Pacific Insects 11 (3-4): 507-520 10 December 1969

POLYNESIAN BITING MIDGES OF THE GENUS *CULICOIDES* (Diptera: Ceratopogonidae)

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Abstract: The 6 species of biting midges of the genus *Culicoides* known from Polynesia are described and figured, and a key is given for separation of females. Three species are described as new: *belkini* from the Society Is. and *samoensis* and *polynesiae* from Samoa. *Culicoides belkini* has become a troublesome bloodsucking pest of man, possibly because of major increases in its breeding habitat due to airports, roads, and other major construction.

One of the many features that make the tropical islands of Polynesia a "paradise" is the relative freedom from bloodsucking insects and tropical diseases. True, a few mosquito species are present and several mosquito-borne diseases are endemic in the islands, but modern medicine and techniques of mosquito control have been successful in suppressing them to the point that they have been of minor importance in recent years.

Concurrent with the great increase of tourism in the Pacific since 1950 has been the development in the Polynesian islands of large hotel complexes and airport facilities to handle tourist traffic. These developments have sometimes involved the draining, filling, leveling, and grading of extensive land areas and the disturbance of natural vegetation and other biota. At the same time, a new plague arose in French Polynesia that was first called to our attention in 1961 by Dr F. Cohic of Nouméa, New Caledonia. He wrote that in 1960 he collected at Bora Bora "a very noxious species I never met before, in 1954, when I was studying coconut pests in this area. —In my opinion this Ceratopogonidae was introduced in Bora Bora from elsewhere (the species is very common around the airfield built on the coral reef). I also collected it on the main islands. Now the species is supposed to be present in Tahaa and Tahiti". The species to which Dr Cohic referred was first thought to be *Culicoides insulanus* Macfie, but more study showed it to be a new species here described as *Culicoides belkini.*

The *Culicoides* pest problem in French Polynesia has been investigated by Dr John N. Belkin and Dr A. R. Barr of the University of California, Los Angeles (abbreviated hereafter as UCLA) in 1961 and 1967, respectively, and by Dr Eric J. Reye of the University of Queensland, Brisbane, Australia, in 1962. We are greatly indebted to these entomologists for the opportunity to study their collections and for their notes and opinions on the problem discussed later in this paper. We are also indebted to Dr J. Linsley

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Gressitt of the B. P. Bishop Museum (BISHOP) in Honolulu for the opportunity to study the earlier Polynesian collections of O. H. Swezey and E. C. Zimmerman; to Dr M. Tokunaga of Kyoto, Japan, who turned over to us his unpublished notes on Polynesian ceratopogonids; to Dr W. R. Kellen of Fresno, California and Dr C. P. Hoyt of Christchurch, New Zealand for their extensive Samoan collections; and to Dr Reye for his collections from Tahiti, Samoa, and Fiji and for permission to deposit types from his material in the U. S. National Museum (USNM) collections in Washington.

The following special terms are used in our descriptions of the female and in our summary of quantitative characters in Table 1. Proboscis/Head Ratio (P/H Ratio) is the length of the proboscis measured from the distal end of the labrum-epipharynx to the anterior margin of the tormae divided by the distance measured from the anterior margin of the tormae to the median hair socket between the inner eye margins. Palpal Ratio (PR) is the length of the 3rd palpal segment divided by its greatest breadth. Antennal Ratio (AR) is the combined lengths of the 5 elongated distal antennomeres (for convenience, hereafter referred to as "segments.") divided by the combined lengths of the 8 shorter preceding segments. Wing length is measured from the basal arculus to the wing tip; the Costal Ratio (CR) is the wing length divided by the length of the costa measured from the basal arculus to the tip of the 2nd radial cell (2RC).

Table 1. Mean Values of Characters of Polynesian *Culicoides*

Species	Wing Length (mm.)	Costal Ratio	Tibial Spines	Antennal Ratio	Antennal Sensoria	Palpal Ratio	Mand. Teeth	P/H Ratio
belkini	1.11	0.61	4	1.13	3-14	2.9	12-15	0.79
mollis	0.88	0.58	4	1.38	3-9, 11-14	2.2	12-13	0.84
samoensis	1.08	0.61	4	1.43	3-14	2.3	18	0.80
insulanus	0.65	0.51	4	1.35	3, 8-10	1.4	8-10	0.60
cancrisocius	1.25	0.67	4	1.81	3-10	3.2	14	0.80
polynesiae	1.54	0.65	5	1.49	3, 8, 9, 11-15	4.0	13-15	0.70

KEY TO FEMALES OF POLYNESIAN CULICOIDES SPECIES

1. Small species (wing 0.65 mm long); wing nearly bare, with distinct markings, but only 1 pale spot in cell Ml [sensoria present on antennal segments 3, 8-10] ..... **insulanus** Macfie
   Larger species (wing 0.88-1.54 mm long); wing distinctly hairy, cell Ml with 2 pale spots or without pale spots 2
2. Wing grayish with streaks along veins, definite pale spots present only over r-m crossvein and at tip of 2RC; large species (wing 1.25-1.54 mm long) 3
   Wing with extensive pale spots, 2 in cell Ml; size moderate (wing 0.88-1.11 mm long) 4
3. Poststigmatic pale spot located entirely distad of 2RC; 3 palpal segment with small round sensory pit ..... **cancrisocius** Macfie
   Poststigmatic pale spot covering distal 1/4 of 2RC; 3 palpal segment with sensoria scattered on surface ..... **polynesiae***
4. Antenna with sensoria present on segments 3-9, 11-14; palpal pit round and moderately

* Described as new.

deep; halter knob pale; mandibular teeth enlarged toward base of series; [pale wing markings not crossing veins Ml and M2] ..... mollis Edwards

Antenna with sensoria present on segments 3-14; palpal pit shallow and more or less irregular; halter knob brownish; mandibular teeth subequal in size 5

5. Pale wing markings interconnected, extending broadly across veins Ml and M2; palpal pit large, subdivided, extending on to proximal 1/2 of segment ..... samoensis*

Pale wing markings smaller, not crossing veins Ml and M2; palpal pit less irregular and not subdivided, confined to distal 1/2 of segment ..... belkini*

Culicoides belkini Wirth and Arnaud, new species Fig. 1-13, 27-28.

♀. Length of wing 1.11 mm; breadth 0.50 mm.

