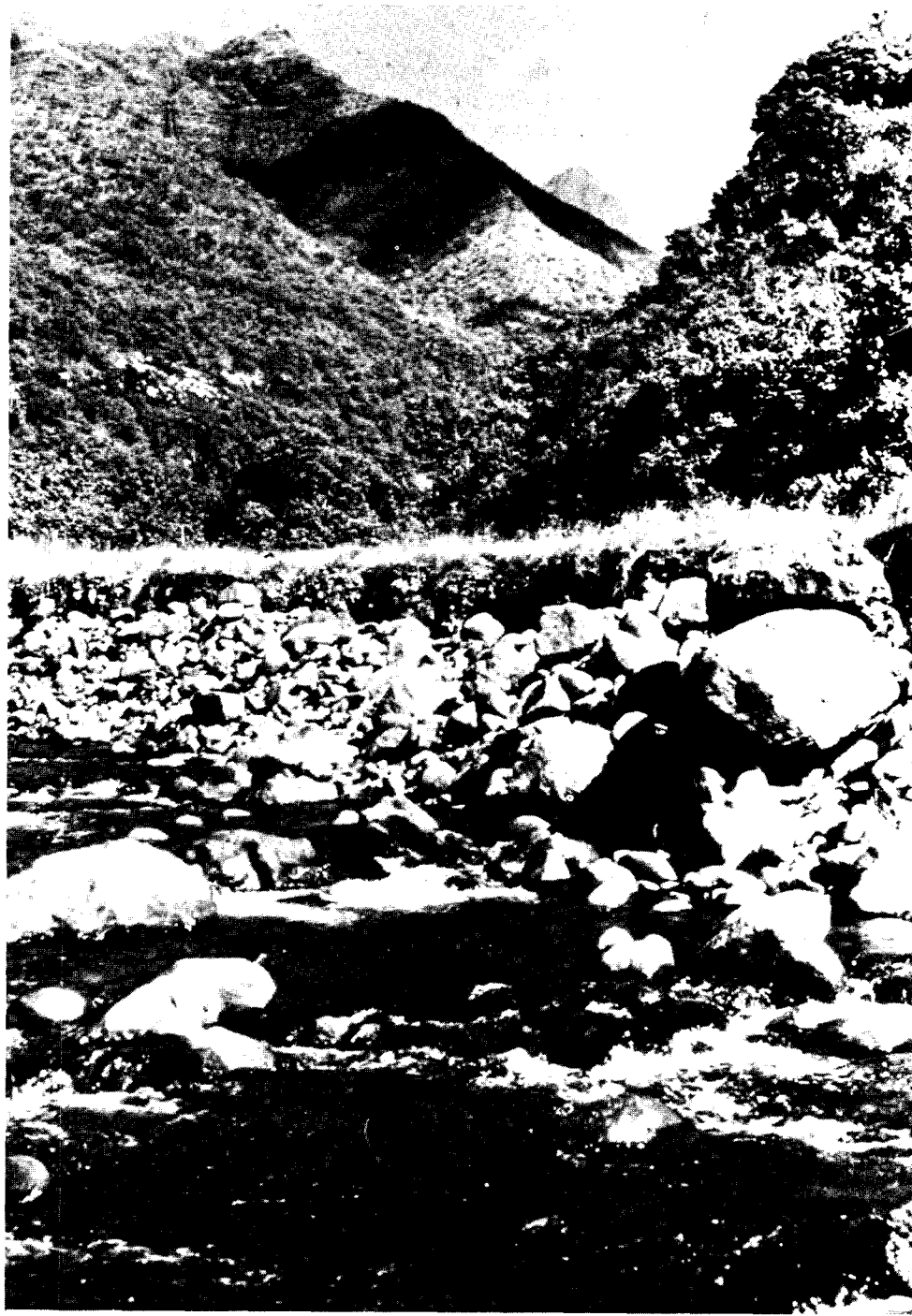




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Frontispiece. Tuauru River, Mahina, Tahiti. A typical habitat of larvae of *Simulium tahitiense* Edwards and *S. oviceps* Edwards.

A TAXONOMIC ACCOUNT OF THE BLACK FLIES (DIPTERA: SIMULIIDAE) OF THE  
SOCIETY ISLANDS - TAHITI, MOOREA AND RAIATEA

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ABSTRACT

*The taxonomy of black flies of the Society Islands - Tahiti, Moorea and Raiatea is revised. With the exception of one new species, Simulium anatolicum n. sp., subgenus Hebridosimulium Grenier and Rageau, all species are assigned to the subgenus Inseliellum Rubtsov, for which a diagnosis is given. An amended diagnosis is provided for Hebridosimulium. Thirteen species are recognised in the Society Islands, of which eight (S. admixtum n. sp., S. arlecchinum n. sp., S. cataractarum n. sp., S. exasperans n. sp., S. lotii n. sp., S. malardei n. sp., S. mesodontium n. sp., S. neoviceps n. sp.) are described as new from Tahiti, one (S. opunohuense n. sp.) from Moorea, and one (S. castaneum n. sp.) from Raiatea. The three previously described species (S. tahitiense Edw., S. oviceps Edw. and S. cheesmanae Edw.) are fully redescribed. Four species groups are recognised. The malardei - group contains S. malardei, and S. teruamanga Craig and Craig from Rarotonga; the opunohuense - group contains S. lotii and S. opunohuense; the oviceps - group contains S. admixtum, S. arlecchinum, S. castaneum, S. cataractarum, S. mesodontium, S. neoviceps, S. oviceps and Simulium sp. The tahitiense - group contains S. exasperans, S. tahitiense and Simulium "IIS". The other species are left ungrouped. Keys are provided for known larvae, pupae and adults of the Tahitian Simuliidae. Brief information is given on habitats.*

RÉSUMÉ

*Une révision de la taxonomie des mouches noires des Îles Société - Tahiti, Moorea et Raiatea est présentée. À l'exception d'une nouvelle espèce, Simulium anatolicum n. sp., sous-genre Hebridosimulium Grenier et Rageau, toutes les espèces sont regroupées dans le sous-genre Inseliellum Rubtsov. Une diagnose est produite pour le sous-genre Inseliellum, et une diagnose révisée est présentée pour Hebridosimulium. Treize espèces sont reconnues pour les îles Société: dont huit nouvelles espèces (S. admixtum n. sp., S. arlecchinum n. sp., S. cataractarum n. sp., S. exasperans n. sp., S. lotii n. sp., S. malardei n. sp., S. mesodontium n. sp., S. neoviceps n. sp.) décrites pour Tahiti, une (S. opunohuense n. sp.) pour Moorea, et une (S. castaneum n. sp.) pour Raiatea. Les trois espèces restantes (S. tahitiense Edw., S. oviceps Edw. et S. cheesmanae Edw.) sont entièrement redécrites. Quatre groupe-espèces sont reconnus. Le groupe-malardei contenant S. malardei et S. teruamanga Craig et Craig, de Rarotonga; le groupe-opunohuense (S. lotii et S. opunohuense); le groupe-oviceps (S. admixtum, S. arlecchinum, S. castaneum, S. cataractarum, S. mesodontium, S. neoviceps, S. oviceps et Simulium sp), et la groupe-tahitiense contenant S. exasperans, S. tahitiense et Simulium "IS". Les espèces restantes demeurent non-groupées. Des clefs d'identification sont présentées pour les larves, nymphes et adultes connus pour Tahiti. Les habitats sont brièvement décrits.*

INTRODUCTION

Simuliidae occur on many of the world's volcanic and continental islands (Crosskey, 1981). With few exceptions, such as large islands like New Zealand and New Guinea (Smart and Clifford, 1965; Dumbleton, 1973b; McLea and Lambert, 1983), the number of simuliid species

living on individual islands is low. Even for an ecologically diverse and geologically old island such as New Caledonia (Holloway, 1979) only two taxa of simuliids are known, despite moderately intensive collection (Bedo, 1977; 1984).

When simuliids were first reported from Polynesian islands, few taxa were recognized (Edwards, 1927; 1933; 1935) and the taxonomic situation was not definite as Edwards (1927) indicated by comments about *S. cheesmanae*.

While larvae of the Tahitian *S. tahitiense* and *S. oviceps* were common and relatively well described, larvae of *S. cheesmanae* were unknown. Grenier and Rageau (1960) provided more extensive descriptions for *S. tahitiense* and *S. oviceps*, as well as descriptions of new larval and pupal material, suggesting that it might be that of *S. cheesmanae*; but still a relatively simple taxonomic situation.

While studying the number of larval instars of *S. tahitiense* and *S. oviceps* (Craig, 1975a), I too, described new larval material, but realized it was probably not that of *S. cheesmanae* because of its small size, since *S. cheesmanae* is the largest Tahitian simuliid. At that time I also collected larval material for karyotyping. Rothfels (*in* Craig, 1975a) commented that *S. tahitiense* and *S. oviceps* were remarkably close to each other chromosomally. A reconstructed phylogeny of the Tahitian Simuliidae then seemed very simple (Craig, 1975b). Rothfels (*pers. comm.*, 1974) subsequently collected more material himself which included at least one taxon not related to those then known.

In 1980, 1981 and 1983, I collected other species of simuliid in Tahiti which were confirmed karyologically by Rothfels (*in* Craig, 1983) and it became apparent that the Rarotongan, Marquesan and Tahitian species were unique in the Simuliidae by possessing heterogametic females. The taxonomic situation then became far from simple. As can be seen by this present work, many of the new species are morphologically distinct in the immature stages, and an intriguing question is why were they not discovered sooner? In retrospect, two aspects of work on Tahitian Simuliidae provide the answer. Firstly, both *S. tahitiense* and *S. oviceps* larvae prefer the abundant larger, open rivers of Tahiti, while the newly discovered species are in more specialized habitats, such as cascades, small heavily-shaded streams, or from the only lake-fed river on the island. Earlier collections, as judged from locality labels, were simply made from the large rivers which had easier access and probably provided more satisfying results in terms of numbers of specimens. The new species sometimes occur in very low densities, and several are known, unfortunately, only from unique specimens. Secondly, *S. tahitiense* is morphologically variable and the limits of the variation were not then well known. Consequently, *S. exasperans*, *S. lotii* and *S. malardei* had been collected previously by earlier workers and me, but were not recognized.

One of the major difficulties with Tahitian Simuliidae has been association of life stages. Larvae of most species (both karyotyped and not) are morphologically quite distinct, with pupae less so and the adults difficult to distinguish without detailed preparation of their genitalia. Therefore, great care was taken to ensure that adults reared from pupae were correctly associated to their larvae. With as many as four species occurring sympatrically, and with little to distinguish some of the later stages, it is remarkable that the original association of stages of *S. tahitiense* and *S. oviceps* was correct. In large part that was because material taken over the years was from large populations from preferred habitats of those species. However, the probability of *S. tahitiense* being confused with *S. exasperans* n. sp. existed because that species is so similar to *S. tahitiense* and it occurs in the same habitats, at quite high frequency in many places. Likewise, pupae of *S. lotii* n. sp. are easily confused with small pupae of *S.*

*exasperans*. This raises a serious problem with collections of pinned adults of Tahitian simuliids. Many such specimens are severely collapsed because the adults are small and cannot withstand drying. Therefore many exterior characters cannot be easily seen. Without associated pupal exuviae, and without detailed preparation of the genitalia, specific identification of such pinned adults is almost impossible. This particularly applies to *S. tahitiense* and *S. exasperans*. Indeed, in some collections of pinned reared adults, associated pupal exuviae show that *S. exasperans* had previously been identified as *S. tahitiense*. Consequently the work of correctly identifying present collections of pinned material will be onerous, if not impossible. This makes reared material valuable, and such is essential for future collections.

Of considerable importance for correct association were specimens undergoing larval/pupal moults, which allowed characters of both stages to be definitively associated. A few pupal exuviae from reared adults retained the larval exuviae and these specimens assumed even more importance.

Some larval material which is karyologically distinct cannot yet be morphologically characterized. Rothfels (*in* Craig, 1983) showed two distinct cytotypes, "IIS" and "IS-complex", however, the larval remains from the karyological examination are not adequate to provide sufficient morphological details to erect species for these distinct cytotypes. Larvae of "IIS" are presently morphologically indistinguishable from *S. tahitiense* and those of "IS-complex" cannot be distinguished from *S. cataractarum*.

Interpretation of the type status of previously described species has been difficult because Edwards failed to label his type specimens. It was necessary to infer the types and the status from data labels on the material in the British Museum (Natural History); the lectotypes designated here are from series of syntype specimens so determined by R.W. Crosskey (BMNH). For *S. oviceps*, no Tahitian data were explicitly given for any specimen and syntype status was inferred by Crosskey from Mumford and Adamson's locality data and by back reference to material originally mistakenly identified as *S. bussoni* (Edwards, 1927).

In comparison to Northern Hemisphere simuliids, little is known about the biology of the simuliids from the Society Islands, but Schröder (1985, 1988) has made an important contribution by studying larval distribution, habitats and feeding behaviour.

#### MATERIAL

More than 200 adults were reared from pupae for this study and a similar number of pinned adults from various institutions were also examined. Approximately 250 larvae were identified to species, but many hundreds of larvae of the commoner species were available.

Codens for institutions where material is deposited:

- BMNH Department of Entomology, British Museum (Natural History), Cromwell Road, London, SW7 5BD England.
- BPBM Bernice P. Bishop Museum, P. B. 19000-A, Honolulu, Hawaii, 96819. U. S. A.
- CNCI Canadian National Collection of Insects, Arachnids and Nematodes, Biosystematics Research Centre, Ottawa, Canada. K1A 0C6.
- DAC Personal collection. D. A. Craig, Department of Entomology, University of Alberta, Edmonton, Canada. T6G 2E3.

- DSIR New Zealand Arthropod Collection, Entomology Division, DSIR, Private Bag, Auckland, New Zealand.
- IP Institut Pasteur, 25 et 28, Rue du Docteur-Roux, 75724 Paris, France.
- MNHP Department d'Entomologie, Muséum National d'Histoire Naturelle, 45 Rue de Buffon, 75005, Paris, France.
- UASM Strickland Museum, Department of Entomology, University of Alberta, Edmonton, Canada. T6G 2E3.
- USNM United States National Museum, NHB 168, Washington, D. C. 20560, U. S. A.

## METHODS

### Collection and Treatment of Specimens

When possible, two collections of larvae were made, one into Carnoy's fixative for eventual karyological examination, the other into 90% ethanol to extrude the anal papillae. For scarce material, fixation in Carnoy's took precedence.

Adults were reared from pupae placed in tubes with damp filter paper. After emergence, adults were allowed to mature before preservation in 90% ethanol along with their pupal exuviae. Most of this material was critical point dried. Although colours are slightly muted, this is a preferred technique for it results in minimal collapsing. Most museum collections of pinned specimens of Polynesian simuliid adults, which were allowed to dry naturally, collapsed and are of little taxonomic use.

Larvae and pharate pupae for examination by light microscopy were dealt with following Currie (1986). Cleared material was placed in glycerine-jelly as a temporary mountant during examination. Material for scanning electron microscopy was prepared according to Craig and Borkent (1980).

### Notes about Structural Features

Determination of homologous hypostomal teeth is not without difficulty when all the teeth are similar in shape and length as in *S. oviceps*, or when only the median tooth is differentiated as in *S. lotii*. Following Currie (1986), I distinguish between apical teeth formed from the dorsal wall of the hypostoma and the lateral serrations formed from the ventral one. For most hypostoma a distinct line marks the two structures (Figs. 36, 37, 39, 40). A prominent apical tooth in a lateral position is termed "lateral tooth - 1 tth", e.g., as in *S. malardei*. Such a decision results in three lateral teeth and two paralateral teeth per side (Fig. 40).

Of particular importance taxonomically is presence or absence of thoracic tubercles on the pupae. When only late last instar larval material is available, with care, some of the pharate pupal cuticle can be dissected out with the pupal gills. Tubercles can then clearly be seen with phase microscopy (Fig. 73). In many older preserved specimens, larval cuticle has separated from the underlying pharate pupa and is relatively easy to remove. The pharate pupal carcass can then be examined with a scanning electron microscope (Fig. 72).

Adult Tahitian Simuliidae are relatively difficult to identify and normally require detailed preparation of their genitalia.

### Water Characteristics

To determine amount of suspended material larger than 0.45  $\mu\text{m}$  in the water (Lacey and Lacey, 1983), 500–1000 ml of water were filtered through previously weighed Millipore®, Type



HA filters. These were then dried and reweighed. The pH of water was determined with a portable, Fisher, Digital pH meter, Model 609.

#### **Localities and Locality Data**

Polynesian place names are used for most localities. Where alternative spellings are available, both are given initially. Localities are listed in order from Papeete clockwise (*i.e.*, north, east; Map 1) with the district given first and italicized. Tahiti is formed from two extinct volcanic centres, with the larger western land mass termed "Tahiti-nui", the smaller, "Tahiti-iti". Localities on Tahiti-iti are so indicated. Names, longitudes and latitudes were taken from the maps - "Edition Provisoire 1958, 1:40,000, Ministere des Travaux publics et des Transports, Institut Geographique National, France" and "Carte Touristique, 1:100,000, Edition 3, 1977, Institut Geographique National, France". Where distances from the coast, or other definitive statement is made on older collections, longitude and latitude was determined for those localities. Data for a given locality are listed chronologically. Where detailed localities are not given on labels, these are listed first under "*Tahiti*". The station numbers (*e.g.*, Stat. #3) given on some labels refer to data in the author's field notes.

#### **Species Criteria**

Possession of a unique character state, or unique combination of character states, was taken as an indication of reproductive isolation and specific status. In most instances, morphological specific status agrees with cytospecies determined by Rothfels (*in* Craig, 1983). Choice of types for three species was dictated by existence of syntypes. Otherwise, the life stage most likely to be encountered and most easily identified was chosen. Larvae were the preferred stage for types because of relative ease of identification. Whenever possible, karyotyped larval material (Rothfels *in* Craig, 1983) has been deposited in the institution holding the type.

Data from labels of type specimens are cited in the manner following O'Hara (1983). Labels are listed from the top down, with each label enclosed in quotation marks; lines of text within a label are indicated by a slash mark. Repositories for all types and material examined are given in parentheses.

#### **Species Groups**

Species which appear to be morphologically closely related have been assigned to species groups. At present these are based mainly on pupal and larval characteristics. Some species, such as *S. cheesmanae* for which only adults are known, are not placed in any group.

#### **Figures**

In Figures 26–35 of larval head capsules, rays of labral fans have been omitted for clarity, as have the hypostomal sensilla in Figures 36–44.

#### **TAXONOMIC TREATMENT**

##### **Key to Female Adults of Tahitian Simuliidae**

Use of this key requires preparation of the adults' genitalia. Females of *S. admixtum*, *S. arlecchinum*, *S. malardei*, *S. mesodontium* and *S. neoviceps* are unknown.

- 1            Large-sized species: body length 2.5–3.8 mm; antennae and legs distinctly yellow . . . . . 5.



- 1' Moderate to smaller-sized species; body length 1.2–2.1 mm; antennae yellow basally; legs dark, or with yellow/pale pattern ..... 2
- 2 (1') Body: blackish-brown; length 1.2–1.6 mm ..... 3
- 2' Body: brownish; length 1.5–1.9 mm ..... 4
- 3 (2) Body: black. Genitalia: cerci and anal lobe small; lateral sclerite of genital fork simple; sternite VIII with median pigmented region ovoid (Fig. 6) .....  
..... *S. lotii* n. sp., p. 388
- 3' Body: brownish-black. Genitalia: cerci and anal lobe large; lateral sclerite of genital fork with accessory arm; sternite VIII with median pigmented region broad and diffuse (Fig. 8) ..... *S. oviceps* Edwards, p. 405
- 4 (2') Genitalia: spermatheca without reticulate pattern; lateral sclerite of genital fork with anterior projection sharply rounded (Figs. 5, 9) ..... 6
- 4' Genitalia: spermatheca with slight reticulate pattern; lateral sclerite of genital fork with anterior projection blunt (Fig. 3) .....  
..... *S. cataractarum* n. sp., p. 400
- 5 (1) Calcipala: expanded enormously. Anepisternal membrane: haired (*Hebridosimulium*). Genitalia: cerci narrow basally and apically; hypogynial valves locked basally to anal lobes; sternite VIII with median pigmented region deeply concave (Fig. 1) ..... *S. anaticum* n. sp., p. 382
- 5' Calcipala: not so expanded. Anepisternal membrane: bare (*Inselillum*). Genitalia: cerci broadly rounded apically; hypogynial valves free of anal lobe bases; sternite VIII with pigmented region diffuse, subrectangular medially (Fig. 4) ..... *S. cheesmanae* Edwards, p. 385
- 6 (4) Sternite VIII: with median pigmented region small; genital fork stem broader; anal lobes bare (Fig. 5) ..... *S. exasperans* n. sp., p. 392
- 6' Sternite VIII: with median pigmented region distinct, extended laterally; genital fork stem slim; anal lobes hairy (Fig. 9) .....  
..... *S. tahitiense* Edwards, p. 394

#### Key to Male Adults of Tahitian Simuliidae

Use of this key requires preparation of the adults' genitalia. Males of *S. admixtum*, *S. arlecchinum*, *S. mesodontium* and *S. neoviceps* are unknown.

- 1 Large-sized species; body length 3.0 mm (Fig. 11) .....  
..... *S. cheesmanae* Edwards p. 385
- 1' Moderate to small-sized species; body length less than 2.5 mm ..... 2
- 2 (1') Gonocoxa: median surface straight to slightly concave, no medial projection (Figs. 10–16) ..... 3
- 2' Gonocoxa: median surface convex, with medial projection (Fig. 17) .....  
..... *Simulium* sp. p. 408
- 3 (2) Small-sized species; body length less than 1.5 mm ..... 4
- 3' Moderate-sized species; body length between 1.6–2.5 mm ..... 5
- 4 (3) Ventral plate: heart-shaped; bare; anterior arms subparallel to curving medially; anteriomedian notch indistinct (Fig. 14) .....  
..... *S. malardei* n. sp., p. 387
- 4' Ventral plate: broad; posteromedian region hairy; anterior arms diverging; anterior median notch rounded, distinct (Fig. 15) .....

- ..... *S. oviceps* Edwards, p. 405
- 5 (3') Ventral plate: broadly rounded anteromedially; median notch broad (Figs. 10, 12, 16) ..... 6
- 5' Ventral plate: protruded anteriorly; median notch deeply incised (Fig. 13) ..... *S. lotii* n. sp., p. 388
- 6 (5) Ventral plate: anterolateral arms flanged distally (Figs. 10, 12) ..... 7
- 6' Ventral plate: anterolateral arms smooth distally (Fig. 16) ..... *S. tahitiense* Edwards, p. 394
- 7 (6) Ventral plate: posterolateral margins concave distally, cone-shaped, hairy medially ..... *S. exasperans* n. sp., p. 392
- 7' Ventral plate: posterolateral margins slightly concave, posterior apex broad, hairy posteriorly ..... *S. cataractarum* n. sp., p. 400

#### Key to Pupae of Tahitian Simuliidae

Pupae of *S. admixtum*, *S. cheesmanae* and *S. neoviceps* are unknown.

- 1 Thoracic tubercles: present (Fig. 18); pupal cocoon: either boot- or slipper-shaped ..... 2
- 1' Thoracic tubercles: absent (Fig. 19); pupal cocoon: slipper-shaped ..... 3
- 2 (1) Gill filaments: shorter than thorax; postscutellum not cone-shaped in lateral view (Fig. 18); cocoon boot-shaped ..... *S. anaticum* n. sp., p. 382
- 2' Gill filaments: as long or longer than thorax; postscutellum cone-shaped in lateral view (Figs. 20, 21); cocoon slipper-shaped ..... 4
- 3 (1') Dorsal gill filament: shorter than other filaments ..... *S. lotii* n. sp., (p. 388) and *S. cataractarum* n. sp., (p. 400) ..... 5.
- 3' Dorsal gill filament: as long as other filaments ..... *S. exasperans* n. sp., p. 392 and *S. malardei* n. sp., p. 387
- 4 (2') Thoracic tubercles: rounded; dorsal gill filament longer than thorax, sometimes reflexed posteriorly (Fig. 21) ..... *S. tahitiense* Edwards, p. 394
- 4' Thoracic tubercles: pointed; dorsal gill filament shorter than thorax and other filaments, rarely long (Fig. 20) ..... *S. oviceps* Edwards, p. 405
- 5 (3) Pharate pupal material indicates that *S. arlecchinum* n. sp. (p. 398) and *S. mesodontium* n. sp., (p. 403) may also have short dorsal gill filaments and lack thoracic tubercles.

#### Key to Mature Late Instar Larvae of Tahitian Simuliidae

The larvae of *S. cheesmanae* and *S. anaticum* are unknown.

- 1 Labral fan: fully developed; head spot pattern positive (Fig. 35). Posterior abdomen: expanded gradually (Fig. 22), or expanded ventrally (Fig. 23). Anal sclerite extended laterally ..... 7
- 1' Labral fan: rays reduced in number or size, or virtually absent (Figs. 32, 34, 66, 67); head spot pattern partially (Figs. 28, 32), or completely negative (Figs. 29, 34). Posterior abdomen: hemispherical, or abruptly expanded laterally at segment VI (Fig. 25). Anal sclerite extended laterally, or almost, or completely extended around anal proleg (Fig. 24)

	..... <i>oviceps</i> -group (p. 397) .....	2
2	(1') Labral fan stem: shorter than antenna. Line of hypostomal teeth convex (Fig. 43); median tooth rarely prominent (Fig. 41) .....	3
2'	Labral fan stem: longer than antenna. Line of hypostomal teeth concave; lateral teeth and median tooth prominent (Fig. 38) .....	4
3	(2) Labral fan: with <i>ca.</i> 12 small rays. Hypostoma: not protruding markedly anteriorly. Head sensilla: numerous (Fig. 66). Anal sclerite: extended laterally, or further ventrally .....	5
3'	Labral fan: virtually absent (Fig. 32). Hypostoma: protruding markedly anteriorly. Head sensilla: not numerous (Fig. 67). Anal sclerite: extended completely around anal proleg, sometimes fused .....	
	..... <i>S. neoviceps</i> n. sp., p. 403	
4	(2') Anal sclerite: extended almost complete around anal proleg (Fig. 24). Head spot pattern: distinctly positive (Fig. 29) .....	
	..... <i>S. cataractarum</i> n. sp., p. 400	
4'	Anal sclerite: extended only laterally. Head spot pattern: negative .....	6
5	(3) Abdominal cuticle: lacking tubercles. Hypostoma: teeth subequal in size (Fig. 43) .....	
	..... <i>S. oviceps</i> Edwards, p. 405	
5'	Abdominal cuticle: covered with ovoid, greyish tubercles (Fig. 63). Hypostoma: sublateral teeth, laterad to median tooth, small (Fig. 41) .....	
	..... <i>S. mesodontium</i> n. sp., p. 403	
6	(4') Head cuticle: corrugated and rugose (Fig. 26). Head spot colour pattern: 8-shaped .....	
	..... <i>S. admixtum</i> n. sp., p. 397	
6'	Head cuticle: not corrugated and rugose. Head spot colour pattern: H-shaped (Fig. 27) .....	
	..... <i>S. arlecchinum</i> n. sp., p. 398	
7	(1) Body pale: length less than 4.5 mm. Posterior abdomen: expanded gradually (Fig. 22). Anal papillae: simple .....	8
7'	Body dark: length longer than 4.5 mm. Posterior abdomen: expanded abruptly ventrally. Anal papillae: simple or complex (Fig. 23) .....	9
8	(7) Sublateral hypostomal teeth: three per side (Fig. 40) .....	
	..... <i>S. malardei</i> n. sp., p. 387	
8'	Sublateral hypostomal teeth: more than three per side (Fig. 39) .....	
	..... <i>S. lotii</i> n. sp., p. 388	
9	(7') Anal papillae: simple .....	
	..... <i>S. exasperans</i> n. sp., p. 392	
9'	Anal papillae: complex .....	
	..... <i>S. tahitiense</i> Edwards, p. 394	

#### Subgenus *Hebridosimulium* Grenier and Rageau

*Hebridosimulium* Grenier and Rageau, 1961a: 96 (as genus). Type species: *Simulium jolyi* Roubaud, 1906 (by original designation).

*Simulium* (*Hebridosimulium*) Grenier and Rageau. Crosskey, 1967: 27.

*Diagnosis*.— As for Crosskey (1967), but with the following modifications necessitated by additional material from Fiji and Vanuatu and by present description of a new species from Polynesia. Adult: with or without distinct "cell" basal to anterior branch of media (MA); cibarial pump without armature; hypogynial valves and anal lobes coadapted basally; spermatheca with slight or heavy pattern, with or without clear area around junction of sperm duct.

Pupa: dorsal thoracic tubercles rounded, lateral and posterior tubercles pointed; gill with eight or ten simple elongated filaments; scutellum not pointed dorsally.

