



New *Azana* species from Western North America (Diptera: Mycetophilidae)

PETER H. KERR

California Department of Food and Agriculture, Plant Pest Diagnostics Branch, 3294 Meadowview Rd., Sacramento, CA, 95832–1448 USA. E-mail: pkerr@cdfa.ca.gov

Abstract

Two new species of fungus gnats (Diptera: Mycetophilidae), *Azana malinamoena* and *Azana frizzelli*, spp. nov., are described and figured from California. These species represent the first records of *Azana* for western North America. A diagnosis of the genus *Azana* Walker is presented and a provisional key for the New World species of the genus is given. The discovery of *A. malinamoena* and *A. frizzelli* in California and their apparently close relationship to *A. nigricoxa* Strobl from south-western Europe (rather than to the only other *Azana* species known from North America, *A. sinusa* Coher) implies a more complicated biogeographic history of this genus in North America, one that probably includes multiple, independent dispersal events.

Key words: Systematics, fungus gnats, new species, California

Introduction

The Mycetophilidae are a prolific group of dipterans that are both abundant and diverse throughout forests worldwide, particularly in temperate regions. While a number of phylogenetic studies have emerged recently to facilitate a greater appreciation and understanding of the large scale evolutionary patterns within the family (Søli 1997, Rindal & Søli 2006, Rindal *et al.* 2009), much of the group's diversity remains undocumented, even in North America.

The sciophiline genus *Azana* Walker is currently composed of 12 recent species that have been recorded from Europe (four species), tropical Africa (two species), Canary Islands (*A. palmensis* Santos-Abreu), China (two species), Sri Lanka (*A. asiatica* Senior-White), Brazil (*A. atlantica* Oliveira & Balbi), and the United States (*A. sinusa* Coher) (Table 1). It is also recorded from Baltic amber (*A. rarissima* Meunier). *Azana* is readily distinguished from other genera by its heavily reduced wing venation, where M is obsolete at its base, and M and Cu are not clearly branched. A remnant wing vein, CuA₁, is usually present near the wing margin (= M₄ of Matile 1998, Amorim *et al.* 2008a). The biology of *Azana* is unknown.

In North America, Johannsen (1912) and Fisher (1937) first reported *Azana* species from Eastern North America (Maine and Cape Breton I., Nova Scotia, respectively). Laffoon (1965) catalogued *Azana* from Nova Scotia and Minnesota, although the species remained unidentified. Specimen vouchers of these records remain unavailable. However Coher (1995) described *A. sinusa* from Massachusetts, Maine, and New Hampshire, and this species is thought to represent all prior records of the genus in the Nearctic Region. Two closely related species of *Azana* have recently been collected in California, however, that are easily differentiated from *A. sinusa* and others in the genus. These species are described and figured here.

Material and methods

Terminology for wing venation follows Vockeroth (1981) and that for thoracic and genitalic morphology follows Søli (1997). Whole specimens and genitalia were macerated in 10% KOH at approximately 95° C for

15–20 minutes to remove soft tissue, then rinsed in distilled water and dilute glacial acetic acid, and dissected in water. Female reproductive organs were additionally stained with a saturated solution of Chlorazol Black in water. All genitalia preparations were placed in a drop of DMHF and dry mounted onto a small card with transparent backing, held to the pin beneath the specimen. Line drawings and plates were made using Adobe Illustrator Creative Suite software, aided by digital images taken using Q-imaging Micropublisher 5.0, a scope-mounted digital camera. Habitus images were taken with the same digital camera, using an LED dome lighting system (Kerr *et al.* 2008). All digital images were enhanced using Photoshop Creative Suite 2 software. Both holotypes are deposited in the California State Collection of Arthropods, Sacramento, California, USA (CSCA). Additional types are deposited at the CSCA, the California Academy of Sciences, San Francisco, California, USA (CASC), the Zoological Museum of the University of Oslo, Norway (ZMUO), and the private collection of Peter H. Kerr (PHKC; currently residing at the CSCA). Types are also deposited in 100% EtOH in the Frozen Tissue Collection of the CSCA (CSCA-FTC) at -80°C for DNA preservation.

TABLE 1. Species of *Azana*. Valid species are in bold type; junior synonyms are indented below.

PALEARCTIC:

Azana anomala (Staeger, 1840: 238) — Europe, North Africa

Azana altera Becker, 1907: 234

Azana scatopsoides Walker, 1856: 26

Azana nigricoxa Strobl, 1898: 600 — SE Europe

Azana flavohalterata Strobl in Czerny & Strobl, 1909: 129 — Bulgaria, Spain

Azana bulgarensis Coher, 1995: 87

Azana palmensis Santos Abreu, 1920: 45 — Spain: Canary Islands

Azana corsicana Coher, 1995: 88 — France: Corsica

NEARCTIC:

Azana frizelli Kerr sp. nov. — USA: California

Azana malinamoena Kerr sp. nov. — USA: California

Azana sinusa Coher, 1995: 85 — NE North America

NEOTROPICAL:

Azana atlantica Oliveira & Balbi in Amorim *et al.*, 2008b: 67 — Brazil

AFROTROPICAL:

Azana minuta Matile, 1999: 131 — Cote d'Ivoire

Azana pusilla Matile, 1999: 132 — Gabon

ORIENTAL:

Azana asiatica Senior-White, 1922: 116 — Sri Lanka

Azana sinensis Xu & Wu, 2002: 621 — China: Zhejiang

Azana grandispinosa Xu & Wu, 2002: 622 — China: Zhejiang

FOSSIL:

Azana rarissima Meunier, 1904: 173 — Baltic Amber

Taxonomy

Azana Walker

Azana Walker 1856:26

Type species. *Azana scatopsoides* Walker 1856: 26, by monotypy (= *Azana anomala* Staeger 1840).

Diagnosis. Three ocelli (except two in *A. atlantica*), antennae with 14 cylindrical flagellomeres, maxillary palpus 1-, 4-, or 5-segmented. Thorax arched, anepisternum setose on upper half or bare, laterotergite and mediotergite with setae, tibial spurs 1:2:2. Wing membrane usually with micro- and macrotrichia; costa produced beyond tip of R₅; subcosta usually short, ending free; r-m long, arising near base of wing; M obsolete at its base and apparently unbranched; Cu unbranched or branched with CuA₁ obsolete at its base and visible near wing margin.

***Azana malinamoena* sp. nov.**

(Figs. 1, 3–7, 13, 15, 17–18, 21)

Type material. Holotype: ♂, USA: CA: Del Norte Co, SixRiversNF, ForRoute16N02, nr. BearBasin Outlk, 41.8016°N, 123.7369°W, 1500masl, 3.vi–24.vii.2009 P.H.Kerr & O.Lonsdale, 6m MT, CSCA09L526 [CSCA]. Complete specimen (#09D441) on point mount.

