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The Genus *Sigmatineurum* Parent in Hawaii (Diptera: Dolichopodidae), with a Revised Key to Species[1]

NEAL L. EVENHUIS (Hawaii Biological Survey, Bishop Museum, 1525 Bernice Street, Honolulu,Hawaii 96817, USA)

Introduction

Collections since the recent review of *Sigmatineurum* (Evenhuis & Polhemus, 1994) have added new species and a re-examination of currently known species and comparisons with other hydrophorine species have better defined the taxonomic limits of this endemic Hawaiian genus. As a result of these investigations, three new species, *S. nigrum* (East Maui), *S. parenti* (East Maui), and *S. meaohi* (Hawaii Island), are described and illustrated and *Eurynogaster binodata* Parent from Oahu is newly transferred to *Sigmatineurum*. Also, a male of *S. iao*, one of only two specimens of this species to have been collected from Iao Valley on West Maui since the 1930s, has its male abdomen described for the first time. As a result of these new additions to the genus, a revised key to the species of Hawaiian *Sigmatineurum* is presented.

Materials and Methods

Specimens examined in this study derived from The Natural History Museum, London (BMNH), Bishop Museum (BPBM), Hawaii State Department of Agriculture, Honolulu (HDOA), and the University of Hawaii at Manoa (UHM). Terminology follows Bickel (1991) with the addition of the abbreviation tr = trochanter.

Systematics

Sigmatineurum iao Evenhuis Fig. 7

Sigmatineurum iao Evenhuis *in* Evenhuis & Polhemus, 1994: 8–9.

The original description of this species was based on two specimens, one each collected in 1915 and 1931. Recent collection of a single male and female allow examination and description of the abdomen (broken off in the type specimen) and male hypopygium for the first time. Otherwise, characters given in Evenhuis & Polhemus (1994) for this species remain the same.

Abdomen. Brown with emerald green and magenta reflections, long dark setae posterolaterally on tergite I, thinner hairs posterolaterally on tergites IV and V; sternal 4 process (Fig. 7) dark brown to black, triangular in shape, long, thin, in lateral view. Hypopygium dark brown.

Material examined. MAUI: West Maui: 1 male, 1 female, Iao Valley, Poohahoahoa Stream, 2000 ft. [610 m], 6.v.1994, D.A. Polhemus [preserved in alcohol] (BPBM).

Sigmatineurum omega Evenhuis Fig. 1

Sigmatineurum omega Evenhuis *in* Evenhuis & Polhemus, 1994: 8–9.

The original illustration of the male leg in Evenhuis & Polhemus (1994: fig. 17) was inaccurately drawn, however the description is correct. A corrected figure is given here (Fig. 1).

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Sigmatineurum binodatum (Parent), **new combination** Figs. 2, 6, 8

Eurynogaster binodata Parent, 1939: 241.

Diagnosis. Keys to *S. mnemogagne* Evenhuis using the key to species in Evenhuis & Polhemus (1994), but is easily distinguished by the foliate sternal 4 process (Fig. 8), which is thick in lateral view; the small pointed process on the the mid trochanter; the lack of strong bristles on the ventral surface of FII (Fig. 2); and the setal characters of TII.

Types: Holotype and two male paratypes from: Hawaiian Islands: Oahu, Kaluanui Stream, 2000 ft [610 m], 18.x.1936, F.X. Williams in BMNH, examined. A female paratype of *binodata* so labeled in BMNH from Mt. Kaala, Oahu, September 1936, F.X.Williams, is probably a specimen of *Eurynogaster minor* Parent and may have been mislabeled.

Other material examined. Hawaiian Islands: OAHU: [Koolau Mountains:] Kaluanui Stream, 2000 ft. [610 m], 3.iv.1938, 14.v.1946, 18.x.1936, 22.xi.1936, all F.X. Williams (HDOA).

Habitat. Williams (1939) gave a detailed description of the general habitat and biology of this species as well as observations on its behavior (some of this information was presented in Evenhuis & Polhemus, 1994).