*Simulium (Hebridosimulium) anaticum* n. sp.

(Figs. 1, 18, 69)

*Types.*—

*Holotype.* Female: pinned; reared, with pupal cocoon and exuviae as subsidiary material; label data:—“Holotype”, “*Simulium* (H.)/ *anaticum* Craig/ det./ D.A. Craig 1986”, “Tahiti, Mahaena, Mahape R./ 17° 34' 00" S. 149° 20' 33" W./ alt. 700m. 14-vi-1980,/ D.A. & R.E.G. Craig. Stat. #6.” (MNHP). Head, genitalia and pupal exuviae in vial. Left gill of pupa as slide mount, same data as adult (MNHP). Small portion of pupal exuviae used for scanning electron microscopical examination (DAC).

*Specific epithet.*— The specific epithet is based on the Greek word “*anaticos*”, meaning “eastern”, in reference to this new record well to the east of other *Hebridosimulium*.

*Diagnosis.*—

Adult: large; yellowish; mandibles small; wing with no basal “cell”, veins R1, Sc, lacking hair; spermatheca, pattern tuberculate, unpigmented region at junction of sperm duct.

Pupa: sternite V hooks close-set.

*Description.*—

*Adult female.* (Single reared specimen). Body: generally yellowish-brown. Length: 2.5 mm. Head: grayish-brown, width 0.98 mm, length 0.69 mm. Eyes: yellowish-grey; interocular distance 0.33 width of clypeus; frontal angle, 115 degrees; ommatidia 0.014 mm in diameter, ca. 34 and 45 respectively across and up eye in middle row. Frons: bulging ventrally over sunken antennal bases, densely covered with silver scale-like hairs. Clypeus: concolorous with ventral region of frons, slightly longer than wide, densely covered with silver hairs medially; lateral hairs dark, extended beyond bases of maxillary palpi. Postociput: densely covered with silver hairs extended to eye margin, scattered long black hairs extend over posterior margin of eye. Antenna: yellowish; length 0.63 mm. Mouthparts: length, 0.50 head depth; mandibles with ca. 30 very fine teeth; lacinia with ca. 25 pronounced retrorse teeth; maxillary palpus (distal articles absent from specimen), basal articles flattened and densely covered with black hairs; sensory vesicle of third article elongated occupying 0.50 width of article, opening of vesicle 0.66 width of vesicle, ca. 25 bases of sensilla visible. Cibarial pump: space between proximal arms flat, smooth, 1.3 times as wide as deep. Thorax: rich brown; length 1.4 mm; postpronotum, contiguous area with scutum creamy, remainder of scutum uniformly brown, moderate vestiture of silver hair, in some views three darker vittae; scutellum yellowish, with sparse black and golden hairs; postnotum brown medially and posteriorly, yellow laterally; anepisternal membrane with distinct pale yellow flattened hairs; katapisternum bare; mesepimeral hair tuft black, sparse. Wing: length 2.9 mm, maximum width 1.3 mm; veins pale yellow, hairs black; stem vein hair tuft black, covering vein; basal section of vein R with hairs dorsally and ventrally; R1 clear dorsally; Sc clear dorsally, with hairs ventrally; area basal to vein MA without distinct clear “cell”. Halter: creamy-white. Legs: coxae, femura and tibiae yellow, distal portion of tibiae brown; fore basitarsus six times longer than wide, brown anteriorly; hind basitarsus parallel sided, seven times longer than wide; calcipala enormously extended to 0.66 length of 2nd tarsomere; 3rd tarsomere with two long hairs extended to pretarsal claws. Pretarsal claw: smoothly curved, simple, no basal tooth. Abdomen: generally black with dense dark scales anteriorly, pale scales posteriorly on each segment; basal fringe of shiny dark golden hairs extended to abdominal segment II; tergites III–VII lighter in colour than others; sternite VII distinct, narrower anteriorly; pleural regions with dense silver scales. Genitalia (Fig. 1): complex; cercus, sharply ovoid distally in ventral view; anal lobes straight sided medially, almost in contact under hypogynial valves, divergent posteriorly almost at right angles; valves divergent only slightly posteriorly, closest approach before apex, bluntly rounded posteriorly; sternite VIII with posterolateral edges of valves very thin; bases of valves and anal lobes interlock, with anterolateral edge of anal lobe overlapping ventrally base of valve; genital fork stem smooth, thin, with slight anterior knob, lateral arms divergent at right angles, lateral sclerite acutely triangular. Spermatheca (destroyed during preparation for illustration): dark brown; distinct tuberculate pattern; region at duct junction unpigmented.

*Adult male.* Unknown.

*Pupa.* Length; 3.6 mm. Gill (Fig. 18): 1.4 mm in length, eight filaments, branching directly out of base; two ventral filaments branching from short stem, single median filament directed anterolaterally from base; dorsal branch dividing into three, two of these divide again, medial filament single. Head and thoracic cuticle (Fig. 69): with rounded black tubercles, those more lateral and posterior, pointed and hooked. Thorax: trichomes trifold. Abdomen: tergite II with spine combs anteriorly; tergites III and IV with eight recurved hooks posteriorly; last tergite small, with spine field anteriorly;

caudal sclerite with distinct terminal spines; sternites V and VI each with six hooks. Cocoon: boot-shaped, 4.6 mm long, 1.6 mm wide, 1.9 mm high; length of ventral lip 1.9 mm; opened at 45 degrees to base, lateral and posterodorsal edges well formed, anteroventral edge rough, with small fenestrae.

*Larvae.* Unknown.

*Bionomics.*— The pupa from which the adult was reared came from grass trailing in a small, rapidly flowing, open stream. Velocity was *ca.* 80 cm/s and temperature 29° C. *Simulium tahitiense* and *S. lotii* were taken from the same locality.

*Distribution.*— The subgenus *Hebridosimulium* was previously known only from Fiji and Vanuatu (=New Hebrides), where it is widely distributed. This new record from Tahiti, represents a range extension of some 3500 km.

*Phylogenetic Relationships.*— Dumbleton considered the simuliid from Fiji to represent a species separate from *S. jolyi* of Vanuatu (=New Hebrides). Crosskey (1974), on the other hand, maintained that *S. laciniatum* and *S. jolyi* were conspecific subspecies.

Since the morphological character state differences between adults and pupae of the taxa in *Hebridosimulium* are of the same nature as those which separate species within *Inseliellum* and which are corroborated karyologically (Rothfels *in* Craig, 1983), it seems logical to consider the three taxa in *Hebridosimulium* as species. Further, the great distances between the respective islands and likely lack of vicariant genetic interchange among their simuliid faunas for considerable time (*e.g.*, maximum six to 13 million years between Fiji and Vanuatu. Douth, 1981), adds weight to the probable specific status of these taxa. For the present, I hypothesize specific status for the Tahitian *Hebridosimulium*.

The discovery of a single specimen from a subgenus unexpected in Tahiti initially suggested that it was a contaminant from collections made either in Fiji or Vanuatu. However, *S. anaticum* is morphologically distinct from *S. jolyi* and *S. laciniatum*. The pupa of *S. anaticum* has only eight filaments, not ten, indicating that perhaps it is more closely related to the Fijian *S. laciniatum*. Further material from Tahiti, and detailed karyological and morphological examination of extensive collections in my possession from both Fiji and Vanuatu may help resolve this situation.

Rothfels (pers comm., 1986), commented that *S. anaticum* might be the cytospecies he had found on Tahiti and termed “forbidden” (*in* Craig, 1983). Apparently “forbidden” and *Hebridosimulium* had similar karyological characteristics.

#### Subgenus *Inseliellum* Rubtsov

*Inseliellum* Rubtsov, 1974: 275 (as genus). Type species: *Simulium oviceps* Edwards 1933, by original designation and monotypy (see Crosskey, 1987 for discussion).

*Simulium (Inseliellum)* Rubtsov. Craig and Craig, 1986: 357. Crosskey, 1987: 388.

Rubtsov (1974) did not provide a diagnosis for *Inseliellum* beyond stating that the characteristics were as given for *S. oviceps* by Grenier and Rageau (1960: 734–735). Since Craig (1975a, b; 1977; 1983), Crosskey (1987), and this work, show fairly conclusively that *Inseliellum* is not just restricted to *S. oviceps*, a more detailed diagnosis is provided.

*Diagnosis.*—

*Adult Female.* Cibarial pump: unarmed. Wing: basal section of radius haired. Thorax: scutum without conspicuous pattern; pleural membrane bare; katapisternum bare. Legs: fore tarsus slender, fore basitarsus five to seven times as long as its greatest width; calcipala, extended to 0.50 length of adjacent tarsomere; pedisulcus not prominent; claws with large basal tooth. Abdomen: covered with pale scales, semishining or dull on last few segments; sternite VII clearly developed. Genitalia: hypognial valves rounded or slightly angulate apically in lateral

view; anal lobes normal; cerci rounded to angulate; spermatheca with faint pattern, clear area at junction of sperm duct. Heterogametic.

*Description.*—

*Adult Male.* Upper eye: ommatidia not exceptionally enlarged, 12–22 rows. Thorax: scutum without bold pattern. Legs: hind basitarsus slightly dilated. Genitalia: gonostyles simple, tapered, with single substantial terminal spine; ventral plate not toothed, broadly subtriangular, with moderately well developed shoulders, basal arms short, directed anteriorly, rounded or angular; median sclerite simple, rod-shape; parameres long and slender.

*Pupa.* Gill: shorter than, or as long as, pupa; four to eight fine filaments, dorsal filaments variable, shorter than, or as long as others. Thorax: tubercles present or absent, rounded or pointed; trichomes simple; scutellum pointed or rounded dorsally. Abdomen: onchotaxy normal; tergites I and V bare, II–IV with hooks, VI–VIII with spine combs; terminal spines small to absent. Cocoon: slipper-shaped.

*Larva.* Head: margins from essentially parallel to strongly convex; antenna either shorter than labral fan stem or just longer; labral fans normal to strikingly reduced, rays variable, from normal numbers and shape, to reduced in number, and/or reduced in size to essentially absent; spot pattern ranging from positive to negative; frontoclypeal apotome variable in shape, from wide posteriorly, to narrow; apotome cuticle variable, ranging from normally smooth to strongly corrugated, and/or with raised sensillar sockets; sensilla number normal or very numerous; postgenal cleft variable, from broadly rounded to essentially absent; hypostoma variable, ranging from 12–15 apical teeth, with median and lateral teeth prominent and three sublateral teeth per side, or four or five sublateral teeth per side and only median tooth prominent, or no teeth prominent, or median tooth absent; hypostoma produced anteriorly normal amount, to strongly produced, four to eight hypostomal sensilla, normally lying in rows parallel to hypostomal edge, or tightly grouped; mandibles normal, to short and robust, serration various, from subequal sides, to one side half length of other, sides concave or flat, apex sharp; basal sensillum either on base of serration or on mandible. Abdomen: posterodorsal cuticle with small trichoid, bifid, trifid, or stellate sensilla; cuticle either smooth, tuberculate or with laterally elongate ovoid, low tubercles; general shape either normal, gradually increased and decreased in size, broadcast at segment VI or VII, or expanded abruptly ventrally at segment VI and abruptly posteriorly at segment VIII, or expanded abruptly laterally at segment VI and decreased gradually posteriorly; posteroventral tubercles present or absent. Anal papillae complex with secondary papillae, or one or all papillae simple. Rectal scales absent. Posterior circlet of hooks with 60–108 rows of 10–17 hooks.

*Bionomics.*— Eggs laid on rocks (Craig, 1983), or vegetation (Schröder, pers. comm., 1987). Larvae and pupae found on rocks or vegetation in a great variety of habitats, ranging from large, fast open rivers to small, densely-shaded streams; in trickles of water and in leaf packs on upstream surfaces of rocks (Craig and Craig, 1986).

*Geographic Distribution.*— Polynesia: Huahine, Marquesas, Moorea, Rarotonga, Raiatea, Tahiti (Craig, 1983; Craig and Craig, 1986; Séchan in Klein *et al.*, 1983). Possibly Micronesia: Guam, Palau, Truk (Crosskey, 1987).

*Phylogenetic Relationships.*— *Inseliellum* morphologically is close to *Eusimulium* and *Pomeroyellum* and is difficult to separate from those taxa. As Grenier and Rageau (1960) indicated, adult characteristics of Tahitian species of *Inseliellum* place it very close to *Eusimulium* Roubards as defined by Edwards. Edwards (1935) commented that the Tahitian and Marquesan simuliids formed a distinct subgroup within *Eusimulium*, but he did not state his basis for that comment. Under a scheme suggested by Freeman and de Mellion (1953), Grenier and Rageau (*loc. cit.*) suggested that the three then known Tahitian species belonged to Division A. Group I, of *Simulium*. They further comment that the Tahitian species cannot be placed in *Eusimulium* as defined (Rubtsov, 1956), because of lack of conical ventral tubercles in the larvae. However, these structures are present, although not as well developed as in *Eusimulium*. Edwards (1932) commented that the difference between typical *Eusimulium* species and Tahitian species is the latter's complete absence of hair on the upper surface of the Rs vein and eight pupal gill filaments. Edwards further noted that in these features they resembled Enderlein's *Gomphostibia*. He was not aware that some of the Marquesan species have the typical *Eusimulium* arrangement of four pupal gill filaments (Séchan in Klein *et al.*, 1983). Rubtsov (1974) states that *S. oviceps* and *S. tahitiense* have affinities with *Eusimulium*. Craig (1983) briefly considers the similarity of Polynesian Simuliidae to *Pomeroyellum* and the possibility that ancestral Polynesian simuliids may have entered the

Pacific from the West.

Because of the problem of indistinct morphological limits to the subgenera, the main feature that will probably establish monophyly of *Inseliellum* is karyological *i.e.*, heterogametic females. Establishing the sister taxon to *Inseliellum* for outgroup analysis for cladistic purposes will probably be difficult.

*Simulium (Inseliellum) cheesmanae* Edwards  
(Figs. 4, 11)

*Simulium cheesmanae* Edwards, 1927: 242. Lectotype female (by present designation), TAHITI. Edwards, 1935: 38. Smart, 1945: 502.

*Simulium (Inseliellum) cheesmanae* Edwards. Crosskey, 1987: 388.

*Types.*—

*Lectotype.* Female: pinned. By present designation; label data:- “Lectotype”, “Syntype”, “Society Is. Tahiti./ 8.3.25. E. Cheesman./ BM 1925-464”, “*Simulium cheesmanae* Edw. SYNTYPE ♀/ det. R.W. Crosskey 1979”, “*Simulium* (I.)/ *cheesmanae* /det /D.A. Craig 1986” (BMNH). Missing right antenna. Both wings with damaged anterior veins.

*Paralectotypes* – designated from syntypes. Female: pinned; head and genitalia cleared; in vial; same data as for lectotype, but date “5.5.25” (BMNH). Female: cleared; in vial; same data as for lectotype, but date “10.3.25” (BMNH). Male: cleared; in vial; label data:- “Matacia Aug 1928 A Tonnoir” (BMNH).

*Diagnosis.*—

Adult female: large; antennae and legs yellow.

*Description.*—

*Adult Female.* Body: generally dark brown; length 2.9–3.8 mm. Head: dark brown, with distinct areas pollinose; width 1.1 mm, depth 0.8 mm. Eyes: interocular distance slightly less than 0.33 width of clypeus; frontal angle, 95 degrees; ommatidia 0.023 mm in diameter, *ca.* 27 and 52 respectively, across and up eye in middle row. Vertex: dark brown ventrally to frons, regions adjacent to eyes silvery-pollinose extended down between antennae; vestiture of sparse golden hairs. Clypeus: as long as wide; silvery-pollinose. Post-ocular hairs: barely extended anteriorly to eye margin. Antenna: length 0.71 mm; dark yellow, lighter basally. Mouthparts: length less than 0.33 head depth; mandibles insubstantial, with only fine apical serrations; lacinia with *ca.* 26 pronounced, pigmented retrorse teeth; palpus, 0.8 mm long, distal article 0.4 mm long; third article with distal medial angle distinct, sensory vesicle occupying 0.33 width of third article, 0.50 width of vesicle, *ca.* 10–14 sensilla sockets barely visible. Cibarial pump: space between proximal arms slightly less than twice as wide as deep, rounded with slight medial projection. Thorax: dark brown to black; length 1.6–1.8 mm; postpronotal lobes distinct with broadly rounded anterolateral margins, slightly pollinose in dorsal view; scutum uniformly very dark brown, faint vittae in some views; scutellum and postnotum concolourous with scutum; scutellum subshiny, with hairs on posterior edge directed anteriorly; postnotum prominent, pollinose in some views; pleuron light brown. Wing: length 3.7–4.2 mm, maximum width 1.4–1.9 mm; basal cross veins dark brown; stem vein yellow, hair tuft black. Halter: yellow. Legs: generally yellow, fore- and meso-tarsi dark brown; metabasitarsus and distal metatarsomere dark brown to black, distal region of metatibia darker; pretarsal claw, smoothly curved with moderately sharp apex, prominent basal tooth slightly longer than 0.50 length of claw. Abdomen: generally dark brown; basal fringe of golden hairs extended to abdominal segment III; tergites I–V with sparse golden hairs, remainder of tergites slightly pollinose under denser golden hairs; pleural and sternal regions greyish. Genitalia (Fig. 4): cercus, blunt apically in ventral view, narrow basally; anal lobe twice as broad as long; hypogynial valves very broad, median edges virtually straight, extended well over anal lobe; genital fork stem smooth and narrow, slightly wider anteriorly, lateral arms broad and smooth, lateral sclerite triangular, anterior apex forming 90°; sternite VIII slightly sclerotized for full width with median rectangular region more heavily sclerotized. Spermatheca: slightly ovoid; heavily pigmented; no reticulate pattern; unpigmented region at junction of sperm duct normal.

*Adult Male* (Single Specimen). Body: generally brownish-black; length 3.1 mm. Head: width 1.3 mm, depth 0.9 mm. Eyes: upper ommatidia orangey-red; 0.068 mm in diameter, 13 and 15 respectively up and across the eye; lower ommatidia dark brownish-red, 0.025 mm in diameter. Frons: slightly more than 0.33 head width; dark black-brown, slightly pollinose. Clypeus: dark brown; 0.20 as wide as head. Antenna: length 0.7 mm; scape, pedicel and basal portion of first flagellomere yellowish, remainder light brown; first flagellomere as long as scape and pedicel; whole antenna slender in appearance. Mouthparts: very short, 0.16–0.20 as long as head depth; mandibles possibly absent; lacinia without retrorse teeth, apex hairy; palpus 0.69 mm long, apical article 0.35 mm in length, sensory vesicle in third article 0.33 as wide as article, opening

0.33 as wide as vesicle, ca. 10 sensilla sockets visible. Cibarial pump: space between proximal arms deeply U-shaped, with smooth edge. Thorax: length 1.1 mm; postpronotal lobe with vestiture of golden scales; scutum uniformly black, vestiture as for postpronotal lobe; scutellum and postscutellum concolourous with scutum; scutellum with sparse black hairs, otherwise bare. Wing: length 2.7 mm, maximum width 1.3 mm. Halter: yellowish. Legs: yellowish-brown; vestiture of dense yellowish-brown hairs; hind leg with femur 3.0 times longer than greatest width, tibia 3.3 times longer than width; pretarsal claw with ca. 22 grappling hooks. Abdomen: dark brown with pilose areas; basal fringe of long golden hairs extended to abdominal segment III. Genitalia (Fig. 11): gonocoxa approximately twice as long as maximum width; gonostylus ca. 0.33 as wide as long, slightly curved with one blunt terminal spine, slightly longer than wide; ventral plate extensively haired medially, cone-shaped posteriorly, posterolaterally concave, anterior arms concave anteromedially, anteromedian notch broad.

*Pupa.* Unknown.

*Larva.* Unknown.

*Bionomics.*— The females of this species are the largest of the Tahitian simuliids. Although J. L. Gressitt (label data) has taken specimens of *S. cheesmanae* at higher altitudes in Malaise traps, adults are also collected at lower altitudes flying around humans, where the simuliids are very conspicuous because of their colour. The largest specimen ever taken was probing the skin of a man's neck. The substantial teeth on the laciniae indicate that the females may be capable of blood feeding. It is possible that this is the species which gave rise to the intriguing, older reports of Tahitian simuliids feeding on humans (Edwards, 1927; Cheesman, 1932).

*Phylogenetic relationships.*— Although Grenier and Rageau (1960) suggested that the immature stages of the species named later herein as *S. lotii*, might be those of *S. cheesmanae*, this is clearly not so since all stages of *S. lotii* have been associated. Furthermore, individuals of *S. lotii* are amongst the smallest of Tahitian simuliids. It is interesting that no *S. cheesmanae* adults were obtained from the many pupae reared during this study. Large larvae, distinct from those of *S. tahitiense*, the next largest Tahitian simuliid, have not been found. This suggests that *S. cheesmanae* either occurs at very low frequencies and the adults are concentrated by their host-seeking behaviour around man, or they have an unusual habitat yet to be discovered, or both. The male is assumed to be that of *S. cheesmanae* because of its association with females of that species and because of its large size.

*Material Examined.*— In addition to types, I have seen the following:

*Tahiti.* 03-viii-25, L.E. Cheesman (1 ♀, BMNH); 05-viii-25, L.E. Cheesman (1 ♀, BMNH); 00-i-68, J.C. Hitchcock (10 ♀, USNM).

*Papeete*, Fautaa (sic.) V. alt. 1000', 23-viii-28, A.M. Adamson (1 ♀, BPBM); Fautaua V. alt. 1500', 11-xi-28, A.M. Adamson (1 ♀, BPBM); Mt. Aorai. alt. 4000–5000', 16-ix-34, E.C. Zimmerman (1 ♀, BPBM); Fare Rau Apa. 00-i-60, N.L.H. Krauss (1 ♀, BPBM); Fautaua V. alt. 25 m, 5/11-vii-61, J.L. Gressitt (1 ♀, BPBM); NW. ridge, Mt. Aorai. alt. 1400–1450 m, 10-vii-61, J.L. Gressitt (1 ♀, 1 ♂, BPBM); Fautaua R., Bain Loti. 17° 33' 15" S. 149° 33' 00" W. 08-vii-80, D.A. & R.E.G. Craig (1 ♀, CNCI); Fautaua R., Papeete. 17° 35' 30" S. 149° 31' 42" W. 1-vii-81, D.A. Craig (1 ♀, MNHP).

*Faaa*, Papearii. alt. 600', 09-xi-28, A.M. Adamson (1 ♀, BPBM); Tipaerui V (= V. de la Reine), 17° 33' 20" S. 149° 25' 45" W. 12-ix-28, A.M. Adamson (1 ♀, BPBM).

*Papenoo*, Papenoo V. 17° 36' 22" S. 149° 25' 08" W. 25-x-28, A.M. Adamson (1 ♀, BPBM); Papenoo V., 13-ii-61, N.L.H. Krauss (1 ♀, USNM).

*Papara*, Papara V. (?=Taharuu V), alt. 750', 21-xii-28, A.M. Adamson (1 ♀, BPBM); Mumford & Adamson (1 ♀, BMNH).

#### *malardei* - group

*Diagnosis.*—

*Pupa:* thoracic tubercles, present or absent, if present rounded.

*Larva:* hypostomal sublateral teeth, four or less; paralateral teeth, two or more; posterior abdominal segments with dorsal tubercles.

This group may eventually include some of the Marquesan simuliids.



*Included taxa.*— *Simulium teruamanga* Craig and Craig (Craig and Craig, 1986); RARATONGA: *Simulium malardei* n. sp.; TAHITI.

*Simulium (Inseliellum) malardei* n. sp.  
(Figs. 14, 22, 40, 51, 59)

*Simulium* "new". Craig, 1983: 534.

*Types.*—

*Holotype.* Larva: last instar; in alcohol; label data:—"Holotype", "*S. malardei*", "Tiarei, west of Trou du Souffleur, 17° 31' 30" S. 149° 23' 32" W./ alt. 10m, 17-ii-87, D.A. Craig" (MNHP).

*Paratypes.* Male: reared; pinned; with pupal exuviae and cocoon as subsidiary material; cleared, in vial; label data:—"Paratype", "*Simulium* (I.)/ *malardei* Craig/det./ D.A. Craig 1986", "TAHITI, Tahiti-iti, Tautira, /E. trib. Vaitepiha R.,/ 17° 46' 58" S. 149° 10' 39" W./ alt. 50m, 17-ii-83,/ D.A. Craig. Stat. #61" (MNHP). Female: reared; pinned; with pupal exuviae and cocoon as subsidiary material; label data:— as for male (MNHP). Pupa: label data:—"Paratype", "*Simulium* (I.)/ *malardei* Craig/ det./ D.A. Craig 1986", "Tahiti-iti, Tautira, E. trib. Vaitepiha R.,/ 17° 46' 30" S. 149° 10' 20" W. alt. 50m,/ 19-vii-80, D.A. Craig." (1, MNHP). Larva: as slide mount; label data:—"Paratype", "*Simulium* (I.)/ *malardei* Craig/ det./ D.A. Craig 1986", "Tahiti-iti, Plateau de Taravao, Trib. Vaitepahua R., 17° 46' 25" S. 149° 15' 26" W./ alt. 640m, 10-vii-73,/ D.A. Craig" (CNCI). Larva: as slide mount; label data:—"Paratype", "*Simulium* (I.)/ *malardei* Craig/ det./ D.A. Craig 1986", "Tahiti-iti, Tautira, E. trib. Vaitepiha R.,/ 17° 46' 30" S. 149° 10' 20" W. alt. 50m,/ 19-vii-80, D.A. & R.E.G. Craig. Stat. #12" (BMNH). Larva: last instar; as slide mount; label data:—"Paratype", "*Simulium* (I.)/ *malardei* Craig/ det./ D.A. Craig 1986", "Tahiti-iti, Tapuaemaui, Fanaa R.,/ 17° 47' 20" S. 149° 17' 25" W. 15-ii-1984, P. Schröder." (BMNH). Larva: last instar; as slide mount; label data:—"Paratype", "*S. malardei*", "Tahiti-iti, Tautira, E. trib. Vaitepiha R.,/ 17° 46' 58" S. 149° 10' 39" W./ alt. 50m, 02-vii-81,/ D.A. & R.E.G. Craig" (MNHP).

Larvae: in alcohol; label data:—"Paratype", "*Simulium* (I.)/ *malardei* Craig/ det./ D.A. Craig 1986", "Tahiti-iti, Plateau de Taravao, Trib. Vaitepahua R.,/ 17° 46' 25" S. 149° 15' 26" W. 10-vii-73,/ alt. 640m, D.A. & R.E.G. Craig" (9, BMNH; 8, MNHP). Larvae: penultimate instar; label data:—"Paratype", "*Simulium* (I.)/ *malardei* Craig/ det./ D.A. Craig 1986", "Tahiti-iti, Tautira, E. trib. Vaitepiha R.,/ 17° 46' 30" S. 149° 10' 20" W./ alt. 50m, 19-vii-80, D.A. Craig" (3, CNCI; 1 MNHP). Larvae: penultimate; label data:—"Tiarei, immediately west of Trou du Souffleur, 17° 31' 30" S. 149° 23' 32" W. alt. 10m, 17-ii-87,/ D.A.C." (3, BMNH; 3, BPBM; 3, CNCI; 4, MNHP; 3 UASM; 3, USNM).

*Specific epithet.*— Because of the probable phylogenetic importance of this species, it is named in honour of the Institut Territorial de Recherches Medicales "Louis Malardé", Papeete, Tahiti. The personnel of this institute and that of ORSTOM, Papeete, provided assistance without which this study would not have been completed.

*Diagnosis.*—

Pupa: dorsal gill filaments long; thoracic tubercles absent. Larva: hypostoma with three sublateral teeth per side only.

*Description.*—

*Adult Female.* Unknown.

*Adult Male* (single reared specimen). Body: generally blackish-brown; length 0.8 mm. Head: width 0.8 mm, depth 0.6 mm. Eyes: upper ommatidia 0.03 mm in diameter, 18 and 22 respectively across and up eye; lower ommatidia, 0.01 mm in diameter. Clypeus: 0.20 as wide as head. Antenna: length 0.7 mm. Mouthparts: 0.25 length of head depth; mandibles slender, with apical hairs only; lacinia short with small retrorse teeth; palpus 0.7 mm long, distal article 0.3 mm, sensory vesicle spherical, occupying only 0.50 of width of third palpal article, opening less than 0.33 width of vesicle, ca. 10 sensillar sockets visible. Thorax: length 0.7 mm; scutum evenly jet black; postpronotal lobe lighter, vestiture of even silver-golden scales; scutellum broadly cone-shaped with obtuse angle, vestiture of long pale hairs crossing at midline; postscutellum light brown; pleuron brown; anepisternal membrane pale. Wing: length 1.7 mm, maximum width 0.6 mm; stem vein hair tuft small, but distinct; basicostal vein with distinct black hairs. Halter: white. Legs: generally brown; pretarsal claw smooth, basal tooth clear, 0.33 as long as claw, ca. 24 grappling hooks on each claw. Abdomen: generally dark brown; basal fringe of brown hairs extended to abdominal segment III; tergite II pale medially, light brown laterally, other tergites evenly brown. Genitalia (Fig. 14): gonocoxa 2.0 times as long as basal width; gonostylus ca. 2.5 times as long as basal width, terminal spine prominent; ventral plate heart-shaped, bare, anterior arms robust and heavily pigmented, medial notch shallow.

