

**High Altitude Flower-Breeding
Drosophila (Diptera: Drosophilidae)**

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Abstract.—Four new species of *Drosophila* (Diptera: Drosophilidae) which breed in flowers in the region of Bogota, Colombia are described and named here. *D. chisaca* breeds only in the flowers of *Espeletia hartwegiana*. *D. acuminatus* breeds in *Liabum megacephalum* while *D. colmenares* and *D. franii* breed in both *L. megacephalum* and *Bidens rubifolia*. They are characterized by wide ovipositor plates with many stubby teeth. The eggs lack filaments and are laid between the buds of the disc flowers of these composites. The 4 species belong to the group of six anthophilic *Drosophila* previously described from the same region.

Over 100 species of *Drosophila* have been reported to breed in flowers (Brncic, 1983). Many of these utilize decaying flowers and the larvae feed on microorganisms. For example, cosmopolitan species such as *D. immigrans* Sturtevant and *D. busckii* Coquillett are polyphagous and the larvae develop in a variety of decaying plants. *Drosophila* which require living flowers for larval development have been described by Pipkin (1964, 1966), Heed (1968), Lachaise (1974) and other workers listed in the review by Brncic (1983). I have described 5 new species of obligate flower breeders from altitudes of over 2,000 m. in Colombia (1979). Relatively few collections of *Drosophila* have been made at higher elevations, but Heed, Carson and Carson (1960) reported associations of Drosophilidae with flowers of the Bogota region of Colombia. In continuing these studies I have found 4 more new species which breed in the flowers of several species of composites. Their descriptions follow.

***Drosophila chisaca*, NEW SPECIES**
(Figs. 1 & 2)

External characters of imagines.—Arista with 3 dorsal and 1 ventral branches in addition to terminal fork. Basal antennal segments pale gray; 3rd segment light tan (brown on allotype female); 1 medium and 1 long bristle on 2nd segment. Frontal and ocellar triangles pale grey (darker on allotype female). Anterior proclinate orbital bristle $\frac{2}{3}$ length of posterior reclinate; anterior reclinate $\frac{1}{3}$ of posterior. Face very pale grey; carina high, narrow, slightly sulcate. Cheeks gray, wide; 1 long oral bristle; 2nd bristle $\frac{1}{2}$ length of 1st. Distance from border of eye to base of 1st oral $\frac{1}{5}$ of greatest diameter of eye. Eyes light plum; fine yellow pile; eye index (height divided by width) 1.1. Palpi pale gray with 1 long, several medium length hairs.

Acrostichal hairs in 5–6 rows between dorsocentrals; no prescutellars; anterior scutellars divergent. Thorax, including pleurae and scutellum uniform gray (allotype

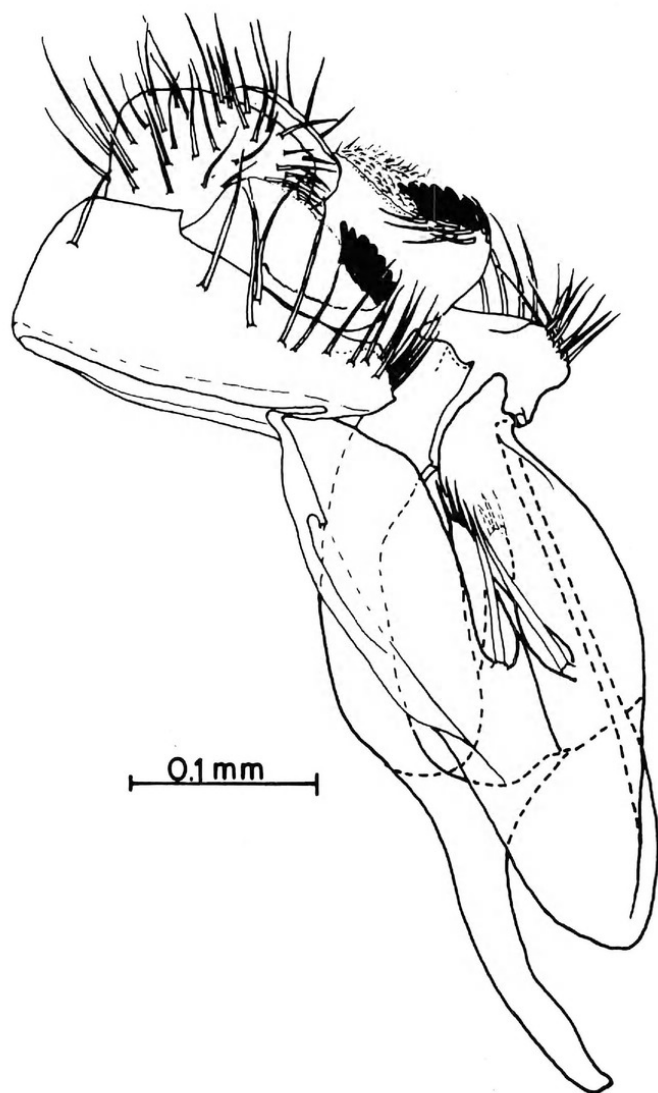


Figure 1. *Drosophila chisaca*, male genitalia.

female darker steel gray); halteres very pale gray. Anterior sternopleural bristle $\frac{2}{3}$ length of posterior; 1 short hair between them.