Sigmatineurum nigrum Evenhuis, **new species** Figs. 3, 8

Diagnosis. Keys to *mnemogagne* Evenhuis using the key to species in Evenhuis & Polhemus (1994), but differs from that species by the distinct triangular process on the ventral surface of the mid femur, the pointed process on the trochanter, the long, thin sternite 4 process, its larger size, and its dark body coloration.

Male. Body length: 6.5 mm. Wing length: 5.5 mm. Head. Front, face, and vertex dark brown with blue-green reflections, clypeus pale brownish pruinose, with darker anterior tentorial pits and light blue-green highlights; inner eye margins parallel-sided from level of antenna to level of upper margin of clypeus; palp and proboscis brown; antenna with arista length slightly less than head height.

Thorax. Mesoscutum and scutellum brown with magenta and green reflections; notopleural area shining magenta; anepisternum with brassy green (below) and magenta (above) reflections; remainder of pleura brown; thoracic setae black to dark chocolate brown: 5 *dc*; 2 + 1 *np*; 1 *ph*; 1 *pa*; 1 + 1 *sc*; *ac* absent.

Legs. Brown, blue-green reflections on coxae, femora, and tibia. FI predominantly bare, a few hairs ventrally at apex; TI (Fig. 3a) slightly sinuous with long, dense hairs along ventral surface (MSSC), single strong seta on anterior surface near middle. It1 long, 6 times length of It2, with long, dense setae on ventral surface (MSSC). It3-5 unmodified. IItr with distinct thorn-like process apically. FII (Fig. 3b) with distinct triangular process ventrally at apical one-fourth (MSSC); with strong, thorn-like apicalmost seta, small, short, peg-like setae covering apex of triangular process, and scattered fine hairs and setae from middle of segment to thorn-like apical seta (MSSC). TII sinuous, with subbasal notch and slightly swollen area at apical 1/3; strong hairs and setae along ventral surface, longest at basal one-third and near apical swollen area; strong spur at swollen area, slightly sorter than longest hairs there. IIt1 slightly bowed, with patch of dense setae basally. IIt2-5 unmodified. Right midleg broken off and missing beyond basal one-third of tibia. Leg III unmodified.

