Description of the Female of *Acrophotopsis* (Hymenoptera: Mutillidae) with Synonymy of *Sphaeropthalma dirce*

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**Abstract.**—The female of *Acrophotopsis campylognatha* Schuster is described. *Sphaeropthalma dirce* (Fox), known from females only, is transferred to *Acrophotopsis* and is the senior synonym of *A. eurygnatha* Schuster. This represents the first description of females for *Acrophotopsis*. Most importantly, the females of *Acrophotopsis* can be diagnosed by the following unique combination of characters: having a distinct basal tooth on ventral margin of mandible and a tooth-like projection at the anterior termination of the dorsal mandibular carina; having the mesosoma and second metasomal tergite moderately punctate to reticulately sculptured and having rasp-like tubercles situated between the reticulations that are more apparent anteriorly; having the first metasomal segment petiolate with the second; having the pygidium laterally defined by carinae with granulate sculpturing; and having the propodeum and fringes of tergites two through four with distinct white plumose setae.

**Key words.**—velvet ant, Sphaeropthalminae, *Dilophotopsis*, ITS1 and ITS2

*Acrophotopsis* Schuster (Hymenoptera: Mutillidae) is an easily recognized genus of nocturnal mutillid possessing deeply excised mandibles, a flattened hypopygidium with lateral, basal carinae, and genitalic parameres that overlap in situ, while lacking mesosternal processes. The genus currently contains four species recently revised by Pitts and McHugh (2002). All species of *Acrophotopsis* are found in the southwestern U.S. and Mexico, and are known only from males (Manley and Pitts 2002). Although females of *Acrophotopsis* are unknown, they are presumed to be active at night similar to males. Nothing more is known about the biology of *Acrophotopsis*.

R.M. Schuster (1958) described the genus *Acrophotopsis* based on males of two species of previously undescribed nocturnal Sphaeropthalmini from the Nearctic region, *A. campylognatha* Schuster and *A. eurygnatha* Schuster. These two species are sympatric in the Mojave Desert. *Acrophotopsis campylognatha* occurs in Baja California and in the western Sonoran and Mojave Deserts of Southern California, while *A. eurygnatha* occurs in eastern Sonoran Desert of Arizona and Mexico, and into the Mojave Desert as far west as Nevada (Ferguson 1967). A third species, *A. bergi* Casal, was added to the genus later and occurs in central Mexico in the states of Jalisco, Morelos, and Puebla, Mexico (Casal 1967). The last species to be added to the genus was *A. nickeli* Pitts and McHugh, described from Baja California Sur (Pitts and McHugh 2002).

The genus is known from a single sex, in part, due to the extreme sexual dimorphism that occurs in mutillids (Brothers 1995). Nocturnal velvet ant males are easily collected in light traps, while females are rarely collected. Sex associations are further complicated by great morphological similarity among species. This makes associating sexes nearly impossible based on examination of museum specimens and
sex associations made by catching pairs in copula are rare. More advanced molecular techniques, however, can be used to make sex associations using species-specific genetic loci (Pilgrim and Pitts 2006; Pitts et al. 2007; Pilgrim et al. 2008).

The purpose of this study is to associate the females with the two species of Acrophotopsis found in the United States, A. campylognatha and A. eurygnatha.

MATERIALS AND TERMINOLOGY

Trapping methods.—Field studies were conducted throughout the Southwestern U.S. during the summers of 2005–2008 to collect fresh specimens of both sexes of nocturnal velvet ants to attempt associating the sexes using molecular techniques. Male and female nocturnal mutillids were collected at 60 field sites across the Southwestern U.S.

Specimens were collected using black light and fluorescent lantern traps, and by hand. Specimens collected with light traps were captured in soapy water and transferred into 95% ethanol, while all hand-collected specimens were placed directly into 95% ethanol.

Molecular methods.—The two internal transcribed spacers (ITS1 and ITS2) were sequenced for representatives of each available species and sex, sequences were aligned, and females were associated with males based on identical or nearly identical DNA sequences for those loci (i.e., very small genetic distances). The methods proposed by Pilgrim and Pitts (2006) were followed for performing sex associations. ITS1 and ITS2 were sequenced for at least one female of each morphospecies and several male specimens of each described species. PCR was used to amplify the ITS1 and ITS2 regions of the nuclear genome using the molecular protocols described in Pilgrim and Pitts (2006). DNA samples were sequenced in both directions and combined using Sequencher 4.0 (Gene Code Corp., Ann Arbor, MI). DNA sequences were aligned using Clustal W (Thompson, et al. 1994) and intraspecific and interspecific genetic distances were calculated from these alignments. DNA sequences were deposited in GenBank (Accession Nos. GQ223230-GQ223237).

