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New species and records of biting midges (Diptera: Ceratopogonidae) associated with cacao in São Tomé, West Africa

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Twenty-five species of Ceratopogonidae were taken at flowers of cacao in São Tomé, West Africa, during studies on cacao pollination. Three species were reared from larvae collected from rotting or fungiinfected cacao pod husks. Four new species are described: *Forcipomyia* (*Warmkea*) *kaufmannae*, *Dasyhelea theobromatis*, *Stilobezzia* (*Neostilobezzia*) *limai*, and *S. (N.) tomensis*.

Very few records exist of ceratopogonid midges from the island of São Tomé in the Gulf of Guinea. We have been able to find only one reference, EDWARDS (1934), that reported seven species of Ceratopogonidae collected by the Perdy Sladen and Godman Trusts Expedition of 1932-1933. The junior author spent three years in 1972-1975 studying the insects associated with the culture of cacao (*Theobroma cacao* L.) in São Tomé, where ceratopogonids are important pollinators. The purpose of this paper is to present a list of ceratopogonids found in cacao flowers and to make the names of the four most important new species available for a detailed report on the biological studies of cacao insects in São Tomé.

Considerable work has been done on the ceratopogonids associated with cacao pollination in West Africa. Beginning with the pioneer work of POSNETTE (1950) in Ghana, there followed intensive studies by DESSART (1961, 1963) in Zaire and KAUFMANN (1974, 1975 a, b, c) in Ghana on the mechanism and ecology of cacao pollination by ceratopogonid midges. In addition, Dr. L.G. SAUNDERS deposited in the U. S. National Museum in Washington a large collection of unidentified ceratopogonids reared at the Tafo Cocoa Research Institute in Ghana in 1963 in connection with pollination studies. He also left extensive manuscript notes and drawings which were not completed because of his serious illness and death.

Explanation of our ceratopogonid terminology can be found in the excellent papers by SAUNDERS (1956) and DESSART (1963). We are indebted to Ms. BIRUTA AKERBERGS for the illustrations.

List of Ceratopogonidae taken at flowers of cacao in São Tomé

All species have been collected in a cacao plantation of the Agriculture and Forest Research Station of Boa Nova, São Tomé.

Atrichopogon sp. 1
Atrichopogon sp. 2
Atrichopogon sp. 3
Forcipomyia (*Caloformipomyia*) *apicalis* GOETGHEBUER
Forcipomyia (*Euprojoannisia*) *psilonota* (KIEFFER)
Forcipomyia (*Forcipomyia*) *castanea* (WALKER)¹
Forcipomyia (*Forcipomyia*) *flavicoxis* GOETGHEBUER
Forcipomyia (*Forcipomyia*) *genualis* (LOEW)¹
Forcipomyia (*Forcipomyia*) *macronyx* GOETGHEBUER
Forcipomyia (*Lepidohelea*) *cacaoi* DESSART¹
Forcipomyia (*Lepidohelea*) *clastrieri* DESSART
Forcipomyia (*Lepidohelea*) *venusta* INGRAM & MACFIE
Forcipomyia (*Lepidohelea*) sp. 1 near *pampoikila* INGRAM & MACFIE
Forcipomyia (*Lepidohelea*) sp. 2
Forcipomyia (*Microhelea*) *fuliginosa* (MEIGEN)
Forcipomyia (*Microhelea*) sp. 1
Forcipomyia (*Thyridomyia*) sp. near *inconspicua* (INGRAM & MACFIE)
Forcipomyia (*Warmkea*) *kaufmannae* n. sp.
Dasyhelea theobromatis n. sp.
Dasyhelea sp. 1
Dasyhelea sp. 2
Dasyhelea sp. 3
Culicoides imicola KIEFFER
Stilobezzia (*Stilobezzia*) *spirogyrae* CARTER, INGRAM & MACFIE
Stilobezzia (*Neostilobezzia*) *limai* n. sp.
Stilobezzia (*Neostilobezzia*) *tomensis* n. sp.

Forcipomyia (*Warmkea*) *kaufmannae* WIRTH and DERRON, new species (fig. 1)

Color notes from life (by L.G. SAUNDERS): Male with pale orange-yellow thorax and legs, tarsi dusky; mesonotum with broad brown median band same breadth as scutellum; face and antennal torus pale; flagellum and palpus gray, plume blackish. Halter with gray knob. Wing pale gray, darker along anterior margin. Abdominal terga uniformly gray, sterna paler. Female as in male but thoracic band slightly narrowed in midportion; abdominal sterna pale except caudally; cerci pale.