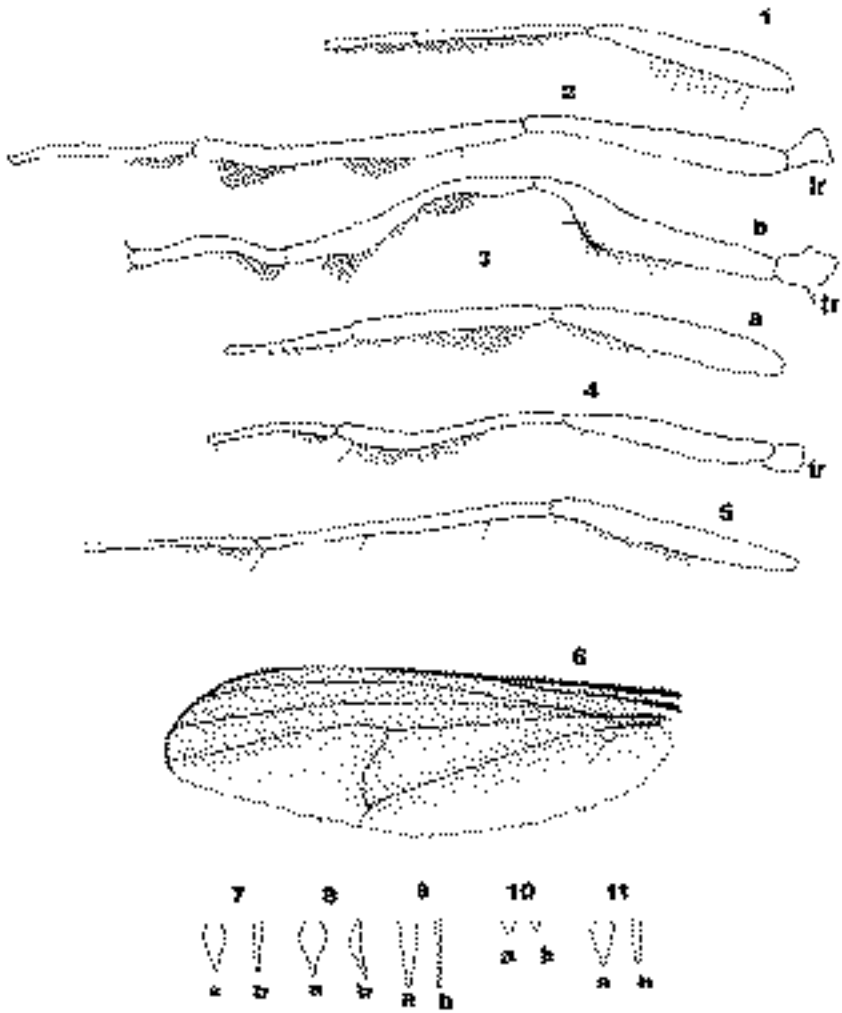
I—5.0;5.0;3.0/0.5/0.5/0.5/0.5

II—8.0;6.8;3.5/3.3/3.0/2.0/1.5

III—8.0;9.5;5.0/3.5/2.5/1.4/1.3

Wing. Subhyaline throughout, brown color densest basally and along anterior margin to apex of R2+3; crossvein m-cu bent slightly at middle, not S-shaped; slight brown tinting on M1 slightly beyond crossvein m-cu (MSSC); CuA1 almost reaching wing margin; CuAx 4.5; halter dark brown.

Abdomen. Dark brown with green reflections dorsally, reflections brassy green and magenta laterally; black hairs posterolaterally on tergite I, thinner denser patch of hairs at posterolateral angle of tergite V; sternite 4 process (Fig. 9) rather large, foliate, thin in lateral view. Hypopygium light brown with brown cerci.



Figs. 1-5. *Sigmatineurum* legs (femur to tarsus 1). **1**, *S. omega* midleg. **2**, *S. binodatum* midleg. **3**, *S. nigrum* legs; **a**, foreleg; **b**, midleg. **4**, *S. parenti* midleg. **5**, *S. meaohi* midleg. **Fig. 6**. *Sigmatineurum meaohi,* male wing. **Figs. 7-11**, *Sigmatineurum* sternite 4 processes (a, caudal view; b, lateral view). **7**, *S. iao*. **8**, *S. binodatum.* **9**, *S. nigrum.* **10**, *S. parenti.* **11**, *S. meaohi.* tr = trochanter.

Female. As in male except for lack of MSSC; legs normal, without modifications.

Types. Holotype male (BPBM 15,853) and paratype female from Hawaiian Islands: MAUI: East Maui: Maunawainui Stream, 1800 ft. [550 m], 8.ix.1994, D.A. Polhemus.

Habitat. Only a single male of this species were collected in association with *S. parenti* on rocks in the splash zone along the Maunawainui Stream.

Etymology: This species is named for the characteristic black coloration of the body.

Sigmatineurum parenti Evenhuis, **new species** Figs. 4, 10

Diagnosis. Keys to *S. mnemogagne* Evenhuis using the key to species in Evenhuis & Polhemus (1994), but *parenti* is easily distinguished from *mnemogagne* by the characters of the male postabdomen: sternite 4 process is very small, peg-like (this process much larger in *mnemogagne*).

Male. Body length: 3.5–4.9 mm. Wing length: 3.5–4.8 mm. Head. Front, face, and vertex dark brown with dark blue-green reflections, clypeus slightly gray-brown pruinose, with darker anterior tentorial pits; inner eye margins parallel-sided from level of antenna to level of upper margin of clypeus; palp and proboscis pale brown; antenna with arista length two-thirds head height.