Head: Eyes (fig. 2) bare, narrowly separated. Antenna (fig. 9) with lengths of flagellar segments in proportion of 12-10-10-10-10-10-10-10-17-17-17-19-23, AR 1.13; distal sensory tufts present on 3-14. Palpal segments (fig. 10) with lengths in proportion of 7-13-20-9-9; 3rd segment moderately swollen, with a broad, shallow, round to slightly irregular sensory pit; PR 2. 9. Proboscis (fig. 2) moderately short, P/H Ratio 0.79; mandible (fig. 6) with 12-15 fine teeth of equal size; mouthparts as in fig. 5, 7-8.

Thorax: Dark brown; scutum with pruinose pattern (fig. 3). Legs (fig. 13) brown, moderately pale bands on bases of femora, and on bases and apices of tibiae, tarsi pale; hind tibial comb (fig. 4) with 4 spines, the 2 nearest the spur longer, subequal.

Wing (fig. 1): Pattern as figured; 2RC with apex in pale area of poststigmatic pale spot; a large pale spot centering on r-m crossvein and extending to costa and media; poststigmatic pale spot large, lying behind 2RC on more than proximal 1-2, extending caudad nearly to vein Ml; distal pale spot in cell R5 large and elongate, broadly meeting wing margin anterodistally; cell Ml with 2 elongate pale spots, the 2nd meeting wing margin; pale spot lying over base of media, 1 lying anterior to mediocubital stem before midlength, a pale streak in cell M2 extending from behind medial fork to level of pale spot in cell M4, the latter spot rounded and broadly meeting wing margin; cell M2 also with large spot at wing margin; anal cell with a pale spot at base, a streak at anal angle, and 2 pale spots in distal portion. CR 0.61; macrotrichia long and numerous, extending nearly to base of anal cell. Halter with brownish knob.

Abdomen: Brownish; tergal and sternal sclerites normal. Spermathecae (fig. 11) 2 plus rudimentary 3rd and sclerotized ring; subequal in size, each measuring 0.061 mm by 0.048 mm, broadly oval, with short, slender necks; genital segments as in figure 12.

♂. Similar to ♀, with the usual sexual differences; antennal plumes normal. Genitalia (fig. 27): 9th sternum narrow with shallow caudomedian excavation, the ventral membrane spiculate anteriorly; 9th tergum broad basally, tapered distally with apicolateral processes moderately approximated, long and slender, with angulate indentation on caudomedian margin between them. Basistyle moderately broad, ventral root not developed, dorsal root slender; dististyle moderately stout, slightly curved, with blunt tip. Aedeagus with short basal arch, extending to only 0.25 of total length, basal arms short, distal portion tapering gradually to blunt, moderately slender tip. Parameres (fig. 28) fused basally; each with short anterolateral process, stem swollen at extreme base, tapering gradually distally to moderately slender distal point bearing a few minute hyaline spinules.

DISTRIBUTION. Society Is., ? Samoa.

Holotype ♀, allotype ♂, Faáa, Tahiti, 18-24. X. 1962, E. J. Reye, reared (Type no. 69,963, USNM). Paratypes: 8 ♂♂, 314 ♀♀, as follows: Tahiti, same data as types, 2 ♂♂, 2 ♀♀

