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RESEARCH ARTICLE

Description of the female of *Simulium* (*Wallacellum*) *tuyense* Takaoka (Diptera: Simuliidae) from the Philippines

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ABSTRACT

Simulium (*Wallacellum*) *tuyense* Takaoka, one of the 14 Philippine species in the subgenus *Wallacellum* Takaoka, is a rare species in having the pupal antennal sheath with a row of stout spines on the apex of each protuberance corresponding to flagellomeres 2–9. The female of this species is described for the first time based on specimens from Mindoro, the Philippines. It is characterized by an elongate sensory vesicle, triangular ovipositor valve, genital fork with two projections, and paraproct not produced anteriorly. This species is morphologically indistinguishable in the female, as in the male and pupa, from *S*. (*W*.) *yonakuniense* Takaoka from Yonakuni Island, Japan and Lanyu Island, Taiwan. Taxonomic notes on the female of this species relevant to those of related species are provided. Collection data to validate earlier distribution records of *S*. (*W*.) *tuyense* and *S*. (*W*.) *suyoense* Takaoka from Mindanao are presented.

Keywords: Black fly; taxonomy; biting insects.

INTRODUCTION

Wallacellum, one of the three small subgenera among 11 subgenera in the Oriental Region, is morphologically remarkable by having, in the female and male, both the pleural membrane and katepisternum haired, hind tibia with a narrow long ridge on the inner anterior surface along the basal half or little more, and elongate calcipala; and in the pupa, abdominal segments 5-9 lacking spine-combs dorsally, and abdominal segments 6 and 7 each lacking an outer hook ventrally on each side (Takaoka, 1983). It has an insular distribution roughly overlapping "Wallacea", an area with mixed elements from the Oriental and Australasian Regions (Takaoka, 2003; Adler, 2021). In addition to the 14 species of this subgenus recorded from the Philippines, one species was reported in the north from Yonakuki Island, the Nansei Islands, Japan, and Lanyu Island, Taiwan (Takaoka, 1972; Chung, 1986), and one species was in the south from Sulawesi Island and one species in the southeast from Seram Island and Biak Island, Indonesia (Takaoka, 2003). In addition, larvae of an unidentified species of the subgenus *Wallacellum* were reported from Flores Island, Sumba Island, and Timor Island, Indonesia (Takaoka *et al*., 2006, 2018; Almet *et al*., 2016). Otsuka and Takaoka (2015) divided species of the subgenus *Wallacellum* into three groups (A, B and C) using sequences of cytochrome *c* oxidase Subunit I (COI) and16S ribosomal RNA (16S rRNA), combined with morphological analysis. Certain morphological features including the female and male genitalia and pupal gill are plesiomorphic in group A, apomorphic in group B, and intermediate in group C. Group A is widely distributed, whereas groups B and C are distributed only in the large islands of the Philippines suggesting species radiation in these large islands (Otsuka & Takaoka, 2015).

The biological aspects including biting habits, and medical and veterinary importance of the species of this subgenus have not been investigated.

Simulium (*W*.) *tuyense* Takaoka, originally described from Luzon Island, the Philippines (Takaoka, 1983), and subsequently recorded from Mindoro Island (Takaoka & Tenedero, 2007a), Palawan Island (Takaoka & Tenedero, 2007b) and Samar Island (Takaoka & Tenedero, 2008), is one of the three Philippine species in group A (Otsuka & Takaoka, 2015).

We describe the female of *S*. (*W*.) *tuyense* for the first time and compare its morphological characteristics with those of the 15 other species (except *S*. (*W*.) *molawinense* Takaoka, of which the female is unknown) from the Philippines and other countries. In an appendix, we present the collection data to validate the distribution records of *S*. (*W*.) *tuyense* and *S*. (*W*.) *suyoense* Takaoka from Mindanao Island, which were briefly noted based on unpublished data (Otsuka & Takaoka, 2015).

MATERIAL AND METHODS

Specimens of *S*. (*W*.) *tuyense* used for morphological observation and description were five females reared from pupae collected from a small stream (width 0.5–1.0 m, bed rocky, 24°C, shaded, elevation 170 m) flowing down the acute slope of a natural forest, near

Tamalaw Falls, Villa Flor, Puerto Galera, Mindoro Oriental, Mindoro Island, Philippines, 17-IX-2006, by Takaoka, H. and Tenedero, V.F.

The methods of collection, description and illustration, and terms for morphological features, follow those of Takaoka (2003) and partially those of Adler *et al*. (2004).