Thorax. Mesoscutum and scutellum brown with brownish gray pruinosity, blue green reflections dorsally; pleura with magenta and brassy green reflections, otherwise pleura brown; thoracic setae black to dark chocolate brown: 4 + 1 *dc*; 2 *np*; 1 *ph*; 1 *pa*; 1 *sc*; *ac* absent.

Legs. Brown, blue-green reflections on coxae, femora, and tibia. FI predominantly bare, a few stiff hairs ventrally near middle; TI with long hairs along ventral margin (MSSC), longest near middle; remainder of leg I unmodified. FII (Fig 4) with very small, black, stubby bristles along ventral margin (MSSC), bristles absent at base, thinning out apically to subapical seta; TII (Fig. xx) slightly distorted with long, black ventral hairs (MSSC) on apical half, spur undifferentiated from other ventral setae; IIt1 slightly bowed with small dense patch of short subbasal setae (MSSC); IIt2-5 unmodified. Leg III unmodified.

I—5.5;4.7;2.0/0.7/0.7/0.3/0.3
II—6.0;6.0;4.0/2.5/1.2/0.6/0.6
III—4.0;8.5;4.5/3.0/1.5/1.0/1.0

Wing . Hyaline, brown infuscation only at extreme anterior margin along costal vein; crossvein m-cu bent slightly at middle, not S-shaped; no thickening of veins R2+3, R4+5, or M1; CuA1 reaching or almost reaching wing margin; CuAx 2.0; halter white.

Abdomen. Dark brown with green reflections dorsally, reflections green and brassy green laterally; black hairs posterolaterally on tergite I; sternite 4 process (Fig. 10) very small, peg-like, thick in lateral view. Hypopygium brown.

Female. As in male except for lack of MSSC; legs normal, without modifications.

Types. Holotype male (BPBM 15,854) and 22 paratypes from Hawaiian Islands: MAUI: East Maui: Maunawainui Stream, 1800 ft. [550 m], 8.x.1994, D.A. Polhemus.

Habitat. This species was collected from rocks in the splash zone of the Maunawainui Stream.

Etymology: This species is named in memory of abbé Octave Parent, in honor of his foundational work with Hawaiian dolichopodids and for describing the genus *Sigmatineurum*.

Sigmatineurum meaohi Evenhuis, **new species** Figs. 5, 6, 11

Diagnosis. Keys to *S. omega* using the key to species in Evenhuis & Polhemus (1994), but differs from that species based on the much longer and denser setae on TII and by its larger size and darker body coloration.

Male. Body length: 4.4–4.8 mm. Wing length: 4.2–4.4 mm. Head. Front, face, and vertex dark brown with dark blue-green reflections, clypeus dark brown, with black anterior tentorial pits and some light blue-green highlights; inner eye margins parallel-sided from level of antenna to level of upper margin of clypeus; palp and proboscis dark brown; antenna with arista length slightly less than head height.

Thorax. Mesoscutum and scutellum dark brown, some blue green reflections; notopleural area shining blue-green; anepisternum with greenish reflections; remainder of pleura brown; thoracic setae black to dark chocolate brown: 5 *dc*; 2 *np*; 1 *ph*; 1 *pa*; 1 + 1 *sc*; *ac* absent.

Legs. Brown, blue-green reflections on coxae, femora, and tibia. FI predominantly bare, a few hairs ventrally at apex; remainder of leg I unmodified. FII (Fig 5) with strong stubby bristles along

ventral margin, densest and strongest from basal one-third to subapically; base and apex bare. TII slightly distorted, with fine hairs along most of ventral margin, dorsal surface with 2 strong black setae. IIt1 as in *parenti*, n. sp.; IIt2–5 unmodified. Leg III unmodified.

