

The "*Forcipomyia ingrami*" Complex in Hawaii (Diptera: Ceratopogonidae)

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ABSTRACT

Biting midges of the genus *Forcipomyia* are some of the most important pollinators of cacao and other tropical crop plants. A study of the species known as *F. ingrami* revealed that it has been misidentified, and that the African species formerly known as *ingrami*, now *psilonota*, does not occur in Hawaii. Instead there are at least four other species: *palikuensis* Hardy, a large, shining blackish species from Hawaii and East Maui; *kaneohe* n. sp., a small shining species from Oahu; *pholeter* n. sp., a small pale species living in lava tube caves on Hawaii; and *hardyi* n. sp., a dull brownish species which is extremely common on all the islands; all probably endemic to the Hawaiian Islands. The immature stages of these midges, which breed in wet, decaying vegetation, leaf axils, and aquatic vegetation, have excellent characters diagnostic for species. Characters are illustrated and discussed showing how these species may be distinguished from their closely related congeners from the Pacific, Asia, and Africa. *Forcipomyia clara* Chan and LeRoux from Singapore is a junior synonym of *F. sauteri* Kieffer (N. SYNONYMY).

Biting midges were first recorded from the Hawaiian Islands by Grimshaw (1901) as *Ceratopogon* sp. Perkins (1913:clxxxi) in the introduction to the Fauna Hawaiiensis reported "The smaller chironomids such as *Tanytarsus* and *Ceratopogon* are found in the mountain forests and the species may prove to be endemic." Bridwell (1920:284) reported "finding (in a salt marsh at Waikiki) rather numerously a species of *Ceratopogon*, of which genus there is a different species in the mountains." Of this note, Bryan (1934:405) added: "Related specimens, sent to Johannsen, were referred to the subgenus *Prohelea*. Perkins (1913, p. clxxxi) stated that more species probably exist in the mountains. At times small clouds of these gnats are to be seen."

Macfie (1934a:134) listed *Forcipomyia ingrami* Carter from nine collections made by F.X. Williams and O.H. Swezey in Hawaii, and gave the following notes casting some doubt on the correctness of his determination: "The specimens are exceptionally dark in colour, but do not seem to differ from typical examples of *F. ingrami* in any material respect, except in having the first tarsal segment in the males unusually long, slightly longer than the second segment instead of rather shorter, the tarsal ratio being about 1.1 instead of about 0.8. The genitalia of the males appear to be indistinguishable from those of *F. ingrami*. For this reason and because *F. ingrami* is known to be somewhat variable, there does not seem to be any sufficient reason for considering these specimens as distinct from that species."

Williams (1936a:111) reported *Forcipomyia ingrami* Carter from various points on Oahu and Hawaii. Again (1936b:325) he mentioned *F. ingrami* as occurring in Hering Valley, Honolulu, on algae-covered wet banks along with

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nymphs of the damselfly *Megalagrion hawaiiense* (McLachlan) which preyed on the midge larvae along with other insects sharing this aquatic habitat.

Williams (1944:173) gave extensive notes and descriptions of his collections of *F. ingrami* in Hawaii. Fig. 1 is taken from Williams' superbly illustrated paper, showing the general habitus of all stages of these midges. Williams presented observations on their habits and life history, better and in more detail than any other yet made in Hawaii, and his paper should be read carefully for the details. We have examined Williams' slide preparations of *F. ingrami* in the HSPA collection (now in the Bishop Museum). Our summaries, and the results of our attempt to sort out his observations to their respective species, will be presented under the appropriate species below.

Wirth (1946:492) reported his collections of *F. ingrami* from Hawaii, including what he thought might be a different species taken in a light trap at Wheeler Field, as well as by hand collections from Manoa Valley, Kamananui Stream and Mt. Kaala, all on Oahu. Females were much smaller and darker than typical *ingrami*, and the hairs of the mesonotum were black rather than golden. Hardy (1952:448) also reported records of *F. ingrami*. Later he (1960:173) redescribed and figured the species and gave characters to separate it from *F. palikuensis* Hardy, which he described as new. He also gave notes on the biology and distribution of the species in Hawaii.

Biting midges of the genus *Forcipomyia* Meigen, and especially in the subgenus *Euprojoannisia* Brèthes, have been shown to be the major pollinators of cacao (*Theobroma cacao* L.), rubber (*Hevea brasiliensis* L.) and other important tropical crop plants (see Warmke 1951, Saunders 1959, Fontanilla-Barroga 1961, Dessart 1961a, Soria 1971, Entwistle 1972, Winder and Silva 1972, Soria and Wirth 1974, Winder 1977, 1978). Mainly through the important studies of Saunders (1956) the classification of *Forcipomyia* has been placed on a sound footing by the combined use of taxonomic characters of larval, pupal and adult stages. From the recent studies by Tokunaga and Murachi (1959) in Micronesia, Dessart (1963) in Africa, Chan and LeRoux (1971) in Asia, and Bystrak and Wirth (1978) in North America we are now able to characterize adequately the previously described species of *Euprojoannisia* and to compare them with the species found in Hawaii.

Through the courtesy of D. Elmo Hardy of the University of Hawaii we were able to borrow for study the extensive collections he used in his review of the ceratopogonids in the "Insects of Hawaii" (1960). These were indispensable and when used in conjunction with the material in the B.P. Bishop Museum, the U.S. National Museum, and our own collecting in Hawaii, have given us what we believe is a fairly adequate sample of the Hawaiian fauna. In all, we examined 2413 specimens in our study. We would like to express our thanks to William L. Grogan, Jr. for the SEM photographs shown in fig. 2, to Linda Heath Lawrence for the drawings shown in fig. 3, and to Molly Ryan for the drawings in figs. 4-7.

Keys to the Hawaiian Species of the Subgenus *Euprojoannisia*

ADULT FEMALES

1. Large species, wing length more than 1.0 mm; distal antennal segments elongate, antennal ratio 1.14-1.27; hind tarsal ratio about 1.5-1.7; spermathecal necks gradually tapering 2

- Smaller species, wing length less than 1.0 mm, distal antennal segments shorter, antennal ratio 0.89-0.86; hind tarsal ratio less than 1.5; spermathecae abruptly tapering to short slender necks 3
2. Shining dark brown to blackish species; palpal pit small and deep with small pore opening; legs dark brown *palikuensis* Hardy
Brownish species, mesonotum with dull grayish pollinosity; palpal pit broad and shallow; legs usually yellowish to pale brown *hardyi* n. sp.
3. Shining dark brown to blackish species; hind tarsal ratio 1.43; mandible with about 30 well developed teeth; not cavernicolous *kaneohe* n. sp.
Yellowish to pale brown species; hind tarsal ratio 1.17; mandible with about 7 vestigial teeth; cavernicolous. *pholeter* n. sp.

ADULT MALES

1. Aedeagus more elongate, at least 1.2 x as long as basal breadth, tapering to slender tip, usually with a distinct caplike apical swelling *hardyi* n. sp.
Aedeagus about as long as basal breadth, distomedian process various 2
2. Basistyle bearing a prominent setose lobelike swelling on mesal margin at base; apex of aedeagus appearing trilobed, with a slender distal point and two small bladelike apicolateral processes directed ventrad and anterolaterad *palikuensis* Hardy
Basistyle without lobelike swelling on mesal margin; apex of aedeagus with simple blunt tip not modified as above 3
3. Yellowish to pale brown species; midtarsal ratio 1.11 *pholeter* n. sp.
Dark brown to blackish species; midtarsal ratio 1.20 *kaneohe* n. sp.

KNOWN LARVAE

1. Dorsal *a* hairs of body segments moderately long and stout, hyaline, gradually expanded distally, the extreme tip with distinct microscopic fringe; *a* hairs borne on prominent conical dark brown mounds *hardyi* n. sp.
Dorsal *a* hairs of body segments shorter, hastate to lanceolate distally with apex not fringed, borne on less prominent brownish mounds *kaneohe* n. sp.

KNOWN PUPAE

1. Respiratory horn elongate, about three times as long as greatest breadth, apex with 16-20 spiracular openings 2
Respiratory horn short and broad, broader than long, apex with about 45 spiracular openings; (dorsal thoracic tubercles well developed and granulose, dorsal abdominal tubercles small and not spinulose) *kaneohe* n. sp.
2. Cephalothorax with a pair conical bristle-bearing tubercles behind respiratory horns and three pairs of smaller granulose posterior tubercles; abdominal segments each with the dorsal pair of tubercles enlarged in a spinulose cushion. *hardyi* n. sp.
Cephalothorax with only the large anterior pair of bristle-bearing tubercles, the three posterior pairs not developed; abdominal segments with the dorsal pair of tubercle small, not spinulose *pholeter* n. sp.

***Forcipomyia (Euprojoannisia) hardyi* Wirth and Howarth, new species**
(Figs. 1b-g, 2, 3c, 4)

Forcipomyia ingrami Carter (misidentified); Macfie, 1934a: 134 (notes; Hawaii records); Williams, 1936a:111 (Hawaii records); Williams, 1936b:326 (larval habitat; Oahu; prey of Odonata nymphs); Williams, 1944:173 (Hawaii; notes; all stages figured; biology); Wirth, 1946:492 (notes; Hawaii); Hardy, 1952:448 (notes; Hawaii); Hardy, 1960:173 (redescribed; Hawaii distribution; figs; notes); Lupton, 1962:8 (Hawaii; female biting man).

Diagnosis. — A uniformly dull grayish-brown, moderately large species, with color of legs and vestiture of mesonotum somewhat variable; third palpal segment with well-marked, round, shallow, sensory pit; female mandible with about 50 fine teeth; two slightly unequal spermathecae; aedeagus with slender, simple, caplike tip; hind tarsal ratio 1.67 in female, 1.15 in male; mid tarsal ratio 1.20 in male; male hind basitarsus not swollen.

Female Allotype. — Wing length 1.26 mm; breadth 0.59 mm.

