

DESCRIPTION OF *BRUCEHARRISONIUS*, A NEW SUBGENUS OF *OCHLEROTATUS*, AND A REDESCRIPTION OF ITS TYPE SPECIES *OC. (BRH.) GREENII*

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ABSTRACT. The new subgenus *Bruceharrisonius* is described and principal features of all known stages are provided for separating it from other subgenera of genus *Ochlerotatus*. The female, male, female and male genitalia, pupa, and 4th-stage larva of the type species, *Oc. greenii*, are described in detail. Eight species (*Oc. alektorovi*, *Oc. aureostriatus*, *Oc. doonii*, *Oc. christophersi*, *Oc. greenii*, *Oc. hurlbuti*, *Oc. okinawanus*, and *Oc. taiwanus*) currently are recognized in the subgenus.

KEY WORDS *Bruceharrisonius*, *Ochlerotatus*, *Oc. greenii*, Culicidae, Diptera, new subgenus

INTRODUCTION

During studies on the genera and subgenera in tribe Aedini, family Culicidae, a new subgenus, *Bruceharrisonius*, was discovered and is described below. The subgenus is included in genus *Ochlerotatus* Lynch Arribalzaga (genus recently restored to generic rank by Reinert [2000a]) and includes species formerly placed in subgenus *Finlaya* Theobald. Species included in the new subgenus are *Oc. alektorovi* (Stackelberg), *Oc. aureostriatus* (Doleschall), *Oc. doonii* (Wattal, Bhatia, and Kalra), *Oc. christophersi* (Edwards), *Oc. greenii* (Theobald), *Oc. hurlbuti* (Lien), *Oc. okinawanus* (Bohart), and *Oc. taiwanus* (Lien). Harrison et al. (1990) elevated *Oc. greenii* from subspecies to species, synonymized variety *kanaranus* (Barraud) with it, and clarified the status of *Oc. greenii* in relation to some of the other species of the subgenus. Tanaka (2002) elevated *Oc. okinawanus* to species status and considered *Oc. taiwanus* as a subspecies of it. This subspecies and the variety *doonii* of *Oc. aureostriatus* are herein provisionally accorded species status based on characters provided by Wattal et al. (1958), Lien (1968), Tanaka et al. (1979), and Tanaka (2002).

For adequate examination of specimens, the male genitalia must be dissected to observe the details of the claspette and the basomesal structures of the gonocoxite. Also, positions of setae 5–7-C and measurement of the median length of the dorsal apotome are best observed in the exuviae of 4th-stage larvae. Terminology used follows Harbach and Knight (1980, 1982), except for terminology proposed by Reinert (1999, 2000b).

SUBGENUS *BRUCEHARRISONIUS* REINERT, NEW SUBGENUS

Type species: *Howardina greenii* Theobald,
1903

- Culex*, in part of Doleschall (1857), Giles (1900, 1902), Theobald (1901).
Howardina, in part of Theobald (1903, 1905, 1907, 1910), Blanchard (1905), Brunetti (1907, 1912, 1920).
Aedes (*Ochlerotatus*) group *Finlaya*, in part of Edwards (1917).
Ochlerotatus, in part of Senior-White (1923).
Finlaya, in part of Barraud (1923, 1924), Senior-White (1926, 1927).
Aedes (*Finlaya*), in part of Edwards (1922a, 1922b, 1924, 1932, in Barraud 1934), Brug (1926, 1931, 1934), Brug and Edwards (1931), Barraud (1934), Taylor (1934), Lee (1944), Bohart (1946), Bohart and Ingram (1946a, 1946b), King and Hoogstraal (1946), Brug and Bonne-Wepster (1947), Carter (1950), Knight and Hull (1951), Monchadskii (1951), Knight and Marks (1952), Bonne-Wepster (1954), Chow et al. (1954), Gutsevich (1955, 1975), Iyengar (1955, 1960), Horsfall (1955), Stone and Knight (1956), Nakata (1956, 1959), Rao and Rajagopalan (1957), Macdonald (1957), Chu (1957, 1958), Wattal et al. (1958), Hara (1959), Bohart (1959), Thurman (1959), Stone et al. (1959), Macdonald and Traub (1960), van der Assem (1961), Stone (1961, 1970), Kurihara (1963, 1978), Thurman (1963), Scanlon and Esah (1965), Joshi et al. (1965), Steffan (1966), Lien (1967, 1968), Huang (1968), Tanaka (1971), Stone and Delfinado (1973), Saugstad (1973), Hochman and Reinert (1974), Gutsevich et al. (1974), Tanaka et al. (1975), Bhat (1975), Wada et al. (1976), Danilov (1977), Knight and Stone (1977), Lien et al. (1977), Knight (1978), Tanaka et al. (1979), Gutsevich and Dubitsky (1981), Jayasekera and

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Chelliah (1981), Amerasinghe (1982), Lu and Li (1982), Lee et al. (1982), Saini and Mishra (1984), Lee et al. (1984), Lei et al. (1984), Toma and Miyagi (1986), Apiwathnasorn (1986), Tsukamoto et al. (1987), Lu and Su (1987), Lee (1987), Lee and Zorka (1987), Rattanaarithikul and Harrison (1988), Amerasinghe and Munasingha (1988), Lu et al. (1988), Evenhuis and Gon (1989), Darsie and Pradhan (1990), Reinert (1990), Townsend et al. (1990), Harrison et al. (1990), Kaur (1992), Darsie et al. (1991), Ward (1992), Stojanovich and Scott (1995, 1996), Lu and Ji (1997), Peyton et al. (1999), Reinert (2002).

