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HAWAIIAN SPIDERS OF THE GENUS *TETRAGNATHA*: III. *TETRAGNATHA ACUTA* CLADE

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ABSTRACT. This study continues documentation of the species radiation of the genus *Tetragnatha* in the Hawaiian archipelago. The *T. acuta* clade comprises four known species which are characterized by pointed abdomens, with strong patterns of black on white or brown/gray accentuating the dorsal peak. They tend to specialize on habitats (such as exposed ridges, lava rock and dry forest) which appear to be unfavorable to their congeners. Three new species are described in this clade; and the morphology, ecology and distribution of representatives are compared.

The Hawaiian Islands are characterized by exceptionally high numbers of species representing very few species groups (Simon 1987) and provide some of the best illustrations of such species swarms including both animals (e. g., drepaniid honeycreepers [Freed et al. 1987], land snails [Cooke et al. 1960], crickets [Otte 1989], and *Drosophila* [Carson & Kaneshiro 1976; Kaneshiro & Boake 1987]) and plants (e. g., silverswords and their relatives [Carr 1987]). Several groups of spiders have undergone species radiations in the islands, yet little is known of the extent or nature of these radiations. In particular, three genera are known to be exceptionally diverse in the Hawaiian archipelago: *Tetragnatha* (Tetragnathidae [Karsch 1880; Simon 1900; Okuma 1988; Gillespie 1991, 1992]), *Theridion* (Theridiidae [Simon 1900]) and *Mecaphesa* (Thomisidae [Simon 1900; Suman 1970; Lehtinen 1993]). Many representatives of these groups remain undescribed, and analyses of patterns of phylogeny have only recently been initiated (Gillespie 1993; Gillespie et al. 1994).

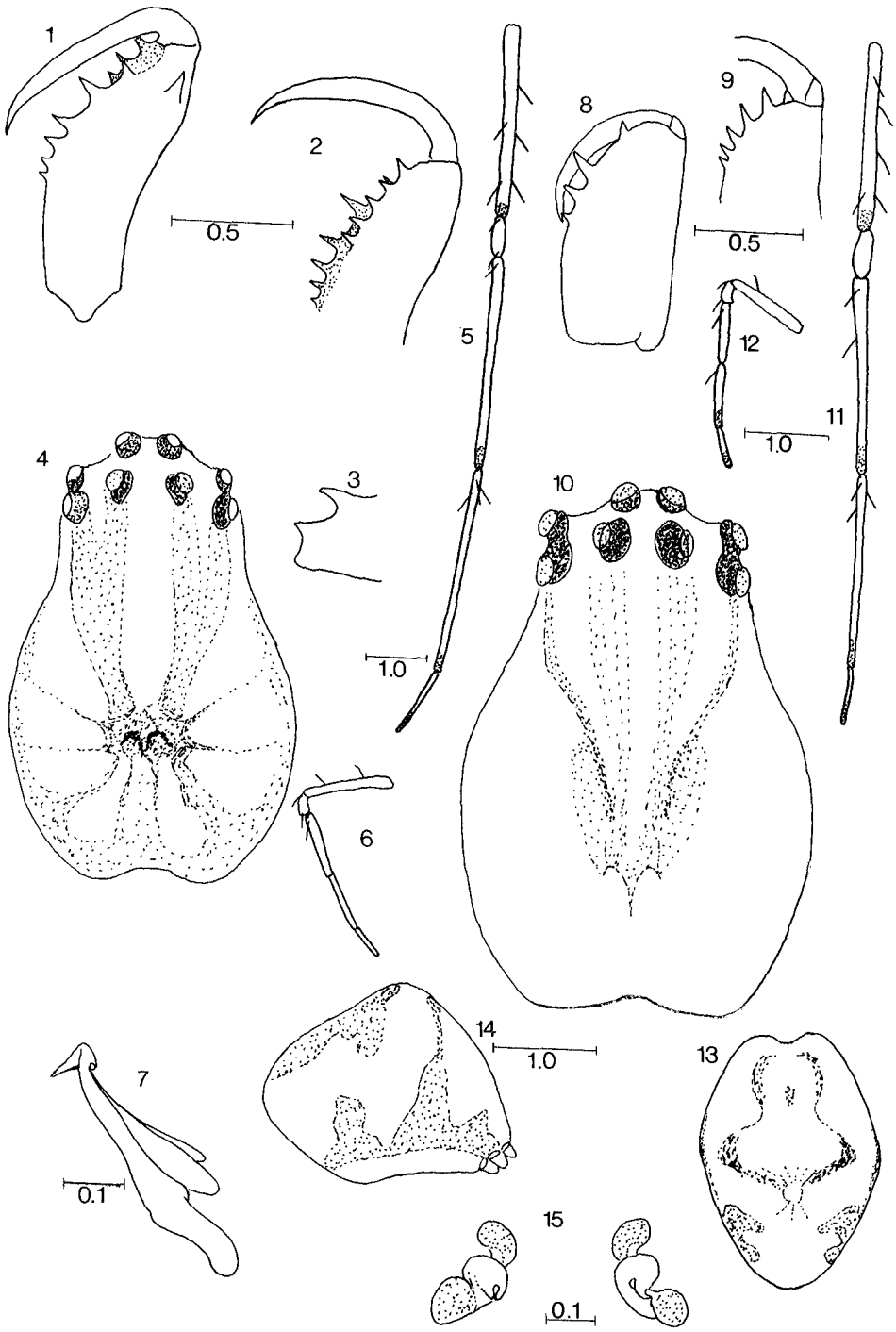
This paper is the third in a series documenting the radiation of *Tetragnatha* spiders in the archipelago. The species described in the present paper are distinct in shape and pattern of the abdomen and carapace and the shape of the palpal conductor. The abdomen is drawn up to a peak, the depth sometimes even equaling the length (Figs. 14, 29, 38); the pattern on the abdomen consists of distinctive black marks on a gray, or creamy white, background. The palpal conductor is very similar in shape in all species, consisting of a simple cap (Figs. 7, 22, 39, 45–47). The leg macrosetae are short, unlike representatives of the 'spiny leg' clade (Gillespie 1991); and individuals build the small, flimsy webs characteristic of the genus *Tetragnatha*. In addition, the spiders tend to specialize on particular habitats, where they may be locally abundant. These habitats include dry forest for *T. albida* new species, exposed lava rock, craggy ridges and wet bogs for *T. acuta* Gillespie, and exposed cliffsides for *T. maka* new species.