Paratypes: 6 ♂♂, 1 ♀, USA: CALIFORNIA, same data as holotype [4 ♂♂ CSCA / 1 ♂ CASC / 1 ♂, 1 ♀ ZMUO]; 1 ♂, USA: CA: Calaveras Co., BigTreesSP, South Grove, Sequoia #298 (Creek), canopy trap nr. ground, top bottle, 38.2415°N 120.2554°W 1405masl, 16.v–6.vi.2009 P.Kerr & R.Frizzell, CSCA09L247 [CSCA-FTC]; 1 ♂, USA: CA: Calaveras Co., BigTreesSP South Grove, Sequoia #282 (Stellar), canopy trap nr. ground, top bottle, 38.2407°N 120.2546°W 1425masl, 16.v–6.vi.2009 P.Kerr & R.Frizzell, CSCA09L253 [PHKC]; 2 ♂♂, USA: CA: Calaveras Co., BigTreesSP, South Grove, Sequoia #317(Neighbor), canopy trap nr. ground, top bottle, 38.2405°N 120.2562°W 1410masl, 16.v–7.vi.2009 P.Kerr & R.Frizzell, CSCA09L259 [PHKC]; 6 ♂♂, 1 ♀, USA: CA: Calaveras Co. Calaveras Big Trees SP, S. grove, *Asarum hartwegii* bog, MT#3, 38°14.41'N 120°15.75'W 1385masl, 22.v.–11.vi.2007, P.H.Kerr & M. Hauser 07LOT088 [CSCA]; 4 ♂♂, USA: CA: Amador Co., Indian Grinding Rock St. Pk., nr campsites in small gully. MT, 38.4216°N 120.6450°W, 715masl, 30.iii–8.v.2009 P.Kerr, CSCA09L230 [CSCA-FTC].

Diagnosis. This species can be distinguished from most *Azana* species by having 5-segmented maxillary palpus and simple gonostylus that lacks spines. The relatively long mouthparts and the gonostylus bearing long thin cuticular process (Figs. 17–18, 21) will readily differentiate this species from *A. nigricoxa* Strobl, *A. sinensis* Xu & Wu, and *A. grandispinosa* Xu & Wu. This species is most apt to be confused with its sympatric congener, *A. frizzelli* sp. nov. In *A. malinamoena* sp. nov., the setae of the head and dorsum are predominantly yellowish brown or golden (not dark brown), the scape and pedicel are yellow (not brown), the anterolateral margins of the dorsum are yellowish or cream colored, and the mid and hind coxae also tend to be cream colored (although sometimes lightly brownish). Additional diagnostic characters may be found in the male genitalia where the anterior margin of the epandrium (t9) is angled inward to form a point (Fig. 15) and the aedeagal sheath is shallowly produced medially (Fig. 17, not as Fig. 19).

Description. Body length (n=7): 1.8–2.2 mm (avg = 2.0 mm). Wing length: 1.8–2.2 mm (avg = 2.1 mm). Males and females approximately the same size.

Coloration (Fig. 1). Head brown, face yellowish, clypeus yellowish brown; basal palpomere yellowish or pale brown, otherwise palpomeres yellow and becoming increasingly white distally; palpomeres 4 and 5 entirely white. Antennal scape and pedicel yellowish, flagellomeres dark brown. Scutum and scutellum brown. Antepnotum and proepisternum yellow, anepisternum brown, katepisternum brown except cream-colored or pale brown along lower posterior margin, anepimeron brown except cream-colored at ventral margin, meron cream-colored, metepimeron and metepisternum light brown, laterotergite and mediotergite brown. Fore coxa cream-colored; mid and hind coxae with some brown on uppermost margin, but otherwise cream-colored (in female, a little more brownish throughout); fore and mid femora yellowish, hind femur yellowish, fading to brown dorsoapically light brown; tibiae and tarsi yellowish (tarsi looking darker on account of vestiture of brown trichia); tibial spurs yellowish brown. In female, femora, tibiae, tibial spurs, and tarsi more light brownish throughout. Wing lightly infusate without markings, membrane densely microtrichose, with scattered macrotrichia; where present, wing veins thick and brown (except CuA₁, which is faint); haltere stem and knob white. Abdominal segments brown, with gold-colored setae. Terminalia brown in male; in female, cercus pale to yellowish brown.

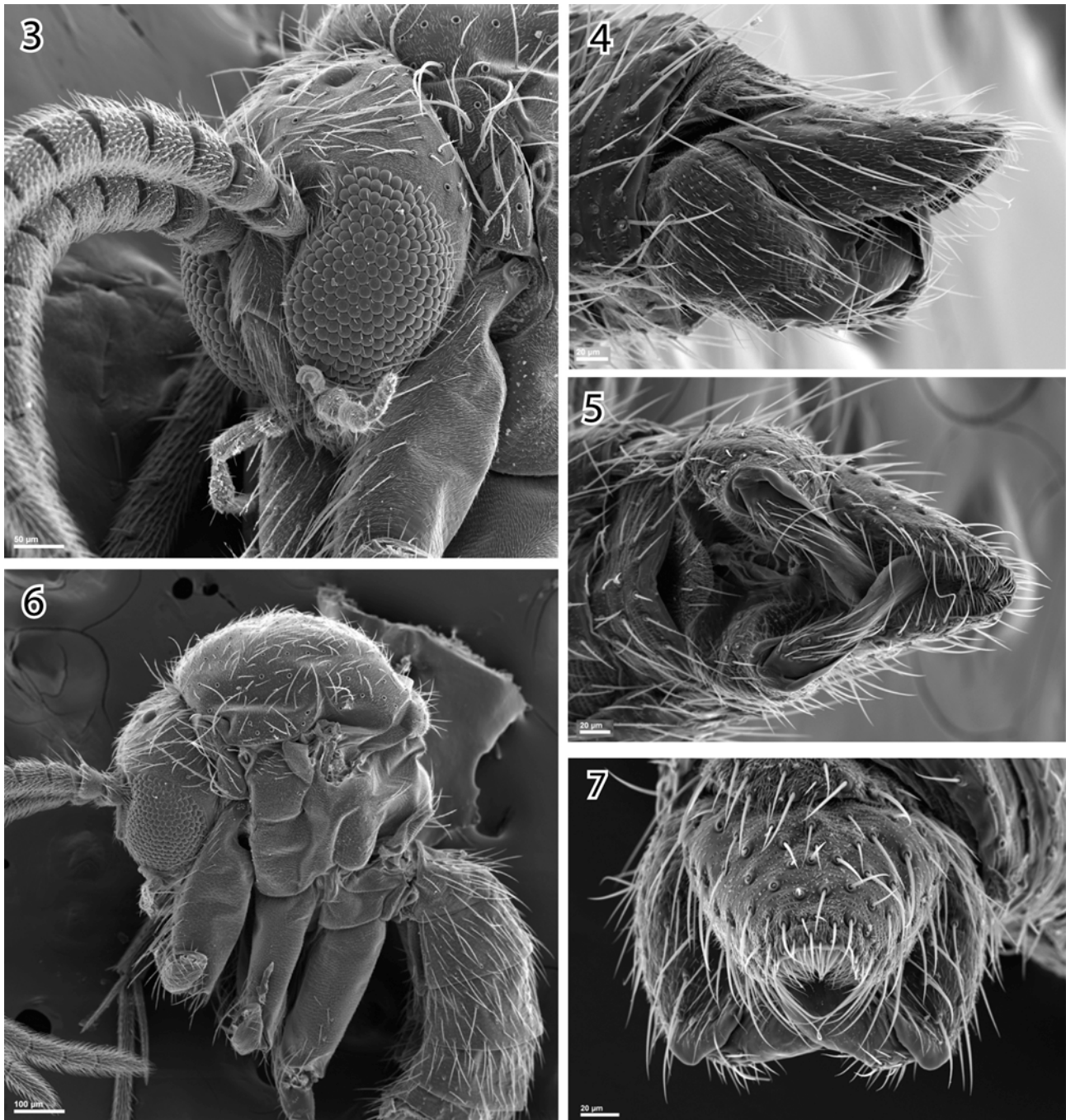
Head (Fig. 3). Three ocelli, middle one approximately half the size (or less) and slightly anterior of others; lateral ocellus approximately five times its widest diameter from eye margin. Frons with relatively long yellow setae, some approximately 0.5x length of frons. Frontal tubercle between antennal bases; transverse frontoclypeal membrane present; face longer than wide, converging with straight edges to a point dorsally, with short, appressed microsetae throughout; clypeus longer than wide, with microsetae throughout. Palpus approximately long enough to reach dorsal margin of antennal scape; five palpomeres, successively longer distally; palpomere I short, as wide as long, remaining palpomeres longer than wide; palpomere 5 cylindrical,



FIGURES 1–2. *Azana* spp. from California, habitus, lateral view. 1, *Azana malinamoena*, holotype; 2, *Azana frizzelli*, holotype. Scale bar = 0.5 mm.

approximately 2x length of palpomere 4; third palpomere with small area of sensilla cochleariformis on aboral surface (visible in SEM). Antennal length in male approximately 3.5x the length of head; in female, antennal length approximately 2–2.5x the length of head; antennal bases separated by approximately 1/5 width of

scape; scape with ring of yellow setae around distal margin, setae approximately as long as length of scape or shorter, with a few short setae ventrally; pedicel approximately same width as scape in lateral view, with yellow setae, approximately as long as length of pedicel; all flagellomeres densely setulose, flagellomeres 1–12 slightly longer than wide, terminal flagellomere approximately 2x longer than wide.