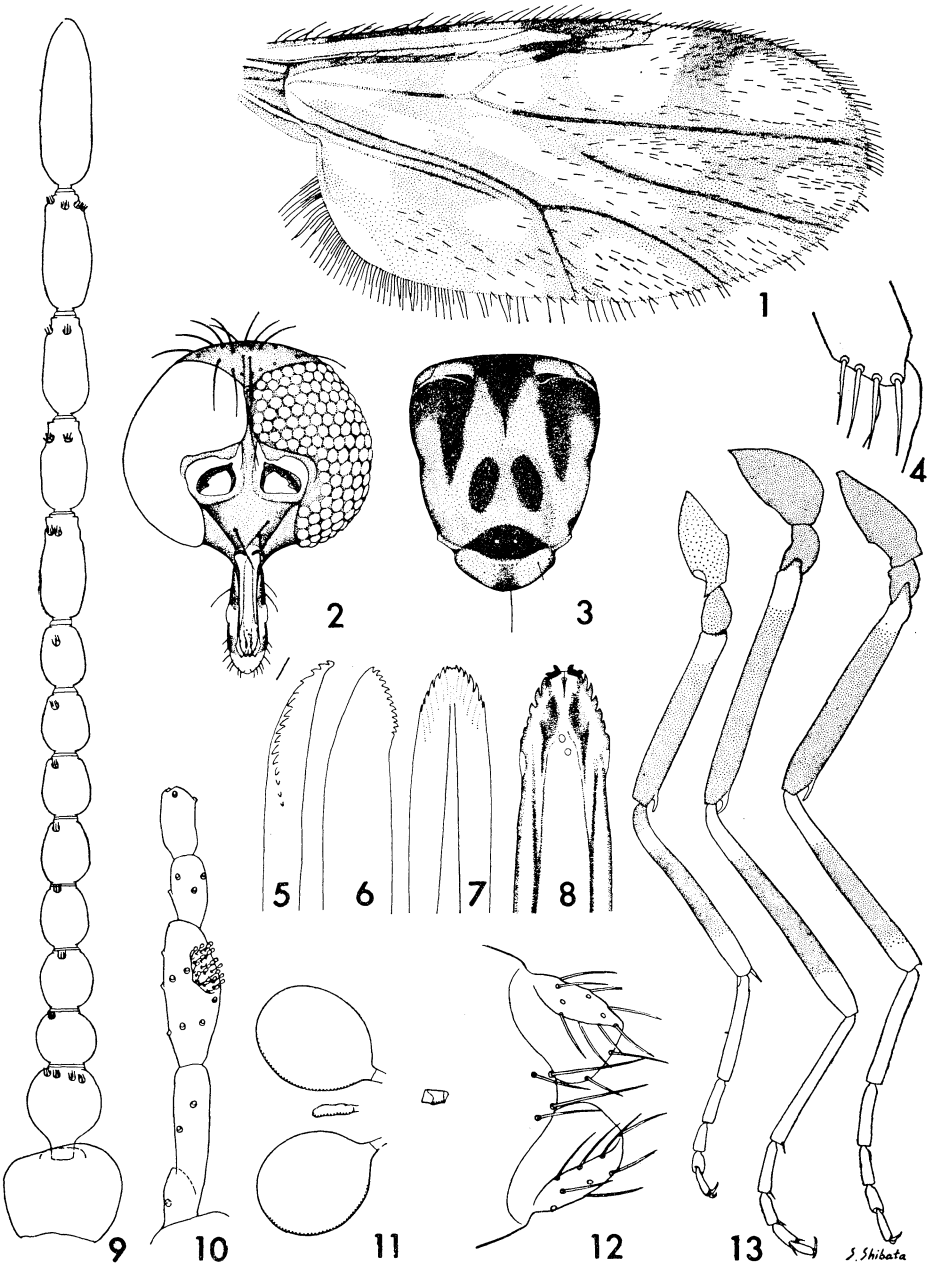

Fig. 1-13. *Culicoides belkini*, ♀ : 1, wing; 2, head, anterior view; 3, thorax, dorsal view; 4, hind tibial comb; 5, galea; 6, mandible; 7, hypopharynx; 8, labrum-epipharynx; 9, antenna; 10, palpus; 11, spermathecae; 12, tip of abdomen, ventral view; 13, fore, mid, and hind legs.

(Reye coll.). Tahiti, Faáa, 21. XI. 1962, H. Adams-Chapman, light trap, 6 ♂♂, 13 ♀♀ (Reye coll.). Tahiti, Faáa, 17. IV. 1963, H. Adams-Chapman & N. R. Spencer, 30 larvae (UCLA). Tahiti, Papeete, Maiao, III.1962, 35 ♀♀ (Reye coll.). Tetiaroa, 14. VI. 1967, A. R. Barr, biting man, 1800 hours, 14 ♀♀ (UCLA). Bora Bora, III–IV. 1961, J. N. Belkin & H. Adams-Chapman, biting man, 250 ♀♀ (UCLA).

ADDITIONAL RECORDS. SAMOA: Tutuila Naval Station, 24–29. VIII. 1940, Swezey & Zimmerman, at light, 2 ♀♀ (BISHOP). Identity doubtful.

Biology. This species is a typical member of the Ornatus Group which includes numerous species in the Pacific Islands and westward to SE Asia and Australia. They breed in various types of coastal salt marshes, mangrove swamps, beaches, and tidal estuaries. Some species are severe bloodsucking pests of man.

On Tahiti, this species was reared by Reye at the Faáa airport in wet brackish situations in the upper half of the intertidal zone. Adams-Chapman and Spencer collected larvae in sand, in shallow, brackish water with algae near the Faáa airport. Dr Barr wrote us that on Tetiaroa a brackish water lagoon exists which would afford a comparable habitat in the wet soil on the margins; he did not have an opportunity to search for larvae, however. Tetiaroa is a small atoll 42 km N of Tahiti and the *Culicoides* are a "veritable scourge", the inhabitants calling them "nonos". Dr Belkin wrote in 1961 that the characteristic habitat of this species on Bora Bora is a light coral sand with a considerable number of crabholes.

Discussion. Whether *Culicoides belkini* occurred in French Polynesia before modern development of the islands, or was introduced by modern transportion is a moot question. The 2 females mentioned from Samoa cannot definitely be separated from the Society Island population and hence are included questionably under *belkini*, but serious doubt can be cast on their identity. For one thing, no pest problem has been reported from Samoa. In fact the nearest Pacific islands where a pest problem exists because of species of the Ornatus Group are the Palaus in Micronesia, where a quite different species, *peliliouensis* Tokunaga, has been a problem for many years. The most reasonable conclusion from available evidence, and it is a very tentative one, is that *belkini* is an endemic species in French Polynesia but was relatively rare until recent construction and other disturbance greatly increased its suitable habitats. The rare instances in the past of midge attacks on humans attributed to the common inland species *insulanus* Macfie may actually have been caused by *belkini* instead or in addition.

Culicoides mollis Edwards Fig. 29–33.

Culicoides mollis Edwards, 1928, *Ins. Samoa*, Part IV, fasc. 2: 55 (♀; Samoa, Fiji).... Tokunaga, 1961, *Kontyu* **29**: 182 (♀ redescr.; Fiji; fig. wing, palpus, spermathecae).

♀. Length of wing 0.88 mm; breadth 0.44 mm.

Head: Eyes bare, narrowly separated, the space slightly broader above. Antenna (fig. 29) with lengths of flagellar segments in proportion of 10-7-8-9-9-9-9-9-16-17-18-20-26, 15 tapering distally; AR 1.38; distal sensory tufts present on 3-9, 11-14. Palpal segments (fig. 30) with lengths in proportion of 5-9-15-6-8; 3rd segment moderately swollen, with moderately broad and deep, round pit opening by a slightly smaller pore; PR 2.2. Proboscis moderately long, P/H Ratio 0.84; mandible with 12-13 teeth that are large proximally, becoming smaller distally in series.

Thorax: Uniformly tawny brown, pruinose, scutum without pattern. Legs brownish, tibiae