Female Holotype. Wing length 1.16 mm, breadth 0.46 mm.

Head: Antenna (fig. 1a) with lengths of flagellar segments in proportion of 35-25-27-27-27-27-28-34-60-63-63-63-90; antennal ratio 1.48; verticils especially strong, bristlelike. Palpus (fig. 1b) with lengths of segments in proportion of 15-25-56-50; third segment slender, spindleshaped, with sensilla scattered on surface of segment; fourth and fifth fused without trace of junction. Mandible with 24 minute teeth.

Thorax: Tibiae with scattered long, yellowish bristles on extensor side. Hind tarsal ratio 1.40. Tarsi (fig. 1f) with empodium well developed; claws

¹reared from rotting cacao pod husks

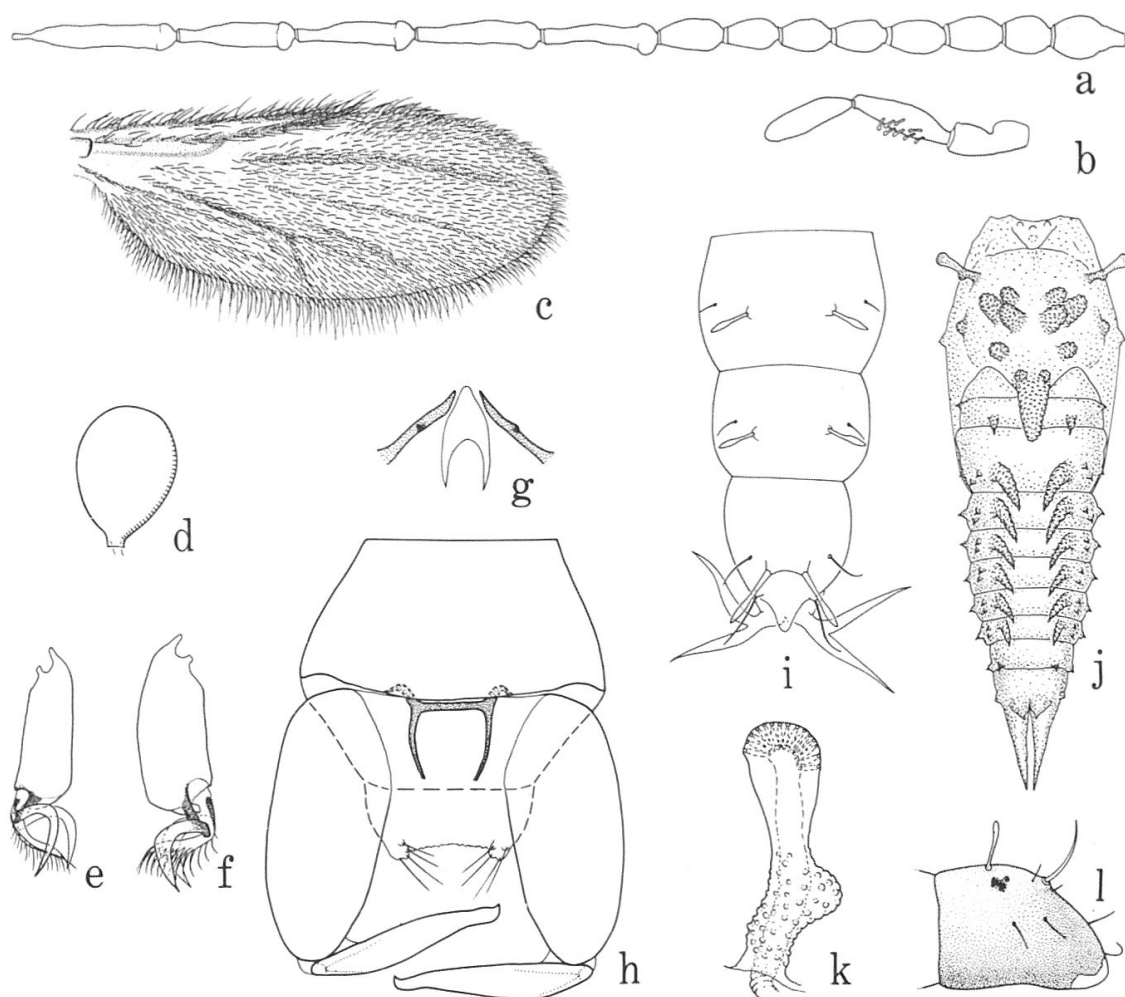


Fig. 1. *Forcipomyia kaufmannae* n. sp.: a, female antenna; b, female palpus; c, female wing; d, female spermatheca; e, male fifth tarsomere; f, same, female; g, male parameres; h, male genitalia, parameres removed; i, larva, posterior segments, dorsal view; j, pupa, dorsal view; k, pupal respiratory horn; l, larval head, lateral view.