Aedes (Finlaya) of Stackelberg (1943), Tanaka (2002).

Aedes, in part of Lee and Lien (1970), Reisen and Basio (1972), da Costa Pinhao (1974), Sazonova (1981), Mogi et al. (1981), Toma and Miyagi (1981), Lee et al. (1984), Amerasinghe and Munasinghe (1984–85), Lee and Egan (1985), Toma and Miyagi (1992).

Ochlerotatus (Finlaya), in part of Kaur (2003).

Females. *Head:* Antennal pedicel with several short, fine setae and usually few small, pale or dark scales mesally; maxillary palpus dark-scaled, short; proboscis dark-scaled, longer than femur I, narrow, more or less straight; clypeus bare; ocular line narrow, with narrow scales; vertex with median patch of pale, narrow, curved, recumbent scales and several erect forked scales, broad scales laterally; occiput with numerous erect forked scales; eyes contiguous in front. *Thorax:* Scutum covered with narrow, curved scales, background scales dark, pale scales on anterior promontory and antedorsocentral areas, pale scales forming lines on acrostichal and dorsocentral areas, posterior half of scutum with pale lines narrow, anterior half of scutum with pale lines variable from narrow to most of area covered with pale scales, lateral portion of supraalar area pale-scaled, prescutellar space bare except for narrow line of pale scales on each side mesad of prescutellar setae; golden to brown setae as follow: few anterior promontory, acrostichal (few anterior, 0 to few posterior), few antedorsocentral, dorsocentral (several anterior, several posterior), several prescutellar, few scutal fossal, few antealar, several supraalar (including patch of shorter, blunt-tipped, pale ones in front of wing base), 1 parascutellar; scutellum with narrow, curved scales on all lobes, several setae on each lobe; antepnotum with broad, pale scales, several short and long setae; postpronotum with pale scales, narrow, curved ones dorsally and moderately broad to broad ones ventrally, few posterior setae; postspiracular area with or without scales, several setae; subspiracular area with elongate patch of broad, pale scales; paratergite, mesomeron, and metameron bare; mesokatepisternum with upper and lower patches of broad, pale scales, few upper and few to several posterior

setae; prealar area with large patch of broad, pale scales on lower area, several setae on upper area; mesepimeron with large patch of broad, pale scales covering much of area, several setae on upper, posterior area, lower setae absent (except present in *Oc. okinawanus*); mesomeron with dorsal margin well above base of hindcoxa. *Legs:* Antepcoxal and postcoxal membranes bare; coxae I–III with patch of broad white scales, I also with median dark scales in some species; trochanters with broad, pale scales; femora I–III with anterior surface dark-scaled but normally with pale-scaled areas at base and dorsoapically; tibiae I–III often with pale-scaled spot ventrobasally; tarsus III dark-scaled with pale-scaled basal bands on at least tarsomeres 1–3, some species with pale-scaled basal bands or scales on tarsomeres 4,5 and apical bands or scales on tarsomeres 1–4; posttarsi I,II with 2 ungues, equal in size, both toothed, III with 2 ungues, equal in size, both simple. *Wing:* Dorsal and ventral veins with dark scales, base of costa with or without white scales; vein R_2 longer than vein R_{2+3} ; alula with row of narrow, dark scales on margin; upper calypter with row of setae on margin; remigium with 1–3 dark setae. *Abdomen:* Terga dark-scaled with pale-scaled patches basolaterally on I–VII, II–IV also with or without pale scales dorsobasally and forming narrow band in some species; sterna III–VII pale-scaled proximally and dark-scaled distally, II usually entirely pale-scaled.

Female genitalia. *Segment VIII:* Laterally compressed. *Tergum VIII:* Covered with minute spicules; moderately pigmented; relatively long; base moderately wide, shorter than length, gently concave; numerous broad, spatulate scales on distal 0.52–0.90; several short setae on distal 0.64–0.87; apical margin gently convex or straight, with 2–4 long and 3–5 short to moderately long setae; basolateral seta present; VIII-Te index 0.78–1.06; VIII-Te/IX-Te index 2.18–3.06; length 0.23–0.29 mm; width 0.23–0.35 mm. *Sternum VIII:* Covered with minute spicules; moderately pigmented; apex gently convex or flat, usually with minute (0.01–0.02 of dorsal VIII-S length), median emargination, numerous short and moderately long, relatively straight setae intermixed on apical margin, setae tend to increase in length laterally; base narrower than apex, gently concave; numerous broad, spatulate scales covering distal 0.89–0.96, scales do not, or only partially, overlap presenting somewhat shaggy appearance; numerous short setae on distal 0.85–0.93; basolateral seta present or absent; setae 1–3-S in more or less diagonal line, 1-S basomesad and some distance from base of sclerite, 3-S apicolaterad; apical, intersegmental membrane nonpigmented; intersegmental membrane between segments VII and VIII moderately long, covered with minute spicules; VIII-S index 0.74–0.95; length 0.27–0.36 mm; width 0.33–0.39 mm. *Tergum IX:* Covered with minute spicules; comprised of single relatively short (moderately long in *Oc. okinawan-*

