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Description of two new species of *Tangaroa* Lehtinen 1967 (Arachnida: Araneae: Uloboridae)

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Abstract. Two new species of *Tangaroa* Lehtinen 1967 (Araneae: Uloboridae) from the Cook Islands are described here: *Tangaroa vaka* n. sp. from Rarotonga, and *Tangaroa pukapukan* n. sp. from Mitiaro, both based on male and female specimens.

Keywords: Spiders, Haplogynae, cribellate spider, Deinopoidea

Tangaroa Lehtinen 1967 is a genus of cribellate orb weaver spiders belonging to the family Uloboridae. It is recognized by the presence of six eyes; the members of this group have lost the anterior lateral eyes, having a pair of small pigment spots instead. Males have a distal crook on the ventral surface of tibia I, a simple palpus with a flattened embolus and no sclerite guides, a stridulatory apparatus on the endites, and females are considered secondary haplogyne (Opell 1979, 1983).

Tangaroa was erected by Lehtinen (1967) to include the type-species *T. tahitiensis* (Berland 1934) from Rapa, Tahiti, and *T. dissimilis* (Berland 1924) from New Hebrides, New Caledonia, both species transferred from *Uloborus* Latreille 1806. In 1983, Opell revised the genus, described a third species, *T. beattyi* Opell 1983 from the Caroline Islands, Philippines, and also provided a cladistic hypothesis with the three species reviewed based on fifteen morphological characters, where nine of those were scored based on the presence and position of macrosetae.

A phylogenetic study published by Coddington (1990) supported *Tangaroa* as a sister group of the monotypic *Waitkera* Opell 1979 and, based on the primitive state of its palp, *Tangaroa* was also proposed as the basal uloborid rather than *Waitkera* as suggested by Opell (1979).

The collection of the California Academy of Science was examined during a visit by the first author. Two new species of *Tangaroa* were recognized from the Cook Islands, one from Rarotonga, and other from Mitiaro. Both are described in this paper, with detailed illustrations of diagnostic characters.

METHODS

The material was deposited in the collection of the California Academy of Sciences, California (curator: C. Griswold). Descriptions and morphological terminology follows Opell (1979). The specimens were kept in 80% ethanol and examined under Leica MZ AP0 stereoscopy. Internal tissues of epigynes were digested with pancreatin and cleared with methyl salicylate. Palpi were also cleared with methyl salicylate. For the Scanning Electron micrographs

(LEO 1430VP), both sexes' genitalia were cleaned ultrasonically for 1–3 minutes, and after critical point drying (Autosandri-815), the structures were mounted and sputter coated with gold (Denton Vacuum). The specimens were photographed using a Leica M205A stereoscopic microscope equipped with a Leica DFC425 camera and LAS software, and also some images were refined using Helicon Focus (version 5.3; www.heliconsoft.com) software from Helicon Soft Ltd. The images were edited in Adobe Photoshop CS3. For the illustrations, images were used as templates to trace vector graphics in Adobe Illustrator CS4 (version 14.0.0). The measurements are in millimeters and were taken under various magnifications using a Leica MZ AP0. Abbreviations: ALE — Anterior Lateral Eyes; AME — Anterior Median Eyes; cd — Copulatory ducts; el — Embolar lobe; Go — Gonopore; mb — Microbarbs; pg — Pore glands; PLE — Posterior Lateral Eyes; PME — Posterior Median Eyes; S — Spermathecae heads; Ue — Uterus externus.

TAXONOMY

Tangaroa Lehtinen 1967

Tangaroa Lehtinen 1967: 266. Type species *Uloborus tahitiensis* Berland 1934, by original designation.

Tangaroa vaka new species

Type Material.—**Holotype:** male from Cook Islands, Rarotonga, 21°13'57.9" S, 159°45'57.5" W, 15-18.I.1996, J. Boutin col., deposited in CAS. **Paratypes:** two males and three females, same data as holotype.

Etymology.—The specific epithet means “canoe” in the common language of the Polynesian Islands and it was an important transportation used by natives in Cook Islands. The vaka have a symbolic significance to the Polynesian society symbolizing the interconnectedness of the village, the sea, the Earth and the Heavens.

Diagnosis.—Males of this species are distinguished from other *Tangaroa* species by the first leg having three macrosetae in or adjacent to the ventral tibial notch (Figs. 1e, 9g), two prolateral femoral macrosetae, and five dorsal tibial macrosetae. Also differs from *T. dissimilis* and *T. beattyi* by



Figure 1.—*Tangaroa vaka* n. sp. a. female, dorsal view; b. male, dorsal view; c. femur IV, calamistrum, prolateral view, female; d. carapace, lateral view, male; e. femur I, distal crook (arrow), retrolateral view. Scale bars: a, b. 1 mm; c, d. 0.2 mm; e. 0.5 mm.

the rounder than ovoid tegulum (Figs. 3a, 9a); from *T. beattyi* by lacking a cymbial notch (Fig. 9a); and, from *T. pukapukan* n. sp., by lacking microbarbs on the embolus and lacking a lobe on base portion of the embolus (Fig. 9c, d, f). Females are characterized by having one prolateral and one retrolateral macrosetae on femur I, by the shape of the spermathecae and the interdistance between spermathecae being more than twice the spermathecae diameter (Fig. 2c, e). Also differs from *T. dissimilis* by having genital macrosetae (Fig. 2a); from *T. beattyi* by lacking an elongated pigmentation of the PME (Fig. 1a); and from *T. pukapukan* n. sp. by lacking a notch on the posterior margin of the epigynum (Fig. 2a).