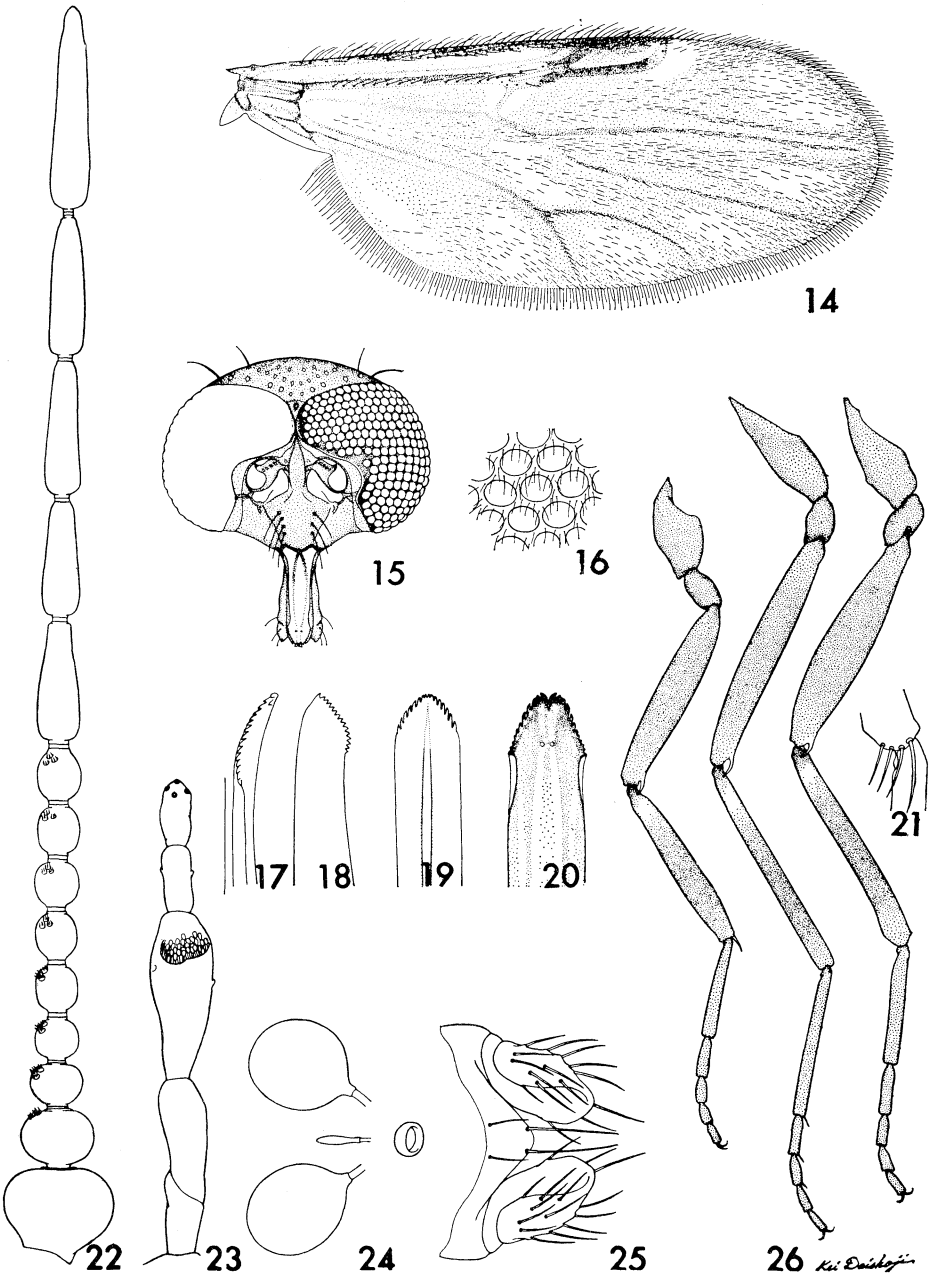

Fig. 14-26. *Culicoides cancrisocius*, ♀: 14, wing; 15, head, anterior view; 16, eye facets, enlarged; 17, galea; 18, mandible; 19, epipharynx; 20, labrum-epipharynx; 21, hind tibial comb; 22, antenna; 23, palpus; spermathecae; 25, tip of abdomen, ventral view; 26, fore, mid, and hind legs.

with pale narrow basal rings; hind tibial comb with 4 spines, the one nearest the spur longest.

Wing: Pattern similar to that of *belkini*; 2 radial cell pale distally but demarcation gradual; dark markings not intense; large pale spot centered on r-m crossvein; poststigmatic pale spot large and including apex of 2RC, lying behind 2RC for more than 1/2 its length; distal pale spot in cell R5 large, elongate, broadly open to wing margin anterodistally; cell M1 with 2 elongate pale spots, the distal one broadly meeting wing margin; cell M2 with long pale streak at base, extending distally to level of pale spot in cell M3 + 4, which is rounded, nearly filling cell and broadly meeting wing margin; cell M2 with similar pale spot at wing margin; anal cell with large pale spot at base and a large double pale spot in distal portion. CR 0.58; radial cells distinct, with narrow lumen; macrotrichia moderately long and numerous, extending proximad to base of anal cell. Halter pale.

Abdomen: Pale, tergal and sternal sclerites reduced. Spermathecae (fig. 31) 2 plus a rudimentary 3rd, sclerotized ring absent; functional pair slightly unequal, measuring 0.064 mm by 0.038 mm and 0.058 mm by 0.033 mm, ovoid gradually tapered to short necks.

♂. Similar to ♀ with usual sexual differences; antennal plumes normal. Genitalia (fig. 33): Ninth sternum narrow with slight caudomedian excavation; 9th tergum broad distally, with long, slender, apicolateral processes, the caudal margin between them slightly indented. Basistyle moderately slender, ventral root not developed, dorsal root short; dististyle gradually curved to moderately slender tip. Aedeagus with basal arch massive in midportion, basal arms with anterior breadth subequal to total length of arch to base of distal stem. Parameres (fig. 32) narrowly fused at base; each with broad, anterolaterally curved basal process, stem short, swollen basally, tapered distally to simple distal hyaline filament.

DISTRIBUTION. Fiji, Samoa.

Syntypes, 2 ♀♀ Apia, Upolu, Samoa, 11. XII. 1925, in British Museum (Nat. Hist.), London.

SPECIMENS EXAMINED. FIJI: Vanua Levu, Savu Savu Bay, I. 1941, O. Degener, at light. 1 ♀ (BISHOP). Viti Levu, Nandarivatu, 10. IX. 1938, 810 m, E. C. Zimmerman, at light, 1 ♀ (BISHOP). SAMOA: Tutuila Naval Station, VIII.1940, Swezey & Zimmerman, at light, 1 ♂ (USNM), 1 ♀ (BISHOP). Tutuila, Pago Pago, I-II.1957, W. R. Kellen, 2 ♀♀ (USNM).

Discussion. This species is easily distinguished from the other Polynesian species of the Ornatus Group by the antennal sensory pattern of 3-9, 11-14, by the enlarged proximal mandibular teeth, the round, moderately deep palpal pit with smaller pore in the ♀, and by the shapes of the 9 tergum and the parameres in the ♂ genitalia. Tokunaga's redescription of Fijian specimens agrees closely with ours and with notes made by Wirth on a syntype in the British Museum in 1957.

Culicoides samoensis Wirth and Arnaud, new species Fig. 34-38.

♀. Length of wing 1.08 mm; breadth 0.50 mm.

Head: Eyes bare, narrowly separated. Antenna (fig. 36) with lengths of flagellar segments in proportion of 12-10-10-10-10-10-10-10-20-22-22-23-30, AR 1.43; distal sensory tufts present on 3-14. Palpal segments (fig. 35) with lengths in proportion of 8-22-26-8-8; 3rd segment markedly swollen in midportion, with a large, shallow, subdivided pit extending onto proximal 1/2 PR 2.3. Proboscis moderately long, P/H ratio 0.80; mandible with 18 minute, equal teeth.

