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## DROSOPHILIDAE ASSOCIATED WITH FLOWERS IN PAPUA NEW GUINEA

### II. *Alocasia* (Araceae)

By Toyohi Okada<sup>1</sup> and Hampton L. Carson<sup>2</sup>

*Abstract.* Fourteen new species of Drosophilidae which are flower associates of *Alocasia* in Papua New Guinea are described. *A. macrorrhiza* is a veritable zoological garden. Of 13 associated species, 11 belong to *Drosophila* (subgenus *Scaptodrosophila*), 1 to *Drosophila* (subgenus *Drosophila*) and 1 to *Styloptera*. Seven species were reared from the inflorescences. *D. (Sc.) aproclinata* were found only on *A. holtrungii*; it breeds on the decaying staminate portion of the spadix. Indications are that the subgenus *Scaptodrosophila* has made a major adaptive radiation into the flower-breeding niche in New Guinea. Six of the species, especially those which enter into the close confines of the barely-opened inflorescence, have evolved a reduction in the size of the arisal branches and sometimes other bristles as well. Such reduction is also observed in other flower-dwelling drosophilids, suggesting that bristle reduction is an adaptive response to this specialized niche.

The first paper in this series (Carson & Okada 1980) concerned itself with the systematics and ecology of 3 species of Drosophilidae which were found associated with the inflorescences of the common taro, *Colocasia esculenta*, in eastern Papua New Guinea. Comparable information is presented here for a number of new species of Drosophilidae which have been found to be associated with inflorescences of 3 species of the genus *Alocasia* in the same geographical area. Both *Colocasia* and *Alocasia* belong to the family *Araceae*.

This paper represents the second part of a continuing analytical study of collections and observations made by us in the Morobe Province in NE Papua New Guinea between July and December 1977. Samples were taken from forests at a wide range of altitudes from about 2000 m to sea level. Most of the collecting sites were along the road which runs from Lae through Bulolo to Wau. Other sites were along the road from Wau (up Mt Kaindi) to Edie Creek. Although a variety of collecting techniques were used, particular attention is here given to our discovery that a considerable number of drosophilid species are specifically adapted to complete their life cycles within fresh or wilted flowers. We describe here the basic systematics and

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ecology of 14 species of Drosophilidae, all of which are new to science and are associated with inflorescences of *Alocasia*. Twelve of the 14 species belong to the subgenus *Scaptodrosophila* of the genus *Drosophila*.

All types are deposited in the Bishop Museum, Honolulu, Hawaii (BISHOP).

## MATERIALS AND METHODS

The 3 species of host plants studied and the distribution of the sites at which collections and ecological observations were made are listed in TABLE 1. No baits were used for collecting the flies. When flowering plants were located, individual inflorescences were approached and any specimens present were aspirated directly. In some circumstances, agitation of the inflorescence will cause flies to emerge from within; they may be aspirated as they leave. A better method, however, involves imprisoning the entire inflorescence within a plastic bag. In this manner, all escaping flies can be captured without loss. The counts of flies emerging from individual flowers were made in this manner.

In order to study the distribution of preadult stages, individual inflorescences were dissected and the various parts examined for eggs, larvae and puparia. Imagoes were reared from inflorescences by placing them in vials of water under a glass cylinder or on top of sterile damp sand in a clean container with a fine mesh cover. Summaries of the numbers of specimens captured and reared are given in the right hand column of TABLE 1.

## DESCRIPTIONS OF NEW SPECIES

### 1. *Drosophila* (*Scaptodrosophila*) *aproclinata* Okada & Carson, new species

#### FIG. 1A-K

♂, ♀. Body 1 mm, mat black. Eye dark reddish brown, thickly piled. Antenna (FIG. 1F) grayish brown, arista merely finely pubescent. Ocellar triangle black; ocellars slightly outside triangle. Frons dirty yellowish brown, as broad as long, anterior margin black, with numerous frontal hairs. Periorbits dark yellowish brown. Face yellowish orange. Carina gray, long, broadened below, upper surface flat. Clypeus yellowish gray. Cheek narrow. Anterior reclinate orbitals as long as posterior reclinate; proclinate absent, thus the specific name. Second oral fine. Mesoscutum mat subshining black. Scutellum mat black, pruinose in gray. Dorsocentrals essentially 1 pair, with anterior pair greatly reduced. Thoracic pleura paler than mesoscutum. Humeral 3, subequal. Acrostichal hairs in about 8 dense rows. Prescutellars absent. Sterno-index 0.8. Scutellars divergent, posteriors nearer to anteriors than to each other. Legs yellowish gray; femora fuscous; each tarsal joint nearly as long as broad. About 11 large black teeth (FIG. 1B) on fore tarsi below, ranging from 2nd to 4th joints in both sexes; smaller teeth on distal tarsal joints of mid and hind legs. Wings (FIG. 1A) hyaline,  $R_{2+3}$  nearly straight, C reaching M,  $R_{4+5}$  and M parallel. C-index 1.6; 4V-index 1.9; 4C-index 1.8; 5x-index 2.0; Ac-index 4.0. C1-bristle 1, weak. C3-fringe  $\frac{1}{2}$ . Haltere yellowish gray, with knob darker. Abdominal tergites mat black; ♂ 6th sternite without stout processes. Periphallallic organs (FIG. 1C) pale yellow; epandrium broad below, anteroventral corner acute, posteroventral corner rectangular. Surstylus (c) quadrate, with a straight row of about 6 black teeth. Cercus (t) oblong in lateral aspect. Phallic organs (FIG. 1D): aedeagus (e) oblong, large, rounded at tip, basal apodeme short, about  $\frac{1}{5}$  as long as aedeagus. Paramere (a) long, with sensilla along its long axis. Submedian spines well developed. Ovipositor (FIG. 1E) elongate, pale yellow. Malpighian tubules (FIG. 1J) with common stalks short, posterior branches making complete loop. Testis (FIG. 1K) elongate elliptical, orange-red;

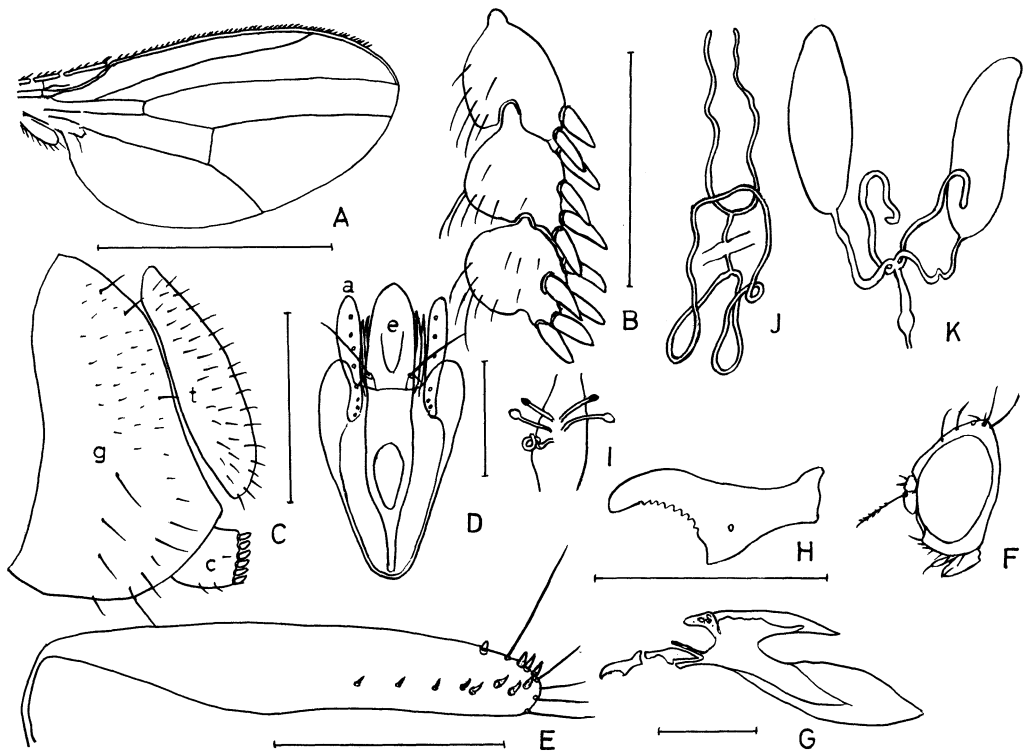


FIG. 1. *Drosophila (Scaptodrosophila) aproclinata*: A, wing; B, 2nd to 4th tarsal joints of fore leg; C, periphallallic organs; D, phallic organs; E, ovipositor; F, head; G, cephalopharyngeal skeleton of 3rd instar larva; H, mouth hook of the same; I, ♀ internal reproductive organs; J, malpighian tubules; K, ♂ internal reproductive organs. a = paramere; c = surstylus; e = aedeagus; g = epanthrium; t = cercus. Scale 1 mm in A; 0.1 mm in others.

paragonia slender. Spermatheca (Fig. 1I) with small head; parovaria pale, longer than spermatheca; ventral receptacle small, 2× coiled. Mouth hook of 3rd instar larva (Fig. 1G,H) serrated below, blunt apically.

**Type data.** PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,810), allotype ♀, Perenin Riv between Bulolo and Lae, 227 m, samples of early stages, 30.VIII.1977, ex flowers of *Alocasia hollrungii* Engl., Carson. Types in BISHOP.

**Relationships.** *D. (Sc.) aproclinata* is different from ordinary *Scaptodrosophila* species in having a long anterior reclinate orbital, no procline orbital and no prescutellars. It somewhat resembles *Drosophilella* species in having stout teeth on the fore tarsi in both sexes but is different in having no sternal process in the ♂.