METHODS

Characters examined.—Measurements were taken of eye separation; cheliceral tooth pattern; form and setation of the first and third legs (I and III representing the greatest divergence in leg function); and form and pattern of the dorsum, venter, carapace, and sternum. In order to estimate variability within a taxon and determine which features best characterize a species, I attempted to measure at least six individuals of each sex of each species with additional observations on other individuals once diagnostic characters had been identified. Genitalia of both sexes were examined using the methods described in Gillespie (1991).

Terminology.—The terminology for the teeth on the cheliceral margins of the males is that used in previous papers (Gillespie 1991, 1992; see Okuma 1987, 1988). CITR (cheliceral inter-tooth ratio) is the ratio of lengths between the distal end of the male chelicerae to sl: sl to T: T to rsul. Setation on the legs of females is given for femur I (fI), tibia I (tI), and metatarsus I (mI) using the format: *n/n/n* for the numbers of prolateral/dorsal/retrolateral macrosetae. Setation is also given for femur III (fIII), tibia III (tIII), and metatarsus III (mIII).

Most of the specimens were collected by the



Figures 1–15.—***Tetragnatha maka*** new species, 1–7, male holotype; and 8–15, female allotype. *Male:* 1. Promargin of right chelicera; 2. Retromargin of left chelicera; 3. Dorsal spur of chelicera, lateral view; 4. Carapace, dorsal; 5. Right leg I, dorsal; 6. Right leg III, prolateral; 7. Left palpus, prolateral. *Female:* 8. Promargin of right chelicera; 9. Retromargin of left chelicera; 10. Carapace, dorsal; 11. Right leg I, dorsal; 12. Right leg III, prolateral; 13. Abdomen, dorsal; 14. Abdomen, lateral; 15. Seminal receptacles, ventral. Scale bar (mm) at Fig. 2 applies to Figs. 1–4; at Fig. 5 to Figs. 5, 6; at Fig. 9 to Figs 8–10; at Fig. 12 to Figs. 11, 12; and at Fig. 14 to Figs. 13, 14.

author (RGG), A. C. Medeiros (ACM), C. Parrish (CP), W. D. Perreira (WDP), D. J. Preston (DJP), and George K. Roderick (GKR). All holotypes are in the Bishop Museum, and all paratypes are currently in the author's collection.

Tetragnatha maka new species
(Figs. 1–15)

Types.—Holotype male, allotype female from Kalalau Overlook, 4280 ft (1300 m), Kauai Island (7 May 1992), (R. G. Gillespie & D. J. Preston), deposited in the Bishop Museum, Honolulu.

Etymology.—The specific epithet, a noun in apposition, is the Hawaiian word meaning 'point', and refers to the shape of the abdomen of these spiders.