Legs pale yellow except brown terminal tarsal segment. Apical and pre-apical bristles on 1st and middle tibiae; pre-apicals only on third tibiae; bristles of 1st and 3rd legs very pale and delicate; several long, pale yellow bristles on front femora.

Wings pale yellow with slightly darker veins. Costal index 3.9, 4th vein index 1.8, 4c index 0.7, 5x index 1.0. Thicker hairs continue along anterior border to basal $\frac{1}{2}$ of 3rd section of costa.

Abdomen gray; each tergite with broad, dark gray band. Allotype female darker.

Body length, males, 2.6 mm; females, 3.0 mm. Wing length, males, 3.3 mm; females, 4.0 mm.

Genitalia of D. chisaca (Figs. 1 & 2).—Aedeagus pale tan; slightly curved. Blunt apex appears chopped off in lateral view; inverted V-shaped trough open ventrally;

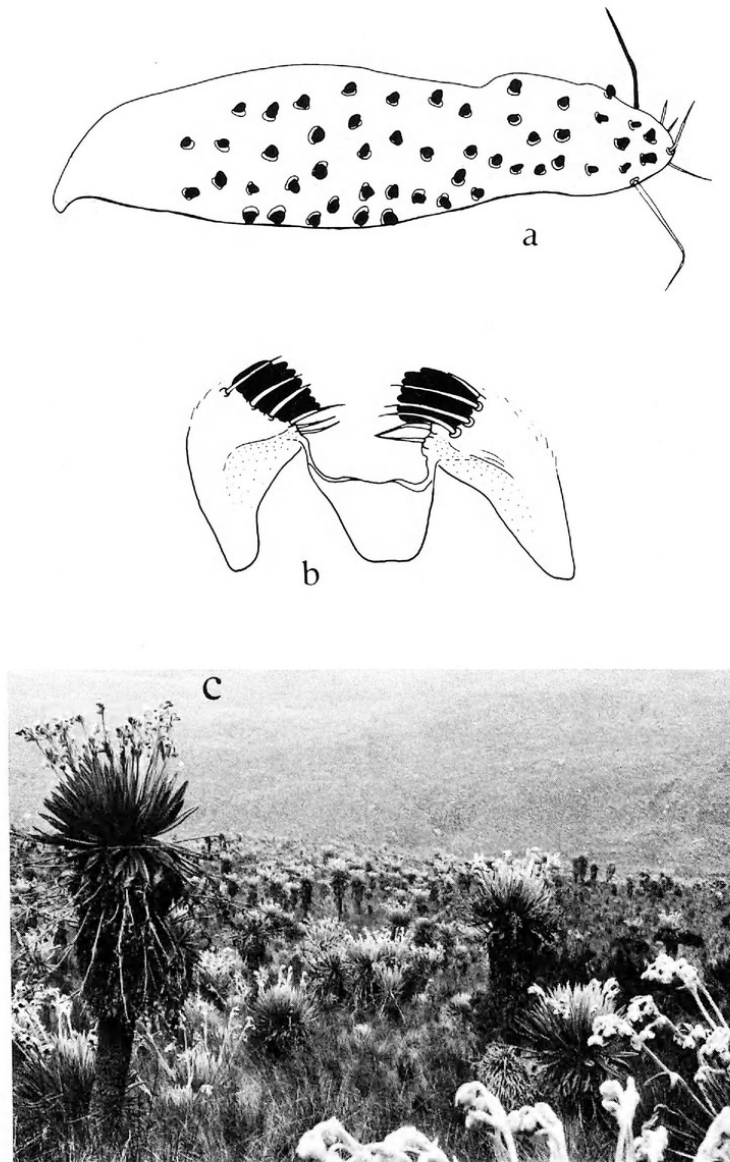


Figure 2. *Drosophila chisaca*, a. left ovipositor plate, b. male claspers, c. *Espeletia hartwegiana* in the paramo of Chisaca.

small, sharp point at both ends and apex of V; apodeme very slightly curved. Hook of genital arch articulates over pointed posterior corner of hypandrium on each side. Genital arch fused to anal plate; tuft of 8 yellow bristles on anterior, medial apex; row of 7–8 yellow bristles on posterior edge extends over clasper. Claspers with 6–7 long, thin, black primary teeth and many short, fine, yellow hairs all over outer surface; long, yellow hairs on inner surface. Claspers united by wide, dorsal bridge. Hypandrium with long, medio-ventral bristle on each side; narrow, finger-like gonapophyses with 3–4 long, yellow hairs.

Spermathecae dark brown, ovoid. Narrow ovipositor plates with 2 short, 1 medium length hairs at tip; 2 longer hairs on dorsal surface; 50–65 short, stubby, black

teeth on each ovipositor plate. Ovipositor plates extend posteriorly from last segment; internal tube extends out beyond the plates.

Other characteristics of D. chisaca.—The adult body shape is narrow like that of *Scaptomyza*. The eggs are without filaments; one female was observed extruding a larva. Eggs, larvae and pupae are found in flowers of the composite, *Espeletia hartwegiana* Cuatrecasas. *Drosophila chisaca* was found only in these plants in the paramo of Chisaca, about 50 kilometers south of Bogota on the unpaved road of El Hato. It was not found in the other species of *Espeletia*, nor in the other paramos. *Drosophila freilejoni* Hunter were also growing in the same flowers along with *D. chisaca*. Sweeping with a net, or attempts at aspiration were not successful because no flies were around the flowers or resting on them. Dry flowers containing pupae were collected and the adults emerged several days later. *Drosophila chisaca* is most closely related to the anthophilic species, *D. freilejoni*, *D. desbaratabaile* Hunter, *D. arboloco* Hunter, *D. bomarea* Hunter and *D. margarita* Hunter.