Description.—**Male (holotype): Carapace:** Total length 3.58, carapace 1.20 long, 1.01 wide; yellow (Fig. 1b, d); shallow fovea. **Eyes:** AME on anterior elevation. Eye diameter: AME = PE, ALEs small pigment spots. Distance between eyes: AME–AME, 0.20; ALE–ALE, 0.40; PLE–PLE, 0.52; PME–

PME, 0.20; PME–PLE, 0.10; AME–ALE, 0.06. **Clypeus:** AME–clypeus, 0.18. **Mouthparts:** **Endites** with stridulatory file formed of about 16 rows of denticles (Fig. 7a–c); serrula present (Fig. 7d); 0.31 long, 0.25 wide; light yellow. **Labium** 0.22 long, 0.20 wide; light yellow. **Chelicerae** light yellow; cheliceral fang with teeth (Fig. 8a, b), and cheliceral groove smooth with two rows of teeth (Fig. 8h), 23 retrolateral teeth, 27 prolateral teeth (Fig. 8c, d). **Sternum:** 0.68 long, 0.58 wide; light yellow. **Pedipalp:** light yellow. **Legs:** Ventrolateral stridulatory picks on proximal portion of femur I (Fig. 6a, b); yellow; formula 1423; **I:** femur 2.48, patella 0.62, tibia 2.48, metatarsus 2.64, tarsus 1.00, total 9.22. **II:** 1.40, 0.48, 1.18, 1.28, 0.62, 4.96. **III:** 1.07, 0.31, 0.69, 0.86, 0.49, 3.42. **IV:** 1.74, 0.39, 1.30, 1.33, 0.81, 5.57. Calamistrum absent. **Abdomen:** 2.38 long, 1.13 wide; abdomen dorsally pale white, posterior and lateral margin with darker patches; ventrally pale white with genital area and spinnerets darker (Fig. 1b). **Palpus:** as in Fig. 3a–e; cymbium with two spines on distal margin

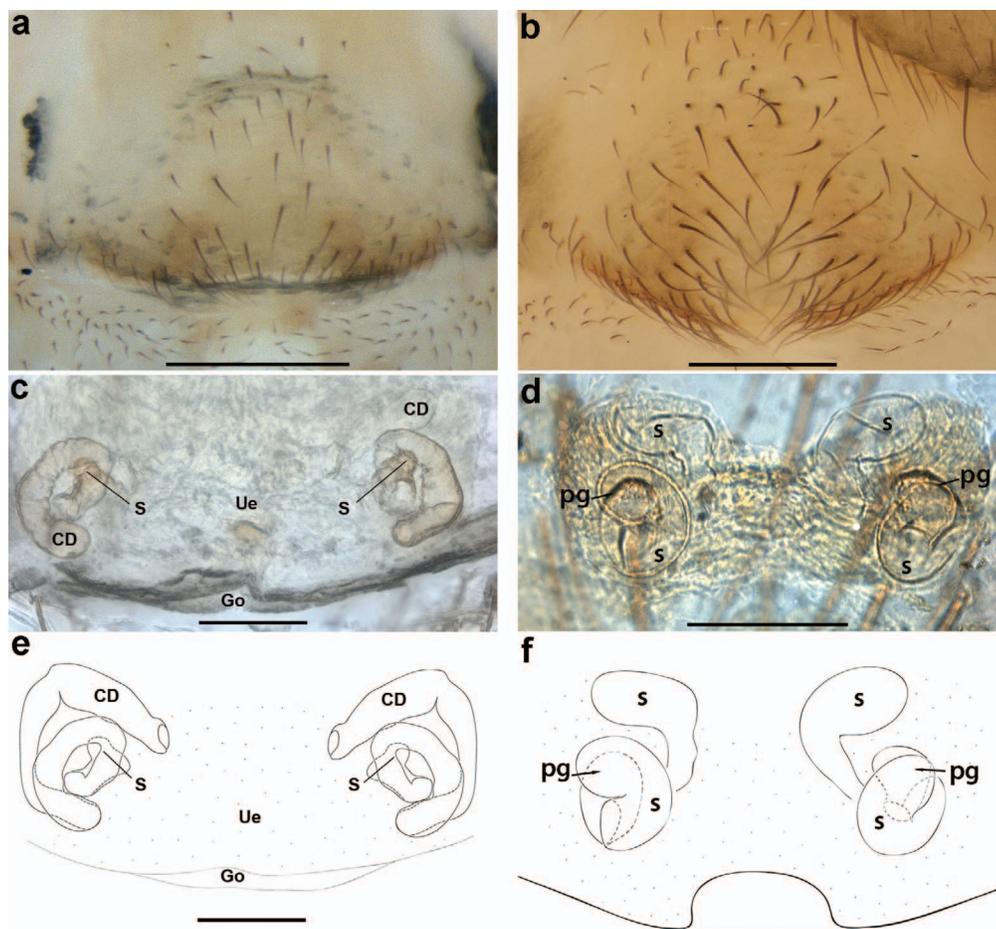


Figure 2.—a–c. *Tangaroa vaka* n. sp., female, epigynum. a. Ventral view; b. cleared, dorsal view; c. dorsal view. d–f. *Tangaroa pukapukan* n. sp., female, epigynum. d. Ventral view; e. cleared, dorsal view; f. dorsal view. Scale bars: a, 0.3 mm; b, c, e, f, 0.1 mm; d, 0.2 mm.

(Fig. 9b); embolus long and flattened, except at tip (Fig. 9f); not associated with a conductor, but the basal area in a tegular sulcus (Fig. 3a, d)

Female (paratype): Carapace: Total length 4.50, carapace 1.40 long, 1.02 wide; pale yellow with darker paramedian bands (Fig. 1a). Shallow fovea. **Eyes:** as in males, except AME not on anterior elevation. Distance between eyes: AME–AME, 0.20; ALE–ALE, 0.44; PLE–PLE, 0.60; PME–PME, 0.26; PME–PLE, 0.05; AME–ALE, 0.04. **Mouthparts: Endites** 0.34 long, 0.31 wide; light yellow. **Labium** 0.20 long, 0.23 wide; light yellow. **Chelicerae** as in male; pale yellow. **Sternum:** 0.74 long, 0.54 wide; yellow. **Pedipalp:** pale yellow; claw with ten teeth. **Legs:** pale yellow; formula 1423; **I:** femur 2.79, patella 0.71, tibia 2.60, metatarsus 2.72, tarsus 1.05, total 9.87. **II:** 1.63, 0.53, 1.18, 1.53, 0.75, 5.62. **III:** 1.30, 0.30, 0.83, 1.00, 0.58, 4.01. **IV:** 2.17, 0.53, 1.65, 1.70, 1.18, 7.23. Calamistrum present (Fig. 1c). **Abdomen:** 3.10 long, 1.49 wide; abdomen dorsally pale white with darker patches; lateral margin darker; ventrally pale white (Fig. 1a). **Epigynum:** no modification externally (Fig. 2a); one pair of weakly sclerotized, elongated and coiled spermathecae with two inconspicuous spermathecae heads and pores glands (Fig. 2c, e).

