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Society Islands beach bum black flies (Diptera: Simuliidae)

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Abstract

Aspects of the body of work on the Central and Western Pacific black fly *Simulium* (*Inseliellum*) are briefly reviewed. Female adults collected from beaches in Tahiti and Raiatea are described as *Simulium* (*Inseliellum*) *littopyga* n. sp., *Simulium* (*Inseliellum*) *littosocius* n. sp. and *Simulium* (*Inseliellum*) *littosodalis* n. sp.. Immature stages of the three species are not associated.

Key words: Simuliidae, *Simulium*, *Inseliellum*, Society Islands, new species

Preliminary discourse

The wide-ranging Pacific simuliid subgenus of *Inseliellum* has been well examined. The segregate is known from Micronesia and the Cook, Austral, Society and Marquesas Islands. In the Marquesas Islands *Simulium buissoni* Roubaud is known to bite humans and poultry, with *S. gallinum* Edwards only ornithophilic (Edwards 1927, 1932, Lavondes & Pichon 1972). Indeed, biting by females of *S. buissoni* was serious enough that they were referred to as the "Scourge of the Pacific" (Edwards 1932, Cheesman 1932) and the species subject to unsuccessful eradication attempts (Fossati & Séchan 1993, Craig *et al.* 1995, Englund 2008). Of some relevance to this present work, females of *S. buissoni* are known to fly considerable distances for a blood meal—even out to moored boats to feed on the inhabitants (Cheesman 1932: 94, Craig 1995: 775).

Of note for Tahiti, larvae of *Simulium oviceps* Edwards, with small labral fans plus concomitant narrowed anterior head, have received considerable attention (Grenier & Rageau 1960, Dumbleton 1962, Davies 1965, Craig 1974, 1975, 1977, 1987), in major part because the head shows similarities to those of fan-less *Gymnopais* and *Twinnia* larvae of Prosimuliini—a similarity that is now known to be an independent development (Currie & Craig 1987). Adults of *S. oviceps* are amongst the smallest known simuliids and have not been recorded as blood feeding. While common, that species is less so than *S. tahitiense* Edwards.

The range of labral fan expression in Polynesian simuliid larvae was integral to a model of fan structure in relation to habitat parameters (Palmer & Craig 2000). Filter-feeding behaviour of Tahitian larvae has been investigated in detail by Schröder (1985, 1988).

Simulium tahitiense immatures are common in the larger rivers of Tahiti and can occur in astronomical numbers. The adults, of moderate size, are often a considerable nuisance, but are not recorded, specifically, as biting. Indeed, the females do not fly more than some metres from running water (Cheesman 1932: 96, DAC pers. obs.). On the other hand, female *Simulium cheesmanae* Edwards—of distinct yellow colour and amongst the largest of known simuliids, do fly well away from running water and are definitively known to bite humans (Craig 1987, 1997).

Up until the study by Craig (1987), only three species of simuliids were known from Tahiti: *S. tahitiense*, *S. oviceps* and *S. cheesmanae*; the last only from adults. The discovery that Tahitian simuliids inhabited cascades (*e.g.*, *S. cataractarum* Craig 1987) changed the search paradigm of habitats and led to numerous species from

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unusual habitats, mainly madicolous flows (thin films of water). With the three new species described here, numbers now presently total some 34 for Tahiti and 56 for Polynesia as a whole (Craig & Joy 2000, Craig 2004, Adler & Crosskey 2017). An estimate as to possible numbers of simuliid species for Tahiti was made by Craig (1987: 408) and later (Craig 1997: 869, Craig 2004: 2). All were incorrect because numbers of the species described were eventually shown to be species complexes. Not only will unusual habitats need further examination, time of year of collection is here suggested as important for discovering new species.

Nonetheless, this now-recognized species radiation, plus known ages of Polynesian hot-spot islands led to phylogenetic (*e.g*., Craig & Currie 1999, Craig *et al*. 2001), cytological (Spironello *et al*. 2002), molecular- and genetic-based examinations (Joy & Conn 2001, Joy *et al.* 2007), plus biogeographic speculation (*e.g*. Craig 2003), and was used to test the McArthur-Wilson biogeographic model (*e.g*. Spironello & Brooks 2003).

Despite the amount of collecting effort since the late 1920s, no simuliid from the Society Islands has ever been reported as collected from a beach, this despite considerable time spent in such places by various collectors. However, as part of general collecting of aquatic Diptera of Tahiti and Raiatea (a component of a grant-funded terrestrial arthropod survey of French Polynesia), adults of previously unknown simuliids were collected along beaches (*e.g*., Fig 42).

An overarching problem for Society Island simuliids is that the majority of species are known only from distinctive larvae; neither pupae nor adults having ever been associated. As noted below, the possibility exists that the three species described here from female adults have already been described as immatures.

Material and methods

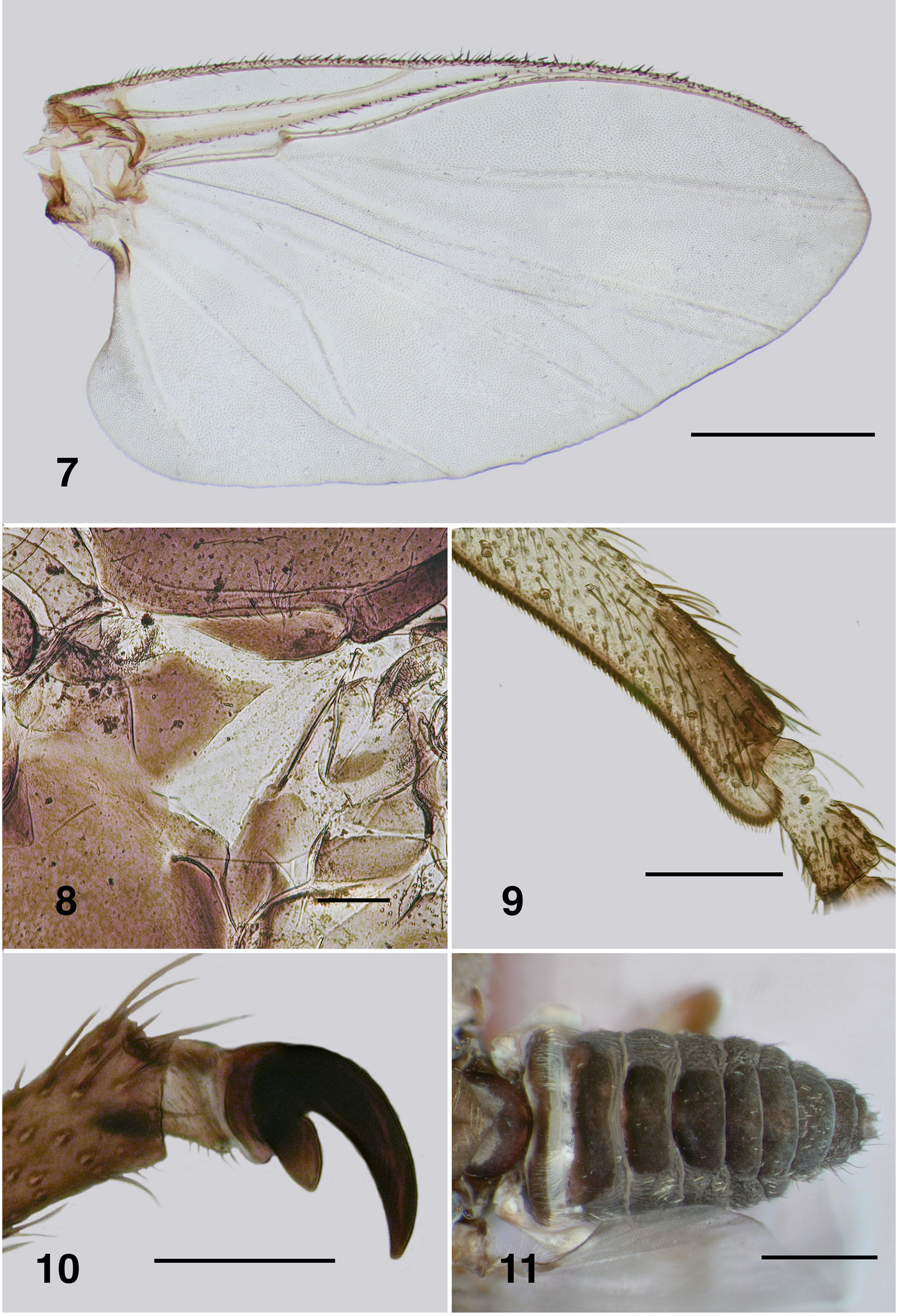
Examination follows that of Craig *et al*. (2012). Original alcohol material was dried using Peldri II™. All images are by DAC except where noted. Individual labels are indicated by square brackets [ ] with a slash (/) to indicate a new line of text. All material is deposited in the Bernice P. Bishop Museum, Honolulu (BPBM).