Diagnosis.—*Tetragnatha maka* could be confused with *T. acuta*. Both sexes are readily diagnosed by the lack of leg macrosetae on tibia I (prolateral, dorsal, retrolateral 0, 1, 1, as compared to 3, 2, 3 in *T. acuta*). The spiders are small, with a distinct pattern on the carapace. The cheliceral armature is distinct from all other species in the group.

Description.—*Holotype male:* (Figs. 1–7). Chelicerae about two-thirds carapace length. Cheliceral fang slightly shorter than base, bent over at both proximal and distal ends. Promargin of chelicerae (Fig. 1): distance between Gu and s1 slightly greater than between s1 and T, CITR 4:3:3; Gu indistinct or absent; s1 small point, projecting directly out from margin, width 35% length (approximately half width and height of T); T quite short, robust peak; rsu four straight spikes. Retromargin of chelicerae (Fig. 2): total of 4–5 teeth; AX1 tiny and indistinct; G1 robust, slightly larger than rest of teeth on retromargin. Dorsal spur short (9% carapace length), tip bluntly pointed (Fig. 3). Length of carapace 1.7 mm (1.6–1.8), total length 4.0 mm (Fig. 4). Thoracic fovea two semicircular depressions with black markings radiating toward lateral, proximal and distal margins. Coloration and eye pattern as in female. Abdomen with indistinct medial tubercle. Leg setation similar to female (Figs. 5, 6). *Conductor tip:* (Fig. 7). Conductor cap simple, not highly peaked, with small backward flange; apex blunt.

Allotype female: (Figs. 8–15). Chelicerae just less than half length of carapace. Cheliceral fang quite short (approximately half length of base), tapering to smooth point distally. Promargin of chelicerae (Fig. 8): series of 4–5 teeth; U1 robust, slightly narrower, much shorter (< half) and well separated from (12% cheliceral length) U2 and U3; U2 slightly larger than U3; U4–U6 decreasing in size proximally. Retromargin of chelicerae (Fig. 9): series of five teeth decreasing in size proximally: L1 similar in height to U1 and L2 and slightly separated from L2. Length of carapace 2.4 mm, total length 4.8 mm. Eyes larger than distance separating them; median ocular area slightly wider posteriorly (Fig. 10); lateral eyes contiguous. Carapace brown with double fovea consisting of two broken semicircles, and with dark markings radiating towards ocular area; sternum dusky dark. Abdomen raised to peak at midline, height 1.8 mm; dorsum brown with black marks accentuating medial protuberance (Fig. 13, 14); venter brown with medial dark, longitudinal bar. Legs brown with dark bands at distal margins of each joint (Figs. 11, 12). Leg setation: fI 3/2/0; tI 0/1/1; mI 1/1/1; fIII with no ventral, and tIII and mIII without prolateral, macrosetae.

Seminal receptacles (Fig. 15): lobes compact, medial area forming a tight coil.

Natural History.—*Tetragnatha maka* builds webs almost exclusively in small dwarf trees, particularly Ohia (*Metrosideros polymorpha*), on precipitous windswept mountain ledges in wet-to-mesic forest on west Kauai.