expanded in midportion. Wing (fig. 1c) with abundant, long, semiappressed macrotrichia distributed uniformly over surface; radial cells narrow; costa long, costal ratio 0.54.

Abdomen: With moderately abundant, semi-appressed, yellowish-brown hairs. Genital sclerotization not conspicuous. Spermatheca (fig. 1d) one, ovoid with short slender neck, well sclerotized; measuring 0.061 by 0.043 mm.

Male Allotype. Wing length 1.17 mm; breadth 0.36 mm. Similar to female with usual sexual differences. Antennal plume of long, rather stiff verticils; antennal segments 5–12 fused; segments 13–15 with lengths in proportion of 90–75–90. Tarsi (fig. 1e) with empodium well developed, claws more slender than in female; hind tarsal ratio 1.30. Genitalia (fig. 1h): Dististyle slightly sinuate, tapering to slender, slightly bent tip. Aedeagus lightly sclerotized except narrow basal arch and narrow lateral margins; distally with a blunt membranous lobe. Parameres (fig. 1g) in form of a stout U-shaped structure suspended on slender basal apodemes; base of the «U» rather broad, the distal

processes short and stout, scarcely surpassing tip of aedeagus, with tips pointed.

Larva. Resembling that of *F. bicolor* Saunders as described and figured by SAUNDERS (1956). Body creamy white, head heavily sclerotized, dark brown. Head with *p* hairs strong, nearly as long as antenna, stout with expanded tip (fig. 1l); *q* hairs minute. Body hairs inconspicuous except *a* hairs (fig. 1i), which are strong and spear shaped, pale in color, arising from strong tubercles. Cauda conical but without setulae.

Pupa (fig. 1j). Resembling that of *F. bicolor*. Dorsal spinose lobes of thorax more prominent than in *bicolor*, with coarse blunt spinules and shagreening. A pair of long, curving, spinose processes on dorsum of first six abdominal segments, each process bearing a strong colorless spine at tip. Prothoracic respiratory horn (fig. 1k) with basal projection more prominent than in *bicolor*; about 20 spiracular papillae on expanded distal portion of horn.

Distribution: São Tomé, Ghana, Nigeria.

Types. Holotype, female, allotype, male, São Tomé, 26 December 1974, J. DERRON, from cacao flowers (Type no. 71143, USNM). Paratypes, 8 males, 6 females, 7 larvae, 6 pupae, as follows: GHANA: Tafo, 17 May 1963, L.G. SAUNDERS, reared from large lily, 5 males, 4 females, 7 larvae, 6 pupae. NIGERIA: Ibadan, Sept. 1962, D.C. EIDT, malaise trap, 1 female; Ibadan, Nov. 1964, R.W. WILLIAMS, 1 female. SÃO TOMÉ: 3 males, same data as type.

Discussion. This species is named for Dr. TOHKO KAUFMANN of the Church World Service at Agades, Niger, West Africa, in recognition of her important contributions to the biology of ceratopogonid pollinators of cacao at the Tafo Experimental Station in Ghana.

F. kaufmannae is most closely related to the Neotropical species *F. bicolor* SAUNDERS, but *bicolor* has the female hind tarsal ratio 1.6, the palpal sensilla are clustered in a compact group, the posterior processes of the male parameres are longer, and the larval *p* hairs are much smaller.

F. kaufmannae is the first representative of the subgenus *Warmkea* known from the Ethiopian Region, but it is apparently not rare in the cacao ecosystem. Most of the known species of *Warmkea* breed in the leaf axils of water-holding plants. According to SAUNDERS (1956, p. 671) «the larvae live above the water line and move farther up to pupate. The pupa sheds the larval skin completely and cements itself to the leaf surface by the penultimate segment». In the Neotropical Region SAUNDERS found *Warmkea* species breeding in the leaf axils of terrestrial aroids, *Pandanus*, and epiphytic bromeliads; he reared one species in Malaya from a banana plant.