*Pupa.* (From above male, and one fully developed pharate pupa.). Length: 2.0 mm. Gill: 1.4 mm in length; branching pattern typical; eight slender filaments, subequal in length. Thorax: tubercles absent; cuticle straw coloured and shiny. Abdomen: tergite I bare, with lateral pigment patches; tergite II with small hooks; tergites III and IV with substantial hooks; tergite V bare; tergites VI–VIII with small hooks in single row; sternite III bare; sternites IV–VII with four equally

spaced hooks; caudal spines very short.

*Larva.* Last instar with dark pupal gills; length 5.7 mm. Body: light brownish-grey with creamy intersegmental regions. Head capsule (Fig. 31): broadest at stemmata, narrowing posteriorly, but not conspicuously so; generally pale in colour; frontoclypeal apotome broadest posteriorly; head-spots colour pattern positive, but faint; anteromedian, anterolateral and posteromedian spots fused, posterolateral spot faint; sensilla number normal; cervical sclerites distinct, but partially fused to postocciput. Stemmata: surrounded by clear area, extended posterodorsally to ecdysial suture. Antenna: extended well beyond labral fan stem, total length 0.39 mm, distal article 0.12 mm, annulation between basal and medial articles insubstantial. Labral fans: with 29 rays, ca. 0.73 mm in length; six or seven medial rays shorter and less robust; microtrichia of median rays 1.1 times as long as ray width, no microtrichial pattern (Fig. 59). Hypostoma (Fig. 40): heavily pigmented; median tooth slightly shorter than lateral teeth; three sublateral teeth per side; lateral teeth prominent; one to two paralateral teeth; six to seven lateral serrations per side; hypostomal sensilla, five per side in row. Postgenal cleft: squarish, 1.3 times as wide as deep, rough anteriorly. Postgenal bridge: 1.3 times as long as cleft (Fig. 31). Mandible: apex (Fig. 51) with 10–11 spinous teeth between apical teeth and mandibular serration; distance between serration and spinous teeth as long as width of serration base; serration higher than width as base, anterior edge twice as long as posterior, concave; basal sensillum 0.50–0.33 length of serration, on distinct base. Maxillary palpus: 2.8 times as long as width at base. Mandibular phragma: extended ventrad to 0.50 depth maxillae base. Abdomen: segments increased gradual in size to segment V, then to maximum size, but not suddenly (Fig. 22); posterodorsal cuticle with evenly spaced spine-like tubercles, trichoid and trifold sensilla, 4.5  $\mu\text{m}$  and 3.1  $\mu\text{m}$  long respectively; terga VI with two anterodorsal tubercles (Fig. 22); smaller tubercles on anterior segments (absent from earlier instars); posteroventral tubercles very small. Anal sclerite: with posteroventral arms 2.0 times longer than dorsolateral arms; lateral accessory sclerite consisting of two groups of semifused sclerites, dorsal group larger, or posteroventral arms extended almost around anal proleg. Circling of hooks: 60 rows of hooks, 14 hooks per row. Anal papillae simple (Fig. 22).

*Bionomics.*— All material known is from vegetation in small, densely shaded streams and trickles of water. At the Vaitepiha R. site, particulate material in the water was 0.6 mg/L. Noticeable was that the water was clear even during heavy rain.

*Phylogenetic Relationships.*— *Simulium malardei* is the only Tahitian simuliid possessing six sublateral hypostomal teeth in the larva. This plesiomorphic character state resembles that of the Marquesas Island simuliids (Séchan *in* Klein *et al.*, 1983). Tubercles on the posterodorsal abdomen of the larvae is a character state shared with larvae of the Rarotongan *S. teruamanga* (Craig and Craig, 1986).

*Material Examined.*— In addition to types I have seen the following:

*Tiarei*, immediately west Trou du Souffleur, 17° 31' 30" S. 149° 23' 32" W. alt. 10m., 17-ii-87, D.A. Craig (6 early instar larvae, DAC).

#### *opunohuense* - group

*Diagnosis.*—

*Pupa:* thoracic tubercles absent; gill with dorsal filaments shorter than others.

*Larva:* generally pale; hypostomal median tooth prominent, others not; postgenal cleft squarish; anal papillae simple.

*Included taxa.*— *Simulium lotii* n. sp. TAHITI; *Simulium opunohuense* n. sp. MOOREA.

#### *Simulium (Inseliellum) lotii* n. sp.

(Figs. 6, 13, 30, 39, 50)

*Simulium* sp. ? *cheesmanae* Edwards. Grenier and Rageau, 1960: 733; Grenier and Rageau, 1961b: 174.

*Simulium* sp. Craig, 1975a: 470.

*Simulium* sp. "light". Craig, 1983: 534. Schröder, 1985: 5.

*Types.*— A larva has been chosen as the holotype because definitive association of stages was difficult. The holotype comes from Bain Loti, where morphologically identical specimens are karyologically distinct from sympatric species (Rothfels *in* Craig, 1983).

*Holotype.* Larva: last instar; slide mount; label data:— "Holotype", "*Simulium* (I.)/ *lotii* Craig/ Tahiti, Papeete, Fautaua R., Bain Loti, / 17° 33' 15" S. 149° 33' 00" W. / 11-vii-80,

D.A. & R.E.G. Craig.” (MNHP).

*Paratypes.* The reared adults chosen as paratypes have associated pupal exuviae closely matching pharate pupal material taken from last instar larvae. However, there is a possibility that some of these specimens could be of *S. exasperans*.

Female: pinned; reared; with pupal exuviae and cocoon as subsidiary material; head and genitalia in vial; label data:- “Paratype”, “*Simulium* (I.)/ *lotii* Craig/det./ D.A. Craig 1986”, “Tahiti, Papeete, Fautaua R./ Bain Loti/ 17° 33' 15" S. 149° 33' 00" W. / 08-vii-80,/ D.A. & R.E.G. Craig. Stat. #2” (MNHP). Female: pinned; reared; with pupal exuviae and cocoon as subsidiary material; genitalia in vial; label data:- “Paratype”, “*Simulium* (I.)/ *lotii* Craig/det./ D.A. Craig 1986”, “Tahiti, Tiarei, Fareteuira R./ Cascades de Faarumai,/ 17° 32' 10" S. 149° 23' 48" W./ 21-vii-80,/ D.A. & R.E.G. Craig. Stat. #15” (BMNH). Male: pinned; reared; with pupal exuviae and cocoon as subsidiary material; label data:- “Paratype”, “*Simulium* (I.)/ *lotii* Craig/ det./ D.A. Craig 1986”, “Tahiti, Mataiea, Vaihira R./ 17° 41' 31" S. 149° 25' 02" W./ alt. 250m. 17-vii-80,/ D.A. & R.E.G. Craig. Stat. #11” (MNHP).

Alcohol material: karyotyped larval remains; label data:- “Paratype”, “*Simulium* (I.)/ *lotii* Craig/ det./ D.A. Craig 1986”, “Tahiti, Papeete, Fautaua R./ Bain Loti,/ 17° 33' 15" S. 149° 33' 00" W./ 8-vii-80,/ D.A. & R.E.G. Craig. Stat. #2” (4, MNHP). Karyotyped larval remains; label data:- as above, but date “11-vii-80/ Stat. #5” (3, BMNH; 4, CNCI). Larvae: label data:- “Paratype”, “*Simulium* (I.)/ *lotii* Craig/ det./ D.A. Craig 1986”, “Tahiti, Paea, Aoua St., 20-vi-73, D.A. Craig.” (5, CNCI). Pupa & larvae: label data:- “Paratype”, “*Simulium* (I.)/ *lotii* Craig/ det./ D.A. Craig 1986”, “Tahiti, Papeete, Fautaua R., Bain Loti, 17° 33' 15" S. 149° 33' 00" W. alt. 92m. 15-vii-74, D.A. & R.E.G. Craig” (1 pupa, 3 larvae, DSIR). Larvae: label data:- “Paratype”, “*Simulium* (I.)/ *lotii* Craig/ det./ D.A. Craig 1986”, “Tahiti, Papeete, Fautaua R., Bain Loti, 14-iv-61, J.N. Belkin” (6, USNM). Larva: label data:- “Paratype”, “*Simulium* (I.)/ *lotii* Craig/ det./ D.A. Craig 1986”, “Tahiti, Haapape, Tuauru R./ 17° 32' 10" S. 149° 29' 15" W. alt. 60m. 09-vii-80/ D.A. & R.E.G. Craig. Stat. #3.” (1, UASM).

*Specific epithet.*— In reference to “Bain Loti”, a pool in the Fautaua River, where this species was first collected. This pool is well known in Tahiti because of the famous French writer and traveller, Pierre Loti. In “Marriage of Loti” (Loti, 1887), “Loti” spent many hours dallying in a pool (now Bain Loti) of the Fautaua River with his beautiful young bride Rarahu.

*Diagnosis.*—

*Larvae:* small; pale; head spot pattern positive, spots lightly fused.

*Description.*—

*Adult Female.* Body: generally black; length 1.6 mm. Head: black; width 0.6 mm, depth 0.4 mm. Eyes: dark grey; interocular distance 0.50 width of clypeus; frontal angle, 88 degrees; ommatidia 0.013 mm in diameter, *ca.* 27 and 37 respectively across and up eye in middle row. Vertex and frons: subshiny, black, slightly pilose. Clypeus: 0.25 head width; concolourous to slightly lighter than frons, slightly pilose with vestiture of sparse hairs. Antenna: length 0.4 mm; scape, pedicel and basal portion of first flagellomere lighter in colour than remainder. Mouthparts: length 0.50 head depth; mandibles shorter than labrum, with *ca.* 20 very fine teeth; lacinia with *ca.* 16 retrorse teeth; palpus 0.4 mm long, distal article 0.08 mm long, proximal article concolourous with clypeus, sensory vesicle occupying 0.50 width of third article, opening 0.50 width of vesicle, *ca.* 15 sensillar sockets visible. Cibarial pump: space between proximal arms U-shaped, as wide as deep, smooth. Thorax: length 0.3 mm; postpronotum brown, junction with scutum distinct; scutum uniformly black-brown, subshiny with vestiture of very sparse silver scales; scutellum pale yellow, vestiture of very sparse hairs, posterolateral edges slightly concave; postscutellum, concolourous with scutellum. Wing: length 1.7 mm, maximum width 0.7 mm; stem vein hair tuft not prominent. Halter: pale yellow. Legs: forelegs paler than others; pretarsal claw with basal tooth 0.50 length of claw. Abdomen: generally dark brownish-grey; basal fringe of insubstantial golden hairs extended back to abdominal segment II; tergites increasing in size posteriorly, subshiny; tergites VII and VIII with long dark hairs. Genitalia (Fig. 6): cercus, bluntly cone-shaped in ventral view; hypopygial valves divergent smoothly posteriorly, almost in contact distally, smoothly rounded apically; stem of genital fork long and thin, lateral sclerites triangular with acute anterior apex; sternite VIII medial pigmented area subrectangular. Spermatheca: slightly ovoid; no pattern; not strongly

pigmented; unpigmented area at junction of sperm duct normal.

*Adult Male.* Body: generally black; length 2.3 mm. Head: width 0.7 mm, depth 0.6 mm. Eyes: upper ommatidia 0.05 mm in diameter, 18 and 20 per row respectively, up and across eye; lower ommatidia 0.03 mm in diameter, 34 and 28 per row respectively, up and across eye. Clypeus: black; 0.25 as wide as head; vestiture of long black hairs. Antenna: uniformly dark grey; length 0.45 mm. Mouthparts: 0.66 length of head depth; labrium pale laterally; mandibles with *ca.* 20 fine teeth; lacinia with *ca.* 15 retrorse teeth; palpus, uniformly blackish-brown, 0.38 mm long, sensory vesicle occupying 0.50 width of third palpal article, opening less than 0.50 width of vesicle, *ca.* 15 sensillar sockets visible. Thorax: length 0.3 mm; scutum and postpronotum uniformly matt black, anterior vestiture of long golden scales; scutellum lighter than scutum, vestiture of dense black hairs; postscutellum black; pleuron dark brown. Wing: length 1.6 mm, maximum width 0.8 mm. Halter: dark grey. Legs: dark; pretarsal claw smoothly curved and slender, *ca.* 19 grappling hooks on each claw. Abdomen: black; basal fringe of long black hairs, extended to abdominal segment IV; tergites V–VI with pale areas laterally; sternites with yellowish-brown mottled area. Genitalia (Fig. 13): gonocoxa 2.3 times as long as basal width; gonostylus *ca.* 0.50 as wide as long, curved with one blunt terminal spine; ventral plate extensively haired, broadly rounded posteriorly, posterolateral edges concave, distinct lateral angle, anterior arms heavily pigmented, anteromedial area domed with deep medial incision.

*Pupa.* Length: 2.4 mm. Gill: length 1.6 mm; branching pattern normal, dorsal pair of filaments 0.50 length of contiguous pair; markedly varied, both same length, or one, or other shorter, length from 0.25–0.66 length of other contiguous pair, a few with one filament on that branch (*i.e.*, seven filaments in total). Thorax: tubercles absent; cuticle light brown, shiny. Abdomen: tergite I bare; tergite II with small hooks and trichoid sensilla; tergites III–IV with substantial hooks; tergite V bare; tergites VI–VIII with small hooks; tergite IX with field of small spines; sternites IV and V with two pairs of hooks; sternites VI and VII with hooks evenly spaced; caudal spines, small to absent.

*Larva.* Length: last instar with dark pharate pupal gills, 4.3–4.9 mm. Body: greyish-brown with pale intersegmental regions as broad as colour bands. Head capsule (Fig. 30): essentially parallel-sided; generally pale to light brown, variable; frontoclypeal apotome broadest at posterior, pale anteriorly, light brown posteriorly; spot pattern positive with anteromedian, anterolateral and posterolateral spots lightly fused; cervical sclerites distinct; sensilla, normal number. Antenna: longer than labral fan stem, distal article 0.1 mm, proximal articles 0.47 mm; basal article light brown. Labral fans: with 31–33 rays, *ca.* 1.1 mm in length, the six medial rays less substantial; microtrichia of medial rays 2.2 times longer than ray width; microtrichial pattern only on medial rays, with 6–7 small microtrichia interspersed with larger microtrichia. Hypostoma (Fig. 39): median tooth prominent; other teeth subequal in length, tips in straight line, four sublateral teeth per side, two paralateral teeth, three or four small lateral serrations and four to six hypostomal sensilla per side; lateral and paralateral teeth with tines. Postgenal cleft: squarish. Postgenal bridge: three times longer than cleft. Mandible: apex (Fig. 50) with nine to 10 spinous teeth; area between teeth and serrations as wide as serration base; serration as high as basal width, anterior edge 1.5 times longer than posterior edge, edges straight; sensillum small, not on serration. Maxillary palpus: 2.0 times as long as width at base. Mandibular phragma: extended ventrad to 0.50 depth of maxilla base. Abdomen: segments I–V increased slightly in size to VI, segment VII markedly larger, segment VIII largest; posteroventral tubercles almost absent; posterodorsal cuticle with low ovoid tubercles, and trichoid sensilla, 22.5  $\mu$ m long. Anal sclerite: posteroventral arms 2.0 times longer than dorsolateral arms; lateral accessory sclerite fused to posteroventral arm via narrow junction. Cirlet of hooks: 92 rows of hooks, 15–16 hooks per row. Anal papillae: simple.

*Bionomics.*— *Simulium lotii* is widespread on Tahiti and occurs with *S. tahitiense*, *S. exasperans* and *S. oviceps* in shaded, larger rivers and streams. There is a tendency for the larvae to be on vegetation (Schröder, 1985).

*Phylogenetic Relationships.*— This species was first recognised by Grenier and Rageau (1960) as *Simulium* sp. (= ? *cheesmanae*). Examination of their material (Craig, 1983), showed that it was conspecific with material described as *Simulium* sp. (Craig, 1975a) and material termed “light” by Craig (1983). The pupae, and female genitalia of material described here agree with the material described by Grenier and Rageau (1960) and which I have examined. However, the ventral plate of the male described here is more cone-shaped apically than that of the male described by Grenier and Rageau (*loc. cit.*). This leaves open the possibility of a misassociation either by Grenier and Rageau, or me, or, the presence of another species similar to *S. lotii*.

*Material Examined.*— In addition to the types, I have seen the following:

*Papeete*, Faataua (sic) R., Bain Loti, 17° 33' 15" S. 149° 33' 00" W. 00-ix-1954, 00-vi-1959, Grenier, P. and J. Rageau (slide material of pharate male, IP). 11-vii-74, D.A. & R.E.G. Craig (larvae in alcohol, BMNH; BPBM; CNCI; DSIR).

*Pirae*, Pirac R., undated material, Grenier, P. and J. Rageau. (slide material of pharate female, IP).

*Tiarei*, Fareteura R., Cascades de Faarumai, 17° 32' 10" S. 149° 23' 48" W. 21-vii-80, D.A. & R.E.G. Craig (1 ♀, 1 ♂, DSIR).

*Mataiea*, Vaihira R., 17° 41' 31" S. 149° 25' 02" W. alt. 250 m. 17-vii-80, D.A. & R.E.G. Craig (1 ♀, 1 ♂, BMNH; 1 ♂,

CNCI).

*Simulium (Inseliellum) opunohuense* n. sp.  
(Figs. 7, 33, 42, 54)

*Types.*—

*Holotype.* Larva: last instar; as slide mount; label data:— “Holotype”, “*Simulium* (I.) opunohuense Craig/ det./ Craig 1986”, “Polynesia, Moorea, /Opunohu V. Marae de Titiroa, 17° 32' 00" S. 149° 49' 40" W./26-ii-84, P. Schröder” (MNHP).

*Paratypes.* Larvae: Penultimate instars; as slide mounts; other earlier instars in alcohol; label data:— “Paratype”, “*Simulium* (I.) opunohuense Craig/ det./ Craig 1986”, “Polynesia, Moorea, Opunohu V.,/ nr. road leading to Pao Pao, 17° 31' 42" S. 149° 50' 00" W./26-ii-84, P. Schröder” (1 slide, 5 larvae, BMNH; 1 slide, 5 larvae, MNHP).

*Specific epithet.*— Named after the Opunohu Valley, Moorea, where the larvae and presumably the adult were found.

*Diagnosis.*—

*Female adult:* jet black; sternite VIII without median pigmented region. Larva: head spot pattern positive, spots separate; accessory sclerite of anal sclerite absent.

*Description.*—

*Adult Female* (single specimen, see Phylogenetic Relationships). Body: evenly jet black; length 2.5 mm. Head: width 0.6 mm, depth 0.5 mm. Eyes: interocular distance 0.33 width of clypeus; frontal angle 45 degrees; ommatidia 0.02 mm in diameter, ca. 26 and 36 respectively across and up eye in middle row. Clypeus: as wide as long, 0.20 as wide as head, densely pilose, vestiture of sparse golden hairs. Antenna: length 0.4 mm; scape and pedicel dark orangey-brown; flagellomeres dark. Mouthparts: length 0.33 head depth; mandibles as long as labrum, with ca. 14–16 small sharp teeth; lacinia as long as labrum, with ca. 24 very sharp retrorse teeth; palpus, 0.6 mm long, distal article 0.2 mm long, sensory vesicle elongate, occupying 0.50 length and 0.50 width of third article, opening 0.50 width of vesicle, ca. 50+ sensilla sockets visible. Cibarial pump: space between proximal arms U-shaped, 1.5 times wider than deep, smooth. Thorax: length 0.9 mm; postpronotal lobe slightly pilose; scutum evenly jet black, vestiture of sparse golden hairs, denser posteriorly; scutellum and post scutellum concolourous with scutum; scutellum with slightly concave sides, vestiture of long black hairs; postscutellum slightly pilose. Wing: length 2.0 mm, maximum width 0.9 mm; stem vein hair tuft insubstantial. Halter: dark yellow. Legs: dark with dense vestiture of fine yellow hairs; pretarsal claw very slender, basal tooth longer than 0.50 length of claw. Abdomen: evenly black; basal fringe of golden hairs extended back to abdominal segment II. Genitalia (Fig. 7): cercus in ventral view bluntly rounded; hypogynial valves diverging slightly then converging posteriorly, extended 0.50 way along anal lobe; stem of genital fork smooth thin, with angulate anterior apex, dark brown with pigment continuing posteriorly into fork; lateral sclerites sharply triangular, anterior apex forming acute angle; sternite VIII pigmented evenly over full width, slightly darker medially. Spermatheca: ovoid; slight reticulate pattern; not heavily pigmented; clear area at junction of sperm duct substantial.

*Adult Male.*— Unknown.

*Pupa.* (based on pharate pupal material from holotype larva). Gill: length 2.1 mm; eight filaments; branching pattern typical, two dorsal-most filaments equal in length, 0.50 length of other filaments. (Possibly variable; one filament shorter and one almost absent). Thorax: tubercles probably absent.

*Larva.* Last instar larva with dark pharate pupal gills; length 2.8–3.4 mm. Body: pale grey with narrow intersegmental regions. Head capsule (Fig. 33): generally pale to light brown; frontoclypeal apotome pale anteriorly, light brown posterolaterally; spot pattern positive, anteromedian and posteromedian spots fused, occasionally central spots surrounded by very light brown; cervical sclerites small, but distinct. Stemmata: with posterior light brown area. Head cuticle: essentially smooth, corrugated laterally; sensilla number normal. Antenna: longer than labral fan stem; distal, proximal articles and antennal base light brown. Labral fans: with 29 substantial and three insubstantial rays, ca. 0.73 mm. in length, darker than head; microtrichia of medial rays up to 2.0 times longer than ray width, pattern of seven or eight small microtrichia between larger ones. Hypostoma, postgenal cleft and bridge (Fig. 33, 42): essentially as for *S. tahitiense*; five hypostomal sensilla per side. Mandible: apex (Fig. 54) with eight spinous teeth; distance between spinous teeth and mandibular serration smaller than serration base width; serration as high as basal width, sharply pointed and with concave sides; lengths of anterior and posterior sides equal; sensillum peg-like. Maxillary palpus: 3.0 times as long as width at base. Mandibular phragma: extended ventrad to 0.33 depth of maxilla base. Abdomen: segments I–IV increased smoothly laterally to maximum size at segments V and VI; posteroventral tubercles very small; posterodorsal cuticle with ovoid scales with longitudinal striae, and with trichoid sensillae 6.9 µm long. Anal sclerite: posteroventral arms 1.5 times longer than dorsolateral arms; accessory sclerite absent. Circling of hooks: 81 rows of hooks, 14–16 hooks per row. Anal papillae:

simple.

*Bionomics*.— The holotype larva was collected from a small, heavily shaded rocky stream, the bottom of which was covered with red epilithic algae. The paratype larvae came from further downstream and were on trailing roots of trees. The water was 5 cm deep with velocity ca. 50 cm/s (P. Schröder, pers. comm., 1987).

*Phylogenetic Relationships*.— Larvae of *S. opunohuense* are morphologically very similar to those of *S. lotii*, differing mainly in the more distinct head spot pattern. However, the female adults of the two species differ in a number of characteristics, such as colour of body and legs, and shape and sclerotization of parts of the genitalia. Cytological examination will no doubt show these two taxa to be very closely related. The single adult collected by Puleston, while probably of *S. opunohuense*, was not included in the types series because the association to the immature stages was not definitive. The possibility remains that if this unique female has not been correctly associated, *S. opunohuense* may be conspecific with *S. lotii* and the adult is then that of an undescribed species.

*Material Examined*.— In addition to types I have seen the following:

FR. POLYNESIA, Opunohu Bay (word "Bay" crossed out), vii.6.1959, D.E. Puleston (♀ pinned; head and genitalia cleared and in vial, USNM).

#### *tahitiense* - group

*Diagnosis*.—

Pupa: scutellum bluntly pointed dorsally. Larva: body expanded rapidly ventrally at segment VI, decreased abruptly at segment VIII (Fig. 23); head spot pattern positive; margins of head capsule not markedly convex (Fig. 35).

*Included taxa*.— *S. tahitiense* Edwards, *S. exasperans* n. sp. and *Simulium* "IIS"; TAHITI.

#### *Simulium (Inseliellum) exasperans* n. sp. (Figs. 5, 12, 19, 49)

*Types*.—

*Holotype*. Female: pinned; reared; with pupal exuviae and cocoon as subsidiary material; label data:- "Holotype", "Simulium (I.)/ exasperans Craig", "Tahiti, Punaauia, Punaruu R., / 17° 38' 20" S. 149° 35' 05" W. / alt. 120m. 07-vii-80, / D.A. Craig. Stat. #1" (MNHP).

*Paratypes*. Adults: pinned; reared; with exuviae and cocoons as subsidiary material; label data as for holotype (2 ♂, BMNH; 1 ♂, BPBM; 1 ♀, 2 ♂, MNHP). Male: pinned; reared; with exuviae and cocoon as subsidiary material; label data:- "Paratype", "Simulium (I.)/ exasperans Craig", "Tahiti, Papeete, Fautaua R., Bain Loti, /08-vii-80, 17° 33' 15" S. 149° 33' 00" W. / D.A.Craig. Stat. #2" (1 ♂, MNHP). Females: pinned; reared; with exuviae and cocoons as subsidiary material; label data as for Bain Loti, but date as "11-vii-80.Stat. #5" (1 ♀ each, BMNH; BPBM; CNCI; MNHP). Male: slide mount; label data as for Bain Loti, but date:- "08-vii-1974" (DAC). Female: pinned; reared; with exuviae and cocoon as subsidiary material; label data:- "Tahiti, Tiarei, Fareteuira R., Cascades de Faarumai, /17° 32' 10" S. 149° 23' 48" W. / 21-vii-80, / D.A. & R.E.G. Craig. Stat. #15" (1 ♀, BMNH). Male and female: pinned; reared; with exuviae and cocoons as subsidiary material; label data:- "Tahiti-iti, Tautira, Vaitepiha R., /17° 46' 30" S. 149° 10' 21" W. / alt. 50m. 19-vii-80, / D.A. & R.E.G. Craig. Stat. #13" (1 ♀, 1 ♂, MNHP). Males and females: pinned; reared; with exuviae and

cocoons as subsidiary material; label data:- "Tahiti, Mataiea, Vaihiria R., / 17° 41' 31" S. 149° 25' 02" W. / alt. 250 m. 17-vii-80, /D.A. & R.E.G. Craig. Stat. #11" (2 ♀, 1 ♂, each BMNH; BPBM; CNCI; MNHP; 1 ♀, DSIR). Female: pinned; reared; with exuviae and cocoon as subsidiary material; label data:- "Tahiti, Mataiea, E. Lac Vaihiria, /17° 40' 58" S. 149° 24' 51" W. / alt. 430m. 22-vii-80, /D.A. & R.E.G. Craig. Stat. #16" (1 ♀, MNHP). The following material was previously identified as *S. tahitiense*. Female: pinned; reared; with exuviae and cocoon as subsidiary material; label data:- "Tahiti, Bains (sic) /Loti /April 14, 1961. /J.N. Belkin #35" (1 ♀, USNM). Female: pinned; reared; with exuviae and cocoon as subsidiary material; label data:- "Tahiti, Paea, / March 30 1961, /D.G. Basio #26" (1 ♀, USNM). Female: pinned; reared; with exuviae and cocoon as subsidiary material; label data:- "Tahiti, Paea, / April 2 1961, /J.N. Belkin #28" (1 ♀, USNM). Pupa: with larval exuviae; label data:- "Tahiti, Punaruu R., / 1969. B. Hocking" (MNHP). Larva: last instar; label data:- "Tahiti, Mataiea, Vaihiria R., / 17° 41' 31" S. 149° 25' 02" W. / alt. 250m. 17-vii-80, /D.A. & R.E.G. Craig" (BMNH). Pupal and larval material: as slide mounts; two last instar larvae; label data:- "Tahiti. Paea, Aoua St., /20-vi-73, D.A. Craig" (BMNH; MNHP). Alcohol material: Pharate adult; label data:- "Papeete, Fautaua R., Bain Loti, / 17° 33' 15" S. 149° 33' 00" W. / 08-vii-80, D.A. & R.E.G. Craig. Stat. #2" (CNCI). Larvae: label data:- "Tahiti, Paea, Aoua Str., /20-vi-73, D.A. Craig" (larvae, 2 pupae each BMNH; BPBM; MNHP; larvae, CNCI; DSIR; USNM). Larvae: label data:- "Tahiti, Paea, / 'Robinson's Place', /28-iii-61. J. N. Belkin" (5, USNM). Larvae and pupa: label data:- "Paea, Public Garden, / 03-vii-81, D.A. Craig" (6 larvae, BMNH; 5 larvae, 1 pupa, MNHP).