Holotype male emerged from flowers of *E. hartwegiana* collected in the paramo of Chisaca, 50 km south of Bogota, VIII-29-80, A. S. Hunter. Paratypes, same locality and date. Holotype #15855 and paratypes deposited in California Academy of Science.

Drosophila acuminanus, NEW SPECIES

(Figs. 3 & 4)

External characters of imagines.—Arista with 2 dorsal and 1 ventral branches in addition to terminal fork; wide separation between 2 dorsal branches. Antennal segments brown with 1 medium length and 2 short bristles on 2nd segment. Frontal and ocellar triangles black. Anterior proclinate orbital bristle $2/3$ length of posterior reclinate; anterior reclinate $2/3$ of proclinate bristle. Face brown; carina medium height, not sulcate. Cheeks brown, narrow; 1 long oral bristle. Distance from border of eye to base of first oral bristle $1/5$ of greatest diameter of eye. Eyes dark wine-red; eye index 1.1. Palpi tan with 1 long, several medium hairs.

Acrostichal hairs in 6-7 rows between dorsocentrals; anterior dorsocentral $2/3$ length of posterior; no prescutellars; anterior scutellars divergent. Thorax shiny black, pleurae duller; halteres tannish yellow. Anterior sternopleural bristle $2/3$ length of posterior; middle, $1/4$ length of first sternopleural.

Legs with black coxae; femora mostly black except paler distally; tibiae and tarsi tannish yellow except terminal black tarsal segment. Delicate, short pre-apical bristles on first and third legs; black, strong pre-apical and apical bristles on middle legs; few long bristles on first femora.

Wings pale tan, veins tan. Costal index 3.8, 4th vein index 1.8, 4c index 0.6, 5x index 1.2. Thicker, heavier hairs continue along border to almost basal half of third section of costa.

Abdomen brown, each tergite with wide black band, complete laterally; sternites gray; abdomen relatively short, fat.

Body length, males 2.6; females, 2.8 mm. Wing length, males 3.0 mm; females, 3.2 mm.

Genitalia of D. acuminanus (Figs. 3 & 4)—Aedeagus tan, very slight dorso-ventral curve, trough-shaped shaft with serrated borders; at apex, lateral extensions form pointed tips. Penis curves asymmetrically left; apodeme long, thick, straight. Genital arch joined to anal plate dorso-posteriorly. Hypandrium articulates with genital

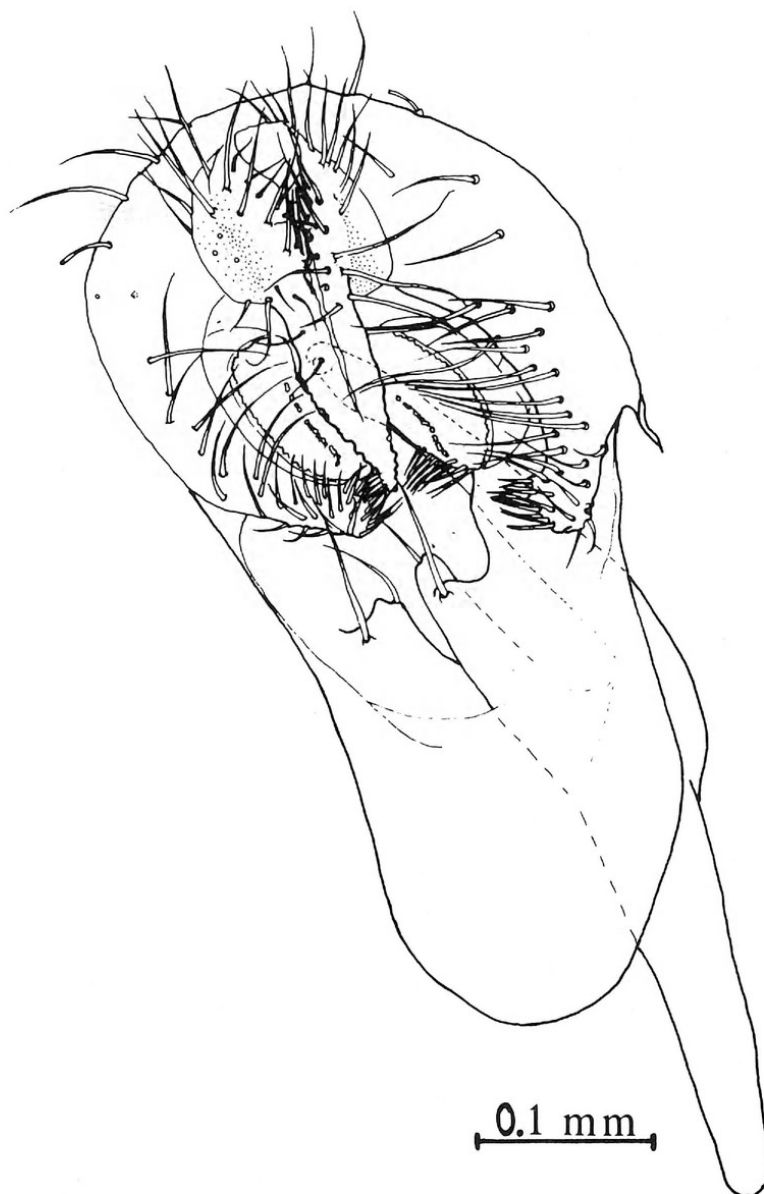


Figure 3. *Drosophila acuminanus*, male genitalia.

