1b* 18–27 [21–26], *2b* 15–22 [18–22], *3a* 12–24 [14–18], *4a* 43–88 [43–75], *ag* 11–18 [15–17], *g1* 13–21 [17–18], *g2* 15–20 [18–19], *ps2* 11–18 [18], *ps3* 11–18 [14].

Spermatheca. (Fig. 250b) A membranous duct is visible at the genital opening for approximately 30 μm, then difficult to see.

Legs. (Figs 252–255) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-9(1), 1-1-3-3-4-9(1), 0-1-2-1-3-5, 0-1-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion *ω″* (ta I 13–18 [17–18]; ta II 11–14 [13–14]) and two eupathidia distally *pζ′–pζ″* (ta I 13–16 [13–14], 13–14 [13–14]; ta II 11–14 [11–13], 12–14 [12–13]). Finely tapered companion seta *ft″* on tarsus I 17–24 [22–24] and tarsus II 12–19 [14], inserted adjacent to solenidion *ω″* (Fig. 254). Dorsal seta, *d*, on tibiae I–II tapered, but not finely tapered. Femora I with four setae (*d*, *l′*, *v′*, *bv″*), femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with three setae (*d*, *l′*, *l″*). Claws I and IV 20–21; claws and empodia with numerous small barbs dorsally (Figs 254–255); tenent hairs on claws with three attachment points.

Male. ***Dorsum.*** (Figs 256–258) Body measurements (11): length between setae *v2–h1* 175–205, width between setae *sc2–sc2* 137–156, *c3–c3* 127–153, *f2–f2* 47–53, *f3–f3* 66–70. Prodorsum mostly smooth with some light transverse striae and scattered punctations; with pair of rounded pores and one to two pairs of minute pores mesally, and pair large pores on posterior margin (often hidden in fold of sejugal furrow). Opisthosoma with some transverse striae, strongest between setae *d1* and *f2*; with two pairs of large slit pores and pair of minute pores between setae *c1* and *d2*; pair of minute pores between setae *e1* and *e2*; with finely punctate transverse shield between setal rows C–D; finely punctate pygidial shield present. Dorsal setae spatulate, barbed along entire length, narrower than female. Seta *h1* and *h2* weakly spatulate. Dorsal setae measurements: *v2* 25–31, *sc1* 22–26, *sc2* 30–41, *c1* 14–21, *c2* 18–23, *c3* 38–48, *d1* 14–19, *d2* 17–22, *d3* 42–49, *e1* 13–20, *e2* 17–22, *e3* 43–54, *f2* 19–26, *f3* 45–54, *h1* 18–24, *h2* 15–23.

Palps. (Figs 256, 257b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (8–11) and one finely tapered eupathidium (9–12) distally, and one seta dorsally (13–17); palp femorogenu with one seta (18–25).

Venter. (Fig. 259) Ventral cuticle almost completely plicate, covered in mostly transverse striae; coxal fields smooth, and a distinct patch of smooth cuticle on either side of setae *ag*. Setae *g1*, *g2* lightly barbed or smooth; *ps3* modified as accessory genital stylets, into short spurs (Figs 257, 259). Setal measurements: *1a* 41–91, *1b* 14–22, *2b* 12–19, *3a* 9–14, *4a* 42–73, *ag* 9–12, *g1* 12–17, *g2* 12–15, *ps2* 9–11, *ps3* 8–12.

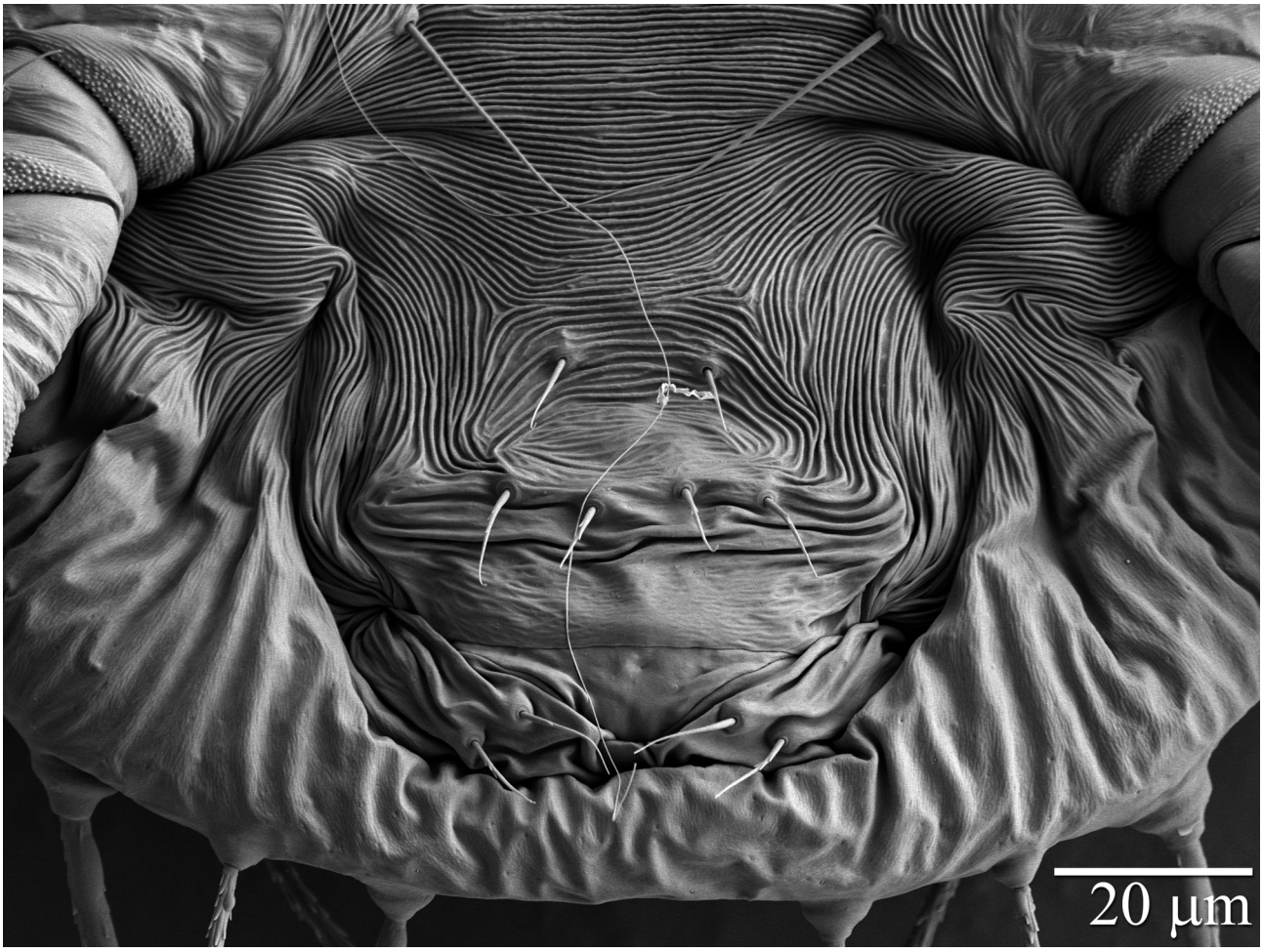


FIGURE 251. *Raoiella* wandoo Beard & Ochoa, adult female (jarrah population): posterior venter.

Aedeagus. (Figs 257c, 259) Aedeagus narrow, elongate and sclerotised (74–80), tapering to a blunt point distally (at genital opening).

Legs. (Figs 258, 260–261) Setal formula for legs I–IV (coxae to tarsi): 1-1-4-3-4-10(2), 1-1-3-3-4-10(2), 0-1-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with two solenidia (ta I adaxial 13–16, abaxial 12–16; ta II adaxial 11–14, abaxial 12–17), and two eupathidia distally (ta I 11–14, 11–13; ta II 10–13, 10–11). Companion seta *ft″* on tarsus I 16–23 (barbed; finely tapered distally, difficult to see tip) and tarsus II 11–15, inserted adjacent to solenidion *ω″* (Fig. 261). Tibiae I–II with dorsal seta *d* tapered, but not finely tapered. Femora I with four setae (*d*, *l′*, *v′*, *bv″*), femora II with three setae (*d*, *v′*, *bv″* present; *l′* absent), genua I–II with three setae (*d*, *l′, l″*). Claw I 16–17, claw IV 15–16; tenent hairs on claws with three attachment points.

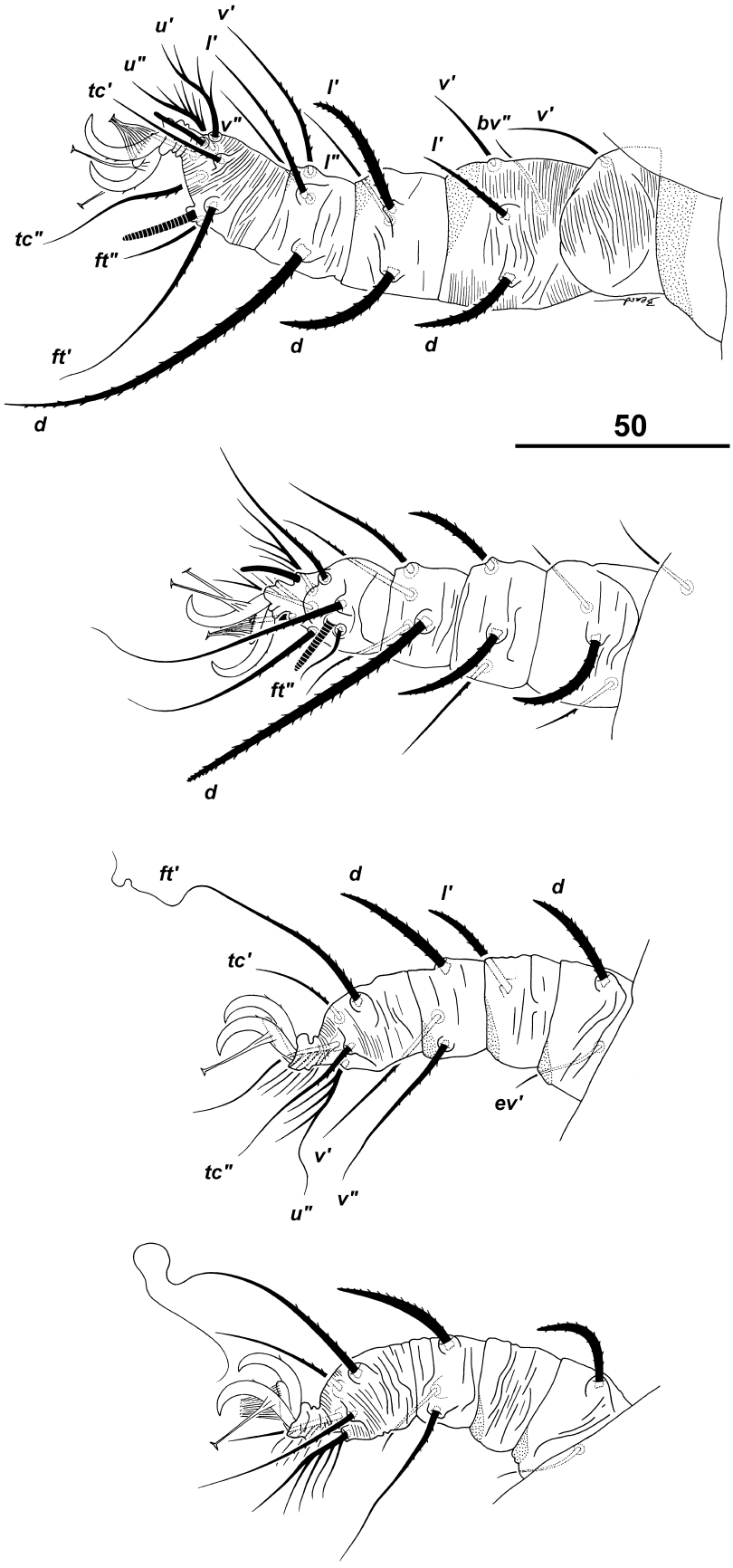


FIGURE 252. *Raoiella* wandoo Beard & Ochoa, adult female (wandoo population): legs I–IV (left side; leg I dorsal to adaxial aspect, leg II dorsal aspect, legs III-IV abaxial aspect).