*Specific epithet.*— Based on the Latin word "exaspero", meaning "to irritate", in reference to the difficulty of associating the stages of this species.

*Diagnosis.*—

Pupa: thoracic tubercles absent; dorsal gill filaments long.

Larva: *tahitiense*-like, but anal papillae simple.

*Recognition.*— This species is very difficult to distinguish in all stages from both, *S. tahitiense* and *S. lotii*. Consequently, further work is needed to clarify the limits of the taxa. Adults of *S. tahitiense*, without the associated pupal exuviae, are virtually impossible to separate from *S. exasperans*. For this reason alone, reared adults are absolutely necessary for taxonomic studies on Tahitian simuliids.

*Description.*—

*Adult Female.* Body: generally blackish-brown; length 1.5–2.1 mm. Head: very dark brown; width 0.5 mm, depth 0.4 mm. Eyes: dark red; interocular distance 0.50 width of clypeus; frontal angle, 75 degrees; ommatidia 0.02 mm in diameter, *ca.* 24 and 26 respectively across and up eye in middle row. Post-ocular hairs black; extended to eye margin. Clypeus: 0.16 mm, lighter than frons, margins pilose, vestiture of sparse black hairs. Antenna: length 0.4 mm; scape, pedicel and anterior region of first flagellomere yellow, remaining flagellomeres dark brown. Mouthparts: length 0.4 times head depth; mandibles, as long as labrum, with *ca.* 21 teeth; lacinia with *ca.* 16 retrorse teeth; palpus, 0.4 mm long, distal article 0.13 mm long, proximal article concolourous with clypeus, remainder lighter, sensory vesicle occupying 0.50 width of third article, opening 0.50 width of vesicle, eight to 10 sensillar sockets visible. Cibarial pump: space between proximal arms flat, smooth, three times as wide as deep. Thorax: length 0.8–0.9 mm; scutum evenly very dark brown; postpronotal lobes with posterior margins lighter, sparse, even vestiture of silver-golden scales; scutellum cone-shaped, forming slightly obtuse angle, lateral margins straight, vestiture of sparse, long golden and black hairs; postscutellum, concolourous with scutum, pilose in some views; pleuron evenly dark brown. Wing: length 1.9–2.1 mm, maximum width 0.8–0.9 mm; stem vein hair tuft substantial; basicostal vein with dense black hairs. Halter: pale. Legs: as for *S. tahitiense*. Abdomen: evenly very dark brown; basal fringe of golden hairs extended back to posterior of abdominal segment II. Abdomen: tergites II–VII mottled with lighter markings; vestiture of very sparse golden scales, black on tergites VIII and IX; pleural and sternal regions pilose and greyish. Genitalia (Fig. 5): cercus pointed distally in ventral view; anal lobe curving smoothly medially; hypogynial valves diverging distally, but converging apically, very blunt, extended just to anal lobes; stem of genital fork thin, smooth, lateral sclerite with rounded angulate anterior apex and long thin posterior arm; sternite VIII with pigmented median region narrow posteriorly, expanded anteriorly. Spermatheca: ovoid; no pattern; not heavily pigmented;

clear area at junction of sperm duct normal.

*Adult Male.* Body: generally blackish-brown; length 1.6–1.7 mm. Head: width 0.6 mm, depth 0.5 mm. Eyes: upper ommatidia 0.09 mm in diameter, 16 and 18 per row respectively across and up the eye; lower ommatidia, 0.03 mm in diameter. Clypeus: 0.20 as wide as head; vestiture of sparse black hairs. Antenna: length 0.4 mm; evenly dark brown. Mouthparts: 0.33 length of head depth; mandibles very thin, no teeth, only fine apical hairs; lacinia with *ca.* 23 small retrorse teeth; palpus 0.4 mm long, distal article 0.2 mm, sensory vesicle spherical, occupying 0.66 of width of third palpal article, opening less than 0.50 width of vesicle, *ca.* 10 sensillar sockets visible. Thorax: length 0.6 mm; scutum evenly black; postpronotal lobes slightly lighter; scutellum lighter, pale posteriorly, vestiture of long black hairs crossing in midline; postscutellum dark brown, slightly pilose; pleuron brown. Wing: length 1.5–1.7 mm, maximum width 0.7–0.8 mm; stem vein hair tuft small, but distinct. Halter: brown. Legs: as for *S. tahitiense*. Abdomen: generally blackish-brown; basal fringe of black hairs extended to abdominal segment II; tergite II pale; III–VII mottled brown; VIII–X dark brown; tergites III, VI, VII in some views pilose laterally. Genitalia (Fig. 12): gonocoxa 2.0 times as long as basal width; gonostylus approximately 3.5 times longer than basal width, curved with one blunt terminal spine; ventral plate with broadly rounded apex posteriorly, concave posterolaterally, anterior arms angulate and strongly pigmented, anteromedial notch barely present; hairy region narrow in middle.

*Pupa.* Length 2.0–2.5 mm. Gill (Fig. 19): length 0.9–1.0 mm; branching as for *S. tahitiense*. Head and thoracic cuticle: without tubercles; cuticle straw coloured and shiny. Abdomen: tergites essentially as for *S. tahitiense*; tergite I without tubercles, but with small scales; tergite II without hooks, but with anteriorly directed short hairs; tergites III and IV hooks slender; those of tergites VI–IX small and in single rows; caudal spines essentially absent; sternites as for *S. tahitiense*.

*Larva.* Virtually indistinguishable from *S. tahitiense*. Head capsule: paler than *S. tahitiense*; to very pale (similar to *S. lotii*). Labral fans: with 29 rays (15s ray robust others finer), *ca.* 0.45 mm. in length; microtrichia of medial rays up to 1.6 times longer than ray width; no microtrichial pattern. Hypostoma: as for *S. tahitiense* (Fig. 44). Abdomen: posterior shape not as pronounced as for *S. tahitiense*; ventral tubercles not prominent; posterodorsal cuticle with laterally elongated and sharply pointed sculpting; trichoid sensilla 16.0  $\mu$ m. Anal sclerite: with posteroventral arms 2.0 times longer than dorsolateral arms. Cirlet of hooks: as for *S. tahitiense*. Anal papillae: simple.

*Bionomics.*— Larvae tend to be found on vegetation in well shaded, larger streams. In some situations it forms almost the complete population, *e.g.*, Aoua Stream, Paea, otherwise, it is found with *S. lotii*, *S. oviceps* and *S. tahitiense*.

*Phylogenetic Relationships.*— It is interesting that no karyological evidence of *S. exasperans* was detected by Rothfels (*in* Craig, 1983). However, this species may be cytospecies “IIS” which Rothfels (*loc. cit.*) found only on Tahiti-iti, but *S. exasperans* is also found extensively on Tahiti-nui. Association of stages of this species was particularly difficult. The connection between larval and pupal stages was eventually made via some pupae retaining their larval exuviae in the cocoon, and by partially ecdysed pharate adults.

*Material Examined.*— In addition to types, I have seen the following:

Alcohol material.

*Papeete*, Fautaua R., Bain Loti, 17° 33' 15" S. 149° 33' 00" W. 15-vii-74, (1 pupa, CNCI); 1-vii-81, (10 pupae, BMNH), D.A. & R.E.G. Craig.

*Papenoo*, Papenoo V., 22-x-28. 17° 36' 22" S. 149° 25' 08" W. A.M. Adamson (2 pupae, BPBM).

*Tiarei*, Onofea R., 17° 33' 30" S. 149° 23' 47" W. alt. 110m. 14-vii-80, D.A. & R.E.G. Craig (3 pupae, UASM)

*Mataatea*, Vaihiria R., 17° 41' 31" S. 149° 25' 02" W. alt. 250m. 17-vii-80, D.A. & R.E.G. Craig (4 pupae, BPBM).

*Tautira*, (Tahiti-iti), E. trib. Vaitepiha R., 17° 46' 30" S. 149° 15' 20" W. alt. 50m. 14-vii-80 (3 pupae, DSIR), 19-vii-80 (3 pupae, USNM), D.A. & R.E.G. Craig; E. trib. Vaitepiha R., 17° 46' 58" S. 149° 10' 39" W. alt. 50m. 02-vii-81. D.A. Craig (5 larvae, BPBM).

*Teahupoo*, (Tahiti-iti), Tiirahi R., 17° 51' 05" S. 149° 14' 15" W. 20-vii-80, D.A. & R.E.G. Craig (4 pupae, UASM).

*Tauemaui*, (Tahiti-iti), Fanaa R., 15-ii-84, P. Schröder (1 pupa, MNHP).

*Paea*, Public Gardens, 03-vii-81, D.A. Craig (larvae, DAC).

*Punaauia*, Punaruu R., 17° 38' 20" S. 149° 35' 05" W. alt. 120m. 27-iv-69, B.M. Hocking (1 pupa, UASM); 7-vi-80, D.A. & R.E.G. Craig (2 pupae, UASM); 17-vii-80, P. Schröder (5 pupae, MNHP).

### *Simulium (Inseliellum) tahitiense* Edwards

(Figs. 9, 16, 21, 23, 35, 44, 56, 65, 71-73)

*Simulium tahitiense* Edwards, 1927: 242. Lectotype female (by present designation), TAHITI. Edwards, 1935: 35. Smart, 1945: 242. Grenier and Rageau, 1960: 728. Grenier and Rageau, 1961b: 174. Rubtsov, 1974: 242, 244. Craig, 1975a: 468. Crosskey, 1981: 8. Craig, 1983: 534. Schröder, 1985: 17.



*Simulium (Inseliellum) tahitiense* Edwards. Crosskey, 1987: 388.

*Types.*—

*Lectotype.* Female: pinned; label data:- “Lectotype”, “Syntype”, “Tahiti. Tautira /9.viii.25 /Miss Cheesman B.M. 1925. 392”, “*Simulium tahitiense* Edw”, “*Simulium tahitiense* Edw /Syntype ♀, /det. R.W. Crosskey, 1979”, “*Simulium* (I) *tahitiense* Edw. /det./ D.A. Craig 1986” (BMNH).

*Paralectotype.* Female: pinned; label data:- as for lectotype (BMNH).

*Diagnosis.*—

Pupa: gill filaments long; thoracic tubercles rounded.

Larva: head spots positive; general body colour dark; anal papillae complex.

*Recognition.*— Larvae of this species are morphologically varied, particularly so in size, colour and shape of body. Some of the apparent variation may be due to the difficulty of, as yet, clearly separating the similar stages of *S. exasperans*.

*Description.*—

*Adult Female.* Body: generally dark brown; length 1.5–1.9 mm. Head: dark brown, slightly pollinose; width 0.71 mm, depth 0.55 mm. Eyes: interocular distance 0.50 width of clypeus; frontal angle, 90 degrees; ommatidia 0.012 mm in diameter, *ca.* 31 and 43 respectively, across and up eye in middle row. Vertex: dark brown. Frons and clypeus pilose; latter with sparse golden hairs. Clypeus: as long as wide; apex with small medial projection. Antenna: length 0.47 mm; scape, pedicel and proximal portion of first flagellomere lighter in colour than remainder. Mouthparts: length less than 0.50 head depth; mandibles as long as labrum, with 22 fine teeth; lacinia with *ca.* 21 retrorse teeth; palpus, 0.46 mm long, distal article 0.23 mm long, sensory vesicle spherical, occupying 0.50 width of third article, opening 0.50 width of vesicle, *ca.* 13 sensillar sockets visible. Cibarial pump: space between proximal arms U-shaped, smooth, as wide as deep. Thorax: dark brown, lightly pilose; length 1.1 mm; postpronotal lobe pollinose at junction with scutum (in dorsal view); scutum uniformly dark brown, vestiture of fine silver scales; scutellum pale brown, angle of posterior apex obtuse, sides slightly concave, vestiture of sparse black hairs; postnotum dark brown; pleuron medium brown. Wing: length 1.8–2.5 mm, maximum width 0.8–1.2 mm; stem vein hair tuft distinct; hairs on basicosta not prominent. Halter: pale gray. Legs: forecoxa concolourous with pleuron; trochanter, femur and most of tibia mottled yellow-brown; distal portion of tibia and tarsus dark brown; mid- and hind leg as for fore leg; hind basitarsus yellow with distal portion and tarsomeres mottled yellow and dark brown; pretarsal claw slender with sharp apex, basal tooth 0.50 length of claw, lying subparallel to claw. Abdomen: generally dark brown; basal fringe of golden hairs extended to segment II; tergites slightly pollinose, mottled, vestiture of dark hairs; posterior tergites subshining with sparse dark hairs; sternum pale gray. Genitalia (Fig. 9): cercus, in ventral view, slightly curved laterally, curved posteromedially; stem of genital fork, thin, smooth, lateral sclerite triangular with anterior apex forming acute angle, directed laterally, notched, or not; hypogynial valves slightly curved medially, broadly rounded posteriorly, extended to anal lobes; sternite VIII with ovoid median pigmented region. Spermatheca: slightly ovoid; not densely pigmented; no reticulation; unpigmented area at junction of sperm duct normal.

*Adult Male.* Body: generally dark brownish-black; length 1.6–1.9 mm. Head: width 0.5 mm, depth 0.4 mm. Eyes: upper ommatidia, 0.04 mm in diameter, 12 rows both up and across eye; lower ommatidia 0.1 mm in diameter. Clypeus: 0.20 as wide as head. Antenna: total length 0.3 mm. Mouthparts: 0.50 length of head depth; mandibles 0.33 length of labrum; lacinia as long as labrum, no retrorse teeth, apex hairy; palpus 0.4 mm long, distal article 0.2 mm, sensory vesicle spherical, occupying only 0.33 of width of third palpal article, opening 0.50 width of vesicle, *ca.* 10 sensillar sockets visible. Thorax: length 0.7 mm; postpronotal lobe pale; scutum evenly dark brown to black, vestiture of moderately long, golden scales; scutellum pale, slightly convex laterally, forming right angle at apex, vestiture of sparse, long black hairs; postscutellum dark brown; pleuron brown. Wing: length 1.4–1.6 mm, maximum width 0.6–0.7 mm; stem vein hair tuft small, but prominent. Halter: greyish brown. Legs: coxae brown, trochanter and portions of femur and tibia pale, banding distinct, vestiture of dense black hairs; pretarsal claw with *ca.* 23 grappling hooks on each claw. Abdomen: brown; vestiture of very sparse golden scales; basal fringe of pale hairs extended to abdominal segment II; tergites V–VII mottled. Genitalia (Fig. 16): gonocoxa 1.8 times as long as basal width; gonostylus approximately 2.5 times as long as basal width, single blunt terminal spine; ventral plate with median posterior apex rounded, slightly convex sides expanded laterally to broadly rounded angle, extended anteriorly to pigmented arms with rounded apices, anteromedially slightly domed, with broad medial notch, median hairy patch, slightly expanded anteriorly.

*Pupa.* Length: 1.8–2.4 mm male, 1.9–2.3 mm female. Gill (Fig. 21): length 0.8–1.2 mm male, 0.7–1.1 mm female; branching pattern typical, dorsal-most filament long, often reflexed posteriorly over thorax under cocoon. Thorax: cuticle light brown; tubercles rounded (Fig. 71–73); scutellum in lateral view with distinct blunt peak. Abdomen: tergite I bare, tergites II–IV with anteriorly directed hooks, tergite V bare, tergites VI–VIII with fine spine combs; sternites IV and V with hooks close to mid-line, those on sternites VI and VII more lateral, evenly spaced; caudal spines absent; terminal caudal sclerites, distinct, angular.

*Larva.* Last instar with dark pharate pupal gills; length 3.9–4.9 mm. Body: greyish with anterior intersegmental regions light, producing a banded appearance. Head capsule (Figs. 35, 65): generally dark brown to blackish; frontoclypeal

apotome pale anteriorly, very dark posteromedially; spot pattern generally positive, or posteromedian and posterolateral spot-two, negative, or concolorous with surrounding head cuticle; apotome with anterior pale area extended posteriorly along ecdysial line to posterolateral spot-one; cervical sclerites distinct. Stemmata: surrounded by small clear area, with, or without, curved anterodorsal mark. Head cuticle: corrugated transversely, bent, or not, around anteromedian head spots in form of U- or V- shaped mark anteriorly; sensilla number normal. Antenna: as long as labral fan stem, distal article 0.1 mm, proximal articles 0.2 mm. Labral fans: with 30–33 rays, ca. 0.45 mm in length; microtrichia of medial rays up to 1.4 times longer than ray width, no microtrichial pattern. Hypostoma (Fig. 44): median tooth protruded, other teeth in line sloped posterolaterally; five sublateral teeth per side; lateral tooth slightly higher and broader; one paralateral tooth; two to three lateral serrations; six to eight hypostomal sensilla per side. Postgenal cleft: wider than deep, squarish, with either flat or slightly bifurcate apex. Postgenal bridge: 2.3 times length of cleft (Fig. 35). Mandible: apex (Fig. 56) with nine to 11 spinous teeth; distance between spinous teeth and mandibular serration less than 0.50 width of serration base; serration as high as basal width; sensillum small and not on serration. Maxillary palpus: 3.0 times as long as width at base. Mandibular phragma: extended ventrad to 0.33 depth of maxilla base. Abdomen: segments increased gradually in size to segment V; segment VI markedly enlarged ventrally; at segment VIII size reduced sharply (Fig. 23); ventral tubercles placed laterally; posterodorsal cuticle with low, laterally ovoid tubercles and with trichoid sensilla, 9.2  $\mu$ m long. Anal sclerite: with posteroventral arms 3.0 times longer than dorsolateral arms; lateral accessory sclerite absent, but in darker specimens evident as lightly pigmented disc. Circlet of hooks: 123 rows of hooks, 21–23 hooks per row. Anal papillae: complex (Fig. 23).

**Bionomics.**— *Simulium tahitiense* is the most wide-spread species in Tahiti. Its larvae are found mainly in the larger rivers, in dense aggregations on and under large boulders in strong flow. If vegetation trails in high velocity water it usually supports large populations of *S. tahitiense* also. In the Papanoo Valley and elsewhere, the adults form dense swarms around humans and cause considerable nuisance although they do not bite. Larvae of the ephydrid *Apulvillus cheesmanae* Edwards (W. N. Mathis, pers. comm., 1983) are found with many of the larger aggregations of *Simulium tahitiense*. Although extremely slow moving there is a possibility that *A. cheesmanae* larvae are predaceous on the simuliid larvae. *S. tahitiense* larvae can be found in almost all the other simuliid habitats in Tahiti. In more shaded localities, such as at Bain Loti, it is associated with *S. lotii* and *S. exasperans* larvae, but its larvae prefer hard substrate to vegetation. Schröder (1985) provides details of the feeding behaviour of larvae of this species.

**Material Examined.**— In addition to types, I have seen the following:

- Papeete*, Fautaua R., Bain Loti, Tahiti, Bains (sic) Loti, April 14, 1961, J.N. Belkin #35 (4 ♀, USNM); 17° 33' 15" S. 149° 33' 00" W. alt. 92m, 11-vii-74 (larvae, DSIR; UASM), 15-vii-74 (larvae, UASM), 16-vii-74 (larvae, UASM), 07-vii-80 (larvae, CNCI), 08-vii-80 (1 ♂, CNCI; 2 ♀, DSIR), 11-vii-80 (5 ♀, 5 ♂, BMNH; 5 ♀, 5 ♂, BPBM; 1 ♀, 5 ♂, CNCI; 1 ♀, DSIR; 1 ♂, UASM; 6 ♀, 2 ♂, USNM; karyotyped larvae, BMNH, UASM; larvae, UASM) D.A. & R.E.G. Craig.
- Haapape*, Tuauru R., 17° 32' 10" S. 149° 29' 15" W. alt. 50m. 09-vii-80, D.A. & R.E.G. Craig (1 ♂, BMNH; 1 ♂, BPBM; larvae, DSIR; 2 ♂, UASM; 2 ♂, USNM). Papanoo, Papanoo R., 17° 33' 15" S. 149° 25' 50" W. 22-x-28, A.M. Adamson (1 ♂, BMNH); 17° 36' 52" S. 149° 24' 51" W. 10-vii-80, D.A. & R.E.G. Craig (1 ♀, DSIR; 1 ♀, 3 ♂, MNHP; 4 ♂, UASM; karyotyped larvae, BMNH).
- Tiarei*, Fareteuira R., Cascades de Faarumai, 17° 32' 10" S. 149° 23' 48" W. 14-vii-80, 21-vii-80, D.A. & R.E.G. Craig (larvae, UASM). Onofea R., 17° 33' 30" S. 149° 23' 47" W. alt. 110 m. 14-vii-80, D.A. & R.E.G. Craig (larvae, UASM).
- Mahaena*, Mahape R., 17° 34' 00" S. 149° 20' 33" W. alt. 700 m 14-vii-80, D.A. & R.E.G. Craig (karyotyped larvae, BMNH).
- Faaoe*, Utuofai R., 17° 39' 15" S. 149° 19' 00" W. 10-vii-73, D.A. & R.E.G. Craig (larvae, UASM).
- Tautira*, (Tahiti-iti), E. trib. Vaitepiha R., 17° 46' 30" S. 149° 15' 20" W. alt. 50 m. 19-vii-80, D.A. & R.E.G. Craig (1 ♀, 3 ♂, DSIR; larvae & pupae BMNH); Vaitepiha R., 17° 46' 30" S. 149° 10' 21" W. alt. 50m. 19-vii-80, D.A. & R.E.G. Craig. (3 ♀, CNCI; 1 ♂, DSIR; karyotyped larvae, BMNH; 1 ♂, larvae, UASM).
- Teahupoo*, (Tahiti-iti), Tiirahi R., 17° 51' 05" S. 149° 14' 15" W. 20-vii-80, D.A. & R.E.G. Craig (karyotyped larvae, BMNH; 3 ♀, 1 ♂, larvae, pupae, CNCI; 2 ♀, 2 ♂, larvae, pupae, DSIR; larvae and pupae UASM).
- Paea*, Ofaipapa, Robinson's Place, 02-iv-61, 28-iv-61, J.N. Belkin (larvae, USNM). Vaitiu R., 17° 34' 00" S. 149° 41' 22" W. 16-vii-74, D.A. & R.E.G. Craig (larvae, UASM).
- Mataiea*, Vaihiria R., (= Tahiria) 17° 44' 22" S. 149° 24' 15" W. alt. 80 m. 16-vii-80, (1 ♀, 1 ♂, DSIR; 1 ♀, larvae, UASM); 17° 41' 31" S. 149° 25' 02" W. alt. 250m. 17-vii-80, (1 ♀, larvae, pupae, BMNH; 1 ♀, 2 ♂, CNCI; 1 ♂, DSIR; 1 ♀, USNM; larvae, UASM), D.A. & R.E.G. Craig.
- Mahaiatea*, Taharuu R., 17° 42' 45" S. 149° 29' 15" W. alt. 135 m. 15-vii-80, D.A. & R.E.G. Craig (larvae, CNCI).
- Punaauia*, Punaruu R., 27-iv-1969, B. Hocking (larvae, UASM); 17° 38' 20" S. 149° 35' 40" W. 21-vi-73, 02-vii-73,

03-vii-73, 04-vii-73, (larvae, UASM); 17° 38' 20" S. 149° 35' 05" W. alt. 120m. 05-vii-73 (larvae, UASM), 06-vii-73 (larvae, UASM), 09-vii-73 (larvae, UASM), 05-vii-74 (larvae, UASM), 06-vii-74 (larvae, UASM), 08-vii-74 (larvae, UASM), 22-vii-74 (larvae, UASM), 07-vii-80 (2 ♂, BMNH; 1 ♀, MNHP; 1 ♀, 1 ♂, UASM) D.A. & R.E.G. Craig.

*Simulium* (*Inseliellum*). "IIS"

Larvae of this cytospecies as identified by Rothfels (*in* Craig, 1983), cannot be morphologically separated from larvae of *S. tahitiense*. Possibly these larvae will eventually be shown to be those of *S. exasperans* (Rothfels, pers. comm., 1986), however, "IIS" is known only from Tahiti-iti.

*Material Examined*.— *Tautira*, (Tahiti-iti), Vaitepiha R., 17° 46' 30" S. 149° 10' 21" W. alt. 50 m. 19-vii-80, D.A. & R.E.G. Craig (5 karyotyped early instar larvae as slide mounts, DAC).

*Remarks*.— The material was taken with *S. tahitiense* larvae.

*oviceps* - group

*Diagnosis*.—

*Pupa*: scutellum rounded dorsally; with or without tubercles, if present, pointed; gill with dorsal filaments shorter, or subequal in length to others.

*Larva*: labral fans reduced; ray number small, rays short to almost absent; head spot pattern partially or completely negative; head margins prominently convex; postgenal cleft small to absent; head sensilla number normal or greatly increased; hypostomal teeth variable, from medial and lateral teeth sharp and prominent, to all teeth rounded and subequal in length, to median tooth with adjacent sublateral teeth short, or median tooth absent; posterior abdomen expanded abruptly laterally at segment VI, decreased in size more gradually posteriorly, or shape more normal. Anal sclerite with posteroventral arms extended partway, or virtually completely around posterior proleg. Anal papillae simple, with at most, only small accessory basal papillae.

*Included taxa*.— *S. castaneum* n. sp.; RAIATEA. *S. admixtum* n. sp., *S. arlecchinum* n. sp., *S. cataractarum* n. sp., *S. mesodontium* n. sp., *S. neoviceps* n. sp., *S. oviceps* Edwards and *Simulium* sp.; TAHITI.

*Simulium* (*Inseliellum*) *admixtum* n. sp.

(Figs. 36, 45)

*Type*.—

*Holotype*. Larva: penultimate instar; as slide mount; label data:—"Holotype", "*Simulium* (I.) *admixtum* Craig/ det D.A. Craig 1986", "Tahiti, Tiarei, Fareteuira R./ Cascades de Faarumai, /17° 32' 10" S. 149° 23' 48" W. /16-ii-83, D.A. Craig" (MNHP).

*Specific epithet*.— Named after the Greek word "admixtus" meaning "mixed", in reference to the unique suite of characters possessed by the single larva.

*Diagnosis*.—

Larva: head; sensilla numerous; spot pattern negative; median hypostomal tooth lacking; abdomen; cuticle with numerous, low ovoid tubercles.

*Description*.—

*Adult Female*. Unknown.

*Adult Male*. Unknown.

*Pupa.* Unknown.

*Larva.* Single penultimate instar larva; length 5.2 mm. Body: generally greyish with indistinct intersegmental regions. Head capsule: margins strongly convex posteriorly, as for *S. cataractarum* (Fig. 29); background colour pale with apices of corrugations dark brown; frontoclypeal apotome lighter anteriorly, darker posteriorly; anteromedian and posteromedian head spots negative, but barely so, posterolateral spots concolourous with surrounding darker brown; cervical sclerites fused to postocciput by narrow junction; stemmata surrounded by dark brown anterodorsally, narrow oblique clear posterodorsal region; cuticle with numerous lateral corrugations dorsally and ventrally; sensilla numerous with raised and strongly pigmented sockets, producing rugose appearance. Antenna: length 0.4 mm, just longer than labral fan stem, distal article length 0.1 mm. Labral fans: with 26 rays, nine lateral rays less substantial, ca. 0.6 mm. in length; microtrichia of median rays 0.50 times as long as ray width, pattern of long microtrichia interspersed between eight to 10 smaller microtrichia. Hypostoma (Fig. 36): median tooth lacking, four sublateral teeth per side, increasing slightly in length laterally, lateral teeth prominent, one paralateral tooth with steep base down to four lateral serrations, six hypostomal sensilla in row per side. Postgenal cleft: very shallow, broadly U-shaped, 5.0 times wider than deep. Postgenal bridge: 4.0 times longer than cleft. Mandible: apex (Fig. 45) with seven to nine spinous teeth extended almost to mandibular serration; serration as high as basal width, anterior edge longer than posterior, sensillum virtually absent from one mandible, double on other. Maxillary palpus: 3.5 times as long as width at base. Mandibular phragma: heavily pigmented, extended ventrad to 0.33 depth of maxilla base. Abdomen: segments I-IV of similar size, gradually increased in size to segment VIII; posteroventral tubercles situated laterally and very small; posterodorsal cuticle with clear, low ovoid tubercles and with trichoid sensilla, 16.0  $\mu$ m long. Anal sclerite: with posteroventral arms 2.3 times longer than dorsolateral arms; pigment more distinct along anterior edges, sensillar sockets numerous and obvious. Circling of hooks: 91 rows of hooks, 18-20 hooks per row. Anal papillae: simple, but each with very small basal papilla.