Head: Brown; antenna and palpus dark brown. Eyes broadly contiguous. Antenna (fig. 4b) with lengths of flagellar segments in proportion of 25-23-25-26-26-26-26-28-45-46-50-50-70; segments 3-10 short tapering, slightly longer than wide; segments 11-14 long tapering, segment 11 about 2.5 as long as greatest breadth, 15 with long, slender, apical papilla; antennal ratio 1.27. Palpus (fig. 4c) with lengths of segments in proportion of 35-70-32-20; third segment moderately swollen in midportion, 3.0 x as long as greatest breadth, with a distinct, large, round, shallow, sensory pit in midportion. Mandible with about 50 fine teeth.

Thorax: Mesonotum and postscutellum dull brown, scutellum slightly paler; mesonotum with numerous long bristly hairs varying in color from pale brassy to brownish. Legs yellowish to yellowish brown, tarsi slightly darker. Spur of hind tibia short, 0.20 x as long as basitarsus; tarsal ratio 2.06 on foreleg, 1.50 on midleg, 1.67 on hindleg. Wing densely covered with moderately coarse, long, curved macrotrichia; costa extending to 0.55 of wing length. Halter brownish.

Abdomen: Brownish. Spermathecae (fig. 4d) two, very slightly unequal, measuring 0.109 by 0.078 mm and 0.102 by 0.070 mm; ovoid tapering gradually to slender opening of the ducts; well sclerotized, brownish, without hyaline perforations or surface sculpturing.

Male Holotype. — Wing length 1.44 mm; breadth 0.45 mm.

Similar to female with usual sexual differences. Antenna with lengths of last four flagellar segments (fig. 4a) in proportion of 57-37-24-31. Palpus with third segment scarcely swollen, with distinct small round shallow sensory pit. Hind tibial spur short, 0.22 as long as basitarsus; tarsal ratio 1.57 on foreleg, 1.20 on midleg, 1.16 on hindleg; hind basitarsus (fig. 4e) slender, not darkened. Male genitalia (fig. 4f) with ninth sternum about as broad as long; basistyle short and stout, twice as long as broad; dististyle moderately long and slender, slightly tapering and curved to slender pointed tip. Aedeagus 1.2 x as long as basal breadth, basal arch not developed, anterior margin slightly undulating; triangular in ventral profile with sides nearly straight, tapering to slender tip usually with distinct caplike apical swelling. Basistylar apodeme slender, straight, with distinct mesal spur distally, joined anteriorly in a straight, transverse line a third as long as distance between their distolateral tips.

Larva. — Length (mature 4th instar) 4.2 mm. Body elongated and tapered. Color pale yellowish brown, head brown; basal tubercles of *a* and *b* hairs dark

brown. Antenna moderately stout and straight on proximal three-fourths, tapering distally; distal fourth filiform, bent posteriorly. Head with *p* hair lanceolate, *q* hair elongate spoon shaped, *t* hair stiff and erect, other hairs inconspicuous. Body segments each with *a* hair (fig. 3c) moderately long and stout, hyaline, gradually expanded distally, the extreme tip with distinct microscopic fringe; *a* hairs of second to eleventh body segments borne on prominent conical dark brown mounds; basal tubercle of *a* hair on first body segment small, similar to those at bases of the stout, brown, laterally fringed *b* hairs; each body segment with four pairs of slender, relatively inconspicuous paler brown lateral hairs. Basal tubercles of *a* hairs of last (twelfth) body segment fused in a stout transverse bar. Cauda long, tapering, fringed with microscopic setae, about as long as last body segment. Prothoracic pseudopod the usual spinulose cushion with microscopic spinules, coarser in anterior series; posterior pseudopod a transverse ridge bearing two rows of black hooks, 10 in each row, those in posterior row much longer than those in anterior row.

Pupa. — Length 3.2 mm. Pale brown; cephalothorax with the usual granulose moundlike tubercles as in *F. psilonota* Kieffer; abdomen without conspicuous tubercles or spines. Larval exuviae not retained. Respiratory horn (fig. 3c) about 3.2 x as long as greatest breadth, basal stem short, swollen distal portion relatively long; bearing at apex a double palisade of about 20 spiracular openings. Body segments (fig. 3c) each on each side with a small spinulose dorsal tubercle, a smaller dorsolateral tubercle bearing a single spinule and five minute ventrolateral tubercles. Terminal processes sharply pointed, short and divergent in female, longer and somewhat appressed in male.

Distribution. — Common throughout all the main Hawaiian Islands.

Types. — Holotype, male, allotype, female, with pupal exuviae, Mt. Tantalus, Oahu, 425 m, 2.v.1976, F.G. Howarth, reared from leaf axils of *Alocasia macrorhiza* (L.) G. Don (BPBM11546). Paratypes, 31 males, 23 females, 11 larvae, 7 pupae: OAHU: 1 male, 1 female with pupal exuviae, 1 male pupa; 4 larvae; some data as holotype. Kalihi, 120 m, 15-31.v.1977, F.G. Howarth (BISH), reared from larvae on petioles of spiderlily, 5 females, 7 males, with pupal exuviae, 6 pupae, 7 larvae. HAWAII: Kilauaea, Hawaii Volcanoes National Park, Bird Park, 3.iii.1946, W.W. Wirth, swept (USNM), 23 males, 17 females.

Other Specimens Examined. — 839 males, 1221 females. HAWAII: 286 males, 420 females, from 21 locations up to 2100 m elevation. KAUAI: 144 males, 173 females from 10 locations up to 1200 m elevation. LANAI: 13 males, 44 females from Lanaihale, 960 m. MAUI: 146 males, 225 females from 15 locations up to 3000 m. MOLOKAI: 75 males, 60 females from 9 locations up to 1200 m. OAHU: 165 males, 305 females from 36 locations up to 1200 m.

Discussion. — This species is named for D. Elmo Hardy in recognition of his long and productive years of service to Entomology in Hawaii, and his important contributions to the study of Pacific Diptera.

Variation. — *Forcipomyia hardyi* is exceedingly variable in size and color. Leg color ranged from pale yellowish to moderately dark brown. Typically the mesonotal vestiture is yellowish or brassy, but in some populations, particularly at higher elevations, the hairs may become brownish; the integument is typically dull grayish pollinose, sometimes appearing slightly greenish or bluish. Halter color varies from pale yellowish to smoky brown. The measurements and ratios are given for the types; in the large series of specimens which we have examined we noted a variation of as much as 10% from these values, comparable to the

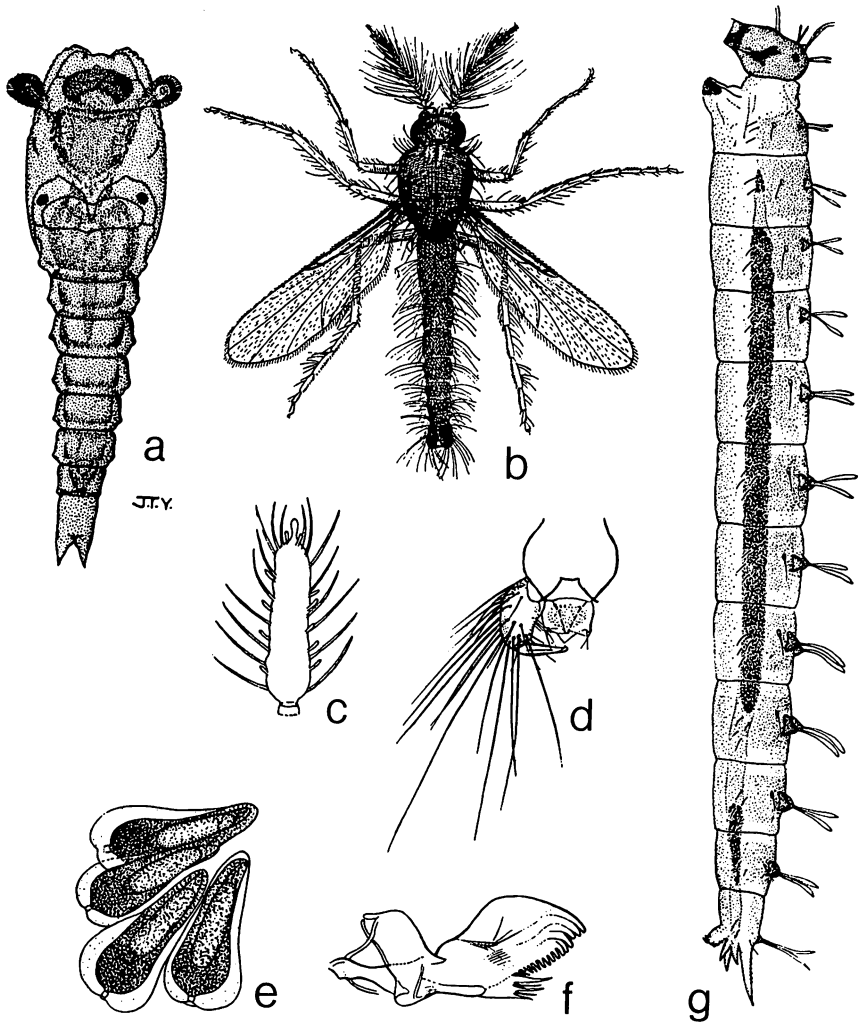


FIGURE 1. Hawaiian *Forcipomyia* (*Euprojoannisia*): a, *F. kaneohe*, presumed pupa; b, *F. hardyi*, male habitus; c, *F. hardyi*, distal segment of female antenna; d, *F. hardyi*, male genitalia; e, *F. hardyi*, eggs; f, *F. hardyi*, larval mandible; g, *F. hardyi*, larva (from Williams, 1944).

latitude of variation found by Bystrak and Wirth (1978) in the North American species.