***Simulium* (*Inseliellum*) *littopyga* Craig & Evenhuis, n. sp.**

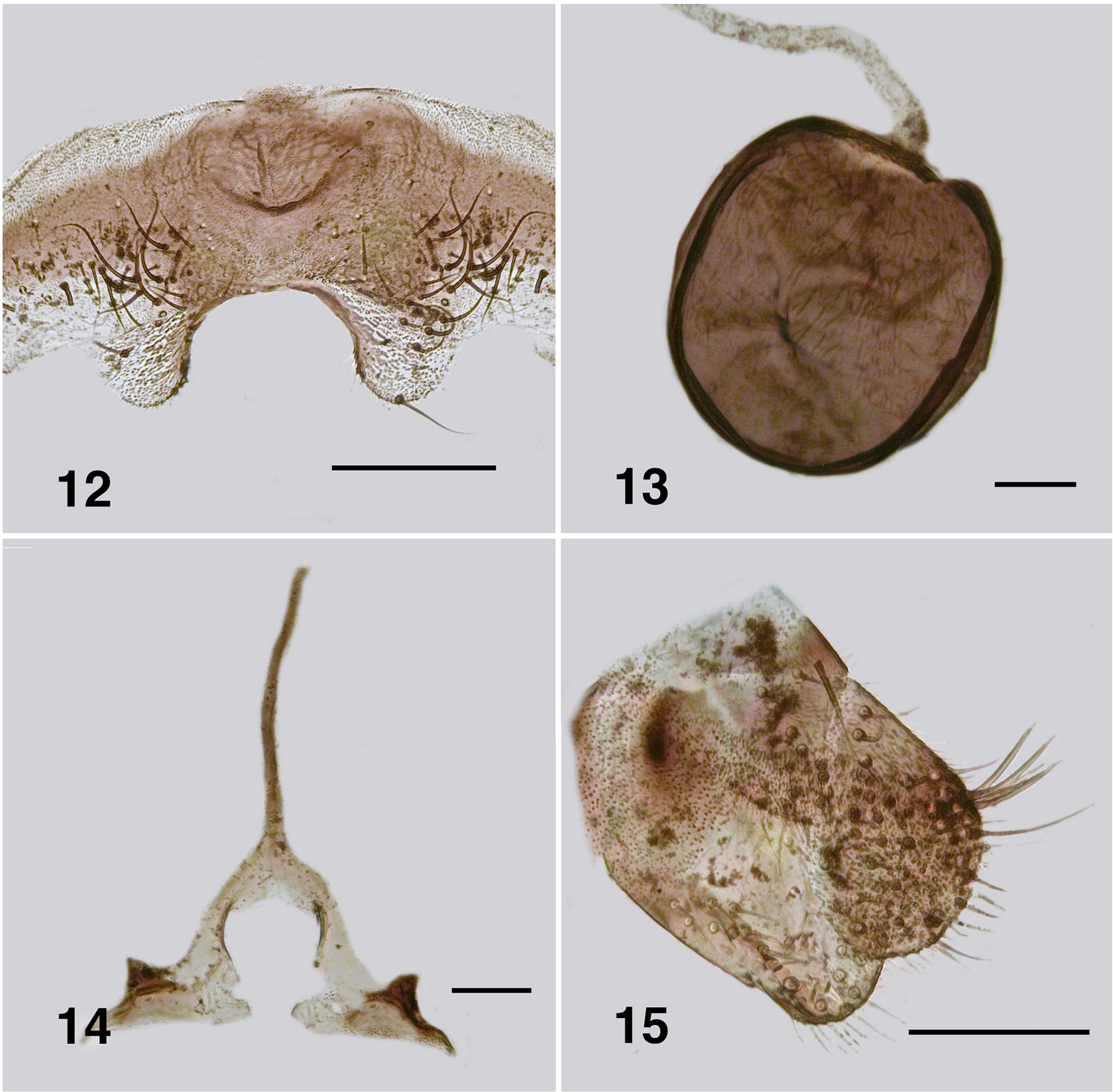
Figs. 1–15.