*Bionomics.*— The single larva was collected from the sheet of water flowing down the vertical rock face on the western side of the Cascade de Vaimahuta (Cascades de Faarumai), along with larvae of *S. cataractarum*, *S. oviceps* and *S. neoviceps*. Water temperature was 17° C. This temperature is relatively cool for simuliid localities in Tahiti.

*Phylogenetic Relationships.*— This species is similar in many respects to *S. cataractarum* in possessing strongly convex head margins, negative spots, lateral teeth of hypostoma longer than remainder of teeth and fused cervical sclerites. Eventual cytological examination of this species will probably show a close relationship. However, lack of the median hypostomal tooth (Fig. 36), and possession of two mandibular serrations on one mandible (Fig. 45), are unique.

*Simulium (Inseliellum) arlecchinum* n. sp.

(Figs. 27, 46)

*Types.*—

*Holotype.* Larva: mature last instar as slide mount; thorax used for scanning electron microscopy; hypostoma damaged; label data:— “Holotype”, “*Simulium* (I.) *arlecchinum* Craig/det/ D.A. Craig 1986”, “Tahiti, Mataia, Vaihiria R.,/ 21-ii-84, P. Schröder” (MNHP).

*Paratypes.* Larvae: penultimate instars; as slide mounts; label data:— as for holotype (1, BMNH; 1, MNHP).

*Specific epithet.*— Based on the Italian word “arlecchino”, meaning “harlequin” - in reference to the distinctive colour pattern on the ventral surface of the abdomen of the larvae.

*Diagnosis.*—

Larva: colour pattern on frontoclypeal apotome H-shaped; lateral hypostomal teeth prominent; abdomen with triangular pattern ventrally.

*Description.*—*Adult Female.* Unknown.*Adult Male.* Unknown.

*Pupa.* (Based on pharate material from holotype larva). Gill: length 0.9 mm; branching pattern normal, dorsal-most filament more than half as long as other filaments. Thorax: tubercles absent.

*Larva.* Last instar with dark pharate pupal gills; length 4.2 mm. Body: greyish-brown with pale narrow intersegmental regions. Head capsule (Fig. 27): margins generally parallel-sided; generally light brown; frontoclypeal apotome with broad

pale bands along ecdysial sutures; anteromedian and posteromedian head spots negative, H-shaped brown region surrounding muscle spots, extreme posteromedian region darker; cervical sclerites distinct; cuticle essentially smooth, corrugations normal; sensilla number normal. Antenna: slightly longer than labral fan stem, distal article length 0.8 mm, proximal article length 0.19 mm. Labral fans: with *ca.* 18 normal rays, 0.56 mm. in length, plus 13 smaller, less robust rays; microtrichia of medial rays up to 1.3 times longer than ray width, no microtrichial pattern. Hypostoma: essentially as for *S. tahitiense* (Fig. 44), but sublateral teeth slightly more prominent; six to eight hypostomal sensilla in row per side. Postgenal cleft: twice as wide as deep, sloping to slightly rounded vertex. Postgenal bridge: 3.0 times longer than cleft. Mandible: apex (Fig. 46) with ten spinous teeth extended essentially to mandibular serration; serration as high as basal width; proximal sensillum 0.50 height of serration. Maxillary palpus: 2.5 times as long as width at base. Mandibular phragma: extended ventrad to dorsal edge of maxillary base. Abdomen: segments I–III with triangular and diagonal pattern on sterna, less distinct on terga; posterior abdominal shape as for *S. cataractarum*; posteroventral tubercles placed laterally and not obvious; posterodorsal cuticle with ovoid, scale-like tubercles and with trichoid sensilla, 4.0  $\mu$ m long. Anal sclerite: with posteroventral arms 1.4 times longer than dorsolateral arms; no lateral accessory sclerites. Circlet of hooks: 108 rows of hooks, 18–20 hooks per row. Anal papillae simple.

*Bionomics.*— Collected from grass trailing in the main stream of the unshaded, upper Vaihiria River, in fast, 5 cm deep water (P. Schröder, pers. comm., 1985).

*Phylogenetic Relationships.*— This species is placed in the *oviceps* - group on the basis of abdominal shape and negative head-spot pattern; however, head capsule and mouthpart structure are very similar to those of species in the *tahitiense* - group.

*Simulium (Inseliellum) castaneum* n. sp.

(Figs. 2, 28, 37, 47, 58, 60, 61)

*Types.*—

*Holotype.* Larva: slide mount; label data:- “Holotype”, “*Simulium* (I.)/ *castaneum* Craig”, “Society Islands, Raiatea, Temehani R., /1800”, 1-ix-77, S.L. Montgomery,/ Bishop Museum Acc. #1977.361”, “det. D.A. Craig 1986” (BPBM).

*Paratypes.* Adult: female; cleared and in vial; label data:- “*Simulium* (I.)/ *castaneum* Craig /det./ D. A. Craig 1986”, “SOCIETY IS/ Raiatea, Uturoa,/ 0-100 m, III.1971.”, “N.H.L. Krauss/ Collector/ BISHOP MUSEUM” (BPBM). Material in alcohol: one pupa, five last instar larvae, 10 penultimate larvae, twenty(+) earlier instar larvae; label data:- as for holotype (BPBM).

*Specific epithet.*— Based on the Greek word “castanea”, meaning “brown”, in reference to the generally even dark-brown of the larval head, labral fans, pupa and its cocoon.

*Diagnosis.*—

Larva: head uniformly dark brown; labral fan rays brown; hypostomal teeth very sharp.

*Description.*—

*Adult Female.* (From single specimen and immature pharate specimens). Body: generally black. Head: width 0.7 mm, depth 0.5 mm. Eyes: interocular distance 0.12 head width; frontal angle 86 degrees; ommatidia 0.01 mm in diameter, *ca.* 28 respectively across and up eye in middle row. Vertex: dark brown; vestiture of sparse dark brown hairs. Antennae: dark. Mouthparts: length, 0.33 head depth; mandibles, shorter than labrum, with *ca.* 14 minute teeth; lacinia with *ca.* 15–16 retrorse teeth; palpus, sensory vesicle 0.33 width of third article, opening 0.33 width of vesicle, *ca.* 10 sensillar sockets visible. Cibarial pump: space between proximal arms U-shaped, as wide as deep, smooth. Thorax: length 0.85 mm; scutum dark brown, shiny; scutellum lighter. Wing: length 1.7 mm, maximum width 0.8 mm. Legs: hind basitarsus parallel-sided, 7.5 times longer than wide; pretarsal claw smoothly curved with pointed apex, basal tooth 0.20 length of claw. Genitalia (Fig. 2): cercus bluntly cone-shaped in ventral view; hypogynial valves broadly rounded apically, extended to anal lobes, strongly diverged medially; stem of genital fork narrow, slightly swollen anteriorly, lateral triangular sclerites with blunt anterior apices; sternite VIII sclerotized medially, narrow posteriorly, widening anteriorly. Spermatheca: ovoid; pigmented; no pattern: clear area at junction of sperm duct normal.

*Adult Male.* Unknown.

*Pupa.* Length: 2.8 mm, female. Gill: length 1.3 mm; branching pattern typical, dorsal-most filament 0.50–0.66 length of others. Thorax: tubercles absent, cuticle shiny. Abdomen: tergite I without hooks or spines; tergites II–IV with pronounced recurved hooks, those of tergite III smaller; tergites V and VI bare; tergites VII and VIII with very fine spine fields, those of tergite VIII stronger; sternite III clear; sternites IV–VII with anteriorly directed hooks, those of tergites IV

and V grouped close to midline, those of sternites VI and VII widely spaced; caudal spines very small. Cocoon: slipper-shaped, of medium weave; darkly coloured; covering pupa to base of gills; anterior edge loosely woven, with spaces between threads.

*Larva.* Last instar larva with dark pharate pupal gills; length 6.2 mm. Body: evenly dark greyish-brown with thin lighter intersegmental regions. Head capsule (Fig. 28): relatively uniformly dark brown; posterolateral margins strongly convex; frontoclypeal apotome slightly lighter anteriorly, darker posteriorly; posteromedian and anterolateral head spot-two, negative, others positive; stemmata with darker area anteriorly, distinct lighter diagonal mark; cuticle with corrugations running laterally; sensilla numerous, with distinct raised sockets (Fig. 60); cervical sclerites fused to postoccipt. Antenna: longer than labral fan stem, distal article length 0.14 mm, proximal articles length 0.34 mm, basal article very dark brown and longitudinally striated, medial article with irregular lighter patches, distal article uniformly light brown. Labral fans: with 29 dark brown rays, ca. 0.88 mm. in length, lateral four rays less substantial; microtrichia of all rays short, only 0.6 times as long as ray width, pattern of long microtrichia interspersed with five smaller microtrichia, very distinct (Fig. 58). Hypostoma (Fig. 37): teeth sharply pointed, median tooth prominent, five sublateral teeth per side, subequal in length, line of teeth tips sloping anteriorly to prominent lateral tooth longer than median tooth, one paralateral tooth, with steep base down to five or six lateral serrations; five or six hypostomal sensilla in row per side. Postgenal cleft: small, wider than deep, flat anteriorly. Postgenal bridge: 2.0 times longer than cleft. Mandible: apex (Fig. 47) with nine to 11 spinous teeth extended almost to mandibular serration; serration as high as basal width, length of sides subequal; proximal sensillum cone-shaped, on base of serration. Maxillary palpus: 3.1 times as long as width at base. Mandibular phragma: extended ventrad to 0.50 depth of maxilla base. Abdomen: segments increased gradually in size posteriorly to segment IV, then smoothly increased to maximum size at segment VII; posteroventral tubercles very small; posterodorsal cuticle with regular hemispherical tubercles and with trichoid sensilla, 15.0  $\mu$ m long (Fig. 61). Anal sclerite: with posteroventral arms broad and continuous with lateral accessory sclerite extended to ventral surface, but not fused ventrally. Circle of hooks: 106 rows of hooks, 14–16 hooks per row. Anal papillae: essentially simple; lateral papillae with one or two very small pointed basal papillae.

*Bionomics.*— Little is known about the habitat of this species. Larvae and pupae were taken from a cascade; a piece of grass was included with the material, but it is not known if the specimens were on vegetation.

*Material Examined.*— In addition to types I have seen the following: Two pupal cocoons and pieces of pupal exuviae, in alcohol, data as for holotype (BPBM).

*Simulium (Inseliellum) cataractarum* n. sp.

(Figs. 3, 10, 24, 29, 38, 48, 64)

*Simulium "IS".* Craig, 1983: 534. Schröder, 1985: 18.

*Types.*—

*Holotype.* Male: pinned; reared; emerging from pupa, with larval abdominal exuviae still attached; label data:— "Holotype", "♂", "Simulium (I.) / cataractarum Craig / det. / D.A. Craig 1986", "TAHITI, Mataiea, E. Lac Vaihiria, / 17° 40' 58" S. 149° 24' 51" W. / alt. 480m. 22-vii-80, / D.A. Craig. Stat. #16." (MNHP).

*Paratypes.* Female: pinned; reared; pupal exuviae and cocoon as subsidiary material; head and genitalia in vial; label data as for holotype (MNHP). Females: pinned; reared; pupal exuviae and cocoons as subsidiary material; label data:— "TAHITI, Tiarei, Fareteuira R., / Cascade de Faarumai, / 17° 32' 10" S. 149° 23' 28" W. / 17-ii-87, D.A. Craig. Stat. #15" (1 each, BPBM; BMNH; CNCI; DSIR; USNM; UASM). Male: pinned; reared; with pupal exuviae and cocoon as subsidiary material; complete specimen cleared and in vial; label data as for holotype (MNHP). Male: pinned; reared; with pupal exuviae and cocoon as subsidiary material; head and genitalia in vial; label data as for holotype (BMNH). Males: pinned; reared; pupal exuviae and cocoons as subsidiary material; label data:— "TAHITI, Tiarei, Fareteuira R., / Cascade de Faarumai, / 17° 32' 10" S. 149° 23' 28" W. / 17-ii-87, D.A. Craig. Stat. #15" (1 each, BPBM; BMNH; CNCI; DSIR; USNM; UASM). Pupa: (in alcohol), posterior larval exuviae still attached; label data as for holotype (BMNH). Larvae: in alcohol; label data as for holotype (9 penultimate, BMNH). Larvae: karyotyped; label data as for holotype (4,

BMNH; 3, BPBM; 4, MNHP). Larvae: in alcohol; locality data:- "Tiarei, Cascades de Faarumai, Fareteuira R., 17° 32' 10" S. 149° 24' 00" W. 20-vii-80, D.A.C." (8 last, MNHP). Larvae: penultimate; label data:- "Mataiea, E. Lac Vaihiria, /17° 40' 58" S. 149° 24' 51" W./ alt. 430m. 17-vii-80, /D.A. & R.E.G. Craig". (14, CNCI; 19, DSIR). Larvae: label data:- "Tiarei, immediately west of Trou du Souffleur, 17° 31' 30" S. 149° 23' 32" W. alt. 10m. 17-ii-87, / D.A.C." (9 penultimate, DAC).

*Specific epithet.*— Named after the Latin word "cataracta" for "water fall", in reference to the cascades where larvae of this species are usually found.

*Diagnosis.*—

*Pupa:* gill with short dorsal filament; thoracic tubercles absent.

*Larva:* *oviceps* -type; head spot pattern negative; labral fan ray number reduced, rays pigmented medially; anal sclerite extended ventrally around anal proleg.

*Recognition.*— The holotype was chosen because the larval abdominal exuviae and the pupal exuviae provide definitive association to all stages. Larvae of *S. cataractarum* are very distinctive and it is quite surprising that they were not discovered previously. Included here for the present is the single karyotyped larval specimen designated *Simulium* "IS-complex" by Rothfels (*in* Craig, 1983). That specimen (DAC) is morphologically indistinguishable from larvae of *S. cataractarum*.

*Description.*—

*Adult Female.* Body: generally dark brown-black; length 1.7 mm. Head: width 0.6 mm, depth 0.3 mm. Eyes: interocular distance 0.6 times width of clypeus; frontal angle, 105 degrees; ommatidia 0.016 mm in diameter, *ca.* 33 and 37 respectively across and up eye in middle row. Post-ocular hairs: extended just to eye margin. Clypeus: pale, concolourous with ventral frons, as wide as deep; vestiture of substantial pale hairs. Antenna: total length 0.36 mm; scape, pedicel and base of first flagellomere yellowish, remaining flagellomeres light brown. Mouthparts: length, 0.33 head depth; mandibles, shorter than labrum with *ca.* 14 fine teeth; lacinia with 14–16 retrorse teeth; palpus, 0.5 mm long, distal article 0.2 mm long, third article with pronounced distomedial angle; sensory vesicle occupying 0.50 width of third article, opening 0.33 width of vesicle, *ca.* 20+ sensillar sockets visible. Cibarial pump: space between proximal arms smooth, U - shaped, as wide as deep. Thorax: length 0.9 mm; postpronotal lobe with tuft of yellow hair extended laterally beyond head margin; scutum uniformly blackish brown, anterolateral margins lighter, vestiture of substantial pale hairs; scutellum with distinctly concave posterolateral edges, vestiture of pale golden and dark hairs meeting medially; postscutellum concolourous with abdomen; pleuron brown; mesepimeral tuft of hairs golden. Wing: length 1.6 mm, maximum width 0.8 mm; veins pale yellow; stem vein hair tuft sparse; basicosta with darker hairs, remainder of costa with spines and hairs. Halter: pale. Legs: foreleg light brown; fore-femur 0.63 mm long; fore-basitarsus 6.0 times as long as wide, tarsomeres dark brown; meso- and metatrochanter dark brown, distal quarters of meso-femur and tibia darker brown; basitarsus darker brown on distal 0.33; hind basitarsus parallel-sided, 6.0 times longer than wide, distal tarsomere squarish; pretarsal claw slender, gently curved with sharp apex, basal tooth 0.50–0.66 length of claw. Abdomen: generally dark brown; basal fringe of pale yellow hairs extended to abdominal segment II; tergites not distinct, vestiture of tergites I–VI of pale shiny hairs, those of tergites VII–IX darker; pleural regions concolourous with tergum; sternites paler. Genitalia (Fig. 3): cercus, bluntly rounded in ventral view; hypogynial valves extended to anal lobe, medial margins slightly concave, converging posteriorly, broadly rounded posteriorly; stem of genital fork smooth, lateral arms broad, lateral sclerite large, with apex anteriorly-directed, sharply angulate; sternite VIII pigmented region broadly dome-shaped. Spermatheca: ovoid; slight reticulate pattern; not heavily pigmented; clear area at junction of sperm duct large.

*Adult Male.* Body: generally blackish-brown; length 1.7 mm. Head: width 0.5 mm, depth 0.4 mm. Eyes: upper ommatidia 0.03 mm in diameter, 19 and 22 respectively up and across middle rows; lower ommatidia 0.01 mm in diameter, eight and 12 respectively up and across middle rows. Labrum: pale. Clypeus: narrow dorsally, widening ventrally, 0.20 as wide as head. Antenna: length 0.4 mm; pedicel and scape slightly lighter in colour than flagellum; pilose. Mouthparts: 0.25 length of head depth; mandibles insubstantial, three very small apical teeth; lacinia hairy, without retrorse teeth; palpus 0.29 mm long, distal article 0.27 mm, sensory vesicle occupying only 0.50 of width of third palpal article, opening less than 0.33 width of vesicle, eight to 10 sensillar sockets visible. Thorax: length 0.24 mm; postpronotal lobe with small tuft of golden hairs; scutum black, vestiture of golden hairs, longer posteriorly; scutellum pale yellow, posterior edges slightly concave in dorsal view, vestiture of lateral golden hairs; postscutellum dark, dull brown. Wing: length 1.5 mm, maximum width 0.7 mm; veins pale; stem vein dark, hair tuft black, substantial. Halter: yellowish. Legs: coxae shiny brown; fore-femur with yellow medial area; middle and hind femurs similar, vestiture of long dark hairs; tibiae dark on posterior margin, fore basitarsus parallel sided, but expanded slightly distally, 5.0 times longer than wide; fore tibia 7.0 times as long as wide; pretarsal claw smoothly curved, *ca.* 22 grappling hooks. Abdomen: generally blackish-brown; basal fringe of yellow hairs extended to abdominal segment III; tergite II yellow anteriorly; tergites I–VI with vestiture of golden hairs.

that on tergites VII and VIII darker; pleuron mottled brown; sternites III pale yellow laterally, squarish. Genitalia (Fig. 10): gonocoxa *ca.* 2.0 times as long as basal width; gonostylus *ca.* 0.33 as wide as long, strongly curved with one blunt terminal spine, as long as wide; ventral plate with posterior apex broadly rounded, hairy, posterolaterally slightly concave, broadly angulate, anterior arms heavily sclerotized and angulate, anteromedian notch distinct.

*Pupa.* Length 1.9–2.6 mm. Gill: length 1.4–2.0 mm; branching pattern typical, dorsal-most filament 0.33–0.50 length of other filament, occasionally reflexed posteriorly over thorax. Thorax: cuticle clear, brown; tubercles absent. Abdomen: tergite I–III bare; tergites IV and V with hooks; caudal spines very short, but distinct. Cocoon: slipper-shaped.

*Larva.* Last instar with dark pharate pupal gills; length 4.3–5.3 mm. Body: greyish-brown, with slightly paler intersegmental regions. Head capsule (Fig. 29): generally rich brown; margins convex, widest at 0.33 length from posterior of capsule (Fig. 64); frontoclypeal apotome brown anteriorly; head spots negative, surrounded by darker area; cuticle slightly rugose, with corrugations; sensilla numerous; cervical sclerites distinct, but fused to occiput; Antenna: slightly shorter than labral fan stem; length 0.38 mm; distal article 0.13 mm long, proximal article darker than head capsule, other articles lighter; base pigmented. Labral fans: with 12–15 robust brown rays *ca.* 0.8 mm. in length, plus three to five thinner, smaller medial rays; each ray with median dark brown patch; microtrichia of rays 0.50 as long as ray width, no microtrichial pattern. Hypostoma (Fig. 38): flexed dorsally; median tooth rounded, not protruding beyond prominent lateral teeth; five sublateral teeth per side increasing in size slightly to prominent lateral teeth; one small paralateral tooth; six lateral serrations; five to six hypostomal sensilla in row per side. Postgenal cleft: small, U-shaped, twice as wide as deep. Postgenal bridge: 2.5 times as long as cleft (Fig. 29). Mandible: apex (Fig. 48) with 16 to 20 spinous teeth, decreased rapidly in size posteriorly, extended almost to mandibular serration; serration prominent, as high as basal width, anterior edge twice as long as posterior edge, basal sensillum minute and on serration base, heavily pigmented. Maxillary palpus: 4.1 times as long as width at base. Mandibular phragma: heavily pigmented and substantial, extended ventrad to 0.50 depth of maxillary base. Abdomen: segments increased gradually in size to segment V where a sudden lateral increase in size occurs (not as prominent as in *S. oviceps*); posteroventral tubercles prominent (Fig. 24); posterodorsal cuticle smooth, with numerous trichoid sensilla 11.0–22.0  $\mu\text{m}$  long. Anal sclerite: with median portion broad, deeply pigmented; sensillar sockets showing clearly; anterodorsal arms with small lateral extension; posteroventral arms continuous with lateral accessory sclerites, extended, or almost, completely around posterior proleg. Circlet of hooks: 108 rows of hooks, 15–17 hooks per row. Anal papillae: simple.

*Bionomics.*— A typical habitat for larvae of this species, such as at the Cascades de Faarumai (= La Trois Cascades) and at Lac Vaihiria, consists of thin sheets and trickles of water flowing over hard rock. At Cascades de Faarumai, larvae were on the rock face, on filamentous algae, leaves of macrophytes and dead leaves blown onto the rock face. The Cascades de Faarumai (Vaimahuta Cascade) site is of spring origin, arising from a horizontal crack two-thirds of the way up, and to the right of the main falls. On the 17-ii-1987 suspended particulate material larger than 0.45  $\mu\text{m}$  in the water was 6.9 mg/litre. That in the main cascade was 3.0 mg/litre. This difference is surprising, because the spring-fed flow over the rock was expected to have less particulate material. Examination of the filters, showed that diatoms were the dominant material in the spring-fed flow. Whether this is significant for evolution of the species which occupy this habitat is not known. The pH was 8.2. Water temperatures ranged from 17–23° C. The origin of the Lac Vaihiria cascade is not known, but water temperature was 20° C.

*Simulium cataractarum* is clearly a torrenticolous species. Schröder (1985) has collected *S. cataractarum* larvae from cascades in the Maruia, Taharuu and Tuauru Valleys, and in the Potiai and Vaihiria Rivers. A particularly important site for this species is the small cascade west of le Trou du Souffleur. Here, *S. cataractarum* larvae only are found in a small cascade above the circum-island road, but immediately above that, where the stream flattens out, only *S. malardei* larvae are found. This unique situation may allow determination of habitat requirements for the two species. Schröder (1985, 1988) notes that larvae of *S. cataractarum* have lower selectivity for small algae than do larvae of *S. tahitiense*.

Larvae of *S. cataractarum*, along with those of *S. neoviceps* and some of those of *S. oviceps*, have countercoloured body pigmentation, *i.e.*, with the dorsal surface much darker than the pale ventral surface. Presumably this is to blend into the dark basaltic rock substrate. Whether this is an adaptation to avoid predation, or for protection from intense solar radiation is not known.



*Material Examined.*— In addition to types, I have seen the following:

*Tiarei*, Fareteuira R., Cascades de Faarumai, 17° 32' 10" S. 149° 23' 28" W. 30-vi-80, 14-vii-80, 20-vii-80, 21-vii-80, 02-vii-81, 11-ii-83, 16-ii-83, D. A. & R.E.G. Craig (larvae, DAC).

*Teahupo*, (Tahiti-iti), cascade below Mt. Arope, alt. 30 m. 22-iii-84, P. Schröder (small, early instar larvae, DAC).

*Paea*, Grotte de Mara, 17° 44' 48" S. 149° 34' 10" W. 00-00-74, D.A. Craig (2 larvae, DAC).

*Simulium (Inseliellum) mesodontium* n. sp.

(Figs. 41, 52, 63)

*Type.*—

*Holotype.* Larva: mature last instar; as slide mount; label data:- “Holotype”, “Tahiti, Tiarei, Cascades de Faarumai, /Fareteuira R., 17° 32' 10" S. 149° 23' 48" W./ 14-vii-80, D.A. Craig.” (MNHP).

*Specific epithet.*— Named after the Greek words “mesos” for “middle”, and “odontos” for “tooth” in reference to the prominent median tooth of the hypostoma.

*Diagnosis.*—

*Larva:* hypostoma with sublateral teeth laterad of median tooth small; abdomen covered with ovoid tubercles.

*Description.*—

*Adult Female.* Unknown.

*Adult Male.* Unknown.

*Pupa.* Based on pharate material from last instar larva. Thorax: tubercles absent. Gill: length 1.2 mm; branching pattern normal, dorsal-most filaments equal in length, slightly longer than 0.50 length of longest other filament.

*Larva.* (Single carcass remaining from karyotyping). Last instar with dark pharate pupal gills; length 4.0 mm. Body: generally light brownish-grey with slightly lighter intersegmental regions. Head capsule: pattern as for *S. oviceps*; sensilla numerous; cervical sclerites fused to postocciput. Hypostoma (Fig. 41): with two main lateral lobes, separated by large median tooth and two small sublateral teeth; other sublateral teeth increased smoothly in size out to lateral tooth and single paralateral tooth; lateral serrations absent; five hypostomal sensilla grouped per side. Postgenal cleft: very small, V-shaped. Postgenal bridge: 5.0 times longer than cleft. Mandible: apex (Fig. 52) with 13 fine spinous teeth extended to base of mandibular serration, apical teeth rounded; serration wider at base than high; sensillum small and closely applied to serration. Abdomen: as for *S. oviceps*; posteroventral tubercles absent; posterodorsal cuticle with raised, closely packed, lightly pigmented, ovoid tubercles, 18  $\mu$ m long, tubercles evenly distributed over dorsal surface of abdomen, smaller on prothoracic dorsum, absent from ventral cuticle; and with trichoid sensilla, 22.0  $\mu$ m long (Fig. 63). Anal sclerite: with anterodorsal arms longer than normal; posteroventral arms thin, fused to accessory sclerite, extended around anal proleg, not fused ventrally. Circlet of hooks: 96 rows of hooks, 15–17 hooks per row. Anal papillae: simple; each with small basal papilla.

*Bionomics.*— Gut contents appear normal as for typical filter feeding larvae, so no special function can be assigned to the aberrant median tooth of the hypostoma.

*Phylogenetic relationships.*— Head, labral fan structure and body shape of the larva place this species firmly in the *oviceps* - group. Karyotypic examination of the specimen provisionally identified it as *S. oviceps* (Rothfels, pers. comm. 1984), but morphologically it is clearly a separate species.

*Simulium (Inseliellum) neoviceps* n. sp.

(Figs. 32, 53, 67, 68)

*Simulium* “neoviceps”. Craig, 1983: 534.

*Types.*—

*Holotype.* Larva: penultimate instar; in alcohol; label data:- “Holotype”, “Tiarei, Fareteuira R., Cascade de Faarumai, / 17° 32' 10" S. 149° 24' 00" W. 18-ii-87”, “*Simulium* (L.) neoviceps Craig/ det/ D. A. Craig 1987” (MNHP).

*Paratypes.* Larva: penultimate instar; as slide mount; label data:- "Tahiti, Mataiea, E. Lac Vaihiria, / 17° 40' 58" S. 149° 24' 51" W. alt. 480m. /16-vii-80. D.A. & R.E.G. Craig." (MNHP).

Larva: penultimate instar; as slide mount; label data:- "Paea, Grotte de Mara, /17° 44' 48" S. 149° 33' 48" W. /alt. 10m. 1974, D.A. Craig," (MNHP). Larvae: in alcohol; label data as for holotype (1, BMNH; 2, BPBM; 2, DAC; 1, MNHP).

*Specific epithet.*— Named after the Greek word "neos" meaning "new" and "oviceps", from *S. oviceps*, in reference to this species' similarity to *S. oviceps*.

*Diagnosis.*—

*Larva:* labral fans highly reduced, virtually absent; hypostoma protruding anteriorly; anal sclerite extended ventrally around posterior proleg.

*Recognition.*— Although *S. neoviceps* is quite distinct morphologically and cytologically from *S. oviceps* (Rothfels in Craig, 1983) by virtual absence of labral fans, extent of the posteroventral arms of the anal sclerite around the anal proleg and number of head sensilla (or hairiness), some larvae presently assigned to *S. oviceps* have very small labral fans and may be mistaken for those of *S. neoviceps*.

*Description.*—

*Adult Female.* Unknown.

*Adult Male.* Unknown.

*Pupa.* Unknown.