Thorax: Dark brown, scutum without apparent pattern. Legs pale brown, tibiae with faint

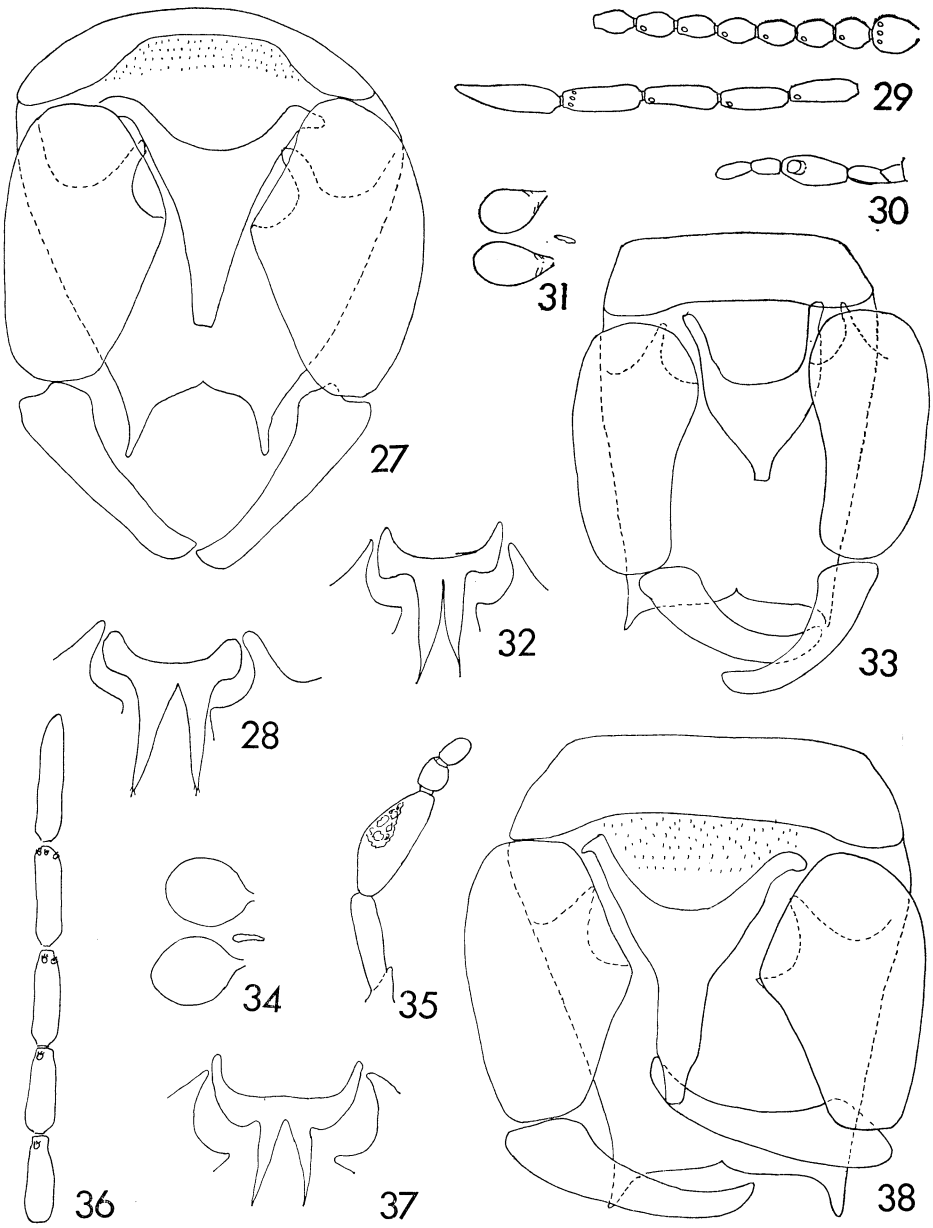

Fig. 27-38. *Culicoides belkini*: 27, ♂ genitalia, parameres removed; 28, parameres. Fig. 29-33. *Culicoides mollis*: 29, antenna; 30, palpus; 31, spermathecae; 32, parameres; 33, ♂ genitalia, parameres removed. Fig. 34-38. *Culicoides samoensis*. 34, spermathecae; 35, palpus; 36, antenna, 5 distal segments; 37, parameres; 38, ♂ genitalia, parameres removed.

basal pale rings; hind tibial comb with 4 spines, the 2 nearest the spur longer, subequal.

Wing: Pattern similar to that of *belkini*; posterior and distal margins of 2RC in pale area of poststigmatic pale spot; a large pale spot centering on r-m crossvein and extending to costa and past media; poststigmatic pale spot large, more than proximal 1/2 lying behind 2RC, extending caudad nearly to vein M1; distal pale spot in cell R5 elongate, nearly filling apex of cell, dark area between it and poststigmatic pale spot forming a narrow transverse bar; cell M1 with 2 pale spots, the proximal one elongate and nearly filling space between veins M1 and M2, the distal one oval and meeting wing margin; distinct oval pale spot lying over base of media, narrowly connected caudad to irregular pale area extending across stem MCu and filling base of anal cell; pale streaks lying behind medial fork and in front of mediocubital fork, cell M2 with elongate pale spot lying ahead of large pale spot in cell M4; distal spots in cells M2 and M4 large and broadly meeting wing margin; anal cell with 2 pale spots, slightly confluent, in distal portion. Macrotrichia long and numerous, extending to base of anal cell; CR 0.61; radial cells both elongate with distinct lumen, 2RC rather narrow. Halter knob brownish.

Abdomen: Brownish, tergal and sternal sclerites normal. Spermathecae (fig. 34) 2 plus rudimentary 3rd and sclerotized ring; subequal in size, each measuring 0.072 mm by 0.054 mm, broadly oval with short slender necks.

♂. Similar to ♀, with usual differences; antennal plumes normal. Genitalia (fig. 38): Ninth sternum narrow with slight caudomedian excavation, the ventral membrane spiculate; 9th tergum moderately broad and long, tapering distally to widely separated, moderately short, slender, apicolateral processes, the caudal margin between them slightly indented. Basistyle moderately broad, ventral root not developed, dorsal root slender; dististyle moderately stout, slightly curved, with blunt pointed tip. Aedeagus with low broad basal arch extending to 0.25 of total length, basal arms short; distal portion parallel-sided, with abrupt subapical constriction and slender, rounded tip. Parameres (fig. 37) fused basally; each with short, slender anterolateral process, stem slender, tapering to filamentous tip.