The specimens used are deposited in the Entomology Section of the Queen Sirikit Botanic Garden, Chiang Mai, Thailand.

RESULTS AND DISCUSSION

Description of the female of *S.* (*W.*) *tuyense* Takaoka

Female (n=5). Body length 2.0–2.2 mm. ***Head***. Nearly as wide as thorax. Frons dark brown, densely covered with yellowish white scale-like recumbent short hairs interspersed with few dark longer hairs along each lateral margin; frontal ratio 1.44–1.48:1.00:1.28–1.32; frons:head ratio 1.00:3.34–3.50. Fronto-ocular area well developed, triangular, directed dorsolaterally. Clypeus dark brown, densely covered with yellowish white scale-like hairs interspersed with several dark longer hairs on each side. Labrum 0.82–0.91 times length of clypeus. Antenna composed of scape, pedicel and nine flagellomeres, yellow except first flagellomere somewhat darkened; first flagellomere 1.9–2.1 times as long as second. Maxillary palpus (Figure 1A) composed of five segments, light to medium brown, proportional lengths of third, fourth, and fifth segments 1.00:0.60–0.64:0.90–1.07; sensory vesicle (Figure 1B) long (0.59–0.65 times length of third segment), with moderate-sized opening. Maxillary lacinia with 8–10 inner and 12–15 outer teeth. Mandible with 20 or 21 inner teeth and lacking outer teeth. Cibarium (Figure 1C) simple, unarmed. ***Thorax***. Scutum dark brown, with three faint dark longitudinal vittae, densely covered with yellow scale-like recumbent short hairs. Scutellum dark brown, covered with yellowish white short hairs and dark brown long upright hairs along posterior margin. Postnotum dark brown, and bare. Pleural membrane densely covered with whitish yellow fine hairs mixed with few dark hairs. Katepisternum longer than deep, dark brown, densely covered with fine yellow and brown short hairs. ***Legs***. Foreleg: dark brown except base of trochanter and basal extreme of tibia yellow; tarsus with moderate dorsal hair crest; basitarsus moderately dilated, 7.50–7.88 times as long as its greatest width. Midleg: dark brown except base of tibia yellow and submedial portion of tibia dark yellow to light brown. Hind leg: medium to dark brown except base of tibia yellow and submedial portion of tibia dark yellow to light brown (Figure 1D), median large portion of basitarsus, basal two-thirds of second tarsomere and bases of third and fourth tarsomeres yellowish white, apical one-third of second tarsomere, and apical two-thirds of third and fourth tarsomeres light brown (Figure 1G); tibia with long and low ridge on inner anterior surface along its shaft extending from base to point slightly before middle (Figure 1E), its surface covered with spinous minute processes (Figure 1F); basitarsus (Figure 1G) narrow, nearly parallel-sided, though slightly narrowed apically, 6.07–6.21 times as long as wide, and 0.70–0.74 and 0.53–0.54 times as wide as greatest widths of tibia and femur, respectively; calcipala (Figure 1G) elongate, reaching apex of second tarsomere, and nearly as wide as apical portion of basitarsus; pedisulcus (Figure 1G) well developed; claw (Figure 1H) with large basal tooth 0.55–0.57 times length of claw. ***Wing***. Length 2.0 mm. Costa with dark spinules and dark and pale hairs except basal patch of dark hairs. Subcosta with dark hairs except near apex. Base of radius with tuft of dark hairs. Basal portion of radius fully haired. R_1 with dark spinules and hairs; R_2 with hairs only. Basal cell absent. ***Halter***. White except basal portion darkened. ***Abdomen***. Basal scale medium brown, with fringe of whitish yellow hairs. Dorsal surface of abdomen dark brown, densely covered with yellowish white short hairs mixed with dark short to long hairs; tergites not shiny. Sternal plate on segment 7 undeveloped. ***Terminalia***. Sternite 8 (Figure 1I) bare medially, with 30–38 short to long hairs together with three to seven slender short hairs on each side. Ovipositor valves (Figure 1I) triangular (although posteromedial corner rounded), thin, membranous, each moderately covered with microsetae interspersed with four to eight slender short hairs; inner margins gently sinuous, somewhat sclerotized, and moderately separated from each other. Genital fork (Figure 1J) of usual inverted-Y form, with long slender stem; arms of moderate width, each with two distinct projections, of which one directed anteriorly and another one posteromedially. Paraproct in ventral view (Figure 1K) nearly quadrate, with two to five sensilla on unpigmented anteromedial surface; paraproct in lateral view (Figure 1L) moderately produced ventrally beyond ventral tip of cercus, 0.63 times as long as wide, with 38–41 short to long hairs on ventral and lateral surfaces. Cercus in lateral view (Figure 1L) short, rounded posteriorly, 0.40 times as long as wide. Spermatheca (Figure 1M) ovoidal, 1.14–1.18 times as long as its greatest width, well sclerotized and darkened except duct and small area near juncture with duct unpigmented, and with many reticulate surface patterns; internal setae absent; both accessory ducts unpigmented, slender, subequal in diameter to major one.