us) plate, moderately pigmented, but mesal area more lightly pigmented; apex with small, median emargination; 3–7 short setae distally on each side of midline, 6–12 total setae; base with small to moderately deep, median emargination; IX-Te index 0.64–0.80; length 0.08–0.14 mm; width 0.11–0.18 mm; dorsal spheres present, dark. *Insula*: Covered with short spicules; moderately pigmented; liplike; 2 moderately long, closely set setae on each side laterally, 4 total setae. *Lower vaginal lip*: Covered with short spicules; moderately pigmented; narrow; hinge narrow; lower vaginal sclerite absent. *Upper vaginal lip*: Covered with short spicules; heavily pigmented; narrow with median posterior area flattened; upper vaginal sclerite small, moderately pigmented. *Spermathecal eminence*: Membranous; more or less broadly oval in outline; few short, simple, spermathecal eminence spicules on basolateral areas. *Postgenital lobe*: Covered with short spicules; moderately pigmented; moderately long; moderately wide; apex with small to moderately deep (0.05–0.22 of dorsal length), median emargination; 7–13 (1 long, remainder short) setae distally on each side of midline, 15–25 total setae; basal mesal apodeme moderately pigmented, more or less triangular in outline; ventral PGL/Ce index 0.49–0.67; dorsal PGL index 0.65–1.04; ventral PGL index 1.19–1.57; ventral length 0.08–0.11 mm. *Proctiger*: With scattered small spicules; membranous. *Cercus*: Covered with short spicules; moderately pigmented; moderately long; relatively narrow; apex sharply rounded; dorsal surface normally without scales or when present, usually 1 or 2, rarely with 4–6 scales, with number of short setae on distal 0.67–0.77, 2,3 long and 2–4 moderately long setae on approximately distal 0.11–0.22; ventral surface with 3,4 short setae on apicolateral margin; cercus index 2.03–2.73; Ce/dorsal PGL index 2.56–3.60; length 0.14–0.19 mm; width 0.06–0.09 mm. *Spermathecal capsules*: One large and 2 medium; heavily pigmented; spherical; with several small, spermathecal capsule pores near orifice. *Accessory gland duct*: Basal area moderately pigmented; duct to moderately long.

Males. Similar to females in general habitus. *Head*: Antenna strongly plumose with setae directed mainly dorsally and ventrally, shorter than proboscis and maxillary palpus; maxillary palpus dark-scaled, with 5 palpomeres, palpomeres 4 and 5 fused, slender throughout, nearly straight but distal portion slightly upturned, very few short to moderately long, dark setae distally on palpomeres 3 and 5 and ventrolaterally on palpomere 4, shorter than proboscis; proboscis longer than femur I. *Thorax*: Scutum sometimes with pale scaling more extensive on approximately anterior 0.5. *Legs*: Posttarsi I,II with 2 unguis, unequal in size, both toothed, III with 2 unguis equal in size, both simple.

Male genitalia. *Tergum IX*: Moderately pig-

mented; with 2 heavily pigmented, short, narrow lobes on posterior margin each bearing 3–6 short, stout, somewhat flattened setae apically. *Gonocoxite*: Moderately pigmented; moderately long; distal portion relatively narrow and proximal portion broader; dorsal surface with basal lobe bearing several moderately long, moderately stout or lanceolate setae on mesal margin (*Oc. alektorovi* with these setae short and slender); lateral and ventral surfaces with numerous broad scales; ventral surface with row of moderately long to long, nearly straight setae from base to apex, setae decreasing in length on proximal area; mesal margin membranous. *Gonostylus*: Attached to apex of gonocoxite; lightly to moderately pigmented; long; narrow throughout, but decreasing in size distally; slightly curved mesad; gonostylar claw short, slender, slightly curved, attached to apex of gonostylus. *Claspette*: Comprised of median, ventral, columnar stem with terminal, large, flattened filament, and narrow, lateral arm extending from base bearing 2 to several setae, 1 or more of distal setae flattened. *Proctiger*: Paraproct narrow, heavily pigmented, but distal portion more heavily pigmented, apex rounded with short, pointed beak; cercus membranous, with 1,2 minute setae apicolaterally. *Tergum X*: Narrow; heavily pigmented; curved; extending from base of paraproct to base of narrow lobe of tergum IX. *Phallosome*: Aedeagus simple, scooplike, ovoid, relatively short; paramere heavily pigmented, narrow, longer than aedeagus; basal piece heavily pigmented, moderately wide. *Sternum IX*: With 4–9 short and moderately long setae.

Pupae. *Cephalothorax*: Seta 3-CT very long, stout, much longer than 1-CT; 5-CT multiple-branched, noticeably longer than 4-CT; 6-CT short; 7-CT very long, stout, multiple-branched; 10-CT with several slender branches, shorter than 11,12-CT; 11-CT stout, usually single, occasionally with 2,3 branches, equal to or slightly shorter than 12-CT; 12-CT with several branches. *Trumpet*: Apex broad; base narrow; tracheoid area basal, weakly developed. *Abdomen*: Seta 3-I long, stout, normally 2-branched, rarely single or 3-branched; 6-I long, stout, single, longer than 7-I; 1-II short, with several to numerous slender branches; 2-II short, laterad of 1-II, mesad of 3-II; 5-II multiple-branched, laterad and longer than 4-II; 6-III slender, branched; 5-IV–VI long, stout, 5-IV single or 2-branched, 5-V,VI single; 2-VI anteromesal to 1-VI; 3-VI anterolateral to 1-VI; 7-VI relatively long, single, longer than 6-VI; 6-VII short, with few slender branches, anteromesal to 9-VII; 9-VII short, with few to several stout, aciculate branches; 9-VIII long, with numerous stout, aciculate branches. *Paddle*: Relatively narrow without hairlike spicules on margins; outer buttress narrow, dark, long; midrib narrow, dark, extending from base to apex; seta 1-Pa moderately long, single.