A series of 18 females and 13 males from 15 km W Hilo, Hawaii, elevation 400 m, collected in a light trap by Howarth 10.xii.1976, is unusually dark with dark brown legs, halteres and mesonotal vestiture. The male aedeagus differs from that of typical *hardyi* in being slightly shorter with the sides concave, making the distal point unusually slender. In measurements and ratios this series falls well within the range for *F. hardyi*. Provisionally we are treating this series as conspecific with *hardyi*. In the same trap collection we identified 2 females

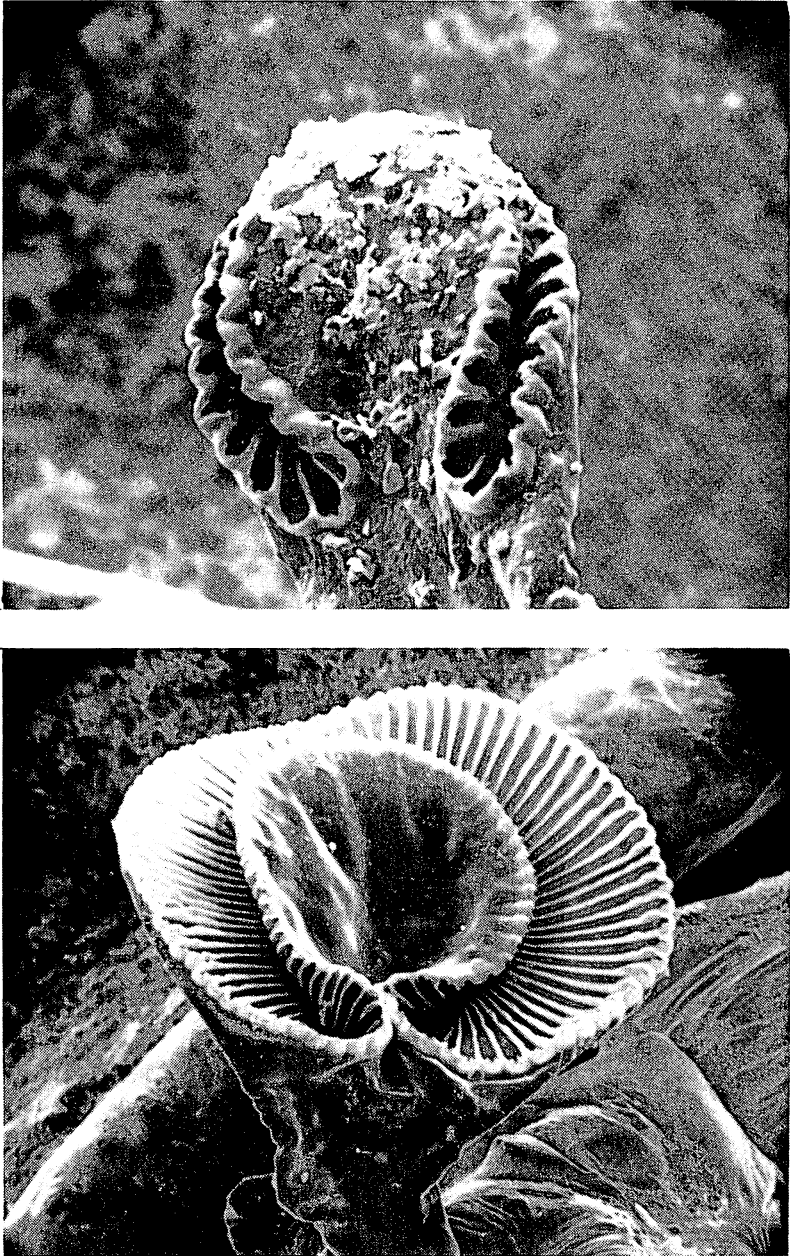


FIGURE 2. Scanning electron microscope photographs of the apices of pupal respiratory horns of *Forcipomyia* (*Euprojoannisia*) species showing the palisade arrangement of the spiracular openings. Top, *F. hardyi* from Mt. Tantalus, Oahu, reared by Howarth. Bottom, for comparison, *Forcipomyia* sp. from Puerto Rico, reared by L.G. Saunders, respiratory horn very similar to that of the presumed *F. kaneohe* reared by Wirth (photos by W.L. Grogan Jr.).

and 4 males of typical *hardyi*, as well as 2 females which agree with *F. pholeter* n. sp. except that the mandibular teeth are more numerous.

Biology. — Apparently, *F. hardyi* breeds in a variety of semi-aquatic habitats in Hawaii, even when eliminating from possible consideration those previous records which probably were based on misidentifications of related Hawaiian species.

The following comments by Williams (1944:173) undoubtedly pertain to *hardyi*: It is "a widespread insect in the Hawaiian Islands. On the big island of Hawaii it has been taken at Kilauea, 4000 ft. (O.H. Swezey); and at Hauhi, 5200 ft. (O.H. Swezey and F.X. Williams); on Oahu it has been collected from the lowlands to the highest peak (4028 ft.). It may be very common in Honolulu during the wetter months — when more breeding places exist — the adults hovering in swarms before sunset about the gables of houses, the more prominent portions of the taller plant growth, or they may even use the gardener's head as a rallying point. Occasionally these swarms — which seem to consist almost entirely of males — become a nuisance. In December 1936 — January 1937, following heavy rains, this midge invaded dwellings in certain parts of the city in annoying numbers. *Forcipomyia*, together with certain other small flies, is often attracted to freshly painted surfaces.

"In the mountains one often observes their swarms dancing alongside trees and bushes.

"When enclosed in vials stoppered with moist cotton or cloth, *Forcipomyia* often laid masses of glassy white eggs shaped like fat cigars, the mass swelling on being placed in water. The eggs are about 0.30 mm. long. In less than a week they hatch into glassy white caterpillar-like larvae with a large head bearing reddish eyespots and some dark shade at the mouth and within the head, both head and body being provided with club-like hairs and hairs of ordinary type. A large horn-like pair, the antennae, adorns the head in front of the eyes. Well forward on the breast is a large pseudopod by means of which the insect drags itself along. The mandibles play with alternate down and backwards strokes."

Williams (p. 174) gave detailed notes on the habits of larvae and pupae taken from Hering Valley behind Honolulu. We examined four slides from Williams' collection from Hering Valley with eggs, adults and larvae which agree with *F. hardyi*. There was no slide-mounted pupa in Williams' collection so we are unable to verify the source of the specimen Williams figured (fig. 48) for "*ingrami*", but his figure clearly is not that of *hardyi* and apparently represents a specimen of *kaneohe* n. sp., a species not represented in Williams' collection. Williams' slide collection also contained immature stages of *F. hardyi* from three other localities: Pauoa Headwaters, Honolulu, iv.1933, 1 larva, 1 female; Mt. Kaala, Oahu, *Gunnera* spring, 22.i.1939, 1 larva; Nauhi, Hawaii, 5200 ft., 28.ix.1931, at base of sheath of calla lily, 3 larvae.

Williams continues with the following summary: "*Forcipomyia ingrami* breeds in a variety of situations. At Kilauea, Hawaii, in October 1929, Mr. O.H. Swezey secured a number of the adult flies from well-watered cabbages, between the leaf bases of which there was some detritus and decay and where no doubt the larvae were feeding. At Nauhi, Hawaii, in September 1931, *Forcipomyia* larvae were found at the base of the spathe of the calla lily (*Richardia aethiopica* Spreng, Araceae) where water and debris collect. The immature stages may be very common among wet leaves and trash in the forest as well as in the dense cover

of the uluhe fern (*Gleichenia linearis* (Burmam Clark)).”

Hardy (1960:173) summarized the breeding habits of the species thus: “*Forcipomyia ingrami* (in Hawaii) breeds in a wide variety of aquatic and semi-aquatic situations – in bogs, shallow water ponds and streams choked with vegetation, at the bases of leaves of plants where water collects, among wet leaves and trash in the forest, as well as in the dense cover of the uluhe fern.”

The following observations on the larval biology of *F. hardyi* were made by Howarth: The type series was reared from Mount Tantalus, Oahu, 425 m, 2 May 1976, from leaf axils of arum, *Alocasia macrorrhiza*. The larvae and pupae were found on the wet slime on the surface of the rotting axil after it had turned yellow and up to the time it turned dark brown and had nearly disintegrated. Larvae were also found in wet leaf litter where they were observed crawling on the surface slime on very wet but not submerged leaves.

The species was reared again in May 1977 as follows: Large fresh leaf petioles of spider lily were placed upright in one inch of water in a wide mouth gallon jar which was then covered with plastic wrap. Female and male midges, aspirated from lights in Kalihi Valley, 120 m, were added over the course of a week from 12-23 May. Larvae were first noted on May 28 and the jar dismantled on May 31, and the larvae and pupae were isolated in vials with moist cotton in order to rear the associated adults.

Adult Habits. – The ubiquitous swarms of adult midges, especially after rainy weather and in the mountains, were described by Williams, and we have also observed these swarms many times, nearly everywhere in Hawaii. Elsewhere in the tropics an extensive literature has been built up pointing to the importance of various species of the subgenus *Euprojoannisia* in the pollination of tropical crop plants. Because of the abundance and widespread distribution of *F. hardyi* in Hawaii, it seems likely that the species may play an important role in the pollination of some of the native Hawaiian plants. A study should be made of this problem at the earliest possible time before more of the endemic Hawaiian flora is wiped out by human intervention. We have several observations indicating possible pollinating activity by *F. hardyi*. Wirth collected adults at flowers of Compositae on Mt. Kaala, Oahu, 4000', 22.viii.1946. Howarth observed great numbers of both sexes at mango blossoms in Kalihi, Oahu, 29.iii.1977.

When large swarms of these midges enter houses, they are sometimes blamed for bites and rashes. Most of these reports of biting remain unconfirmed. However, three unusual observations of female *F. hardyi* feeding habits indicate that some bloodsucking may be characteristic of the species but need verification by further studies.