*Larva.* Similar to *S. oviceps*, but differing in the following characters:- Head: spot colour pattern negative, but not distinctly so medially (Figs. 32, 67); cuticle essentially smooth; sensillar number normal. Antenna: much longer than cephalic fan stem, length 0.18 mm; distal article length 0.07 mm; proximal articles darker, concolourous. Labrum: cone-shaped; labral fans (Figs. 67, 68) highly reduced with only four longer rays; ca. 0.04 mm in length, plus two very short rays; microtrichia as long as ray width. Hypostoma: extending anterior of head capsule lateral margins; teeth as for *S. oviceps*, six to seven hypostomal sensilla per side, tightly grouped. Mandible: apex (Fig. 53.) with seven spinous teeth extended to serration; serration small, as high as wide; sensillum separate from serration. Abdomen: shape as for *S. oviceps*; posteroventral tubercles distinct. Anal sclerite: extended completely around anal proleg; fused ventrally. Circllet of hooks: 86 rows of hooks, 16–18 hooks per row. Anal papillae: simple.

*Bionomics.*— The habitat for larvae of this species is perhaps the most extreme of all Tahitian simuliid habitats. In the Cascades de Faarumai, larvae were taken from the right of the main falls where water was flowing in a thin sheet down vertical bare rock. Larvae probably do not filter feed, since the labral fans are so small. Browsing feeding behaviour is suggested from examination of gut contents which showed many pieces of fine inorganic material, and by the rounded and broken hypostomal teeth in specimens ready to moult. Recently ecdysed individuals had sharp hypostomal teeth, as do *S. oviceps* (Craig, 1975a). No other simuliid species were taken from that particular site. A few meters closer to the main falls where filamentous algae grew on the rocks, both *S. cataractarum* and *S. oviceps* were collected, similar to the situation at the Lac Vaihiria site.

*Phylogenetic relationships.*— The morphological convergences in *S. neoviceps* and *S. oviceps* larvae to those of the browsing simuliid *Gymnopais* is startling. The body shape, to allow the abdomen to bend so that the mouthparts can be applied to the substrate (Craig, 1977); the reduction of the labral fan with concomitant reduction in size of the labrum (Craig, 1974); the reduction in the size of postgenal cleft, probably for strengthening the head; the shortening of the mandible and reduction of apical teeth for scraping the substrate; and flattening of the hypostomal teeth and extension of the hypostoma anteriorly for the "pan and broom" technique of feeding (Currie and Craig, 1987), have been independently developed in both groups.

*Material Examined.*— In addition to types I have seen the following: *Tiarei*, Fareteuira R., Cascade de Faarumai, 17° 32' 10" S. 149° 23' 48" W. 16-ii-83, D.A. Craig (SEM specimen, DAC). Larvae: two destroyed during karyotyping.

*Simulium (Inseliellum) oviceps* Edwards  
(Figs. 8, 15, 20, 25, 34, 43, 55, 66, 70)

*Simulium oviceps* Edwards 1933: 37, 1935: 37. Lectotype larva (by present designation), TAHITI. Smart, 1945: 511. Grenier and Rageau, 1960: 734. Grenier and Rageau, 1961b: 174. Dumbleton, 1962: 77. Davies, 1965: 172. Rubtsov, 1974: 242, 244. Craig, 1975a: 466. Craig, 1975b: 299. Crosskey, 1981: 8, 61. Craig, 1983: 533. Schröder, 1985: 17.  
*Inseliellum oviceps* (Edwards). Rubtsov, 1974: 275.  
*Simulium (Inseliellum) oviceps* Edwards. Crosskey, 1987: 388.

*Types.*—

*Lectotype.* By designation from syntype series. Larva: slide mount; label data:- "625 TYPE 625./ *Simulium oviceps* Edw./ Papara River, Tahiti,/ Mumford and Adamson" (BPBM).

*Paralectotypes.* Adults: pinned; on acetate; label data:- "Paralectotype", "Syntype", "*Simulium* (I.) *oviceps* Edw./ det. /D.A. Craig 1986", "Tahiti, Tautira. /9.viii.1925. /Miss Cheesman./ B.M. 1925. 392", "Syntype" (2 ♀, BMNH). Adult: pinned; on acetate; label data:- "Paralectotype", "Syntype", "*Simulium* (I.) *oviceps* Edw./ det. /D.A. Craig 1986", "Society Is. Tahiti. /16.3.25 L. E. Cheesman. /B. M. 1925 - 464", "Syntype" (1 ♀, BMNH). Adult: pinned; label data:- "Paralectotype", "Syntype", "*Simulium* (I.) *oviceps* Edw./ det. / D.A. Craig 1986", "Tahiti", "Society Is. 500' . /Tahiti I.", "Faraura Val. /11-17-28", "Hitiaa 11-17-28", "5 miles from sea", "A.M. Adamson Collector", "Pacific Entomological Survey", "Brit. Mus. 1931.234", "? *oviceps*" (1 ♀, BMNH). Adult: pinned; label data:- "Society Is. Tahiti I", "Faraura Val. 12-20-28", "Hitiaa 500", "5 miles from sea", "Mumford & Adamson", "Pacific Entomological Survey", "Brit. Mus. 1931-234", "Syntype", "Paralectotype", "*Simulium* (I.) *oviceps* Edw./ det. /D.A. Craig 1986" (1 ♀, BMNH). Adult: pinned; label data:- "Society Is. / 1000' Tahiti I", "Fautaua Val. / 8-23-28", "NR VANILLA PLANT", "SIMULIUM", "A.M. Adamson collector", "Pacific Entomological Survey", "Brit. Mus. 1931-234", "Syntype", "Paralectotype", "*Simulium* (I.) *oviceps* Edw./ det. / D.A. Craig 1986" (1 ♀, BMNH). Adult: pinned; label data:- "Society Is. / 1000' Tahiti I", "Fautaua Val. / viii-22-28", "NR VANILLA PLANT", "SIMULIUM", "A.M. Adamson collector", "Pacific Entomological Survey", "Brit. Mus. 1931-234", "Syntype", "Paralectotype", "*Simulium* (I.) *oviceps* Edw./ det. /D.A. Craig 1986" (1 ♀, BMNH). Adult: pinned; label data:- "Society Is. /150m Tahiti I", "Papenoo Val /xi-9-28", "A.M. Adamson Collector", "Pacific Entomological Survey", "Brit. Mus. 1931-234", "Syntype", "Paralectotype", "*Simulium* (I.) *oviceps* Edw./ det. / D.A. Craig 1986" (1 ♀, BMNH). Adult: pinned; label data:- "Society Is. /150m Tahiti I", "Papenoo Val /10-23-28", "10 kilo from sea", "A.M. Adamson Collector", "Pacific Entomological Survey", "Syntype", "Paralectotype", "*Simulium* (I.) *oviceps* Edw./ det./D.A. Craig 1986" (1 ♀, BMNH). Adult: pinned; label data:- "Society Is. /150m Tahiti I", "Tipaerui Val /ix-12-28", "3 miles from sea", "A.M. Adamson Collector", "Pacific Entomological Survey", "Syntype", "Paralectotype", "*Simulium* (I.) *oviceps* Edw./ det. /D.A. Craig 1986" (1 ♀, BMNH).

*Diagnosis.*—

*Pupa:* dorsal gill filament short or long; thoracic tubercles pointed.

*Larva:* reduced labral fans; head sensilla numerous; laterally expanded posterior abdomen.

*Recognition.*— Included for the present in this species are larvae which have even smaller labral fans with fewer rays. These larvae have the arms of the anal sclerite further extended around the anal proleg.

*Description.—*

*Adult Female.* Body: colour variable, generally black to light brown; length 1.2–1.5 mm. Head: black-brown; width 0.36–0.41 mm, depth 0.25–0.36 mm. Eyes: interocular distance 0.12 width of head.; frontal angle 85 degrees; ommatidia 0.013 mm in diameter, *ca.* 28 and 30 respectively across and up eye in middle row. Vertex: black with vestiture of concolorous hairs. Frons: black-brown. Clypeus: concolorous with frons, pale ventrally; finely pilose; slight medial projection. Antenna: length 0.25 mm; evenly dark brown. Mouthparts: length less than 0.50 head depth; mandibles as long as labrum, *ca.* 15 small teeth; lacinia with *ca.* 15 retrorse teeth; palpus, 0.88 mm long, distal article 0.19 mm long, proximal article concolorous with clypeus, sensory vesicle occupying 0.50 width of third article, opening 0.33 width of vesicle, *ca.* 10 sensillar sockets visible. Cibarial pump: space between proximal arms U-shaped, smooth, as wide as deep. Thorax: length 0.52–0.63 mm; postpronotal lobe with tuft of hairs paler than scutum; scutum evenly dark brown, slightly shiny, vestiture of short, slightly golden hairs; scutellum apex sharp, posterolateral sides concave, forming generally obtuse angle, pale to concolorous with scutum, vestiture of sparse black hairs; postscutellum, concolorous with scutellum; pleuron dark brown. Wing: length 1.1–1.4 mm, maximum width 0.53–0.58 mm; stem vein hair tuft variable, from sparse to almost absent; basicostal vein with few hairs. Halter: pale. Legs: generally evenly brown: pretarsal claw smoothly curved with sharp apex; basal tooth 0.50 length of claw, diverging from claw. Abdomen: light brown to dark brown; basal fringe of sparse hairs extended to posterior of segment II. Abdomen: tergites I and II as wide as abdomen; tergites III–VI narrower anteriorly, expanded posteriorly, occasionally subshining; pleural regions pilose; sternum slightly mottled; sternites I–IV not apparent; sternites VI and VII narrow anteriorly, expanded posteriorly. Genitalia (Fig. 8.): cercus in lateral view slightly curved dorsally and ventrally with sharp apex; hypogynial valves with dark edges medially, pale apically, broadly rounded posteriorly extended just beyond base of anal lobe; stem of genital fork smooth, long, lateral sclerites triangular with anterior apex sharply angulate, laterally concave. Spermatheca: ovoid; slight pattern of longitudinal striations; not heavily pigmented; clear area at junction of sperm duct normal.

*Adult Male.* Body: generally black; length 1.1–1.4 mm. Head: width 0.44–0.50 mm, depth 0.34–0.39 mm. Eyes: upper ommatidia 0.02 mm in diameter, 16 and 14, respectively up and across eye; lower ommatidia, 0.01 mm in diameter. Frons: shiny black-brown, 0.33 head width. Clypeus: 0.25 as wide as head. Antenna: length 0.24 mm, uniformly dark brown. Mouthparts: 0.20 length of head depth; mandibles with fine hair-like teeth apically; lacinia lacking retrorse teeth, but with fine hairs apically; palpus 0.19 mm long, sensory vesicle spherical, occupying only 0.33 of width of third palpal article, opening less than 0.33 width of vesicle, *ca.* nine sensillar sockets visible. Thorax: length 0.41–0.55 mm; scutum velvety black brown, vestiture of short golden hairs; postpronotal lobe lighter with small tuft of hairs; scutellum cone-shaped in dorsal view, apex pronounced and pale with vestiture of sparse, black hairs; postscutellum dark brown, medial black area; pleuron brown. Wing: length 1.1–1.2 mm, maximum width 0.5–0.6 mm, stem vein hair tuft of few, but substantial hairs. Halter: greyish. Legs: generally brown, with black vestiture; pedisulcus distinct; pretarsal claw slightly curved; *ca.* 22 grappling hooks. Abdomen: jet black; vestiture of sparse black hairs; basal fringe of dark hairs extended to segment III. Genitalia (Fig. 15): gonocoxa 1.0–1.2 times as long as basal width; gonostylus approximately 2.0 times as long as basal width, strongly curved with one large blunt terminal spine; ventral plate hairy medially, broadly rounded posteriorly, slightly concave laterally, anterior sclerotized arms pointed, anteromedian notch very distinct and rounded.

*Pupa.* Length; 1.3–1.6 mm male; 1.3–1.9 mm female. Gill (Fig. 20): length, 0.8–0.9 mm male, 0.56–1.0 mm female; branching pattern typical, dorsal filament 0.25–0.75 length of other filament, occasionally as long, or very short, or absent, variable even on same specimen. Thorax: tubercles pointed (Fig. 70); sternites and tergites as for *S. exasperans*.

*Larva.* Last instar with dark pharate pupal gills; length 2.7–3.8 mm. Body: greyish-brown with narrow pale anterior intersegmental regions; ventrally pale, dorsal colour occasionally extended completely around abdominal segment I. Head capsule (Figs. 34, 66): variable, generally rich brown, but may be pale ventrally; frontoclypeal apotome pale anteriorly and laterally, posteriorly to stemmata, light brown medially, brown posteriorly; shape, narrow anteriorly, widest opposite stemmata, narrowing rapidly to parallel sided (variable – may be narrowest just posterior to stemmata, widening slightly posteriorly); spot pattern negative; stemmata with clear area posterolaterally, occasionally with narrow curved mark dorsally; cervical sclerites fused to head capsule; sensillae numerous (Fig. 66). Antenna: 3.0 times longer than labral fan stem, length 0.14 mm, distal article 0.06 mm; antennal phragma extensive and heavily pigmented. Labral fans: reduced; stem small, but distinct; eight to 12 short rays, *ca.* 0.17 mm in length; microtrichia of medial rays as long as ray width, pattern of longer microtrichia interspersed with seven or eight smaller microtrichia. Hypostoma (Fig. 43): all teeth similar and forming slightly convex line, median tooth protruding slightly; depending on age of larva, wear may be apparent on sublateral teeth; two paralateral teeth; two or three small lateral serrations; four or five grouped hypostomal sensilla per side; hypostoma produced anteriorly from head capsule. Postgenal cleft: rounded, as wide as deep, irregular anteriorly. Postgenal bridge: 3.0 times length of cleft. Mandible: short and curved, apex (Fig. 55) with blunt apical teeth of similar length (depending on age of larva), seven or eight spinous teeth extended to mandibular serration; serration as high as basal width, sharply pointed and curved posteriorly; sensillum more than 0.50 height of serration, similarly shaped. Maxillary palpus: 2.0 times as long as width at base. Mandibular phragma: strongly pigmented, extended ventrad to 0.50 depth of maxilla base. Abdomen: segments I to IV of similar size, segment V increased in size rapidly laterally to maximum size at segment VI; segments I–IV, constricted at intersegmental region, giving corrugated appearance to abdomen; posteroventral tubercles prominent; posterodorsal cuticle essentially smooth, with bifurcate sensilla, 8.4  $\mu$ m long. Anal sclerite; with posteroventral arms 2.2 times longer than dorsolateral arms, expanded ventrally; separate lateral accessory sclerites absent. Circling of hooks; 91 rows of hooks, 13–14 hooks per row. Anal papillae: variable; two or three basal tubercles on each papilla, ranging in size from small to as long as papilla (Fig. 25).

*Bionomics.*— *Simulium oviceps* is the second most common simuliid on Tahiti, occurring sympatrically with *S. tahitiense* in most of its habitats. *Simulium oviceps* has always commanded the most interest of all the Tahitian simuliids, because of the highly reduced labral fans of the larvae (Dumbleton, 1962; Davies, 1974; Craig, 1974; 1975 a, b). I had suggested (Craig, 1975a), that *S. oviceps* larvae were browsers because of the particles of volcanic glass in their guts. That was corroborated by observations on feeding behaviour (Craig, 1977). Schröder (1985) found a higher proportion of ingested detritus particles in *S. oviceps* larvae than in associated *S. tahitiense* larvae.

In the larger rivers, larvae of *S. oviceps* tend to be found around the outside of the dense aggregations of *S. tahitiense* which are normally found under large rocks in strong flow. Elsewhere, *S. oviceps* larvae and pupae can be found in deep depressions in the volcanic boulders, or on the smooth rock of cascades, or occasionally on filamentous algae. Although nowhere nearly as abundant as larvae of *S. tahitiense*, those of *S. oviceps* can be numerous and form monospecific populations. At Bain Loti (19-ii-1987), a full range of larval instars and pupae, were collected from dead leaves, and in particular, from plastic bags (garbage) in the water. Particulate matter larger than  $0.45 \mu\text{m}$ , in the water at that time, was 8.3 mg/litre. The pH was 8.3 and the temperature  $23^\circ \text{C}$ .

*Phylogenetic Relationships.*— *S. oviceps* as presently described is probably a complex of species. Larvae taken with *S. tahitiense* from the larger rivers are morphologically very consistent. However, some larvae from the Cascades de Faarumai and the Vaihiria River possess labral fans intermediate in size between *S. oviceps* and *S. neoviceps*, and the anal sclerite posteroventral arms extend well around the anal proleg. Further material and karyological examination of that form is needed.

*Material Examined.*— In addition to types, I have seen the following:

*Adults:* pinned:

*Tahiti*, Faraura Val. 11-17-28, 11-17-28, 5 miles from sea, A.M. Adamson Collector, Pacific Entomological Survey, Brit. Mus. 1931.234, *Simulium* (l) *oviceps* /det./ D.A. Craig 1986 (1 ♀, BMNH).

*Papeete*, Fautaua R., Bain Loti,  $17^\circ 33' 15'' \text{S}$ .  $149^\circ 33' 00'' \text{W}$ . 19-ii-87, D.A. Craig. (2 ♂, DSIR; 2 ♂, 1 ♀, MNHP; 4 ♂, BPBM; 2 ♂, 2 ♀, USNM)

*Haapape*, Tuauru R.,  $17^\circ 32' 10'' \text{S}$ .  $149^\circ 29' 15'' \text{W}$ . alt. 50 m. 09-vii-80, D.A. & R.E.G. Craig. Stat. #3 (2 ♂, BMNH; 2 ♂, MNHP).

*Papenoo*, Society Is. 150 m. Tahiti I., Papenoo Val. 10-27-28, 10 kilo. from sea, in cop., A.M. Adamson Collector, Pacific Entomological Survey, Brit. Mus. 1931.231, ? *oviceps*, (specimens now cleared and in vial) (1 ♂, 1 ♀, in cop., BMNH). Papenoo R.,  $17^\circ 36' 52'' \text{S}$ .  $149^\circ 24' 51'' \text{W}$ . 10-vii-80, D.A. & R.E.G. Craig (1 ♂, BPBM; 1 ♂, 1 ♀, CNCI; 4 ♂, DSIR; 2 ♂, UASM).

*Tautira*, (Tahiti-iti), Vaitepiha R.,  $17^\circ 46' 30'' \text{S}$ .  $149^\circ 10' 21'' \text{W}$ . alt. 50 m. 19-vii-80, D.A. & R.E.G. Craig. Stat.#13 (1 ♀, 1 ♂, BPBM).

*Teahupoo*, (Tahiti-iti), Tiirahi R.,  $17^\circ 51' 05'' \text{S}$ .  $149^\circ 14' 15'' \text{W}$ . 20-vii-80, D.A. & R.E.G. Craig (2 ♀, 1 ♂, DAC; 2 ♂, DSIR; 1 ♂, UASM).

*Mataiea*, Aug. 1928. A. Tonnoir. BM. 1930.513, ?*oviceps* (1 ♂, BMNH). Vaihiria R.,  $17^\circ 44' 22'' \text{S}$ .  $149^\circ 24' 15'' \text{W}$ . alt. 80m. 16-vii-80, D.A. & R.E.G. Craig (1 ♂, CNCI).

*Punaauia*, Punaruu R.,  $17^\circ 38' 20'' \text{S}$ .  $149^\circ 35' 05'' \text{W}$ . alt. 120m. 07-vii-80, D.A. & R.E.G. Craig (1 ♀, cleared in vial, BMNH; 1 ♀, MNHP; 1 ♀, UASM).

Alcohol material:-

*Papeete*, Fautaua R., Bain Loti,  $17^\circ 33' 15'' \text{S}$ .  $149^\circ 33' 00'' \text{W}$ . 08-vii-74 (larvae, DSIR), 15-vii-74 (larvae, pupa, BMNH); 16-vii-74 (larvae, BMNH); 08-vii-80, (larvae CNCI; larvae, pupae, USNM), 01-vii-81 (larvae, pupa, CNCI; larvae, DAC), D.A. & R.E.G. Craig.

*Haapape*, Tuauru R.,  $17^\circ 32' 10'' \text{S}$ .  $149^\circ 29' 15'' \text{W}$ . alt. 50m. 09-vii-80, D.A. & R.E.G. Craig (pupa, DAC; larvae, MNHP).

*Papenoo*, Papenoo R.,  $17^\circ 36' 52'' \text{S}$ .  $149^\circ 24' 51'' \text{W}$ . 10-vii-80, D.A. & R.E.G. Craig (larvae, CNCI).

*Tiarei*, Fareteuiria R., Cascades de Faarumai,  $17^\circ 32' 10'' \text{S}$ .  $149^\circ 24' 00'' \text{W}$ . 16-ii-83, (larvae, MNHP); 17-ii-87 (larvae, DAC) D.A. Craig.

*Mahaena*, Mahape R.,  $17^\circ 33' 00'' \text{S}$ .  $149^\circ 20' 33'' \text{W}$ . 14-vii-80, alt. 700m. D.A. & R.E.G. Craig (karyotyped larvae, BPBM; larvae, DAC).

*Tautira*, (Tahiti-iti), Vaitepiha R., 17° 46' 30" S. 149° 10' 21" W. alt. 50m. 19-vii-80, D.A. & R.E.G. Craig (larvae, CNCI; larvae, MNHP).

*Teahupoo*, (Tahiti-iti), Tiirahi R., 17° 51' 05" S. 149° 14' 15" W. 20-vii-80, D.A. & R.E.G. Craig (larvae, pupae, BMNH).

*Vairoa*, (Tahiti-iti), Vavi R., 22-ii-84, P. Schröder (pupa, MNHP).

*Mataiea*, Vaihiria R., 17° 44' 22" S. 149° 24' 15" W. alt. 80m. 16-vii-80, D.A. & R.E.G. Craig (larvae, DAC); Vaihiria R., 17° 41' 31" S. 149° 25' 02" W. alt. 250m. 17-vii-80, D.A. & R.E.G. Craig (larva, DAC). E. Lac Vaihiria, 17° 40' 58" S. 149° 24' 51" W. alt. 480m. 22-vii-80, D.A. Craig. (pupa, DAC).

*Mahaiatea*, Taharuu R., 17° 42' 45" S. 149° 29' 15" W. alt. 135m. 15-vii-80, D.A. & R.E.G. Craig (pupae, DSIR). *Paea*, Public Gardens, 03-vii-81, D.A. Craig (larvae, DAC).

*Punaavia*, Punaruu R., 17° 38' 20" S. 149° 35' 05" W. 27-vi-69, B. Hocking (larvae, UASM); 03-v-73 (larvae, pupae, DAC); 05-vii-73 (larvae, UASM), 6-vii-73 (larvae, MNHP), 04-vii-74 (larvae, DAC), 05-vii-74 (larvae, DAC), 08-vii-74 (larvae, DSIR), 18-vii-74 (larvae, CNCI), 07-vii-80 (larvae, DAC), D.A. & R.E.G. Craig.

### *Simulium (Inseliellum) sp.*

(Fig. 17)

#### *Description.*—

*Adult Female.* Unknown.

*Adult Male.* (Based on pharate material). Head: width 0.6 mm, depth 0.5 mm. Eyes: upper, larger ommatidia 0.04 mm, 12 rows both up and across eye, lower, smaller ommatidia 0.01 mm. Mouthparts: less than 0.50 of head depth; lacinia with hairs apically; palpal sensory vesicle spherical, 0.50 width of article, opening 0.33 width of vesicle, four or five sensillar sockets visible. Legs: segments with pigmented distal regions; pretarsal claw with 17–20 grappling hooks. Genitalia (Fig.17): gonocoxa with pronounced posteromedial projection; gonostylus broad, roundly truncated distally, single prominent apical spine; ventral plate hairy and broadly cone-shaped posteromedially, rounded laterally, anterior arms heavily pigmented, anteromedian notch broad.

*Pupa.* Thorax: tubercles pointed. Gill: length 1.2 mm; as for *S. oviceps*; dorsal-most filament 0.33 length of other filaments.

*Larva.* Unknown.

*Phylogenetic relationships.*— This adult has been placed in the *oviceps*-group on the basis of pupal characteristics, namely the short dorsal gill filament and the pointed thoracic tubercles, both characteristic of *S. oviceps*. However, the genitalia (Fig. 17) with unique large posteromedian projection on the gonocoxa, show that this male is not of *S. oviceps*. Because this specimen may belong to one of the *oviceps*-group of species that are based only on larvae, it is not given specific status at this time.

*Material Examined.*— Pupa: pharate adult; as slide mount; label data: *Simulium* (I.) sp., TAHITI, Mataiea, E. Lac Vaihiria, 17° 40' 58" S. 149° 24' 51" W. alt. 480 m. 22-vii-80, D.A. Craig. Stat. # 16 (MNHP).

### CONCLUDING REMARKS

I estimate that only 75% of simuliid species in Tahiti have been described, based on the rate at which species were discovered once it was realized that the new species were from specialized habitats; which had not been well collected. Further, morphological variation indicates that species such as *S. oviceps* and perhaps *S. neoviceps* are probably complexes of species.

When description of the Marquesas (Sechan *in* Klein *et al.*, 1983) and Huahine (Sechan pers. comm.) simuliids are complete, preferably with karyological data, it should be possible to attempt a cladistic analysis for *Inseliellum*. This could be particularly valuable, because it would include almost a total fauna which, to judge from the ages of the islands involved (Duncan and McDougall, 1974; 1976), and from karyological and morphological data, is monophyletic. If so, it should then prove possible to test the zoogeographic hypotheses of Craig (1983) and to make predictions regarding discovery of simuliids on other Polynesian islands.

Such an analysis will require establishing the sister taxon to *Inseliellum* for outgroup comparison. That may prove difficult because of the homogeneous morphological nature of possible candidate subgenera.

Bionomically, Polynesian simuliids are poorly known, but Schröder (1985) has made a valuable start with his studies on feeding behaviour and distribution of Tahitian simuliids. This provides a basis for investigation of resource partitioning by the larvae in relation to their morphological and presumably behavioural characteristics. Of particular interest, but probably very difficult to do, will be examination of the reproductive behaviour which keeps the sympatric species from hybridizing, and the mechanisms by which the very rare species manage to locate mates.

Marquet and Lamarque (1987) report that there are 17 species of fresh water fish in Tahiti and Moorea, and that waterfalls have a marked effect on their distribution. In the larger rivers on Tahiti fish are very common and noticeable (pers. obs.). Fish are known predators of black fly larvae and these can be an important food item (Davies, 1981; Allen, 1982). Further, there are suggestions (Peckarsky, 1984) that such prey organisms may form large groups to reduce chances of predation per individual.

At the Cascades de Faarumai, in particular at the Haamaremarerahi cascade, where the wet rocks directly entered the pool at the base of the cascade, small gobiid sucker-fish (*Sicyopterus taeniurus*) were common on the rock faces. These fish could move with startling agility up and across the wet rock. Upon disturbance, the fish would either swim rapidly up the rock, or leap off into the pool below. Noticeable was that in these situations the rock was bare. Where there was a rubble base to the rock face and the fish did not have direct access to a pool beneath, they did not occur and algae and macrophytes grew in the water flowing over the rock. Black fly larvae were found on the vegetation and patches of bare rock. A search of the bare rock faces above the pool failed to reveal larvae of *S. neoviceps* or, indeed, of any black fly. However, analysis of gut contents of six of the gobiids produced five larval carcasses of the short labral fan-form of *S. oviceps*. The remainder of the gut contents was algae, of which a high proportion was diatomaceous, and small pieces of volcanic glass. The gobiids are apparently browsers, ingesting the black fly larvae incidentally along with the epilithic algae. This observation, in addition to those on distribution of *S. tahitiense* and *S. oviceps* larvae in the larger rivers, where larvae respectively, either form large aggregations, or are in depression in the rocks, suggests that fish feeding behaviour has an effect on distribution of Tahitian Simuliidae. This hypothesis could perhaps be tested by examining the distribution and aggregation behaviour of larvae of black flies species above and below waterfalls high enough to effect distribution of fish.

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The British Museum (Natural History) loaned available Edwards syntypes. A large series of pinned material was made available by the Bishop Museum, Honolulu and also the United States National Museum, Washington, D.C. F. Rodhain, Institut Pasteur, Paris, loaned the *S.*

*lotii* material described by Grenier and Rageau (1960). I extend thanks to D. Hollingdale for her usual high quality line drawings, and for being such a delight to work with. J. S. Scott and G. D. Braybrook provided technical assistance with scanning electron microscopy and photography.

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K. Rothfels was always pleased to receive larval simuliids from such places as Tahiti and he provided me with invaluable karyological information. His sudden death in October, 1986 will make work such as this much more difficult. I am pleased to dedicate this paper to his memory.