arch; latter with thick tuft of 10–12 medium length, black bristles on long toe; 18–20 long bristles on genital arch overlap claspers. Unusual claspers lack typical teeth; covered with fine, short, yellow hairs; cluster of long, thin yellow bristles at antero-medial apex; middle of each clasper with curved row of about 10 pegs, 3 small teeth at anterior end of row; lateral surface of each clasper with curved, elevated ridge of several irregular rows of about 50 short teeth. Claspers united by narrow bridge with median projection. Hypandrium with long, medio-ventral bristle on each side; gonapophyses broad, each with a single bristle.

Spermathecae dark brown, pear-shaped. Ovipositor plates brown, curved, with many small fine teeth all over; 15 longer teeth dorsally; 3 apical hairs project from each plate.

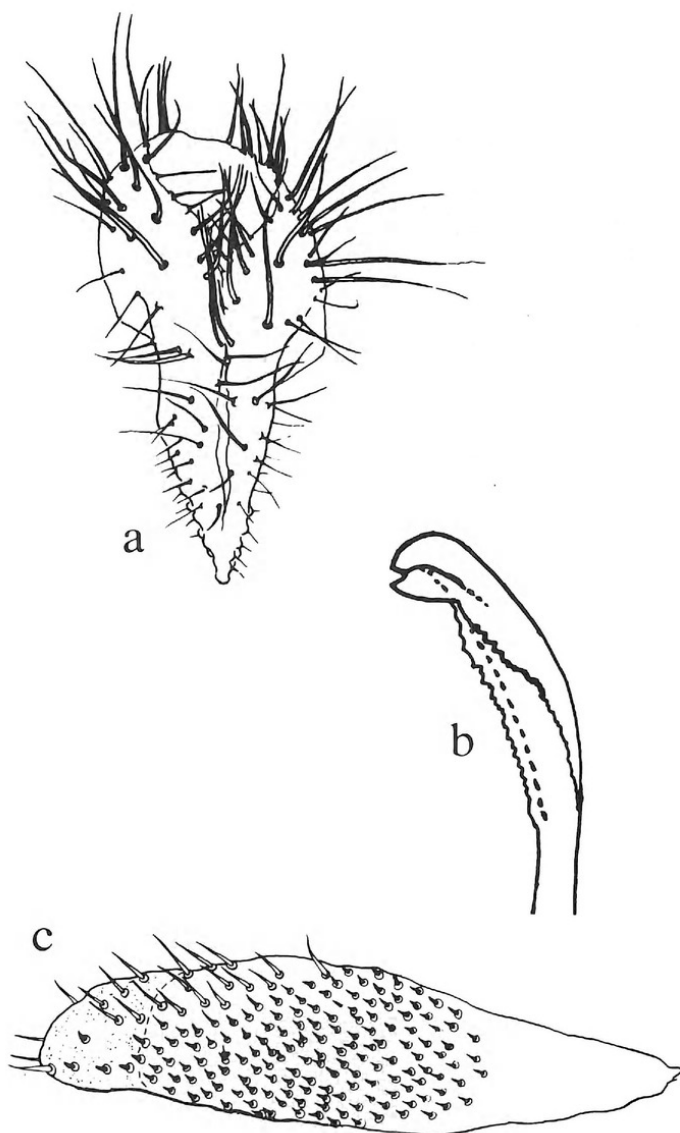


Figure 4. *Drosophila acuminanus*, a. male anal sternite, b. tip of aedeagus, c. right ovipositor plate.

Other characteristics of D. acuminanus.—The adult body looks short and fat compared to other *Drosophila*. The eggs lack filaments and are pointed anteriorly. The adults emerge from flowers of *Liabum megacephalum* Schultze, which is a yellow-flowered composite. They rest on these flowers and other related composites in the vicinity. They occur in a wooded area in the aqueduct drainage of the mountain, Monserrate. This species was not found anywhere else in extensive collections in the Bogota region.

Drosophila acuminanus is most closely related to the other anthophilic *Drosophila*, such as *D. margarita*, associated with composite flowers in the Bogota region. The presence of many teeth all over the ovipositor plates, the asymmetry of the aedeagus and lack of egg filaments are characteristic of this anthophilic group of *Drosophila* from the Bogota region. The pointed apex of the anal sternite which covers over

the external genitalia and the lack of teeth on the claspers are characteristics which distinguish this species from the other related anthophilic flies. The species is named for the unusual anal sternite.

Holotype male swept over flowers of *L. megacephalum* along the river in the aqueduct drainage of the mountain, Monserrate in Bogota, VIII-15-80, A. S. Hunter. Paratypes from same locality. Holotype #15852 and paratypes deposited in California Academy of Sciences.