Description. *Adult female* (based on 21 specimens). *Body* (Figs. 1): overall dark brown, abdomen occasionally mottled ventrally; total length 2.0–2.6 mm. *Head* (Fig. 2): width 0.79 mm; depth 0.57 mm; postocciput with sparse black hairs; frons black, decreased slightly in width ventrally, with sparse hairs laterally, frons/head ratio 1.0:17.0; frontal angle 50º. *Eye*: dark orange, interocular distance 0.1 mm; ommatidia diameter 0.014 mm; *ca.* 24 rows across and 30 down at mid-eye. *Clypeus*: width 0.2 mm; blackish brown, bare. *Antenna* (Figs. 2, 3): not markedly extended beyond head margins, overall clear pale yellow, nine flagellomeres; total length 0.55 mm; scape and pedicel slightly darker, pedicel rounded; flagellomere I square; flagellomere II twice as wide as long, III–VIII similar in shape, gradually increased in length, flagellomere IX cone shaped. *Mouthparts*: not markedly developed, *ca.* 0.3x length of head depth; maxillary palp (Fig. 4) length 0.56 mm, palpomeres I and II small, palpomere III small and sub-cylindrical, sensory vesicle occupying half of palpomere, palpomere V subequal in length to remainder of palp, proportional lengths of palpomeres III–V 1.0:1.3:2.6, respectively; mandible (Figs, 4, 5) slightly flared apically with *ca.* 19 small blunt inner teeth, outer teeth absent; lacinia with 15 and 13 teeth on inner and outer edge respectively; cibarium (Fig. 6) with cornuae sclerotized apically, lightly sculpted, median gap angulate. *Thorax*: length 1.0–1.1 mm; width 0.8–0.9 mm; evenly blackish brown, with sparse fine pale vestiture; postpronotal lobe well developed with vestiture as for scutum; antepronotal lobe with sparse hairs; proepisternum with clump of hairs, fore coxa with sparse hairs; scutellum concolourous with scutum, vestiture of longer hairs, V-shaped apically, markedly overhanging the postnotum; postnotum concolourous with scutum, pollinose anteriorly, bare; anepisternal membrane bare (Fig. 8); katepisternum dark brown, sulcus distinct. *Wing* (Fig. 7): membrane slightly dusky on apex and anal lobe, length 2.1–2.4 mm; width 1.1–1.2 mm; anterior veins markedly expressed; costa with mixture of thin hairs and short substantial spines; subcosta bare apically; radius with spines and hairs; a/b ratio 1.0:3.6; r-m cross vein slightly pigmented; basal medial cell well expressed; M_1 slightly doubled; CuA_2 not markedly sinuous; A_2 extended nearly to wing margin; narrow sclerotised crescent in anal lobe angle. *Haltere*: white. *Legs*: overall yellow; fore and mid legs with tarsomeres brown; hind legs yellow with distal end of

FIGURES 1–6. *Simulium* (*I*) *littopyga* **n. sp**. (1). Holotype, female *Simulium* (*I.*) *littopyga*. In ETOH. Scale bar = 0.5 mm. (2) Frontal view of head. Scale bar = 0.2 mm. (3). Antenna. Scale bar = 0.1 mm. (4). Maxillary palp, mandible, lacinia. Scale bar = 0.1 mm. (5). Mandible apex. Scale bar = 0.02 mm. (6). Cibarium. Scale bar = 0.05 mm.



FIGURES 7–11. *Simulium* (*I.*) *littopyga* **n. sp**. (7). Wing. Scale bar = 0.5 mm. (8). Anepisternal membrane. Scale bar = 0.1 mm. (9). Hind basitarsus, calcipala, pedisulcus. Scale bar = 0.1 mm. (10). Claw & basal tooth. Scale bar = 0.05 mm. (11). Abdominal tergites. (Holotype, dried). Scale bar = 0.5 mm.



FIGURES 12–15. *Simulium* (*I.*) *littopyga* **n. sp**. (12). Hypogynial valves. Scale bar = 0.1 mm. (13). Spermatheca. Scale bar = 0.02 mm. (14). Genital fork. Scale bar = 0.05 mm. (15). Cercus & anal lobe. Scale bar = 0.05 mm.

basitarsus brown as are other tarsomeres; hind basitarsus narrowed, ventral regular row of stout spines proximally, less so distally; calcipala slightly flared laterally, half width of tarsomere, as long as wide; pedisulcus distinct; tarsomere II about 2.0–2.2 times as long as distal width (Fig. 9); claw (Fig. 10) with main talon well curved and evenly tapered, basal tooth 0.25x length of claw, thumb-like, heel small. *Abdomen* (Fig. 11): basal scale vestiture short, barely reaching tergite II; tergites II–VI well sclerotized, vestiture essentially absent from tergites II–IV, tergite II 5x wider than long, tergite III 3x wider than long, tergite IV 2x wider than long, ovoid, tergites V and VI 3x wider than long, tergites VII and VIII not markedly expressed, with vestiture of sparse pale scales. *Genitalia*: markedly small, yellowish; sternite VIII with distinct depression medially, with large strong hairs posterolaterally; hypogynial valves (Fig. 12), lightly pigmented, vestiture of triads of microtrichia and strong hairs, valves markedly separated, median edges of valves broadly concave and strengthened, rounded apically; spermatheca spherical, small, but strongly expressed (Fig. 13), surface lightly wrinkled, internal spines (acanthae) absent, membranous area at junction with spermathecal duct not distinct; genital fork (Fig. 14) with stem narrowed, not expanded apically, lateral arms moderately spread with lightly strengthened medial edges, lateral plates not markedly expressed, apodeme distinct; cercus in lateral view small, broadly rounded, with marked cluster of stiff setae apically, anal lobe small, rounded (Fig. 15).

Male: unknown.

Immatures: not associated.

Material. *Holotype*: Female, micropinned. Dried from ETOH. Label data:- [Holo / type] [*Simulium*/ (*Inseliellum*) / *littopyga*] [FP: TAHITI ITI: 3.5 km E. / Tautira. 0 m, North Road / beach rubble, 18 Jul 2006 / N. Evenhuis, P. O'Grady] [BPBM 17,838], (*ca*. S17.7667° W149.1411°).

Paratypes: Five females, micropinned. Five females in ETOH. Labels as for Holotype, but with [Para / type].

Other material: Two adults as slide mounts. Locality data as for types. Three adults each in ETOH, respectively, from [FP: TAHITI NUI: / North Road, PK 42.7 / 17 Jul 2006, 0 m, beach / rocks. N. Evenhuis], (*ca*. S17.6474° W149.3103°); [FP: TAHITI NUI / Trou de Souffler, 0 m / 17 Jul 2006, beach rocks / N. Evenhuis], (aka Arahoho Blowhole. *ca*. S17.5256° W149.3909°) and [FP: TAHITI ITI: 3.5 km E./ Tautira, 0 m, North Road/ beach rubble, 18 Jul 2008/ N. Evenhuis, P. O'Grady].

Etymology. In reference to inhabiting beaches; deriving from *litto* [= "beach"] + *pyga* [= "rump"]; hence a "beach bum" of sorts. The name is treated as a noun in apposition.

Distribution. Known only from Tahiti.

Remarks. In the key to Tahitian simuliid adults then known (Craig 1987: 378), *Simulium littopyga* would key out at the first couplet as *S. cheesmanae*; on the basis of yellow antennae and legs. However, it differs in being smaller than the smallest known *cheesmanae* adult, the body is darker and the hypogynial valves (Fig. 12) and spermatheca (Fig. 13) are markedly different (Craig 1987: *cf*. his Fig. 4).