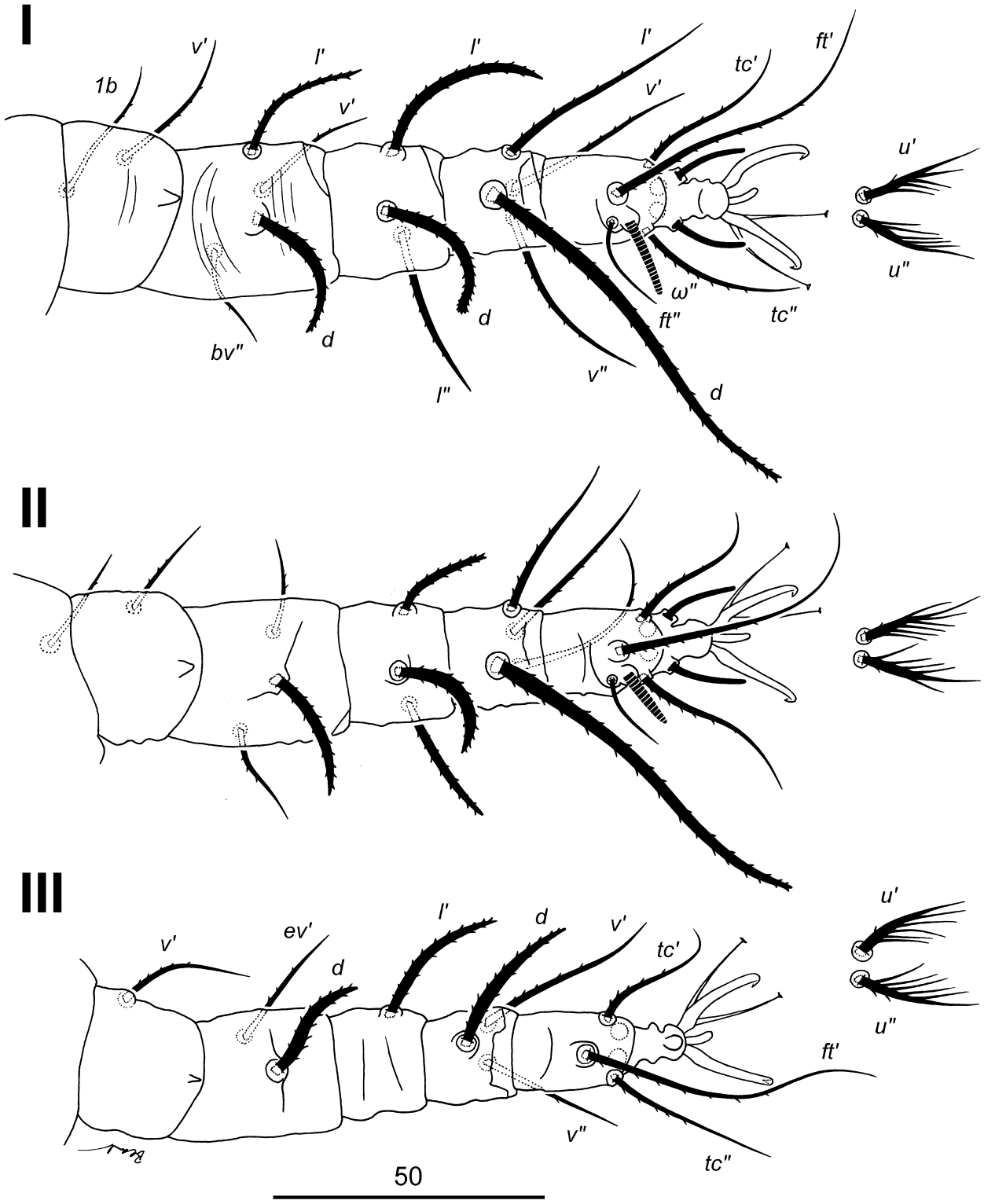


FIGURE 253. *Raoiella* wandoo Beard & Ochoa, adult female (jarrah population): legs I–III (right side; dorsal aspect).

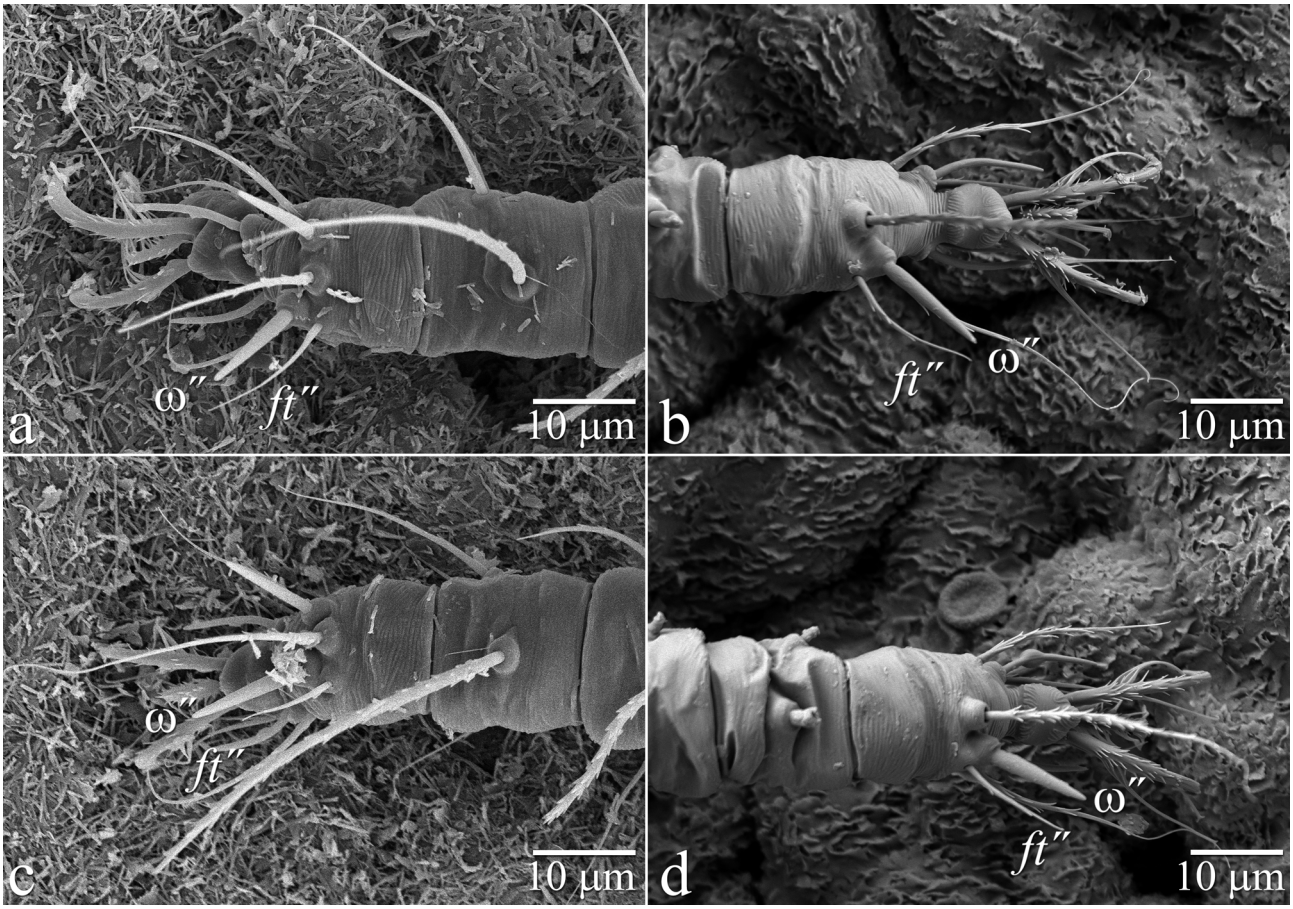


FIGURE 254. *Raoiella* wandoo Beard & Ochoa, adult female: detail of tarsus I (a, b) and detail of tarsus II (c, d)—a., c. population from wandoo (left legs); b., d. population from jarrah (right legs).

Deutonymph. ***Dorsum.*** (Figs 262a,b) Body measurements (10 female, 3 male): length between setae *v2–h1* female 207–241 (male 183–189), width between setae *sc2–sc2* 153–172 (132–142), *c3–c3* 151–170 (130–142), *f2–f2* 42–46 (34–39), *f3–f3* 64–77 (49–54). Dorsum mostly smooth with light transverse striations between *c1–e1*. Large pore between setae *c1–d2*; minute pore between setae *d1–d2* and *e1–e2*. Lateral setae (*c3*, *d3*, *e3*, *f3*) longer than sublateral setae (*c2*, *d2*, *e2*, *f2*). Dorsal setae strongly spatulate in female (Fig. 262a), less so in male (Fig. 262b); lateral setae with larger spatulae than mesal setae; dorsal setae barbed along entire length; setae *h1* weakly to broadly spatulate in female, weakly spatulate in male; setae *h2* blunt to weakly spatulate. Dorsal setae measurements: *v2* 40–48 (29–33), *sc1* 27–33 (22–28), *sc2* 40–49 (30–34), *c1* 16–20 (15–19), *c2* 21–25 (19–22), *c3* 41–51 (32–40), *d1* 17–20 (14–18), *d2* 21–25 (17–21), *d3* 44–52 (33–39), *e1* 18–23 (15–18), *e2* 24–28 (20–22), *e3* 45–55 (34–40), *f2* 27–38 (21–28), *f3* 47–56 (27–38), *h1* 22–27 (11–21), *h2* 10–17 (8–11).

Palps. (Fig. 262c) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (both sexes 7–9) and one finely tapered eupathidium distally (both sexes 9–13), and one seta dorsally (both sexes 11–15); and femorogenu with one seta (both sexes 17–22).

Venter. (Fig. 262c) Cuticle almost completely plicate, covered with mostly transverse striae, except with patch of longitudinal striae between setae *1a–1b*, and *ag–ps3*, and coxal fields smooth (see also Figs 20a, 128a, 190a, 234a). Setae *1a* and *4a* elongate, fine (difficult to determine full length); setae *2b*, *3b*, *4b* absent. Setae smooth to weakly barbed. Setal measurements: *1a* 29–65 (39–52), *1b* 12–17 (14–18), *3a* 7–12 (10–11), *4a* 24–48 (19–59), *ag* 7–10 (9), *g1* 8–11 (8–9), *ps2* 5–8 (8–10), *ps3* 5–9 (7–8).

Legs. (Fig. 263) Setal formula for legs I–IV (coxae to tarsi): 1-0-3-2-4-9(1), 0-0-3-2-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-5 respectively. Tarsi I and II each with one abaxial solenidion (both sexes ta I 10–12; ta II 7–10) and two eupathidia distally (both sexes ta I 8–9, 8–10; ta II 8–9, 8–9). Companion seta *ft″* barbed on tarsus I 6–10 (7–8) and tarsus II 5–9 (6–8), inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta *d* finely tapered. Female claw I 14–16, claw IV 13–14; tenent hairs on claws with three attachment points.

Protonymph. ***Dorsum.*** Body measurements (10): length between setae *v2–h1* 141–176, width between setae *sc2–sc2* 121–136, *c3–c3* 120–137, *f2–f2* 25–33, *f3–f3* 39–46. Prodorsum smooth or with weak longitudinal to oblique striae. Dorsal opisthosoma with widely spaced transverse striae between *c1–e1*. Dorsal setae spatulate, barbed along entire length; setae *h1* blunt to weakly spatulate, barbed; setae *h2* tapered to weakly spatulate. Dorsal setae measurements: *v2* 26–38, *sc1* 21–27, *sc2* 23–35, *c1* 16–19, *c2* 17–23, *c3* 27–38, *d1* 14–18, *d2* 15–23, *d3* 25–37, *e1* 17–20, *e2* 18–25, *e3* 22–36, *f2* 19–27, *f3* 13–27, *h1* 7–15, *h2* 8–15.

Palps. Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–7) and one finely tapered eupathidium (7–10) distally, and one seta dorsally (9–13); palp femorogenu with one seta (12–17).

Venter. Cuticle almost completely plicate, covered with mostly transverse striae, except patch of longitudinal striae between setae *1a–1b* and *ag–ps3*, and longitudinal striae laterad *ps* setae; coxal fields smooth. Setae *2b*, *3b* absent. Seta *1a* elongate, fine (difficult to determine full length). Setae smooth to weakly barbed. Setal measurements: *1a* 31–81, *1b* 9–13, *3a* 8–13, *ag* 7–10, *ps2* 4–6, *ps3* 4–5.