***Drosophila colmenares*, NEW SPECIES**

(Figs. 5 & 6)

External characters of imagines.—Arista with 2-3 dorsal and 2 ventral branches ventral branches in addition to terminal fork. Basal antennal segments brown; 2 long bristles on 2nd segment. Frontal and ocellar triangles dark brown. Anterior proclinate orbital bristle $\frac{2}{3}$ length of posterior reclinate; anterior reclinate $\frac{2}{3}$ of anterior proclinate; orbital region dark brown. Face brown; carina moderately high, sloping lower ventrally; not sulcate but with a medial, pale line. Cheeks brown, average width, with 1 large oral bristle. Distance from border of eye to base of 1st oral $\frac{1}{4}$ greatest diameter of eye. Eyes sepia with fine pile; eye index 1.2. Palpi tan with many fine hairs and 2 slightly longer hairs.

Acrostichals in 6 rows between dorsocentrals; no prescutellars; anterior scutellars divergent. Thorax, including pleurae and scutellum shiny brown; halteres tan. Anterior sternopleural bristle $\frac{2}{3}$ length of posterior; middle sternopleural bristle very fine and $\frac{1}{3}$ length of first.

Legs pale yellow except brown terminal tarsal segment. Apical and pre-apical bristles on 1st and middle tibiae; 1st apical bristle thin and small; fine pre-apical bristles on posterior tibiae; 5 long, dark bristles on first femora.

Wings pale grey with tan veins. Costal index 3.6, 4th vein index 1.7, 4c index 0.7, 5x index 1.2. Thicker, heavier hairs continue along border to basal $\frac{2}{5}$ of 3rd section of costa.

Abdomen tan with dark brown bands, wider on anterior segments and in midline, thin laterally, especially on posterior segments. Allotype female with darker abdomen, more pronounced bands extending laterally.

Body length, males, 2.8 mm; females, 3.0 mm. Wing length, males, 3.0 mm; females, 3.2 mm.

Genitalia of D. colmenares (Figs. 5 & 6).—Aedeagus tan; C-shaped. Apex sharply pointed dorsally; another dorsal spike immediately anterior to tip; ventral apex much broader, paler and spoon-shaped. Apodeme slightly curved. Genital arch fused to anal plate; an irregular row of 8 long, black bristles extends from medial border of arch to overlap claspers; 5 long, black hairs on anterior medial apex. Claspers with 10 primary teeth and many short, fine, yellow hairs over external surface; 3 yellow bristles on internal surface. Claspers united by wide, dorsal bridge. Hypandrium with long, medio-ventral bristle on each side; short, wide-based gonapophyses with 3 long, yellow hairs.

Spermathecae dark brown, ovoid. Narrow ovipositor plates curved ventrally at blunt, dark end, 3 hairs at ventral, apical surface and 1 stouter hair posterior to them; 4 hairs on dorsal apical surface; 44-48 short, stubby teeth on each plate. Ovipositor plates extend out posteriorly beyond last segment; non-chitinized internal tube extends posteriorly beyond plates.

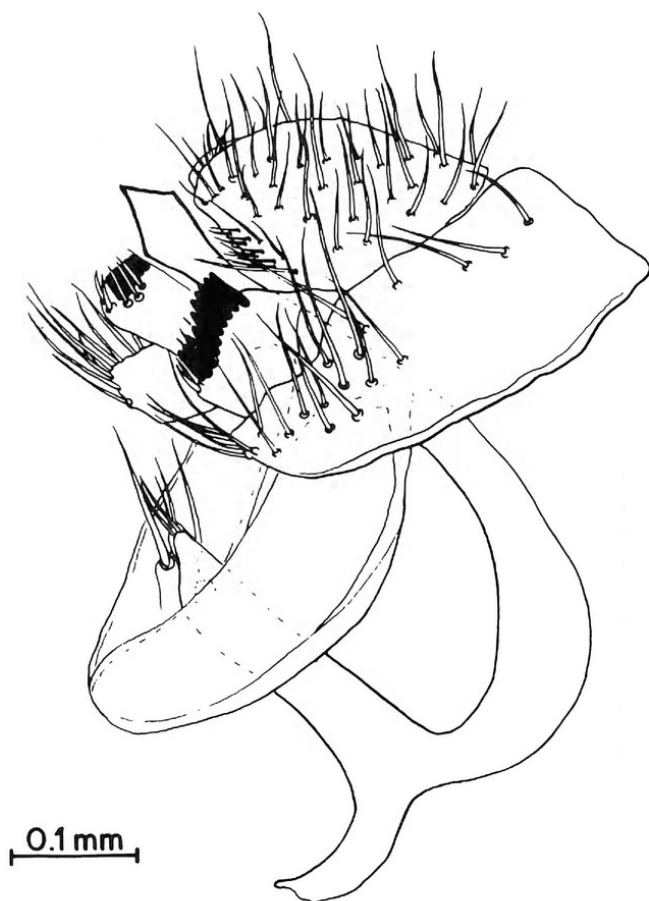


Figure 5. *Drosophila comenares*, male genitalia.