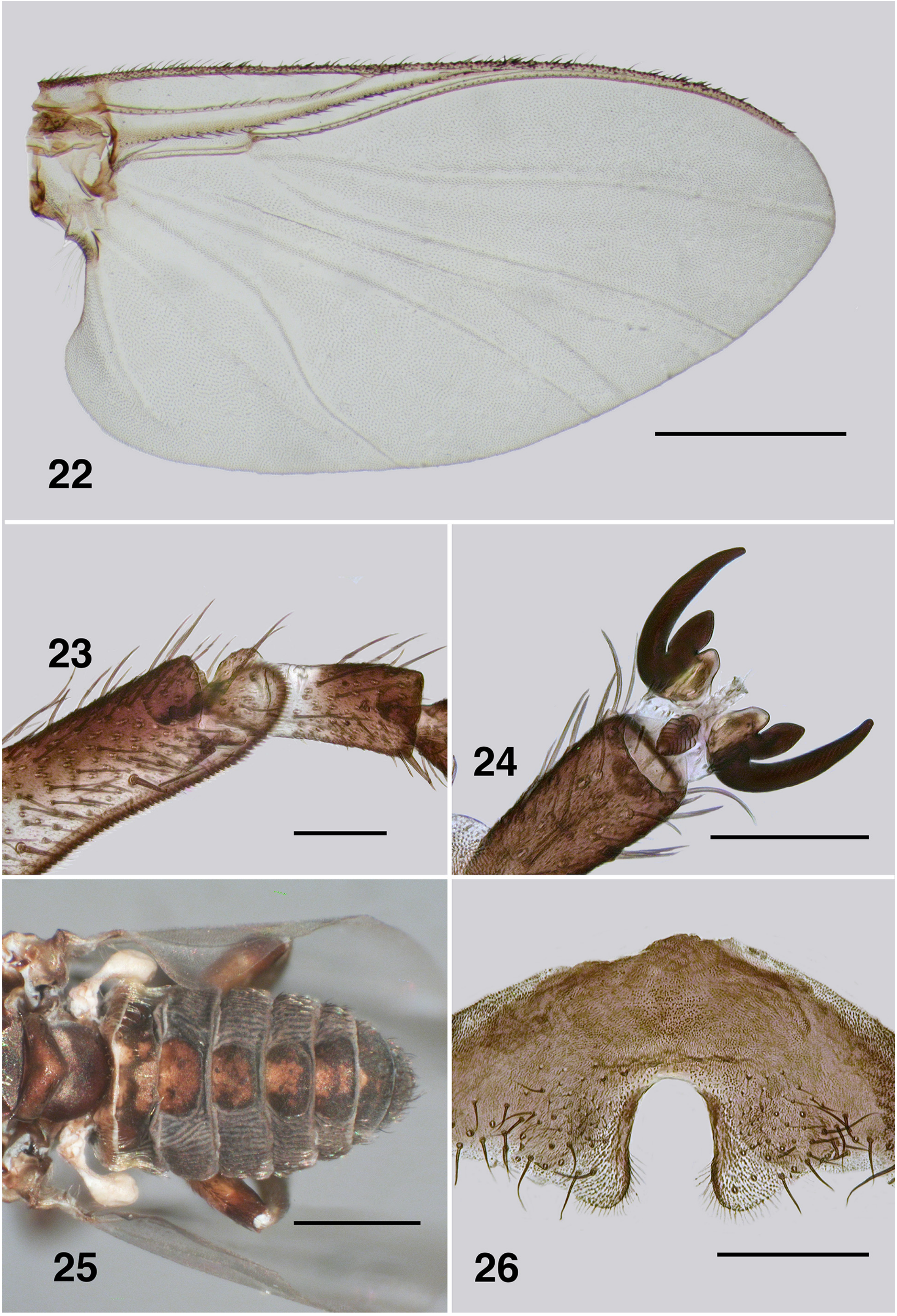
Of significance is the restricted beach-inhabiting behaviour of *S. littopyga.* With exception of *S. cheesmanae*, females of which are known to bite humans, all other known females of Tahitian simuliids have flying behaviour limited to near running fresh water. For *S. littopyga*, smaller mouthparts, teeth only on one side of the mandibles, moderately expressed laciniae and, in particular, well-toothed claws suggest ornithophily (*e.g.* Adler *et al*. 2004, Malmqvist *et al*. 2004).

***Simulium* (*Inseliellum*) *littosocius* Craig & Evenhuis, n. sp.**

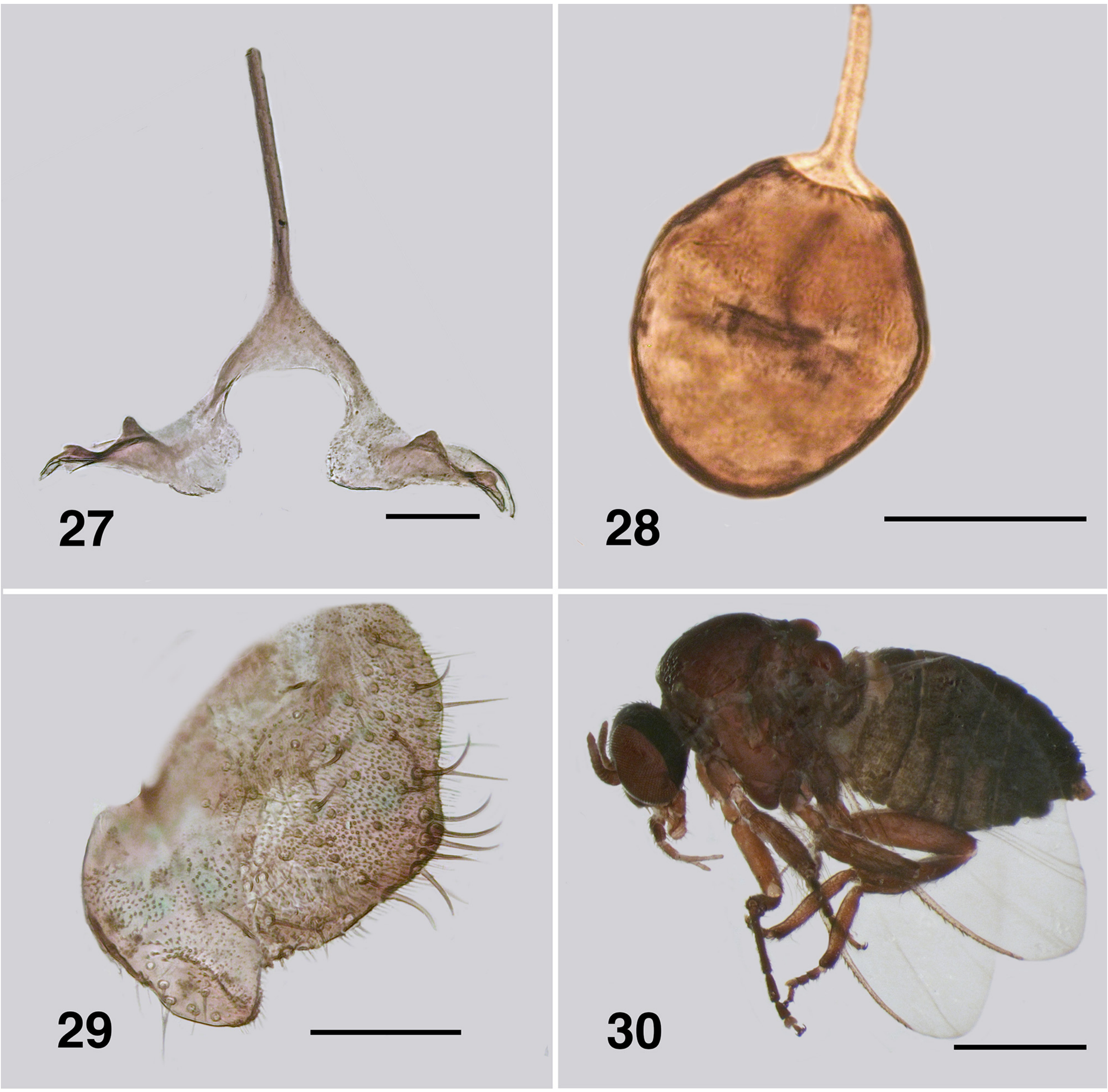
Figs. 16–29.