Remarks. *Simulium* (*W.*) *tuyense* was described from one male, its associated pupal exuviae and one mature larva from Batangus, Luzon, the Philippines (Takaoka, 1983). The pupa of this species is characterized by the gill with four short slender filaments directed forward, antennal sheath with a row of stout spines on the apex of prominent protuberance corresponding to flagellomeres 2–9, and cocoon simple, wall-pocket-shaped (Takaoka, 1983).

The female of this species is similar to those of *S*. (*W*.) *marilogense* Takaoka and *S*. (*W*.) *ogonukii* Takaoka from Mindanao, the Philippines (Takaoka, 1983, 2009), both in group A, in many characteristics including the elongate sensory vesicle (Figure 1B), triangular ovipositor valve (Figure 1I), genital fork with two projections (Figure 1J), and paraproct not produced anteriorly (Figure 1L). It is barely distinguished from the latter two species by the relative length of the height of the frons to its narrowest width (1.28–1.32 in *S*. (*W*.) *tuyense* versus 1.42–1.50 in the latter two species).

This species is distinguished in the female from the 11 other species of this subgenus recorded from the Philippines by the elongate sensory vesicle, except *S*. (*W*.) *suyoense* Takaoka from Luzon and Mindoro, which has a similar elongate sensory vesicle, and *S*. (*W*.) *molawinense*, of which the female is unknown (Takaoka, 2006). The genital fork with two projections on each arm separates this species from *S*. (*W*.) *suyoense*, of which the genital fork has one projection on each arm (Takaoka, 2006).

The female of this species is similar to those of *S*. (*W*.) *alfurense* Takaoka from Seram and Biak, and *S*. (*W*.) *celebesense* Takaoka from Sulawesi, Indonesia (Takaoka, 2003).

However, a slight difference in the relative width of the greatest width against the narrowest width of the frons is present (1.44–1.48 in this species versus 1.3 in the latter two species).

The female of this species is almost indistinguishable from that of *S*. (*W*.) *yonakuniense* Takaoka, from Yonakuni Island, the Nansei Islands, Japan, and Lanyu Island, Taiwan (Takaoka, 1972; Chung, 1986), although the number of rows of hooklets of the larval posterior circlet differs (84 in this species versus 94 in *S*. (*W*.) *yonakuniense*) (Takaoka, 1983).