DISTRIBUTION. Samoa.

Holotype ♀, allotype ♂, Pago Pago, Tutuila, Samoa, I-II. 1957, W. R. Kellen, at light (Type no. 69,964, USNM). Paratypes: 11 ♂♂, 17 ♀♀, Afiamalu, Upolu, Samoa, 660 m, 21. VI. 1940, Swezey 8 Zimmerman, at light (BISHOP, USNM).

Discussion. This species is similar to *belkini* n. sp. but can be readily distinguished by its more extensive pale wing markings, lack of scutal pattern, large subdivided palpal pit, and more elongate distal antennal segments. The ♂ genitalia are also distinctive.

Culicoides insulanus Macfie Fig. 45, 47–48, 50–51.

Culicoides insulanus Macfie, 1933, *Bull. B. P. Bishop Mus.* **113**: 77 (♀ Tahiti; fig. wing).

♀. Length of wing 0.65 mm; breadth 0.34 mm.

Head: Brownish, palpi darker, antennae yellowish white. Eyes narrowly separated by a wedge-shaped space, bare. Antenna (fig. 51) with lengths of flagellar segments in proportion of 10-5-6-7-7-7-7-8-13-14-15-15-20, AR 1.35; distal sensory tufts present on segments 3, 8-10; 2 per segment on 8-10. Palpal segments (fig. 45) with lengths in proportion of 4-6-10-4-4-; 3rd segment short and stout, with a large, shallow sensory pit; PR 1.43. Proboscis extremely short, P/H ratio 0.60; mandible with 8-10 fine teeth.

Thorax: Brownish, scutum with prominent pattern of large yellowish patches. Legs dark brown; on fore and mid legs knees, distal halves of femora, and proximal halves of tibiae

yellowish; hind leg with femur dark to tip, tibia with narrow basal pale ring; tarsi pale; hind tibial comb with 4 spines, the one nearest the spur longest.

Wing: 2nd radial cell dark to tip, in a dark-shaded area; large pale spot centered on r-m cross-vein, extending from costal margin to media; poststigmatic pale spot in cell R5 large and quadrate, extending 3/4 way caudad to vein M1; a small round distal pale spot in cell R5, centered subapically in cell; a large pale area across vein M2, sometimes extensive enough to fuse with poststigmatic pale spot and distal pale spot in cell R5; cell M2 with a pale streak at base, a large pale area between medial and mediocubital forks, no separate pale spot past mediocubital fork; cell M4 with rounded pale spot distally at wing margin; anal cell with 1 large pale spot in distal portion and a pale streak on anal angle. Costa short, CR only 0.51; 2RC short, 1RC incompletely formed; macrotrichia sparse, only a few confined to wing tip. Halter whitish.

Abdomen: Brownish. Spermathecae (fig. 47) 2 plus rudimentary 3rd and ring; unequal, measuring 0.051 mm by 0.027 mm and 0.039 mm by 0.022 mm, irregularly oval, with long, slender necks.

♂. Similar to ♀ with usual sexual differences; antennal plumes well developed. Genitalia (fig. 48): 9th sternum narrow, with shallow caudomedian excavation, ventral membrane bearing a few spicules at posterior apex of aedeagal arch; 9th tergum short and broad, with moderately short, slender, pointed, apicolateral processes, the posterior margin between them convex. Basistyle short and broad, ventral root "foot-shaped", with well-developed proximal "heel" on posterior margin, dorsal root short and slender; dististyle slender and curved to blunt-pointed tip. Aedeagus with basal arch extending to slightly more than 1/2 of total length, basal arms fairly stout and slightly curved, distal stem moderately stout and tapered to blunt, rounded tip. Parameres (fig. 50) each with stout basal knob, stem moderately stout basally, sinuately bent, and gradually narrowed distad, without ventral lobe, with slender distal filament and lateral fringe of 4-5 sharp spines.

DISTRIBUTION. Society Is., Samoa.

Syntypes, 2 ♀♀ from Tahiti collected by A. M. Adamson (BISHOP). The slide specimen with the following data is hereby selected as lectotype; Hitiaa, 4 miles from sea, 1000 feet, 20 November 1928, on *Metrosideros*.

SPECIMENS EXAMINED. SOCIETY IS. Bora Bora, 25. IV. 1961. J. N. Belkin, 9 ♀♀ (USNM). Tahiti, Faraura Vall., 3.2 km from sea, 60 m, XI. 1928, on "Opuhe" (*Zingiber* sp.), 1 ♀ (BISHOP). Tahiti, Hitiaa, 27. III. 1953, D. Bonnet, biting man, 1 ♀ (USNM). Tahiti, Paea, 14. IV. 1961, J. N. Belkin, 10 ♀♀ (USNM). Tahiti, Papenoo Valley, 11.2 km from sea, 105 m, 27. X. 1928, A. M. Adamson, dead leaves of "Opuhe", (*Zingiber* sp.) 1 ♀ pinned syntype (BISHOP).

SAMOA: Tutuila, 13. X. 1954, C. P. Hoyt, 1 ♂, 2 ♀♀ (USNM). Tutuila, 13. V. 1958, W. R. Kellen, at light, 6 ♂♂, 6 ♀♀ (USNM). Tutuila, Fagotogo, X. 1954, C. P. Hoyt, 1 ♂, 1 ♀ (USNM). Tutuila, Pago Pago, 8. I., 16. VI. 1958, I-III, 1957, W. R. Kellen, at light, 14 ♂♂, 33 ♀♀ (USNM). Upolu, Afiamalu, 10. VI. 1940, 660 m, at light, Swezey & Zimmerman, 1 ♂, 7 ♀ (BISHOP).

DISCUSSION. The extremely short proboscis and the reduced mandibular teeth of *insulanus* cast doubt on its ability to suck human blood in spite of the single biting record from Hitiaa, Tahiti, recorded above. It is certainly a common species in both French Polynesia and Samoa, but other than the one record, it has not been known to bite humans. This species is a typical member of the subgenus *Oecacta*.

Culicoides cancrisocius Macfie Fig. 14-26, 46, 49.

Culicoides cancrisocius Macfie, 1946, *Proc. R. Ent. Soc. Lon.* (B) **15**: 15 (♂, ♀; Fiji; fig. wing, ♂ paramere). —Tokunaga, 1961, *Kontyu* **29**: 184 (♀ redescribed; fig. wing, palpus, spermathecae).