Description. *Adult female* (based on 12 specimens). *Body* (Figs. 16): overall dark brown, abdomen lighter ventrally; total length 2.0–2.5 mm. *Head* (Fig. 17): width 0.66 mm; depth 0.46 mm; postocciput black with sparse vestiture of short black hairs; frons markedly narrowed ventrally, frons/head width ratio 1.0:14.0; frontal angle 30°. *Eye*: interocular distance *ca*. 0.14 mm; eyes dark red, ommatidia diameter 0.01 mm; *ca.* 26 rows across and 36 down at mid-eye. *Clypeus*: width 0.14 mm; mottled dark brown, vestiture of scattered hairs ventrally. *Antenna* (Figs. 18): total length 0. 55 mm; evenly dark brown with scape and pedicel paler yellow and subspherical, flagellomere I angulate and as wide as long; flagellomere II markedly wider than long, II–VIII increasing in length, flagellomere IX slightly cone-shaped. *Mouthparts*: feebly developed, *ca.* 0.25× length of head depth; maxillary palp (Fig. 19) length 0.55 mm, palpomere V subequal in length to remainder of palp, palpomeres I and II small, palpomere III small, spherical and darker than other palpomeres, proportional lengths of palpomere III–V 1.0: 1.0: 2.3 respectively; sensory organ spherical, 0.5 length of palpomere III; mandible (Figs. 19, 20) not flared apically, *ca.* 17 inner teeth, outer teeth absent; lacinia small, with 9 inner teeth and 10 or 11 outer teeth; cibarium (Fig. 21) with narrow cornuae sclerotized apically and lightly sculpted, median gap broadly V-shaped. *Thorax*: length 0.7–1.0 mm; width 0.7–0.9 mm; scutum black, postpronotal lobe slightly paler than scutum, vestiture slightly longer; scutellum slightly paler than scutum, vestiture of sparse very fine yellowish hairs; postnotum concolourous with scutellum; antepronotal lobe with patch of yellow hairs; proepisternum with sparse hairs; anepisternal membrane bare; katepisternum dark brown, sulcus deep and distinct. *Wing* (Fig. 22): membrane slightly dusky on anal lobe, length 2.1–2.3 mm; width 0.8–0.9 mm; anterior veins well expressed; costa and radius with mixture of hairs and spines; a/b ratio 1.0:4.3; basal cell distinct; CuA_2 not markedly sinuous; A_2 extended nearly to wing margin; narrow sclerotised crescent in anal lobe angle. *Haltere*: tan or white. *Legs* (Fig. 23): overall dark brown, except hind basitarsus yellowish with distal dark brown region, row of ventral stout spines poorly expressed; calcipala slightly more than 0.5 width of basitarsus, slightly flared laterally; pedisulcus well expressed; tarsomere

FIGURES 16–21. *Simulium* (*I.*) *littosocius* **n. sp.** (16). Holotype, female *Simulium* (*I*) *littosocius*. In ETOH. Scale bar = 1.0 mm. (17). Frontal view of head. Scale bar = 0.2 mm. (18). Antenna. Scale bar = 0.1 mm. (19). Maxillary palp, lacinia, mandible. Scale bar = 0.1 mm. (20). Mandible apex. Scale bar = 0.02 mm. (21). Cibarium. Scale bar = 0.1 mm.



FIGURES 22–26. *Simulium* (*I.*) *littosocius* **n. sp.** (22). Wing. Scale bar = 0.5 mm. (23). Hind basitarsus, calcipala, pedisulcus. Scale bar = 0.05 mm. (24). Claw & basal tooth. Scale = 0.02 mm. (25). Abdominal tergites (holotype). Scale bar = 0.5 mm. (26). Hypogynial valves. Scale bar = 0.1 mm.



FIGURES 27–30. *Simulium* (*I.*) *littosocius* **n. sp. FIGURE 30.** *Simulium* (*I*) *littosodalis* **n. sp.** (27). Genital fork. Scale bar = 0.05 mm. (28). Spermatheca. Scale bar = 0.05 mm. (29). Cercus & anal lobe. Scale bar = 0.05 mm. (30). Holotype. In ETOH. Scale bar = 0.5 mm.

II *ca*. 2.5 times as long as distal width; claw (Fig. 24) with main talon finely curved and tapered, apex moderately blunt, basal tooth large, *ca*. 0.5x length of claw, heel substantial and rounded. *Abdomen* (Fig. 25): dorsally black, mottled ventrally, tergites paler and mottled; basal scale dark brown, mottled medially, vestiture of short hairs; tergite II broadly U-shaped, 3x wider that deep, tergites III–VII lozenge-shaped, 3x time wider than long, increasing in width posteriorly, vestiture essentially absent from anterior segments, slightly more dense on posterior segments. *Genitalia*: sternite VIII evenly pigmented, not depressed medially; hypogynial valves (Fig. 26) with median gap deeply U-shaped, medial edges strengthened, vestiture of sparse hairs laterally, valves cone-shaped, rounded apically; genital fork (Fig. 27) with stem smooth, narrowed, not expanded apically, lateral arms short, lateral plates small, elongated laterally, apodeme moderately expressed; spermatheca ovoid (Fig. 28), small, dark brown, with slightly wrinkled surface, lacking internal spines, membranous area at junction with spermathecal duct with fluted edge; cercus in lateral view shallowly cone-shaped, concentration of hairs apically, anal lobe small, rounded, protruded ventrally (Fig. 29).

Material. *Holotype*: Female, micropinned. Dried from ETOH. Label data:- [Holo/ type] [*Simulium*/ (*Inseliellum*)/ *littosocius*] [FP: TAHITI ITI: 3.5 km E. / Tautira, 0 m, North Road / beach rubble, 18 Jul 2006 / N. Evenhuis, P. O'Grady] [BPBM 17,839], (*ca*. S17.7667° W149.1411°).

Paratype: Three females micropinned, as for holotype. One microscope slide. Labels with [PARATYPE].

Other material: One microscope slide, two female in ETOH, labels [FP: TAHITI ITI: 0 m, / North Road. PK5 Punatea / Village 19 Jul. [2006] coral / beach rubble. N. Evenhuis], (*ca*. S17.7370° W149.27185°). Two females, ETOH, labels [FP: TAHITI NUI: / North Road, PK 20 / 22 Jul 2006, beach / rocks. Evenhuis] (*ca*. S17.5160° W149.4054°). One female, ETOH [FP: TAHITI NUI, 0 m, / North Road, PK 48, beach / rocks at Vaihi Riv, 30.III.07 / N. Evenhuis], (ca. S17.6765°, W149.3064°). Two females in ETOH. Label [FP: RAIATEA, 0 m / Baie Pufau, 21 Mar 2007 / 16.760158°S 151.48886°W / beach rubble, N. Evenhuis].