Fourth-stage larvae. *Head*: Seta 1-C relatively long, single, proximal portion moderately stout,

distal portion slender and attenuated; seta 4-C short, branched, mesad of 5,6-C, anterior to 5-C, and at approximately same level as 6-C; 5-C long, approximately 0.45–0.65 length of dorsal apotome, branched, stout, mesad and posterior to 6-C; 6-C exceptionally long, approximately 1.3–1.6 median length of dorsal apotome, single, stout; bases of 4–6-C form small triangle mesad and posterior to level of 7-C; 7-C moderately long, branched, posterior to antennal base; 12-C branched; 13-C branched, longer than and laterad of 12-C; 19-C present. *Antenna*: Long, slender; setae 1-A normally single (occasionally 2- or 3-branched). *Thorax*: Seta 4-M branched; 5-M very long, noticeably longer than 7-M, single; 6-T relatively long, single. *Abdomen*: Setae 6-I,II relatively short; 6-II shorter than 6-I,III; 7-I longer than 6-I; 12-I present; 7-II short, multiple-branched; 8-II branched; 6-III–VI single (6-III rarely 2-branched); 1-VII very long, single; 12-VII branched; 2,4-VIII both branched (very rarely 1 of setae single on one side of specimen); comb comprised of numerous scales in patch; saddle incomplete ventrally; 2-X moderately long, branched with dorsal branch shortest; 3-X very long, single; ventral brush with multiple-branched setae on grid composed of both transverse and lateral bars, 2 or 3 shorter, precratal setae, branched. *Siphon*: Pecten with numerous evenly spaced spines; seta 1-S multiple-branched, inserted distal to pecten.

Eggs. Unknown.

Material examined (stages/structures). *Ochlerotatus alektorovi* (female, female genitalia, male, male genitalia, and larva); *Oc. aureostriatus* (female, female genitalia, male, male genitalia, pupa, and larva); *Oc. christophersi* (female, female genitalia, pupa, and larva); *Oc. greenii* (female, female genitalia, male, male genitalia, pupa, and larva); *Oc. hurlbuti* (female, female genitalia, pupa, and larva); *Oc. okinawanus* (female, female genitalia, pupa, and larva); and *Oc. taiwanus* (female and larva). The published literature (see list under synonymy) also was examined.

Distribution. Species included in the subgenus have been reported from China (Hainan Island and Sichuan Province), India, Indonesia, Japan and Ryukyu Archipelago, Malaysia, Nepal, Papua New Guinea, Philippine Islands, South Korea, Russia (Maritime and Ussurii provinces), Sri Lanka, Taiwan, and Thailand.

Bionomics. The usual habitat of immatures is water in tree holes and stumps or internodes of bamboo; however, some species occasionally have been taken from artificial containers (e.g., earthen jars, gravestones, and a wooden box), rock pools, bromeliads, and ferns. Adults of some species have been collected biting humans during the day and in light traps.

Discussion. The following principal features are most distinctive for *Bruceharrisonius*, and they can be used to distinguish this subgenus from other subgenera of *Ochlerotatus*: **females** by the combina-

tion of 1) eyes are contiguous in front; 2) vertex has a median patch of pale, narrow, curved, recumbent scales and several erect forked scales; 3) scutum is covered with narrow, curved scales except for the bare, median, prescutellar area, the background scales are dark, but pale scales form lines on the acrostichal area, dorsocentral area, and along the lateral margins of the prescutellar area mesad of the setae, and patches on the scutal fossal and supraalar areas; 4) acrostichal and dorsocentral setae are present; 5) scutellum has narrow scales on all lobes; 6) subspiracular area has an elongate patch of pale, broad scales; 7) lower prealar area has a patch of pale, broad scales; and 8) mesepimeron has the lower setae absent (except present in *Oc. okinawanus*); **female genitalia** by the combination of 1) sternum VIII has the apex gently convex or flat and usually with a minute, median emargination and bearing numerous short and moderately long, relatively straight setae that tend to increase in length laterally, and numerous broad, spatulate scales that nearly cover the sclerite, these are not, or only partially, overlapping and give somewhat of a shaggy appearance; 2) cercus is moderately long and relatively narrow, the apex is sharply rounded, and scales are normally absent, or when present consist of usually only 1 or 2, rarely 4–6 scales; 3) tergum IX is comprised of a single, normally relatively short, moderately wide plate that is moderately pigmented, but with the mesal area lighter pigmented, the apex has a small, median emargination and bearing 3–7 short setae distally on each side of the midline; and 4) insula is liplike with 2 closely set, moderately long setae laterally on each side of the midline; **males** by the maxillary palpus being dark-scaled, slender throughout, nearly straight but with the distal portion slightly upturned, shorter than the proboscis, and with very few short to moderately long setae on palpomeres 3–5; **male genitalia** by the combination of 1) tergum IX has the posterior margin bearing 2 short, narrow lobes each with 3–6 short, stout, somewhat flattened setae; 2) gonocoxite has the ventral surface with a row of moderately long to long, nearly straight setae extending from the base to the apex, setae decrease in length on the proximal area; 3) gonostylus is long, narrow throughout but is narrower distally, and is attached to the apex of the gonocoxite, the gonostylar claw is short, slender, slightly curved, and is attached apically; and 4) claspette is comprised of a median, ventral, columnar stem with a terminal, large, flattened filament, and a narrow lateral arm extending from the base of the stem and bears 2 to several setae of which 1 or more of the distal setae are flattened; **pupae** by the combination of 1) seta 3-CT is very long and much longer than seta 1-CT; 2) seta 3-I is long and normally 2-branched; 3) paddle is relatively narrow with the midrib extending from the base to the apex; and 4) seta 1-Pa is single and relatively long; and **4th-stage larvae** by the