Dasyhelea theobromatis WIRTH and DERRON, new species (fig. 2)

Female Holotype. A small, bright yellow species with blackish abdomen and broad brownish mesonotal vittae. Wing length 0.65 mm; breadth 0.29 mm.

Head: Antenna (fig. 2a) brownish; lengths of flagellar segments in proportion of 23-20-20-20-20-21-22-23-27-27-26-26-37; antennal ratio 0.85; sculpturing

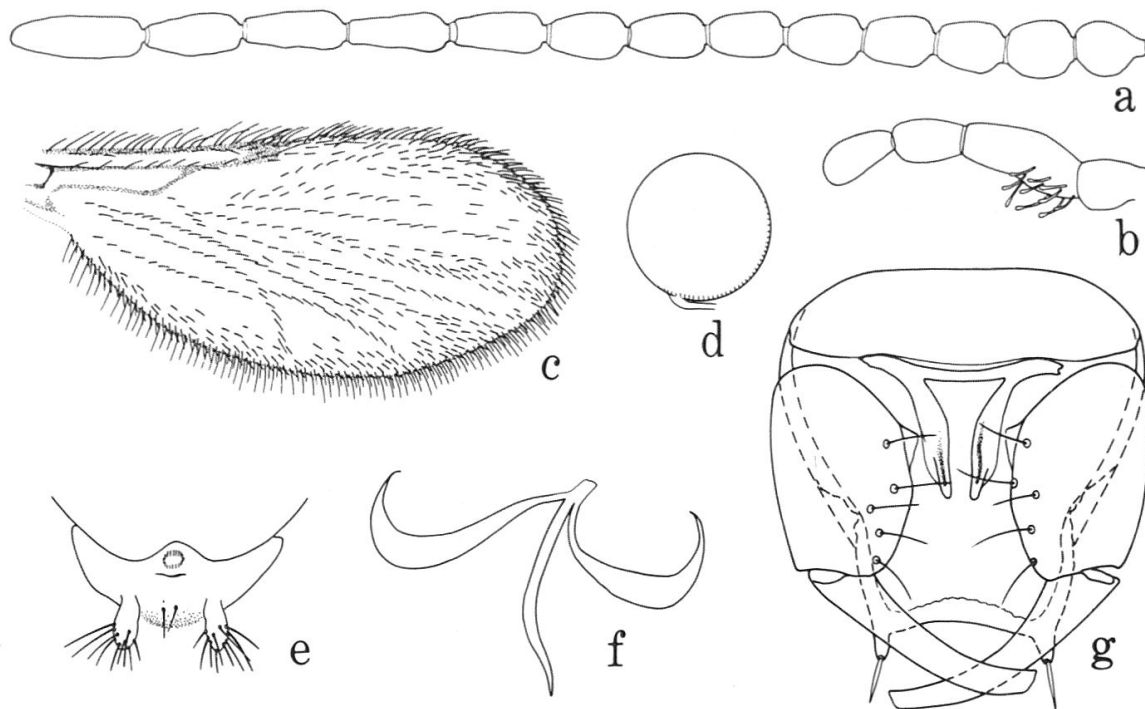


Fig. 2. *Dasyhelea theobromatis* n. sp., a-e, female; f-g, male: a, antenna; b, palpus; c, wing; d, spermatheca; e, genital segments; f, parameres; g, genitalia, parameres removed.

moderately prominent on five distal segments; last segment without terminal stylet. Palpus (fig. 2b) creamy white; lengths of segments in proportion of 13-23-15-17; third segment short and slender, with a few scattered, stalked sensilla.

Thorax: Yellowish with faint brownish infuscation on lower pleuron and postscutellum; mesonotum with three broad brownish vittae in usual position. Legs pale yellowish, knee spots blackish; femora with very faint broad median brownish bands. Wing (fig. 2c) pale grayish, microtrichia coarse giving a slightly milky appearance; costa short, extending to 0.44 of wing length, radial cells slitlike, poorly developed; macrotrichia very long and coarse, appearing somewhat spinelike, moderately numerous, mostly arranged in lines paralleling veins. Halter pale with dark brown stem.

Abdomen: Yellowish; terga 1-7 deeply infuscated, blackish. Without prominent genital sclerotization (fig. 2e), only a circular area of small spicules around gonopore. Spermatheca (fig. 2d) one, subspherical with a very slender appressed neck; rather large, measuring 0.070 mm in diameter, the neck 0.026 mm long.