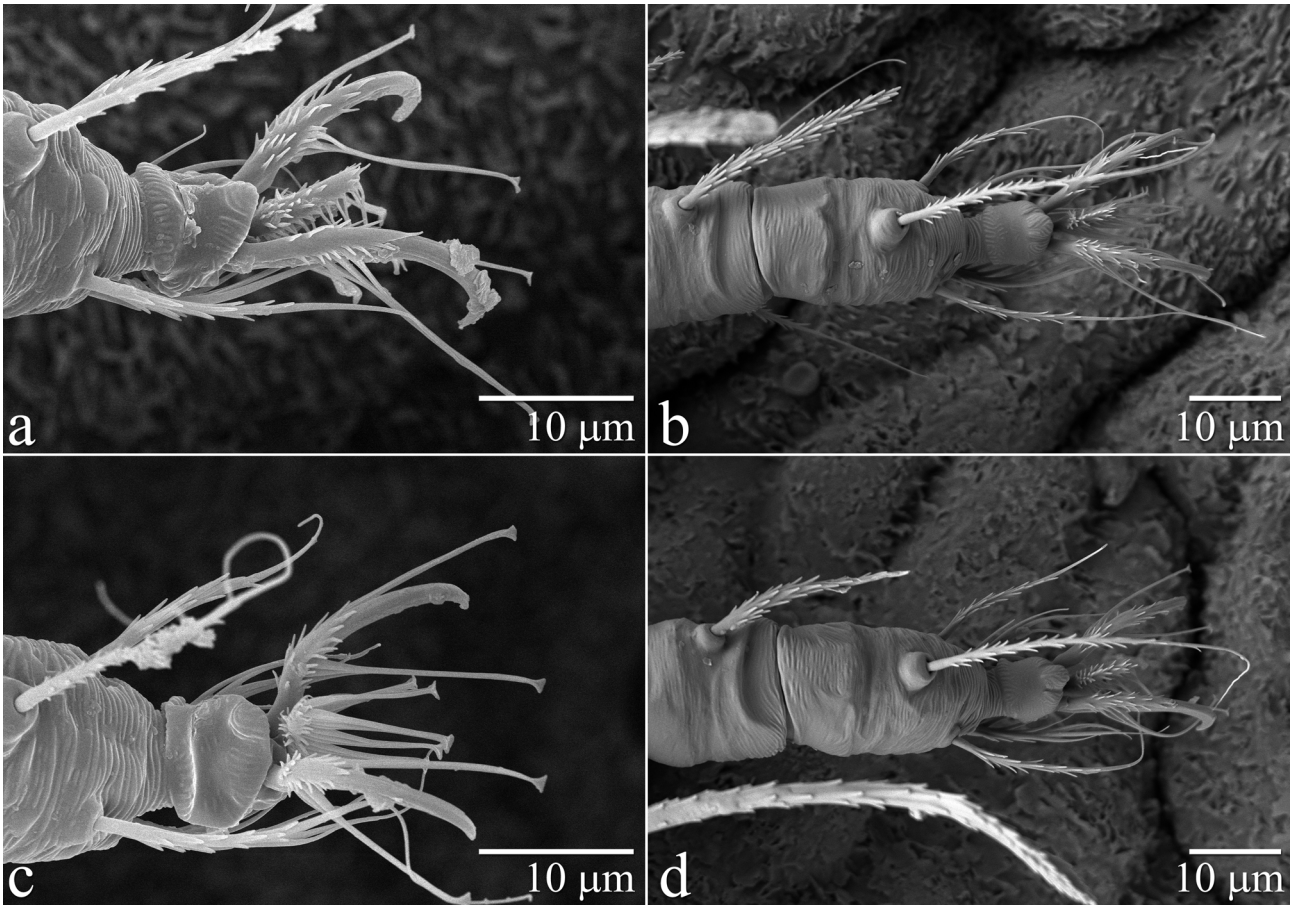


FIGURE 255. *Raoiella* wandoo Beard & Ochoa, adult female: detail of tarsus III (a, b) and detail of tarsus IV (c, d)—a., c. population from wandoo; b., d. population from jarrah (all right side legs).

Legs. Setal formula for legs I–IV (coxae to tarsi): 1-0-3-1-4-9(1), 0-0-3-1-4-9(1), 0-0-2-1-3-5, 0-0-2-0-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 7–11; ta II 6–8) and two eupathidia distally (ta I 7–8, 7–8; ta II 6–8, 6–8). Companion seta *ft″* on tarsus I 4–8 and tarsus II 4–6, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta *d* tapered to slightly spatulate. Claw I 11–12, claw IV 10–11; tenent hairs on claws with two attachment points.

Larva. ***Dorsum.*** (Figs 264–266) Body measurements (8): length between setae *v2–h1* 125–143, width between setae *sc2–sc2* 103–116, *c3–c3* 109–123, *f2–f2* 16–20, *f3–f3* 23–32. Prodorsum with longitudinal to oblique striations, with some short transverse striations posteromesally. Opisthosoma with some mesal transverse striae between setae *c1–e1*. Dorsal setae spatulate, barbed along entire length; setae *e3*, *f2* marginal to ventral; setae *f3*, *h1*, *h2* ventral; setae *f2* weakly spatulate; *f3*, *h1* short, weakly spatulate to tapered; *h2* fine, elongate, filiform. Dorsal setae measurements: *v2* 22–33, *sc1* 24–35, *sc2* 20–26, *c1* 17–20, *c2* 17–21, *c3* 19–24, *d1* 18–22, *d2* 20–24, *d3* 16–22, *e1* 20–25, *e2* 19–23, *e3* 15–22, *f2* 15–21, *f3* 9–12, *h1* 7–10, *h2* 29–54.



FIGURE 256. *Raoiella* wandoo Beard & Ochoa, adult male (wandoo population): dorsal habitus with details of legs I–IV, setae *ps3* and palp.

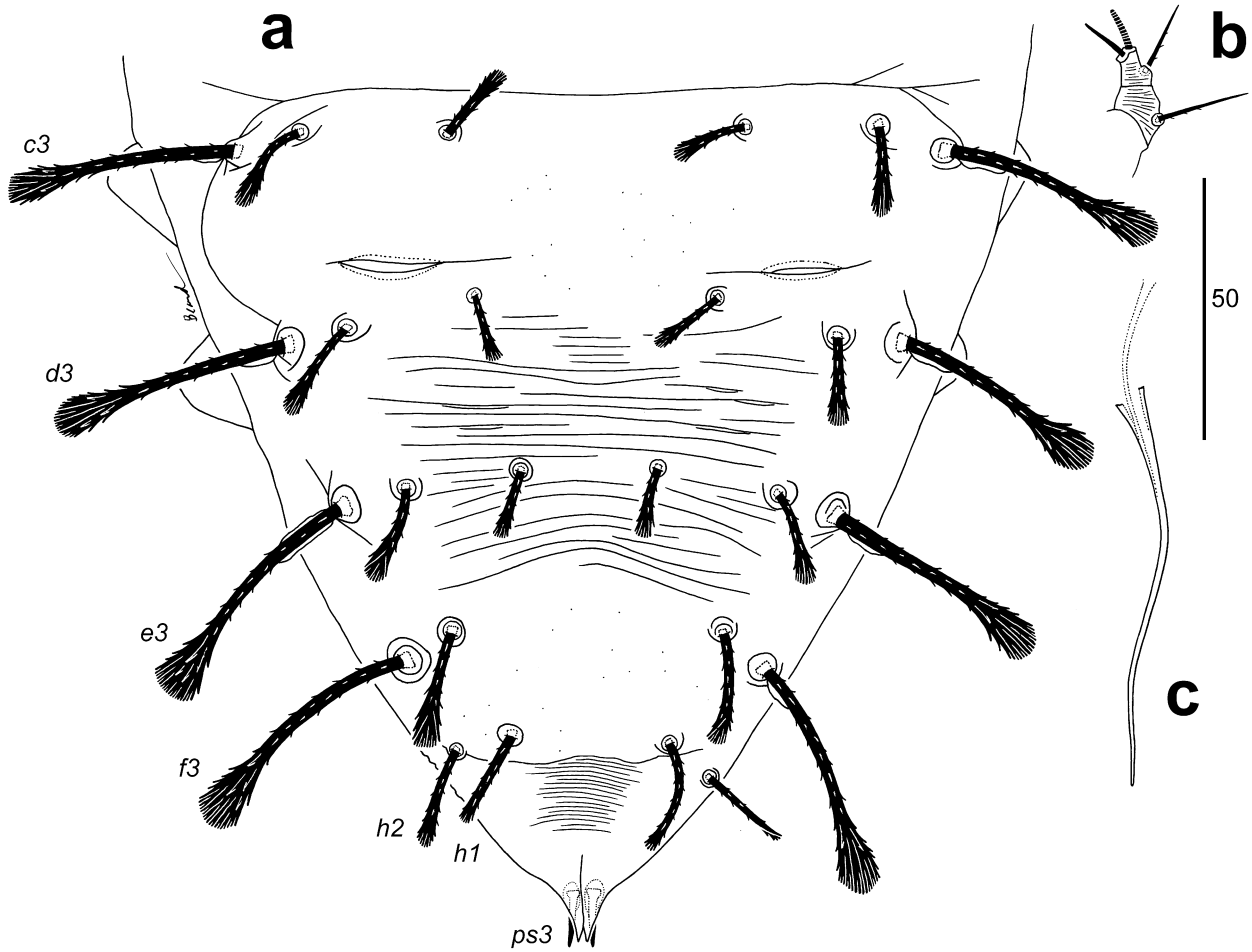


FIGURE 257. *Raoiella* wandoo Beard & Ochoa, adult male (jarrah population): a. posterior dorsum; b. detail of palp; c. detail of aedeagus.

Palps. (Figs 264, 265b) Palps two-segmented. Setal formula: 1, 3(1). Palp tibiotarsus with one solenidion (5–6) and one long finely tapered eupathidium (10–12) distally, and one seta dorsally (9–11); palp femorogenu with one seta (11–13).

Venter. (Figs 267–268) Cuticle almost completely strongly plicate, except coxal fields smooth; transverse striae between *1b–1b*, oblique to longitudinal striae *1b–1a*, transverse striae *1a–3a*, posterior to *3a* with band of transverse striae followed by mostly longitudinal striae with a small diamond of transverse striae mesally (Fig. 268) (see also Figs 23, 44, 56, 70, 100, 115b, 129a, 146, 161b, 178, 191b, 238). Setal measurements: *1a* 26–46, *1b* 10–14, *3a* 7–11, *ps2* 3–5, *ps3* 3–5.

Legs. (Figs 264, 266, 269) Setal formula for legs I–III (coxae to tarsi): 1-0-3-1-4-7(1), 0-0-3-1-4-7(1), 0-0-2-1-3-3 respectively. Tarsi I and II each with one abaxial solenidion (ta I 6–8; ta II 4–6) and two eupathidia distally (ta I 6–8, 6–8; ta II 6–7, 6–7). Companion seta *ft″* on tarsus I 3–8 and tarsus II 4–6, inserted adjacent to solenidion *ω″*. Tibiae I and II with dorsal seta *d* finely tapered. Claw I 12, claw IV 11–12; tenent hairs on claws with two attachment points.

Egg. (Fig. 270) Large, red, elongate ellipsoid in shape, 130–150 long 90–115 wide, often with multiple fine longitudinal bands on surface, and a relatively short distal stipe approximately 110–160 long.

Host. wandoo *Eucalyptus* wandoo Blakely (Myrtaceae).

Distribution. AUSTRALIA: Southwest Western Australia.

Etymology. This species is named after its host plant. wandoo is a local indigenous word for this species of tree, and is also the specific name.

Remarks. *Raoiella* wandoo **sp. nov.** (DNA codes RaIn43 and RaIn44 from *E.* wandoo; RaIn68 from *E. marginata*) was grouped with RaIn67 as *Raoiella* sp. 3 in Dowling *et al.* (2012; Table 1 and Figs 1, 2), and was

listed as *Raoiella* sp. 3A in Beard *et al*. (2013). However, based upon morphological characteristics, geography, and host plant, we have chosen to name *R.* wandoo as a separate species to RaIn67, which is described as *R. tallerack* **sp. nov.** in this publication.

Raoiella wandoo can be separated from *R. tallerack* by the following: *Rw* eggs with a stipe 1–2X the length of the egg; *c1* 18–23, *c2* 25–31, *f2* 31–36, *h2* 22–34, *sc2–sc2* 178–202; vs *Rt* eggs with a stipe 4–5X the length of the egg; *c1* 25–29, *c2* 32–36, *f2* 35–43, *h2* 30–38, *sc2–sc2* 163–176.

A small population of *R.* wandoo was collected from immature jarrah, *E. marginata* growing as an understorey in a mixed forest of *E.* wandoo, *E. marginata* and marri *Corymbia callophylla* (all Myrtaceae). Initially we felt that this could represent a distinct species, due to the different host plant; however, the jarrah population is morphologically inseparable from, and molecularly close to, the wandoo population, and both populations are here considered to be conspecific. Until further evidence suggests otherwise, we do not consider *E. marginata* to be a true host of *R.* wandoo.

As in *R. tallerack*, coxae II is nude in immature stages, i.e. the expression of setae *2b*, normally added in the protonymph, are unusually delayed until the adult stage. Setae *3b* (normally added in protonymph) and *4b* (normally added in deutonymph) are absent.

A host plant voucher of *E. marginata* was deposited with Queensland Herbarium (BRI voucher # AQ814934).