## 2. *Drosophila (Scaptodrosophila) paragama* Okada & Carson, new species

FIG. 2A–D; 5I, J

♂, ♀. Body about 2.5 mm in length. Eye (Fig. 2A) oval, oblique to body axis, dark red, with thick pile. Antenna with 2nd joint brown, 3rd grayish brown, broad. Arista with about 5 upper and 2 lower very fine branches on distal ½. Palpus yellowish brown, broad, with a few long black setae below. Ocellar triangle

subshining black, large. Ocellars short, somewhat outside triangle. Periorbits subshining black, broad, reaching anterior margin of frons. Postverticals moderate. Frons velvety black, with frontal hairs, anteriorly as broad as median length, and  $\frac{1}{2}$  head width. Face gray, pubescent. Carina very high, not reaching buccal margin. Cheek broad, grayish brown,  $\frac{1}{4}$  as broad as the greatest diameter of eye; postgena wider. Clypeus large, brownish black. Anterior reclinate orbitals as long as posteriors, widely apart from the latter; proclinate orbitals absent. Vibrissa long, 2nd oral  $\frac{2}{5}$  vibrissa. Mesoscutum and scutellum mat black, humerus slightly paler. Thoracic pleura also slightly paler. A mesopleural bristle present. Humeral 2, long. Anterior dorsocentrals short,  $\frac{1}{4}$  posteriors; cross distance of dorsocentrals equal to length distance. Sternopleurals fine, median one slightly longer than anteriors. Sterno-index 0.4. Anterior scutellars slightly divergent, as long as posteriors, which are somewhat nearer to each other than to anteriors. Legs rather thick, yellowish gray; femora, distal  $\frac{1}{2}$  of tibiae, and ultimate 2 tarsal joints black. Fore femur with a row of long setae below. Preapicals of fore tibia and apicals (2 or 3 in number) of mid tibia in both sexes very large. Metatarsi longer than succeeding 3 tarsal joints taken together. Wing dark along costa;  $R_{2+3}$  straight;  $R_{4+5}$  and M parallel. C-index 1.8; 4V-index 2.3; 4C-index 1.4; 5x-index 1.7; Ac-index 3.4. C1-bristles 2, subequal; C3-fringe  $\frac{2}{7}$ . Haltere yellowish brown, with knob yellow and elongate triangular. Abdominal tergites uniformly mat black. Periphallallic organs (FIG. 2B) dark brown; surstylus paler, with about 10 black teeth in a convexed row; epandrium pointed ventroanteriorly. Cerci constricted nearly at lower tip in lateral aspect. Phallic organs (FIG. 2C) pale yellow; aedeagus elongate, ventromedially with distally furcated conical process; paramere long, pointed, with a few sensilla in a row. Ovipositor (FIG. 2D) apically rounded, dark brown, distally pubescent, with about 20 black teeth distally and a few long bristles more proximally. Testis (FIG. 5I) simple, bright orange; paragonia slender. Egg (FIG. 5J) elongate, 0.7 mm in length, without filaments.

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,811), allotype ♀, Mt Kaindi, 1900 m, 30.XI.1977, Carson; 2♂ paratypes from same locality, 10.X.1977 and 16.XI.1977, Carson; 2♀ paratypes, Bulldog Road, 2000 m, 22.VIII.1977 and 18.XI.1977, Carson. All ex flowers of *Alocasia macrorrhiza* Schott, designated "paragum" in neo-Melanesian (pidgin) name, hence the specific name. Types in BISHOP.

*Relationships.* This species is unique in the presence of a mesopleural bristle, in the absence of proclinate orbitals and in having 2 or 3 stout apicals on mid tibia. It is somewhat allied to the foregoing species, *D. aproclinata*, in male genitalia and in the absence of proclinate orbitals. The presence of mesopleurals recalls *Camilla* but this species differs in having a merely pubescent arista and no proclinate orbitals.

### 3. *Drosophila* (*Scaptodrosophila*) *plaua* Okada & Carson, new species FIG. 2E-H

♂, ♀. Body 2 mm in length. Eye (FIG. 2E) dark red, with pile. Antenna with 2nd joint brown, 3rd black. Arista distally with 5 upper and 3 lower very short branches and a minute fork. Palpus dark brown, with a few long setae below. Ocellar triangle large, subshining black. Ocellars outside triangle. Periorbits subshining black,  $\frac{3}{4}$  as long as frons. Frons anteriorly as broad as median length, dark brownish gray, with many frontal hairs. Face gray; carina high, broad. Cheek grayish brown, laterally black,  $\frac{1}{6}$  as broad as the greatest diameter of eye. Clypeus shining black. Anterior reclinate orbitals fine, at middle between proclinate and posterior reclinate, which are subequal in length. Postverticals as long as proclinate orbitals. Vibrissa long, 2nd oral  $\frac{1}{4}$  as long as vibrissa. Mesoscutum shining black; scutellum black, gray pruinose. Thoracic pleura paler. Humeral 2. Acrostichal hairs in 6 rows. Scutellars as long as anterior dorsocentrals, which are  $\frac{1}{2}$  as long as posteriors; length distance of dorsocentrals  $\frac{2}{3}$  cross distance. Sterno-index 0.8, middle sternopleural long. Anterior scutellars slightly divergent, as long as posteriors, which are subequally apart from each other and from anteriors. Legs black; tarsi, tip of tibiae and knee joints paler; metatarsi nearly as long as succeeding 4 tarsal joints taken together. Wing hyaline, veins black;  $R_{2+3}$  nearly straight;  $R_{4+5}$  and M slightly convergent distally. C-index 2.0; 4V-index 3.5; 4C-index 1.5; 5x-index 2.2; Ac-index 3.5. C1-bristles 2, unequal; C3-fringe  $\frac{1}{2}$ . Haltere yellowish brown. Abdominal tergites mat yellowish brown, with faint dark distal bands; caudal tergites in ♀ pale. Periphallallic organs (FIG. 2F) pale yellowish gray; epandrium broadly truncate below; surstylus quadrate, distally with about 12 black pointed

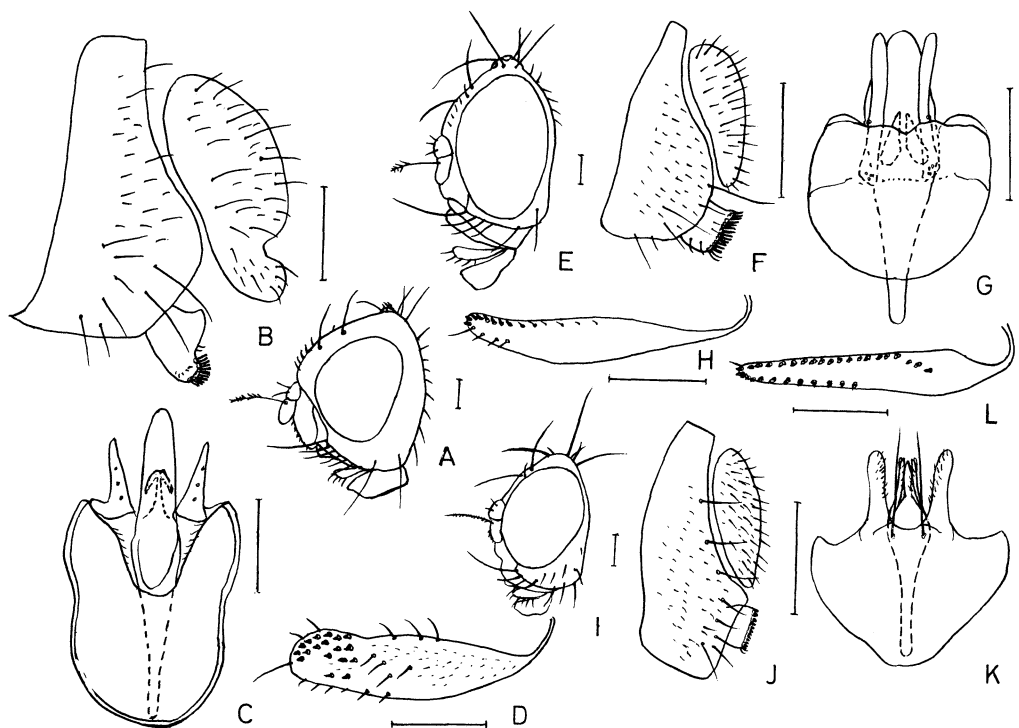


FIG. 2. A-D, *Drosophila (Scaptodrosophila) paraguma*. E-H, *D. (Sc.) plaua*. I-L, *D. (Sc.) nuda*. A,E,I = head; B,F,J = peripheral phallic organs; C,G,K = phallic organs; D,H,L = ovipositor. Scale 0.1 mm.

teeth in a straight row. Phallic organs (FIG. 2G) pale brown; aedeagus robust, obovate; paramere slender, as long as aedeagus; ventral fragma rounded proximally. Ovipositor (FIG. 2H) pale yellowish brown, elongate, with about 15 small teeth.

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,812), allotype ♀, 1♂, 2♀ paratypes, Mt Kaindi, altitude 1900 m, 3-10.X.1977, reared ex flowers of *Alocasia macrorrhiza* Schott, Carson. The specific name, *plaua*, means flower in neo-Melanesian (pidgin). Types in BISHOP.

*Relationships.* *D. plaua* is somewhat allied to the foregoing species, *D. paraguma*, in the shape of the arista and phallic organs, but is distinguished from it in having proclinate orbitals.