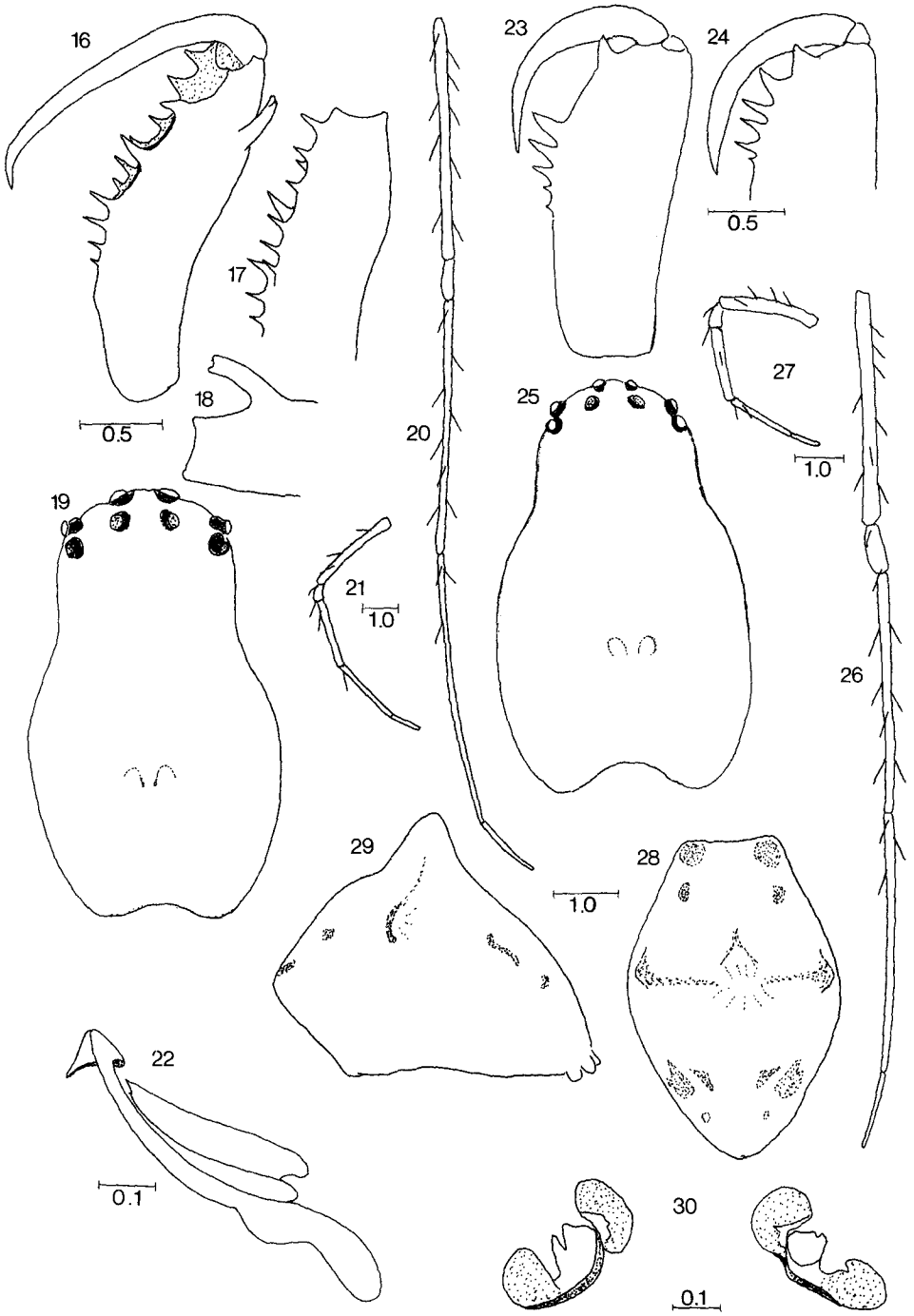
Paratypes.—*Kauai Island*, on the upper lips of the Waimea Canyon 1040 m, 1♂1♀, 27 July 1990 (RGG & CP); rim of Kalalau Overlook 1300 m, 2♂2♀, 7 May 1992 (RGG & DJP); Waialae-Mohihi Trail, DOFAW transect 5, station 8, 1200 m, 1♀, 28 February 1990 (RGG & CP); Mohihi Ditch, 1070 m, 3♀, 17 February 1991 (RGG & GKR); Milolii Trail, Kuia Natural Area Reserve, 600 m, 1♀, 19 February 1991 (RGG & GKR).

Tetragnatha albida new species
(Figs. 16–30, 45)

Types.—Holotype male, allotype female from Maui, Auwahi, 4100 ft (1250 m), Maui Island, 12 May 1990 (R. G. Gillespie & A. C. Medeiros), deposited in the Bishop Museum, Honolulu.

Etymology.—The specific epithet is the Latin word meaning 'whitish', and refers to the green-tinged white coloration of these spiders.

Diagnosis.—*Tetragnatha albida* could be confused with *T. acuta*. Both sexes are readily diagnosed by their coloration and eye pattern. The carapace, abdomen, and legs are white with a slight tinge of green in life (creamy yellow in alcohol), and only the abdomen carries the dis-



Figures 16–30.—***Tetragnatha albida*** new species, 16–22, male holotype; and 23–30, female allotype. 16. Promargin of right chelicera; 17. Retromargin of left chelicera; 18. Dorsal spur of chelicera, lateral view; 19. Carapace, dorsal; 20. Right leg I, dorsal; 21. Right leg III, prolateral; 22. Left palpus, prolateral. *Female:* 23. Promargin of right chelicera; 24. Retromargin of left chelicera; 25. Carapace, dorsal; 26. Right leg I, dorsal; 27. Right leg III, prolateral; 28. Abdomen, dorsal; 29. Abdomen, lateral; 30. Seminal receptacles, ventral. Scale bar (mm) at Fig. 16 applies to Figs. 16–19; at Fig. 21 to Figs. 20, 21; at Fig. 24 to Figs. 23–25; at Fig. 27 to Figs. 26, 27; and at Fig. 28 to Figs. 28, 29.

tinctive black pattern characteristic of the group. The lateral and median eyes are separated by more than the width of the eyes (separation much less than eye width in *T. acuta*). Tibia I has 3 prolateral, 2 dorsal, 3 retrolateral macrosetae. *Tetragnatha albida* could also be confused with *T. kea* (diagnostic characters given below).