Etymology. In reference to the association with beaches; deriving from *litto* [= "beach"] + *socius* [= "companion"]; hence a second "beach bum" of sorts. The name is treated as a noun in apposition.

Distribution. Known from Tahiti and Raiatea.

Remarks. Female *Simulium littosocius* are easily distinguished from those of *S. littopyga* on the basis of brown antenna with yellowish scape and pedicel, and browner legs. Additionally, *S. littosocius* is smaller in size and the width of the frons in relation to head width is markedly narrowed (Fig. 17) in comparison to that of *S. littopyga* (Fig. 2) and *S. littosodalis* (Fig. 31), below.

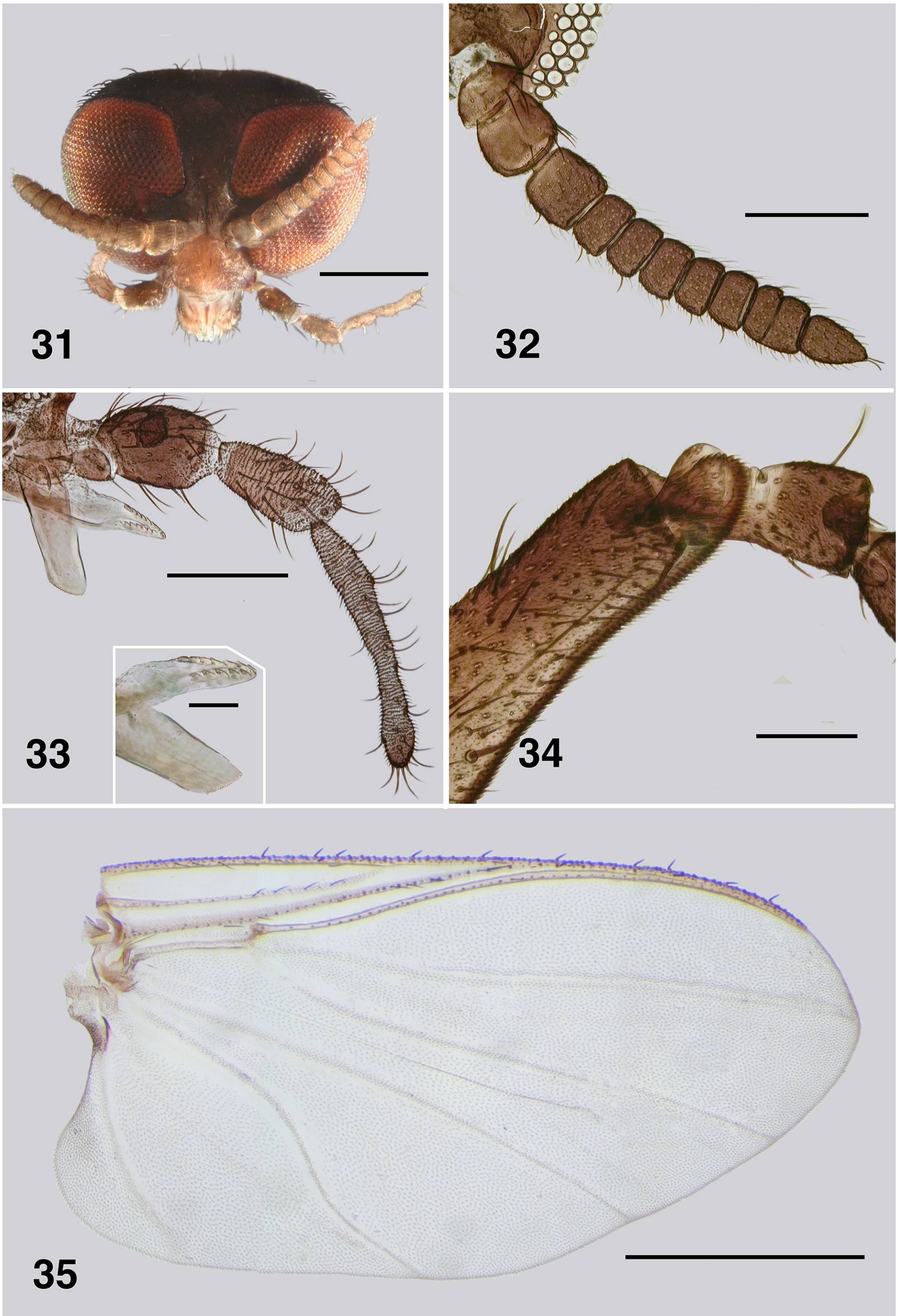
Abdominal tergites (Fig. 25) of *S. littosocius* are well developed, but not as broad as those of *S. littopyga* (Fig. 11). *Simulium littosocius* mandibles are parallel-sided, not slightly flared as in *S. littopyga* (*cf.* Figs. 4, 20). Expression of the hypogynial valves differs between the two species (*cf.* Figs. 12, 26). Differences in the claw tooth and heel is marked, with both structures much smaller in *S. littopyga* (*cf.* Figs. 10, 24).

The presence of *S. littosocius* on Raiatea, 250 km to the WNW of Tahiti, is not surprising, since the island shares *S. malardei* Craig*, S. lotii* Craig and *S. oviceps* with Tahiti. Precinctive to Raiatea are *S. pufauense* Craig, *S. castaneum* Craig, *S. proctorae* Craig and *S. bogusium* Craig (*e.g*., Craig & Joy 2000).