Male Allotype. Wing length 0.81 mm; breadth 0.27 mm; costal ratio 0.46. Similar to female with usual sexual differences. Coloration as in female. Antenna with sparse brown plume extending to segment 12; proximal segments not fused, segment 12 binodose; last five segments with lengths in proportion of 25-50-46-40-60. Genitalia (fig. 2g) with ninth sternum transverse caudally, contiguous with base of aedeagus; ninth tergum short and broad, tapering to moderately separated, slender apicolateral processes, each bearing a long, strong, terminal spine; caudal margin between processes slightly concave. Basistyle short and stout, without mesal lobe but with a few scattered setae;

dististyle moderately long and slender, tapering and curving slightly to pointed tip. Aedeagus with transverse, slender basal bridge; a submedian pair of moderately long and slender, moderately sclerotized, posterior processes. Parameres (fig. 2f) asymmetrical; basal apodemes slender and curved; distal process long and sinuate, moderately slender with pointed tip.

Distribution. São Tomé.

Types. Holotype, female, São Tomé, 1 June 1974, J. DERRON, from cacao flowers (Type no. 71488, USNM). Allotype, male, São Tomé, Boa Nova, 27 Nov. 1974, J. DERRON, from cacao. Paratypes, 6 females, same data as holotype, 1 male, 5 females, same data as allotype.

Discussion. The name *theobromatis* is derived from *Theobroma*, the generic name of the cacao plant. In size and color this species resembles *D. flava* CARTER, INGRAM and MACFIE which was described from Ghana, but *flava* has a smaller spermatheca lacking the appressed slender neck and there is a very distinctive genital sclerotization including a prominent median process arising from the posterior margin of the eighth sternum, and in the male genitalia the dististyle is remarkably bifurcate and hooked, and the ninth sternum bears a long, forked caudal process.

Stilobezzia (Neostilobezzia) limai WIRTH and DERRON, new species (fig. 3 a-h)

Female Holotype. Wing length 1.62 mm; breadth 0.55 mm. A moderately large, uniformly yellowish-brown species without distinctive markings.

Head: Eyes contiguous, the interocular space narrowly wedge shaped above. Vertex with prominent, strong, bristly, dark brown hairs. Antenna (fig. 3a) brownish, segments with narrow bases paler; lengths of flagellar segments in proportion of 28-17-20-20-20-22-22-23-43-42-42-40-55; antennal ratio 1.30. Palpus (fig. 3b) brown; lengths of segments in proportion of 6-14-21-13-18; third segment very slightly swollen, with a small, round, inconspicuous, sensory pit at 0.6 of its length. Mandible with eight coarse, heavily sclerotized teeth.

Thorax: Without prominent color pattern or any trace of anterior spine or tubercle. Mesonotum with scattered strong bristly hairs; scutellum with four bristles. Legs with scattered, moderately strong, bristly hairs, a row of about six strong extensor bristles along length of hind tibia; mid basitarsus with strong spinelike seta near base and two at apex. Lengths of femora, tibiae, and tarsomeres 1-5 in following proportions: (fore leg) 80-80-46-20-6-8-18, (mid leg) 100-95-62-20-6-8-18, (hind leg) 105-110-60-27-7-7-17; lengths of claws (fig. 3f) in proportion as follows: (fore) 6/13, (mid) 6/16, (hind) 5/16. Wing (fig. 3c) grayish hyaline, the veins obscurely dark brownish; costa extending to 0.81 of wing length; second radial cell 2.8 times as long as first; r-m crossvein 0.67 as long as first radial cell; macrotrichia scattered over apex of wing past tip of costa. Halter infuscated.