♀ (from Votua, Viti Levu). Length of wing 1.25 mm; breadth 0.58 mm.

Head: Eyes narrowly separated, with numerous interfacetal hairs (fig. 16). Antenna (fig. 22) with lengths of flagellar segments in proportion of 15-10-10-10-10-10-10-10-27-28-29-30-40. AR 1.81; distal sensory tufts present on segments 3-10. Palpal segments (fig. 23) with lengths in proportion of 8-18-32-10-10; 3rd segment moderately swollen distally, with a broad, shallow, sensory pit located near tip; PR 3.2. Proboscis (fig. 15) moderately short, P/H ratio 0.80; mandible (fig. 18) with 14 teeth, other mouthparts as in fig. 17, 19, 20.

Thorax: Dark brown, scutum without definite pattern. Legs (fig. 26) brown, tibiae with narrow subbasal pale rings, hind tibia narrowly pale at tip; hind tibial comb (fig. 21) with 4 spines, the one nearest the spur longest; 4th tarsomere cylindrical.

Wing (fig. 14): Pattern as figured; 2RC in a dark spot to its apex; 2 distinct pale spots, one lying over r-m crossvein and other lying just past tip of 2RC; other faint, indistinct pale spots lying toward apices of cells R5, M1, M2, M4, and anal cell, and between bases of medial and mediocubital forks; wing veins somewhat darkened throughout wing; 1RC slitlike, 2RC elongate, 2-3 × as long as broad, the vein between the 2 sometimes indistinct. Macrotrichia numerous and long on wing, extending nearly to base of anal cell; CR 0.67. Halter knob brownish.

Abdomen: Dark brown. Spermathecae (fig. 24) 2 plus rudimentary 3rd and ring; slightly unequal, measuring 0.065 mm by 0.043 mm and 0.058 mm by 0.039 mm, ovoid, tapering to short, slender necks; genital segments as in fig. 25.

♂ (from lectotype). Similar to ♀, with usual sexual differences; antennal plumes well developed. Genitalia (fig. 46): 9th sternum with imperceptible caudomedian excavation, the ventral membrane not spiculate; 9th tergum moderately long and tapering, with short, slender, apicolateral processes, the caudal margin between them not indented. Basistyle moderately stout, dorsal and ventral roots moderately long, the latter with small basal "heel"; dististyle slender and curved, tapering to slender distal point. Aedeagus with basal arch extending to approximately 1/2 of total length, basal arms well-sclerotized and somewhat angulate, distal stem moderately slender and tapering slightly to blunt-pointed tip. Parameres (fig. 49) each with large basal knob, stem slender proximad, curved, and stouter distally with a distinct ventral lobe; distal portion slender and tapering to distal filament and bearing lateral fringe of 4-5 spines.

DISTRIBUTION. Fiji.

Syntypes, 1 ♂, 2 ♀♀, Suva, Fiji, 3. IV. 1945, R. A. Lever, ex crab hole [British Museum (Nat. Hist.)]; these specimens were re-examined, and the ♂ is hereby selected as lectotype.

SPECIMENS EXAMINED. FIJI: Vanua Levu, Savu Savu Bay, Ba langa, I. 1941, O. Degener, at light, 1 ♀ (BISHOP), from the series redescribed by Tokunaga. Viti Levu, Votua, above bridge, 5. XI. 1962, E. J. Reye, netted, 3 ♀♀ (Reye coll.; USNM).

DISCUSSION. The wing pattern, sensorial pattern, presence of 2 functional spermathecae, and ♂ parameres with basal knob, ventral lobe, and distal fringing spines place *cancrisocius*

in the subgenus *Oecacta*. It does not appear to be closely related to any other known Oriental or Australian species.

Culicoides polynesiae Wirth and Aranud, new species Fig. 39-44.

♀. Length of wing 1.54 mm; breadth 0.65 mm.

Head: Eyes (fig. 39) bare, contiguous. Antenna (fig. 40) with lengths of flagellar segments in proportion of 24-12-11-10-10-11-11-11-25-26-30-28-40, AR 1.50; distal sensory tufts present on 3, 8, 9, 11-15, those on 8 and 9 minute, the others with prominent setae. Palpal segments (fig. 41) with lengths in proportion of 10-20-40-13-12; 3rd segment slender, spindle-shaped, without pit but with scattered sensoria and multiple pores scattered on distal 0.7 of segment on measl side; PR 4.0.Proboscis moderately short, P/H ratio 0.70; mandible with 13-15 fine, even teeth.

Thorax: Uniformly medium dark brown. Legs pale brown, without pale rings; hind tibial comb with 5 spines, the 2 nearest the spur longer, subequal; 4th tarsomere moderately cordiform.

Wing: With 2 distinct large pale spots, one lying over r-m crossvein and extending from costa into medial cell, the other lying past end of costa and including distal 1/4 of 2RC; remainder of wing uniformly pale brownish infuscated, except faintly darker area in cell R5 just past poststigmatic pale spot, slightly darker lines over veins, and a much darker area over radial veins between the 2 anterior pale spots and proximad of the 1st pale spot. Macrotrichia sparse but short and spinelike, scattered over distal 1/3 of wing and a few in anal cell; CR 0.65, radial cells with distinct lumen, 1RC narrow, but 2RC rather large with broad lumen. Halter pale brownish.

Abdomen: Brownish, elongate; spermathecae (fig. 42) 2 plus rudimentary 3rd, ring absent; slightly unequal in size, measuring 0.090 mm by 0.058 mm and 0.080 mm by 0.049., pyriform in shape, in addition with short, slender, sclerotized necks.

♂. Similar to ♀ with usual sexual differences, antennal plumes sparse, brownish. Genitalia (fig. 44): 9th sternum narrow with shallow caudomedian excavation, the ventral membrane minutely spiculate, 9th tergum elongate and rather evenly tapered to moderately narrow, truncated tip with short, blunt, apicolateral processes. Basistyle moderately stout; dististyle stout at base, evenly curved and tapering to slender tip. Aedeagus with basal arch low, extending to a 3rd of total length, the basal arms stout; main portion with sides tapering evenly to apex, tip with 2 sharp spinelike distal points. Parameres (fig. 43) fused at base, the stems bulbous in midportion, each tapering distally to slender, nearly straight distal point.

DISTRIBUTION. Samoa.