#### 4. *Drosophila (Scaptodrosophila) nuda* Okada & Carson, new species FIG. 2I-L; 5K

♂, ♀. Body about 1.5 mm in length. Eye (FIG. 2I) dark red, with pile. Antenna black; arista short, straight, merely pubescent along entire length, thus the specific name. Palpus black, with a few setae below. Postverticals rather long. Ocellar triangle large, slightly convexed, shiny black; ocellars inserted inside triangle. Periorbits shiny black, well demarcated, broad. Frons shiny black, gray pruinose, anteriorly broader than median length. Face grayish black; carina roundly convexed. Clypeus black. Cheek black, broad,  $\frac{1}{6}$  as broad as the greatest diameter of eye, caudally much broader. Anterior reclinate orbitals  $\frac{1}{2}$  as long as proclinate, close to the latter. Second to 6th orals  $\frac{1}{2}$  as long as vibrissa. Mesoscutum subshining black,

gray pruinose. Scutellum velvety black. Thoracic pleura slightly paler than mesoscutum. Humeral 2. Acrostichal hairs in 6 rows. Prescutellars shorter than anterior dorsocentrals, which are  $\frac{1}{2}$  as long as posteriors; length distance of dorsocentrals  $\frac{3}{5}$  cross distance. Sterno-index 0.75. Anterior scutellars divergent, as long as posteriors, which are equally apart from anteriors and from each other. Legs brownish black, tarsi paler. Fore metatarsus as long as succeeding 3 tarsal joints taken together; mid and hind metatarsi as long as the rest of tarsal joints. Wing hyaline;  $R_{2+3}$  slightly curved to costa apically;  $R_{4+5}$  and M parallel. C-index 1.8; 4V-index 2.7; 4C-index 1.5; 5x-index 3.0; Ac-index 3.0. C1-bristles 2, subequal; C3-fringe  $\frac{3}{7}$ . Haltere brownish black. Abdominal tergites subshining black, with gray pubescence. Periphallallic organs (FIG. 2J) pale yellowish brown, truncate below; surstylus with about 12 large teeth in a straight row. Cerci narrowing below. Phallic organic (FIG. 2K) pale yellowish brown. Aedeagus elongate, apically bifid. Parameres elongate, pubescent. Submedian spines very long. Ovipositor (FIG. 2L) slender, dark brown, marginally with numerous minute teeth. Egg (FIG. 5K) 0.6 mm in length, without about 5 filaments, which are  $\frac{1}{5}$  as long as egg.

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,813), allotype ♀, Bulldog Road, 2000 m, 22.VIII.1977, Carson; 3 ♂ paratypes, Mt Kaindi, 1900 m, 10-21.X.1977, Carson; all ex flowers of *Alocasia macrorrhiza* Schott. Types in BISHOP.

*Relationships.* *D. nuda* resembles the foregoing species, *D. plaua*, in the shape of ♂ and ♀ genitalia, but differs from it in having merely finely pubescent arista.

##### 5. *Drosophila* (*Scaptodrosophila*) *parviramosa* Okada & Carson, new species

FIG. 3A-C

♂, ♀. Body 1.5 mm in length. Eye castaneous red, with short pile. Antenna black, 2nd joint brownish below. Arista with about 5 upper and 3 lower very short branches and a fine fork, thus the specific name. Palpus black with a few setae below. Ocellar triangle and periorbits black, not well demarcated. Ocellars inside triangle. Frons deep subshining black, somewhat granulose, anteriorly slightly broader than median length. Face dark brown, about  $\frac{1}{7}$  as broad as the greatest diameter of eye. Clypeus black. Anterior reclinate orbital  $\frac{1}{2}$  proclinate, just behind proclinate; posterior reclinate slightly longer than proclinate. Vibrissa very long, other orals much shorter. Mesoscutum deep subshining black, somewhat granulose. Scutellum mat black, broader than long. Anterior scutellars parallel, as long as posteriors, which are equally apart from each other and from anteriors. Thoracic pleura granulose black, finely pruinose, yellowish at the base of wing. Humeral 2, subequal. Prescutellars shorter than anterior dorsocentrals, which are  $\frac{1}{2}$  as long as posteriors; length distance of dorsocentrals  $\frac{1}{2}$  cross distance. Acrostichal hairs in 8 rows. Legs yellowish brown; femora and tibiae black, ultimate tarsal joint dark. Fore metatarsus as long as succeeding 3 tarsal joints taken together, mid and hind metatarsi as long as the rest of tarsal joints. Wing hyaline,  $R_{2+3}$  gently curved to costa at apex.  $R_{4+5}$  and M parallel. C-index 1.8; 4V-index 2.8; 4C-index 1.6; 5x-index 2.7; Ac-index 3.2. C1-bristles 2, subequal; C3-fringe  $\frac{3}{5}$ . Haltere pale yellow. Abdominal tergites subshining black. Periphallallic organs (FIG. 3A) brownish black. Epandrium broad below. Surstylus hemispherical, distally with a straight row of about 15 black teeth. Phallic organs (FIG. 3B) with parameres long and pointed, aedeagus shorter than paramere, submedian spines longer than paramere. Ovipositor (FIG. 3C) lanceolate, yellowish brown, with small teeth along dorsal and ventral margins on distal  $\frac{1}{2}$ .

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,814), Mt Kaindi, 1900 m, 27.X.1977, ex flowers of *Alocasia macrorrhiza* Schott, Carson; allotype ♀, 3 ♂, 1 ♀ paratypes, same locality, 3-28.X.1977, ex flowers of same host, Carson; 1 ♀ paratype, Mt Missim, 1570 m, 1.XII.1977, ex flowers of *Alocasia angustiloba* Engl. & Krause, Carson; 2 ♂ paratypes, Bulldog Road, 2000 m, 22.VIII.1977, ex flowers of *Alocasia macrorrhiza* Schott, Carson. Types in BISHOP.

*Relationships.* *D. parviramosa* is allied to the foregoing species, *D. nuda*, especially in having ♂ and ♀ genitalia closely similar but is distinguished by the presence of short but distinct branches on the arista.

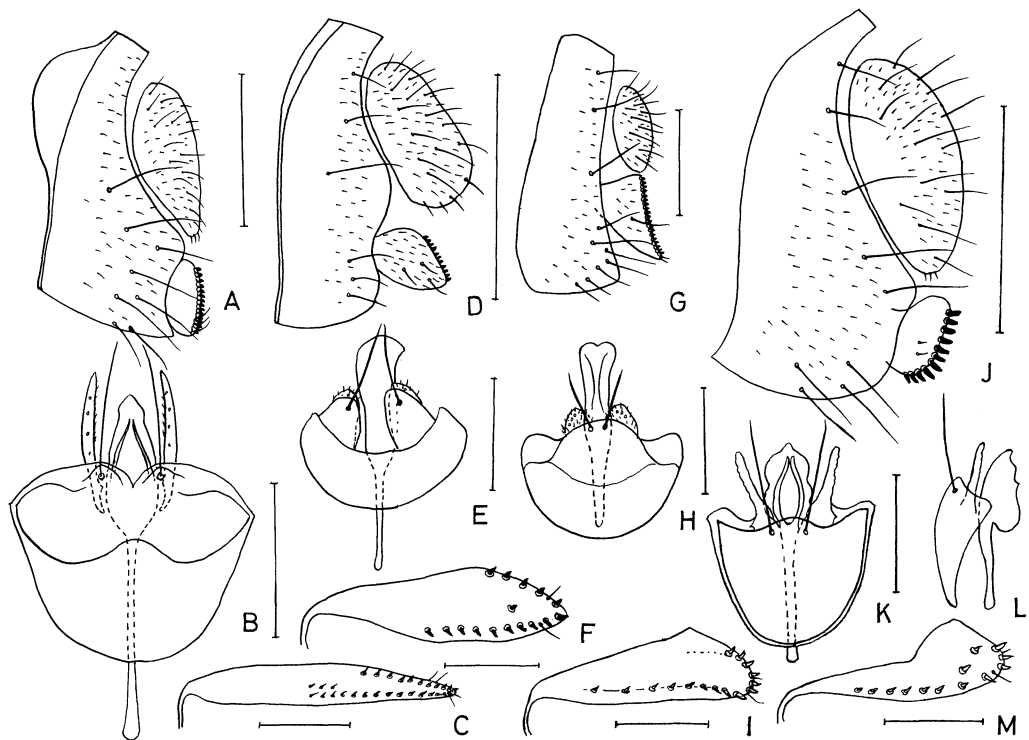


FIG. 3. A-C, *Drosophila (Scaptodrosophila) parviramosa*. D-F, *D. (Sc.) nigrops*. G-I, *D. (Sc.) xanthops*. J-M, *D. (Sc.) incisurifrons*. A, D, G, J = periphallal organs; B, E, H, K, L = phallic organs; C, F, I, M = ovipositor. Scale 0.1 mm.

## 6. *Drosophila (Scaptodrosophila) nigrops* Okada & Carson, new species FIG. 3D-F

♂, ♀. Body about 1.5 mm in length. Eye castaneous brown, with sparse pile. Antenna grayish brown. Arista with 4 upper and 2 lower long branches and a minute fork. Palpus yellow, with a few long setae below. Ocellar triangle and periorbits black. Frons mat black, anteriorly yellowish orange. Face white; carina high, white,  $\frac{1}{2}$  as long as face. Cheek narrow, yellowish white, with a black line connecting the bases of orals. Anterior reclinate orbital  $\frac{1}{4}$  proclinate, middle between proclinate and posterior reclinate. Second to 6th orals  $\frac{1}{3}$  as long as vibrissa. Mesoscutum and scutellum subshining brownish black. Thoracic pleura pale yellow. Humerus black above, yellow below. Humeral 2, upper shorter. Prescutellars slightly shorter than anterior dorsocentrals. Acrostichal hairs in 6 rows. Anterior dorsocentrals  $\frac{3}{5}$  as long as posteriors; length distance of dorsocentrals  $\frac{2}{3}$  cross distance. Sterno-index 0.5; median sternopleural as long as anteriors. Legs yellow, metatarsi as long as the rest of tarsal joints. Wing hyaline, slender;  $R_{2+3}$  nearly straight,  $R_{4+5}$  and M parallel. C-index 2.5; 4V-index 1.8; 4C-index 1.0; 5x-index 2.0; Ac-index 2.4. C1-bristle 1; C3-fringe  $\frac{2}{5}$ . Haltere yellow. Abdominal tergites: 1st gray; 2nd to 4th black, laterally yellow; 5th yellowish orange with a median black eye-spot, thus the specific name; 6th yellowish gray. Periphallal organs (FIG. 3D) pale yellow. Epandrium truncate below. Surstylus large, quadrate, with about 10 teeth in a straight row. Phallic organs (FIG. 3E) pale yellow. Aedeagus thick, oblong, apically hooked dorsally. Paramere oval, finely pubescent. Submedian spines as long as aedeagus, inserted on triangular hypandrial plates. Ovipositor (FIG. 3F) pale yellow, broad, with about 15 marginal black teeth.