Variation.—Cephalothorax length: males ($n = 3$): 1.20–1.30; females 1.17–1.40. Total body length: males ($n = 3$): 3.31–3.71; females ($n = 2$): 4.07–4.50. Femur I, males ($n = 3$): 2.38–2.61; females ($n = 3$): 2.43–2.79.

Distribution.—Known only from Rarotonga, Cook Islands.

Tangaroa pukapukan new species

Type Material.—**Holotype:** male from Cook Islands, Mitiaro, 19°52'45.1" S, 157°42'23.1" W, 19–21.I.1996, J. Boutin col., deposited in CAS. **Paratypes:** three males and three females, same data as holotype.

Etymology.—The specific name refers to one of the spoken languages in the Cook Islands.

Diagnosis.—Males are distinguished from other *Tangaroa* species by the distal crook strongly marked (Fig. 10c), embolus with three microbarbs (Fig. 10d–f), the basal portion of the embolus with a lobe (Fig. 10a, b) and first leg having three or four macrosetae in or adjacent to the ventral tibial notch (Fig. 4e), two prolatateral femoral macrosetae and five dorsal tibial macrosetae. Also differs from *T. beattyi* by lacking a cymbial notch. Females are characterized by having a notch on the posterior margin of the epigynum (Fig. 2b, f),

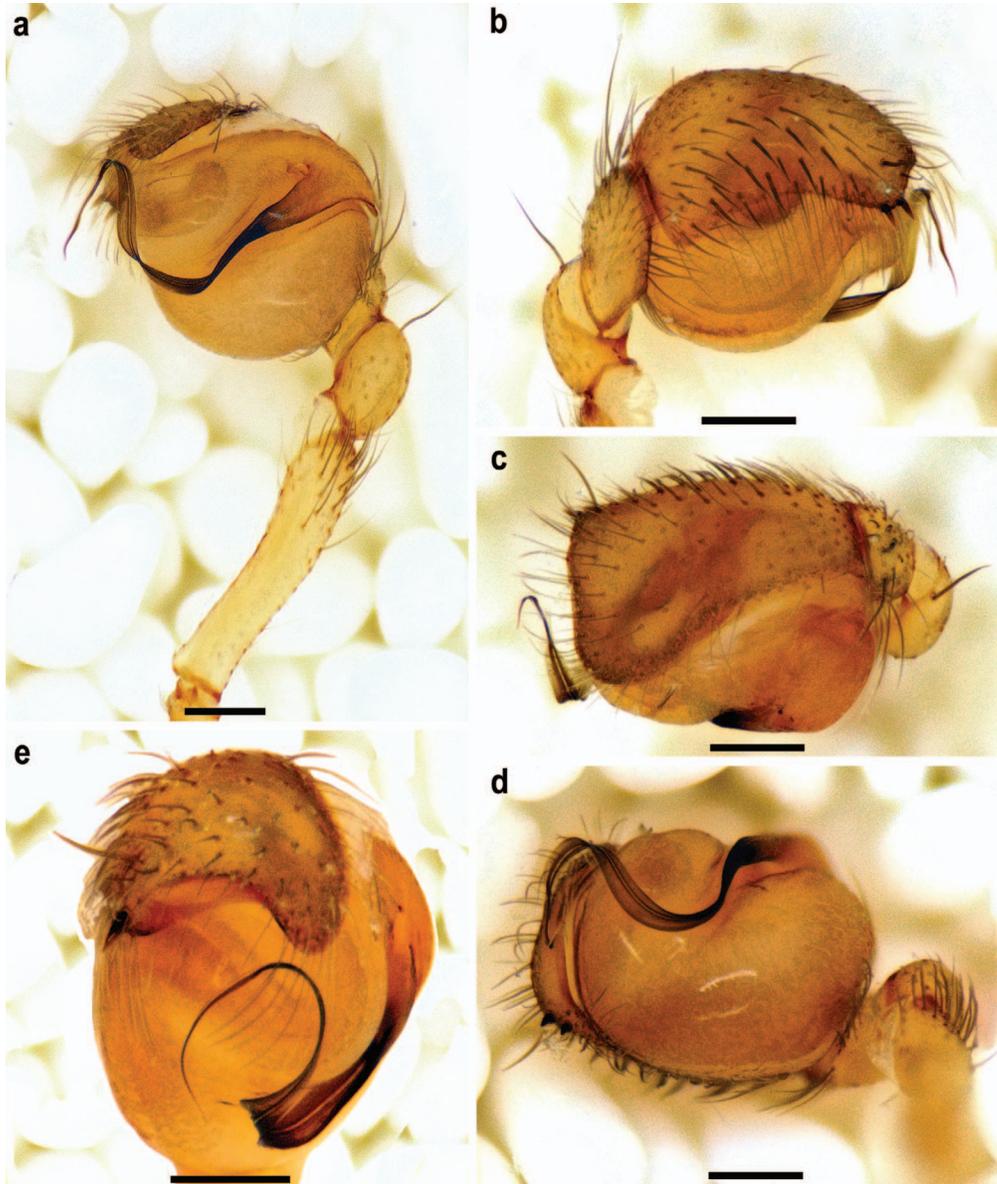


Figure 3.—*Tangarao vaka* n. sp., palp. a. Prolateral view; b. retrolateral view; c. dorsal view; d. ventral view; e. frontal view. Scale bars, 0.2 mm.

by the shape of the spermathecae (Fig. 2d, f) and one prolateral and two retrolateral macrosetae on femur I. Also differs from *T. dissimilis* by having genital macrosetae; differs from *T. beattyi* by the absence of an elongated pigmentation of the PME's.