Description.—*Holotype male*: (Figs. 16–22). Chelicerae shorter (85%) than length of carapace. Cheliceral fang slightly shorter than base, bent over at both proximal and distal ends. Promargin of chelicerae (Fig. 16): distance between Gu and sl slightly greater than between sl and T, CITR 4:3:3; Gu a distinct finger; sl robust, sharply angled down towards proximal margin of chelicerae, width about half length (approximately same width and 60% height of T); T tall, quite wide, bent slightly up toward distal margin of chelicerae; rsu 4–6 straight spikes. Retromargin of chelicerae (Fig. 17): total of 5–8 teeth; AX1 tiny notch; G1 and rest of teeth on retromargin of chelicerae all quite strong. Dorsal spur long, bent finger (17% length of carapace); tip bifurcated (Fig. 18). Length of carapace 1.9 mm (1.8–2.2), total length 5.9 mm (Fig. 19). Thoracic fovea two semicircular depressions with no black markings. Coloration and eye pattern as in female. Abdomen with distinct medial tubercle, height 2.0 mm. Leg setation similar to female (Figs. 20–21). *Conductor tip:* (Figs. 22, 45). Conductor cap similar to others in group, with stem curving over to form short flange projecting behind, triangular portion in front; apical projection short with forward curl.

Allotype female: (Figs. 23–30). Chelicerae about ⅔ length of carapace. Cheliceral fang quite short (approximately half length of base), tapering to smooth point distally. Promargin of chelicerae (Fig. 23): six teeth, U1 robust, almost as wide but shorter (⅔) and well separated from (¼ cheliceral length) U2 and U3; U2 and U3 of similar height, U4–U6 decreasing in size proximally. Retromargin of chelicerae (Fig. 24): series of six teeth: L1 similar in height to U1 and L2, slightly separated from L2, decreasing in size proximally. Length of carapace 2.7 mm, total length 7.6 mm. Eyes separated by distance greater than width of eyes. Median ocular area slightly wider posteriorly (Fig. 25); lateral eyes contiguous. Carapace uniformly pale yellow (off-white in life) with double fovea consisting of two broken semicircles; sternum uniformly pale yellow. Abdomen with medial tubercle, height 4.0 mm; dorsum pale white-yellow (green-tinged white in life), with black marks accentuating medial protuberance (Figs. 28, 29); venter uniformly pale. Legs uniformly pale yellow, unbanded (Figs. 26, 27). Leg setation: fI 5/1/2; tI 3/2/3; mI 1/1/1; fIII with no ventral, and tIII and mIII with one prolateral, macrosetae. *Seminal receptacles:* (Fig. 30). Two kidney-shaped bulbs linked together, medial portion rather heavily sclerotized on inner border; central portion similar in width to bulbs, fits well within area defined by outer limits of bulbs.

Natural history.—*Tetragnatha albida* occurs in remnant dry forest of East Maui, a discrete dryland community on unweathered lava with little soil formation. Individuals build webs in the trees at night, and spend the day camouflaged against the green-tinged white lichen that covers many of the trees. Auwahi on East Maui, the type locality of *T. albida*, has been widely known as the finest dryland forest remaining on Maui and among the best remaining in the Hawaiian Islands (Rock 1913). However, despite remaining rich in native dry forest tree species, Auwahi is now dominated by the aggressive mat-forming kikuya grass (*Pennisetum clandestinum*). Furthermore, most native tree species of Auwahi have only older, senescent individuals present with virtually no smaller size classes to indicate a reproducing population (Medeiros et al. 1986). Without management, this dryland forest and its spider fauna may largely disappear in the next few decades.

Paratypes.—*Maui Island*, Auwahi tract, 1100–1250 m, 3♂18♀, 12 May 1990 (RGG & ACM).