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,815), allotype ♀,

Mt Kaindi, 1900 m, 17.X.1977, Carson; 1♂ paratype, Bulldog Road, 2000 m, 18.XI.1977, Carson; all ex flowers of *Alocasia macrorrhiza* Schott. Types in BISHOP.

*Relationships.* *D. nigrops* is unusual among the members of this subgenus in having yellow thoracic pleura which contrast with the black mesoscutum.

### 7. *Drosophila* (*Scaptodrosophila*) *xanthops* Okada & Carson, new species

FIG. 3G-I

♂, ♀. Body about 1.5 mm (♂)-2.5 mm (♀) in length. Eye red, with fine pile. Antenna with 2nd joint brownish yellow, anteriorly darker; 3rd whitish gray. Arista with 4 upper and 2 lower long branches and a fine fork. Palpus yellowish gray, with a few setae below. Frons including ocellar triangle and periorbits golden brown. Face yellowish white; carina long and high. Cheek yellow, about  $\frac{1}{10}$  as broad as the greatest diameter of eye. Clypeus yellowish brown. Anterior reclinate orbital  $\frac{1}{2}$  proclinate, at middle between proclinate and posterior reclinate. Second oral  $\frac{1}{3}$  as long as vibrissa. Mesoscutum and scutellum dark yellowish brown; thoracic pleura paler. Humeral 2, long. Acrostichal hairs in 6 rows. Prescutellars obscure. Anterior dorsocentrals  $\frac{3}{5}$  posteriors. Sterno-index 0.6; median sternopleural long. Legs yellow, slender; fore metatarsus as long as the rest of tarsal joints; mid and hind longer than the rest of tarsal joints. Wing hyaline;  $R_{2+3}$  weakly curved to costa at tip;  $R_{3+4}$  and M parallel. C-index 2.8; 4V-index 1.8; 4C-index 0.8; 5x-index 2.2; Ac-index 2.5. C1-bristles 2, small. C3-fringe  $\frac{2}{5}$ . Haltere grayish brown. Abdominal tergites orange-brown, caudally with broad black bands; 5th tergite with median black eye-spot, thus the specific name. Periphallallic organs (FIG. 3G) pale yellow. Epandrium truncate below. Surstylus large, triangular, distally with a slightly concave row of about 15 teeth. Cerci relatively small. Phallic organs (FIG. 3H) pale yellow. Aedeagus distally expanded. Paramere oval, pubescent. Submedian spines shorter than aedeagus. Ovipositor (FIG. 3I) pale yellow, apically triangular, with about 15 brown marginal teeth.

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,816), allotype ♀, 2♂, 2♀ paratypes, Mt Kaindi, 1900 m, 3.X.1977 and 21.XI.1977, Carson. All ex flowers of *Alocasia macrorrhiza* Schott. Types in BISHOP.

*Relationships.* *D. xanthops* is allied to the foregoing species, *D. nigrops*, in having a black eye-spot on the 5th abdominal tergite and having the thoracic pleura paler than the mesoscutum. It is distinguished from *D. nigrops* by the paler mesoscutum, smaller ♂ cerci and larger surstylus with more teeth.

### 8. *Drosophila* (*Scaptodrosophila*) *incisurifrons* Okada & Carson, new species

FIG. 3J-M

♂, ♀. Body about 1.8 mm in length. Eye dark red, with thick pile. Antenna black, 2nd joint brownish below. Arista with 3 upper and 2 lower long branches and a large fork. Palpus black, with a long apical seta. Ocellar triangle and periorbit subshining black. Frons mat black, granulose, anteriorly deeply incised and concaved, anteriorly as broad as median length, caudally broadened. Face black, brownish above. Carina narrow, ridged. Cheek brownish black, narrow, about  $\frac{1}{8}$  as broad as the greatest diameter of eye. Clypeus mat black. Anterior reclinate orbital  $\frac{3}{8}$  proclinate,  $2\times$  apart from posterior reclinate as from proclinate. Ocellars as long as posterior reclinate orbital. Second oral  $\frac{1}{3}$  as long as vibrissa. Mesoscutum and scutellum deep black, gray pruinose. Thoracic pleura paler. Humeral 2, long. Prescutellars weak. Acrostichal hairs in 6 rows. Dorsocentrals subequal in length; length distance  $\frac{2}{3}$  cross distance. Sterno-index 0.6. Scutellars subequal in size and in mutual distance. Legs yellow; femora black, thick, apically yellow; ultimate tarsal joints dark. Fore metatarsus as long as succeeding 3 tarsal joints taken together, mid and hind as long as the rest of tarsal joints. Wing hyaline,  $R_{2+3}$  gently curved to costa. C-index 2.0; 4V-index 2.5; 4C-index 1.4; 5x-index 2.4; Ac-index 2.8. C1-bristles 2; C3-fringe  $\frac{3}{7}$ . Haltere yellowish white. Abdominal tergites mostly black. Periphallallic organs (FIG. 3J) yellowish brown. Epandrium broadly rounded below. Surstylus oval, distally with about 10 black teeth in a convexed row. Phallic organs (FIG.



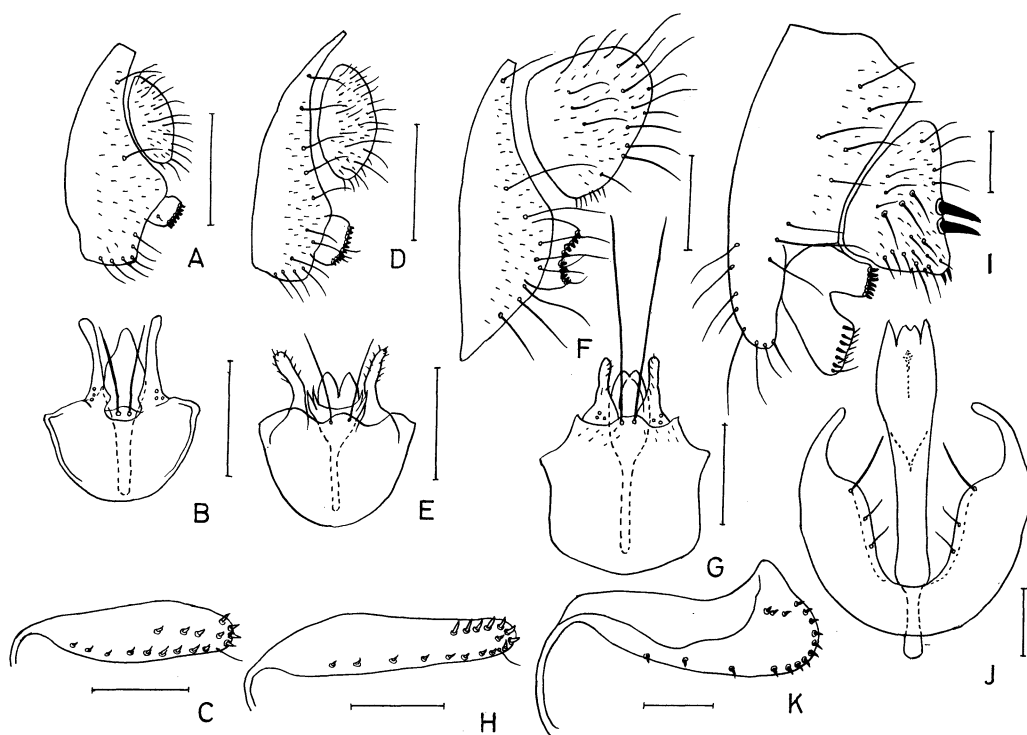


FIG. 4. A-C, *Drosophila (Scaptodrosophila) psychotriae*. D-E, *D. (Sc.) spathicola*. F-H, *D. (Sc.) metatarsalis*. I-K, *D. (D.) alpinae*. A,D,R,I = peripheralhallic organs; B,E,G,J = phallic organs; C,H,K = ovipositor. Scale 0.1 mm.

3K, L) pale yellowish brown. Aedeagus small, pointed apically. Paramere also short, narrow, basally with sensilla, distally somewhat pubescent. Submedian spines slightly longer than aedeagus. Ovipositor (FIG. 3M) yellowish brown, apically somewhat rounded, with about 10 rather large marginal and 2 discal brownish teeth.

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,817), allotype ♀, Mt Kaindi, 1900 m, 3.X.1977, Carson, ex flowers of *Alocasia macrorrhiza* Schott. Types in BISHOP.

*Relationships.* This species is unique in the subgenus in having the frons deeply incised and concaved anteriorly, thus the specific name.

### 9. *Drosophila (Scaptodrosophila) psychotriae* Okada & Carson, new species

FIG. 4A-C

♂, ♀. Body about 1.5 mm in length. Eye dark red, with fine pile. Antenna with 2nd joint pale brown, 3rd darker. Arista with 3 upper and 2 lower long branches and a moderate fork. Palpus yellowish brown, with a long terminal and a few shorter lower setae. Ocellar triangle and periorbits yellowish gray. Frons golden brown, anteriorly orange, anteriorly slightly broader than median length. Face grayish brown; carina large, flat above, rounded below. Cheek narrow, yellowish gray, about  $\frac{1}{8}$  as broad as the greatest diameter of eye. Clypeus yellowish brown. Anterior reclinate orbital  $\frac{1}{3}$  as long as proclinate, nearer to

proclinate than to posterior reclinate; which is longer than proclinate. Second oral  $\frac{1}{4}$  as long as vibrissa. Ocellars as long as posterior reclinate. Postverticals shorter than proclinate. Mesoscutum and scutellum subshining grayish brown; thoracic pleura paler. Humerals 2, upper much shorter than lower. Acrostichal hairs in 6 rows. Sterno-index 0.5. Prescutellars shorter than anterior dorsocentrals, which are  $\frac{1}{2}$  as long as posteriors. Length distance of dorsocentrals  $\frac{2}{5}$  cross distance. Anterior scutellars parallel or divergent, nearly  $2\times$  as long as posteriors, which are equally apart from each other and from anteriors. Legs yellowish gray, metatarsi of all legs as long as the rest of tarsal joints. Wing hyaline,  $R_{2+3}$  straight,  $R_{4+5}$  and M slightly divergent. C-index 2.0; 4V-index 2.0; 4C-index 1.2; 5x-index 2.0; Ac-index 2.8. C1-bristles 2, subequal; C3-fringe  $\frac{1}{5}$ . Haltere yellowish gray. Abdominal tergites pale yellowish brown. Periphallallic organs (FIG. 4A) pale yellow. Epandrium truncate below. Surstylus with 6-8 black teeth in a straight row. Phallic organs (FIG. 4B) pale yellow. Aedeagus long, broad, distally pointed; paramere large, as long as aedeagus; submedian spines long and close to each other at base. Ovipositor (FIG. 4C) pale yellow, distally rounded, with about 15 pointed teeth.