Description.—**Male (holotype): Carapace:** Total length 3.20, carapace 1.20 long, 1.00 wide; pale yellow (Fig. 4b); shallow fovea. **Eyes:** AME on anterior elevation. Eye diameter: AME = PE, ALEs small pigment spots. Distance between eyes: AME–AME, 0.20; ALE–ALE, 0.39; PLE–PLE, 0.56; PME–PME, 0.20; PME–PLE, 0.08; AME–ALE, 0.08. **Clypeus:** AME–clypeus, 0.16. **Endites** with stridulatory file formed of about 16 rows of denticles (Fig. 7e–h); serrula present

(Fig. 7g); 0.33 long, 0.25 wide; light yellow. **Labium** 0.23 long, 0.21 wide; light yellow. **Chelicerae** light yellow; cheliceral fang with teeth (Fig. 8e); cheliceral groove smooth with two rows of teeth, 25 retrolateral teeth, 24 prolateral teeth (Fig. 8g, h). **Sternum:** 0.63 long, 0.53 wide; pale yellow. **Pedipalp:** pale yellow. **Legs:** Ventrolateral stridulatory picks on proximal portion of Femur I (Fig. 6c–f); pale yellow; formula 1423; **I:** femur 2.00, patella 0.58, tibia 2.02, metatarsus 2.05, tarsus 0.90, total 7.55. **II:** 1.15, 0.45, 1.00, 1.05, 0.55, 4.20. **III:** 0.80, 0.25, 0.60, 0.75, 0.48, 2.88. **IV:** 1.33, 0.40, 1.13, 1.08, 0.83, 4.77. Calamistrum absent. **Abdomen:** 2.00 long, 1.00 wide; abdomen dorsally pale white, posterior and lateral margin with darker patches; ventrally pale white with genital area and spinnerets

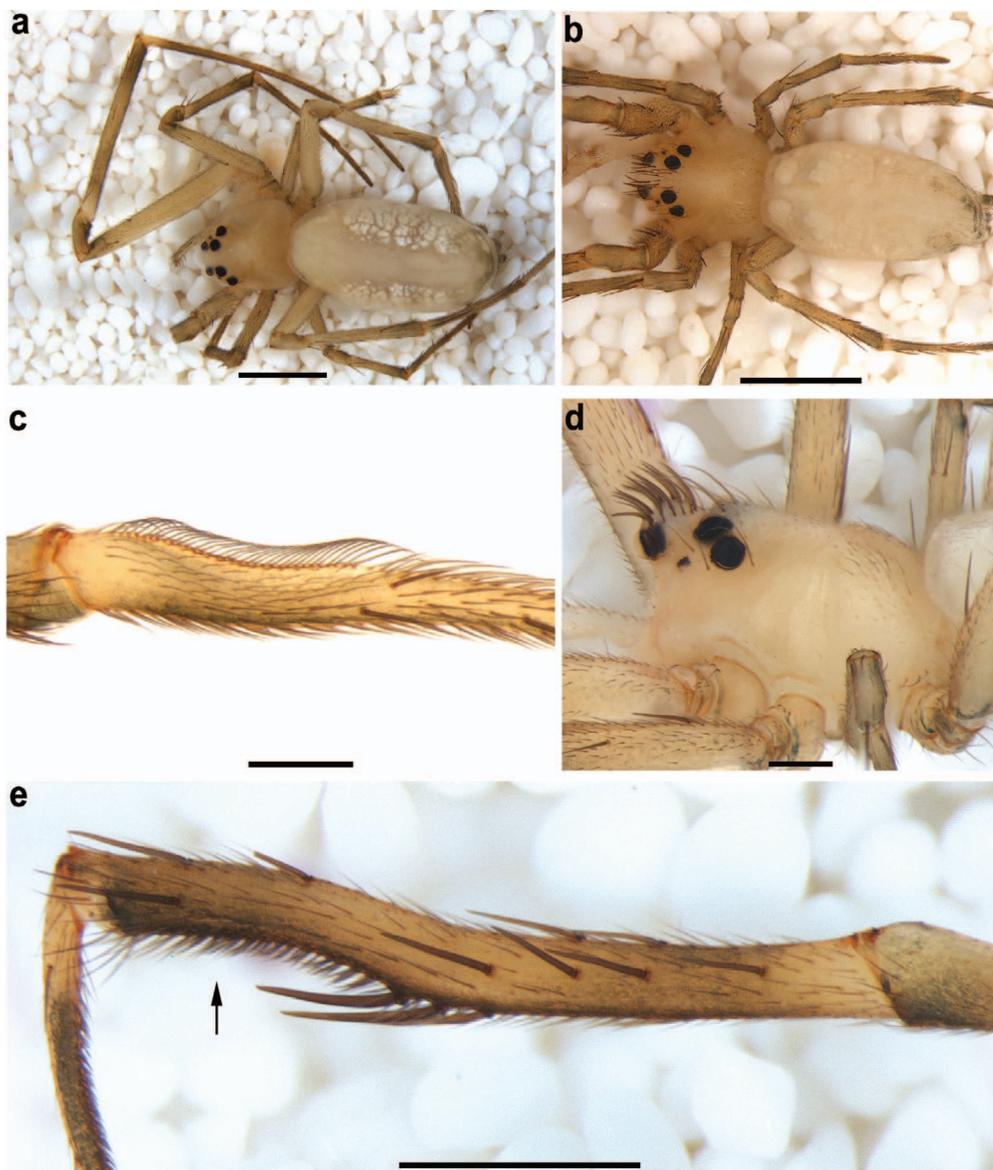


Figure 4.—*Tangaroa pukapukan* n. sp. a. Dorsal view, female; b. dorsal view, male; c. femur IV, calamistrum, prolateral view, female; d. carapace, lateral view, male; e. femur I, distal crook (arrow), retrolateral view. Scale bars: a, b, 1 mm; c, d, 0.2 mm; e, 0.5 mm.

darker (Fig. 4b). **Palpus:** as in Figs. 5a–e and 10a, b, d–h; cymbium longer than wide, with two spines on distal margin (Fig. 5b); embolus long and flattened, with tip coiled and enlarged base (Fig. 10g, h), not associated with a conductor, but the basal area in a tegular sulcus (Fig. 5d, e).

Female: Carapace: Total length 4.76, carapace 1.25 long, 1.05 wide; pale yellow (Fig. 4a); Shallow fovea. **Eyes:** as in males, except AME not on anterior elevation. Distance between eyes: AME–AME, 0.19; ALE–ALE, 0.45; PLE–PLE, 0.59; PME–PME, 0.25; PME–PLE, 0.11; AME–ALE, 0.05. **Mouthparts:** Endites 0.31 long, 0.26 wide; light yellowish green. Labium 0.25 long, 0.24 wide; dark yellowish green. **Chelicerae** as in male, 28 retrolateral teeth and 32 prolateral teeth (Fig. 8g, h); pale yellow. **Sternum:** 0.81 long, 0.56 wide;

pale yellow with margin darker. **Pedipalp:** pale yellow; claw with ten teeth. **Legs:** pale yellow; formula 1423; **I:** femur 2.54, patella 0.68, tibia 2.45, metatarsus 2.54, tarsus 0.96, total 9.17. **II:** 1.30, 0.50, 1.13, 1.18, 0.63, 4.74. **III:** 1.25, 0.38, 0.75, 0.95, 0.58, 3.91. **IV:** 1.80, 0.50, 1.50, 1.33, 0.88, 6.01. Calamistrum present (Fig. 4c). **Abdomen:** 3.51 long, 2.02 wide; abdomen dorsally pale white; white guanine spots scattered throughout length dorsally/laterally; lateral margin pale white; ventrally pale white (Fig. 4a). **Epigynum:** no modification externally (Fig. 2b); one pair of weakly sclerotized, elongated spermathecae with two conspicuous spermathecae heads and pores glands (Fig. 2d, f).