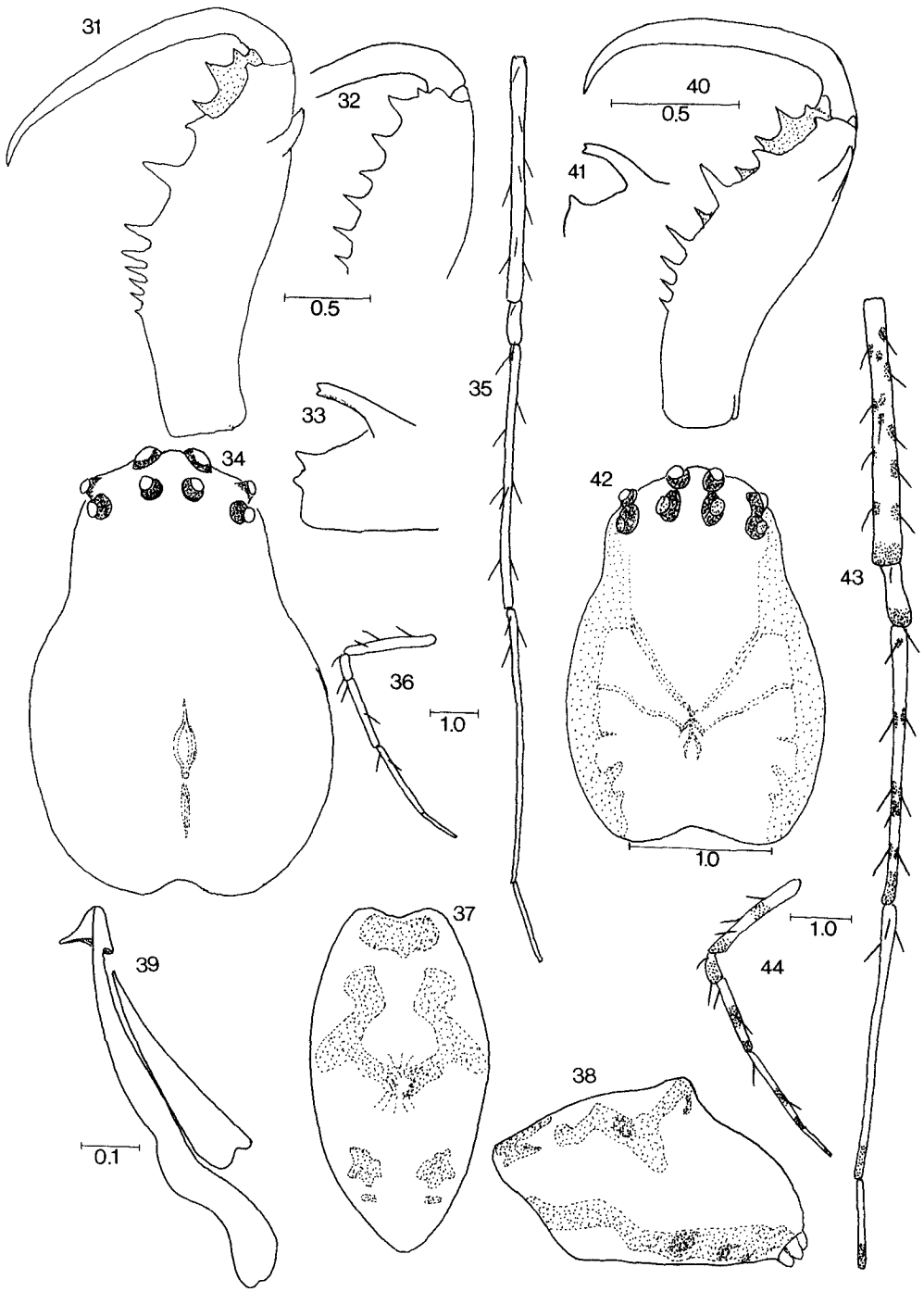
Tetragnatha kea new species
(Figs. 31–38, 46)

Types.—Holotype male from Hakalau, 6150 ft (1880 m), Hawaii Island, 12 October 1990 (R. G. Gillespie), deposited in the Bishop Museum, Honolulu.

Etymology.—The specific epithet is the Hawaiian word meaning 'white', and refers to the creamy white coloration of these spiders.

Diagnosis.—*Tetragnatha kea* is most easily confused with *T. albida*. It is distinguished primarily by the single cephalothoracic fovea (double in *T. albida*) and the strong cephalothoracic markings (dorsal and ventral) (uniformly pale in *T. albida*). The ecological affinities of the two species are very different, with *T. albida* occurring in remnant dry forest of Maui, and *T. kea* in high elevation wet forest on Hawaii Island.

Description.—*Holotype male:* (Figs. 31–38).



Figures 31–44.—***Tetragnatha kea*** new species, male holotype and *Tetragnatha acuta*. 31–39, ***Tetragnatha kea***. 31. Promargin of right chelicera; 32. Retromargin of left chelicera; 33. Dorsal spur of chelicera, lateral view; 34. Carapace, dorsal; 35. Right leg I, dorsal; 36. Right leg III, prolateral; 37. Abdomen, dorsal; 38. Abdomen, lateral; 39. Left palpus, prolateral. 40–44, *Tetragnatha acuta*. 40. Promargin of right chelicera of male; 41. Dorsal spur of male chelicera, lateral view; 42. Female carapace, dorsal; 43. Right leg I of female, dorsal; 44. Right leg III of female, prolateral. Scale bar (mm) at Fig. 32 applies to Figs. 31–34; at Fig. 36 to Figs. 35–38; at Fig. 40 to Figs. 40, 41; and at Fig. 44 to Figs 43, 44.