Lupton (1962:8, note) published the following note which pertains to this species: “*Forcipomyia ingrami* Carter: On February 25, 1961, while Mr. Lupton was hiking on the Palehua (Mauna Kapu) Trail in the Palikea area, Waianae Mountains, Oahu with members of the Hawaiian Audubon Society, two specimens of a midge were collected biting the upper forearms of two of the party. The specimens were identified as *Forcipomyia ingrami* Carter by Dr. W.W. Wirth, U.S. National Museum. Both flies were collected between 3:00 and 3:30 P.M. on a heavily shaded portion of the trail approximately 2,800 feet above sea level. One specimen appeared to completely engorge, leaving a distinct puncture mark, while the other appeared only partially engorged before collection. However, Dr. Wirth mentioned (in corresponding) that the abdomens did not appear to be filled with blood; therefore, the question arises as to whether they were actually

able to take in blood or whether they merely inflicted a painful bite with their mandibles. The habits of *F. ingrami* are unknown (Hardy, Ins. Hawaii, 10:173) and Dr. Wirth states that he knows of no previous record of the species biting man."

W.C. Gagne observed two female midges feeding on a caterpillar of *Anacamp-todes fragillaria* Grossback (Geometridae), Kapua Manuka Forest Reserve on Volcano Road, 1700 ft., Hawaii, 29 July 1970. One specimen was captured, along with the caterpillar, and identified by Wirth as *F. hardyi*. The midges were feeding on the side of the caterpillar near the posterior end.

Howarth and S.L. Montgomery collected four females of *F. hardyi* which were biting two larvae of *Hyles wilsoni* (Rothschild) (Sphingidae), Hawaii Vol-canoes National Park, south of Makaopuhi Crater, 2850 ft., 23 August 1979.

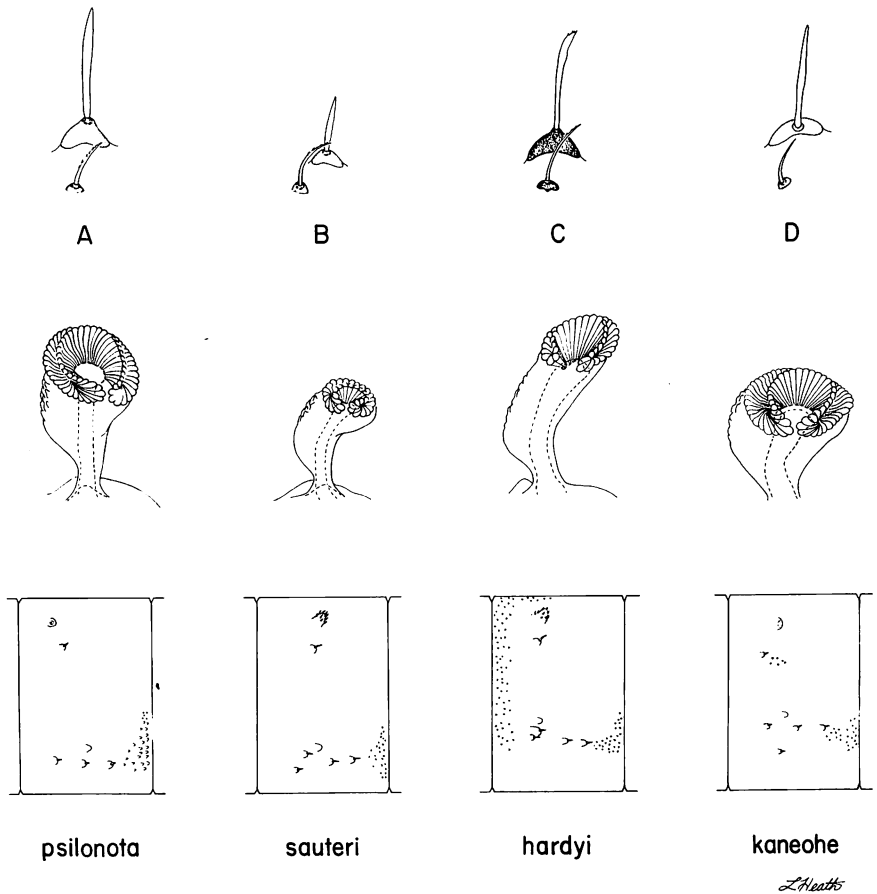


FIGURE 3. Diagnostic characters of *Forcipomyia* (*Euprojoannisia*) larvae and pupae: Top, dorsal hairs *a* and *b* of abdominal segment 3 of larva; middle, pupal respiratory horn; bottom, diagram of abdominal segment 3 of pupa, lateral view showing development of tubercles. a, *F. psilonota* from Ghana; b, *F. sauteri* from the Philippines; c, *F. hardyi* from Mt. Tantalus, Oahu; d, presumed *F. kaneohe* from Kaneohe, Oahu (drawings by Linda Lawrence).

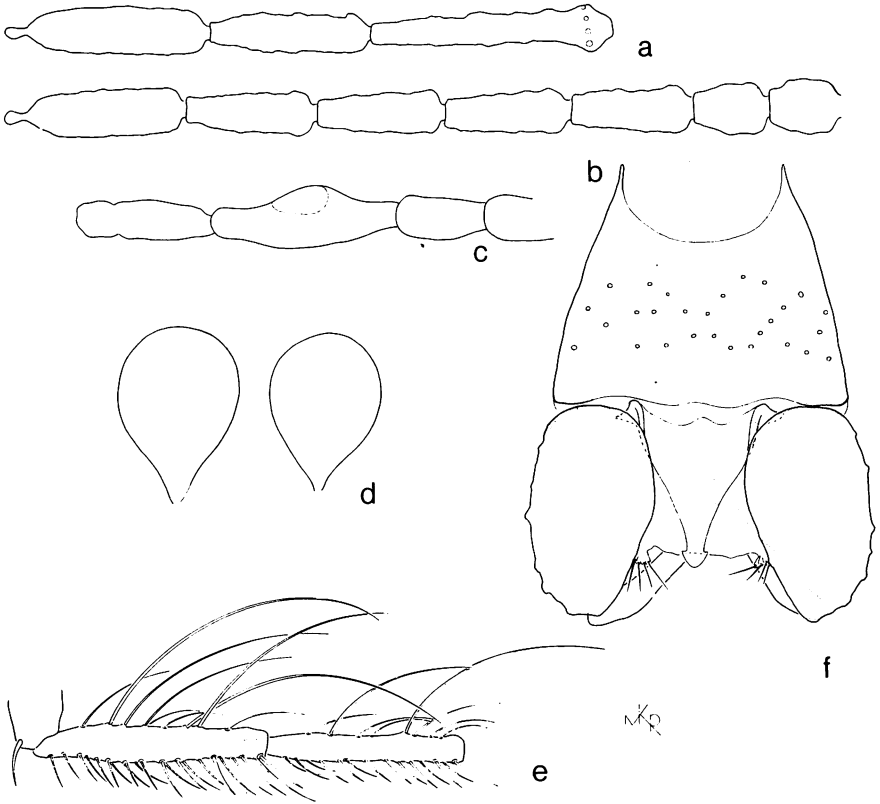


FIGURE 4. *Forcipomyia hardyi*: a, male antenna, segments 13-15; b, female antenna, segments 9-15; c, female palpus; d, spermathecae; e, male tarsomeres 1 and 2 of hindleg; f, male genitalia.

These are apparently the first records of a species of *Euprojoannisia* feeding on an insect host, but many parasites have made unusual host changes in the Hawaiian Islands.

***Forcipomyia (Euprojoannisia) palikuensis* Hardy**
(Fig. 5)

Forcipomyia (Proforcipomyia) palikuensis Hardy, 1960:175 (male, female; Maui; fig. male wing, antenna, genitalia).

Diagnosis. — (from a male paratype, Paliku, Maui; a female from Paliku-Kuiki Trail, Haleakala, Maui, 24.vi.1976, Howarth and Teves). Female wing length 1.26 mm, breadth 0.58 mm; costal ratio 0.51. Female tarsal ratios, foreleg 1.65, midleg 1.61, hindleg 1.61; male tarsal ratios, foreleg 1.42, midleg 0.91, hindleg 1.20. A moderately large dark brown to blackish species with shining mesonotum and dark brown legs.

Female antenna (fig. 5b) with lengths of flagellar segments in proportion of 22-20-20-20-21-22-22-23-34-36-36-36-52; antennal ratio 1.14. Male antenna (fig. 5a) with lengths of last 3 flagellar segments in proportion 86-50-57. Female palpus (fig. 5c) with lengths of segments in proportion of 25-56-35-21, palpal ratio 3.1; sensory pit deep with smaller pore. Mandible with 32 strong teeth. Male hind basitarsus not swollen, hind tibial spur 0.22 x as long as basitarsus. Spermathecae (fig. 5d) slightly unequal, measuring 0.101 by 0.080 mm and 0.091 by 0.061 mm including the slender tapering necks.

Male genitalia (fig. 5g) with basistyle stout, bearing a prominent setose lobe like swelling on mesal margin; dististyle stout, especially in midportion (when viewed in some positions appearing as an angular lobe, as figured by Hardy (1960, fig. 54c). Aedeagus triangular, slightly longer than basal breadth (this ratio variable depending on flattening of the slide mount; see fig. 5f); basal arch low, basal arms very stout; apex appearing trilobed, with a slender distal point, and two small bladeliike apicolateral processes directed ventrad and anterolaterad. Parameres with straight slender basal apodemes connected by a slender anterior bar about half as long as apodemes.

Immature Stages. — Unknown.

Distribution. — Hawaii and eastern Maui.

Types. — Holotype, male, allotype, female, 29 paratypes (17 males, 12 females); all from Paliku, Haleakala Crater, Maui, 1900 m elevation, June 1952 and June 1953, D.E. Hardy, M. Tamashiro, and C.R. Joyce. "This is a wet region on the eastern portion of Haleakala Crater receiving approximately 150 inches of rain per year" (Hardy, 1960).

Specimens Examined. — 109 males, 117 females:

HAWAII I: Ahumoa Crater, 2100 m, 18, 21.VI.1966, Beardsley. Hawaii Volcanoes Nat'l. Park: Kilauea, V.1946, Wirth; Kilauea-Kau, 1200 m, 22.VI.1966, Beardsley; Kipuka Puauulu, 1200 m, 11.XII.1976, Howarth; Makaopuhi Crater, 4.III.1946, Wirth; Mauna Loa Strip Road, 2100 m, 24.VI.1966, Beardsley. Kohala Mts., Acacia Koaie Reserve, 23.I.1971, Howarth. Mt. Hualalai, above Capt. Cook, 1200 m, 12.V.1959, Kimoto. Pauahi, 1300 m, VIII.1956, Hardy. Poha-kuloo, 1800 m, 12.VI.1966, Beardsley.