Abdomen: Pale brown; with scattered, moderately strong, bristly hairs. Genital sclerotization as in fig. 3e. Spermathecae (fig. 3d) three, the third one

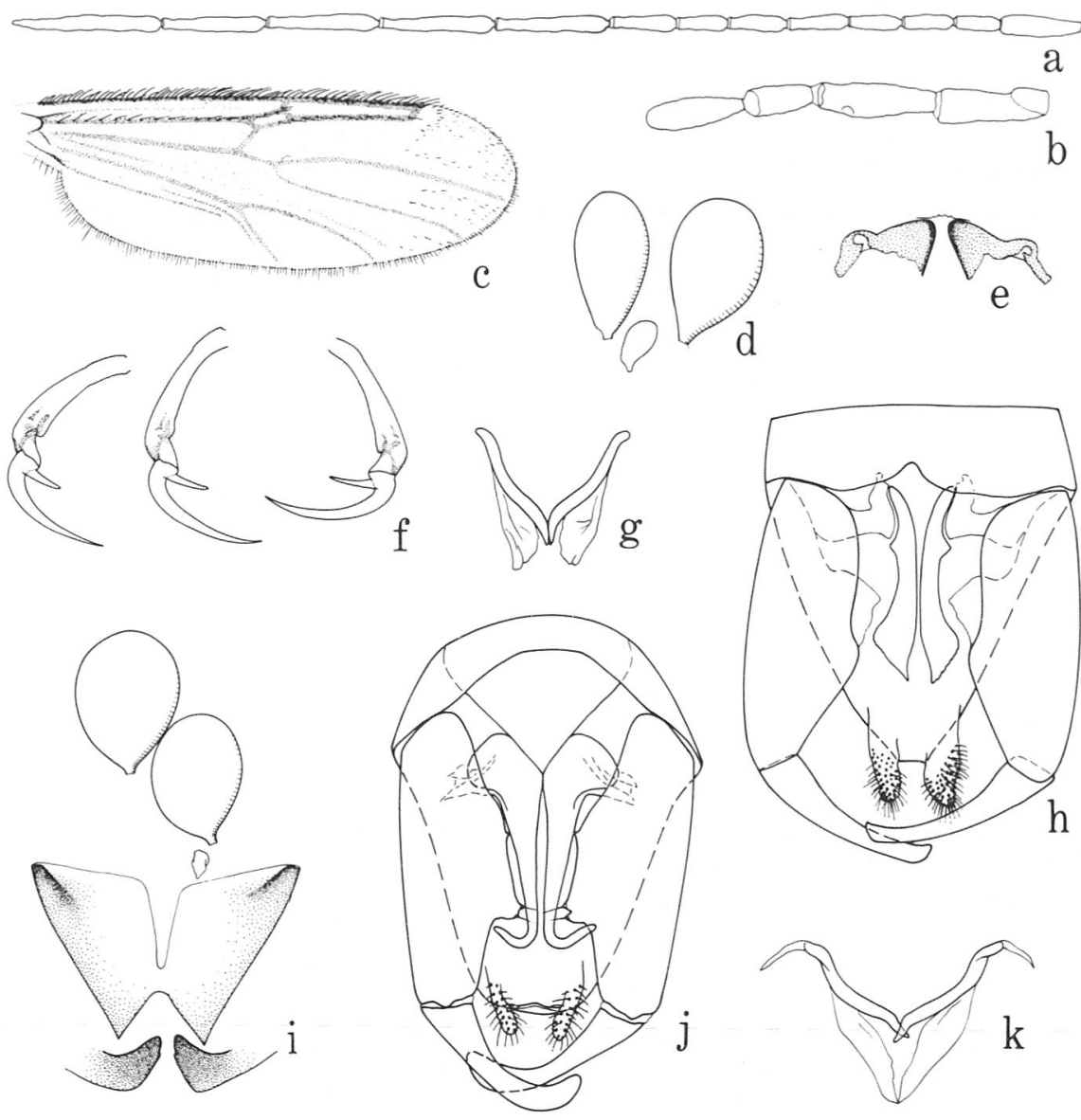


Fig. 3. *Stilobezzia*; a-h, *limai* n. sp.; i-k, *tomensis* n. sp.: a, female antenna; b, female palpus; c, female wing; d, female spermathecae; e, female genital sclerotization; f, female fifth tarsomere and claws, of (left to right) fore, mid, and hind legs; g, male aedeagus; h, male genitalia, aedeagus removed; i, female spermathecae and genital sclerotization; j, male genitalia, parameres removed; k, male aedeagus.

rudimentary and poorly sclerotized; elongate ovoid, measuring 0.080 by 0.051 mm, 0.077 by 0.042 mm, and 0.029 by 0.016 mm respectively.