FIGURES 3–7. *Azana malinamoena*, male. 3, anteroventral view of head; 4, lateral view of genitalia; 5, ventral view of genitalia; 6, lateral view of thorax; 7, posterior view of genitalia. In figure 3, scale bar = 0.05 mm; in figures 4–5 and 7 scale bar = 0.02; in figure 6, scale bar = 0.1 mm.

Thorax (Fig. 6). Scutum with gold-colored setae scattered throughout, longest setae along anterior margin of scutum, extending over head; scutellum relatively small, approximately 2/3 width of thorax, with row of 5–7 longer setae; setae of mesopleuron golden in color; antepronotum and proepisternum bearing setae; anepisternum with short setae on dorsal half of sclerite; laterotergite with long setae; mediotergite longer than wide, with setae on lower half, longest near base; remaining thoracic sclerites without setae. Fore coxa setose

anteriorly, bare laterally; mid and hind coxae setose laterally, in distal half only. Femur covered in short, yellow setae, approximate femur length to tibia length ratio 1.0 (fore leg), 1.0 (mid leg), and 0.8 (hind leg); all tibial setae short, shorter than width of tibia; fore tibia with ovate anteroapical depressed area apically, bearing several rows of small yellowish setae; mid tibia with 4 anterior setae and 2–4 dorsal setae; hind tibia with a row of 4–5 anterior, 0–1 anterodorsal, and 5–8 dorsal setae. Wing (Fig. 13) with densely arranged and relatively long microtrichia and scattered macrotrichia over membrane surface; costal vein extends beyond R_5 , approximately 0.2 of distance between R_5 and M_1 ; Sc short, ending free; R_1 reaching C at approximately middle of wing; M_1 obsolete at base, but well defined in apical 2/3, extending to wing margin clearly beyond level at which costal vein ends; CuA_1 present as light vein or fold, most visible near wing margin, obsolete at its base; CuA_2 strong, slightly curved; A_1 present as fold; all wing veins except A_1 setulose on upper surface.

Male Genitalia (Figs. 4–5, 7, 15, 17–18, 21). Epandrium (= tergite 9) longer than wide, with anterior margin forming ring that arcs ventrally and connects to hypandrium anteriorly, ring with central, posteriorly-projecting process ventrally. Gonocoxites not fused; gonostylus simple, with cluster of setae at proximal half, bearing minute teeth on inner margin and bearing long, thin process on ventral surface and directed inwardly; parameres absent. Aedeagal sheath broad with paired apodemes arcing anteriorly and with two small lobes extending posteriorly, near center; aedeagal apodeme small, forked, forming ‘Y’ shape.

Female Genitalia (as in Figs. 23–24). First cercus segment broad, with moderately produced dorsal lobe, second cercus segment ovoid, flattened; 2 spermathecae, unsclerotized, spherical, spermathecal duct length long, extending to fourth or fifth abdominal segment.

Comments. *Azana malinamoena* was found in three areas of California, from 715–1500 masl, spanning approximately 300 miles. It is expected that this species range extends at least through the high country of coastal Northern California and Oregon and may extend southward, along the western Sierra Nevadas to Tulare County. Although the canopy of three giant sequoia trees were sampled for this species, it occurred only near ground level at the base of each tree.

Etymology. This species is named after my wife, Malin Sofia Vretblad Kerr. The species epithet is formed by a combination of her first name and the quality of being “amoena”, a latin expression meaning attractive, pleasant, agreeable, enjoyable, charming, lovely. She is all of these things.

Azana frizzelli sp. nov.

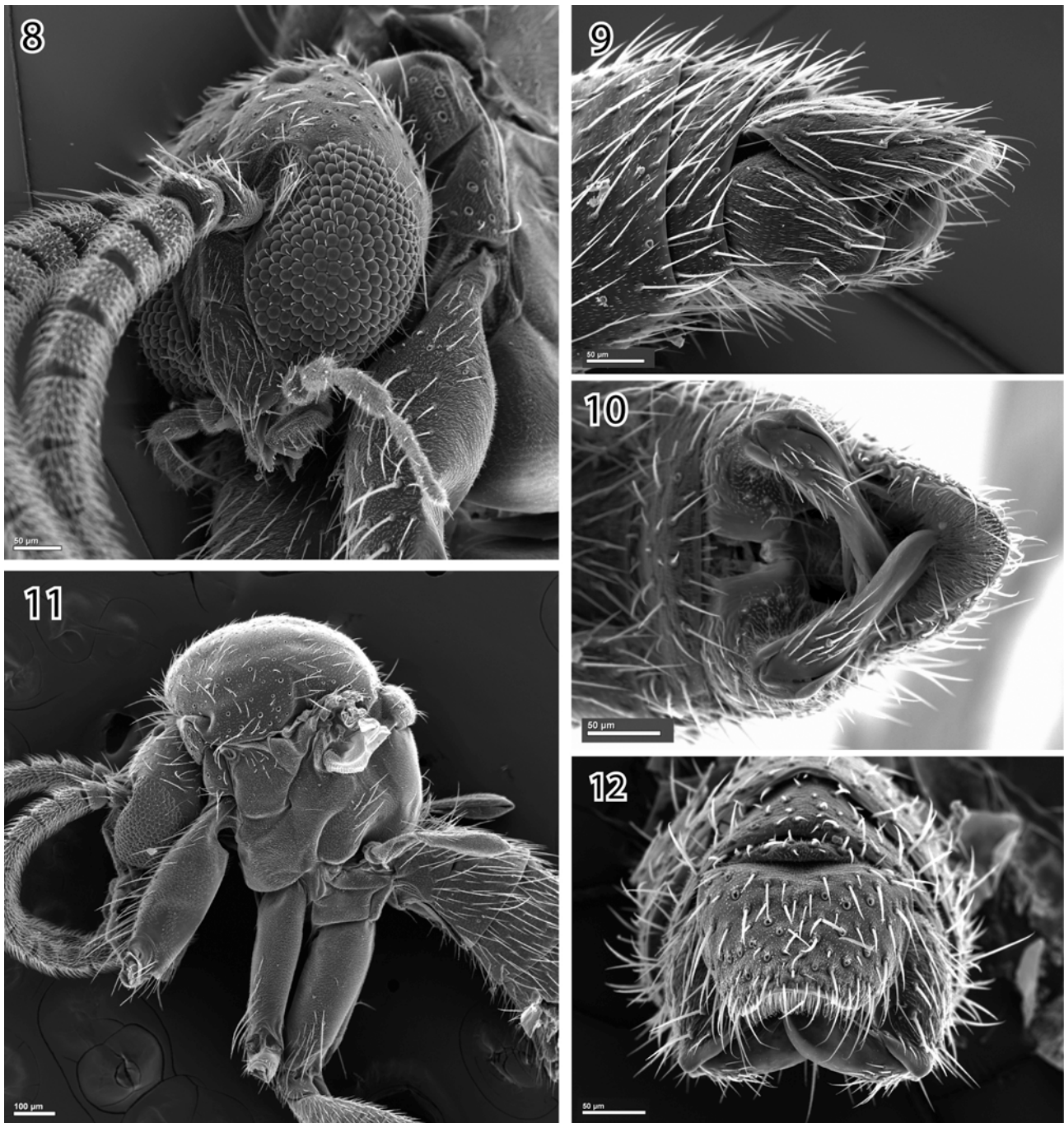
(Figs. 2, 8–12, 14, 16, 19–20, 22, 23–24)