*Type data.* PNG: NEW GUINEA (NE): holotype  $\delta$  (BISHOP 11,818), allotype  $\varphi$ , 1  $\delta$  paratype, Mt Kaindi, 1900 m, 21, 30.XI.1977, Carson, ex flowers of *Psychotria* (Rubiaceae); thus the specific name; 2  $\delta$ , 1  $\varphi$  paratypes, same locality, 18-24.XI.1977, Carson, nr plants of *Alocasia macrorrhiza* Schott. Types in BISHOP.

*Relationships.* This species somewhat resembles *Drosophila scaptomyzoidea* Duda in body coloration and periphallallic organs but is distinguished from it by the much smaller C-index.

#### 10. *Drosophila (Scaptodrosophila) spathicola* Okada & Carson, new species

FIG. 4D, E

$\delta$ . Body about 2 mm in length. Eye deep red, with pile. Antenna pale brown; arista with 4 upper and 2 lower long branches and a small fork. Palpus yellow, with a few black setae below. Ocellar triangle small, black. Periorbits subshining gray-brown. Frons quadrate, dark brown, with a few frontal hairs, anteriorly orange and as broad as median length. Face yellowish white; carina high, narrow. Cheek very narrow, yellowish white. Clypeus yellowish white. Anterior reclinate orbital  $\frac{2}{5}$  proclinate, just behind it; proclinate  $\frac{3}{5}$  posterior reclinate. Vibrissa strong, other orals fine. Mesoscutum and scutellum mat reddish brown. Thoracic pleura paler, whitish below. Humerals 2, subequal. Prescutellars weaker than anterior dorsocentrals. Acrostichal hairs in 8 rows. Anterior dorsocentrals  $\frac{2}{5}$  posteriors; length distance of dorsocentrals  $\frac{2}{5}$  cross distance. Sterno-index 0.9; middle sternopleurals as long as anteriors. Legs yellow; metatarsi as long as the rest of tarsal joints. Wing somewhat fuscous especially distally;  $R_{2+3}$  weakly curved to costa at apex. C-index 5.0; 4V-index 1.5; 4C-index 2.0; 5x-index 2.5; Ac-index 2.0. C1-bristles 2, subequal; C3-fringe  $\frac{1}{4}$ . Haltere yellow. Abdominal tergites subshining deep black; 1st tergite yellowish brown. Periphallallic organs (FIG. 4D) brownish black. Epandrium rounded below; surstylus quadrate, distally with a straight row of about 10 black pointed teeth. Cercus oval in lateral aspect. Phallic organs (FIG. 4E) pale brown. Aedeagus short, bifid, laterally with 2 pointed branches. Paramere elongate, pubescent. Submedian spines as long as paramere.

*Type data.* PNG: NEW GUINEA (NE): holotype  $\delta$  (BISHOP 11,819), Mt Kaindi, 1900 m, 3.X.1977, Carson; 2  $\delta$  paratypes, same locality, 27.X.1977, Carson; 2  $\delta$  paratypes, Bulldog Road, 2000 m, 18.XI.1977, Carson. All ex decaying spathes of *Alocasia macrorrhiza* Schott, thus the specific name. Types in BISHOP.

*Relationships.* *D. spathicola* resembles *D. scaptomyzoidea* in having a high C-index but is distinguished from it by the black abdomen.

### 11. *Drosophila (Scaptodrosophila) metatarsalis* Okada & Carson, new species

FIG. 4F–H

♂, ♀. Body about 2–2.5 mm in length. Eye red, very sparsely piled. Antenna grayish brown, 3rd joint paler. Arista with 4 upper and 3 lower long branches and a large fork. Palpus yellowish gray, with 2 strong subapical setae. Ocellar triangle dark brown; periorbits grayish brown,  $\frac{1}{2}$  as long as frons. Frons mat orange-brown, anteriorly paler and with about 10 frontal hairs, anteriorly concaved and narrower than median length, posteriorly broadened. Face yellowish gray; carina short but high. Cheek narrow, yellowish gray; clypeus yellowish gray. Anterior reclinate orbital  $\frac{1}{3}$  proclinate, nearer to proclinate than to posterior reclinate; proclinate  $\frac{2}{3}$  posterior reclinate. Second oral  $\frac{1}{3}$  as long as vibrissa. Mesoscutum and scutellum mat grayish brown, pleura paler. Humeral 2, long. Prescutellars much weaker than anterior dorsocentrals. Acrostichal hairs in 8 rows. Anterior dorsocentrals  $\frac{1}{3}$  posteriors; length distance of dorsocentrals  $\frac{2}{5}$  cross distance. Sterno-index 0.8; median sternopleural long. Legs yellow; metatarsi much longer than the rest of tarsal joints, thus the specific name. C-index 2.3; 4V-index 1.5; 4C-index 0.8; 5x-index 1.5; Ac-index 2.2. C1-bristles 2, subequal; C3-fringe  $\frac{4}{5}$ . Wings rather slender, slightly fuscous anteriorly.  $R_{2+3}$  straight;  $R_{4+5}$  and M slightly divergent distally. Haltere yellowish gray. Abdominal tergites brownish black, 1st tergite laterally yellow. Periphallallic organs (FIG. 4F) pale yellowish brown. Epandrium elongate, tapering below. Surstylus with a concaved row of about 10 black teeth. Cercus large, oval, with long hairs. Phallic organs (FIG. 4G): aedeagus small; paramere longer, pubescent, basally with a few sensilla. Submedian spines very long, about  $3\times$  as long as paramere. Ovipositor (FIG. 4H) yellow, elongate fusiform, with about 20 pointed marginal teeth.

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,820), Mt Kaindi, 1900 m, 16.XI.1977, Carson; allotype ♀, same locality, 21.XI.1977, Carson; 1 ♂ paratype, Bulldog Road, 2000 m, 18.XI.1977, Carson; all ex or nr flowers of *Alocasia macrorrhiza* Schott. 1 ♀ of this species reared ex mature inflorescence of *Colocasia esculenta* (L.) Schott collected at Kunai Creek, Mt Kaindi, 30.X.1977, Carson. Types in BISHOP.

*Relationships.* *D. metatarsalis* somewhat resembles *Drosophila specensis* Bock from Queensland in the features of ♂ genitalia and large C-index. It may be distinguished from the latter species by a concave row of surstylus teeth and a very long submedian spine of the phallic organs.

### 12. *Drosophila (Scaptodrosophila) tricingulata* Okada & Carson, new species

FIG. 5A–C

♂, ♀. Body about 2.3 mm in length. Eye castaneous red, with fine pile. Antenna with 2nd joint orange-brown, 3rd grayish. Arista with 3 upper and 3 lower long branches and a small fork. Palpus yellowish orange, slender, with a few long setae below. Ocellar triangle brown; ocellars as long as posterior reclinate orbitals. Periorbit grayish orange, ending before anterior end of frons. Frons subshining golden brown, anteriorly orange and slightly narrower than median length. Face yellowish gray; carina high. Cheek very narrow, yellowish orange. Clypeus grayish orange. Anterior reclinate orbital  $\frac{1}{5}$  other orbitals, just behind proclinate. Vibrissa strong, other orals fine. Mesoscutum and scutellum subshining orange-brown. Thoracic pleura yellowish white. Humeral 2, long. Prescutellars weak. Acrostichal hairs in 8 rows. Anterior dorsocentrals  $\frac{1}{2}$  posteriors; length distance of dorsocentrals  $\frac{1}{3}$  cross distance. Sterno-index 0.6; median sternopleural longer than anteriors. Legs yellow; metatarsi as long as the rest of tarsal joints. Wing hyaline;  $R_{2+3}$  slightly curved to costa apically;  $R_{4+5}$  and M parallel. C-index 2.5; 4V-index 1.7; 4C-index 0.9; 5x-index 1.7; Ac-index 2.5. C1-bristle 1; C3-fringe  $\frac{2}{5}$ . Haltere yellowish gray. Abdominal tergites orange-brown, 2nd to 4th tergites with well-demarcated caudal black bands, thus the specific name. Periphallallic organs (FIG. 5A) pale yellow. Epandrium rounded below; surstylus quadrate, distally with a convexed row