I—6.0;5.0;2.0/0.5/0.5/0.5/0.5
II—6.0;7.3;4.0/2.5/1.8/1.0/0.7
III—8.5;10.0;4.8/3.2/2.0/1.5/1.3

Wing (Fig. 8) Infuscated pale brown except in the middle of cells bm + dm and m and in middle of anal lobe, pale brown clouding covering most veins; crossvein m-cu S-shaped, without small spur vein; slight thickening of veins R2+3, R4+5, and M1 at level just beyond m-cu, with brown tinting surrounding thickening, thickest on M1 (MSSC); CuA1 reaching wing margin; CuAx 5.0; halter dark brown, knob brown along edges, white in middle.

Abdomen. Dark brown with blue-green and green reflections dorsally, reflections brassy green laterally; black hairs posterolaterally on tergite I, thinner denser patch of hairs at posterolateral angle of tergite V; sternite 4 process (Fig. 11) rather large, foliate, thin in lateral view. Hypopygium dark brown.

Female. As in male except for lack of MSSC; m-cu not S-shaped, but with slight bend in middle; infuscation on wing lighter throughout; legs normal, without modifications.

Types. Holotype male (BPBM 15,855) and 6 paratypes from Hawaiian Islands: HAWAII: Upper Waipio Valley, Alakahi Stream, 1050 ft. [305 m], 3.x.1996, R. Englund, R. Filbert, riffle habitat above diversion (all in BPBM).

Habitat. This species was swept from the rocks in the swift flowing waters of the Alakahi Stream, a tributary of the Waipio River in Upper Waipio Valley.

Etymology: The specific name is Hawaiian for "collector" and is named in honor of its intrepid collectors, Ron Englund and Randall Filbert, who surveyed and collected the biota of the virtually inaccessible tributaries of the Waipio River complex.

Revised Key to Hawaiian *Sigmatineurum* Parent Based Upon Males

1. Crossvein m-cu straight or with with slight bend near middle, not distinctly S-shaped; FII with only short weak bristles or bristles absent, replaced by fine hairs (*mnemogagne* species complex) 2
-. Crossvein m-cu strongly sinuate to S-shaped (Fig. 6), with or without spur veins; FII with long strong bristles on basal 1/2 (except in *omega*). 5
2. Sternal process 4 thickened in cross section (Fig. 8); tr with small pointed process; FII without black bristles, bristles replaced by fine hairs (Oahu) . . . . . **binodata** (Parent)
-. Sternal 4 process thin in cross section (Fig. 10); tr with or without pointed process; FII with black bristles ventrally 3

3. Sternal process 4 long, thin in cross section; FII with bulge subapically on ventral surface 4
-. Sternal process 4 short, peg-like in cross section (Fig. 10); FII without bulge ventrally (East Maui) . . . . . **parenti** Evenhuis, **n. sp.**

4. Body color black; tr with pointed process; FII with distinct triangular shaped bulge (Fig. 3b); sternal 4 process not flared laterally (East Maui) . . . . . **nigrum** Evenhuis, **n. sp.**
-. Body color brown, paler than above; tr without pointed process; FII with much reduced bulge subapically; sternal 4 process flared apically (East Maui) . . . . . **mnemogagne** Evenhuis

5. Crossvein m-cu without spur veins 6
-. Crossvein m-cu with spur veins 7

6. Sternal 4 process long, thin, capitate in cross section (Fig. 11); FII with bristles in middle ventrally, bare apically and basally (Hawaii—Kohalas) . . . . . **meaohi** Evenhuis, **n. sp**.
-. Sternal 4 process not capitate in cross section; FII with bristles along ventral surface from subbasally to apex (Molokai) . . . . . **chalybeum** Parent

7. TII with distinct bulge subapically; FII with ventral row of short bristles in middle, bare at base and at apex (Hawaii—Mauna Kea) . . . . . **omega** Evenhuis
-. TII without distinct bulge subapically; FII with ventral bristles much longer . . . 8

8. Wing infumate basally, anteriorly, and along most veins; veins R4+5, M1, and crossvein m-cu thickened and darkly tinted; TII without MSSC; sternite 4 process small, pointed, thick in lateral view (Kauai) . . **napali** Evenhuis
-. Wing weakly infuscate basally and anteriorly; crossvein m-cu without thickening and dark tinting; TII with strong bristles and preapical spur (West Maui) . . . . . **iao** Evenhuis