Taxonomic methods.—The following acronyms are for institutions or collections housing the material discussed in this current study: Department of Entomology, Academy of Natural Sciences, Philadelphia, Pennsylvania, U.S.A. (ANSP); Department of Entomology, California Academy of Sciences, San Francisco, California (CASC); and Entomological Museum, Department of Biology, Utah State University, Logan, Utah, U.S.A. (EMUS).

We adopt the following notation after Ferguson (1967) for punctures in the order of decreasing coarseness: reticulate, coarse, moderate, small, fine and micropunctate. Micropunctate refers to punctures that are extremely shallow and do not have vertical walls or sharp margins. Small refers to punctures that do have slight vertical walls and are separated by at least 5× their diameter. We use the term “simple setae” for setae that are smooth and do not have barbed surfaces. “Brachyplumose setae” refers to setae with barbs that are less than, or equal to, the diameter of the shaft at the attachment of the barb. The term “plumose setae” is used instead of “calcaria.” The term “paramere” is used instead of “gonoforceps” to remain consistent with previous mutillid literature. The acronyms T2, T3, etc., denote the second, third, etc., metasomal tergites, respectively. Similarly, S2, S3, etc., signifies the second, third, etc., metasomal sternites, respectively.

Acrophotopsis Schuster


Diagnosis of females.—The females of Acrophotopsis can be diagnosed by the
following unique combination of characters: they are nocturnal with reddish brown to brown integument; the compound eyes are only slightly ovate (Fig. 1); the mandible has a distinct basal tooth on ventral margin and a tooth-like projection at the anterior termination of the dorsal carina; the mesosoma is longer than broad and only slightly wider at the mesonotal spiracle than elsewhere (Fig. 2); the first metasomal segment is petiolate with the second (Figs 1 and 2); the mesosoma and second metasomal tergite are moderately punctate to reticulately sculp-
tured and have rasp-like tubercles situated between the reticulations with the tubercles being more apparent anteriorly than posteriorly (Figs 2 and 3); the punctures, at least on the anterior half of the second tergite, have lateral margins that extend posteriorly appearing as a multitude of longitudinal ridges (Fig. 3); the pygidium is granulate and defined laterally by carinae (Fig. 4); and the propodeum and fringes of tergites two through four consists of distinct white plumose setae (Figs 2 and 3).

*Acrophotopsis campylognatha* Schuster


Diagnosis of female.—The female of *A. campylognatha* can be separated from that of *A. dirce* by the mesosoma and second metasomal tergite being reticulately scul-
tured and the setae on the dorsal of the mesosoma and centrally on the second tergite being whitish and only slightly tinged reddish-brown.
Description of female.—**Coloration and Setal Pattern:** Body reddish-brown to brown. Mandibular apices black. Flagellum and legs yellow to dark yellow. Setae sparse in general, not concealing sculpture.

Head, pleurae, and vertical face of propodeum with decumbent and erect white brachyplumose setae. Dorsum of mesosoma with decumbent and erect brachyplumose setae; setae white, but slightly tinged reddish-brown. Propodeal dorsum and vertical face with distinct, sparsely-spaced, white plumose setae. T1 covered with both decumbent white plumose setae and erect white brachyplumose setae.

**Head.**—Head rounded posteriorly, not as wide as mesosoma, densely punctate. Eye slightly ovate, distance from posterior mandibular articulation ~2.5× length of pedicel. Clypeus protruding anteriorly, postero-medially produced into low triangular swelling with central tubercle. Antennal scrobe without dorsal carina. Antennal tubercle glabrous, except with carinate apical margin. Flagellomere I ~1.2× length of pedicel. Flagellomeres II–III ~1.0–1.2× length of pedicel. Flagellomeres I–III subequal in length. Flagellomeres II–X produced apically on ventral side; appearing crenulate. Mandible bidentate apically. Dorsal mandibular carina with tooth-like projection at anterior termination of carina. Ventral mandibular margin with large basal tooth; lacking excision apical to ventral tooth.

**Mesosoma.**—Mesosoma wider anteriorly than posteriorly, longer than broad. Mesosoma reticulate on dorsum, some reticulations with margin appearing tuberculate; punctures becoming larger and without tubercles posteriorly. Propodeum punctate anteriorly. Humeral angle dentate. Epaulet prominent. Scutellar scale absent. Mesopleuron punctate medially. Metasternum with low transverse tubercle present medially just anterior to mesocoxa. Metasternum tridentate, median tooth ~4× as long as lateral teeth. Extreme ventral region of lateral margin of propodeum punctate. Mid- and hind-tibiae with two rows of spines on outer margin and each with pair of tibial spurs.