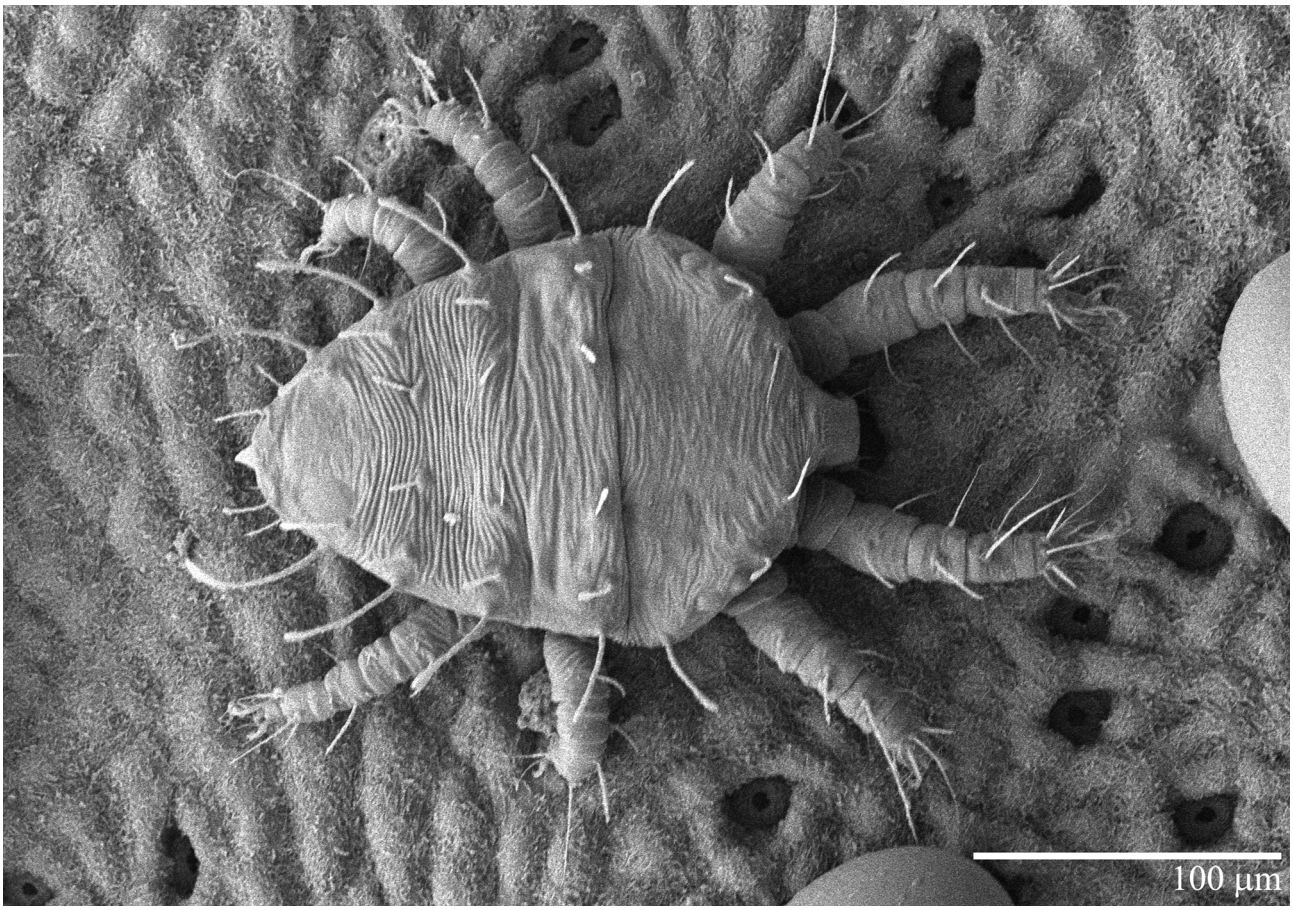


FIGURE 258. *Raoiella* wandoo Beard & Ochoa, adult male (wandoo population): dorsal habitus on host plant.

Discussion

A Bayesian analysis of multiple *Raoiella* species by Dowling *et al.* (2011) suggested the existence of three major clades and a large basal polytomy. The three suggested clades are (1) an Australian clade consisting of *R. australica*, *R. taronga* and *R. marri*, (2) a second Australian clade consisting of *R. bauchani*, *R. crebra*, *R. goyderi*, *R. calgoa*, *R. illyarrie*, *R. karri*, *R. tallerack*, *R. todtiana* and *R.* wandoo, and (3) a clade with an undescribed species from South Africa (close to *R. shimpana*, species 9, RaIn80, in Dowling *et al.* (2011)) and *Ra. indica*. Linking morphology with the molecular analysis, we suggest the following species groups:

Raoiella australica species group consisting of *R. australica*, *R. davisi*, *R. didcota*, *R. marri*, *R. taronga*, with the following shared character states—femora II with four setae; sexual dimorphism on genua I and II with two setae (*l'*, *l''*) in female, with three setae (*d*, *l'*, *l''*) in male; short, tapered setae *h2*; ventral setae *3b*, *4b* absent (i.e. coxae III–IV without setae); tarsi I–II with companion setae (*ft''*) approximately same length as solenidion (tarsus I slightly longer); larva with seta *h2* elongate, flagellate; eggs lack a stipe, except for *R. taronga*.

Raoiella wandoo species group consisting of *R. calgoa*, *R. crebra*, *R. hallingi*, *R. illyarrie*, *R. karri*, *R. tallerack*, *R. todtiana*, *R.* wandoo, with the following shared character states—femora II with three setae; genua I and II with three setae in both sexes (*d*, *l'*, *l''*); ventral setae *3b*, *4b* absent (i.e. coxae III–IV without setae); tarsi I–II with companion setae (*ft''*) subequal to slightly longer than solenidion; larva with seta *h2* elongate, flagellate. Males of *R. calgoa*, *R. hallingi*, *R. illyarrie*, *R. karri* and *R.* wandoo with trochanter IV nude (although see Remarks for *R. hallingi* and *R. illyarrie* for further comments on male trochanter IV).

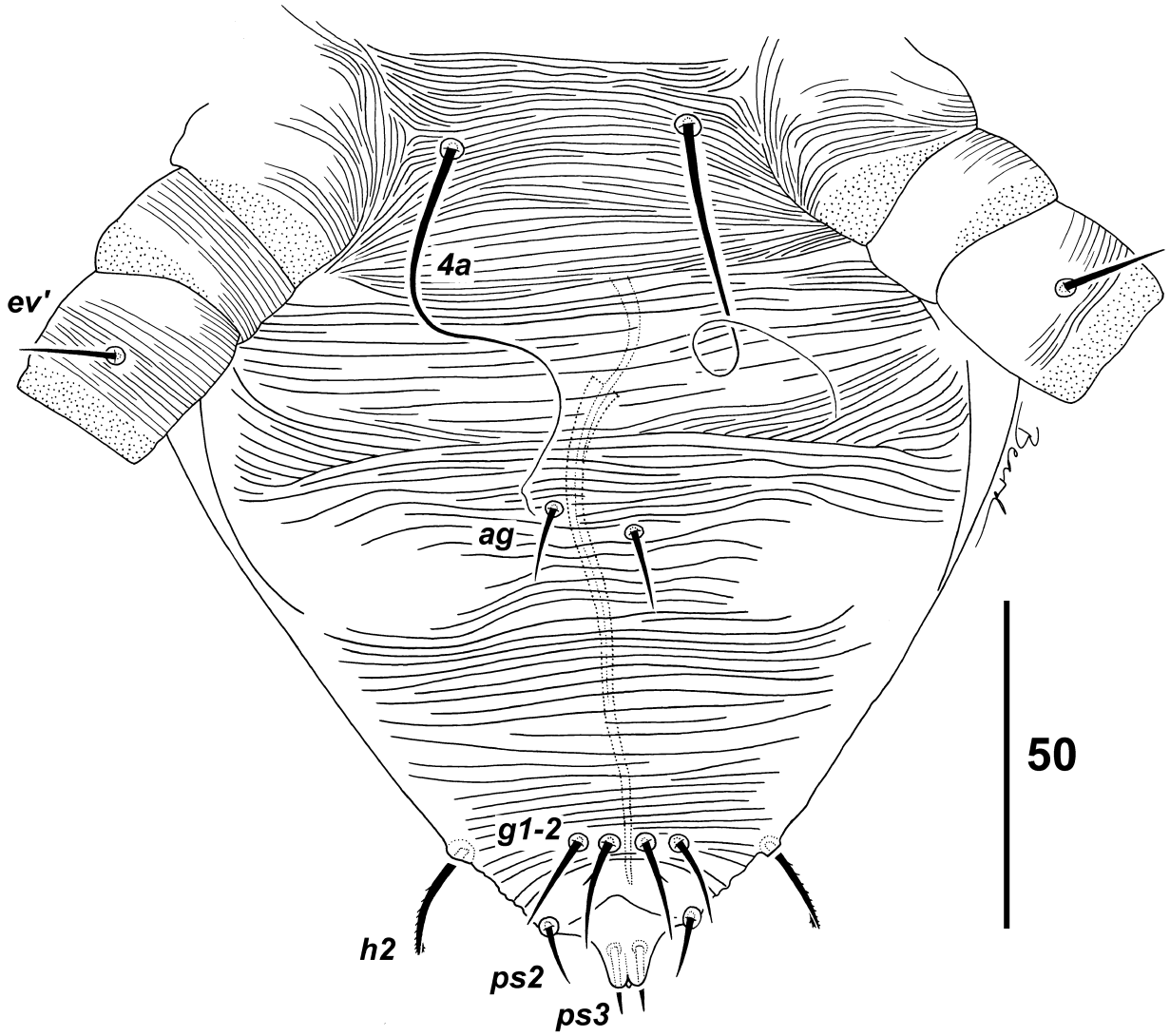


FIGURE 259. *Raoiella* wandoo Beard & Ochoa, adult male (wandoo population): posterior venter with detail of aedeagus and setae *ps3*.

Raoiella bauchani species group consisting of *R. bauchani*, *R. goyderi*, *R. pooleyi*, with the following shared character states—femora II with four setae; genua I and II with two setae (*d*, *l'*); dorsal opisthosomal setae *h1* much longer than *h2*; ventral setae *3b*, *4b* absent (i.e. coxae III–IV without setae); tarsi I–II with companion setae (*ft''*) shorter than solenidion; larva with seta *h2* elongate, flagellate.

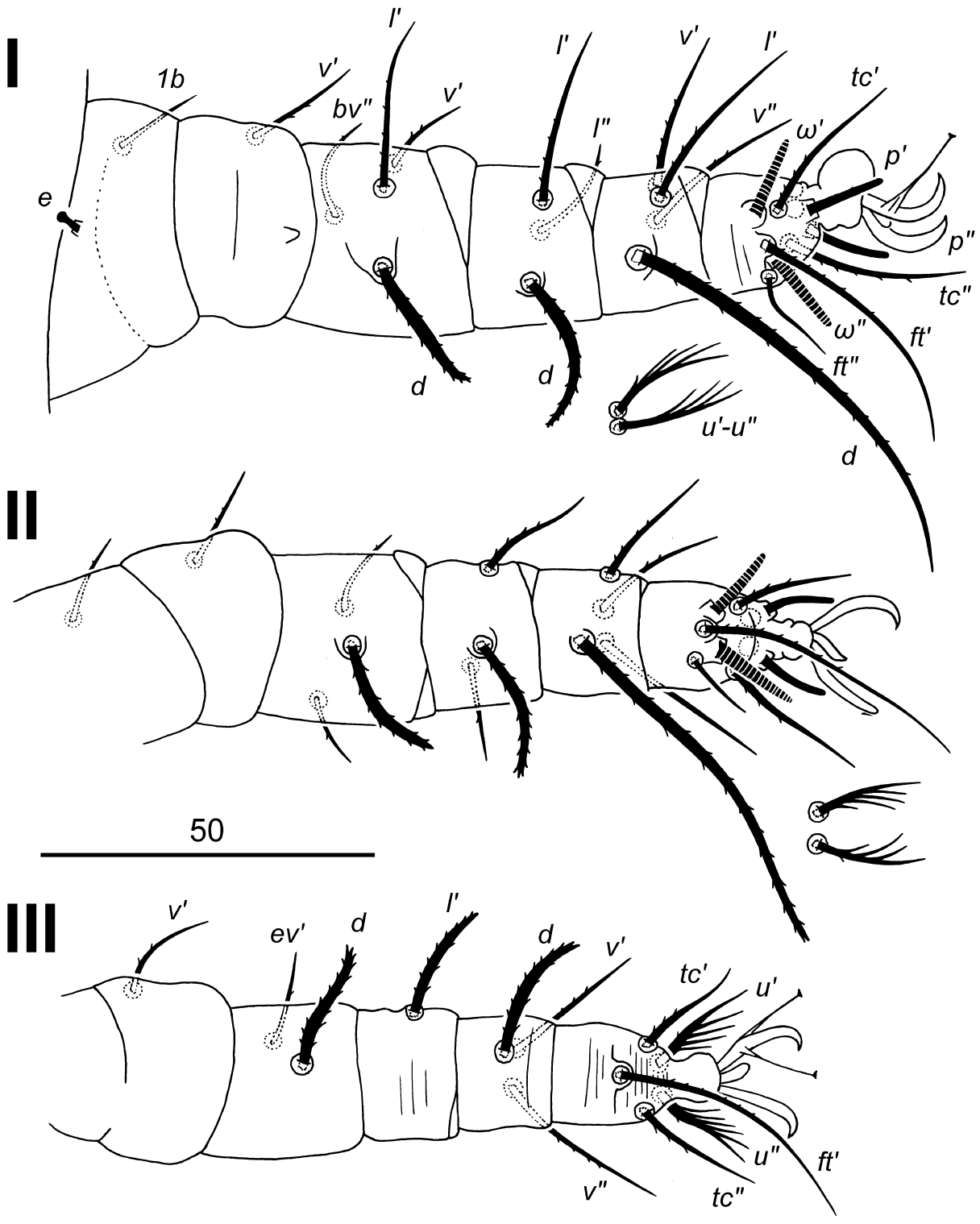


FIGURE 260. *Raoiella* wandoo Beard & Ochoa, adult male (jarrah population): detail of legs I–III (right side, dorsal aspect).