MAUI I. (E.): Auwahi, 20.VII.1965, Beardsley. Haleakala Nat'l. Park, Haleakala, 23.III.1932, Bryant; 3000 m, 29.I.1964, Harrell; Haleakala Crater, Holua, 2.VII.1963, Hardy; Kapalaoa Cabin, 2200 m, 21.VII.1965, Yoshimoto; Paliku, 2000 m, 22.VII.1963, Beardsley; Paliku, 2000 m, VIII.1958, Hardy; Paliku, 23.VII.1963, Hardy; Paliku, 22.VII.1965, Hardy; Paliku, VII.1965, Carson; Paliku-Kukui Tr., 2000 m, 24.VI.1976, Howarth & Teves, sifting leaf litter; Haleakala Road, 1950 m, 15.III.1961, Quate. Kula Pipe Line, 15,19.III, 8.IV.1932, Bryant. Olinda, 1350-1500 m, 18.III., 8.IV.1932, Bryant. Waikamoi, 1200 m, 19.VII.1965, Beardsley.

Discussion. — Apparently *F. palikuensis* differentiated from a stock resembling *F. yapensis* Tokunaga and Murachi in wet areas at high elevations in Hawaii and East Maui. *F. yapensis* is a much smaller species (female wing length 0.81 mm), paler with yellowish legs, the male midbasitarsus not so short (tarsal ratio 1.03) and the male aedeagus with fine subapical serrations instead of the sharp retrorse processes.

One male from Kawaikoi Stream, Kauai, 27.vii.1963, D.E. Hardy, has genitalia appearing as well as could be observed in a poor slide mount to be identical

with those of *palikuensis*, but the specimen is otherwise in such poor condition that we must reserve positive determination of the Kauai record of this species until confirmed by better material.

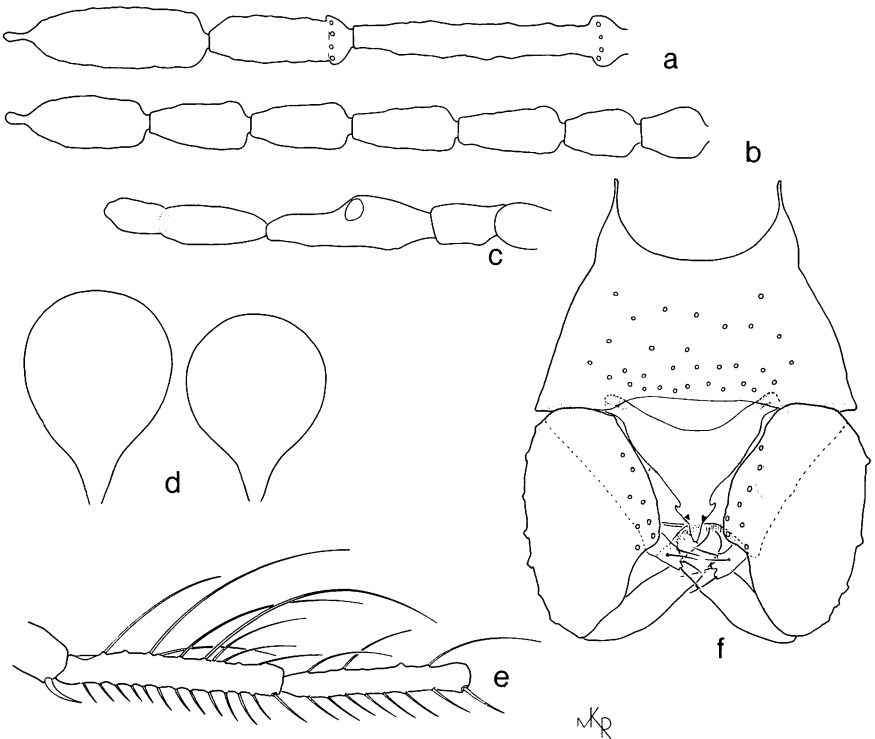


FIGURE 5. *Forcipomyia palikuensis*: a, male antenna, segments 13-15; b, female antenna, segments 9-15; c, female palpus; d, spermathecae; e, male tarsomeres 1 and 2 of hind legs; f, male genitalia of a specimen from Bird Park, Hawaii.

***Forcipomyia (Euprojoannisia) pholeter* Wirth and Howarth, new species**
(Fig. 6)

Diagnosis. — A small yellowish brown species, female wing length 0.89 mm. Female mandible with only 5-10 rudimentary teeth; hind tarsal ratio 1.17 in female; spermathecae small, unequal in size, with abruptly narrowed short necks. Male aedeagus short, with broad truncated tip. Presumed pupa without prominent spines or tubercles; respiratory horn similar to that of *F. hardyi*, with 16 spiracular openings.

Female Allotype. — Wing length 0.89 mm; breadth 0.42 mm.

Head: Pale brown. Antenna (fig. 6b) with lengths of flagellar segments in proportion of 23-20-22-22-22-23-23-27-30-31-33-35-45; antennal ratio 0.96. Palpus (fig. 6c) with lengths of segments in proportion of 18-40-22-13; third

segment moderately swollen proximally, with an indistinct shallow round pit at proximal third. Mandible with 5-10 scarcely discernible teeth.

Thorax: Dull pale brown, legs yellowish brown; vestiture of mesonotum pale brown. Spur of hind tibia short, 0.23 x long as basitarsus; tarsal ratio 1.82 on foreleg, 1.43 on midleg, and 1.17 on hindleg. Wing rather sparsely clad with unusually long, one-stripped macrotrichia; costa extending to 0.48 of wing length. Halter brownish.

Abdomen: Brownish. Spermathecae (fig. 6d) two, slightly unequal, measuring 0.051 by 0.038 mm and 0.043 by 0.032 mm including the necks; ovoid, rather abruptly narrowed to somewhat broad, short necks; without hyaline perforations or surface sculpturing.

Holotype Male. — Wing length 0.95 mm; breadth 0.34 mm.

Similar to female with usual sexual differences. Antenna (fig. 6a) with lengths of last three flagellar segments in proportion of 52-36-53. Palpus with third segment nearly as stout as figured for the female; sensory pit small and round, indistinct. Hind tibial spur short, 0.25 x as long as basitarsus; tarsal ratio 1.70 on foreleg, 1.11 on midleg, and 1.17 on hindleg; Hind basitarsus (fig. 6e) slender, not darkened.

Male genitalia (fig. 6f) with basistyle short and moderately stout, without mesal hump or process; dististyle moderately slender, straight and moderately tapering to pointed tip. Aedeagus slightly broader than long; anterior margin transverse, the basal arms short; sides straight and tapering to blunt, truncated tip. Parameres with basal apodemes a slender, nearly straight ribbon, each with a small knoblike thickening near distal end; connected anteriorly by a straight slender transverse bar about half as long as apodemes.

Presumed Pupa. — The following description is made from a single pupa collected by Howarth in the dark zone of Petroglyph Cave, HVNP (see paratype data list) and therefore presumed to represent this cave-dwelling species.

Length 2.74 mm. Color pale yellowish, pale brownish on cephalothorax and dark reddish on the eyes of the nearly mature female imago within. Body without prominent spines or tubercles, nearly bare. Respiratory horn nearly identical with that of *hardyi* (fig. 3c) with 16 spiracular openings arranged apically in an irregular circle. Terminal processes of abdomen sharply pointed, short, not diverging (female).

Distribution. — Known only from lava tube caves in the eastern part of the island of Hawaii.

Types. — Holotype, male, allotype, female, Kazumura Cave, 400 m, Mountain View, Hawaii, 22.VII.1971, at light, 150 m from entrance in dark zone, F.G. Howarth, (BPBM, 11547.) Paratypes, 29 males, 17 females, 1 pupa, as follows: All collected by F.G. Howarth.

HAWAII: Kazumura Cave, 25.VII.1971, swarming at entrance, (BPBM), 10 males; 2 males, 8 females; Kazumura Cave, 14.VII.1972, 120 m from entrance, (BPBM), 4 males; Kazumura Cave, 11.III.1973, dark zone, (BPBM), 4 females; Kazumura Cave, 8.VII.1973, at light, dark zone, (BPBM), 2 males, 4 females; Keauhou Ranch, cave 143, 1670 m, 8.VII.1976, dark zone, (BPBM), 1 male; Kipuka Puauolu, Hawaii Volcanoes National Park, Bird Park Cave no. 1, 1140 m, 20.VII.1971, BBN-00292, 30 m in dark zone (BPBM), 1 female; Hawaii Volcanoes National Park, Ainahou Petroglyph Cave, 700 m, 13.VII.1976, dark zone (BPBM), 1 pupa.

Discussion. — The specific name is from the Greek noun, in apposition; *pholeter*, one who lurks in a hole, cave, or den.

The small size, pale color, rudimentary female mandibular teeth, short aedeagus with broad truncated tip, and absence of prominent spines or tubercles on the body of the pupa will separate this species from its Hawaiian congeners.

Biology. — Adults of *F. pholeter* are most abundant in lava tubes within the rainforest zone between 150 and 600 meters on Mauna Loa and Kilauea Volcanoes and are less common in caves at higher elevations. They swarm just inside cave entrances and are attracted to headlamps deeper within caves sometimes far from any known entrance.

The larvae breed in the wet oozes, "lava tube slimes," which form on the walls of many passages, as evidenced by the single pupa that has been found on this substrate. These slimes are mostly organic and mineral colloids deposited by percolating ground water.

Howarth (1973) described the Hawaiian lava tube ecosystem including a preliminary diagram of the food web. *F. pholeter* (*Forcipomyia* sp. on the diagram) is a facultative cave species or troglophile (a species that can live its complete life cycle in caves but also lives in similar damp surface habitats).