Variation.—Ocular macrosetae varies from 27 to 38 in males. Carapace length, males ($n = 4$): 1.20–1.25; females

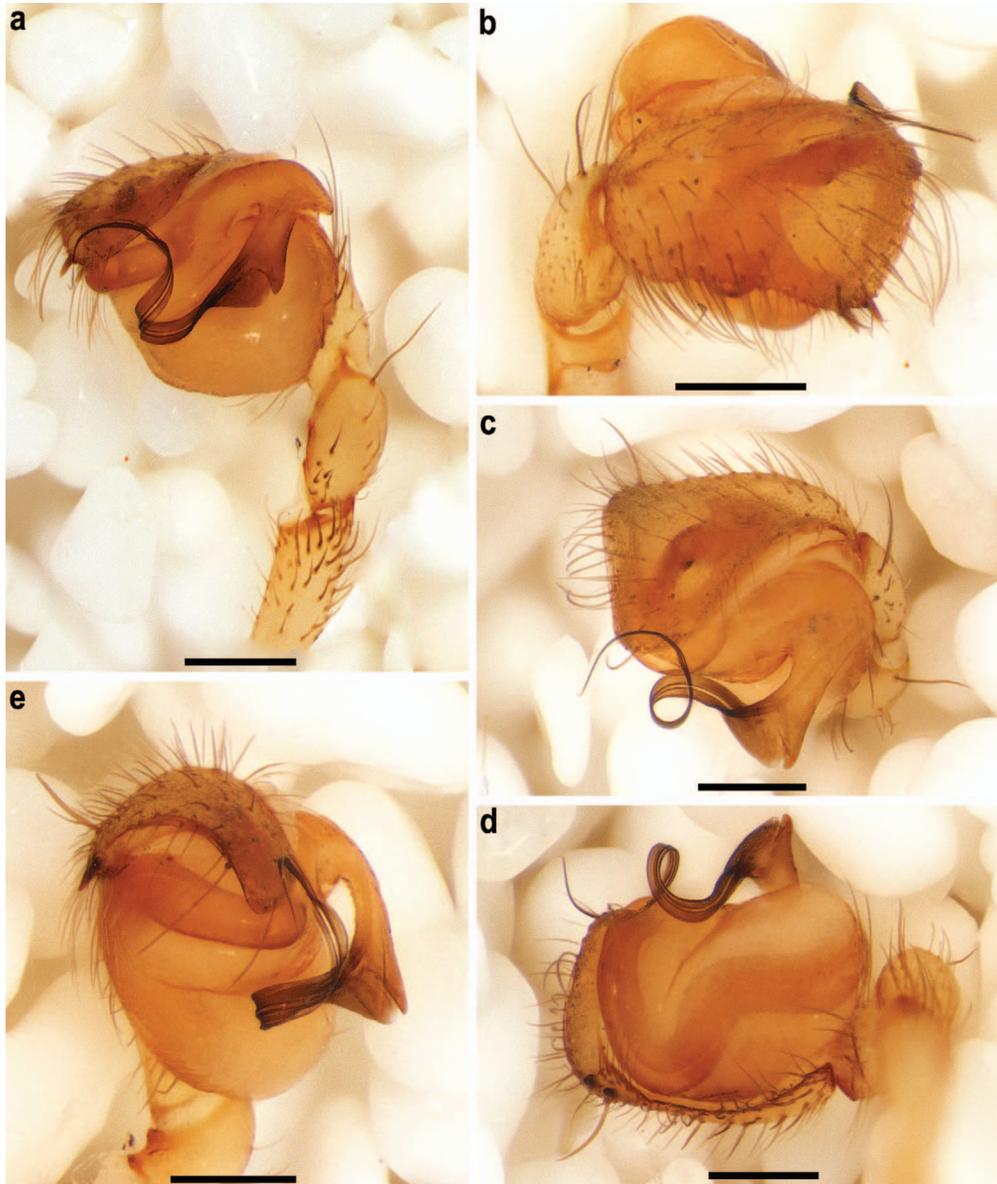


Figure 5.—*Tangaroa pukapukan* n. sp., palp, cleared. a. Prolateral view; b. retrolateral view; c. dorsal view; d. ventral view; e. frontal view. Scale bars: a–e, 0.2 mm.

($n = 3$): 1.15–1.25. Total body length, males ($n = 4$): 3.19–3.35; females ($n = 3$): 3.92–4.90. Femur I, males ($n = 4$): 2.00–2.15; females ($n = 3$): 2.50–2.57.

Distribution.—Known only from Mitiaro, Cook Islands.

DISCUSSION

The morphology of the genitalia of both *Tangaroa vaka* and *T. pukapukan* is typical for the *Tangaroa* species with an elongated tubule with two distinctive spermathecae heads with pore glands in the middle portion of the tubule and close to the copulatory ducts (Opell 1983). Opell (1983) briefly discussed the hypothesis about the dynamics of sperm

storage using histological section observations in *Tangaroa* species.

It is known that spider sperm are non-motile at copulation time (Baccetti et al. 1970), and that males are prevented from directly depositing sperm into the storage sacs by the length and width of the insemination duct, and also by its own organ size (Watson 1991; Huber 1993). It is also known that lengthening the duration of copulation is a form of fertilization strategy, since sperm release can be time-dependent (Watson & Lighton 1994; Szirányi et al. 2005) and the advantage in fertilization goes to the male with the greatest number of sperm within the female's reproductive



Figure 6.—a. *Tangaroa vaka* n. sp., male. frontal view; b. stridulatory picks on femur I; c. *Tangaroa pukapukan* n. sp., male. frontal view; d. stridulatory picks on femur I; e. same; f. detail of a stridulatory pick. Scale bars: a, 0.5 mm; b–d, 0.2 mm; e, 0.02 mm; f, 0.01 mm.

tract and how close the sperm are to the fertilization duct (Uhl & Vollrath 1998).