combination of 1) seta 4-C is short and branched; 2) seta 5-C is long and branched; 3) seta 6-C is exceptionally long and single; 4) bases of setae 4-6-C are positioned in a small triangle with seta 4-C mesad of setae 5,6-C, anterior to seta 5-C, and at approximately the same level as seta 6-C, and seta 5-C is posterior and mesad of seta 6-C; 5) seta 7-C is branched and at a level anterior to setae 4-6-C and posterior to the antennal base; 6) seta 19-C is present; 7) antenna is long, slender, and seta 1-A is normally single (occasionally 2- or 3-branched); 8) setae 6-I,II are relatively short and seta 6-II is shorter than seta 6-I,III; 9) seta 7-I is longer than seta 6-I; 10) seta 1-VII is very long and single; 11) setae 2,4-VIII are both branched (very rarely is 2- or 4-VIII single on one side); and 12) comb is comprised of multiple scales in a patch.

Within subgenus *Finlaya* (genus *Ochlerotatus*), adults of some other groups of species possess a pattern of narrow, pale scales forming lines on the acrostichal and dorsocentral areas of the scutum (e.g., Aureostriatus Group, in part, of Knight and Marks [1952] and the Chrysolineatus Subgroup of Knight [1968]). Adults of *Bruceharrisonius* species can be separated from most of these species by one or more of the following: the entirely dark-scaled palpus and proboscis, broader pale-scaled lines of the scutum, subspiracular area with broad, pale scales, and the development of the male maxillary palpus. The female and male genitalia, pupae, and 4th-stage larvae of these groups differ from those of *Bruceharrisonius* (see above list of principal features). The exceptionally long and single seta 6-C of larvae of *Bruceharrisonius* is shared by members of subgenus *Geoskusea* Edwards and *Oc. (Fin.) gilli* (Barraud); however, numerous other differences exist in all life stages from those of *Bruceharrisonius*. The most distinctive features of the new subgenus are found in the female and male genitalia and the immature stages. Lien (1967) reported that in larvae of *Oc. hurlbuti* seta 6-C was bifid with 1 branch very long whereas the other branch was more slender and shorter, this condition is atypical for the subgenus.

It is a pleasure to name the new subgenus *Bruceharrisonius* in honor of Dr. Bruce A. Harrison, North Carolina Department of Environment and Natural Resources, Winston-Salem, North Carolina, in recognition of his outstanding contributions to the biosystematics of the Culicidae, especially to the genus *Anopheles* Meigen. The subgenus is masculine and is abbreviated *Brh*.

Type species description, *Ochlerotatus (Bruceharrisonius) greenii* (Theobald), 1903

Female (see Fig. 6, Plate III (type form) in Barraud 1934). **Head:** Antennal pedicel mostly dark brown but pale anteriorly, with patch of short, fine, dark setae and 2,3 small, broad, dark brown scales mesally, flagellomere 1 with small, broad, dark

brown scales mesally, 0.78–0.82 length of proboscis; maxillary palpus dark brown-scaled, 0.17–0.19 length of proboscis; proboscis dark brown-scaled, 1.09–1.21 length of femur I; clypeus dark brown; ocular line with narrow, curved, golden scales, setae dark brown; 1 pair of golden interocular setae; vertex with large patch of narrow, curved, golden, recumbent scales and several golden, erect forked scales, patch of broad, dark brown scales laterad of these followed by broad, white scales laterally and caudally; postgena with broad scales, small patch of dark brown ones anteriorly at about level of antepronotum, white ones below; occiput with narrow, curved, golden, recumbent scales and numerous moderately long, golden, erect forked scales.