Holotype ♀, Pago Pago, Tutuila, Samoa, I-II. 1957, W. R. Kellen (Type no. 69,965, USNM). Allotype ♂, 2 ♂ and 2 ♀ paratypes, Naval Station, Tutuila, Samoa, VIII. 1940, Swezey & Zimmerman, at light.

DISCUSSION. This species is closely related to *bancrofti* Lee & Reye from Australia and *costalis* Tokunaga from Bougainville I. and New Britain. The 3 species form a group which is characterized in the ♀ by the poorly marked wing with 2 distinct anterior pale spots. the distal one including the apex of 2RC, and the 3rd palpal segment elongated with scattered sensoria; in the ♂, the 9th tergum is quite elongate with blunt apicolateral processes, the aedeagus is characterized by the low basal arch, stout basal arms, and 2 sharp distal points, and the parameres have a characteristic swelling in midportion with nearly straight, slender apices with simple tip. The ♂ of *bancrofti* is unknown, but the ♀ differs in its much hairier wing, elongate proximal antennal segments, and more elon-

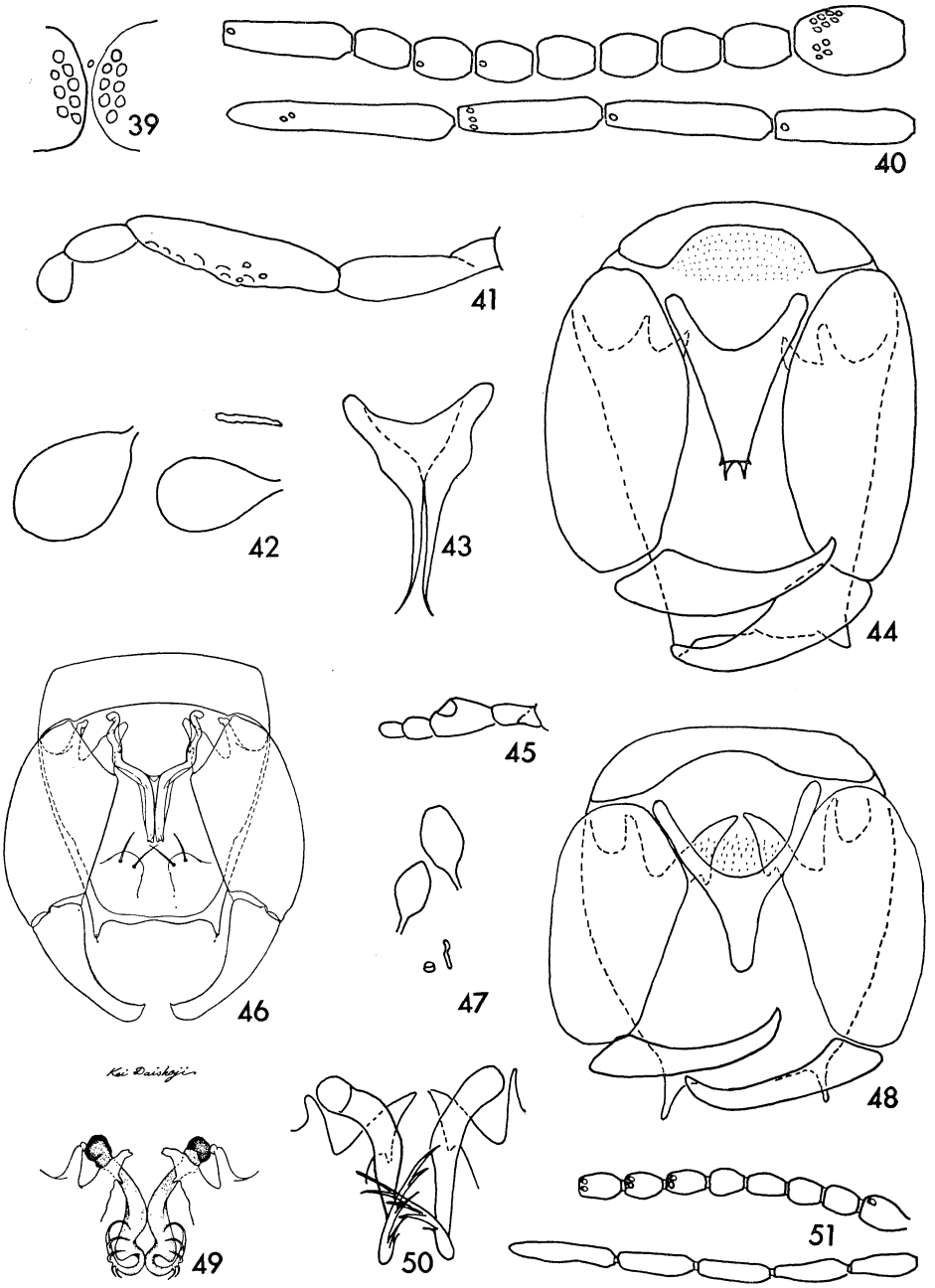

Fig. 39-44. *Culicoides polynesiae*: 39, ♀ eye separation; 40, antenna; 41, palpus; 42, spermathecae; 43, parameres; 44, ♂ genitalia, parameres removed. Fig. 45, 47-48, 50-51. *Culicoides insulanus*. 45, palpus; 47, spermathecae; 48, ♂genitalia, parameres removed; 50, parameres; 51, antenna. Fig. 46, 49. *Culicoides cancrisocius*. 46, ♂ genitalia, parameres removed; 49, parameres.

gate 3rd palpal segment.

There is enough discrepancy between the figures of the male that Tokunaga figured in 1962 (*Pacif. Ins.* **4**: 498. fig. 13) for *costalis*, and the one that he called "*costalis* var." in 1963 (*Nati. Taiwan Univ. Plt. Protect. Bull.* **5**: 133, fig. 2 f, 10) to consider them separate species. The type ♂ of *costalis* from Bougainville has the dististyles curved and the apicolateral processes small as in *polynesiae*, but the parameres are drawn as separate, and the distal points of the aedeagus do not appear to be sharp and distinct. The variety from Bodem, New Guinea has nearly straight dististyles, large angular apicolateral processes, and distinct, sharp, distal points and broad subapical shoulders on the aedeagus though the parameres are nearly the same as in the Bougainville form. Tokunaga describes the 4th tarsomere of his species as cordiform and groups it with *magnesianus* Lee & Reye on this character; in *polynesiae*, the 4th tarsomere is only moderately cordiform; in *bancrofti* it is definitely cylindrical.