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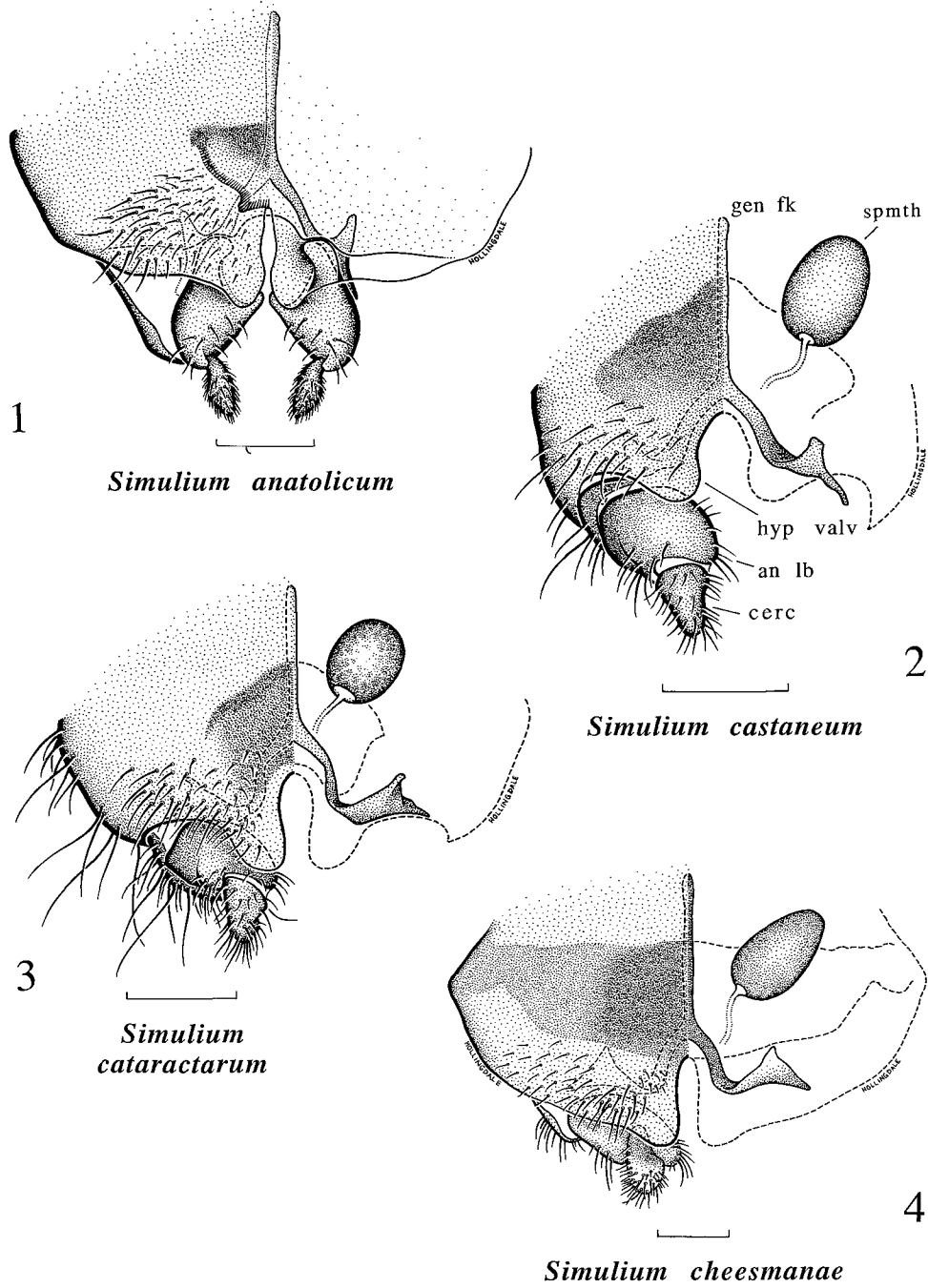
#### REFERENCES

- Allen, J.D. 1982. The effects of reduction in trout density on the invertebrate community of a mountain stream. *Ecology* 63: 1444–1455.
- Bedo, D.G. 1977. Cytogenetics and evolution of *Simulium ornatipes* Skuse (Diptera: Simuliidae) I. Sibling speciation. *Chromosoma (Berlin)* 64: 37–65.
- Bedo, D.G. 1984. Sibling species and sex chromosome differentiation in *Simulium neornatipes* (Diptera: Simuliidae). *Canadian Journal of Genetics and Cytology* 26: 318–325.
- Cheesman, E. 1932. *Hunting insects in the South Seas*. Philip Allen, London. 243 pp.
- Craig, D.A. 1974. The labrum and cephalic fans of larval Simuliidae (Diptera: Nematocera). *Canadian Journal of Zoology* 52: 133–159.
- Craig, D.A. 1975a. The larvae of Tahitian Simuliidae (Diptera: Nematocera). *Journal of Medical Entomology* 12: 463–476.
- Craig, D.A. 1975b. Origin and evolution of the Simuliidae (Diptera) of Tahiti. Abstracts. pp. 299–300. 13th Pacific Science Congress (1975) 1: 358 pp.
- Craig, D.A. 1977. Mouthparts and feeding behaviour of Tahitian larval Simuliidae (Diptera: Nematocera). *Quaestiones Entomologicae* 13: 195–218.
- Craig, D.A. 1983. Phylogenetic problems in Polynesian Simuliidae (Diptera: Culicomorpha): A progress report. *GeoJournal* 7: 533–541.
- Craig, D.A. and A. Borkent. 1980. Intra- and inter-familial homologies of maxillary palpal sensilla of larval Simuliidae (Diptera: Culicomorpha). *Canadian Journal of Zoology* 58: 2264–2279.
- Craig, D.A. and R.E.G. Craig. 1986. Simuliidae (Diptera: Culicomorpha) of Rarotonga, Cook Islands, South Pacific. *New Zealand Journal of Zoology* 13: 357–366.
- Crosskey, R.W. 1967. The classification of *Simulium* Latreille (Diptera: Simuliidae) from Australia, New Guinea and the western Pacific. *Journal of Natural History* 1: 23–51.
- Crosskey, R.W. 1974. The identity and taxonomic status of the man-biting black-fly of Fiji (Simuliidae: Diptera). *Journal of Entomology (B)* 43: 149–158.
- Crosskey, R.W. 1981. Geographical distribution of Simuliidae. pp. 57–68. *In* Laird, M. (Editor). *Blackflies: the future for biological methods in integrated control*. Academic Press, London. 399 pp.
- Crosskey, R.W. 1987. Annotated checklist of the world black flies (Diptera: Simuliidae). pp.

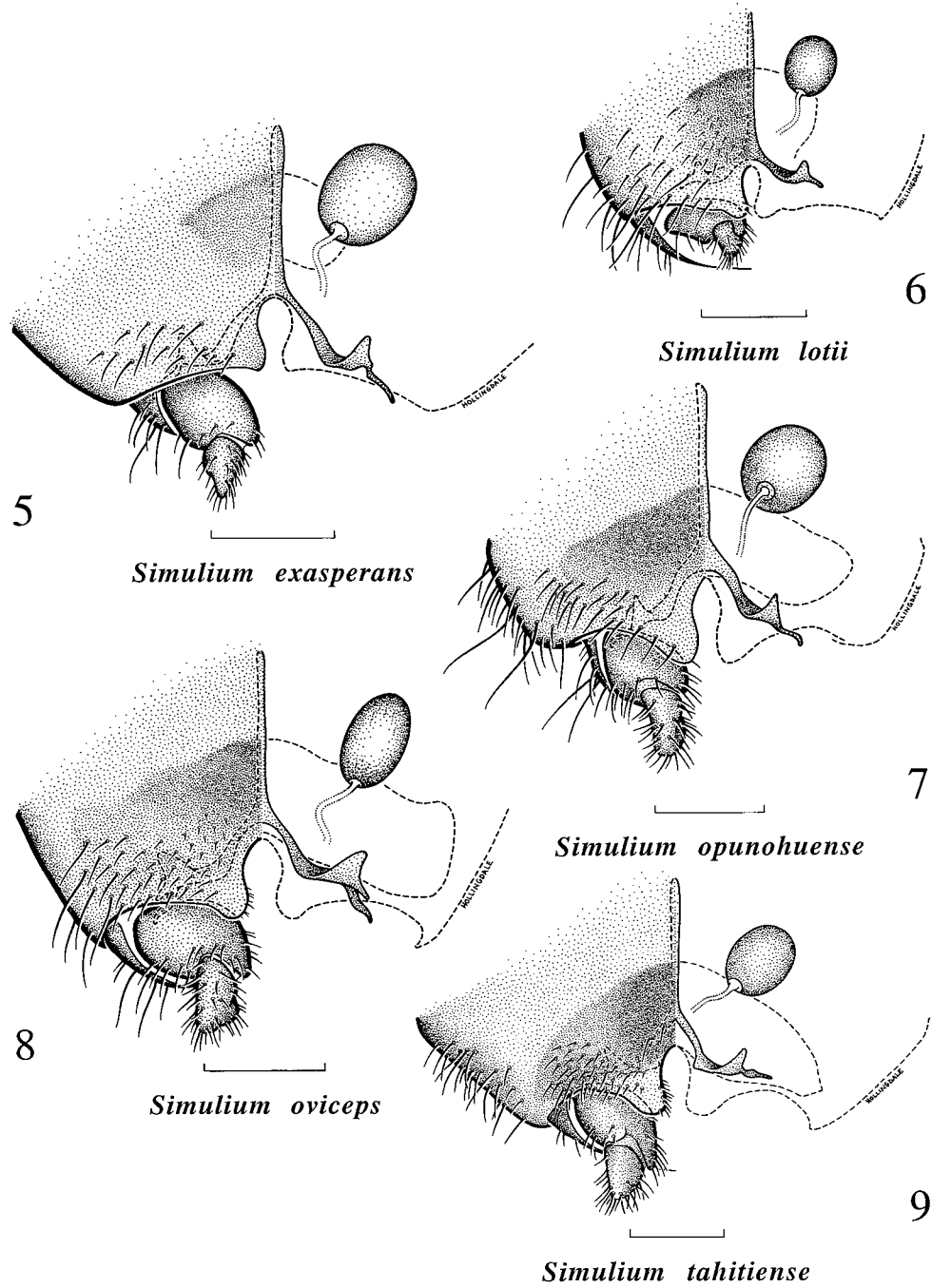


- 358–440. In Kim, K.C. and R.W. Merritt (Editors). Black flies: ecology, population management and annotated world list. Pennsylvania State University Press, University Park. 500 pp.
- Currie, D.C. 1986. An annotated list of and keys to the immature Black Flies of Alberta (Diptera: Simuliidae). *Memoirs of the Entomological Society of Canada* 134: 1–90.
- Currie, D.C. and D.A. Craig. 1987. Larval feeding strategies. pp. 136–148. In Kim, K.C. and R.W. Merritt (Editors). Black Flies: ecology, population management and annotated world list. Pennsylvania State University Press, University Park. 500 pp.
- Davies, D. M. 1981. Predators upon blackflies. pp. 139–159. In Laird, M. (Editor). Blackflies: the future for biological methods in integrated control. Academic Press, Toronto. 399 pp.
- Davies, L. 1965. The structure of certain atypical Simuliidae (Diptera) in relation to evolution within the family, and the erection of a new genus for the Crozet Island black-fly. *Proceedings of the Linnean Society of London* 176: 159–180.
- Davies, L. 1974. Evolution of larval head-fans in Simuliidae (Diptera) as inferred from the structure and biology of *Crozetia crozetensis* (Womersley) compared with other genera. *Zoological Journal of the Linnean Society* 55: 193–224.
- Doutch, H.F. 1981. Southwest Quadrant, Plate-Tectonic Map of the Circum-Pacific Region. Circum-Pacific Council for Energy and Mineral Resources. American Association of Petroleum Geologists, Tulsa, Oklahoma.
- Dumbleton, L. J. 1962. Aberrant head-structure in larval Simuliidae (Diptera). *Pacific Insects* 4: 77–86.
- Dumbleton, L. J. 1973a. *Simulium laciniatum* Edwards – a valid species (Simuliidae: Diptera). *Journal of the Royal Society of New Zealand* 3: 453–456.
- Dumbleton, L. J. 1973b. The genus *Austrosimulium* Tonnoir (Diptera: Simuliidae) with particular reference to the New Zealand fauna. *New Zealand Journal of Science* 15 (1972): 480–584.
- Duncan, R.A. and I. McDougall. 1974. Migration of volcanism with time in the Marquesas Islands, French Polynesia. *Earth and Planetary Science Letters* 12: 414–420.
- Duncan, R.A. and I. McDougall. 1976. Linear volcanism in French Polynesia. *Journal of Volcanology and Geothermal Research* 1: 197–227.
- Edwards, F.W. 1927. Diptera Nematocera from the South Pacific collected by the ‘St. George’ Expedition, 1925. *The Annals and Magazine of Natural History* 20(9): 236–244.
- Edwards, F.W. 1932. Marquesan Simuliidae. *Bulletin of the Bernice P. Bishop Museum* 98: 103–109.
- Edwards, F.W. 1933. Tahitian Simuliidae. *Pacific Entomological Survey Publication* 6: 35–38.
- Edwards, F.W. 1935. Society Island insects. Tahitian Simuliidae. *Bulletin of the Bernice P. Bishop Museum* 113: 35–38.
- Freeman, P and B. De Mellion. 1953. Simuliidae of the Ethiopian Region. *British Museum (Natural History)*. 224pp.
- Grenier, P. and J. Rageau. 1960. Simulies (Dipt., Simuliidae) de Tahiti. Remarques sur la classification des Simuliidae. *Bulletin de la Société de Pathologie Exotique* 4: 727–742.
- Grenier, P. and J. Rageau. 1961a. Un nouveau genre de Simulies: *Hebridosimulium* N.G. (Diptera, Simuliidae) des Nouvelles-Hébrides. Description des stades préimaginaux et du mâle, redescription de la femelle de *H. jolyi* (Roubaud), 1906. *Bulletin de la Société de Pathologie exotique* 54: 95–102.
- Grenier, P. and J. Rageau. 1961b. Simulies (Dipt. Simuliidae) de Tahiti. Remarques sur la

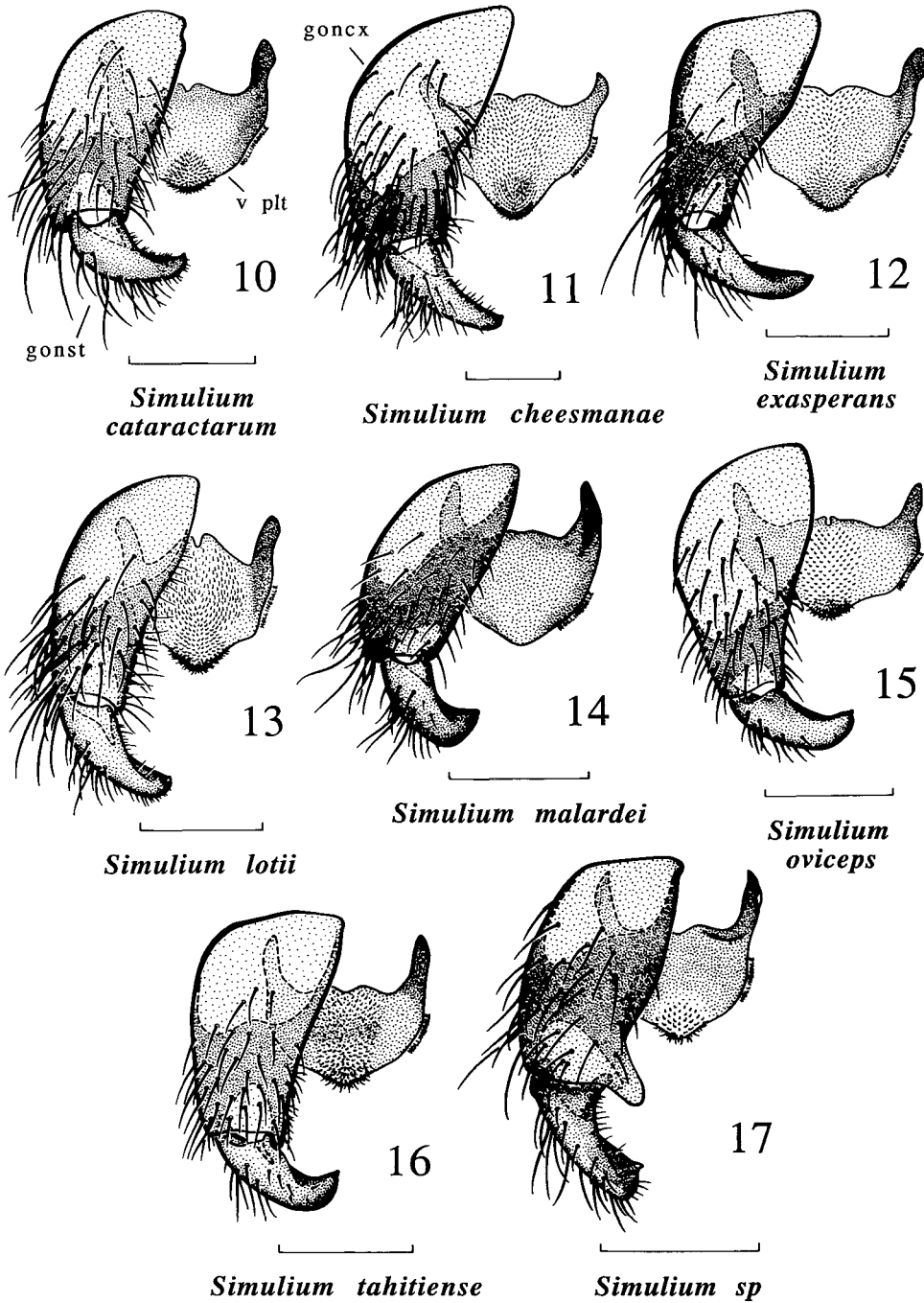
- classification des Simuliidae. pp. 174–177. Verhandlungen XI Internationalen Kongress Entomologie, Wien (1960). 803 pp.
- Holloway, J. D. 1979. A survey of the Lepidoptera, biogeography and ecology of New Caledonia. W. Junk. The Hague. 588 pp.
- Klein, J. M. F. Rivière and Y. Séchan. 1983. Recherches d'entomologie médicale aux Îles Marquises en 1982. Notes et documents d'hygiène et de Santé Publique Entomologie Médicale, Office de la Recherche Scientifique et Technique Outre-mer, Papeete, Tahiti. 7: 1–81.
- Lacey, L. A. and J. M. Lacey. 1983. Filter feeding of *Simulium fulvinotum* (Diptera: Simuliidae) in the Central Amazon Basin. *Quaestiones Entomologicae* 19: 41–51.
- Loti, P. 1887. Le mariage de Loti. Calmann-Lévy, Paris. 313 pp.
- McLea, M.C. and D.M. Lambert. 1983. Cytogenetics of New Zealand blackflies of the genus *Austrosimulium* (Diptera: Simuliidae) 1. The cytogenetics of *Austrosimulium australense*. *New Zealand Journal of Zoology* 10: 271–280.
- Marquet, G. and P. Lamarque. 1987. Prospecting the fauna in the freshwaters of Tahiti and Moorea (French Polynesia). p. 86. *In* Abstracts. XXII Congress of the International Association of Limnology, Hamilton, New Zealand. 142 pp.
- O'Hara, J. E. 1983. Classification, phylogeny and zoogeography of the North American species of *Siphona* Meigen (Diptera: Tachinidae). *Quaestiones Entomologicae* 18: 261–380.
- Peckarsky, B.L. 1982. Predator-prey interactions among aquatic insects. pp. 196–254. *In* Resh, V.H. and D.M. Rosenberg (Editors). *The ecology of aquatic insects*. Praeger Scientific, Toronto. 625 pp.
- Roubaud, M.E. 1906. Sur deux types intéressants de Simuliides de l'Afrique équatoriale et des Nouvelle-Hébrides. *Bulletin du Muséum d'Histoire Naturelle*. Paris. 12: 140–143.
- Rubtsov, I.A. 1956. Simuliidae. *Fauna SSSR* No. 23, (6). Moscow. 532 pp.
- Rubtsov, I.A. 1974. Evolution, phylogeny and classification of the family Simuliidae (Diptera). *Trudy Zoologicheskogo Instituta*. Leningrad 53: 230–281. (In Russian).
- Schröder, P. 1985. Feeding biology of Tahitian Blackfly larvae (Dipt. Simuliidae). Notes et Documents, Hygiène et Santé Publique Entomologie Médicale, Office de la Recherche Scientifique et Technique Outre-mer, Papeete, Tahiti. 11: 1–230.
- Schröder, P. 1988. Gut-passage, particle selection and ingestion of filter-feeding blackfly (Dipt., Simuliidae) larvae inhabiting a waterfall in Tahiti (French-Polynesia). *Aquatic Insects*. (In Press).
- Smart, J. 1945. The Classification of the Simuliidae (Diptera). *Transactions of the Royal Entomological Society of London* 95: 463–532.
- Smart, J. and E.A. Clifford. 1965. Simuliidae (Diptera) of the territory of Papua and New Guinea. *Pacific Insects* 7: 505–619.



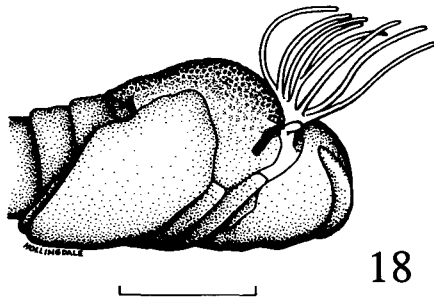
Figures 1-4. Female genitalia, ventral views. Fig. 1. *Simulium anatolicum* n. sp. Right side as true ventral view. Left side with hypopygial valve transparent to show basal connection to anal lobe. Fig. 2. *S. castaneum* n. sp. Fig. 3. *S. cataractarum* n. sp. Fig. 4. *S. cheesmanae* Edwards. Scale line = 0.1 mm; an lb = anal lobe; cerc = cercus; gen fk = genital fork; hyp valv = hypopygial valve; spmth = spermatheca.



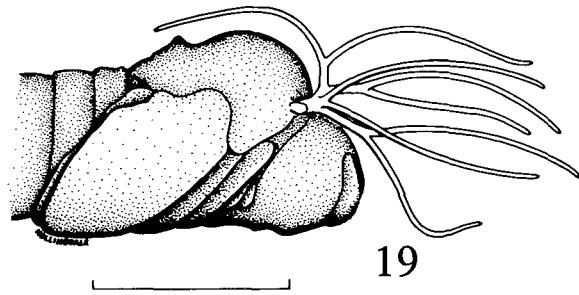
Figures 5-9. Female genitalia, ventral view. Fig. 5. *Simulium exasperans* n. sp. Fig. 6. *S. lotii* n. sp. Fig. 7. *S. opunohuense* n. sp. Fig. 8. *S. oviceps* Edwards. Fig. 9. *S. tahitiense* Edwards. Scale line = 0.1 mm.



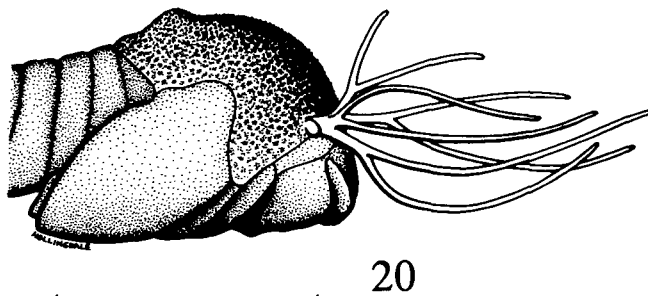
Figures 10–17. Male genitalia, ventral views. Fig. 10. *Simulium cataractarum* n. sp. Fig. 11. *S. cheesmanae* Edwards. Fig. 12. *S. exasperans* n. sp. Fig. 13. *S. lotii* n. sp. Fig. 14. *S. malardei* n. sp. Fig. 15. *S. oviceps* Edwards. Fig. 16. *S. tahitiense* Edwards. Fig. 17. *S. sp*. Scale lines = 0.1 mm; goncx = gonocoxa; gonst = gonostylus; v plt = ventral plate.



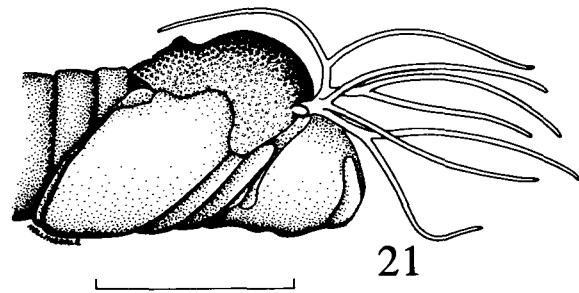
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*Simulium anatolicum*

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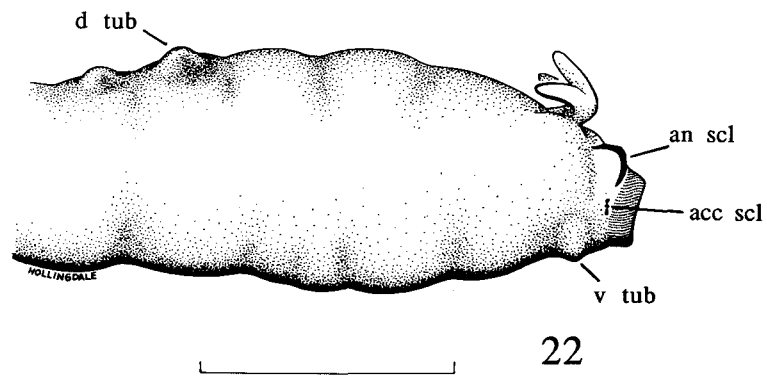
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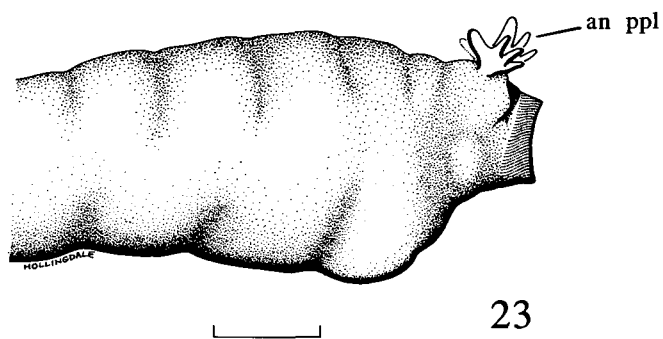
*Simulium oviceps*

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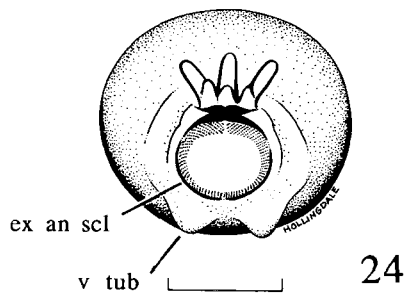
*Simulium tahitiense*



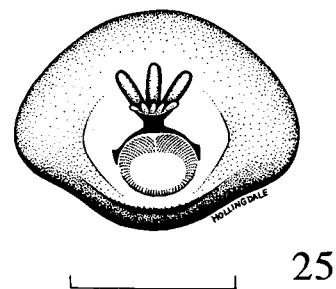
*Simulium malardei*



*Simulium tahitiense*

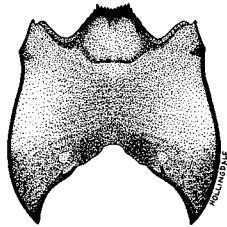
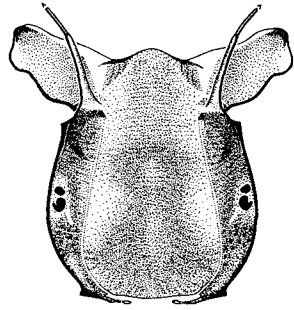


*Simulium cataractarum*

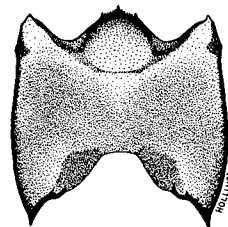
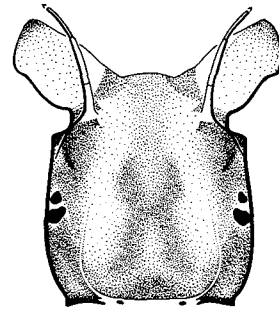


*Simulium oviceps*

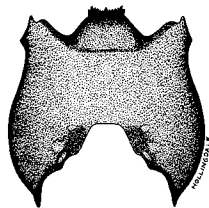
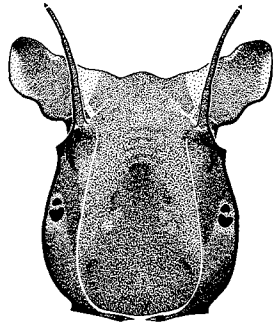
Figures 22 and 23. Left lateral views of larval posterior abdomen. Fig. 22. *Simulium malardei* n. sp. Fig. 23. *S. tahitiense* Edwards. Figures 24 and 25. Posterior views of larval abdomen. Fig. 24. *Simulium cataractarum* n. sp. Fig. 25. *S. oviceps* Edwards. Scale lines = 1.0 mm; acc scl = accessory sclerite; an ppl = anal papillae; an scl = anal sclerite; d tub = dorsal tubercle; ex an scl = ventral extension of anal sclerite; v tub = ventral tubercle.