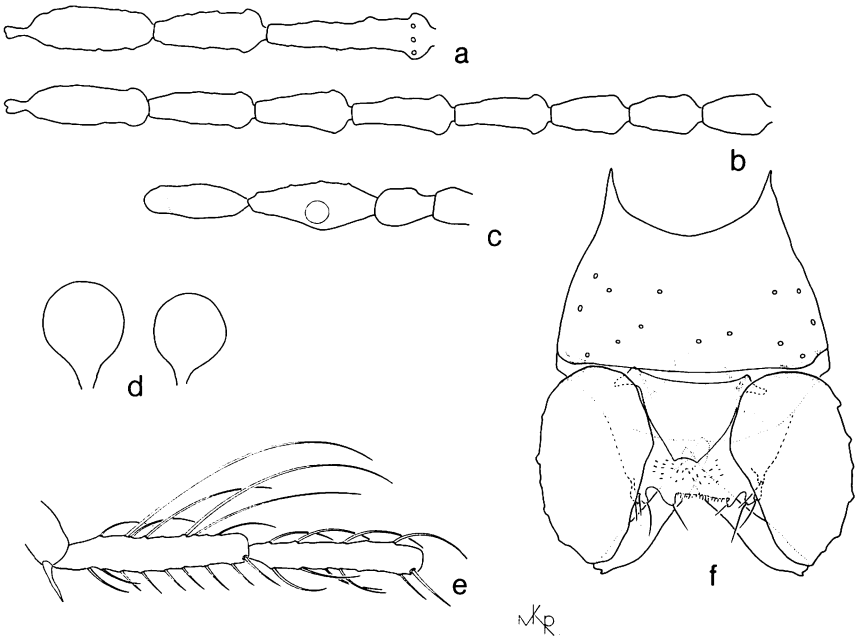


FIGURE 6. *Forcipomyia pholeter*: a, male antenna, segments 13-15; b, female antenna, segments 8-15; c, female palpus; d, spermathecae; e, male tarsomeres 1 and 2 of hindleg; f, male genitalia.

***Forcipomyia* (*Euprojoannisia*) *kaneohe* Wirth and Howarth, new species
(Figs. 1a, 3d, 7)**

Forcipomyia ingrami Carter; Williams, 1944:175 (in part; plate viii, fig. 48 of pupa).

Dagnosis. — A small, uniformly dark brown shining species with dark brown mesonotal hairs; female with distinct mandubular teeth, small round indistinct palpal pit, costal ratio 0.53, hind tarsal ratio 1.40, spermathecae unequal with slender tapering neck. Male aedeagus short with bluntly truncated tip. Presumed pupa with extremely short, broad respiratory organ.

Female Allotype. — Wing length 0.87 mm; breadth 0.39 mm.

Head: Brown. Antenna (fig. 7b) with lengths of flagellar segments in proportion of 21-17-18-18-19-20-20-25-25-25-36, antennal ratio 0.89. Palpus (fig. 7c) with lengths of segments in proportion of 20-38-24-14; third segment moderately swollen proximally, with an indistinct shallow round pit just before midlength. Mandible with 30 minute teeth.

Thorax: Shining dark brown; legs uniformly dark brown; vestiture of mesonotum of long, suberect, one-stripped scalelike hairs. Spur of hind tibia short, 0.21 x as long as basitarsus; tarsal ratio 1.90 on foreleg; 1.54 on midleg, and 1.43 on hindleg. Wing densely clothed with long, one-stripped macrotrichia; costa extending to 0.53 of wing length. Halter dark brown.

Abdomen: Dark brown. Spermathecae (fig. 7d) two, slightly unequal, measuring 0.062 by 0.048 mm and 0.058 by 0.045 mm including necks; ovoid, rather abruptly tapering to short slender necks; without hylaine perforations or surface sculpturing.

Male Holotype. — Wing length 0.98 mm, breadth 0.36 mm.

Similar to female with usual sexual differences. Antenna with lengths of last three flagellar segments (fig. 7a) in proportion of 58-30-48. Palpus with third segment slender, with small round indistinct sensory pit. Hind tibial spur short, 0.14 x as long as basitarsus; hind basitarsus (fig. 73) not swollen or darkened; tarsal ratio 1.66 on foreleg, 1.20 on midleg, and 1.18 on hindleg.

Male genitalia (fig. 7f) with basistyle short and moderately stout, without mesal hump or process; dististyle moderately slender, straight and moderately tapering to blunt tip. Aedeagus about as long as basal breadth; anterior margin with low basal arch, basal arms short and quite stout; sides straight and tapering to blunt, truncated tip. Parameres with basal apodemes a slender nearly straight ribbon, each with a small knoblike thickening near distal end; connected anteriorly by a straight slender transverse bar about two-thirds as long as apodemes.

Presumed Pupa (fig. 1a) — The following description is made from a single pupa collected by Wirth at Kaneohe, Oahu, 3.vii.1946 from debris floating in a pool choked with water hyacinth, *Eichhornia crassipes* (Mart.) Solms-Laub.

Length 2.6 mm. Color pale brown on cephalothorax and stramineous on abdomen. Cephalothorax with the usual tubercles well developed; a pair of large conical bristle-bearing tubercles behind respiratory horns and three pairs of smaller granulose posterior tubercles. Respiratory horn (fig. 3d) short and broad, shorter than that of *F. psilonota* (fig. 3a); with a double row of spiracular openings (45 in outer palisade) arranged in a circular crown. Abdominal segments without conspicuous hairs or tubercles, each (fig. 3d) on each side with two dorsolateral and four ventrolateral minute tubercles, each bearing a single spinule. Terminal processes long and slender as usual (male).

Presumed Larva. — The following description is from a single larva collected at the same time and place as the pupa described above.

Length 3.5 mm. Color yellowish brown; head dark brown; each body segment with a large distinct dorsal area of dark reddish subcutaneous pigment granules. Antenna moderately stout proximally, gradually tapering to a colorless filamen-

tous tip bent posteriorly; *p* hair long and lanceolate; *q* hair nearly as long, expanded apically with an oblique blunt tip; other head hairs moderately long, slender, and erect. Body segments each with *a* hair (fig. 3d) moderately long, stout, brownish in color, distinctly hastate distally but not fringed, each arising from a moderately prominent, low conical, brownish tubercle; *b* hair about half as long as *a* hair, stout and brownish in color, with lateral fringe, and arising from small tubercle; *c*, *d*, *e*, and *f* hairs long and filiform, pale brownish, not arising from tubercles. Cauda long and tapering to filiform tip, 1.4 x as long as last body segment.

Distribution. — Oahu, moderately abundant in the mountains.

Types. — Holotype, male, allotype, female, Aiea Ridge Trail, Oahu, 490 m, 30.v.1976, F.G. Howarth, sweeping (BPBM 11548), Paratypes, 56 males, 36 females, as follows:

OAHU: Aiea Ridge Trail, same data as types, 7 males, 4 females; 480 m, 3.xi.1967, W.C. Gagne, on *Ilex anomala* (H. & A.) (BPBM), 1 male, 4 females. Aiea Loop Trail, 500 m 3.v.1969, 22.vi.1969, F.G. Howarth, sweeping (BPBM), 18 males, 6 females. Halemano, ii.1953, D.E. Hardy (UH), 1 male. Kamananui Gulch, 28.vii.1945, W.W. Wirth (USNM), 1 female. Kukuiala Valley, 9.x.1934, E.H. Bryan, Jr. (BPBM), 1 female. Laie, 330-360 m, 14.x.1940, E.H. Bryan, Jr. (BPBM), 1 male. Manoa Valley, 6.v.1945, W.W. Wirth (USNM), 3 females; 2.ii.1934, C.T. Schmidt (BPBM), 1 male. Mt. Kaala, 1200 m, 22.viii.1945, 25.vii.1946, W.W. Wirth (USNM), 1 male, 4 females; iv. 1952, D.E. Hardy (UH), 1 female; 3.iv.1953, C.P. Hoyt (BPBM), 1 female. Mt. Tantalus, 13.v.1945, W.W. Wirth (USNM), 1 male. Opaepala, 13.viii.1952, L.W. Quate (USNM), 1 female. Palolo Valley, 16.i.1946, W.W. Wirth (USNM), 1 male. Poamoho Trail, 510 m, 1946, W.W. Wirth, swarming (USNM), 6 males; v.1953, D.E. Hardy (UH), 2 males, 3 females; 9.iii.1961, L.W. Quate (BPBM), 15 males, 5 females. Pupukea, iv.xii.1952. D.E. Hardy (UH), 1 male, 1 female. Wheeler Field, xi.1945, W.W. Wirth, light trap (USNM), 1 female. Wiliwilinui Ridge, 540 m, 18.xi.1968, W.C. Gagne (BPBM) 1 male, 2 females.

Discussion. — The specific name *kaneohe* is a noun in apposition, referring to the locality on Oahu where the presumed larva and pupa of the species were collected. The figure of the pupa published by Williams (1944) is apparently of the same species.

Pinned specimens of *F. kaneohe* cannot be separated with confidence from those of *F. hardyi* because the small size and dark color sometimes occur as variants in the latter species. In the female the distal antennal segments of *F. kaneohe* are shorter than those of *F. hardyi*, the respective mean antennal ratios 0.89 versus 1.27. A positive identification of *F. kaneohe* is dependent on a slide mount of the male where the short, distally truncated aedeagus serves to confirm the species. The very short, broad, respiratory horn of the presumed pupa and the long cauda of the presumed larva would readily identify the immature stages, but this must depend, of course, on additional collecting and the definite association of the immatures with reared adults.