Discussion

The species composition of *Sigmatineurum* based on the specimens examined in this study and the revision by Evenhuis & Polhemus (1994) shows a high correlation of one species per volcano throughout the main Hawaiian Islands (with the exception of the three species found on East Maui). Based upon the knowledge of their restricted aquatic habitat, it can be hypothesized that there is a potential of at least one species for every volcano in Hawaii that has swift running streams. The current species composition and island distribution in Hawaii is as follows:

Species	**Island**	**Volcano**
binodatum	Oahu	Koolau
chalybeum	Molokai	East Molokai
iao	Maui	West Maui
meaohi	Hawaii	Kohala
mnemogagne	Maui	Haleakala
napali	Kauai	Kauai
nigrum	Maui	Haleakala
omega	Hawaii	Mauna Kea
parenti	Maui	Haleakala

Thus, the volcanos remaining with no recorded *Sigmatineurum* species that have swift running streams, and that should predictably support species of this genus are as follows:

Oahu	Waianae
Lanai	Lanai
Hawaii	Mauna Loa (Ninole)

Subfamilial Limits of Hydrophorinae

A comprehensive review of the world genera is badly needed in order to fully understand the subfamilial limits of members of the Dolichopodidae. However, few have attempted such a monumental investigation. Robinson (1970) is currently the only worker to have provided a careful analysis of genera within subfamilies and attempted to define subfamilial limits. Unfortunately, his work was limited to New World taxa. Taxa from particular subfamilies in the Old World tropics and native dolichopodids from Oceanic Islands are a very complex group with characters occupying a dizzying variety and that possess character states that often overlap with character states that are typical of other subfamilies. Despite these potential problems, Robinson's work still remains a paradigm and it has been used here as a basis for study for the Hawaiian genera of Dolichopodidae. The following definition of Hydrophorinae is taken from Robinson (1970):

> "Arista dorsal or apical; third antennal segment often elongate or lobed; head rounded posteriorly or slightly depressed behind vertex; epipharyngeal armature with two to four short or long lobed often separated at the base, smooth or slightly to seriately denticulate; labellae sometimes highly sclerotized and mandibuliform, pseudotracheae geminately to massively sclerotized, sometimes the sixth panel unsclerotized, sensory papillae often located on or attached to bases of the pseudotracheae. Thorax rather narrow, acrostichals biseriate to lacking, four to ten pairs of often reduced dorsocentrals; slightly to strongly convex, sometimes flattened posteriorly; proepisternum bare in upper part, often heavily pubescent below; fourth with vein not branched, last of fifth vein often shorter than the posterior crossvein. Femora with poorly differentiated preapicals often remote from the tips of the femora, anterior femora often thickened at the base and bearing distinctive setae. Abdomen sometimes flattened above; hypopygium relatively small or somewhat enlarged but usually enclosed in the tip of the preabdomen; female genitalia with a crest of dornen above. Larvae with obvious lobes posteriorly (7 lobes in *Aphrosylus*)."

The genera found in Hawaii that are currently treated within Hydrophorinae are: *Hydrophorus* Fallén (2 species), *Sigmatineurum* Parent (9 species), *Paraliancalus* Parent (1 species), *Thinophilus* Wahlberg (1 species) (Grootaert & Evenhuis, 1997), and *Thambemyia* Oldroyd (= *Conchopus* of authors) (1 species[2]). I have examined various Hawaiian taxa, compared them with the characters used by Robinson, and concur that the genera listed above are hydrophorine (*sensu* Robinson). This re-examination prompted the transfer of *Eurynogaster binodata* to *Sigmatineurum*. Re-examination of all known species of *Eurynogaster* is currently underway, which will no doubt result in further transfers of species to Hydrophorinae and clarification of generic limits of that genus.

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