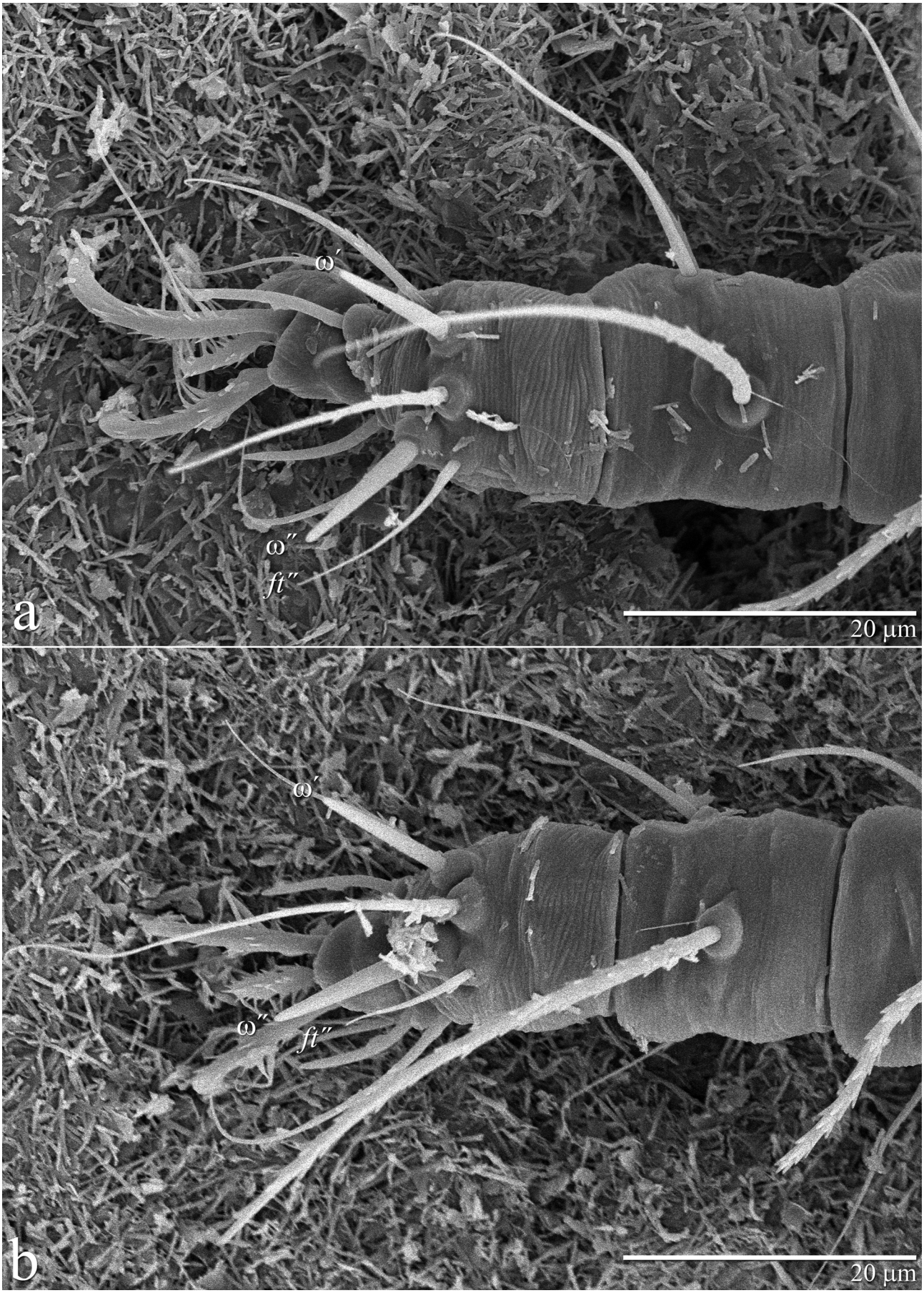


FIGURE 261. *Raoiella* wandoo Beard & Ochoa, adult male: a. detail of tarsus I (left leg); b. detail of tarsus II (left leg).

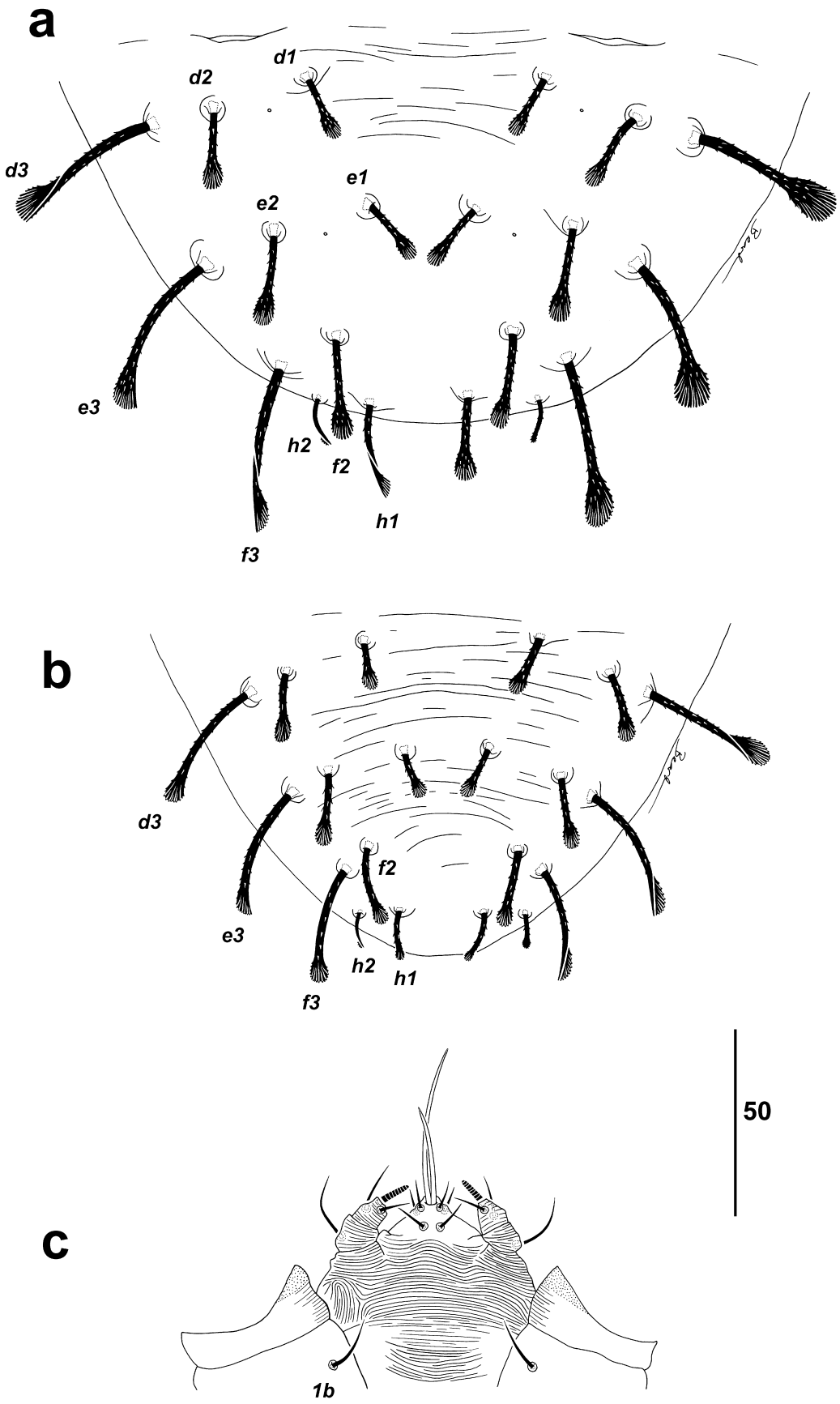


FIGURE 262. *Raoiella* wandoo Beard & Ochoa, deutonymph: a. female deutonymph posterior dorsal opisthosoma b. male deutonymph posterior dorsal opisthosoma; c. female deutonymph ventral infracapitulum with details of palps.

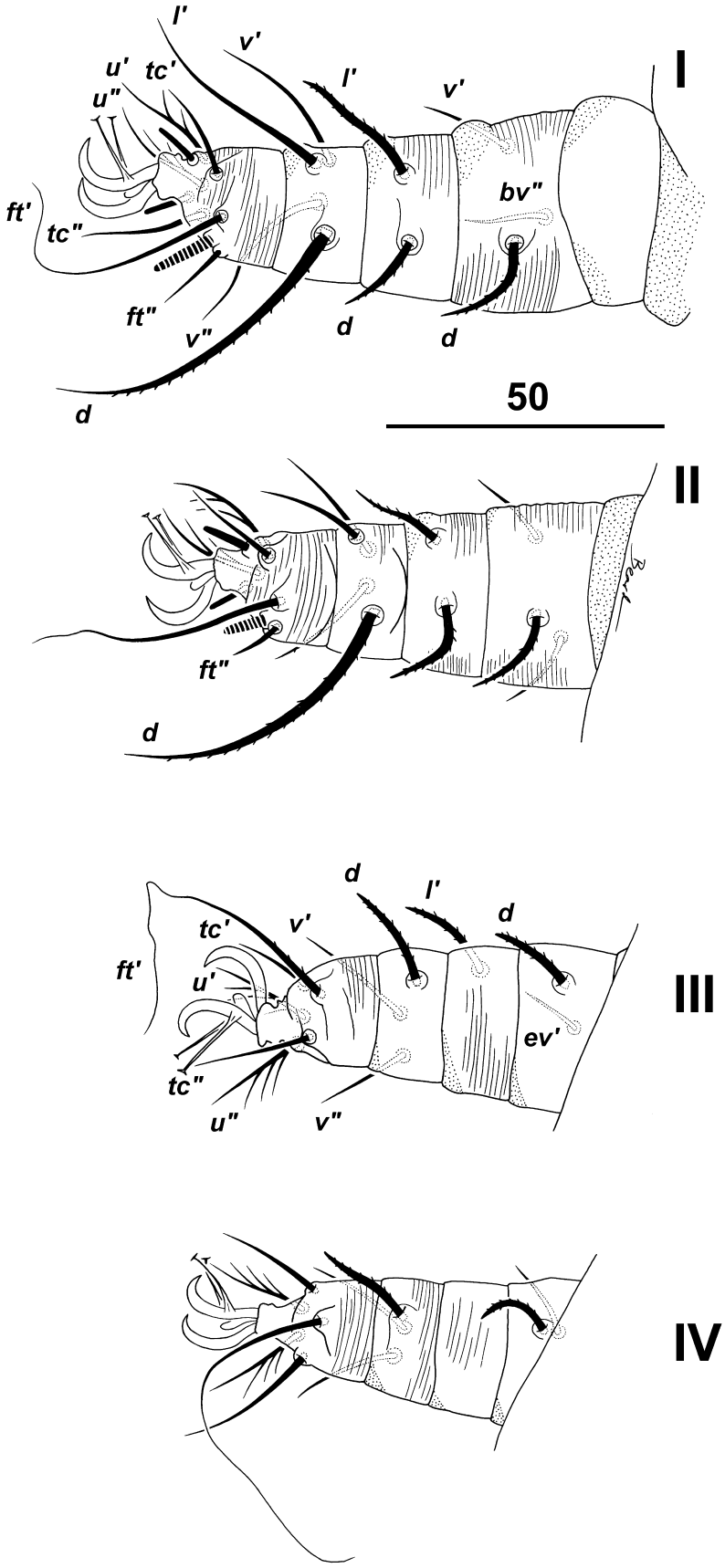


FIGURE 263. *Raoiella* wandoo Beard & Ochoa, deutonymph: legs I–IV (left side, dorsal aspect).