**Metasoma.**—Segment 1 distinctly petiolar with segment 2. T1 with small sparse punctures. T2 with large reticulations on anterior half with tubercles situated between reticulations, becoming more sparsely punctate posteriorly. Reticulations and punctures with lateral margins extending posteriorly forming longitudinal carinules, even in sparsely punctate region. T2 with felt line; length 0.20× length of tergite. T3–T5 shagreened. T6 with distinct pygidial area defined laterally by weak carinae; surface granulate. S2 with slight anteromedian tumid region. S2–S5 with punctuation similar to tergites.

**Length:** ~5.6 mm.

**DNA voucher specimen data.**—**California, San Bernardino Co.:** 5 mi S Barstow, 1 g, 30 May 2005, E.E. & K.A. Williams, KW14; 1 ♀, 30 May 2005, E.E. & K.A. Williams, JP324 (EMUS).

**Distribution.**—**Acrophotopsis campylognatha** is present in the southern regions of the Mojave Desert of California and into the Sonoran Desert of Baja California.

**Remarks.**—This sex association is based on molecular data. A total of 1,432 base pairs (504 bp for ITS1 and 928 bp for ITS2) was used to associate the male and female of this species. Both the ITS1 and ITS2 loci are identical between the male and female and this distance is much smaller than the interspecific genetic distance between *A. campylognatha* and *A. dirce* (8% for ITS1; 11% for ITS2).

**Acrophotopsis dirce** (Fox)


NEW SYNONYM.

Diagnosis of female.—The female of A. dirce can be separated from that of A. campylognatha by the mesosoma and second metasomal tergite being only densely punctate (Fig. 3) and the setae on the dorsum of the mesosoma and centrally on the second tergite being distinctly reddish-brown.

Redescription of female.—

**Coloration and Setal Pattern:** Body reddish-brown to brown. Mandibular apices black. Flagellum, scape and legs yellow to dark yellow. Setae sparse in general, not concealing sculpture (Figs 1 and 2). Head, pleurae, and vertical face of propodeum with decumbent and erect white brachyplumose setae (Fig. 2). Dorsum of mesosoma with decumbent and erect brachyplumose setae (Fig. 2); setae reddish-brown. Propodeal dorsum and vertical face with distinct sparsely spaced white plumose setae (Fig. 2). T1 covered with both decumbent white plumose setae and erect white brachyplumose setae (Fig. 2). T2 with erect white brachyplumose setae, reddish brown centrally; sparse short white plumose setae present on posterior third (Fig. 3). T2–4 (Figs 3 and 4) and S2–S5 with fringe of white plumose setae; fringe becoming more sparse on apical tergites. Fringe of T5 medially with light golden brachyplumose setae, laterally with white plumose setae. Legs with white brachyplumose setae.

**Head.—** Head rounded posteriorly, not as wide as mesosoma, densely punctate. Eye slightly ovate, distance from posterior mandibular articulation ~2.5× length of pedicel (Fig. 1). Clypeus protruding anteriorly, posteromedially produced into low triangular swelling with central tubercle. Antennal scrobe without dorsal carina. Antennal tubercle glabrous, except with carinate apical margin. Flagellomere I ~1.2× length of pedicel. Flagellomeres I–III subequal in length. Flagellomeres II–X produced apically on ventral side; appearing crenulate. Mandible bidentate apically. Dorsal mandibular carina with tooth-like projection at anterior termination of carina. Ventral mandibular margin with large basal tooth; lacking excision apical to ventral tooth. Genal carina absent.

**Mesosoma.—** Mesosoma wider anteriorly than posteriorly, longer than broad (Fig. 2). Mesosoma confluent punctate on dorsum, some reticulations with margin appearing tuberculate; punctures becoming somewhat reticulate posteriorly, but without tubercles (Fig. 2). Propodeon anteriorly, mesopleuron medially, and extreme ventral region of lateral margin of propodeum punctate. Humeral angle dentate. Epaulet prominent. Scutellar scale absent. Mesosternum with low transverse tubercle present medially just anterior to mesocoxa. Metasternum tridentate, median tooth ~4× as long as lateral teeth. Mid- and hind-tibiae with two rows of spines on outer margin and each with pair of tibial spurs.