A collection made by Howarth on Kauai, Kokee, on rotting ginger leaves hanging in a small rushing stream (Kauikinana Stream, 1100 m), 27.v.1979, consisting of a larva, a pupa, and a reared female with its pupal exuviae and cast larval skin, is provisionally referred to *F. kaneohe*. The larvae differ from the presumed larva of *kaneohe* from Oahu mainly in the greater length and broader

hyaline winglike lateral fringe on the dorsalmost lateral hair of each body segment, and the *a* hair of the last segment is only about two-thirds as long. The pupa agrees well except that the posterior tubercles on the cephalothorax are not quite as strongly developed. The female agrees in measurements and ratios with *kaneohe* but the legs are pale bright yellow and the spermathecae are larger and more unequal, measuring 0.087 by 0.058 mm and 0.068 by 0.051 mm. It is possible that this population represents still another species closely related to *F. kaneohe*.

We suspect that additional species occur in Hawaii but it will be necessary first of all to collect the immature stages in order to sort out the most critical characters for species recognition. For example we have a few females of a small pale form with short antennal segments and short palpi which we doubt could possibly represent aberrant *hardyi* or *kaneohe*. We have already noted the collection of two small pale females in a light trap near the caves on Hawaii where *pholeter* occurs which closely resemble the latter species but possess well-developed mandibular teeth.

Biology. — The larval collections reported here suggest that *F. kaneohe* probably breeds in a wetter substrate than that of *F. hardyi*, and are more aquatic, thus resembling the African *pilonota* Kieffer, which also has the short, broad, pupal respiratory horn.

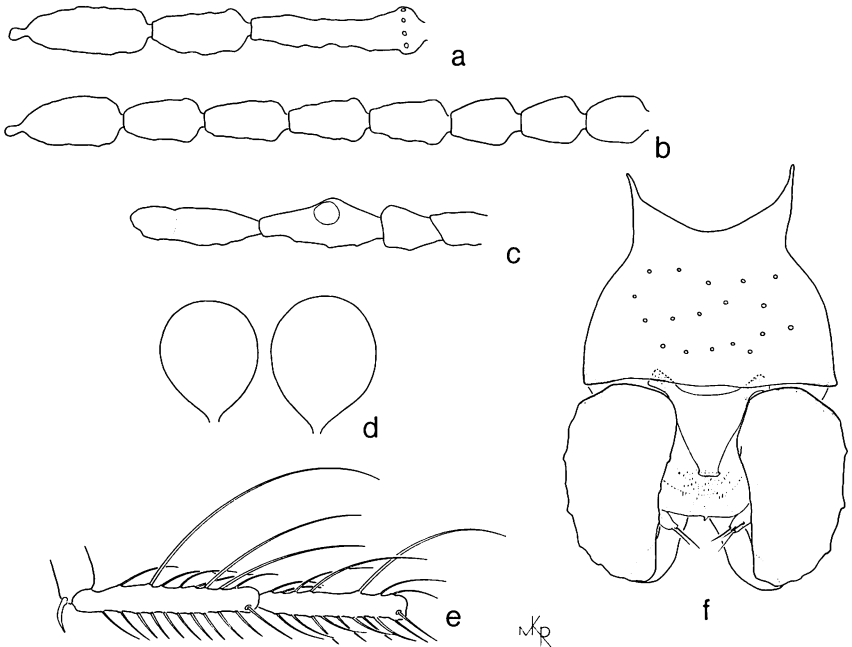


FIGURE 7. *Forcipomyia kaneohe*: a, male antenna, segments 13-15; b, female antenna, segments 8-15; c, female palpus; d, spermathecae; e, male tarsomeres 1 and 2 of hindleg; f, male genitalia.

Similar Non-Hawaiian Species of *Forcipomyia* (*Euprojoannisia*)

None of the North American species of the subgenus *Euprojoannisia* reviewed by Bystrack and Wirth (1978) appears to be closely related to any of the Hawaiian species. A study of the Micronesian species reviewed by Tokunaga and Murachi (1959), however, suggests that *Forcipomyia hardyi* and *palikuensis* probably evolved in Hawaii from an ancestor resembling *F. yapensis* Tokunaga and Murachi. The three species named have in common a characteristic tarsal ratio (1.44-1.67 in female; 1.15-1.26 in male); female costal ratio greater than 0.50 (0.50-0.56); long slender third palpal segment, with *palikuensis* and *yapensis* sharing a small deep sensory pit; male aedeagus much longer than basal breadth, with *palikuensis* and *yapensis* sharing distal modifications, differing in each species; and all having two rather large, elongate, slightly unequal spermathecae with long tapering necks. Since the most striking specific characters of *Euprojoannisia* are in the immature stages, it remains to be seen how *palikuensis* and *yapensis* will compare in these stages.

The relations of *Forcipomyia kaneohe* and *F. pholeter* are more problematical. The hind tarsal ratio of *kaneohe* approaches the minimum value for *F. hardyi*, but that of *pholeter* is closer to those of the African *F. psilonota* (Kieffer) and the Oriental *F. sauteri* Kieffer. The spermathecae and male aedeagus and parameres of *F. kaneohe* and *pholeter* are more similar to those of *psilonota* and *sauteri* than to the other two Hawaiian species. The larval *a* and *b* hairs and pupal respiratory horn of *F. kaneohe* are most similar to those of *psilonota*.

In order to make a detailed comparison between these species, in the following section we present a resume of the diagnostic characters and most important literature for *F. psilonota*, *sauteri* and *yapensis*. A further comparison of numerical adult characters is made in Table 1.

TABLE I. Numerical Characters for Selected Species of *Euprojoannisia*.

(mean values)

	Female Wing Length (mm)	Female Costal Ratio	Female Antennal Ratio	Female Hind Tarsal Ratio	Male Hind Tarsal Ratio	Female Hind Leg (L-Spir/L-T1)	Male Antennal (L-15/L-14)	Female Mandibular Teeth	Male Midleg Tarsal Ratio
<i>psilonota</i>	1.00	0.51	0.87	1.20	0.80	0.30	1.26	30	0.67
<i>sauteri</i>	0.94	0.48	1.18	1.21	0.79	0.30	1.45	35	0.76
<i>yapensis</i>	0.81	0.52	1.03	1.57	1.26	0.39	1.35	40	1.03
<i>palikuensis</i>	1.26	0.51	1.14	1.61	1.20	0.18	1.13	32	0.91
<i>hardyi</i>	1.26	0.51	1.27	1.67	1.16	0.20	1.30	50	1.20
<i>pholeter</i>	0.89	0.48	0.96	1.17	1.17	0.10	1.50	7	1.11
<i>kaneohe</i>	0.87	0.53	0.89	1.43	1.18	0.21	1.60	30	1.20

Forcipomyia (Euprojoannisia) psilonota (Kieffer)
(Fig. 3a)

Ceratopogon psilonotus Kieffer, 1911:337 (male; Seychelles; fig. wing).

Forcipomyia psilonota (Kieffer); Ingram and Macfie, 1924:546 (combination; in key); Wirth and Messersmith, 1977:294 (synonymy; lectotype of *psilonotus* designated; synonyms: *aplonotus* Kieffer, 1911:337; *seychelleanus* Kieffer, 1911:338; *indecora* Kieffer, 1914:269; *ingrami* Carter, 1919:290; *egypti* Macfie, 1924:61; *congolensis* Goetghebuer, 1933:132, *flavopilosella* Goetghebuer, 1933:135; *griseipluma* Goetghebuer, 1935:154; *lulengaensis* Goetghebuer, 1935:155; *superata* Goetghebuer, 1935:160; *griseolella* Goetghebuer, 1948:7).

Forcipomyia indecora Kieffer, 1914:269 (male; South Africa); de Meillon, 1959:327 (notes on types; syn.: *ingrami*); Clastrier, 1960:510 (male redescribed; figs.; Congo); Dessart, 1961b:335 (descriptive notes; synonymy); Dessart, 1963:73 (redescribed; figs.; distribution).

Forcipomyia ingrami Carter, 1919:290 (all stages; Gold Coast; figs.); Ingram and Macfie, 1924:584 (male, female redescribed; figs.).

Diagnosis. — For our concept of this species we refer to the description by Carter (1919) for *ingrami* and the redescription by Dessart (1963) under the name *indecora*. Female wing length 0.96-1.10 mm. Tarsal ratio on hindleg of female 1.1-1.3; of male 0.67-0.93. A small dull grayish brown species with yellowish scutellum and legs. Male hind basitarsus not enlarged. Female antennal ratio 0.87. Third palpal segment slender with small round shallow sensory pit. Spermathecae two, ovoid with short slender necks, subequal, each measuring 0.050-0.060 mm wide by 0.065-0.085 mm long including the neck, sometimes slightly unequal. Male genitalia with aedeagus about as long as basal breadth, basal arch low, sides straight and tapering to blunt, slightly caplike tip; parameres with basal apodemes connected anteriorly by a nearly straight transverse bar not quite as long as apodemes.

Our diagnoses of the larva and pupa of *F. psilonota* are based on a reared series (G29) from Tafo, Ghana, 28 May 1963, L.G. Saunders, from leaves in a rot hole of a tree (USNM collection). We have also seen a larva from Carter's type series of *F. ingrami* that was in the Saunders collection, now in the USNM.

Larva. — Yellowish brown, head dark brown. Antenna moderately stout proximally, gradually tapering to slender tip curving posteriorly; *p* hair long and lanceolate, *q* hair much shorter and stouter, expanded apically with an oblique blunt tip; other head hairs moderately long, slender, and erect. Body segments each with *a* hair moderately long, stout, hyaline, distinctly hastate distally but not fringed, each arising from a moderately prominent, conical, brownish tubercle; *b* hair about two-thirds as long as *a* hair, stout and brownish in color, with lateral fringe, and arising from small pale tubercle; *c*, *d*, *e*, and *f* hairs long and filiform, not arising from tubercles. Cauda about as long as last body segment.

Pupa. — Larval exuviae not retained. Color pale brown. Cephalothorax with the usual anterior tubercles; a pair of large conical bristle-bearing tubercles behind respiratory horns and three pairs of smaller granulose posterior tubercles. Respiratory horn short and broad, only slightly longer than greatest breadth, basal stalk short; apex with a double row of spiracular openings (34-45 in outer palisade) arranged in a circular crown. Abdominal segments without conspicuous hairs or tubercles, each (fig. 3a) on each side with two dorsolateral and four ven-

trochlear minute tubercles, each bearing a single spinule. Terminal processes as usual.