Other characteristics of D. colmenares.—The eggs are without filaments. They are laid in between the disc flowers of 2 composites in which the larvae feed and pupae are formed. The 2 species of plants were identified by Dr. Enrique Forero of the Universidad Nacional as *Liabum megacephalum* and *Bidens rubifolia* Humboldt. These plants grow in the watershed of the Bogota aqueduct between the mountains of Monserrate and Guadalupe as well as the paramo of Choachi. *Bidens rubifolia* is also found south of Bogota on the road to El Hato. These composites are hosts for other species of *Drosophila* as well as other insects. *Drosophila* can be seen flying around the flowers sometimes. *Drosophila colmenares* has the ovipositor studded with many teeth, the asymmetrical aedeagus and lack of egg filaments which are characteristic of related anthophilic species such as *D. freilejoni* and *D. arboloco*. This new species is named for Miguel Angel Colmenares who spent many hours collecting anthophilic *Drosophila*.

Holotype male swept from flowers of *L. megacephalum* in the aqueduct watershed of the mountain Monserrate in Bogota, VIII-13-80, A. S. Hunter. Paratypes from same locality. Holotype #15857 and paratypes deposited in California Academy of Sciences.

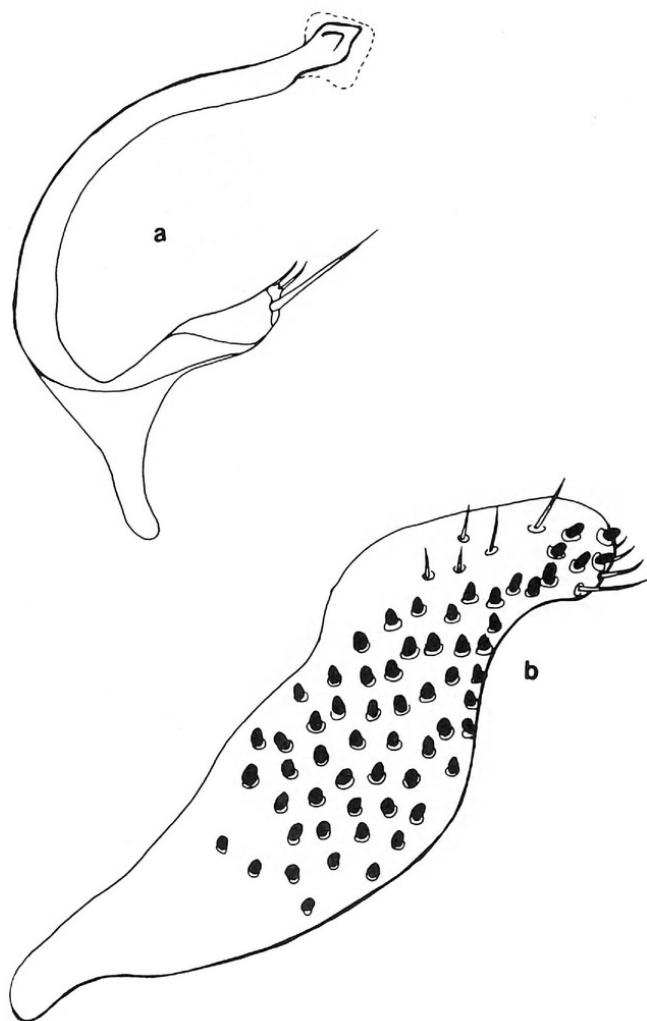


Figure 6. *Drosophila colmenares*, a. aedeagus, b. left ovipositor plate.

***Drosophila franii*, NEW SPECIES**
(Figs. 7 & 8)

External characters of imagines.—Arista with 3 dorsal and 1 ventral branches in addition to terminal fork. Basal antennal segments light brown; 3rd segment dark brown. One medium and one long hair on 2nd segment. Frontal and ocellar triangles dark brown surrounded by gray-brown. Anterior proclinate orbital bristle $\frac{3}{4}$ length of posterior reclinate; anterior reclinate $\frac{1}{2}$ of posterior. Face brown; carina medium height, not sulcate. Cheeks wide, grayish brown; 1 large oral bristle. Distance from border of eye to base of 1st oral $\frac{2}{5}$ of greatest diameter of eye. Eyes sepia; eye index 1.1. Palpi rust colored with 3 medium length hairs. Many fine hairs.

Acrostichal hairs in 7 rows between dorsocentrals; no prescutellars; anterior scutellars slightly divergent. Thorax light brown with central darker stripe; pleurae dark brown; halteres pale tan. Anterior sternopleural bristle $\frac{3}{4}$ length of posterior; middle very small.



Figure 7. *Drosophila franii*, male genitalia.

Legs yellowish-orange except last, black tarsal segment. Apical and pre-apical bristles on middle legs; pre-apicals on 1st and 3rd. First femora with 6 bristles arranged medium, long, short, medium, medium, short.

Wings pale tan with darker veins. Costal index 3.1, 4th vein index 1.6, 4c index 0.8, 5x index 1.1. Thicker, heavier hairs continue along border to basal $\frac{3}{8}$ of third section of costa.

Abdomen yellowish-orange with tan bands in posterior of each segment, wider in midline, fading out laterally, paler on last 3 segments.

Body length, males, 2.7 mm; females, 2.9 mm. Wing length, males, 3.2; females, 3.4.