In the males of *Tangaroa*, the embolus of the male is quite long, which might be an advantage during the insemination. The length of the embolus could help the initial transport of the sperm inside the genitalia ducts by providing a deeper release of the sperm into the female receptacles. Also the lack of a conventional conductor might help to produce a deep insertion. This might reduce the need of a time-consuming copulation. The strategy of a deep release of the sperm suggests that the internal transport of the sperm in *Tangaroa* is not completely dependent on the female.

In addition, microbarbs were observed along the middle portion of the embolus in males of *T. pukapukan* (Fig. 10d–h), which may function as anchors during mating, to aid the male in staying attached to the female. Studies regarding the courtship and mating behavior (female resistance behaviors, intrasexual competition and postcopulatory function of genitalia) of *Tangaroa* species are needed to identify the function of the microbarbs.

Also, some slight differences in the stridulatory apparatus of the two new species and *T. beattyi* were observed. In *T. vaka* (Fig. 7b) the ridges of the stridulatory apparatus are twice as wide and more numerous, with a difference of four to six more

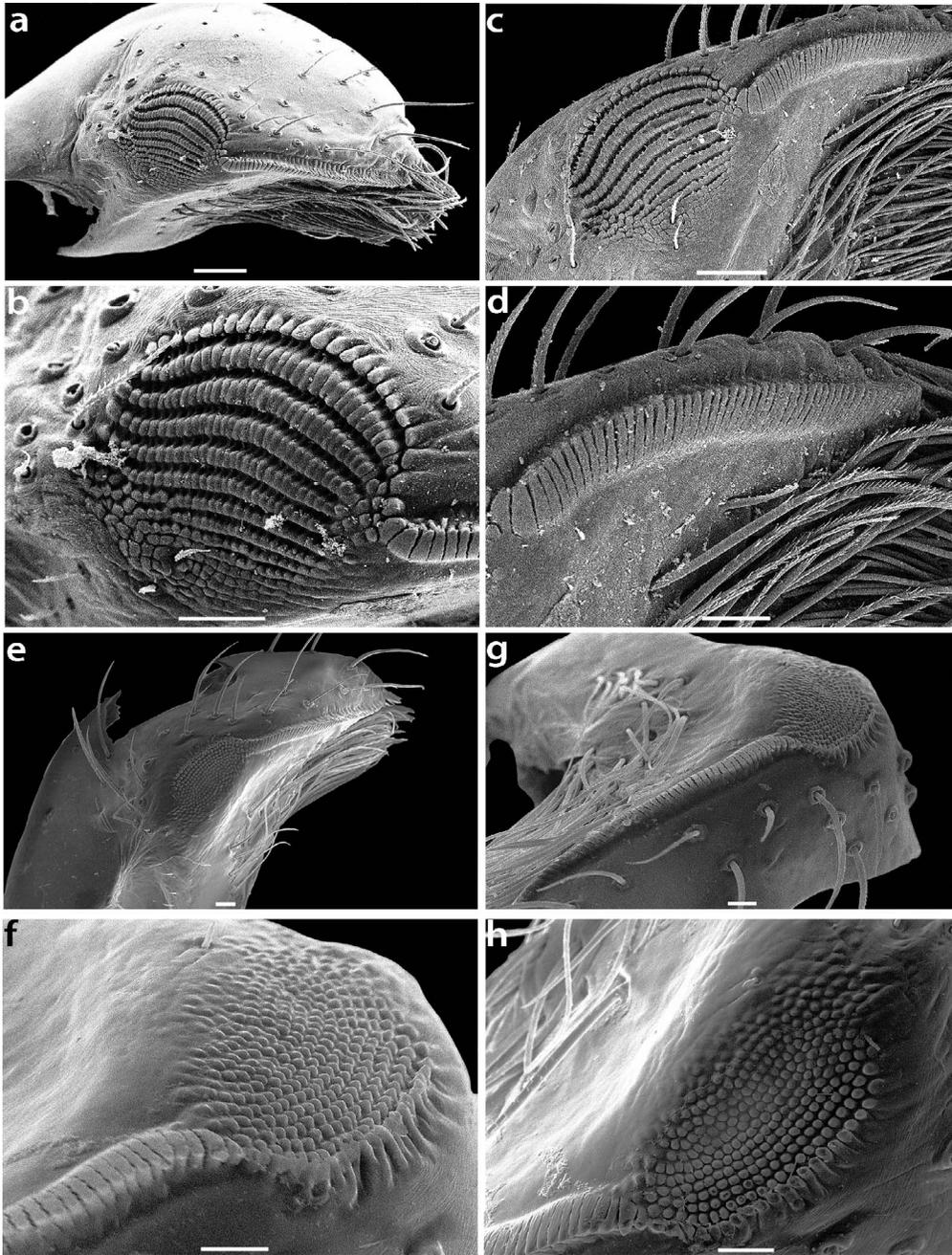


Figure 7.—a–d. *Tangaroa vaka* n. sp., male, endite. a. Endite, dorsolateral view; b. details of stridulatory file; c. stridulatory file and serrula, dorsal view; d. details of serrula. Scale bars: a, 0.04 mm; b, d, 0.02 mm; c, 0.03 mm. e–h. *Tangaroa pukapukan* n. sp., male, endite. e. Endite, dorsolateral view; f–g. stridulatory file and stridulatory file, dorsolateral view; h. details of stridulatory file, dorsal view. Scale bars: e–h, 0.01 mm.

ridges per line than in *T. pukapukan* (Fig. 7f–h) and, a difference of three to seven fewer ridges per line in *T. beattyi* (Opell 1983: fig. 1). The form of the ridges is similar in *T. pukapukan* and *T. beattyi*. The number of stridulatory rows varies from 13 in *T. pukapukan*, 14 in *T. vaka* and 17 in *T. beattyi*.