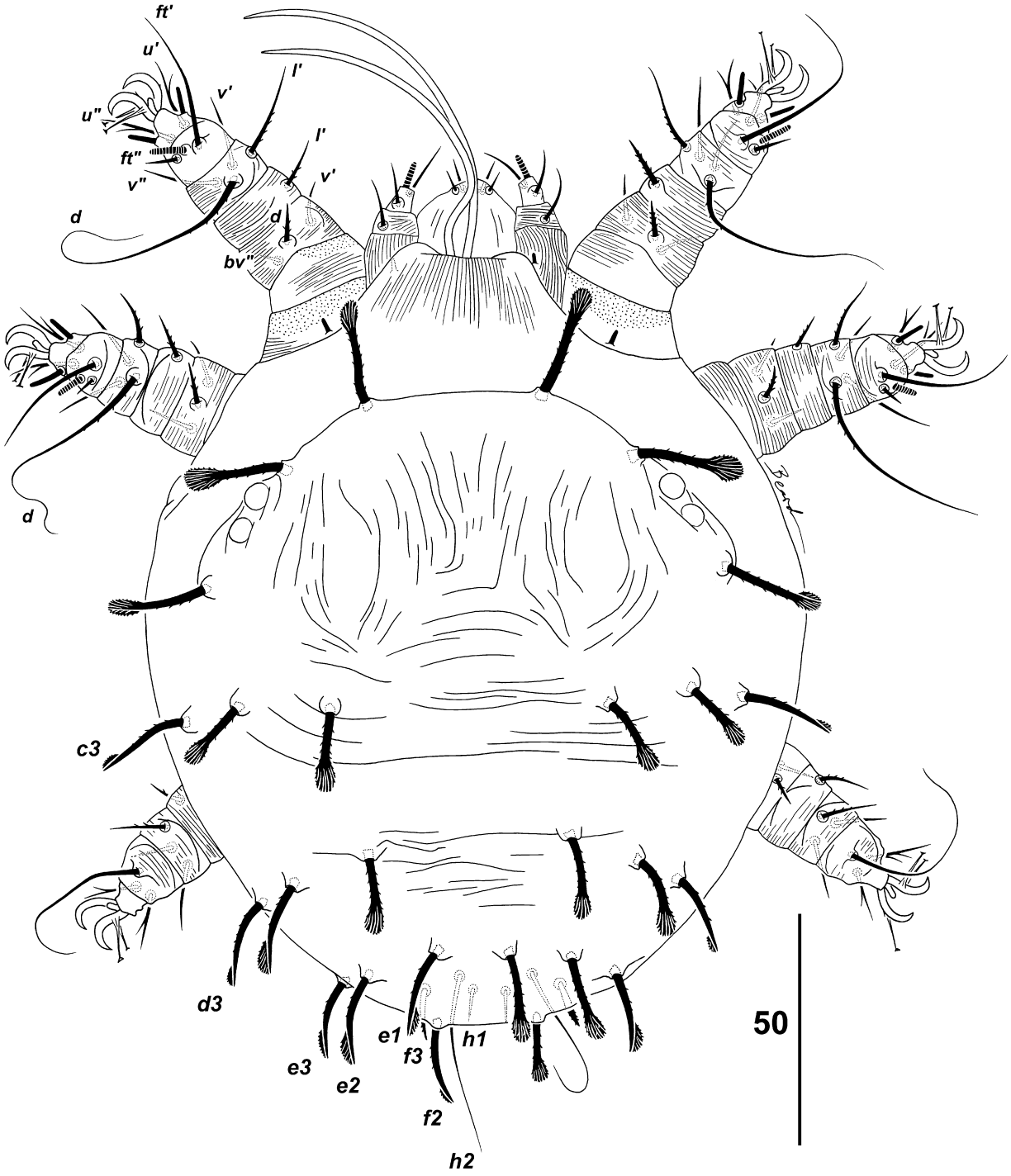


FIGURE 264. *Raoiella* wandoo Beard & Ochoa, larva (wandoo population): dorsal habitus with detail of legs I–III, palps and setae *h2*.

Raoiella indica species group consists of *R. indica*, *R. pandanae* (tentative inclusion; not sequenced, and not examined), with the following shared character states—femora II with four setae; genua I and II with three setae in both sexes (*d*, *l'*, *l''*); ventral setae *3b*, *4b* absent (i.e. coxae III–IV without setae); dorsal opisthosomal setae *h1* approximately the same length as setae *h2*; setae *h2* elongate, flagellate; tarsi I–II with companion setae (*ft''*) obviously longer than solenidion; larva with *h2* same size as *h1*, short.

Raoiella macfarlanei species group (no species sequenced) consists of *R. argenta*, *R. eugeniae*, *R. macfarlanei* and *R. shimpana*, with the following shared character states—femora II with four setae; genua I and II with three

setae in both sexes (*d*, *l′*, *l″*); ventral seta 1c present or absent; ventral setae *3b*, *4b* present (i.e. coxae III–IV with one seta); tarsus I companion setae (*ft″*) obviously longer than solenidion; tarsus II companion seta (*ft″*) obviously shorter than solenidion (subequal in *R. eugeniae*); dorsal setae with plumose spatulate tips; larva with seta *h2* short, same size as *h1*. We assume that *Raoiella* species 9 in Dowling *et al.* (2012) would be placed in this group.

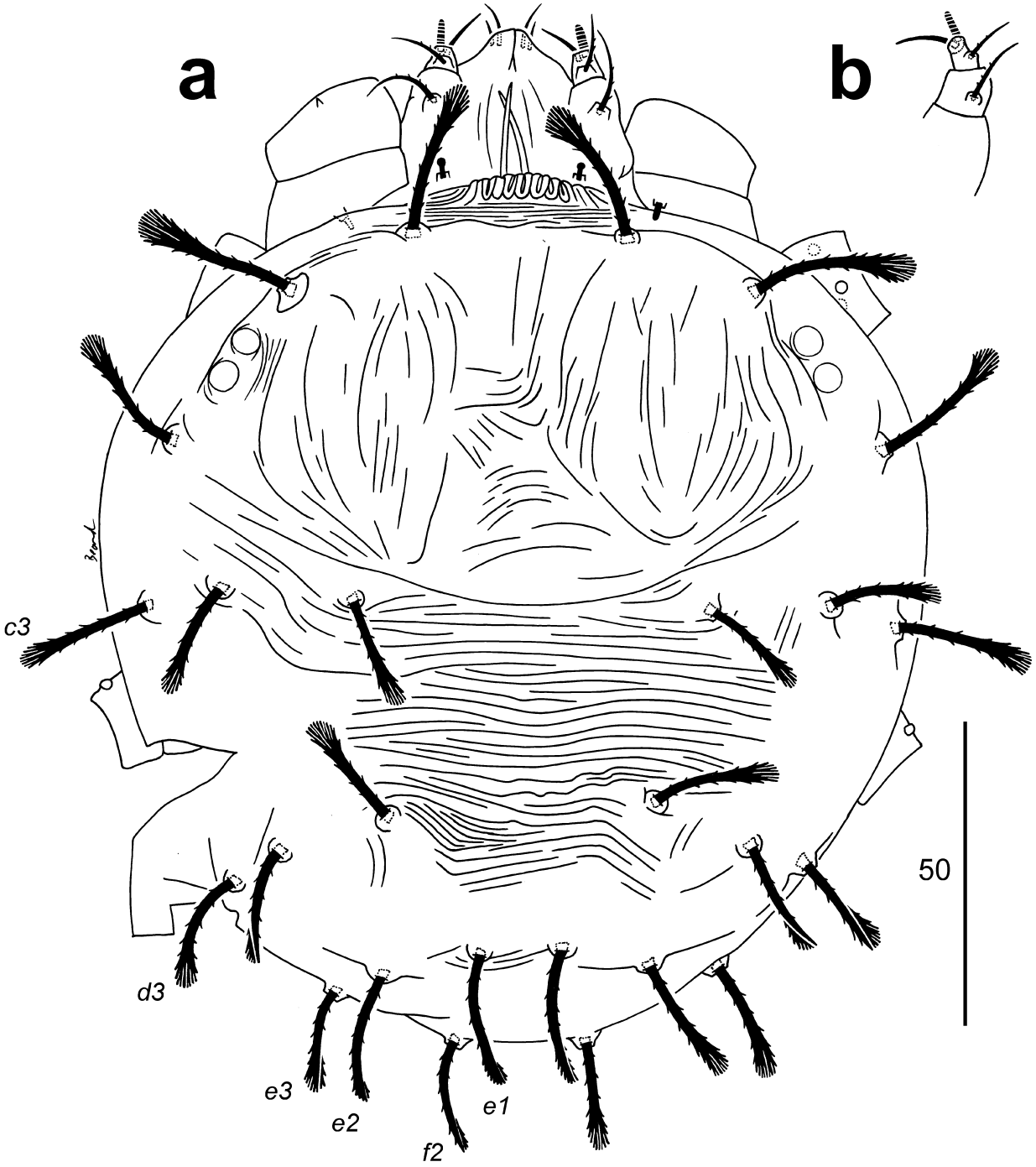


FIGURE 265. *Raoiella* wandoo Beard & Ochoa, larva (jarrah population): a. dorsal habitus; b. detail of palp.



FIGURE 266. *Raoiella* wandoo Beard & Ochoa, larva (wandoo population): dorsal habitus on host plant.

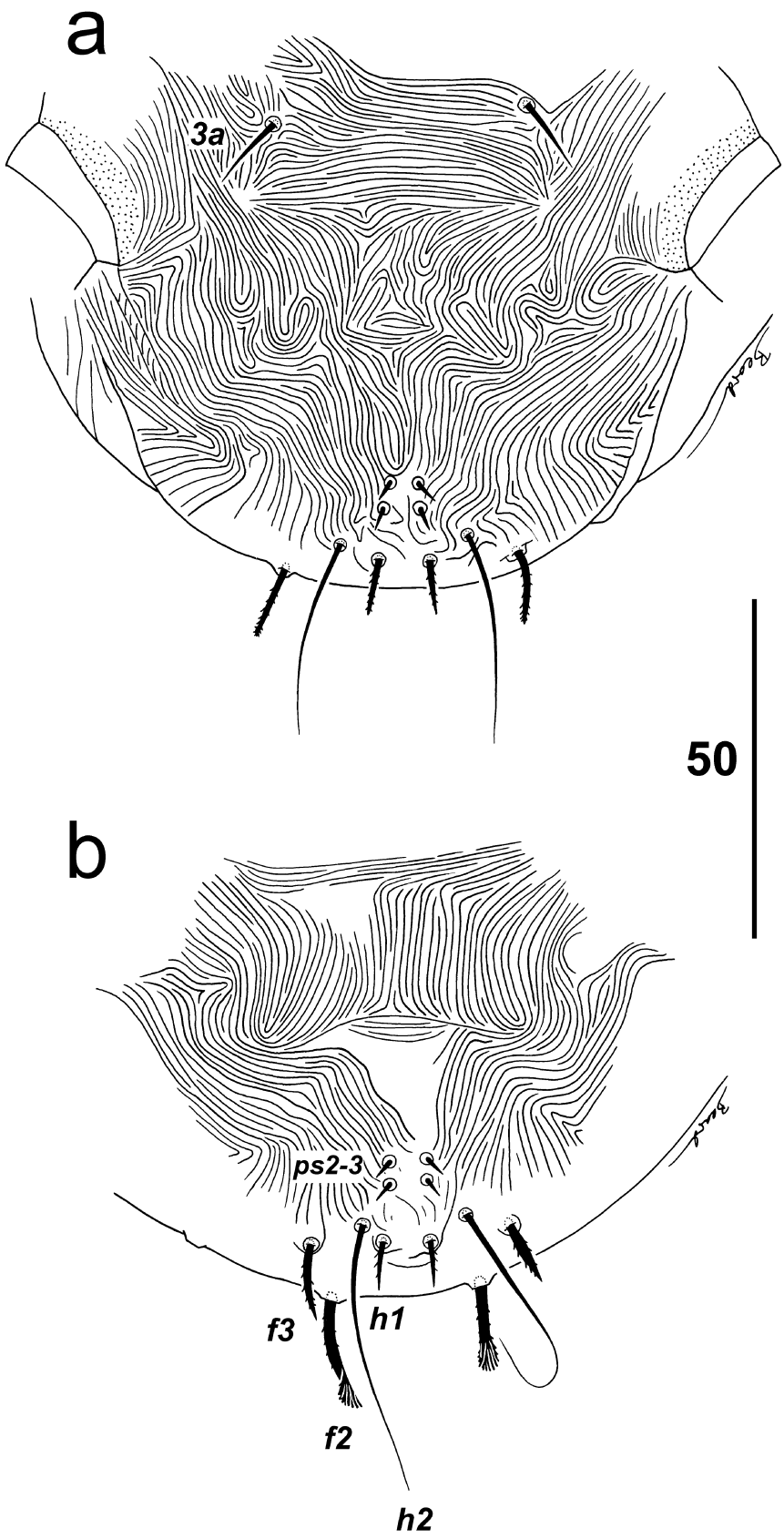


FIGURE 267. *Raoiella* wandoo Beard & Ochoa, larva (wandoo population): a., b. variation in cuticle striations on ventral opisthosoma (b. is same individual as Figure 262).