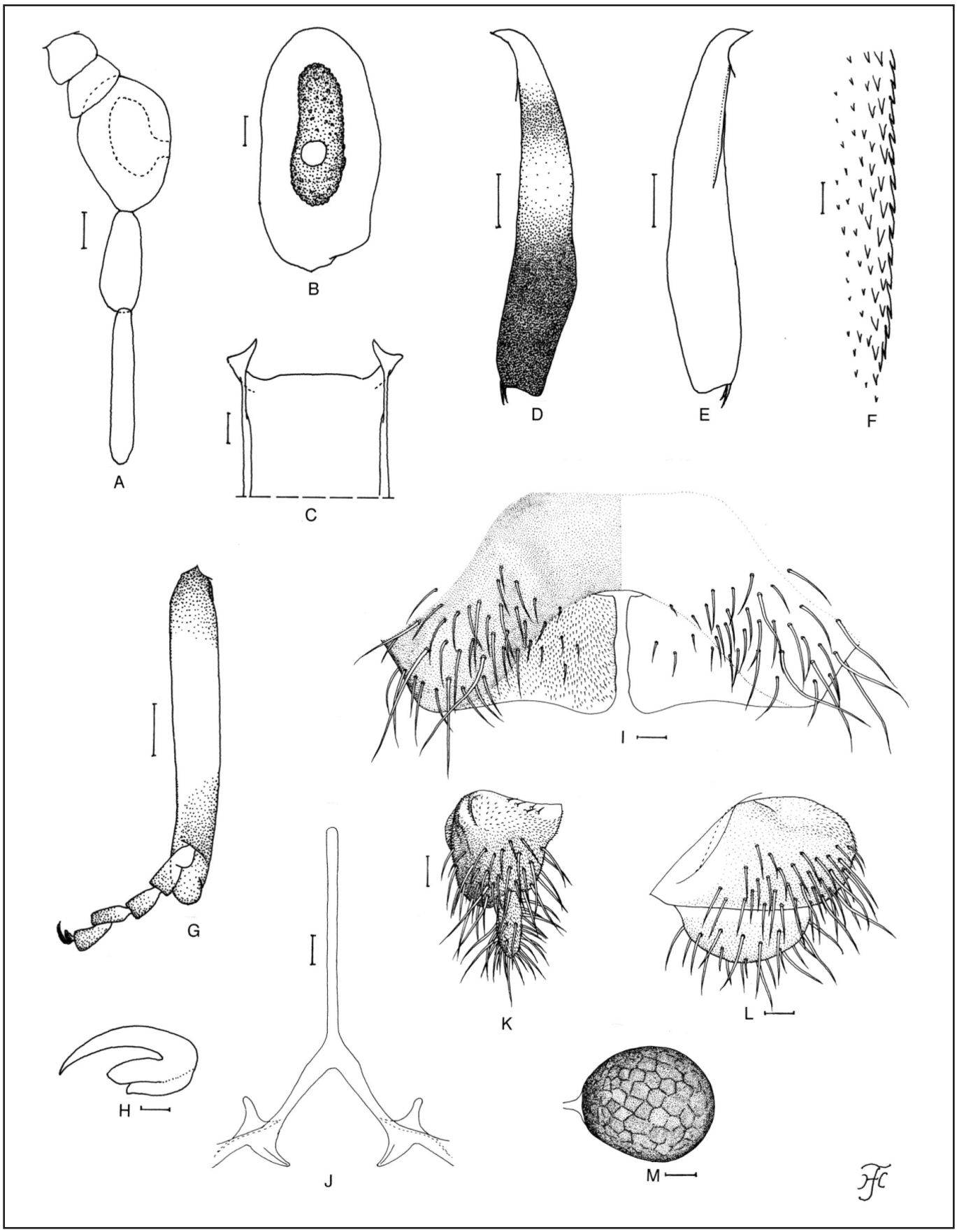

Figure 1. Female of *Simulium* (*W.*) *tuyense*. A, maxillary palpus (right side; lateral view). B, third palpal segment with sensory vesicle (right side; front view). C, cibarium (front view). D, hind tibia showing pigmentation pattern (left side; outer view). E, hind tibia with long, low ridge along anterior margin on inner surface (left side; inner view). F, scale-like processes on apical half of long, low ridge of hind tibia (left side; inner view). G, hind tarsus showing elongate calcipala (left side; outer view). H, claw (lateral view). I, sternite 8 and ovipositor valves (ventral view). J, genital fork (ventral view). K and L, paraprocts and cerci (right side; K, ventral view; L, lateral view). M, spermatheca (lateral view). Scale bars. 0.1 mm for D, E and G; 0.04 mm for A; 0.02 mm for B, C, I–M; 0.01 mm for F and H.

APPENDIX

Data for records of *S.* (*W.*) *tuyense* and *S.* (*W.*) *suyoense* from Mindanao Island

Simulium (*W.*) *tuyense* was first described from Luzon (Takaoka, 1983), and subsequently recorded from Mindoro (Takaoka & Tenedero, 2007a), Palawan (Takaoka & Tenedero, 2007b), and Samar (Takaoka & Tenedero, 2008), whereas *S.* (*W.*) *suyoense* was described from Luzon (Takaoka, 2006), and subsequently recorded from Mindoro (Takaoka & Tenedero, 2007a). The presence of both species in Mindanao was also noted (Otsuka & Takaoka, 2015), but, was based on "unpublished data", without substantial collection data. To validate these records, relevant data are here presented.

Simulium (*W.*) *tuyense*: One female, two males, together with their pupal exuviae and cocoons, collected from a small cascading stream (width 0.5–1.0 m, 24°C, shaded, elevation 300 m), Malasog, 3 km east of Cagayan de Oro, Mindanao, Philippines, 14-XI-2007, by Takaoka, H. and Tenedero, V.

Simulium (*W.*) *suyoense*: Two females, together with their pupal exuviae and cocoons, and two pupae collected from the same stream as noted for *S.* (*W.*) *tuyense*.

Declaration of Competing Interest

We declare that this is our original work. It has not been published elsewhere and we have no conflicts of interest concerning the work reported in this paper. All authors have contributed to this study throughout the study design, field work, data collection, data analyses and data interpretation. The authors have read and approved the manuscript.

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