**Metasoma.—** Segment 1 distinctly petiolar with segment 2 (Fig. 1 and 2). T1 with small sparse punctures. T2 confluent punctate on anterior half with tubercles situated between reticulations, becoming sparsely punctate posteriorly (Fig. 3). Reticulations and punctures with lateral margins extending posteriorly forming longitudinal carinules, but not in sparsely punctate region. T2 with felt line; length 0.20× length of tergite. T3–T5 shagreened. T6 with distinct pygidial area defined laterally by weak carinae; surface granulate (Fig. 4). S2 with slight anteromedian tumid region. S2–S5 with punctuation similar to tergites.

**Length:** ~7 mm.


Distribution.—Acrophotopsis dirce has been collected from the Mojave Desert of Nevada to the Sonoran Desert of Arizona and Mexico.

Remarks.—The sex association is based on the similarities of the female described here with the female associated with A. campylognatha and the known distribution of A. eurygnatha. The type specimen of A. dirce was collected in Tucson, Arizona, and does not differ from other specimens from farther east in Arizona and New Mexico. These specimens are found in the same areas as the A. eurygnatha male. While no females were available for molecular comparisons, the available intraspecific genetic distances between males was low (0.0–0.3% for ITS1).

DISCUSSION

These are the first females to be associated with this genus. Only three nocturnal genera in the Nearctic region, Acanthophotopsis Schuster, Laminatilla Pitts, and Schusterphotopsis Pitts remain known only from a single sex. Ferguson supposedly associated a female with A. eurygnatha during his study at the Nevada Test Site, which was cryptically listed in Allred (1973), but he apparently never described the female and we have been unable to find the specimens referred to in Allred’s manuscript.

The females of Acrophotopsis are easy to recognize as belonging to the genus. Disregarding setal color, they will key out to Dilophotopsis Schuster in Manley and Pitts (2002), from which they can be immediately separated by the presence of the anterior tooth at the termination of the dorsal mandibular carina and the presence of scattered tubercles on the metasoma. There are other nocturnal females that have a subset of these characters that could be confused with Acrophotopsis, but all lack the scattered tubercles on the mesosoma and metasoma. Specifically, Sphaerophthalma laodamia (Fox) and Stethophotopsis maculata Pitts both have longitudinal carinae on the second tergite, but Sp. laodamia has a distinct dorsal carina on the scrobe, while St. maculata lacks this carina (Pitts and Manley 2002). Additionally, Sp. laodamia and St. maculata have neither a large ventral tooth, nor a dorsal tooth on the mandible. They also lack tubercles on the mesosoma and second tergite, and lack a laterally defined pygidium. The male of Sp. laodamia is unknown, but this species seems to be placed in the correct genus. Lastly, Sp. unicolor (Cresson) has a dorsal tubercle on mandible, but lacks a large ventral tooth and has a sessile attachment metasomal segment 1 to metasomal segment 2.

It is rather difficult to differentiate the species of Acrophotopsis based on females. This is not surprising given the difficulty of separating the females of other related taxa (e.g. Pitts et al. 2004; Pitts 2006). The two Acrophotopsis species apparently differ only in the coarseness of the sculpturing on the dorsum of the mesosoma and second tergite of the metasoma, as well as in subtle setal coloration differences in these same areas. The two species do not overlap greatly in range, and, therefore, locality data can also be a good indicator for identifying the females. The males of these species, on the other hand, are not difficult to distinguish and differ in several characters, such as shape of the cuspis of the genitalia (Pitts and McHugh 2002).

Wilson and Pitts (2008) recently concurred along with Pitts and McHugh (2002) and Pitts (2003) in suggesting that Dilophotopsis and Schusterphotopsis Pitts are closely related to Acrophotopsis. The females of D. concolor and D. stenognatha (Cresson) have been described (Mickel 1963; Pitts et al. 2007) and can be compared to the females
of Acrophotopsis. The female of Dilophotopsis paron (Cameron) remains unknown. The females of these two genera are morphologically quite similar and share several notable characteristics, such as a large basal tooth on the ventral margin of the mandible, as well as the dorsal carina of the mandible terminating in a semi-erect tooth and the granulate sculpturing of the pygidium. The females of Dilophotopsis, however, have a longer first flagellomere, have more distinct plumose setal fringes on the metasoma, but lack the erect tubercles on the dorsum of the second metasomal tergite. In some cases the dorsum of the mesosoma of D. concolor has indistinct tubercles, but never to the degree of Acrophotopsis. Although not all of the females of Dilophotopsis are known, the similarities of the females of these taxa further strengthens the assertion that Dilophotopsis and Acrophotopsis are sister groups. In addition, the females of these genera share many characteristics with females of the Sphaeropthalma orestes species-group, more so than with other Sphaeropthalma females, and suggesting that Sphaeropthalma may be a paraphyletic assemblage.

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LITERATURE CITED