On the prolateral portion of the femur I on males of both new species a series of modified distal setae are present (Fig. 6a–d). The SEM images of these setae show that they are a wide, thickened, unilaterally and strongly barbed, spatulate type of setae (Fig. 6e, f). These setae might also act as a scraper. The plectrum in *Tangaroa* species was suggested by

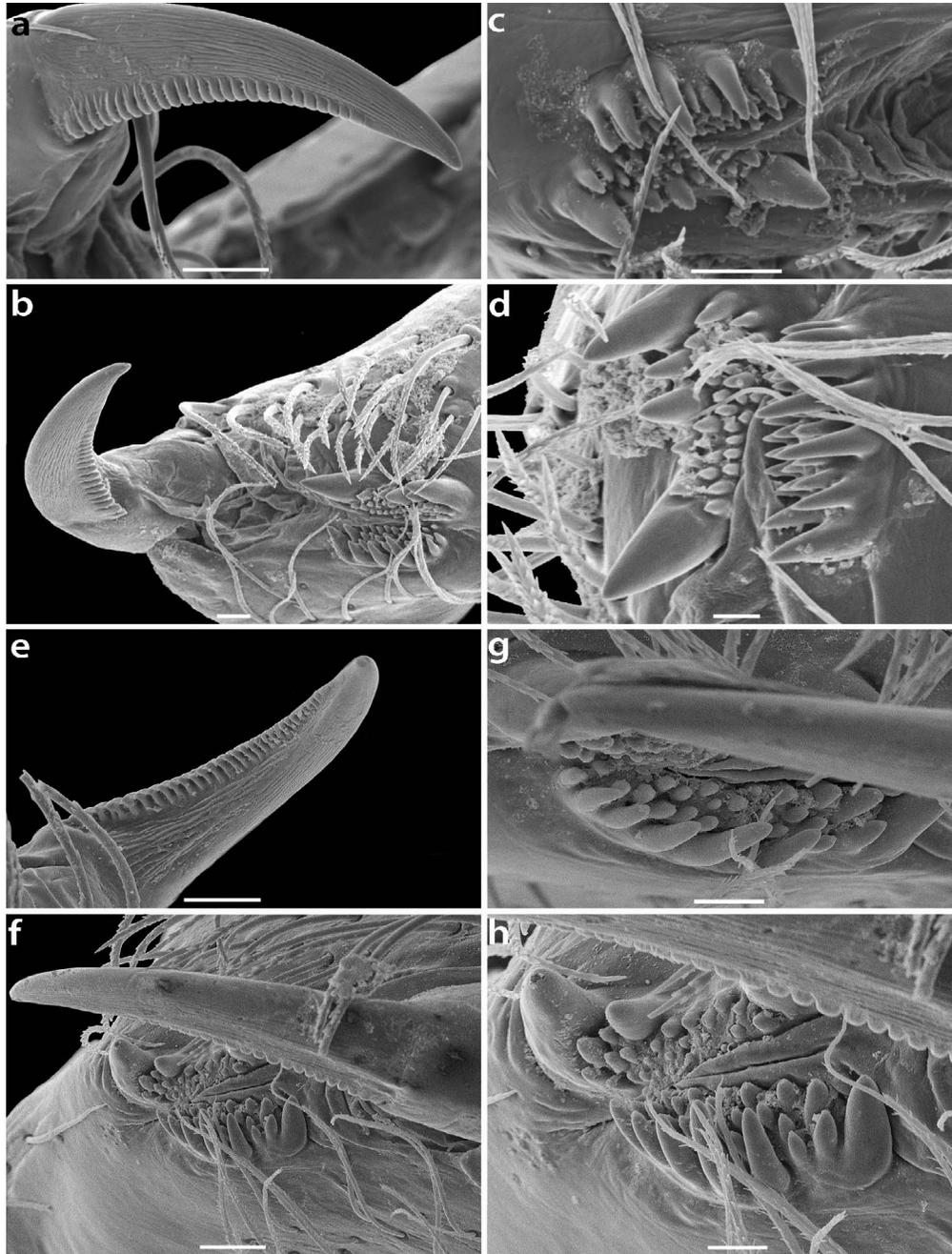


Figure 8.—a–d. *Tangaroa vaka* n. sp., chelicerae. a. Dorsal view; b–d. details of cheliceral teeth. e–f. *Tangaroa pukapukan* n. sp., chelicerae. e. Retrolateral view; f–h. details of cheliceral teeth. Scale bars: a–h, 0.02 mm.

Opell (1983) to be the setal picks on the cymbium and it is present in both new species.

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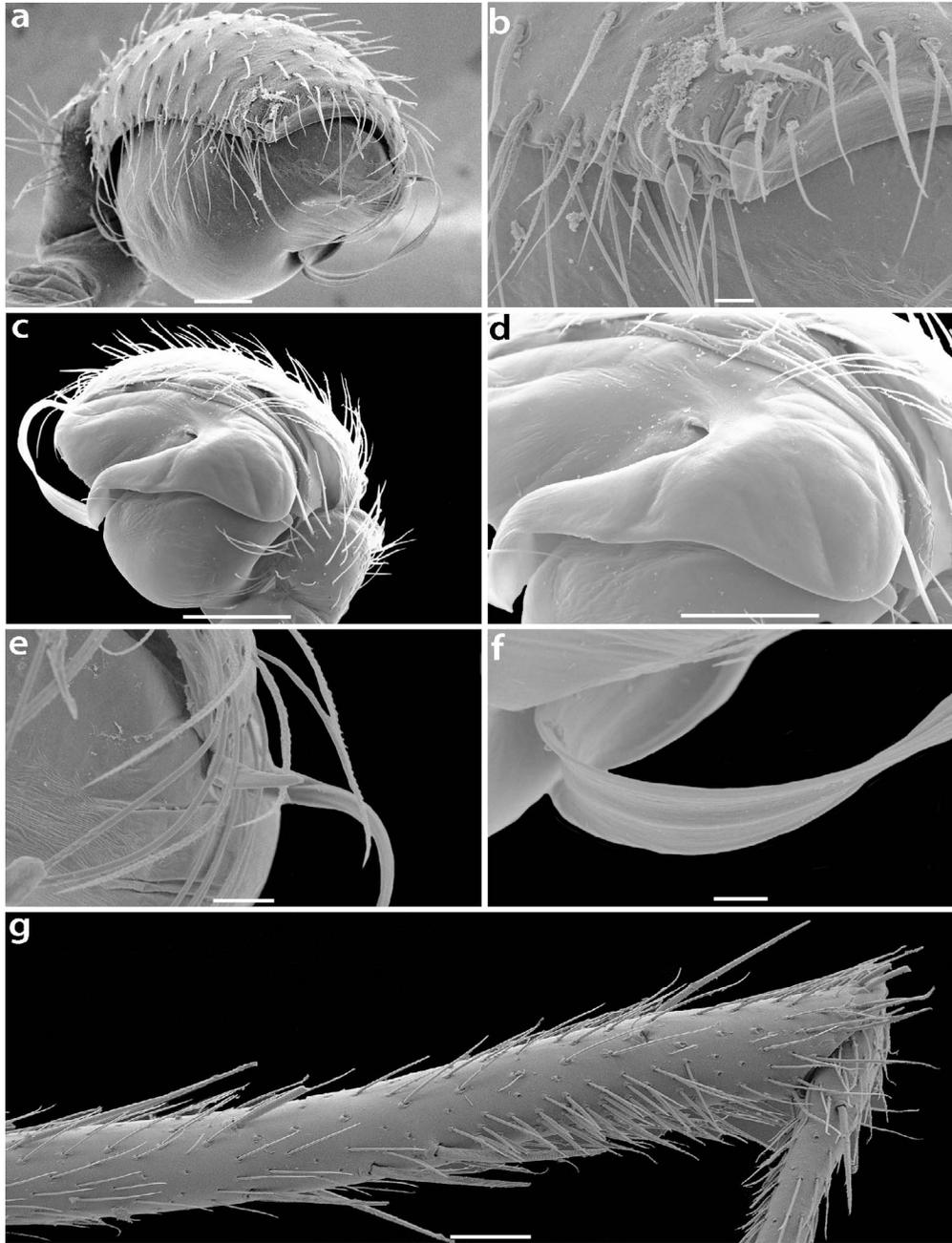