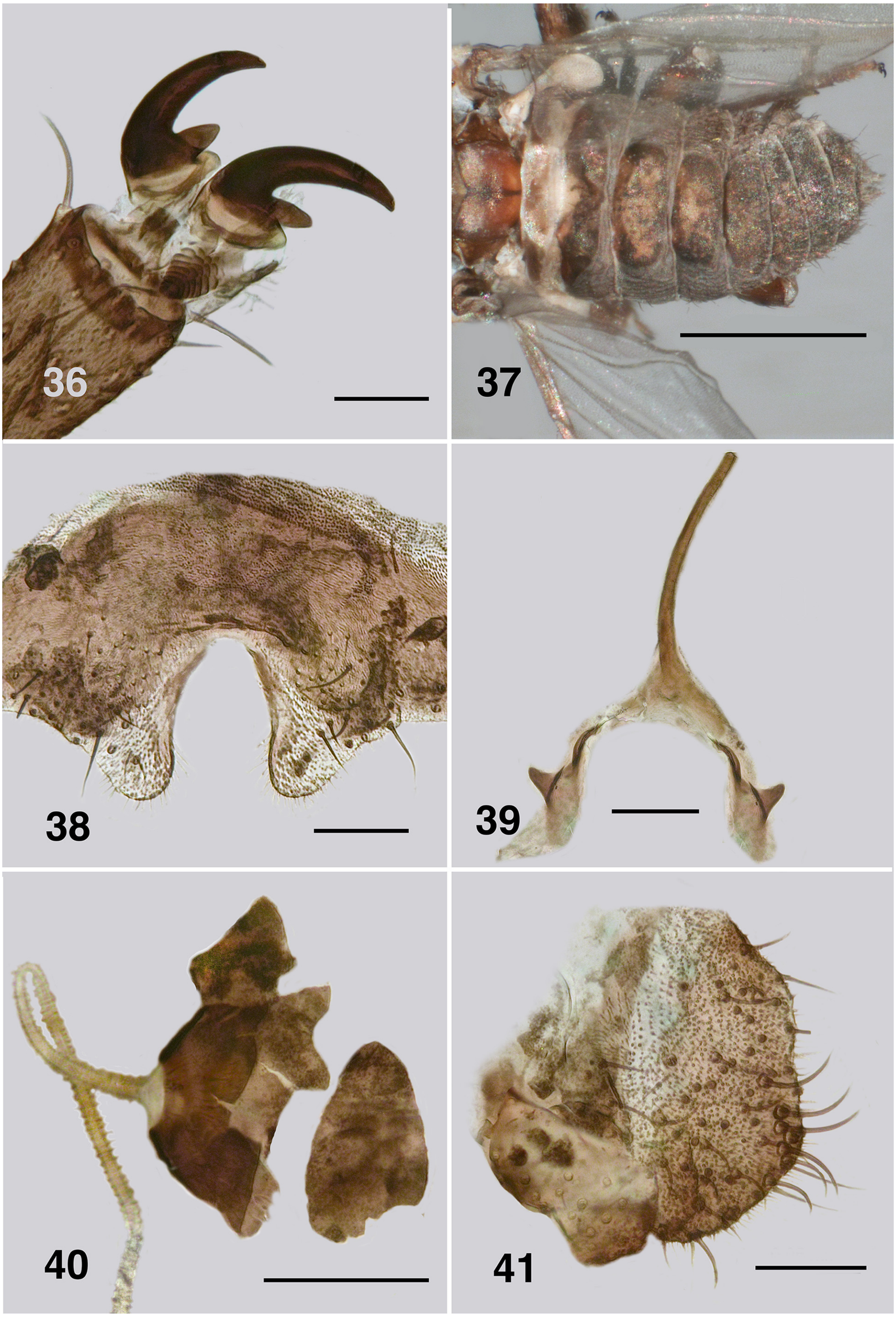
***Simulium* (*Inseliellum*) *littosodalis* Craig & Evenhuis, n. sp.**

Figs. 30–41.

Description. *Adult female* (based on 7 specimens). *Body* (Figs. 30): overall dark blackish brown, abdomen slightly lighter ventrally; total length 1.5–1.9 mm. *Head* (Fig. 31): width 0.55–0.58 mm; depth 0.36–0.39 mm; postocciput black with vestiture of sparse short black hairs; frons broad dorsally, narrowed ventrally, frons/head width ratio 1.0:7.5; frontal angle 50°. *Eye*: minimum interocular distance *ca*. 0.08 mm; eyes dark red, ommatidia diameter 0.012 mm; *ca* 36 down and up at mid-eye. *Clypeus*: width 0.14 mm; mottled medium brown, vestiture of scattered hairs. *Antenna* (Figs. 32): total length 0.40–0.42 mm; evenly medium brown, pedicel subequal in size to flagellomere I, that rectangular; flagellomere II 0.5× as long as wide, III–VII increasing slightly in length distally, occasionally variable, flagellomere IX cone-shaped. *Mouthparts*: feebly developed, *ca.* 0.27× length of head depth; maxillary palp (Fig. 33) length 0.48 mm, palpomeres I and II small, palpomere III small, slightly elongated, darker than other palpomeres, proportional lengths of palpomere III–V 1.0:1.0:2.0, respectively; sensory organ spherical, 0.25x length of palpomere III, opening 0.3× vesicle width; mandibles (Fig. 33) small, not flared distally, straight sided, *ca*. 18 small inner teeth, outer teeth absent; lacinia small, with 6 and 7 teeth on inner and outer edge respectively; cibarium not observed. *Thorax*: length 1.0–1.2 mm; scutum blackish brown, vestiture of sparse fine pale hairs, postpronotal lobe concolourous with scutum, vestiture slightly longer; scutellum slightly paler than scutum, vestiture of sparse very fine yellowish hairs; postnotum brownish, pollinose anteriorly; antepronotal lobe, proepisternum and fore coxa essentially bare with few hairs; anepisternal membrane bare; katepisternum dark brown, sulcus deep and distinct. *Wing* (Figs. 35): membrane slightly smoky on anal lobe, length 1.6–1.8 mm; width 0.8–0.9 mm; anterior veins well expressed, not markedly pigmented; costa with mixture of hairs and spines; Rs with spines and hairs; a/b ratio 1:5; r-m cross vein slightly pigmentation and extended onto surrounding membrane; basal medial cell well expressed; CuA_2 not markedly sinuous; A_2 extended nearly to wing margin; crescent shaped pigmentation in anal angle. *Haltere*: tan. *Legs* (Fig. 34): overall dark brown and hirsute, forelegs with markedly darker tarsomeres, less so on mid and hind legs; hind tibia slightly curved, with row of ventral stout spines poorly expressed and absent from distal portion; calcipala half width of hind basitarsus, as long as wide; pedisulcus well



FIGURES 31–35. *Simulium* (*I.*) *littosodalis* **n. sp.** (31). Frontal view of head. Scale bar = 0.2 mm. (32). Antenna. Scale bar = 0.1 mm.(33). Maxillary palp, lacinia, mandible Scale bar = 0.1 mm. Insert: mandible & lacinia tips. Scale bar 0.02 mm. (34). Hind basitarsus, calcipala, pedisulcus. Scale bar = 0.05 mm.(35). Wing. Scale bar = 0.5 mm.



FIGURES 36–41. *Simulium* (*I.*) *littosodalis* **n. sp.** (36). Claw & basal tooth. Scale bar = 0.02 mm. (37). Abdominal tergites. Scale bar = 0.5 mm. (38). Hypogynial valves. Scale bar = 0.05mm. (39). Genital fork. Scale bar = 0.05 mm.(40). Spermatheca. (Damaged). Scale bar = 0.05 mm.(41). Cercus & anal lobe. (Damaged and partially reconstructed). Scale bar = 0.05 mm.

FIGURE 42. Type locality of *Simulium littosodalis*. Tahiti Nui, North Road, PK 42.7. 17 July 2006. Image N. Evenhuis.

expressed; tarsomere II *ca*. 2.0× as long as distal width; claw (Fig. 36) small, with main talon moderately curved and evenly tapered, basal tooth small, 0.25x length of claw, heel cone-shaped and insubstantial. *Abdomen* (Fig. 37): dorsally evenly black, tergites paler and mottled; basal scale dark brown, markedly pale medially, vestiture of short hairs; tergite II, 4x broader than long, tergites III–V 3x broader than long, remainder of tergites markedly broad**,** vestiture essentially absent, better expressed on posterior segments. *Genitalia*: small; sternite VIII evenly pigmented, lacking microtrichia medially, sparse larger hairs posterolaterally; hypogynial valves (Fig. 38), lightly pigmented, vestiture of microtrichia and sparse strong hairs, median gap between valves deeply U-shaped, slightly narrowed anteriorly, edges slightly divergent posteriorly and concave, strengthened medially, smoothly rounded apically; genital fork (Fig. 39) stem markedly evenly narrowed, not expanded apically, lateral arms narrow, strengthened posteromedially, lateral plates small, elongated posterolaterally, apodemes sharply developed; spermatheca ovoid (Fig. 40), small, dark brown, with slightly wrinkled surface, lacking internal spines, membranous area at junction with spermathecal duct small with fluted edge; cercus lightly pigmented, in lateral view bluntly rounded, with slight apical depression, clump of apicoventral hairs not marked, anal lobes small, angulate (Fig. 41).