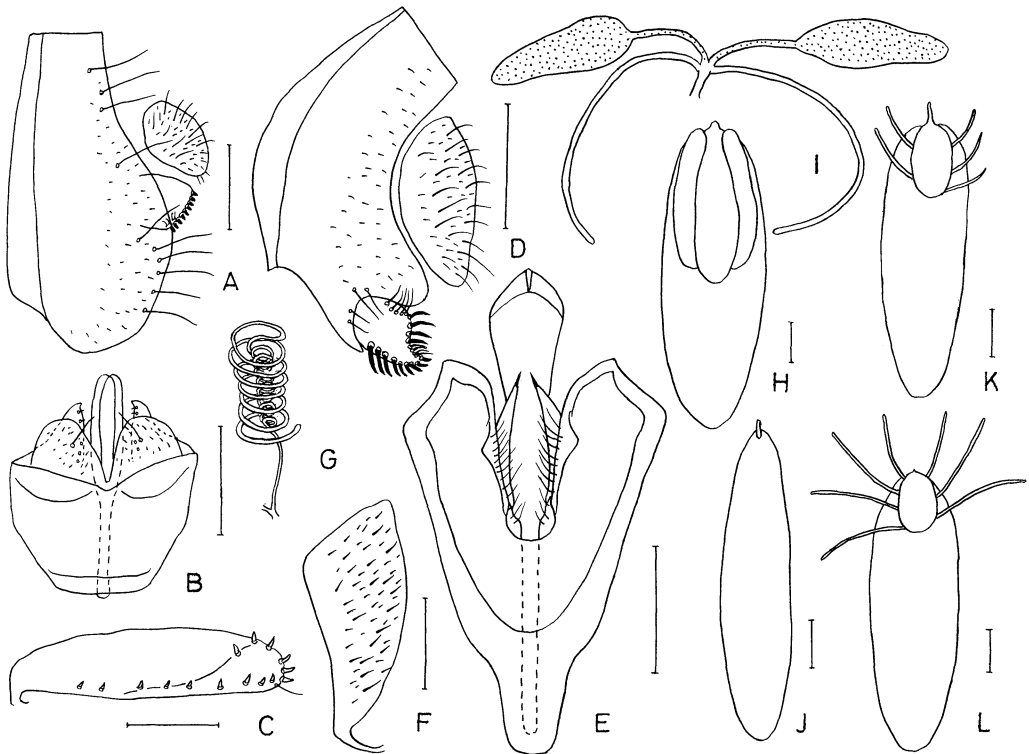


FIG. 5. A-C, *Drosophila (Scaptodrosophila) tricingulata*. D-H, *Styloptera alocasiae*. I-J, *D. (Sc.) paraguayana*. K, *D. (Sc.) nuda*, from ovary. L, *D. (Sc.) nuda*, from host plant. A, D = peripheral phallic organs; B, E = phallic organs; C, F = ovipositor; G = testis; I = testes and paragonia; H, J-L = egg. Scale 0.1 mm.

of about 13 black teeth. Cercus oval, small. Phallic organs (FIG. 5B) pale yellowish brown; aedeagus thick elliptical. Submedian spines short, widely separated from each other. Paramere conical, apically pointed, with a few sensilla along inner margin. Ovipositor (FIG. 5C) elliptical, pale yellowish brown, with about 15 marginal and 2 discal teeth.

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,821), paratype ♀, Mt Kaindi, 1900 m, 30.XI.1977, nr *Alocasia macrorrhiza* Schott, Carson; allotype ♀, same locality, nr same plant, 24.XI.1977, Carson; 2♂ paratypes, same locality, 6.X.1977, Carson. Types in BISHOP.

*Relationships.* In genital features, *D. tricingulata* resembles *D. xanthops* of this paper but is different in having no eye-spot on the 5th abdominal tergite.

### 13. *Drosophila (Drosophila) alpiniae* Okada & Carson, new species FIG. 4I-K

♂, ♀. Body about 2.0 mm in length, orange-brown. Antenna dark brown, 3rd joint broad elliptical. Arista with 4 upper and 5 lower very short branches, with or without fine fork. Palpus yellow, with a few setae. Ocellar triangle large, black. Periorbit narrow,  $\frac{2}{3}$  as long as frons. Frons mat grayish brown, anteriorly orange, with a few frontal hairs. Face pale yellowish brown; carina high and long. Cheek  $\frac{1}{2}$  as broad

as the greatest diameter of eye. Clypeus yellowish brown. Proclinate orbital as long as posterior reclinate; anterior reclinate orbital thin,  $\frac{1}{2}$  as long as posteriors, widely and equally apart from proclinate and from posterior reclinate. Second oral  $\frac{1}{4}$  as long as vibrissa; 3rd as long as 2nd. Mesoscutum subshining orange-brown, with 3 faint narrow black longitudinal stripes. Scutellum slightly darker than mesoscutum; thoracic pleura paler. Humeral 2, subequal. Acrostichal hairs in 6 rows. Anterior dorsocentrals  $\frac{1}{2}$  as long as posteriors; length distance of dorsocentrals  $\frac{1}{2}$  cross distance. Sterno-index 0.6. Median sternopleural rather long. Anterior scutellars divergent, as long as posteriors, which are equally apart from anteriors and from each other. Legs yellow; fore metatarsus as long as succeeding 3 tarsal joints taken together; mid and hind metatarsi as long as the rest of tarsal joints. Wing hyaline, veins brown.  $R_{2+3}$  slightly curved to costa apically. C-index 3.0; 4V-index 2.0; 4C-index 0.7; 5x-index 2.0; Ac-index 2.2. C1-bristles 2, subequal; C3-fringe  $\frac{3}{7}$ . Haltere yellow. Abdominal tergites mat orange-brown, with medially interrupted laterally narrowing obscure caudal black bands; caudal tergites glossy black in  $\delta$ , mat black in  $\text{♀}$ . Periphallallic organs (FIG. 4I) pale or dark brown. Epandrium ventrally elongate, dorsally broad. Surstylus triangular, distally bifurcated, with about 8 upper and 6 lower black teeth. Cercus caudoventrally with stout bristles. Phallic organs (FIG. 4J) pale brown. Aedeagus slender, apically concaved. Hypandrium with deep incision, submedian spines short. Ovipositor (FIG. 4K) yellowish brown; basal isthmus very long; lobe apically rounded, with about 15 marginal teeth.

*Type data.* PNG: NEW GUINEA (NE): holotype  $\delta$  (BISHOP 11,822), allotype  $\text{♀}$ , 6 $\delta$ , 2 $\text{♀}$  paratypes, Mt Kaindi, 1900–2300 m, VIII–IX.1977, Carson, ex flowers of *Alpinia* (Zingiberaceae), thus the specific name, and from banana bait and fungi; 2 $\text{♀}$  paratypes, Mt Kaindi, 1900 m, 18.XI.1977, Carson, ex flowers of *Alocasia macrorrhiza* Schott. Types in BISHOP.

*Relationships.* *D. alpiniae* resembles *D. melanderi* Sturtevant in general coloration and  $\delta$  periphallallic organs, but is distinguished from it by having no black median spots on the abdominal tergites. *D. alpiniae* belongs to the *melanderi* species group of the subgenus *Drosophila*.

#### 14. *Styloptera alocasiae* Okada & Carson, new species

FIG. 5D–H

$\delta, \text{♀}$ . Body 1.5–2.0 mm in length. Eye dark red, with rough pile. Antenna grayish brown, 3rd joint rounded. Arista with 3 upper and 2 lower rather short branches and a small fork. Palpus yellowish gray, apically darker, with a few setae below. Ocellar triangle brown and mat velvety black. Ocellars outside ocellar triangle. Periorbits brown or mat velvety black, anteriorly extended nearly to anterior margin of frons. Clypeus pale brown. Frons mat brownish gray or velvety black,  $1.5\times$  as broad as median length. Face orange-gray. Carina high, not reaching buccal margin. Cheek gray, very broad,  $\frac{1}{3}$ – $\frac{1}{4}$  as broad as the greatest diameter of eye. Orbitals at anterior  $\frac{1}{3}$  of frons; anterior reclinate orbital nearly  $\frac{1}{2}$  proclinate, just outside proclinate; posterior reclinate somewhat longer than proclinate. Vibrissa very long, 2nd oral  $\frac{1}{4}$  as long as vibrissa. Mesoscutum and scutellum subshining brownish black or mat velvety black, with gray pruinosity. Thoracic pleura yellow. Humeral 2, long, subequal. Acrostichal hairs in 4 or 6 rows. Anterior scutellars parallel; posteriors as long as anteriors, equally apart from anteriors and from each other. Dorsocentrals in 3 pairs. Sterno-index 0.7. Legs yellow; metatarsi slightly shorter than the rest of tarsal joints. Wing fuscous especially along costa; cell  $R_{4+5}$  paler;  $R_{4+5}$  and M convexed anteriorly at middle. C-index 1.7; 4V-index 2.4–3.0; 4C-index 1.5–2.0; 5x-index 2.4; Ac-index 3.0–4.0. C1-bristles 2, subequal; C3-fringe  $\frac{1}{4}$ – $\frac{1}{3}$ . Haltere gray, apically brown. Abdominal tergites mat grayish brown, paler than mesoscutum. Periphallallic organs (FIG. 5D) dark brown. Epandrium dorsally not narrowing, ventrally truncate. Surstylus quadrate, with about 13 long curved black teeth in a rectangularly curved row above and about 10 similar teeth in a convexed row below. Phallic organs (FIG. 5E) yellowish brown. Aedeagus thick, apically swollen; apodeme as long as aedeagus. Paramere short, pointed, distally with short spine. Ovipositor (FIG. 5F) pale brown, rather short and thick, merely pubescent on entire surface. Testis (FIG. 5G) yellow, with about 10 inner and 10 outer coils. Egg (FIG. 5H) about 0.65 mm in length, without filaments.

TABLE 1. Summary of collections of drosophilids from 3 species of *Alocasia*, Morobe Province, Papua New Guinea, August–November 1977.

SITE	ALTITUDE (m)	SPECIES AND NO. OF SPECIMENS CAPTURED ON OR NEAR PLANTS (C) AND REARED FROM INFLORESCENCES (R)
A. <i>Alocasia macrorrhiza</i> (L.) Schott		
Edie Creek Road, Mt Kaindi	1900	13 species: C,250; r,36 (see TABLE 2-4)
Bulldog Road, Mt Kumbak	2000	9 species: C,47; R,2 (see TABLE 2-4)
B. <i>Alocasia holtrungii</i> Engl.		
Botanical Garden, Lae	10	<i>Drosophila</i> ( <i>Sc.</i> ) <i>aproclinata</i> R,1
Markham River, 1 km S of bridge	60	<i>D. (Sc.) aproclinata</i> R,18
Garagos River, 49 km S of Lae	151	<i>D. (Sc.) aproclinata</i> C,41; R,125
Perenin River	227	<i>D. (Sc.) aproclinata</i> R,19
Kunai Creek, Mt Kaindi	1515	(nil)
C. <i>Alocasia</i> c.f. <i>angustiloba</i> Engl. & Krause		
Kunai Creek, Mt Kaindi	1515	<i>D. (Sc.) parviramosa</i> C,4; R,1
		<i>D. (Sc.) xanthops</i> C,1
Mt Missim	1570	<i>D. (Sc.) parviramosa</i> C,2

*Type data.* PNG: NEW GUINEA (NE): holotype ♂ (BISHOP 11,823), allotype ♀, 2♂ paratypes, Mt Kaindi, 1900 m, 3–10.X.1977, Carson, ex flowers of *Alocasia macrorrhiza* Schott; 1♂ paratype, nr Perenin Riv between Bulolo and Lae, 227 m, 30.VIII.1977, Carson, ex flowers of *Alocasia holtrungii* Engl. Types in BISHOP.