Type material. Holotype: ♂, USA: CA: Del Norte Co, SixRiversNF, ForRoute16N02, nr. BearBasin Outlk, 41.8016°N, 123.7369°W, 1500masl, 3.vi–24.vii.2009 P.H.Kerr & O.Lonsdale, 6m MT, CSCA09L526 [CSCA]. Complete specimen (#09D439) on point mount.

Paratypes: 11 ♂♂, 4 ♀♀, USA: CALIFORNIA, same data as holotype [8 ♂♂, 1 ♀ CSCA / 1 ♀ CSCA-FTC / 1 ♂, 1 ♀ CASC / 1 ♀ ZMUO]; 2 ♀♀, USA: CA: Calaveras Co., BigTreesSP, South Grove, Sequoia #298 (Creek), canopy trap nr. ground, top bottle, 38.2415°N 120.2554°W 1405masl, 16.v–6.vi.2009 P.Kerr & R.Frizzell, CSCA09L247 [CSCA-FTC]; 1 ♂, USA: CA: Calaveras Co., BigTreesSP South Grove, Sequoia #282 (Stellar), canopy trap nr. ground, top bottle, 38.2407°N 120.2546°W 1425masl, 16.v–6.vi.2009 P.Kerr & R.Frizzell, CSCA09L253 [CSCA]; 1 ♂, 1 ♀, USA: CA: Calaveras Co., BigTreesSP, South Grove, Sequoia #317(Neighbor), canopy trap nr. ground, top bottle, 38.2405°N 120.2562°W 1410masl, 16.v–7.vi.2009 P.Kerr & R.Frizzell, CSCA09L259 [PHKC]; 1 ♀, USA: CA: Calaveras Co., BigTreesSP, South Grove, Sequoia #317(Neighbor), canopy trap nr. ground, bottom bottle, 38.2405°N 120.2562°W 1410masl, 16.v–7.vi.2009 P.Kerr & R.Frizzell, CSCA09L260 [CSCA-FTC]; 1 ♂, USA: CA: Calaveras Co. Calaveras Big Trees SP, South grove old fire road, MT#4, 38°14.4'N 120°15.7'W 1390masl, 22.v.–11.vi.2007, P.H.Kerr & M. Hauser 07LOT089 [CSCA].

Diagnosis. This species is very similar to *A. malinamoena* sp. nov. and can be distinguished from all other non-Californian *Azana* species in the same way, as indicated in the species diagnosis above. It is distinguished from its sympatric congener by having setae predominately brown on head and thorax, antennae and thorax

entirely brown, mid and hind coxae brown or light brown, a smoothly rounded anterior margin of the epandrium (Fig. 16), and aedeagal sheath that is narrowly produced medially (Fig. 19).

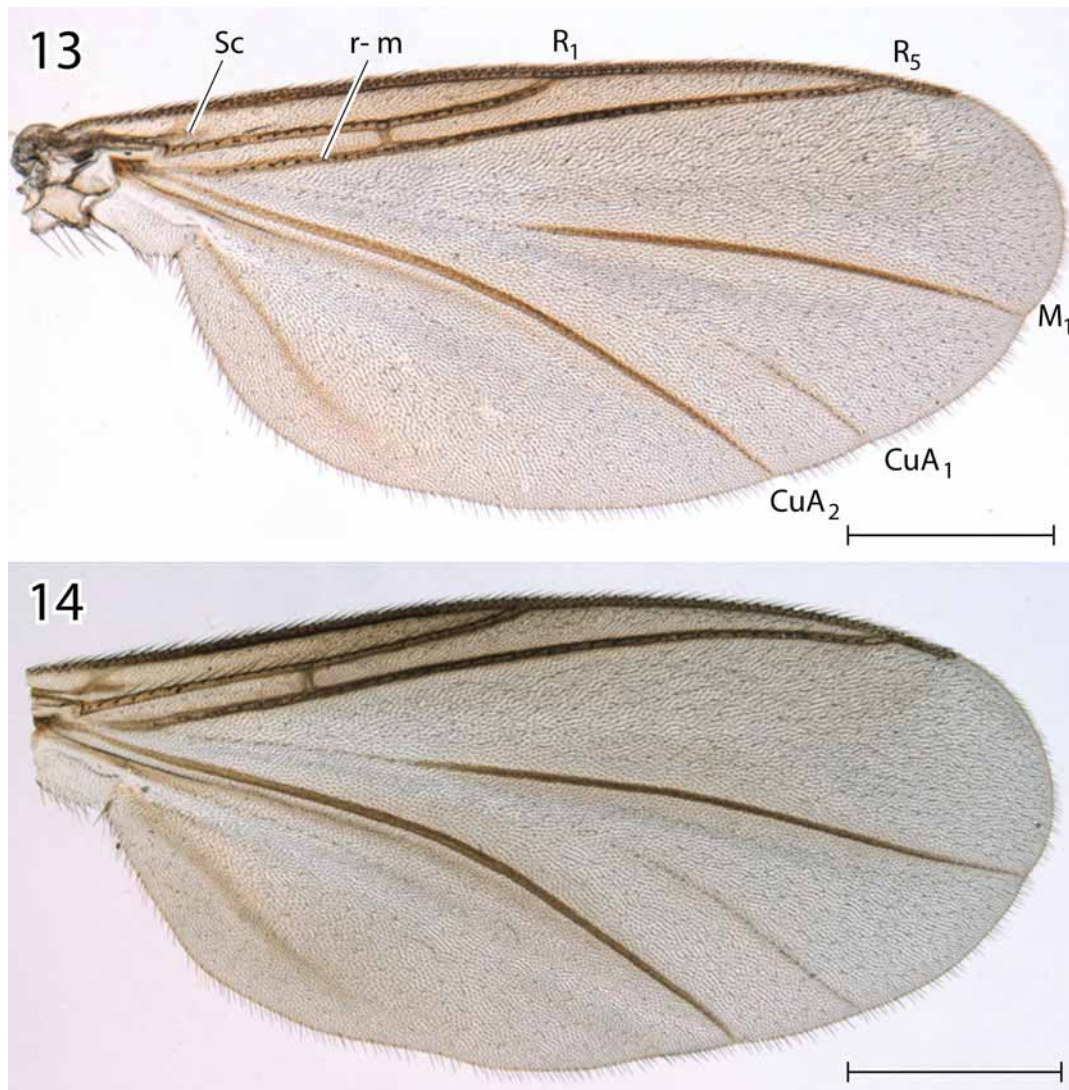


FIGURES 8–12. *Azana frizellii*, male. 8, anteroventral view of head; 9, lateral view of genitalia; 10, ventral view of genitalia; 11, lateral view of thorax; 12, posterior view of genitalia. In figures 8–10 and 12, scale bar = 0.05 mm; in figure 11, scale bar = 0.1 mm.