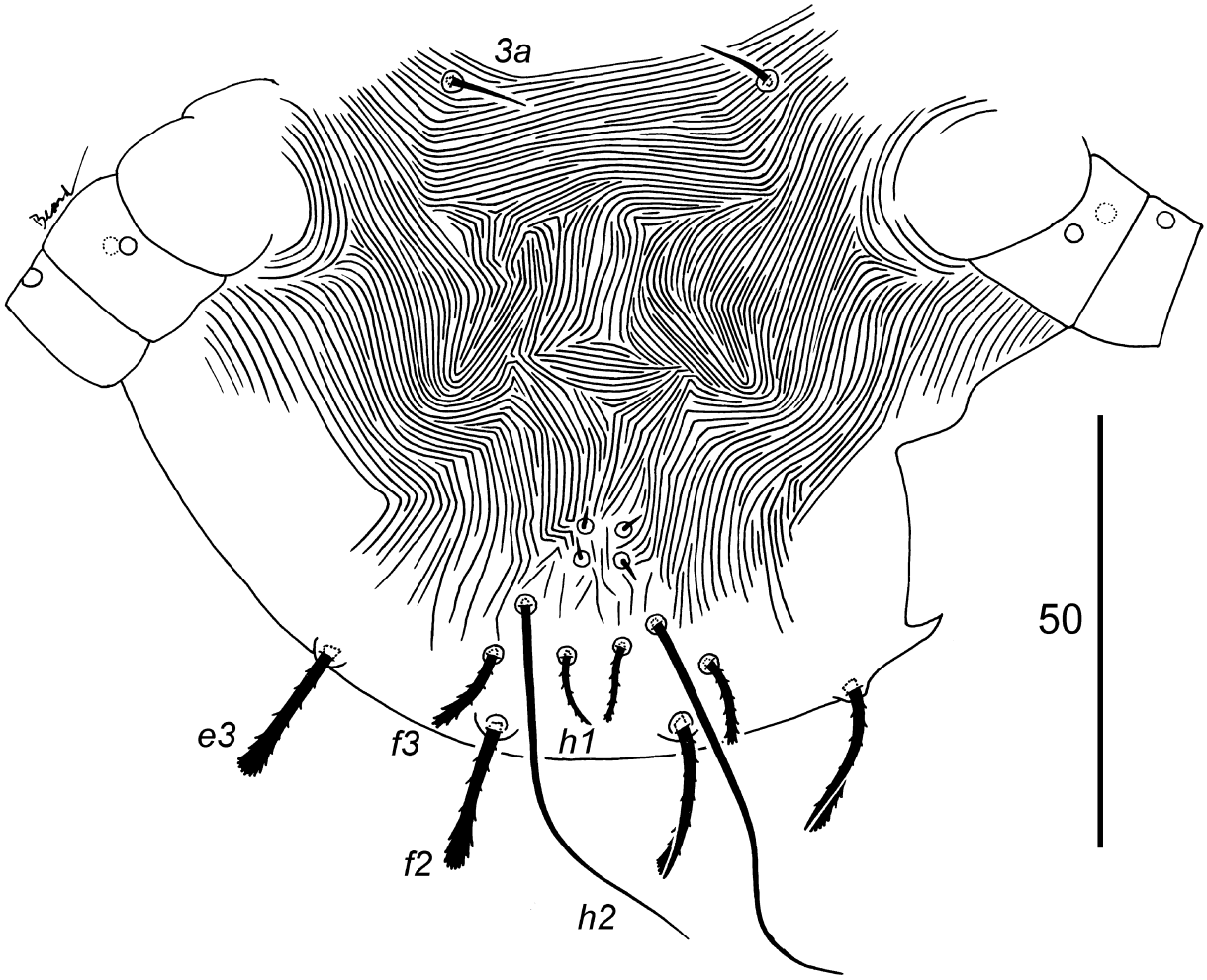


FIGURE 268. *Raoiella* wandoo Beard & Ochoa, larva (jarrah population): posterior venter.

Leg setation—patterns of additions during ontogeny. Few attempts have been made to determine setal homologies and ontogenetic patterns of setal additions within the Tetranychoidea (Lindquist 1985). Lindquist's (1985) detailed data on the leg chaetotaxy of Tetranychidae, highlighted the need for comparative studies of leg setae to determine homologies for the families of the Tetranychoidea. The Tenuipalpidae is proving to be a highly diverse group, as discussed further in Welbourn *et al.* (2017). Here we discuss the patterns in the additions of leg setae during ontogeny for the genus *Raoiella* (Table 1) in relation to the data provided by Lindquist (1985) for the Tetranychidae, as well as data from related tenuipalpid taxa based on direct examination, or to a lesser extent sourced from the literature. It should be noted here that there are extremely few resources available in the literature that provide unambiguous data concerning complete patterns of setal additions through the full ontogeny for tenuipalpid taxa.

Trochanters. The standard basic pattern of setation for trochanters of adult Tenuipalpidae is 1-1-2-1, in which *v′* is present on each trochanter, with a second seta on trochanter III, *l′*. Species of *Raoiella* have an adult pattern of 1-1-1-1, i.e. seta *l′* is completely absent on trochanter III in *Raoiella*, and trochanters I–IV have only seta *v′* present, which are added in the adult. The addition of seta *v′* to tr I–III is delayed one stage, as this seta is normally added in the deutonymph, while the addition of *v′* to tr IV in the adult is standard for the family Tenuipalpidae, and also for the Tetranychidae. Seta *l′* is also not present in the family Tetranychidae.

Femora. The general pattern of setation on the femora of legs I–IV of larvae and protonymphs in the Tetranychidae is 3-3-2-2. This is the same or similar to the two basic patterns that occur in the Tenuipalpidae, 3-3-2-2 or 3-3-2-1 (Welbourn *et al.* 2017). *Raoiella* larvae and protonymphs have the former pattern, i.e. that found in the Tetranychidae, 3-3-2-2 (fe I–II with *d*, *v′*, *bv″* present; fe III–IV with *d*, *ev′* present). Lindquist (1985) suggested that none of the setae (up to six setae) that are normally added to the femora in the deutonymph in the

Tetranychidae are added in the Tenuipalpidae. This is true for *Raoiella* in which no setae are added to the femora in the deutonymph. *Raoiella* delay the addition of seta *l'* to fe I–II or fe I alone until the adult, and retain their larval/protonymphal complement of setae on femora III–IV throughout ontogeny, giving an adult femoral setation of 4-3/4-2-2. In contrast, seta *l'* is added to fe I–II in deutonymph of many species of *Tenuipalpus* and related genera such as *Acaricis*, *Prolixus* and *Lisaepalpus* (Welbourn *et al.* 2017). *Raoiella* are also unusual in that they retain a plesiomorphic pattern for the family Tenuipalpidae by expressing seta *d* on femora IV, whereas the more common pattern for the family is that of reduction with only *ev'* present on fe IV.

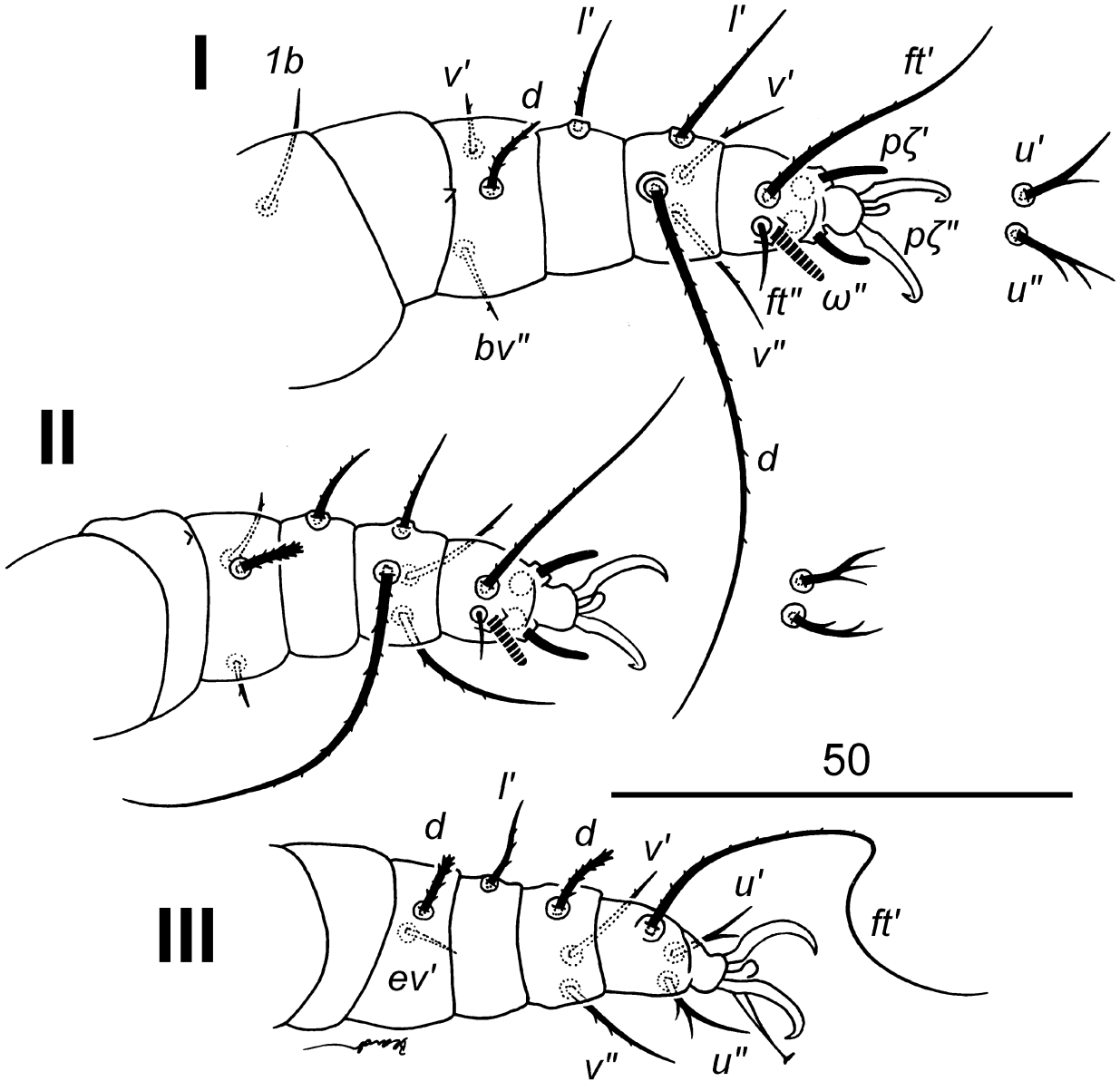


FIGURE 269. *Raoiella* wandoo Beard & Ochoa, larva (jarrah population): legs I–III (right side; dorsal aspect).

Genua. Larval and protonymphal Tetranychidae have a standard genual setation on legs I–IV of 4-4-2-2, with ge I–II each bearing *l'–l"* and *v'–v"* and ge III–IV each bearing *l'* and *v"*. This is a much richer complement of setae than that found in the larvae and protonymphs of all other tetranychoid families. For example, *Raoiella* larvae and protonymphs have a basic pattern of setation on genua I–IV of 1-1-1-0 (*l'-l'-l'*-0). This is a pattern shared with several species of *Tenuipalpus*, and *Acaricis*; while further reductions occur on other species, such as species of *Tenuipalpus*, *Prolixus* and *Lisaepalpus smileyae* with a pattern of 1-1-0-0, and other species of *Tenuipalpus*, *Cyperacarus* and *Gahniacarus* have entirely nude genua throughout ontogeny (Welbourn *et al.* 2017).

In the Tetranychidae: Tetranychinae, seta *d* is added to all legs in the deutonymph (*d*, when present, may be delayed until adult in Bryobiinae) (Lindquist 1985), and is the only seta added to the genua in this stage. Seta *d* is generally added to ge I–II and suppressed on ge III–IV in the deutonymph of the other tetranychoid families, and this character state may represent a shared apomorphy (Lindquist 1985). Species of *Raoiella* have variable, and interesting, patterns of additions on genua I–II. *Raoiella* larvae and protonymphs have only *l′* present on ge I–III (1-1-1-0), seta *d* is added to ge I–II in the deutonymph (2-2-1-0), while seta *l″*, normally a larval seta for Tetranychidae, is delayed until the adult on ge I–II (3-3-1-0) (which contrasts with Lindquist (1985), see below).

The *indica*, *macfarlanei*, and wandoo species groups have the standard basic adult *Raoiella* pattern of three setae present on ge I–II in both sexes (*d*, *l′*, *l″*). There are two species groups (*australica* and *bauchani*) that have only two setae on ge I–II in the adult; however, each of these species groups have two different setae present, and they are also added in different stages: the *australica* species group (*australica*, *davisi*, *didcota*, *marri* etc) have two setae *l′*, *l″* present on the female and three setae *d*, *l′*, *l″* present on the male; and the *bauchani* species group have two setae *d*, *l′* present in both sexes. The *australica* group species have sexually dimorphic deutonymphs (and adults)—female deutonymphs have one seta present on ge I–II—i.e. only the larval seta *l′* is present (*d* is absent); while male deutonymphs have two setae present—i.e. seta *d* is added in this stage (as is standard) to the larval seta *l′* (male deutonymphs unknown for *R. didcota*). The *bauchani* group species deutonymphs have one seta present on ge I–II (larval seta *l′* present; *d* absent) in both sexes, and unusually delay the addition of *l″* until the adult stage. *Raoiella* retain their larval pattern on genua III–IV throughout ontogeny. In *Aegyptobia* and some *Tenuipalpus*, the larvae and protonymphs also have only seta *l′* present on ge I–III, but both setae *d* and *l″* are added to ge I–II in the deutonymph in these genera.