Thorax: Scutum with integument dark brown, covered with narrow, curved scales except for bare prescutellar area and small area on each side of anterior promontory between antedorsocentral areas, background scales dark, reddish-brown, with numerous golden scales on following: anterior promontory, antedorsocentral area, line on acrostichal area from anterior margin to prescutellar area where it forks along lateral margins of prescutellar area mesad of setae, anterior portion of line broad and contiguous with dorsocentral golden line but posterior portion of line narrow, line on dorsocentral area extending from anterior margin but not reaching prescutellar area, narrow line on mesal margin of supraalar area extending from posterior margin of scutal fossal area to posterior margin of scutum laterad of prescutellar setae (narrow line of dark, reddish-brown scales along bases of prescutellar setae), scutal fossal area covered and contiguous with dorsocentral line (except for small, elongate patch of dark, reddish-brown scales on median area), antealar and supraalar areas covered except for an elongate patch of reddish-brown scales on median area of supraalar area; golden to brown setae on following areas: 3,4 anterior promontory, 1–4 anterior acrostichal, 2–4 antedorsocentral, several dorsocentral (anterior and posterior), 7–10 prescutellar, 3,4 scutal fossal, 3,4 antealar, numerous supraalar (upper ones dark and long, small patch of short, blunt-tipped, pale ones in front of wing base), and 1 parascutellar; scutellum with narrow, curved, dark, reddish-brown scales on each lobe, also few golden narrow, curved scales on median area of midlobe and few on lateral lobes, midlobe with 3,4 long and 2–6 short setae, lateral lobe with 3–6 long and 2,3 short setae; pleural integument dark brown; antepronotum with broad, dusty-white scales on anterior, lower lateral, and posterior surfaces, 14–19 setae; postpronotum with narrow, curved, golden scales dorsally and few dusty-white or golden, moderately broad scales ventrally, 3–5 posterior setae; postspiracular area without scales, with 5–8 setae; subspiracular area with elongate patch of broad, white scales; upper proepisternum with patch of broad, white scales, 5–9 pale setae; mesokatepisternum with upper and lower patches of

broad, white scales, 3,4 upper and 4–6 posterior setae; prealar area with large patch of broad, white scales on lower area, 7–10 setae on upper area; mesepimeron with large patch of broad, white scales covering most of area, 4–10 upper pale setae, lower setae absent. *Legs*: Coxa I with broad, white scales dorsally and ventrally separated by median patch of broad, brown scales; femora I–III dark brown-scaled except for white scales as follow: I with narrow, white-scaled, basal band, posterior surface with median, longitudinal stripe from base to apex, stripe broader on basal area and reaching posterodorsal margin, II with small, dorsobasal patch, 2,3 dorsoapical scales and indistinct narrow stripe on ventral margin of anterior surface, posterior surface with posteroventral, longitudinal stripe from base to apex, stripe wider on basal area, III with approximately anterobasal 0.65 and approximately posterobasal 0.58 (except dorsal margin brown-scaled), apex with small, patch on anterior, dorsal, and posterior surfaces; tibiae I–III dark brown-scaled except for small, basal, white-scaled patch on posteroventral area, III and sometimes II with white-scaled patch slightly larger and extending onto anteroventral area; tarsi I,II dark brown-scaled except for white scales on following: II with tarsomere 1 with narrow, basal band (some specimens also with 2,3 dark scales on anterior surface of band), and few at apex, tarsomere 2 with narrow basal band or with 3,4 dorsobasal scales, tarsomere 3 of some specimens with 2–4 scales dorsobasally, III with tarsomeres 1 and 2 with moderate basal band and narrow apical bands, tarsomere 3 with narrow basal band and few dorsoapical scales, tarsomere 4 with few dorsobasal scales. *Wing*: Dorsal and ventral veins with dark brown scales, base of costa with few white scales; remigium with 2,3 relatively long, brown setae. *Halter*: Pedicel pale; capitellum with broad, brown scales except broad, white scales on anterior and ventral surfaces. *Abdomen*: Terga dark brown-scaled with small basolateral white-scaled patch, III–VI with narrow, basal white-scaled bands, bands incomplete on III and IV in some specimens, VI with large basolateral patch nearly meeting dorsomesally; sternum II white-scaled, III–VII dark brown-scaled with basal white-scaled band that becomes broader on lateral areas; terga and sterna with short setae on lateral and posterior margins.

Female genitalia (Fig. 1). *Tergum VIII*: Basal 0.50–0.60 retracted into segment VII; scales on distal 0.52–0.58; setae on distal 0.64–0.66; apical margin more or less straight, with 2 long and 4,5 moderately long setae; basolateral seta near basolateral margin; VIII-Te index 1.04–1.06; VIII-Te/IX-Te index 2.68–3.06; length 0.25–0.28 mm; width 0.23–0.27 mm. *Sternum VIII*: Apex gently convex with minute (0.01–0.02 of dorsal VIII-S length), median emargination; scales covering distal 0.96; setae on distal 0.85–0.91; basolateral seta absent; VIII-S index 0.86–0.88; length 0.30–0.34 mm; width 0.35–

0.38 mm. *Tergum IX*: Apex with 3,4 short setae on each side of midline, 6,7 total setae; IX-Te index 0.73–0.80; length 0.08–0.10 mm; width 0.11–0.13 mm. *Postgenital lobe*: Apex with moderately deep (0.18–0.22 of dorsal length), median emargination; 8–13 setae on each side of midline, 17–25 total setae; ventral PGL/Ce index 0.64–0.67; dorsal PGL index 0.86–0.91; ventral PGL index 1.49–1.57; ventral length 0.10–0.11 mm. *Cercus*: Dorsal surface without scales, with number of short setae on distal 0.68–0.72, 3 long and 3,4 moderately long setae on approximately distal 0.22; cercus index 2.65–2.73; Ce/dorsal PGL index 2.56–2.73; length 0.16–0.18 mm; width 0.06–0.07 mm. *Accessory gland duct*: Basal area relatively short.

Male. Similar to female in general habitus. *Head*: Antenna 0.63–0.66 length of proboscis; maxillary palpus with very few short, dark brown setae on palpomeres 3–5, 0.69–0.73 length of proboscis; proboscis 1.16–1.30 length of femur I. *Thorax*: Scutum with dark-scaled areas reduced and approximately anterior 0.5 primarily golden-scaled. *Wing*: Base of costa dark-scaled.