Description. Body length (n=10): 1.7–2.1 mm (avg = 1.9 mm). Wing length: 1.7–2.1 mm (avg = 2.0 mm). Males and females approximately the same size.

Coloration (Fig. 2). Head dark brown, face and clypeus brown; basal palpomeres light brown, segments becoming increasingly white distally; palpomere 5 entirely white. Antennal scape brown, pedicel brown or light brown, flagellomeres dark brown. Scutum yellowish brown to pale yellow at anterior margin, laterally, and this light coloration extending approximately halfway along lateral margin, otherwise scutum brown;

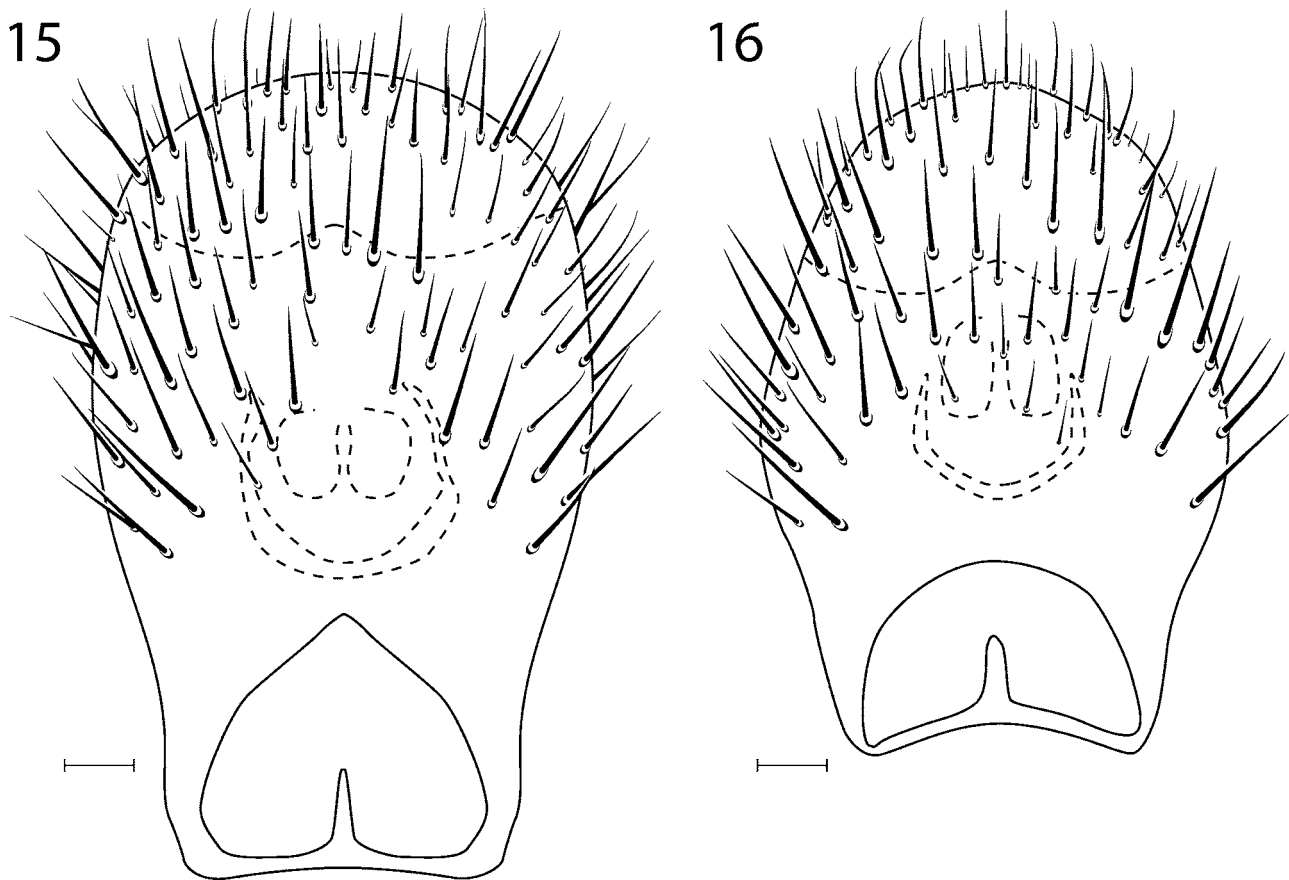
scutellum brown. Thoracic sclerites brown. Fore coxa brown at uppermost margin, otherwise cream-colored; mid and hind coxae brown, usually slightly lighter in color than thoracic sclerites; fore femur cream-colored to light brown, mid and hind femora light brown, darkening to dark brown distally; fore tibia pale brown, lightening to yellowish or cream-colored distally, mid and hind tibiae brown; tibial spurs yellowish brown to brown; tarsi brown. In female, tibiae pale brown to yellowish, tibial spurs usually yellow, and tarsi pale brown to yellowish. Wing lightly infusate without markings, membrane densely microtrichose, with scattered macrotrichia; where present, wing veins thick and dark brown (except CuA₁, which is faint); haltere stem and knob white. Abdominal segments brown to black (in female, light brown to brown), darker at posterior margin, with mostly dark brown setae. Terminalia brown in male; in female, cercus white.



FIGURES 13–14. *Azana* spp. from California, right wings, dorsal view, scale bar = 0.5mm. 13, *Azana malinamoena*; 14, *Azana frizzelli*.

Head (Fig. 8). Three ocelli, middle one approximately half the size (or less) and slightly anterior of others; lateral ocellus approximately five times its widest diameter from eye margin. Frons with short brown setae. Frontal tubercle between antennal bases; transverse frontoclypeal membrane present; face longer than wide, converging with straight edges to a point dorsally, with short, appressed microsetae throughout; clypeus longer than wide, with microsetae throughout. Palpus approximately long enough to reach dorsal margin of antennal scape; five palpomeres, successively longer distally; palpomere 1 short, slightly longer than wide; palpomere 5 cylindrical, approximately 1.7x length of palpomere 4; third palpomere with small area of sensilla cochleariformis on aboral surface. Antennal length in male approximately 3.5x the length of head; in

female, antennal length approximately 2–2.5x the length of head; antennal bases separated by approximately 1/5 width of scape; scape with ring of dark setae around distal margin, setae approximately as long as length of scape, without setae ventrally; pedicel in lateral view wider than scape, with ring of dark setae distally, approximately as long as length of pedicel; all flagellomeres densely setulose, flagellomeres 1–13 longer than wide (becoming more so distally), terminal flagellomere approximately 3x longer than wide.