Chelicerae 85% length of carapace. Cheliceral fang slightly shorter than base, bent over at both proximal and distal ends. Promargin of chelicerae (Fig. 31): distance between Gu and s1 slightly greater than between s1 and T, CITR 4:3:3; Gu small tubercle; s1 very robust, wedge-shaped, sharply angled down toward proximal margin of chelicerae, width 70% length (1.5 times wider than T, but shorter, 60%% height); T tall, quite wide, bent slightly up toward distal margin of chelicerae; rsu 4–6 straight spikes. Retromargin of chelicerae (Fig. 32): total of 5–6 teeth; AX1 tiny notch, G1 and rest of teeth all quite strong. Dorsal spur long, bent finger (17% length of carapace); tip bifurcated (Fig. 33). Length of carapace 1.9 mm, total length 5.3 mm (Fig. 34). Eyes separated by distance greater than width of eyes (Fig. 34); lateral eyes contiguous. Carapace pale yellow (off-white in life), thoracic fovea single and marked by heavy black line running posteriorly to distal margin of carapace; sternum pale yellow with broad black border along lateral margins. Abdomen with distinct medial tubercle, height 1.9 mm; dorsum pale white-yellow (green-tinged white in life), with black marks accentuating medial protuberance (Figs. 37, 38); venter uniformly pale. Leg setation (Figs. 35, 36): fI 4/3/2; tI 3/2/3; mI 1/1/1; fIII with no ventral, and tIII and mIII with one prolateral macrosetae. *Conductor tip:* (Figs. 39, 46). Conductor cap similar to *T. albida*.

Female: Unknown.

Natural history.—To date, only two males of *T. kea* have been found, both in the Hakalau forest area on the windward slopes of Mauna Kea, at 6150 ft (1880 m). The forest in this area is wet, with a canopy dominated by Ohia (*Metrosideros polymorpha*). Little is known of the habits of this species.

Paratypes.—*Hawaii Island*, Hakalau Forest Reserve: 1880 m, 1♂, 5 January 1991 (R. Peck).

Tetragnatha acuta Gillespie
(Figs. 40–44)

Tetragnatha acuta Gillespie 1992: 8–9, figs. 29–42 (male holotype from United States: Hawaii, Maui Island, Honomanu Valley, Waikamoi, 1585 m, in Bishop Museum, examined).

Tetragnatha acuta was described from East Maui (Gillespie 1992), but appears to occur throughout Molokai, Maui and Hawaii islands. The species is described here briefly for comparison with others in the group. CITR 4:3:3

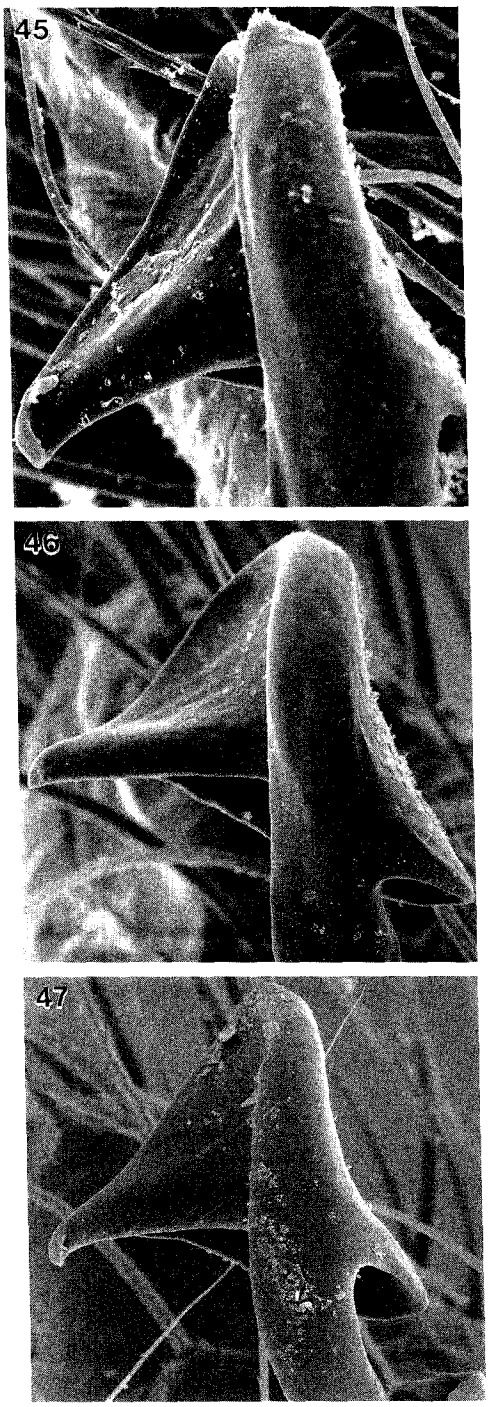


Figure 45–47.—Scanning electron micrographs of conductor tips of male palps (scale on each 400×). 45. ***Tetragnatha albida*** new species; 46. ***Tetragnatha kea*** new species; 47. *Tetragnatha acuta* (from Hawaii).