Male genitalia (Figs. 2A–2C). *Tergum IX*: Pair of lobes on posterior margin each bearing 3–5 short, slightly curved, stout, somewhat flattened setae apically; anterior margin deeply emarginate. *Gonocoxite*: Proximal approximately 0.40 of dorsal surface increasing in width to form more or less triangular lobe with moderately pigmented, posteriorly extended, oval area (that normally projects sternally) bearing 10,11 moderately long, stout, lanceolate setae along mesal margin, each seta with short, basal sheath, lateral margin of oval area surrounded by lightly pigmented, narrow, crescent-shaped strip bearing 9–12 moderately long, slender setae; dorsal surface with about 4 very long (extending beyond apex of gonocoxite), stout setae arising laterally from near base, approximately distal 0.20 with several long, slightly curved, stout setae; lateral and ventral surfaces covered with numerous long, spatulate scales; ventral surface covered with moderately long to long setae scattered over most of area, mesal margin with irregular row of moderately long and long setae from base to apex, setae increasing in length distally. *Gonostylus*: With 1,2 short, slender setae near apex. *Claspette*: Comprised of moderately long, slender stem (somewhat thickened at about 0.74 from base), covered with tiny spicules except distal portion, terminating with large, flattened, leaf-like filament, 3 short, slender setae on thickened area and 1 short, slender seta at about proximal 0.34, stem base with long, narrow arm projecting laterally and curved dorsally, partially connected to sternomesal portion of oval, basomesal area of dorsal surface of gonocoxite, narrow extension bearing several (about 11) setae along margin, distal 5 setae broadly flattened, next 2 or 3 setae proximally lanceolate, and most proximal 2 or 3 setae stout, simple, distal 7 or 8 setae each