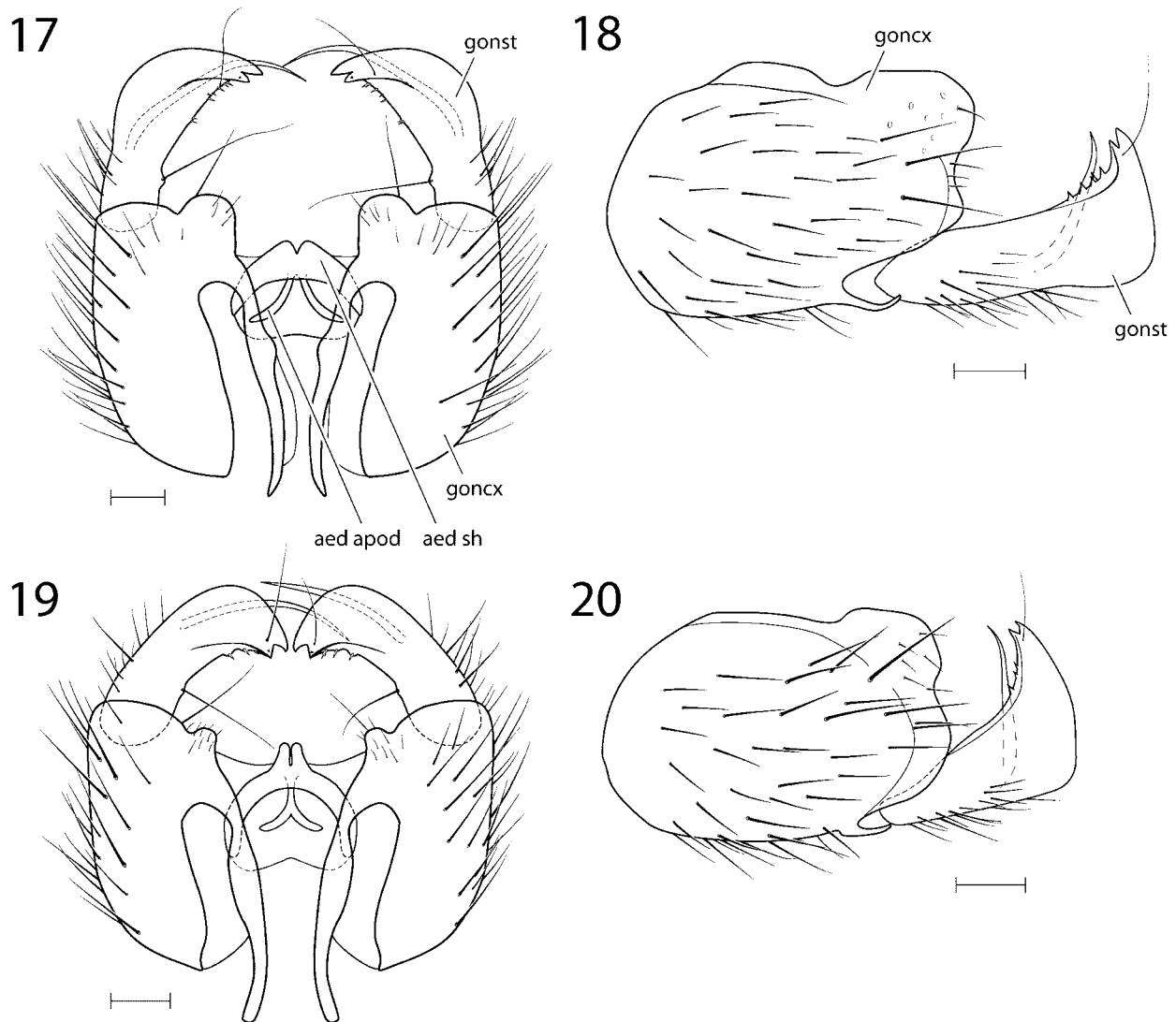


FIGURES 15–16. *Azana* spp. from California, male genitalia, epandria, dorsal view. 15, *Azana malinamoena*; 16, *Azana frizzelli*. Scale bar = 0.05 mm.

Thorax (Fig. 11). Scutum with dark brown and golden brown setae scattered throughout, longest setae along anterior margin of scutum, extending over head; scutellum relatively small, approximately 2/3 width of thorax, with setal pattern as on scutum; setae of mesopleuron yellowish or golden in color; anteprepronotum and proepisternum bearing setae; anepisternum with short setae on dorsal half of sclerite; laterotergite with long but relatively weak setae; mediotergite longer than wide, with setae on lower half, longest near base; remaining thoracic sclerites without setae. Fore coxa setose anteriorly, bare laterally; mid and hind coxae setose laterally, in distal half only. Femur covered in short, pale to dark brown setae, approximate femur length to tibia length ratio 1.0 (fore leg), 1.0 (mid leg), and 0.8 (hind leg); all tibial setae short, shorter than width of tibia; fore tibia with ovate anteroapical depressed area apically, bearing several rows of small yellowish setae; mid tibia with 3 anterior setae and a single dorsal seta, located on distal half; hind tibia with a row of 5 anterior setae, 1 anterodorsal, and 6–7 dorsal setae. Wing (Fig. 14) with densely arranged and relatively long microtrichia and scattered macrotrichia over membrane surface; costal vein extends beyond R_5 , approximately 0.2 of distance between R_5 and M_1 ; Sc short, ending free; R_1 reaching C at approximately middle of wing; M_1 obsolete at base, but well defined in apical 2/3, extending to wing margin clearly beyond level at which costal vein ends; CuA_1 present as light vein or fold, most visible near wing margin, obsolete at its base; CuA_2 strong, slightly curved; A_1 present as fold; all wing veins except A_1 setulose on upper surface.

Male Genitalia (Figs. 9–10, 12, 16, 19–20, 22). Epandrium longer than wide, with anterior margin forming ring that arcs ventrally and connects to hypandrium anteriorly, ring with central, posteriorly-

projecting process ventrally. Gonocoxites not fused; gonostylus simple, with cluster of setae at proximal half, bearing minute teeth on inner margin and bearing long, thin process on ventral surface and directed inwardly; parameres absent. Aedeagal sheath broad with paired apodemes arcing anteriorly and with two small lobes extending posteriorly, near center; aedeagal apodeme small, forked, forming 'Y' shape.

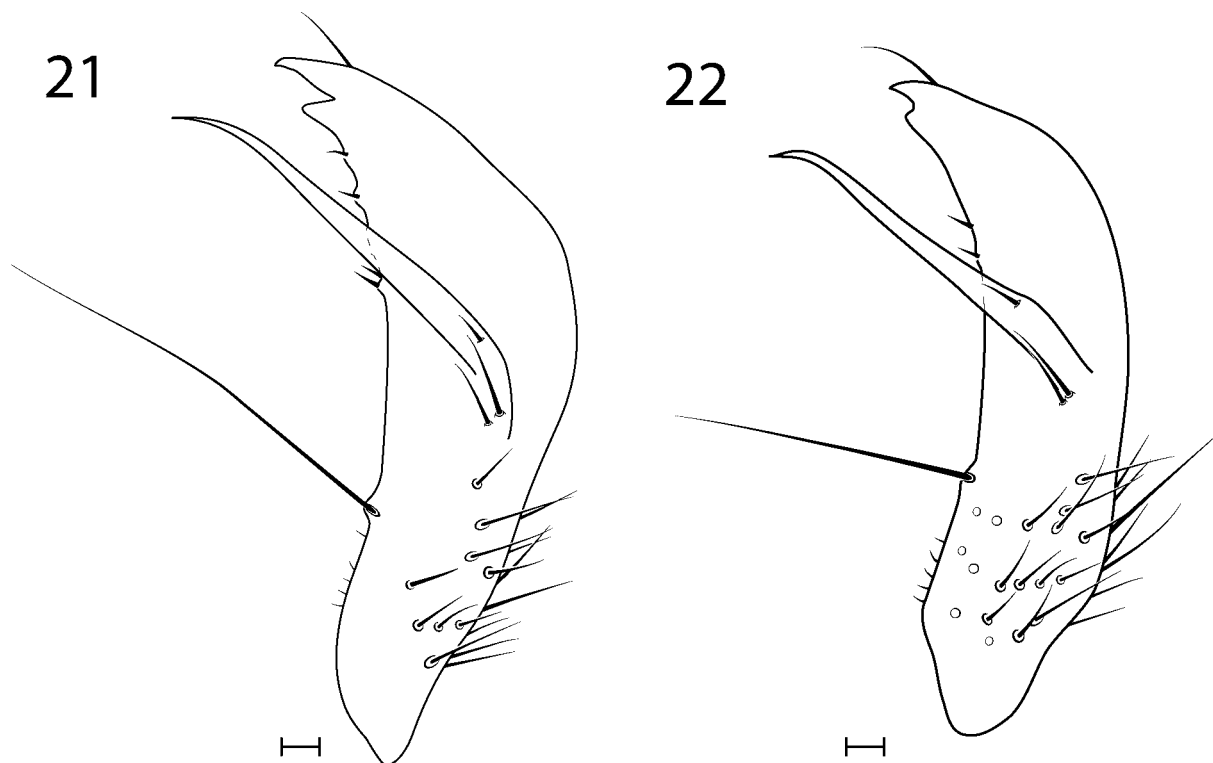


FIGURES 17–20. *Azana* spp. from California, male genitalia. 17. *Azana malinamoena*, dorsal view; 18. *Azana malinamoena*, lateral view; 19. *Azana frizzelli*, dorsal view; 20. *Azana frizzelli*, lateral view. Scale bar = 0.05 mm. Abbreviations: aed apod = aedeagal apodeme; aed sh = aedeagal sheath; goncx = gonocoxite; gonst = gonostylus.