(Fig. 40); Gu small; s1 robust, projecting toward proximal margin of chelicerae; T tall, pointing straight out from cheliceral margin. Conductor cap simple, peaked, with small backward flange, short apical curl (Fig. 47). In females, length of carapace 2.0–2.5 mm, total length 5.0–7.0 mm. Eyes larger than distance separating them (Fig. 42); lateral eyes contiguous. Carapace brown with single fovea, with dark markings radiating from fovea toward ocular area; sternum dusky. Abdomen raised to peak at midline, height 3.0–3.5 mm; dorsum brown with black marks accentuating medial protuberance; venter brown with medial dark, longitudinal bar. Legs brown with dark bands at distal margins of each joint (Figs. 43–44). Leg setation: fI 5/1/4; tI 3/2/3; mI 1/1/1; fIII with no ventral, and tIII and mIII with one prolateral, macrosetae.

Natural history.—*Tetragnatha acuta* is locally abundant, primarily in habitats inhospitable to other species. In particular, on Maui and Molokai it builds small webs low down in low, scrubby vegetation in bogs, or on windswept mountain ledges. On Hawaii Island, the species reaches its highest abundance on the scrubby, sparse vegetation that occurs on new lava flows, particularly near the edges of forested areas.

Material examined.—HAWAII: *Molokai Island*, Kamakou Preserve, Puu Kolekole, 1220 m, 1♀, 21 June 1988 (RGG & CP); 1169 m, 1♂1♀, 16 March 1991 (RGG & GKR). Kawela Gulch, 1110 m, 1♂1♀, 23 June 1988 (RGG & CP). Kawela Gulch, 1070 m, 1♂1♀, 17 March 1991,(RGG & GKR). *Maui Island*, West Maui, Puu Kukui, 1740 m, 1♂, 22 February 1991 (RGG & GKR); Mount Eke, 1340 m, 4♂14♀, 21 February 1991 (RGG & GKR). Haleakala, Honomanu Gulch, 1585 m, 1♂1♀, 6 February 1990 (RGG). Opana Gulch, 1340 m, 2♂1♀, 8 February 1990 (RGG & J. Burgett); 1♂, 27 February 1993 (RGG, P. Follett & GKR); Hanawi Valley, 1340 m, 1♀, 9 February 1990 (RGG & R. Rydell). Bogs, N. E. Rift Haleakala, 1676 m, 8♀, 15-18 January 1988 (RGG & ACM). Kipahulu Valley, 1980 m, 1♀, 27 April 1988 (RGG & ACM). *Hawaii Island*, Kohalas, Kahua Ranch, 1190 m, 1♂1♀, 26 July 1991 (RGG, K. Y. Kaneshiro, WDP & CP); Puu O Umi, Upper Hamakua Ditch, 1220 m, 1♂1♀, 20 October 1990 (RGG & DJP). Hualalai, Kaloko Drive, 1100 m, 1♀, 30 July 1988 (RGG & CP). Mauna Kea, Hakalau, 1880 m, 2♂3♀, 12 October 1990 & 13 October 1990 (RGG, DJP & I. Felger). Mauna Kea-Mauna Loa Saddle, Kipuka 6–8, Saddle Road, 1540–1600 m, 8♂8♀, 25 July 1988 (RGG & CP); Kipuka 9, Saddle Road, 1530 m, 3♀, 4 January 1991 (RGG & CP) and 1♀, 1 April 1991 (WDP); Kipuka at mile 21–22, 1660 m, 1♂3♀, 12 March 1990 (RGG & J. I. M. Gillespie); trail between Puu Laau and Ahumoa, 2200 m, 1♀, 10 January 1990 (WDP); Puu Huluhulu, 2060 m, 1♀, 3 August 1991 (W. P. Maddison). Mauna Loa, Thurston, Volcanoes National Park, 1190 m, 1♂, 31 July 1988 (RGG & CP); Kipahoehoe 1220 m, 2♂3♀, 16 October 1990 (RGG, DJP & J. Kiyabu).

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