Genitalia of D. franii (Figs. 7 & 8).—Aedeagus brown, bilaterally symmetrical with wide, C-shaped opening, at ventral apex. In lateral view apex bifurcated into

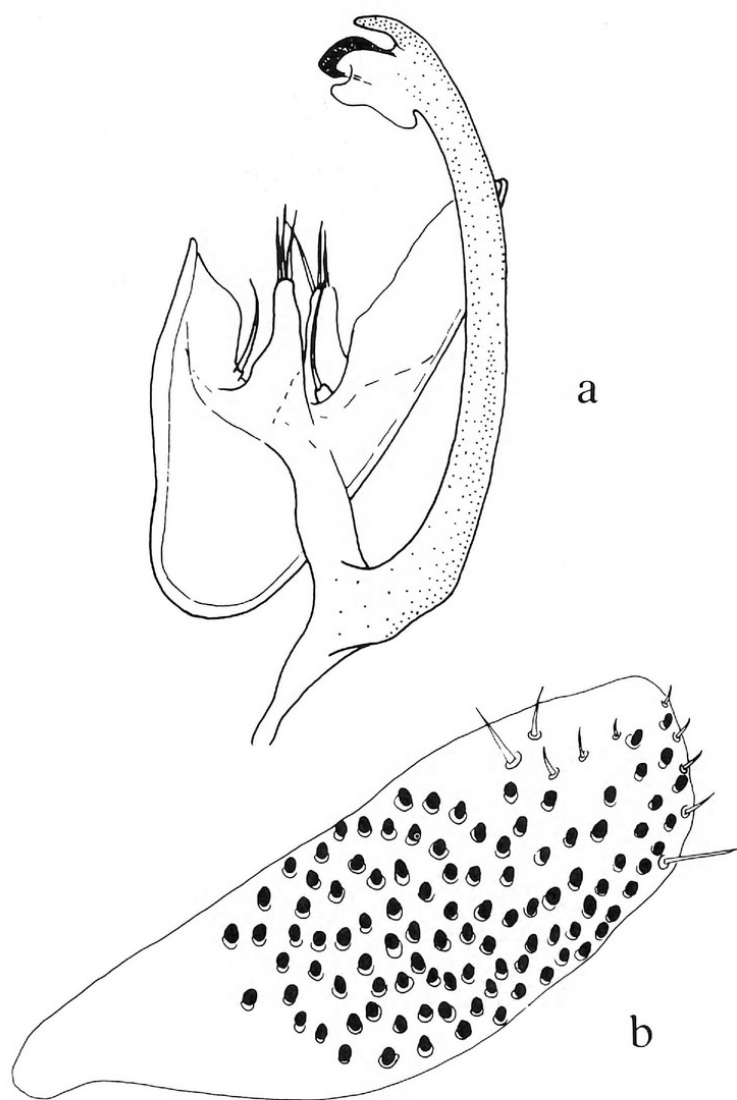


Figure 8. *Drosophila franii*, a. aedeagus; b. left ovipositor plate.

ventral spike and blunt, open, dorsal channel; latter partially enclosed by incomplete, transparent sheath. Apodeme lighter brown, straight. Genital arch fused to anal plate; toe curves medially, with 12 bristles; laterally, 5 long, black hairs, 7 widely spaced toward posterior region where fused with anal plate. Claspers with 8–9 long, closely-placed, black teeth and many, short, fine, yellow hairs all over outer surface; internally, 6 medium length, thick hairs. Claspers united by a wide, shallow bridge. Hypandrium with long, paramedian spines; short, finger-like gonapophyses, each with 3–4 yellow bristles.

Spermathecae oval to rectangular, dark brown. Ovipositor short, broad with 90–100 stubby, black teeth; dorsal apex with 1 long bristle, 4 short, yellow bristles along posterior border, 5 medium length black bristles in subapical, ventral border.

Other characteristics of *D. franii*. Eggs with anterior point, but no filaments. Adults emerge from flowers of *Bidens rubifolia* and *Liabum megacephalum* of the

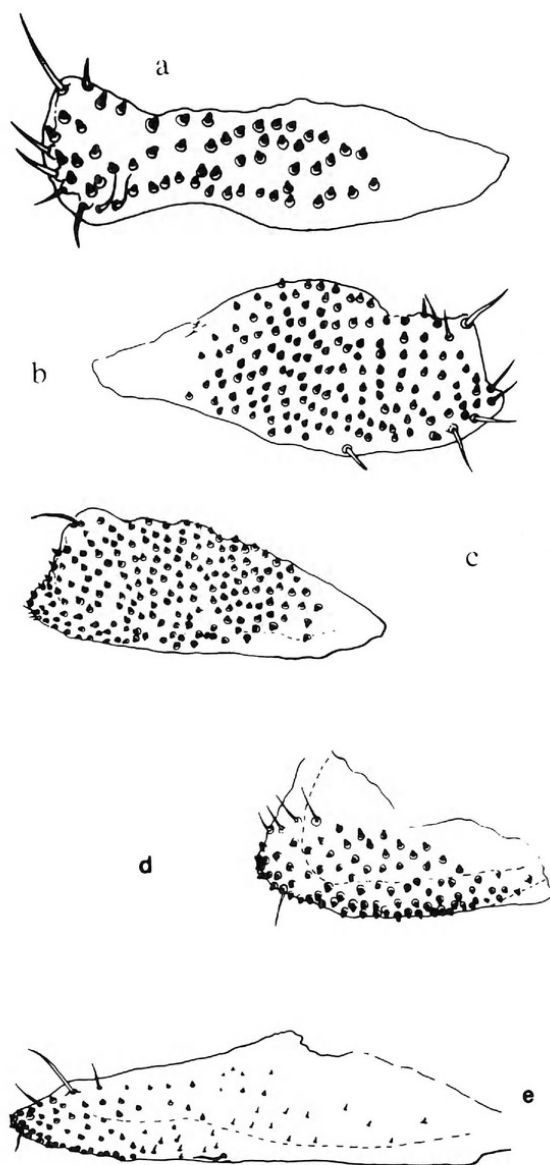


Figure 9. Flower breeding *Drosophila*. a. right ovipositor plate of *D. freilejoni*, b. left ovipositor plate of *D. arboloco*, c. right ovipositor plate of *D. desbaratabaile*, d. right ovipositor plate of *D. carablanca*, e. right ovipositor plate of *D. margarita*.