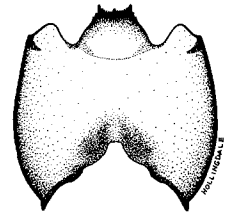
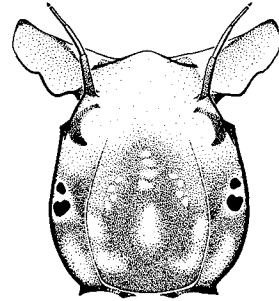
26

*Simulium admixtum*

27

*Simulium arlecchinum*

28

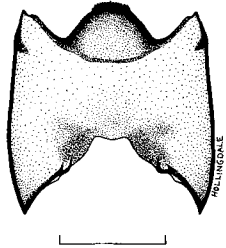
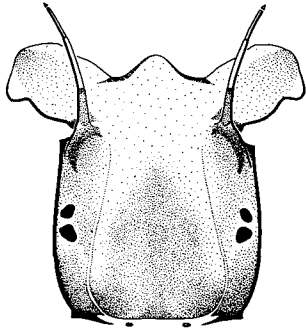
*Simulium castaneum*

29

*Simulium cataractarum*

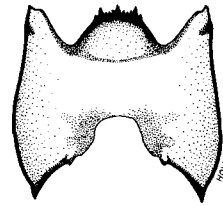
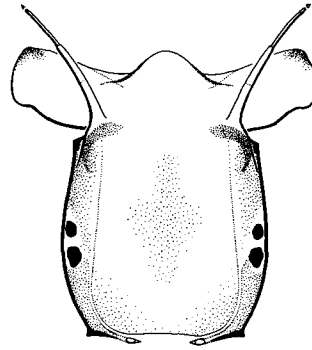
Figures 26–29. Dorsal and ventral views of head capsule (labral fan rays omitted). Fig. 26. *Simulium admixtum* n. sp. Fig. 27. *S. arlecchinum* n. sp. Fig. 28. *S. castaneum* n. sp. Fig. 29. *S. cataractarum* n. sp. Scale lines = 0.25 mm.





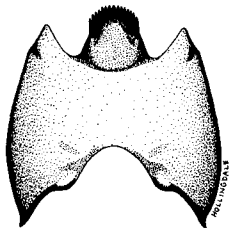
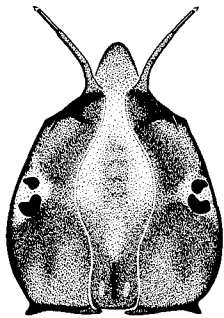
30

*Simulium lotii*



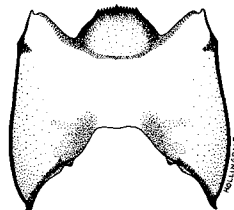
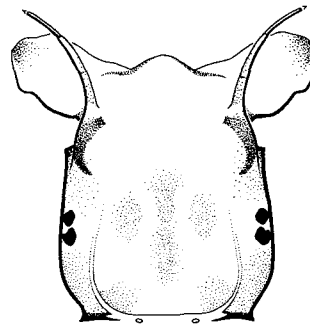
31

*Simulium malardei*



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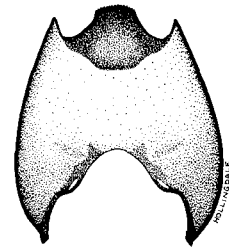
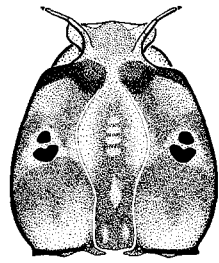
*Simulium neoviceps*



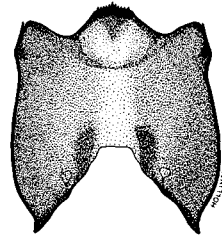
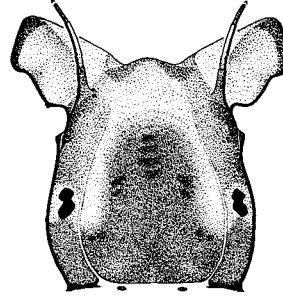
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*Simulium opunohuense*

Figures 30–33. Dorsal and ventral views of head capsule (labral fan rays omitted). Fig. 30. *Simulium lotii* n. sp. Fig. 31. *S. malardei* n. sp. Fig. 32. *S. neoviceps* n. sp. Fig. 33. *S. opunohuense* n. sp. Scale lines = 0.25 mm.



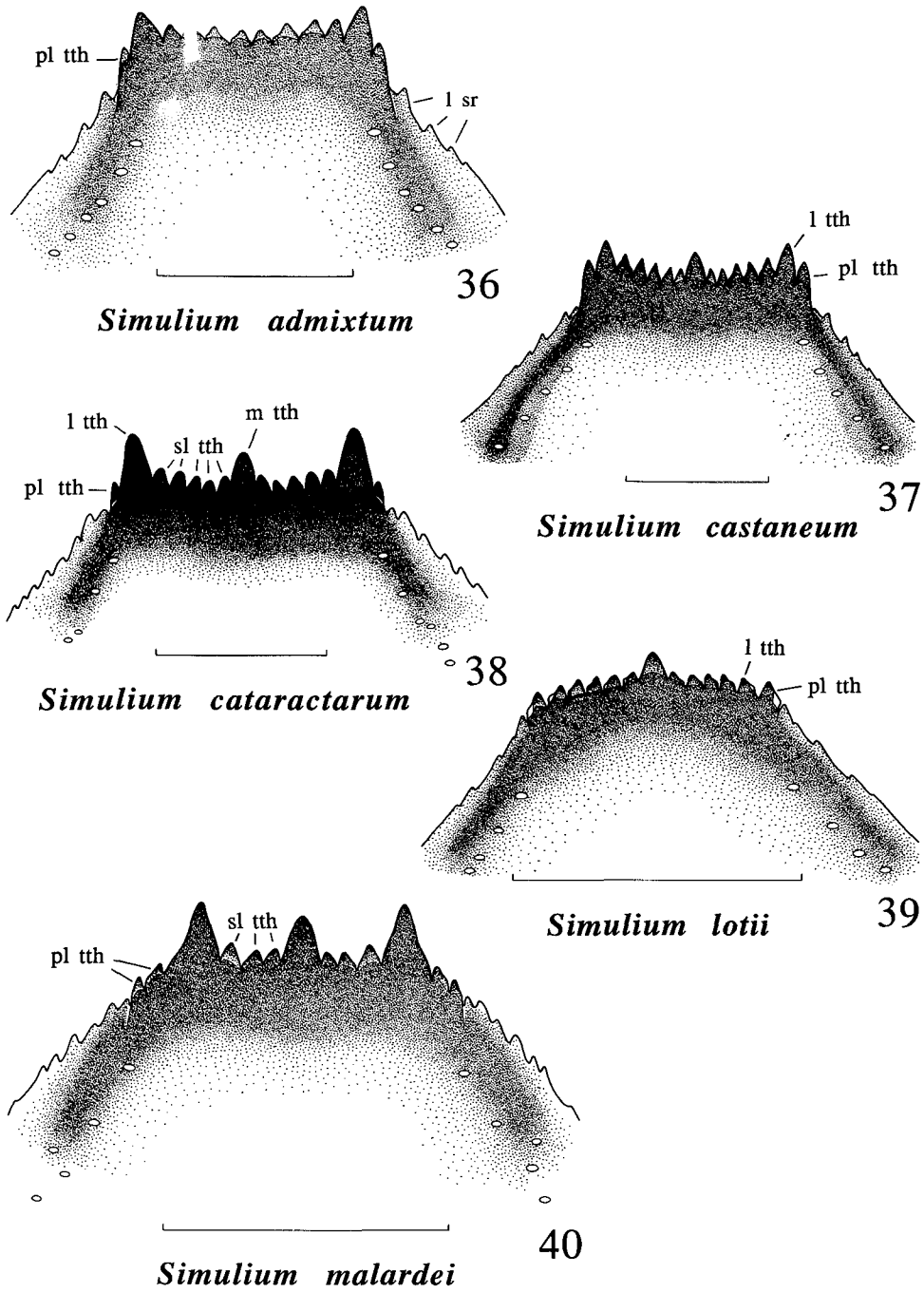
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*Simulium oviceps*

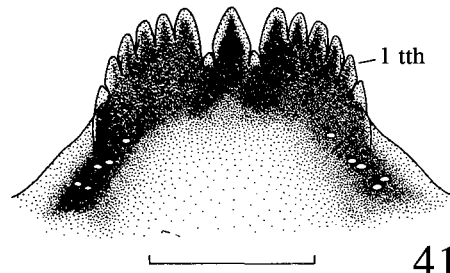
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*Simulium tahitiense*

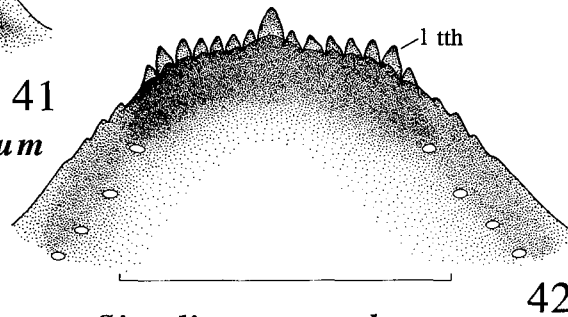
Figures 34 and 35. Dorsal and ventral views of head capsule (labral fan rays omitted). Fig. 34. *Simulium oviceps* Edwards. Fig. 35. *S. tahitiense* Edwards. Scale lines = 0.25 mm.



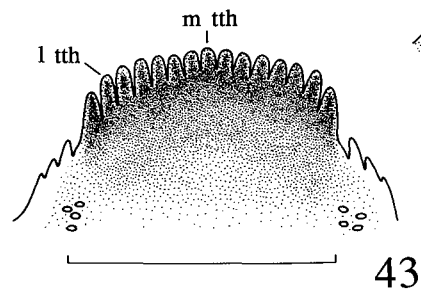
Figures 36–40. Ventral views of larval hypostoma. Fig. 36. *Simulium admixtum* n. sp. Fig. 37. *S. castaneum* n. sp. Fig. 38. *S. cataractarum* n. sp. Fig. 39. *S. lotii* n. sp. Fig. 40. *S. malardei* n. sp. Scale lines = 0.1 mm; l sr = lateral serration; l tth = lateral tooth; m tth = median tooth; pl tth = paralaral teeth; sl tth = sublateral teeth.



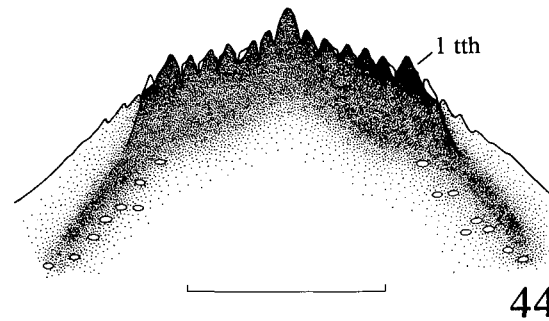
*Simulium mesodontium*



*Simulium opunohuense*

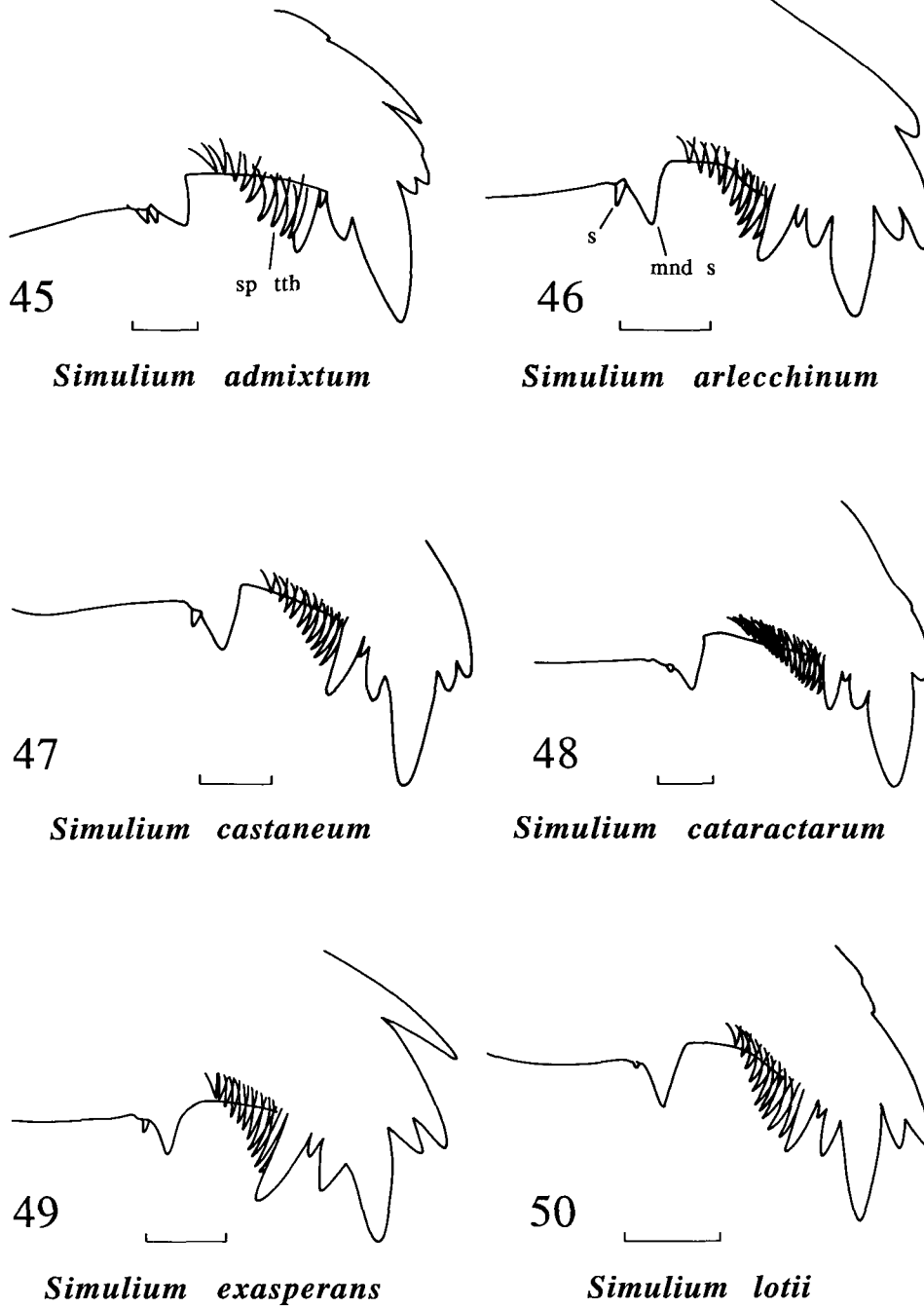


*Simulium oviceps*

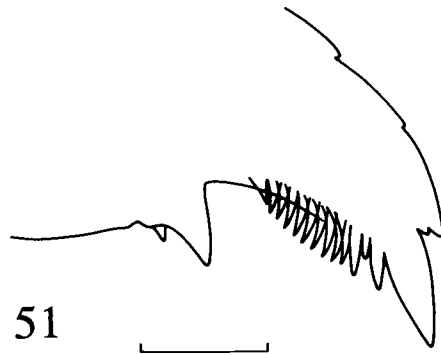


*Simulium tahitiense*

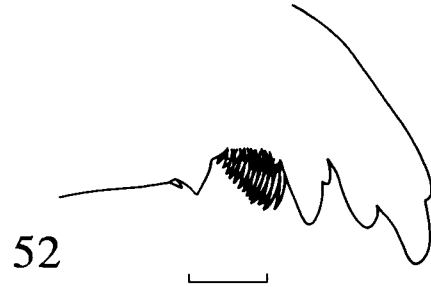
Figures 41–44. Ventral views of larval hypostoma. Fig. 41. *Simulium mesodontium* n. sp. Fig. 42. *S. opunohuense* n. sp. Fig. 43. *S. oviceps* Edwards. Fig. 44. *S. tahitiense* Edwards. Scale lines = 0.1 mm; l tth = lateral tooth; m tth = median tooth.



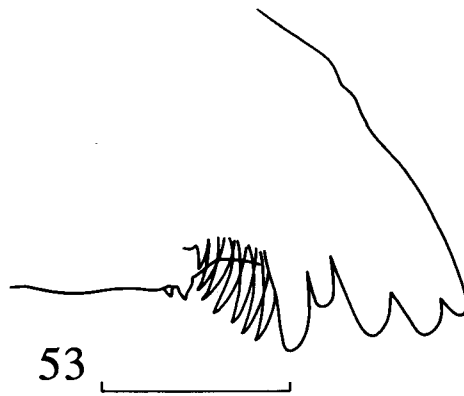
Figures 45–50. Adoral view of left, larval mandibles. Fig. 45. *S. admixtum* n. sp. Fig. 46. *S. arlecchinum* n. sp. Fig. 47. *S. castaneum* n. sp. Fig. 48. *S. cataractarum* n. sp. Fig. 49. *S. exasperans* n. sp. Fig. 50. *S. lotii* n. sp. Scale lines = 0.025 mm; mnd s = mandibular serration; s = sensillum; sp tth = spinose teeth.



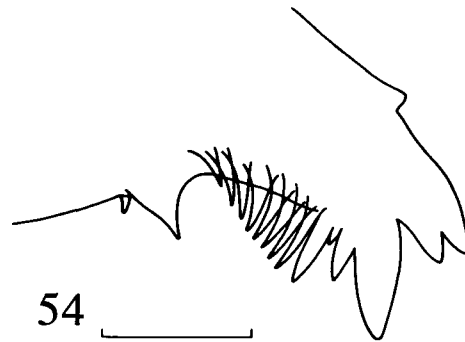
51

*Simulium malardei*

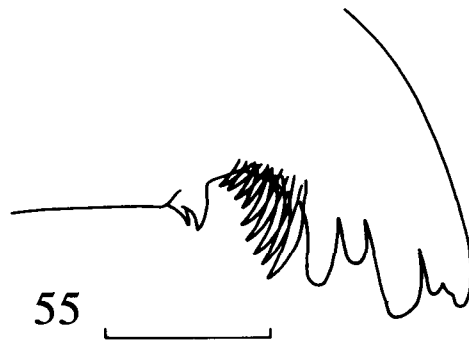
52

*Simulium mesodontium*

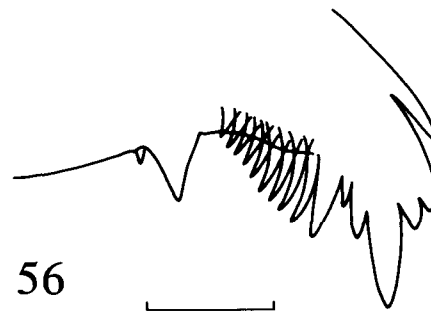
53

*Simulium neoviceps*

54

*Simulium opunohuense*

55

*Simulium oviceps*

56

*Simulium tahitiense*

Figures 51–56. Adoral view of left, larval mandibles. Fig. 51. *Simulium malardei* n. sp. Fig. 52. *S. mesodontium* n. sp. Fig. 53. *S. neoviceps* n. sp. Fig. 54. *S. opunohuense* n. sp. Fig. 55. *S. oviceps* Edwards. Fig. 56. *S. tahitiense* Edwards. Scale lines = 0.025 mm.

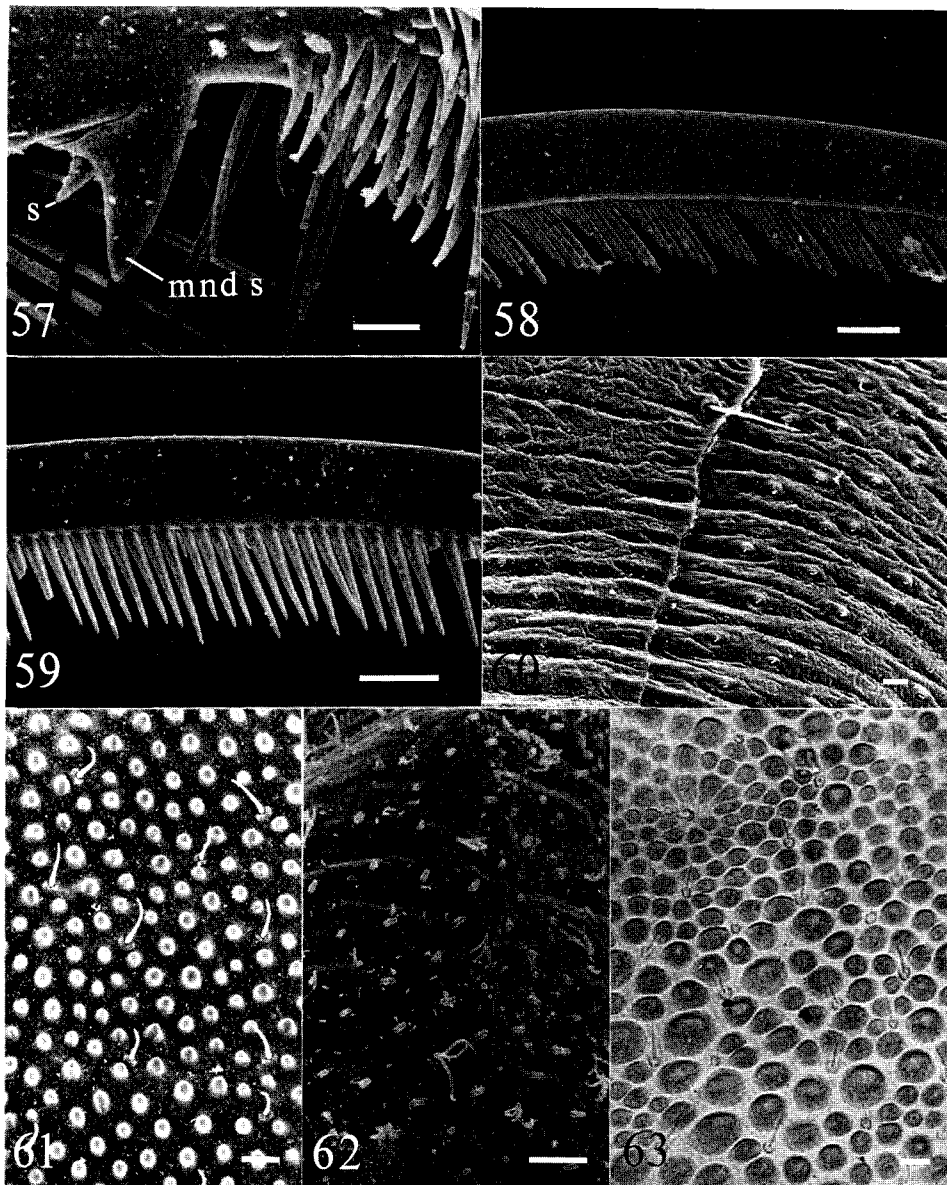
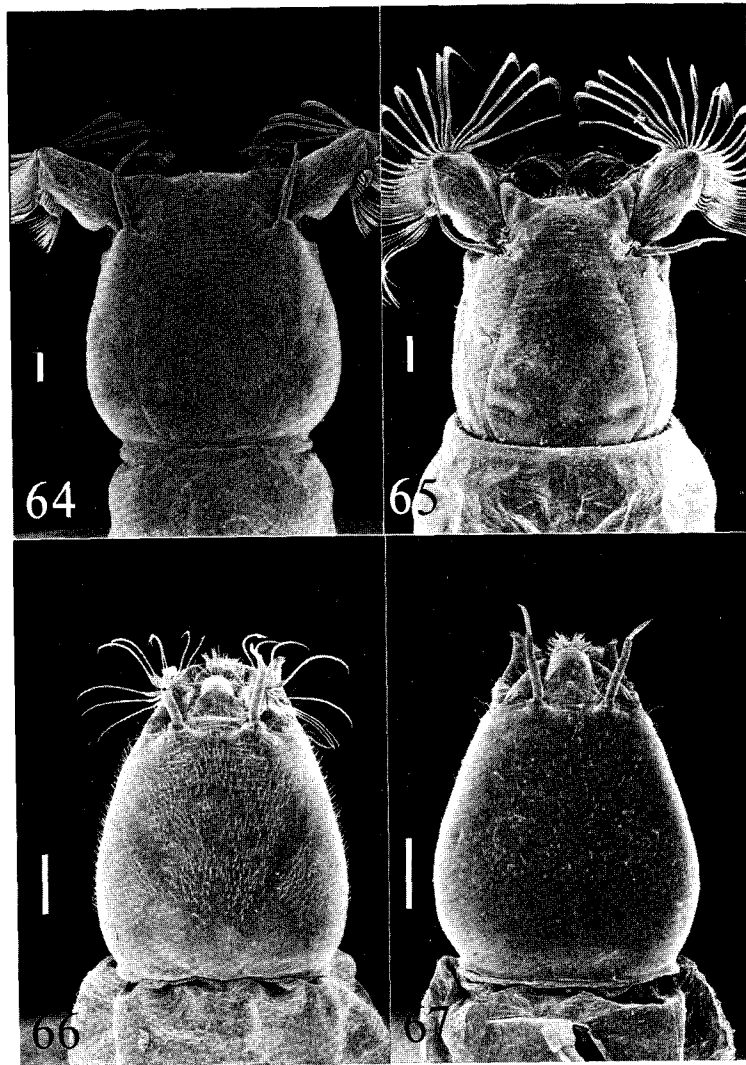


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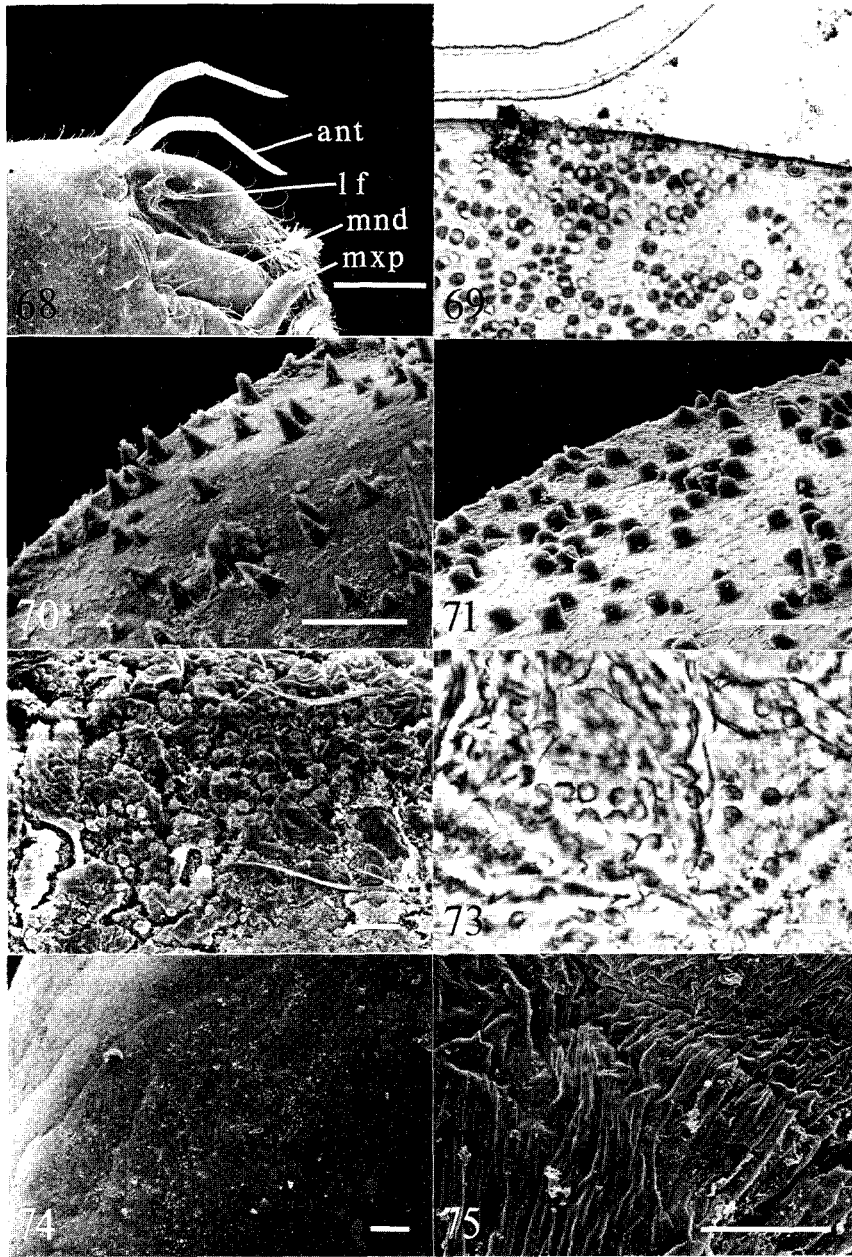


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