*Relationships.* This species somewhat resembles "*Styloptera* (?) sp." of Wheeler & Takada (1964: 219) from the Caroline Is in having a unicolorous mesoscutum and a distally swollen aedeagus, but differs from it in having the body darker, the wing fuscous and the epandrium more setigerous.

#### OBSERVATIONS ON ECOLOGY AND LIFE HISTORY

##### *A. Alocasia macrorrhiza*

This massive aroid was found growing along the Bulldog Road on the slopes of Mt Kumbak at about 2000 m altitude and in a small overgrown native garden near the crossing of a small irrigation ditch at 1900 m altitude on Mt Kaindi. This plant, although not so widely cultivated as the related *Colocasia esculenta*, is nevertheless used widely as a source of food in SE Asia and other parts of the world, especially under conditions of famine. There was no evidence that the plants studied were being tended; those along the Bulldog Road were growing on the floor of the dense natural forest cover which has developed since the abandonment of the road by vehicular traffic about 35 years ago. The Bulldog Road, however, remains an active pedestrian thoroughfare, resembling a forest trail.

Being fairly remote, the Bulldog Road area was visited only twice (August and November, 1977). Both times it was observed that most plants (77/96 = 80%) had no inflorescences of any sort. Indeed, young inflorescences at the stage at which flies

TABLE 2. Drosophilid fauna associated with plants of *Alocasia macrorrhiza* at 2 sites at about 2000 m altitude on Mt Kaindi and on Bulldog Road, Mt Kumbak, Morobe Province, Papua New Guinea, August–November 1977.

SPECIES	COLLECTED WITHIN VERY YOUNG INFLORESCENCE			COLLECTED ON GAPING, OPEN INFLORESCENCE WITH SOME DECAY			COLLECTED NEAR THE PLANTS OR ON LEAVES OR PETIOLES			GRAND TOTALS
	♀	♂	Total	♀	♂	Total	♀	♂	Total	
<i>Drosophila (Sc.) nuda</i>	34	50	84	1	1	2	2	1	3	89
<i>Styloptera alocasiae</i>	38	29	67	3	5	8				75
<i>D. (Sc.) paraguma</i>	9	8	17							17
<i>D. (Sc.) parviramosa*</i>	2	2	4		5	5				9
<i>D. (Sc.) plaua*</i>	1		1							1
<i>D. (Sc.) incisurifrons</i>	6	8	14	6	7	13	1	1	2	29
<i>D. (Sc.) spathicola</i>				4	6	10	1	6	7	17
<i>D. (Sc.) tricingulata*</i>				1	1	2	5	16	21	23
<i>D. (D.) alpiniae</i>				2	2	4	1		1	5
<i>D. (Sc.) xanthops*</i>							8	14	22	22
<i>D. (Sc.) psychotriae</i>							1	3	4	4
<i>D. (Sc.) nigrops</i>							2	2	4	4
<i>D. (Sc.) metatarsalis</i>							2		2	2
Total	90	97	187	17	27	44	23	43	66	297

\* Found only at Mt Kaindi.

enter and oviposit were rare and unusual; in fact only 2 plants of the 96 had such inflorescences. At the Mt Kaindi site, however, 3 actively flowering plants were found, providing a succession of very young and maturing inflorescences for study during October and November.

Since observations indicated that "fly flowers" (inflorescences containing large numbers of imagoes) are infrequent, we have divided our collections of specimens at *Alocasia macrorrhiza* plants into 3 categories or stages, based on the gross aspect of the plant or inflorescence at the time (TABLE 2). Thus, 6 species were aspirated from the very young inflorescence. With the exception of *D. (Sc.) incisurifrons*, these species were either absent or infrequent within the inflorescence after it had become gaping and fully open (2nd category, TABLE 2). In fact, the data in this table show that a different set of species was found around the older inflorescences and yet another group of species was found in the immediate neighborhood of nonflowering plants. Four of the species entering the very young inflorescence (*D. nuda*, *D. paraguma*, *D. parviramosa* and *D. plaua*) have aristae in which the branches are reduced or modified, a fact which will be discussed later.

TABLE 3 gives further details on the populations of flies found within 5 different very young inflorescences. When the flower was approached, no flies could be seen; the counts represent species and sexes which emerged into plastic bags placed over the buds at the time of collection. The data reveal that 3 species in particular were characteristically found within the very young stages. At least 7 of the 13 species

TABLE 3. Counts of drosophilid adults aspirated from 5 very young inflorescences of *Alocasia macrorrhiza*. Morobe Province, Papua New Guinea: no. 1: Bulldog Road, Mt Kumbak, 2000 m; nos. 2-5: Mt Kaindi, 1900 m.

SPECIES	INFLORESCENCE NO. (date of collection)									
	1 (22.VIII. 1977)		2 (27.X. 1977)		3 (16.XI. 1977)		4 (24.XI. 1977)		5 (30.XI. 1977)	
	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂
<i>Drosophila (Sc.) nuda</i>	3	3	11	13	3	4	1	6	1	5
<i>Styloptera alocasiae</i>	6	1	11	8	3	7	4	4	4	2
<i>D. (Sc.) paraguma</i>	4	0	2	3	0	1	1	2	1	1
<i>D. (Sc.) parviramosa</i>	0	1								
<i>D. (Sc.) incisurifrons</i>	0	1								
Totals*	19		48		18		18		14	

\* Mean number of flies per inflorescence =  $23.4 \pm 6.2$ .

found in the inflorescences or near the plants have been reared from inflorescences incubated in the laboratory (TABLE 4). Incubation of decaying vegetative parts of the plant (i.e., leaves and petioles) yielded no Drosophilidae. Because of the relative scarcity of suitable inflorescences, details of the manner in which the flower-breeding niche is shared by the various species was not determined in the case of *Alocasia macrorrhiza*. Nevertheless, microscopic examination of a small number of inflorescences revealed the presence of the highly distinctive eggs of *Styloptera alocasiae* (FIG. 5H). Sixteen such eggs were found in one case and 12 in another. These had been placed in a horizontal position on the surface of the floral units of the "neutral zone," that is, the small group of flowers which lie between the staminate and pistillate sections of the spadix. Some 7-filamented drosophilid eggs, which appear to be those of *D. (Sc.) nuda* (FIG. 5L), were found attached to the top of the stigmas in the carpellate section.

TABLE 4. Drosophilid specimens reared from inflorescences of *Alocasia macrorrhiza*. Except as noted, all are from Mt Kaindi site.

SPECIES	NO. REARED	NO. OF DIFFERENT INFLORESCENCES
<i>Drosophila (Sc.) nuda</i>	11*	3
<i>Styloptera alocasiae</i>	6	3
<i>D. (Sc.) paraguma</i>	1**	1
<i>D. (Sc.) parviramosa</i>	1	1
<i>D. (Sc.) plaua</i>	2	1
<i>D. (Sc.) incisurifrons</i>	2	2
<i>D. (Sc.) xanthops</i>	15	2

\* 1 specimen from Mt Kumbak site.

\*\* From Mt Kumbak site.