family Compositae. They can be swept or aspirated from these and other composite flowers in the paramo of Choachi and the wooded watershed of the aqueduct on the mountain, Monserrate. This species has not been found in other parts of Colombia outside of the environs of Bogota. It has the characteristic ovipositor, egg structure and male genitalia of the anthophilic group of *Drosophila* from the Bogota environs. This includes the 3 other species described in this paper and 6 previously described *Drosophila* (Hunter 1979). *Drosophila franii* is named after my late husband, Francis R. Hunter, a dedicated physiologist who also gave a lot of time to collecting *Drosophila* with me.

Holotype male aspirated from flowers of *B. rubifolia* in the aqueduct watershed on the mountain, Monserrate, in Bogota, VIII-15-80, A. S. Hunter. Paratype, same locality and date. Holotype #15858 and paratypes deposited in California Academy of Science.

DISCUSSION

The 4 species of *Drosophila* described here are related to 6 flower-breeding species previously described from the Bogota, Colombia region (Hunter, 1979). They have several morphological and ecological characteristics in common. The ovipositors of 5 of the previously described *Drosophila* are shown in Figure 9 for comparison with those in Figures 2, 4, 6 & 8. The ovipositor plates are wide and the lateral surfaces are covered with short teeth or bristles. In Duda's 1925 paper there is an illustration of the ovipositor of *D. onychophora* Duda (from Peru and Bolivia) which is similar to those of the Bogota group. Some of the flower-breeding *Drosophila* described by Pipkin (1964) from Panama have ovipositors with lateral teeth. These, along with that of *D. paraguma* Okada and Larson from New Guinea (Okada & Carson, 1980), are similar to but not precisely the same as the ovipositors of the Bogota group. The latter are broader and have more teeth. The ovipositors of *D. paraguma* and the Panama species are more acuminate and have fewer lateral teeth or hairs.

Another distinctive feature of the 4 new species described here, as well as 6 previously described from the same region, is the lack of egg filaments. Other flower-breeding *Drosophila*, such as those of the subgenus *Phloridosa*, also lack filaments. Also, the flower-breeding group *flavopilosa* is characterized by very short egg filaments. This may be related to the nature of the substrate in which the eggs are laid. There is no problem of the egg submerging into a soft mass within the flower buds where they are deposited, so filaments have no adaptive value.

Viviparity was observed in 7 of the 10 flower-breeding species of the Bogota region. This has also been noted in some species of the *flavopilosa* group (Wheeler et al., 1962) as well as some of the Panamanian species (Pipkin et al. 1966). Another characteristic of the Bogota flower-breeding *Drosophila* is the low number of ovarioles in the females, which has also been reported for other flower-breeding drosophilids. It has been suggested that these traits are of adaptive value in the flower niche, with its limited food supply (Brncic, 1983).

Most of the flower-breeding species of *Drosophila* are found in the tropics. Perhaps flowers are available several times during the year, rather than the limited annual flowering in the temperate zone. The Bogota flower-breeding *Drosophila* live in a cool region where the temperature fluctuates around a mean of 15°C. Although Bogota is close to the equator, it is cool because it is at an altitude of 2,600 m. Flowering is affected by the rainfall which has 2 peaks in a year. Many plants flower in December-January and again in April-May. However, the flowers usually survive for a relatively long time in the cool climate. The *Drosophila* in the Bogota region have long life cycles which are correlated with the 2 rainy seasons (Hunter, 1966). It will be of interest to study the duration of the stages of the life cycle of the flower-breeding species.

These 4 new species of *Drosophila* along with those previously described from Bogota are obligate flower-breeders. My coworkers and I have collected *Drosophila* for many years in the Bogota region. A broad variety of possible breeding sites have been checked, with particular attention more recently to the flowers. None of these anthophilic species are ever attracted to yeasted baits. Seven of these *Drosophila* utilize composite flowers as the breeding site. These are not typical host flowers for *Drosophila*. *D. chisaca* is monophagous and has been found in only one of the several species of *Espeletia* of the Bogota environs, while *D. freilejoni* is breeding in the same flowers with *D. chisaca* and also in 3 different species of *Espeletia*. *D. colmenares* and

D. franii both breed in the same composite flowers of 2 different genera, *Bidens* and *Liabum*. To date, *D. acuminatus* has only been found breeding in *Liabum*, but relatively few adults (about 20) were collected emerging from these flowers over several seasons of flowering.

The 4 new species of flower-breeding *Drosophila* described here belong in the anthophilic group previously described from the Bogota region (Hunter, 1979). At present they cannot be placed in any subgenus, but are most closely related to *Phloridosa*.

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