Female Genitalia (Figs. 23–24). First cercus segment broad, with moderately produced dorsal lobe, second cercus segment ovoid, flattened; 2 spermathecae, unsclerotized, spherical, spermathecal duct long, extending to fourth or fifth abdominal segment.

Comments. The biogeographic patterns of *Azana frizzelli* were nearly the same as those observed for *A. malinamoena*, although *A. frizzelli* was found only at elevations above 1300 masl. Until more collecting can be done to verify their ranges, both species are expected to have largely overlapping distributions, covering the north coastal ranges of California and Oregon and extending southward in the western Sierra Nevada Mountains.

Etymology. Named in honor of Randall Frizzell of Nevada City, CA, professional arborist, who assisted in the collection of this species by leading a team of collectors into the canopies of giant sequoias (*Sequoiadendron giganteum*), specifically in pursuit of fungus gnats.



FIGURES 21–22. *Azana* spp. from California, male genitalia, gonostylus, ventral view; 21, *Azana malinamoena*; 22, *Azana frizzelli*. Scale bar = 0.01 mm.

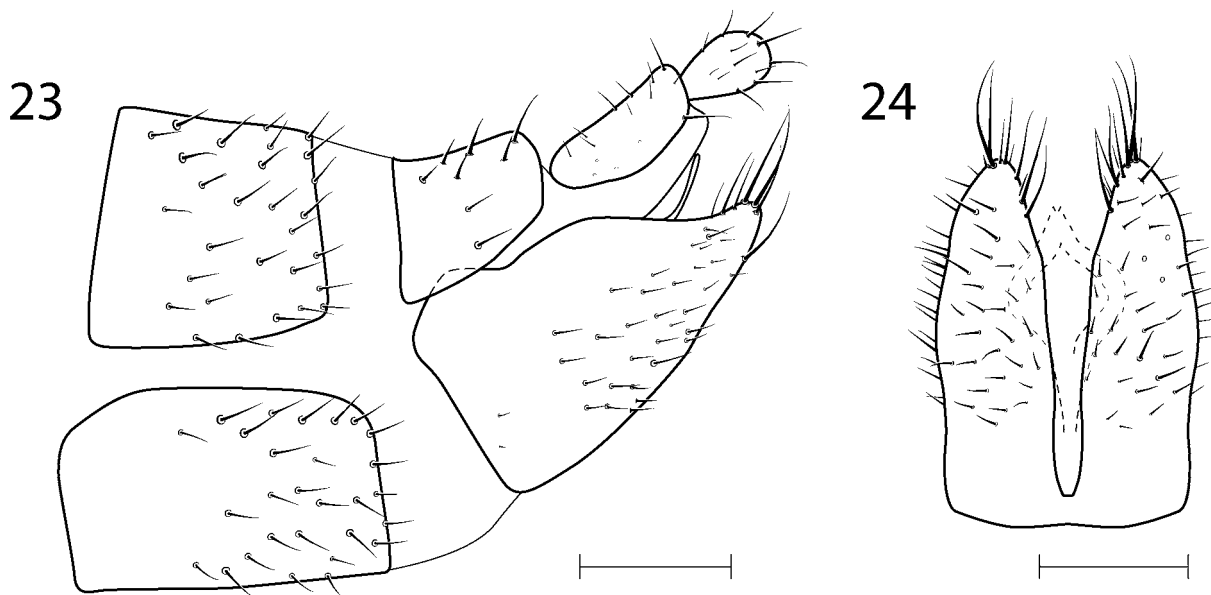
Provisional key to New World *Azana*

As indicated in Amorim *et al.* (2008a), there are undoubtedly more *Azana* species that are currently undescribed from Central and South America.

1. Two ocelli, maxillary palps with one segment, CuA₁ not visible, South America *A. atlantica*
 Three ocelli, maxillary palps with more than one segment, CuA₁ at least visible near wing margin, North America .
 2
2. Clypeus bare, inner style (or digitiform process) of gonostylus present, gonostylus with prominent row of spines
 *A. sinusa*
 Clypeus with setae; gonostylus simple, lacking inner process; gonostylus without row of spines 3
3. Scape and pedicel yellow or yellowish brown, anterolateral margins of dorsum yellow or yellowish brown (contrasting with rest of dorsum, which is brown), setae of head and dorsum predominantly yellowish; mid and hind coxae cream colored (Fig. 1) *A. malinamoena* **sp. nov.**
 Antennae and thorax thoroughly brown; setae of head and dorsum predominantly brown; mid and hind coxae light brown or brown (Fig. 2) *A. frizzelli* **sp. nov.**

Discussion

Azana is allied with ten other Recent sciophiline genera, together known as the *Azana* group, on the basis of having reduced posterior wing veins (Matile 1999, Amorim *et al.* 2008a). The group includes *Acnemia* Winnertz, *Afrocnemia* Matile, *Azana* Walker, *Cluzobra* Edwards, *Monoclona* Mik, *Neoaphelomera* Miller, *Neotrizygia* Tonnoir & Edwards, *Paramorganiella* Tonnoir, *Paratrizygia* Tonnoir, *Parvicellula* Marshall, and *Trizygia* Skuse. *Pseudomanota perplexa* Blagoderov & Grimaldi of Cretaceous amber has been suggested as a possible sister taxon to this group (Blagoderov & Grimaldi 2004). The relationships among genera of this group are poorly understood, however, and a more detailed study is needed to place these taxa into a proper phylogenetic context.



FIGURES 23–24. *Azana frizzelli*, female genitalia. 23, lateral view; 24, Sternite 9, ventral view. Scale bar = 0.1 mm.

A phylogenetic study of the *Azana* group may be complicated by the fact that *Azana* itself is quite broadly circumscribed and displays a relatively large degree of morphological variation. For this reason, a phylogenetic study of the *Azana* group will require thorough taxonomic sampling of *Azana* at the species level for a rigorous test of the monophyly of the genus and its origins within the *Azana* group lineage. Such a study probably remains premature, however, due to the number and variety of undescribed *Azana* species known to still exist. Amorim (pers. comm.) has discovered an undescribed *Azana* species from Singapore and I have seen an undescribed *Azana* species (or close relative) from Bolivia that is unusual in having a complete Sc wing vein, which joins the costa. Undoubtedly, there are additional undescribed *Azana* species in other parts of the world, particularly from South and Central America (Amorim *et al.* 2008, Vockeroth 2009), that will provide additional insights into character evolution and species relationships within the lineage.