Figure 9.—*Tangaroa vaka* n. sp., palp, male. a. Retrolateral view; b. cymbial spines; c. prolateral view; d. distal portion of embolus; e. apical portion of embolus; f. median portion of embolus; g. femur I, distal crook, retrolateral view. Scale bars: a,d,g, 0.1 mm; b, e, f, 0.02 mm; c, 0.2 mm.

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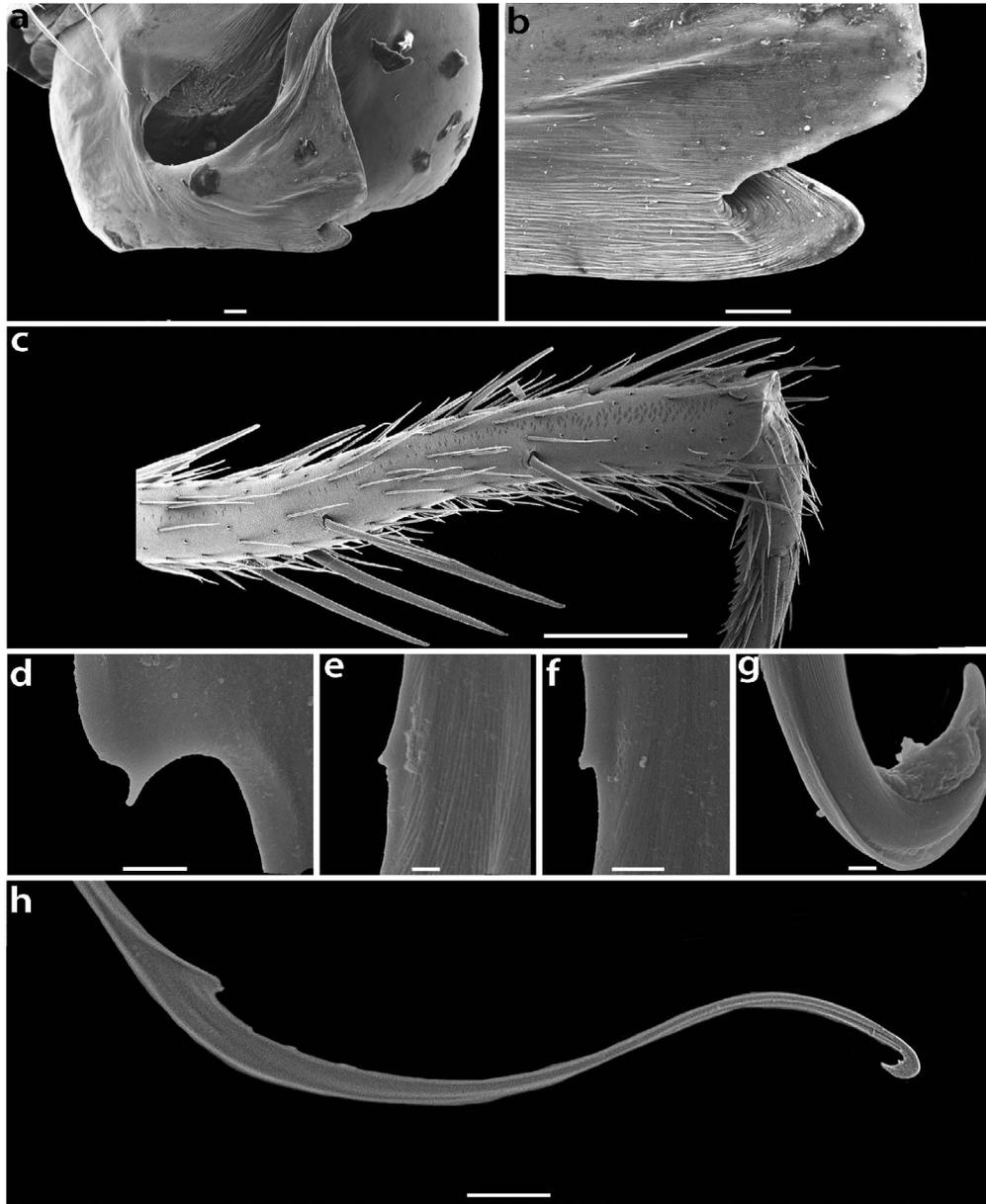


Figure 10.—a–c. *Tangaroa pukapukan* n. sp., palp. a. Distal portion of embolus; b. details of distal portion of embolus; c. femur I, distal crook, retrolateral view. d–h. *Tangaroa pukapukan* n. sp., palp, male. d–f. Microspines of embolus; g. apical portion of embolus; h. embolus. Scale bars: a, c–g, 0.02 mm; b, h, 0.01 mm.

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