Lindquist (1985) stated that no setae are added to the genua in adult Tenuipalpidae (or Linotetranidae). This is true for adults of many tenuipalpid taxa, but not all (Welbourn *et al.* 2017). Some species of *Raoiella* add seta *l″* to genua I–II in the adult (this seta is often in a *v″* position), and *Lisaepalpus* also adds setae to genua in the adult stage, i.e. seta *d* to genua I–II and *l′* to genu IV (Welbourn *et al.* 2017). Genua IV remain nude throughout ontogeny in *Raoiella*, as also occurs in species of *Aegyptobia* and many *Tenuipalpus*. In addition, species of *Colopalpus*, *Crossipalpus*, *Dolichotetranychus*, *Magdalenapalpus*, *Obuloides*, *Palpipalpus*, *Philippipalpus*, *Tenuipalpus* also have ge III nude. The adult genual setation for *Raoiella* is 2/3-2/3-1-0.

Tibiae. The Tetranychidae have a fuller larval/protonymphal complement of setae on the tibiae than do Tenuipalpidae, with one complete whorl present on tibia I–IV plus a solenidion on tibia I. No setae are added to the tibiae during development in the Tenuipalpidae (Lindquist 1985), but the tibial setation patterns vary across the family (Welbourn *et al.* 2017). *Raoiella* have a basic larval/protonymphal tibial setation on legs I–IV of 4-4-3-3 (ti I–II with *d*, *l′*, *v′*, *v″* present and *l″* absent; ti III–IV with *d*, *v′*, *v″*), which is maintained throughout ontogeny. This pattern is shared with *Aegyptobia* and *Dolichotetranychus* for example, but differs to many other tenuipalpid genera (Welbourn *et al.* 2017). Seta *l″* is also absent on tibiae I–II in *Obuloides*, however, this genus also lacks *d* on tibiae III–IV.

Tarsi. Species of *Raoiella* express the standard basic tenuipalpid pattern of tarsal setation in the larvae, 7(1)-7(1)-3, i.e. tarsi I–II with setae *ft′–ft″*, *p′–p″*, *u′–u″*, *ω″* present; and tarsus III with *ft′*, *u′–u″* present; while other tenuipalpid taxa have *ft″* absent on ta I–II, with a tarsal setal count of 6(1)-6(1)-3. In all tetranychoid families, the setal complement of tarsus III in larva appears on leg IV with it is formed in the protonymph (Lindquist 1985). Although the patterns of additions to the tarsal segments are the most variable within the family Tenuipalpidae (Welbourn *et al.* 2017), species of *Raoiella* (in addition to *Aegyptobia*, *Meyeraepalpus*, *Palpipalpus*, *Pentamerismus*, and some *Crossipalpus*) express the standard basic pattern of tarsal setal additions, with *tc′–tc″* being added to tarsi I–III in the protonymph and to tarsus IV in the deutonymph, and with no further additions in the adult (except the basic addition of a second solenidion on tarsus I–II in the male), giving an adult female tarsal pattern of 9(1)-9(1)-5-5.

Lindquist (1985) points out that the larval tetranychid complement on tarsi I and II is uniquely apomorphic within Tetranychoidea in having solenidion *ω″* located closely beside seta *ft″* (which is generally reduced in size relative to *ft′*) to form a set of 'duplex setae', or 'chaetopair', and that within the pair, the solenidion is usually distal to the companion seta. *Raoiella* also has such an arrangement with these two setae. The solenidion (not as elongate and tapered as it is in Tetranychidae) and *ft″* are closely associated, often sharing a small tubercle, and the solenidion is always distal to the companion seta. The only difference is that the length of *ft″* varies, from shorter than the solenidion (many taxa) to significantly longer than the solenidion (e.g. *R. indica*), but it is nearly always shorter relative to seta *ft′* (subequal in *R. indica*), as pointed out by Lindquist (1985) for the Tetranychidae. The length of *ft″*

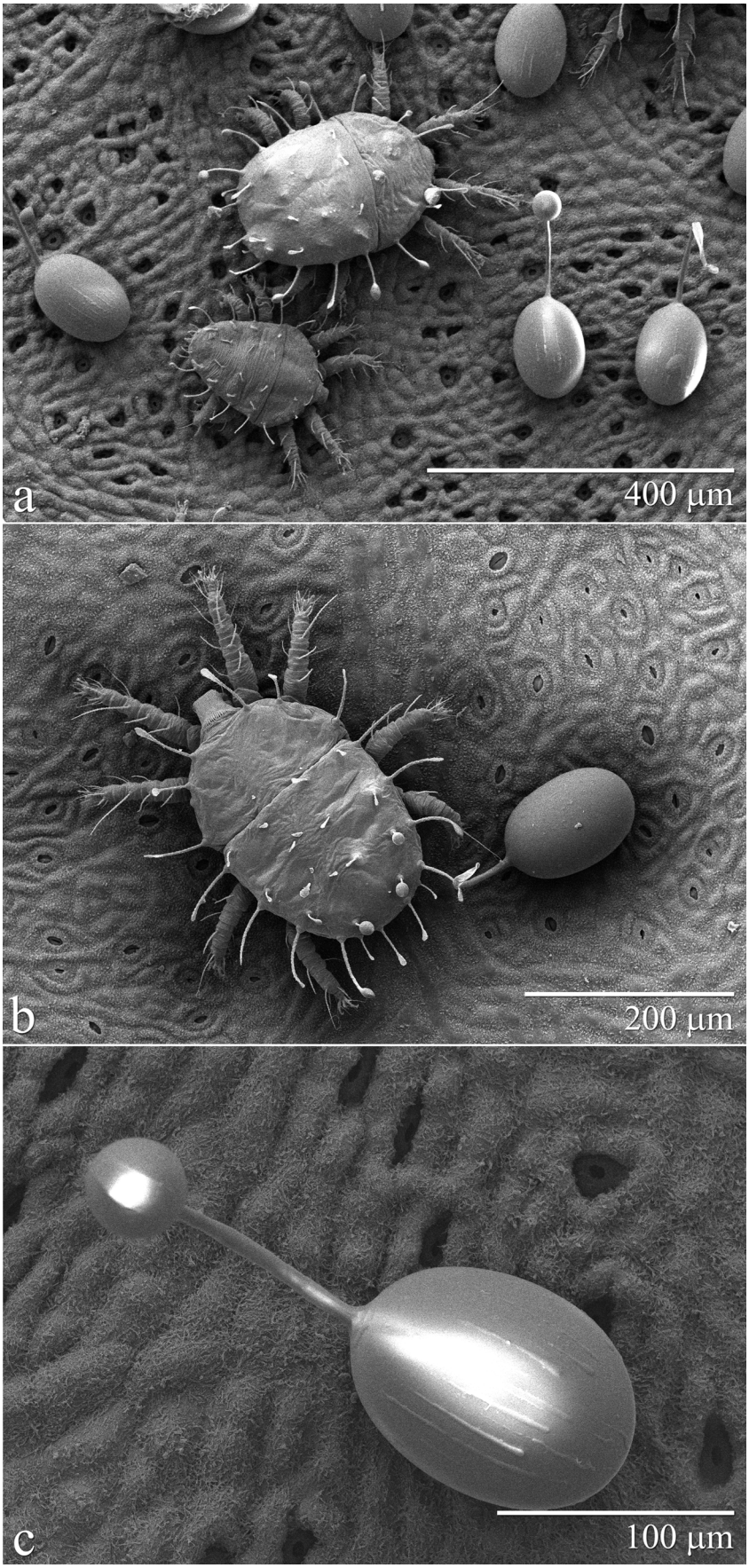


FIGURE 270. *Raoiella* wandoo Beard & Ochoa, eggs on host plant (wandoo population): a. eggs, adult female, adult male; b. egg with adult female; c. egg on host plant.

TABLE 1. Patterns of ontogenetic additions of leg setae in the genus *Raoiella* (Tenuipalpidae).

	Cx I			**Cx II**		**Cx III**		**Cx IV**		**Tr I**	**Tr II**	**Tr III**		**Tr IV**	**Fe I**				**Fe II**				**Fe III**		**Fe IV**	
	1a	*1b*	*1c*	*2b*	*2c*	*3a*	*3b*	*4a*	*4b*	*v′*	*v′*	*l′*	*v′*	*v′*	*d*	*v′*	*bv″*	*l′*	*d*	*v′*	*bv″*	*l′*	*d*	*ev′*	*ev′*	*d*
Larva																										
PN			1																							
DN																										
Adult							2		2													3				

	Ge I			**Ge II**			**Ge III**	**Ge IV**	**Ti I**				**Ti II**				**Ti III**			**Ti IV**		
	l′	*d*	*l″*	*l′*	*d*	*l″*	*l′*		*d*	*l′*	*v′*	*v″*	*d*	*l′*	*v′*	*v″*	*d*	*v′*	*v″*	*d*	*v′*	*v″*
Larva																						
PN																						
DN		4			4																	
Adult			4			4																

	Ta I-II									**Ta III**					**Ta IV**				
	u′	*u″*	*p′*	*p″*	*tc′*	*tc″*	*ft′*	*ft″*	*ω″*	*u′*	*u″*	*tc′*	*tc″*	*ft′*	*u′*	*u″*	*tc′*	*tc″*	*ft′*
Larva																			
PN																			
DN																			
Adult																			

Notes: dark grey cells indicate when a seta is added during ontogeny; light grey cells indicate variable setae.

1. Only *R. eugeniae* and *R. shimpana* (*R. macfarlanei* species group) have seta *1c* present.
2. Only members of the *R. macfarlanei* species group have setae *3b* and *4b* present.
3. Many species have both sexes with four setae on fe II (several species groups), and several species have both sexes with three setae on fe II (*R. wandoo* species group)—seta *l′* is variable.
4. Some species have both sexes with three setae on ge I–II (*R. indica* species group), some species have both sexes with two setae on ge I–II (*R. bauchani* species group), and some species have females with two setae and males with three setae on genu I–II (*R. australica* species group)—setae *d* and *l″* are variable.

also often varies between tarsus I and tarsus II within an individual *Raoiella*, and is used here in species diagnostics. As this arrangement is also present in many other tenuipalpid taxa (*Aegyptobia*, *Brevipalpus*, *Crossipalpus*, *Dolichotetranychus*, *Krugeria*, *Magdalenapalpus*, *Meyeraepalpus*, *Obuloides*, *Palpipalpus*, *Pentamerismus*, *Philippipalpus*, and *Tegopalpus*), it does not appear to be a unique apomorphy for the Tetranychidae.

It is important to note that simple setal counts, as opposed to noting which setae are actually present and the patterns of their additions, can obscure character state data of potential significance (Lindquist 1985). For example, both the *australica* species group and the *bauchani* species group have two setae on genu I–II of the female, however, the two setae that are present are different in each species group, with *l′* and *l″* present in the former, and *d* and *l′* present in the latter, and these setae are added in different developmental stages (see above). Likewise, species of *Aegyptobia* and *Raoiella* both have the same three setae on genu I in the adult male; however, the patterns of additions are different, with *l′* being larval in both genera, *d* and *l″* are added in the deutonymph of the former, while *d* is added in the deutonymph and *l″* in the adult of the latter. We encourage others to provide chaetotactic data and contribute to the determination of homologies and ontogenies for the Tetranychoidea, and ultimately improve our understanding of the systematics and phylogeny of this group.

Additionally, recent works are beginning to indicate that there may be important phylogenetic data to be obtained from the eggs of flat mites. Not a great deal is known about the morphology of tenuipalpid eggs, but as indicated here and in Castro *et al.* (2015), there may be morphological character states of significance at the genus level, similar to what is being discovered regarding the micropatterns inherent on the cuticle surface (e.g. Beard *et al.* 2014; Beard *et al.* 2015; Castro *et al.* 2016b; Tassi *et al.* 2017; Welbourn *et al.* 2017). The inclusion of morphological information regarding the eggs in future descriptions, for example as was provided in Beard *et al.* (2014), Castro *et al.* (2016a), Seeman *et al*. (2016) and Welbourn *et al.* (2017), may also contribute to our broader understanding of this family.

Most known species of *Raoiella* are associated with the plant family Myrtaceae, which includes many economically significant forestry and fruit tree species. On the other hand, *Raoiella indica* is a major concern for the coconut, date, oil and ornamental palm industries, along with the banana industry, which are all of immense economic significance in the Caribbean, the Americas, Asia, and the Mediterranean (see Moraes *et al.* 2012; Silva *et al.* 2014; Da Cruz *et al.* 2015). As these mites also feed via the stomatal opening, the natural defences of their host plants may be compromised, which in turn may make them more vulnerable to fungal and bacterial attack (Ochoa *et al.* 2011). With world palm seed oil production currently at over 60 million metric tonnes per year (Mielke 2017), and the combined banana production of Latin, Central and South America and the Caribbean sitting at over 27 million metric tonnes (http://www.fao.org/economic/est/est-commodities/bananas/en/), these crops are of great economic significance globally, and the potential impact of these mites on these crops warrants further focussed research, including a search for effective biocontrol agents.

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