The only attempt to define subgeneric groupings within *Azana* was carried out by Coher (1995), who described the subgenus *Jugazana*. This subgenus is narrowly defined to include only one species, *A. nigricoxa* Strobl, and consequently, has been of little functional utility. Amorim *et al.* (2008) recommended that this subgenus be abandoned on the presumption that it renders the rest of the group paraphyletic. This may be the case, however, further systematic phylogenetic study is needed to test and verify this assertion.

Given their degree of special similarity, the two new species described here are undoubtedly sister taxa. The identity of their nearest relative within *Azana* is less clear. However, the form of the epandrium and simple gonostylus suggest an alliance with *A. nigricoxa*, from south-western Europe (Chandler *et al.* 2005), rather than with *A. sinusa*, the only other *Azana* species known from North America. So while *A. malinamoena* and *A. frizzelli* represent a significant range expansion within the Nearctic Region, their presence may reveal a more complicated biogeographic history of this genus in North America, one that probably includes multiple, independent dispersal events. Interestingly, the species from California appear to share many of the characters used to define subgenus *Jugazana* and may be provisionally added to this species group.

Acknowledgements

My attention to these species was drawn from samples collected in flight intercept traps that were set in giant sequoia trees (*Sequoiadendron giganteum*). I would like to thank the Save the Redwoods League for funding this research. Many thanks also go to the arbonautical team of Austin De Rock, Randall Frizzell, Bryan Gray,

and Russell Kramer. They set traps hundreds of feet off of the forest floor and provided tireless, expert, and good natured field support throughout the late Spring and Summer of 2009, in pursuit of fungus gnats, high and low. Thanks also to Patricia Raggio, Environmental Scientist with the California Department of Parks and Recreation, whose steadfast and enthusiastic support for collecting and entomological research remains invaluable. Rabbit Korbin kindly helped process specimens and Tom Manos assisted in operating the scanning electron microscope. I'm also grateful for Owen Lonsdale's assistance in rigging six meter Malaise traps in Del Norte County and Martin Hauser's help for the same, in Calaveras County. Two anonymous reviewers provided helpful comments for improving the manuscript; thank you.

Literature cited

- Amorim, D.S., Oliveira, S.S. & Balbi, M.I.P. (2008a) *Azana atlantica*, n.sp., with reduced mouthparts and two ocelli: first record of *Azana* for the Neotropical region (Diptera: Mycetophilidae: Sciophilinae). *Zootaxa*, 1789, 57–65.
- Amorim, D.S., Oliveira, S.S. & Balbi, M.I.P. (2008b) First Neotropical species of genus *Azana* (Diptera: Mycetophilidae: Sciophilinae). *Zootaxa*, 1937, 67–68.
- Becker, T. (1907) Die Ergebnisse meiner dipterologischen Frühjahrsreise nach Algier und Tunis, 1906. *Zeitschrift für Systematische Hymenopterologie und Dipterologie*, 6, 273–287, 353–367.
- Blagoderov, V. & Grimaldi, D. (2004) Fossil Sciaroidea (Diptera) in Cretaceous ambers, exclusive of Cecidomyiidae, Sciaridae, and Keroplatidae. *American Museum Novitates*, 3433, 1–76.
- Chandler, P.J., Bechev, D.N. & Caspers, N. (2005) The Fungus Gnats (Diptera: Bolitophilidae, Diadocidiidae, Ditomyiidae, Keroplatidae and Mycetophilidae) of Greece, its islands and Cyprus. *Studia dipterologica*, 12, 256–314.
- Coher, E.I. (1995) A contribution to a revision of the genus *Azana* Walker, 1856 (Insecta: Diptera: Mycetophilidae: Sciophilinae). *Reichenbachia*, 31(17), 83–91.
- Czerny, L. & Strobl, G. (1909) Spanische Dipteren. III. Beitrag. *Verhandlungen der Kaiserlich Königlich Zoologisch-botanischen Gesellschaft in Wien*, 59, 121–301.
- Fisher, E.G. (1937) North American Fungus Gnats. II (Diptera: Mycetophilidae). *Transactions of the American Entomological Society*, 64, 195–201.
- Johannsen, O.A. (1912) The Fungus Gnats of North America, Part III. *Papers from the Maine Agricultural Experiment Station*, 196, 249–328.
- Kerr, P.H., Fisher, E.M. & Buffington, M.L. (2008) Dome lighting for insect imaging under a microscope. *American Entomologist*, 54 (4), 198–200.
- Laffoon, J.L. (1965) Superfamily Mycetophiloidea, family Mycetophilidae (Fungivoridae), pp. 196–229. In: Stone A., Sabrosky, C.W., Wirth, W.W., Foote, R.H., & Coulson, J.R. (eds), *A Catalog of the Diptera of America North of Mexico*, Agricultural Research Service United States Department of Agriculture, No. 276, Washington, D.C. 1696 pp.
- Matile, L. (1998) Le genre *Azana* en région Afrotropicale [Diptera, Mycetophilidae]. *Revue française d'Entomologie* (N.S.), 20(4), 131–134.
- Matile, L. (1999) Notes sur les Sciophilinae australes du groupe *Azana* et description d'un nouveau genre Afrotropical (Diptera : Mycetophilidae). *Annales de la Société Entomologique de France*, (N.S.), 34(4), 385–395.
- Meunier, F. (1904) Monographie des Cecidomyiidae, des Sciaridae, des Mycetophilidae et des Chironomidae de l'ambre de la Baltique, Brussels, 264 p.
- Rindal, E., Sjøli, G.E.E. & Bachmann, L. (2009) Molecular phylogeny of the fungus gnat family Mycetophilidae (Diptera, Mycetophiliformia). *Systematic Entomology*, 34, 524–532.
- Rindal, E. & Sjøli, G.E.E. (2006) Phylogeny of the subfamily Mycetophilinae (Diptera: Mycetophilidae). *Zootaxa*, 1302, 43–59.
- Santos Abreu, E. (1920) Monografía de los Fungivoridos de las Islas Canarias. *Memorias de la Real Academia de Ciencias y Artes de Barcelona*, 16, 1–154.
- Senior-White, R.A. (1922) Notes on Indian Diptera. *Memoirs of the Department of Agriculture in India. Entomological series*, 7, 83–169.
- Staeger, R.C. (1840) Systematisk fortegnelse over de i Danmark hidtil fundne Diptera. *Naturhistorisk Tidsskrift*, 3, 228–288.
- Strobl, G. (1898) Fauna diptera Bosne, Hercegovine I Dalmacie. *Glasnik Zemaljskog museja Bosni i Hercegovine u Sarajevu*, 10, 387–466, 562–616 (in Serbian).
- Sjøli, G.E.E. (1997) The adult morphology of Mycetophilidae (s. str.), with a tentative phylogeny of the family (Diptera, Sciaroidea). *Entomologica Scandinavica Supplement*, 50, 5–55.

- Vockeroth, J.R. (1981) Mycetophilidae, *In*: McAlpine, J.F., B.V. Peterson, G.E. Shewell, H.J. Teskey, J.R. Vockeroth & Wood, D.M. (coords.), *Manual of Nearctic Diptera. Volume 1*, Research Branch Agriculture Canada, Ottawa, pp. 223–246.
- Vockeroth, J.R. (2009) Mycetophilidae (Fungus Gnats). *In*: Brown, B.V., A. Borkent, J.M. Cumming, D.M. Wood, N.E. Woodley, M.A. Zumbado (Eds.), *Manual of Central American Diptera, Volume 1*, NRC Research Press, Ottawa, pp 267–278.
- Walker, F. (1856) *Insecta Britannica, Diptera*. Volume 3. L. Reeve, London. xxiv + 352 pp.
- Xu, H.-C. & Wu, H. (2002) Two new species of the genus *Azana* from China. *Acta zootaxonomica sinica*, 27, 621–623.