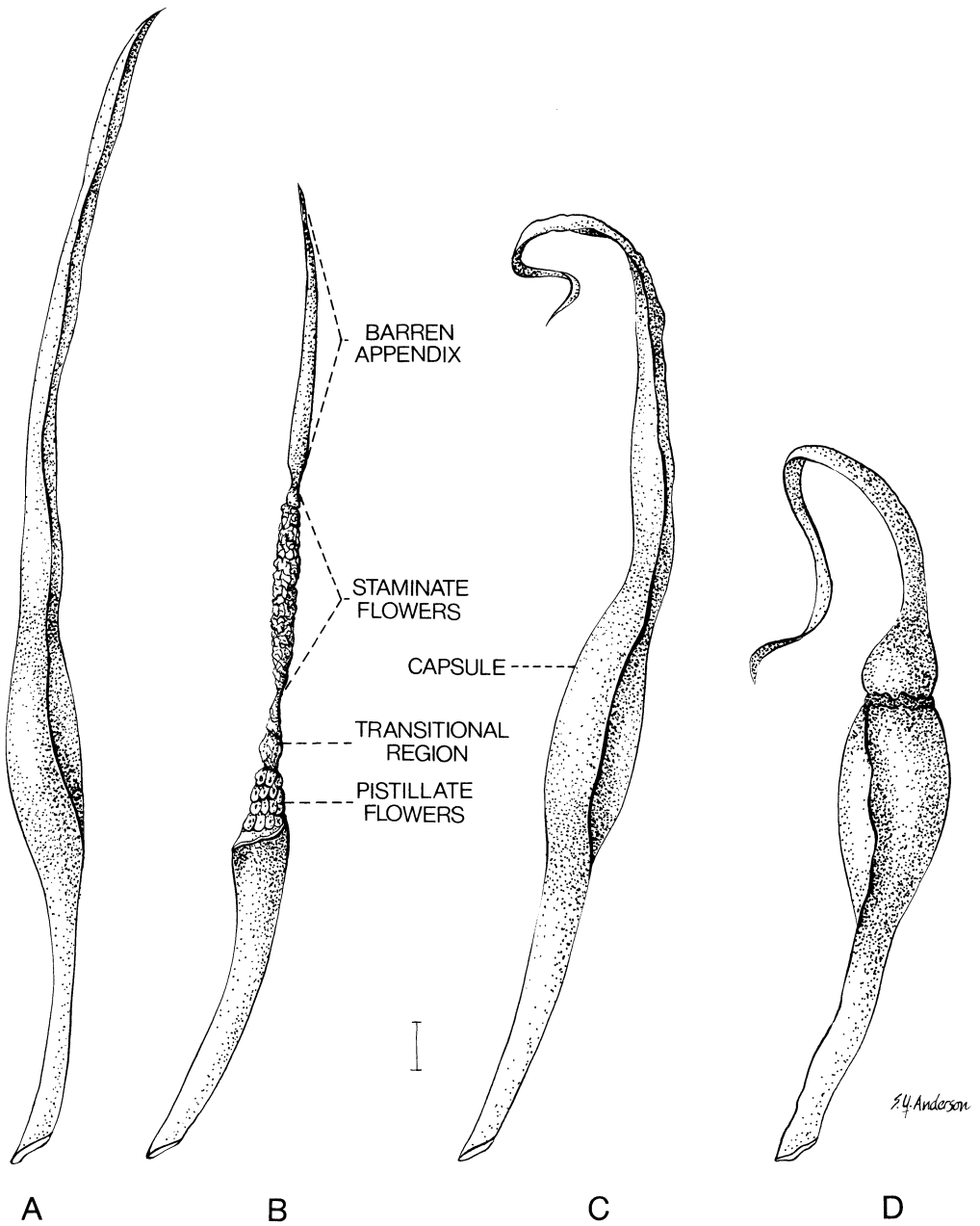


FIG. 6. Inflorescence of *Alocasia holtrungii*: A, inflorescence just opening; B, same, after removal of the spathe, showing the detailed structure of the spadix within; C, inflorescence 5 days older and D, 10 days older. The distal decayed staminate portion soon splits and falls off, carrying with it large larvae and pupae of *D. aproclinata*. The inflated pistillate section, now without any *Drosophila* stages, soon opens, revealing the bright orange berries. Scale 10 mm.

*B. Drosophila aproclinata* breeding on the inflorescences of *Alocasia holtrungii*

The best site for these flies was a roadside slough near the Garagos River (TABLE 1). The host plant was found growing in moderate numbers in slightly drier sites than the closely associated *Colocasia esculenta* (see Carson & Okada 1980). In a number of cases, however, the 2 plants were growing as close as a metre apart. This is of interest because whereas *Colocasia* inflorescences house 2 species of *Drosophilella* and *A. holtrungii* houses *Drosophila aproclinata*, no cases of mixing of these species of flies in nature was noted.

The inflorescence of *A. holtrungii* starts as a bud growing vertically in the center of the leaf crown. The greenish-white spathe is tightly closed around the spadix, sheathing it very tightly. It relaxes only very slightly at opening (FIG. 6A). The time of opening, if indeed the inflorescence may be said to open, is difficult to determine. Flies were never seen on the surface of the bud of the inflorescence. Of approximately 30 such buds artificially opened, none directly revealed the presence of flies inside. In one instance, however, 8 young buds were collected and placed together in a single plastic bag on 4 November 1977. The following morning, 32 ♀ and 6 ♂ of *D. aproclinata* were found free within the bag. Of the 8 inflorescences, only 1 contained unhatched eggs; this one contained a single fly. We infer that this inflorescence was the one that contained the flies at the time of collection and that, as in *Colocasia*, the flies remain within the inflorescence for only a short time in nature.

The inflorescence with unhatched eggs mentioned above was studied by removal of the spathe and examination of the flowers under the binocular microscope (see FIG. 6B). Although 1 egg was found near the tip of the staminate section, the remainder ( $n = 41$ ) were found at the extreme base of the pistillate flower section. Most of the eggs had been inserted between the green carpellate units, although an occasional egg was found resting on the surface of a stigma. The positioning of the eggs is thus roughly similar to those of *Drosophilella pistilicola* Carson & Okada (1980).

Older inflorescences contained large numbers of larvae, although probably not in excess of 40-50 individuals. In the young larval inflorescence, the junction of the staminate and transitional region was teeming with small larvae. None was found in the pistillate section, although empty chorions were seen at the site of oviposition. At older stages, larvae occupy exclusively the decaying staminate flower region. Until the larvae are close to pupation, the rather coriaceous spathe remains as a tight sheath around the inner plant parts, so that neither plant tissue nor larvae are exposed. The spathe dries somewhat on the surface and curls at the end (FIG. 6C). At this time the pistillate section has grown to a heavy green capsule with developing berries inside (FIG. 6C); unlike the case of *Colocasia esculenta*, no larvae are present within it.

As larval life is completed and puparia are formed, the spathe splits transversely along a suture dividing the distal staminate and transitional sections from the lower pistillate section. This trumpet-shaped unit is dehiscent, falling off the plant (see FIG. 6D). Puparia of *D. aproclinata* are often formed within the substance of this trumpet

and may be seen from the outside as small studlike projections. Emergence occurs 4 to 5 weeks after egg-laying.

Accordingly, the life cycle of *D. aproclinata* resembles closely that of *Drosophilella stamenicola* Carson & Okada of *Colocasia esculenta*. Although the bulk of the oviposition appears to be at the carpellate base, the larvae migrate vertically and complete their development in the staminate parts. These fall off the plant, leaving the seed capsule behind. Incubation of many such seed capsules did not yield emerging insects of any sort.

*C. Drosophila parviramosa breeding in inflorescences of Alocasia angustiloba*

Two of the species which were bred from the inflorescences of *A. macrorrhiza* were also found associated with a much smaller wild species of *Alocasia*, *A. angustiloba*. This plant was found only at 2 high-altitude sites (see TABLE 1). It grows sparsely on wholly natural densely-forested slopes. As will be noted from the data in TABLE 1, very few flies were captured near its inflorescences. This is probably related to the fact that the inflorescences are very small and slender and tend to desiccate easily. Several inflorescences contained a few larvae located at the base of the staminate section of the spadix and, in one instance, *Drosophila parviramosa* was reared from this material. *D. xanthops* was also captured on this plant.

#### DISCUSSION AND CONCLUSIONS

All 6 species which enter the young inflorescence of *Alocasia macrorrhiza* have been reared from this substrate. They appear to commence oviposition before noticeable decay has set in. Five of these early-entering species have aristae on which the branches are short or virtually absent. This condition is also found in a 6th species, *D. aproclinata*, which breeds on *A. holtrungii*. In some species (notably *D. paraguma*) other bristles are also reduced or absent. This type of bristle modification occurs in other quite different flower-breeding Drosophilidae, such as members of the genus *Drosophilella* (Carson & Okada 1980), *Exalloscaptomyza* (a subgenus of *Scaptomyza*) (Hardy 1965, Heed 1968), *Colocasiomyia cristata* de Meijere 1914 and in *Drosophila floricola* (subgenus *Phloridosa*) (Sturtevant 1942).

Accordingly, shortened aristae and other bristles appear to be characteristic of flower flies and to have evolved convergently in a number of widely different forms in the family. We have ascribed these new *Alocasia* flies with reduced bristles to *Drosophila* (*Scaptodrosophila*) on genitalial and other characteristics. We interpret their unusual bristle characters as an adaptive response to their specialized niche, the interior of the inflorescence. Their morphological peculiarities will be dealt with in a forthcoming paper by one of us (TO).

The other 7 species associated with *Alocasia macrorrhiza*, of which 2 have been proven to breed in the inflorescence, seem to be associated with considerably later stages of the decaying floral unit, after it has become gaping and open. Six of these

are typical *Scaptodrosophila* and do not show bristle modifications. Indeed, none are particularly aberrant. Thus, their association with the inflorescence appears to be less intimate than in the case of those which actually enter the young flower.

These observations strongly support the notion that, in New Guinea at least, *Drosophila* (*Scaptodrosophila*) flies have made a large-scale entrance into the flower-breeding niche. Other instances of flower-breeding in this subgenus are known. These include the nominate species *D. scaptomyzoidea* Duda (Okada 1975) and *D. hibisci* (Cook, Parsons & Bock 1977). The latter is a highly-adapted apparently obligatory associate of flowers of various Malvaceae in Australia. Unpublished observations by us indicate considerable further exploitation of flowers as breeding sites by other distinct species belonging to the subgenus *Scaptodrosophila* in Papua New Guinea. Some of these will be described in forthcoming papers in this series.

Adults of *Styloptera alocasiae*, a species which enters the inflorescence early, nevertheless have a fully plumose arista. Plumose aristae are found in the late-entering species of *A. macrorrhiza* and in another species of *Styloptera*, *S. repletoides* (Carson & Okada 1980). The latter is known to breed in the inflorescences of *Colocasia esculenta*. The data suggest that *S. repletoides* comes to the drooped, gaping inflorescence and does not oviposit until considerable decay has set in. The rather slight modifications of these 2 species suggest that their association with the flower has evolved more recently than in the other cases. This may also be true of *D. (Sc.) incisurefrons*, which is a relatively unmodified and typical *Scaptodrosophila* species.

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#### LITERATURE CITED

- Carson, H. L. & T. Okada.** 1980. Drosophilidae associated with flowers in Papua New Guinea. I. *Colocasia esculenta*. *Kontyû* **48**: 15-29.
- Cook, R. M., P. A. Parsons & I. R. Bock.** 1977. Australian endemic *Drosophila* II. A new *Hibiscus*-breeding species with its description. *Aust. J. Zool.* **25**: 755-763.
- Hardy, D. E.** 1965. Cyclorrapha II, series Schizophora, section Acalypterae I. Family Drosophilidae. *Insects of Hawaii*. Vol. 12. University of Hawaii Press, Honolulu. 814 p.
- Heed, W. B.** 1968. *Ecology of the Hawaiian Drosophilidae*. *Studies in genetics*. Univ. Texas Publ. 6818: 387-419.
- Okada, T.** 1975. The Oriental drosophilids breeding in flowers. *Kontyû* **43**: 356-63.
- Sturtevant, A. H.** 1942. *The classification of the genus Drosophila, with descriptions of nine new species*. Univ. Texas Publ. 4213: 6-51.
- Wheeler, M. R. & H. Takada.** 1964. Diptera: Drosophilidae. *Insects Micronesia* **14**(6): 163-242.