Etymology. In reference to occurring with other beach simuliids; deriving from *litto* [= "beach"] + *sodalis* [= "comrade", "crony"]; hence a third "beach bum" of sorts. The name is treated as a noun in apposition.

Material. *Holotype*: Female, micropinned. Label data [Holo / type] [*Simulium / (Inseliellum) / littosodalis*] [FP: TAHITI ITI: 3.5 km E. / Tautira, 0 m, North Road / beach rubble, 18 Jul 2006 / N. Evenhuis, P. O'Grady] [BPBM 17,840], (*ca*. S17.7667° W149.2719°).

Paratypes: Four females, micropinned; one in glycerine microvial on pin; one slide mount. Label data as for holotype, but with [PARATYPE].

Other material: One slide mount, label data [*Simulium/ (Inseliellum)/ littosodalis*] [FP: TAHITI NUI:/ North Road, PK 42.7 / 17 Jul 2006, 0 m, beach/ rocks. N. Evenhuis]. (*ca*. S17.6474° W149.3103°). (Fig. 42)

Distribution. Known only from Tahiti.

Remarks. *Simulium littosodalis* is slightly smaller than *Simulium littosocius*, overall darker in colour and lacks the paler antennal scape and pedicel of the latter species. The frons is markedly broader than that of *S. littosocius* (*cf.* Figs. 17, 31). The mandibles of both species are parallel sided (*cf.* Figs. 20, 33), not slightly flared as in *S. littopyga*. *Simulium littosodalis* has low numbers of teeth on the lacinia (Fig. 33) and its legs are more evenly brown and hirsute than those of *S. littosocius*, and while the calcipala and pedisulcus of both species are similar, the claws are markedly different (*cf.* Figs. 24, 36), with *S. littosocius* possessing a large basal tooth and heel; both in *S. littosodalis* are smaller. Abdominal tergites differ, with those of *S. littosodalis* larger (*cf.* Figs. 25, 37). The genital forks of both species are similar, except that that of *S. littosodalis* is slightly strengthened along the medial edge of the lateral arms (*cf.* Figs. 27, 39); the hypogynial valves (*cf.* Figs. 26, 38) are similar as are the spermathecae, cerci and anal lobes. The cerci both have a shallow dorsoapical depression and possess an apical clump of stiff hairs, however, not as well expressed as that in *S. littopyga* that lacks the depression (*cf.* Figs. 15, 29, 41).

Concluding discourse

These three new species add to the small number of female adults described from Tahiti and Raiatea, namely *Simulium cataractarum* Craig*, S. cheesmanae, S. connae* Craig*, S. lotii* Craig*, S. malardei* Craig*, S. oviceps* and *S. tahitiense*. Given the some 27 Tahitian species described from distinct larvae and for which adults are unknown (*e.g*., Craig 1987, 1997, Craig & Joy 2000), there is a probability that the three new species may eventually be shown to be in synonymy with the species based on larvae. While well known (*e.g.* Crosskey 1990, Adler *et al*. 2004, Craig *et al*. 2012 and others) for simuliid female adults to be found long distances from flowing water, here, final association of immatures and adults will no doubt require further collecting, rearing, and molecular techniques (*e.g*., Joy & Conn 2001, Hernádez-Triana *et al*. 2017).

Based on head proportions, *Simulium littosodalis* and *S. littosocius* do not appear to be that closely related; *S. littosocius* possessing a markedly narrowed frons. Similarities in mandible expression, plus similar cerci and genital forks, however, indicate a closer relationship than with *S. littopyga*. Craig & Joy (2000) established species groups for *Inseliellum*, albeit based mainly on larval characteristics. Thence, we are reluctant to formally assign the beach simuliids to any species group, since immatures are unknown. Still, *Simulium littopyga* may be related to the *castaneum*-group and the other two species perhaps the *oviceps*-group.

While simuliid female adults (*Austrosimulium*) that bite humans are all too well known on beaches of New Zealand and were possibly given the local common name “sandflies” for that reason (Craig *et al.* 2012), such is not known for Polynesia, albeit perhaps so in the Marquesas Islands where *Simulium buissoni* females are wide ranging in search of blood meals. There are no known reports of simuliids biting humans on beaches in the Society Islands. For the New Zealand “sandflies” a suggestion has been made that *Austrosimulium ungulatum* Tonnoir and *A. australense* (Schiner) aggregate on beaches to find blood meals from sea birds or perhaps seals, given that New Zealand lacked terrestrial mammals except for bats (Craig *et al*. 2012). However, New Zealand fur seals (*Arctocephalus forsteri* Lesson) have been observed closely (DAC pers. obs. 2014) at a beach outlet of a stream harbouring *A. ungulatum* and there was no sign of any biting insect.

Simulium cheesmanae of Tahiti is the only substantiated Society Islands biter and even then, it is not common. It is, however, wide ranging, no doubt in search of blood meals, and has been captured (albeit in low numbers) at high elevations as well as low (*e.g*. Craig 1987). Females of other simuliids such as *S. tahitiense* and *S. oviceps* can be extremely annoying when one is close to running water because of their astronomical numbers, but are not known to bite. As noted above, when one moves some meters away from running water, those female adults do not follow.

So a question naturally arises—what are these Society Island simuliid females doing on beaches? The one locality illustrated here (Fig. 42) does not appear particularly inviting. Perhaps blood-feeding on birds, albeit no birds were observed during any of the collecting. Why are adults of the common *S. tahitiense* and *S. oviceps* not found on beaches? It is unlikely the beaches are where mating takes place, since no males were collected, albeit mating behavior is totally unknown for Tahitian simuliids. The two known males of *S. cheesmanae* (Craig 1987: 385) were probably collected by netting, with those of other species obtained by rearing from pupae. Another question arises, that of how do these females, blood-fed or not, find their way back to running water for oviposition? Such a question has been investigated for simuliid females elsewhere that are found well away from running water (*e.g*. Hunter & Jain 2000). It has been suggested that gravid females find an oviposition site visually or anemotactically (response to wind). The latter behaviour does not seem appropriate for islandic beach-dwelling simuliid female adults, since wind is normally either a sea- or land breeze and not associated with wind movements down a stream bed. Other work (*e.g.* McGaha *et al.* 2015) has shown that pheromones are involved in oviposition, but this effect is markedly close range.

As alluded to above, there are numbers of interesting unknowns about these three beach-inhabiting simuliids, not the least of which is—where are the immature stages? That and the questions immediately above provide interesting challenges to answer.

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