Male Allotype. Wing length 1.55 mm; breadth 0.50 mm. Similar to female, with usual sexual differences. Antenna with well-developed brownish plume; length of distal five segments in proportion of 15-18-43-64-70. Legs with hairs stronger than in female; mid basitarsus with strong, spinelike ventral seta near base; claws small, equal, and straight with bifid tips. Genitalia (fig. 3h) dark brown; ninth tergum elongated and tapering to closely approximated, setose, caudomedian lobes. Basistyle moderately long, mesal margin with a few scattered minute tubercles, each bearing a fine seta; dististyle long and slender,

slightly curved and tapering to slender, bent tip. Aedeagus (fig. 3g) with slender sinuate lateral sclerites forming a rounded basal arch, a pair of low, obtuse, hyaline lobes arising from shoulders of arch. Parameres separate, each in form of nearly straight process with blunt, sub-basal, lateral projection, expanded distally in form of a flattened blade with pointed distomesal tip and fringe of fine denticles on distolateral margin of expanded portion.

Types. Holotype, female, allotype, male São Tomé, 1 June 1974, J. DERRON, at flowers of cacao (Type no. 71489, USNM). Paratypes, 2 males, 4 females, same data.

Discussion. This species is named for A. Lima who assisted in the field work on cacao pollination in São Tomé. *Stilobezzia limai* is closely related to *S. longicornis* GOETGHEBUER, a widespread Ethiopian species. *S. longicornis* differs in its shorter, more oval and less tapering spermathecae, and by the shape of the tip of the male paramere, which is deeply notched between the caudomesal point and the lateral serrations. *S. longicornis* was admirably re-described and figured by DE MEILLON (1959).

Stilobezzia (Neostilobezzia) tomensis WIRTH and DERRON, new species
(fig. 3 i-k)

Female Holotype. Wing length 1.11 mm; breadth 0.41 mm. Very similar to *S. limai*, but differing as follows: Smaller species, coloration as in *S. limai*. Antenna with lengths of flagellar segments in proportion of 20-13-13-13-14-14-15-16-30-30-30-32-48; antennal ratio 1.44. Palpal segments with lengths in proportion of 4-12-16-10-12; third segment shorter than in *S. limai*, sensory pit indistinct. Mandible with eight moderately strong teeth. Legs with lengths of femora, tibiae and tarsomeres 1-5 in proportion of: (fore) 60-85-32-13-5-4-13, (mid) 72-66-43-14-5-4-13, (hind) 72-70-37-14-5-4-13; lengths of claws in proportion of (fore) 5/13, (mid) 5/13, (hind) 4/12. Wing as in *S. limai*; costal ratio 0.74. Halter infuscated. Abdomen with genital sclerotization as in fig. 3i, a moderately sclerotized anterior trapezoidal sclerite with caudomedian notch present. Spermathecae (fig. 3i) two plus rudimentary third, the functional ones oval with short, slender necks; measuring 0.062 by 0.045 mm, 0.058 by 0.040 mm, and 0.011 by 0.007 mm respectively.

Male Allotype. Wing length 1.09 mm; breadth 0.37 mm; costal ratio 0.71. Similar to female with usual sexual differences. Antenna with well-developed plume, last five segments with lengths in proportion of 13-16-36-45-61. Genitalia (fig. 3j) with ninth sternum bearing a deep, broad, caudomedian excavation, the ventral membrane with fine spicules; ninth tergum long and tapering with closely approximate, setose, caudomedian lobes. Basistyle moderately long, mesal side at 0.7 of its length with distinctly angulate lobe bearing two strong papillae each with a minute seta; dististyle moderately long and slender, markedly curved to bluntly rounded tip. Aedeagus (fig. 3k) with the lateral sclerites very slender and sinuate, forming a basal arch much

broader than high, with distomesal tips meeting and crossing over slightly mesad; hyaline lobes arising from caudal side of distomesal halves of lateral sclerites forming an inconspicuous, subconical, distomesal extension of aedeagus. Parameres separate, each knobbed at base, stem straight and tapering to slender rod distally, abruptly bent ventrolaterad and ending in strongly sclerotized, microscopically fringed process with blunt, slender tip.

Distribution. São Tomé.

Types. Holotype, female, allotype, male, São Tomé, 1 June 1974, J. DERON, at flowers of cacao (Type no. 71490, USNM). Paratypes, 3 males, 2 females, same data.

Discussion. This species' name is a noun in apposition taken from the name of the island, São Tomé, where the species is found. *S. tomensis* is closely related to *S. vandeli* Vattier and Adam from the Congo, but *S. vandeli* differs in lacking the very distinctive tuberculose lobe on the mesal margin of the male basistyle.

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