Distribution. – Widespread in Ethiopian Region.

Discussion. – The literature and synonymy concerning this species are complex and confused because of the close similarity of the species of this group. Until quite recently most of these midges throughout the tropics around the world have gone under the name of *Forcipomyia ingrami* Carter, following the opinion of Macfie, because this was the first species to be described accompanied by a really adequate description. Dessart (1961b) confirmed the opinion of de Meillon (1959) that *F. indecora* Kieffer was an earlier name for his species based on the latter's examination of the South African type of *indecora*, and for a short time Kieffer's name was used. Wirth and Messersmith (1977), in reviewing the ceratopogonids of the Seychelles, re-examined Kieffer's types of *C. psilonota* and found them to be the same as the widespread Ethiopian species, thus necessitating another change of name. We hope the supply of types of earlier, poorly described species of Ethiopian ceratopogonids is now exhausted and that we can expect some stability in the name of this very common species which is an important pollinator of cacao in Africa. In this study we hope to show that the Oriental and Pacific midges that have been called "*ingrami*" can be reincarnated under names that may have more stability.

***Forcipomyia (Euprojoannisia) sauteri* Kieffer**

(Fig. 8)

Forcipomyia sauteri Kieffer, 1912: 27 (female; Formosa); Tokunaga, 1940:83 (Formosa; female redescribed); Tokunaga, 1941:109 (Caroline Islands); Tokunaga and Murachi, 1959:190 (redescribed; figs.; Micronesia); Tokunaga, 1959:293 (New Guinea and New Britain records; Tokunaga, 1962:184 (Ryuku Islands; notes; distribution).

Forcipomyia clara Chan and LeRoux, 1971:729 (all stages; figs.; Singapore; reared from decaying grass). NEW SYNONYMY.

Forcipomyia ingrami Carter (misidentified); Edwards, 1928:51 (Samoa); Macfie, 1934:179 (Malaya); Macfie, 1934c:202 (Sumatra; notes on variation); Macfie, 1934d:94 (Marquesas Islands).

Diagnosis. – Our concept of this species is based on the excellent redescription by Tokunaga and Murachi (1959). A small pale brown species, legs yellowish brown; mesonotum with yellowish-brown markings. Tarsal ratio of hind leg 1.21 in female, 0.79 in male. Female wing length 0.94 mm. Female mandible with many fine teeth. Third palpal segment with small, round, shallow sensory pit. Female antennal ratio 1.18. Hind basitarsus of male not enlarged. Spermathecae two, slightly unequal, ovoid with long slender necks; 0.085 by 0.051 mm and 0.062 by 0.047 mm. Male aedeagus with length subequal to basal breadth, basal arch low, sides straight and tapering to blunt, truncated tip; parameres with basal apodemes connected by a straight transverse bar about as long as apodemes.

Our diagnosis of the larva and pupa of *F. sauteri* is based on a reared series (P1) from Luna, Luzon, Philippines, 28 Oct. 1961, L.G. Saunders, from rotting banana pods.

Larva. – Yellowish with pale brown head. Chaetotaxy as in *F. psilonota*, differing as follows (also agreeing with Chan and LeRoux's description and figures

of *F. clara*): Antenna straighter, not as curved; head hair *p* more hastate, *q* hair with longer and more slender petiole. Body hairs *a* only about half as long and only slightly hastate on first ten body segments, long and hastate on last segment; *b* hairs about as long as *a* hairs, stout and fringed.

Pupa. — Pale brown, differing from that of *F. psilonota* as follows: Dorsum of cephalothorax with six pairs of more prominent spinulose tubercles. Respiratory horn longer and more slender, 1.6-1.8 times as long as wide, with fewer (22-36) spiracles in outer palisade. Body segments each with the uppermost pair of tubercles in form of a prominent setulose cushion as in *F. hardyi*.

Distribution. — Oriental Region, New Guinea, South Pacific Islands.

Discussion. — Chan and LeRoux (1971) compared adults of *F. clara* with *sauteri* and stated that *clara* differed in the pointed tip of the male aedeagus, the narrower base of the dististyle and more slender parameres, their statement that the hind tarsal ratio of male *clara* was 0.56 was in error, that value applying to the mid leg in their own description. They compared adults of *clara* with the "ingrami" described by Hardy (1960) from Hawaii; we know these species differ greatly. They pointed out that *clara* differed from Carter's original description of *F. ingrami* (now *psilonota* (Kieffer) in pupal characters: in *psilonota* there are only four pairs of tubercles on the cephalothoracic dorsum instead of six, and the innermost pair of tubercles on the dorsum of the abdominal segments are simple and not torch-like.

Our synonymy of *F. clara* with *F. sauteri* is based on the study of 2 males and 4 females (USNM collection) received from Chan from his reared series (FW1) of *clara*.

Forcipomyia (Euprojoannisia) yapensis Tokunaga and Murachi

Forcipomyia (Proforcipomyia) yapensis Tokunaga and Murachi, 1959:185 (male, female; Caroline Islands; figs.).

Diagnosis. — (from holotype and allotype in USNM). Female wing length 0.82 mm, breadth 0.41, costal ratio 0.52. Tarsal ratio on hindleg of female 1.57, of male 1.26. A small brown species with yellowish scutellum and legs.

Female antenna with lengths of flagellar segments in proportion of 18-16-16-18-18-18-19-20-26-26-28-28-40; antennal ratio 1.03. Female palpus with lengths of segments in proportion of 10-45-25-15, palpal ratio 3.0; sensory pit rather deep with small diameter. Mandible with about 40 fine teeth. Male hind basitarsus only slightly swollen, hind tibial spur 0.31 as long as basitarsus, in female 0.39. Spermathecae unequal, measuring 0.074 by 0.056 mm and 0.059 by 0.046 mm including the long slender necks. Male genitalia with basistyle stout with distinct mesal swelling at midlength; dististyle rather stout and sinuate to pointed tip; aedeagus approximately an equilateral triangle in ventral profile, anterior margin not concave, the basal arms very short and stout; apex rounded with fine serrated subapical lateral swellings; parameres with basal apodemes connected anteriorly by a transverse bar about half as long as apodemes.

Immature Stages. — Unknown.

Distribution. — Caroline Islands.

Types. — Holotype male, Hill behind Yaptown, Yap I., 60 m, 29.xi.1952, J.L. Gressitt (Type no. 64029, USNM).

Discussion. — The Hawaiian species *F. palikuensis* Hardy is closely related to *yapensis*, having a small deep palpal pit, approximately the same tarsal ratios,

stout male dististyles, male basistyles with distinct mesal swelling at midlength, parameres with transverse anterior connective, and aedeagus with subapical modifications, but *palikuensis* is a much larger species (female wing length 1.16 mm), darker with shining dark brown mesonotum and dark brown legs, the female has fewer and much coarser mandibular teeth, spermathecae only slightly unequal, and the male aedeagus has distinct sharp subapical processes instead of fine serrations.

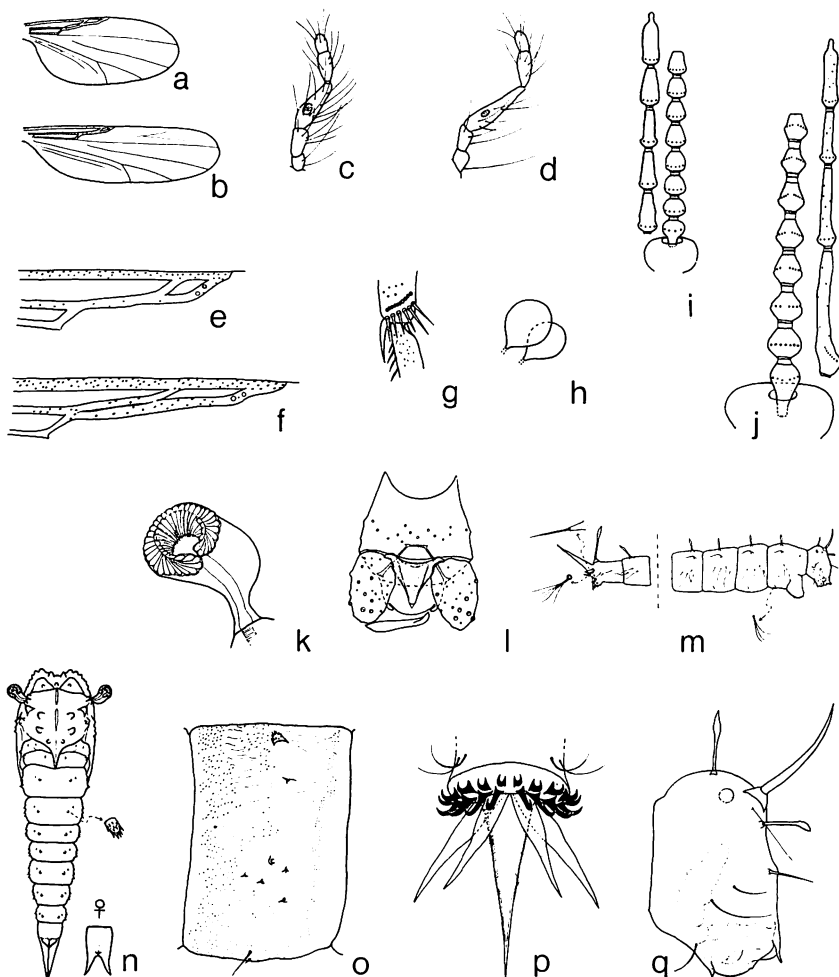


FIGURE 8. *Forcipomyia sauteri*: a, female wing; b, male wing; c, female palpus; d, male palpus; e, costal field of female wing; f, costal field of male wing; g, hind tibial comb of female; h, spermathecae; i, female antenna; j, male antenna; k, pupal respiratory horn; l, male genitalia; m, larva; n, pupa; o, lateral view of segment 3 of pupa; p, ventral view of posterior end of larva; q, lateral view of larval head (from Chan and LeRoux, 1971).

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