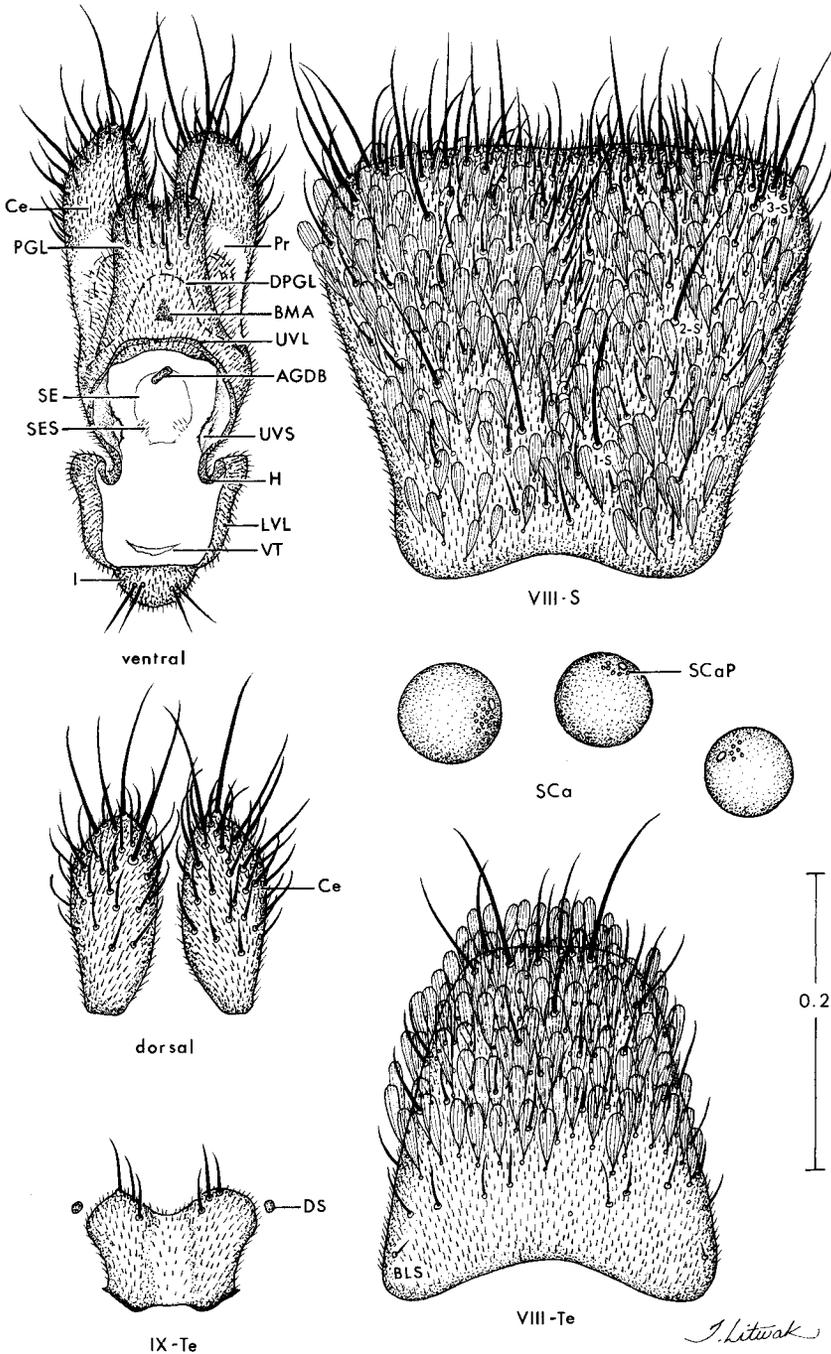


Fig. 1. *Ochlerotatus (Bruceharrisonius) greenii*, female genitalia. AGDB, accessory gland duct base; BMA, basal mesal apodeme; Ce, cercus; DPGL, line of attachment of proctiger to dorsal surface of postgenital lobe; DS, dorsal sphere; H, hinge; I, insula; IX-Te, tergum IX; LVL, lower vaginal lip; PGL, postgenital lobe; Pr, proctiger; SCa, seminal capsule; SCaP, seminal capsule pore; SE, spermathecal eminence; SES, spermathecal eminence spicule; UVL, upper vaginal lip; UVS, upper vaginal sclerite; VIII-S, sternum VIII; VIII-Te, tergum VIII; VT, ventral tuft; 1-3-S, setae 1-3 of sternum VIII.

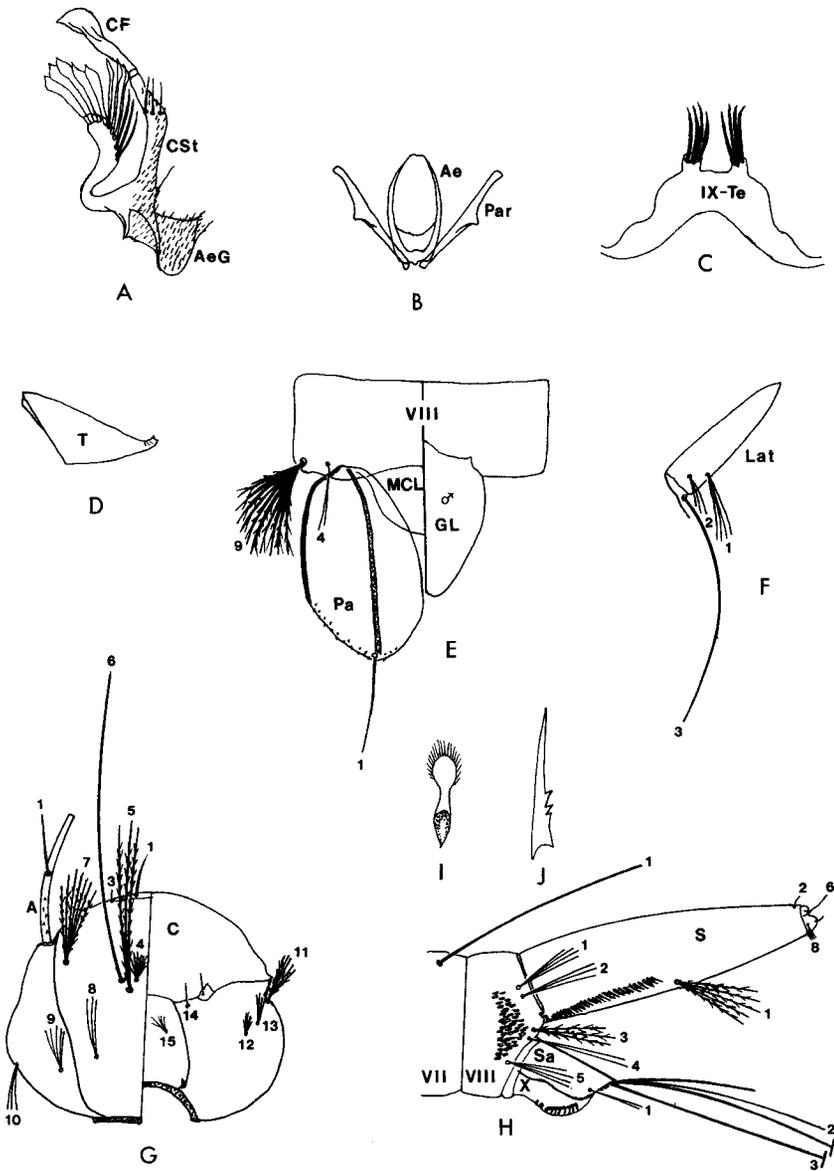


Fig. 2. *Ochlerotatus (Bruceharrisonius) greenii*; male genitalia. (A) claspette, (B) phallosome, (C) tergum IX; pupa, (D) trumpet, (E) abdominal segments VIII and X, genital lobe, and paddle, (F) lateralialia; 4th-stage larva, (G) cranium, (H) abdominal segments VII, VIII, and X, and siphon, (I) enlarged comb scale, (J) enlarged pecten tooth. A, antenna; Ae, aedeagus; AeG, aedeagal guide; C, cranium; CF, claspette filament; CSt, claspette stem; GL, genital lobe; IX-Te, tergum IX; Lat, lateralialia; MCL, median caudal lobe; Pa, paddle; Par, paramere; S, siphon; Sa, saddle; T, trumpet; VII, abdominal segment VII; VIII, abdominal segment VIII; X, abdominal segment X.

with a short, basal sheath; bases of claspette stems connected mesally by wide, spiculate aedeagal guide. **Phallosome:** Aedeagus relatively short with apex narrower than base, narrow lateral areas and approximately basal 0.27 heavily pigmented, remainder lightly pigmented; paramere approximately 1.16 the length of the aedeagus; basal piece approximately 0.74 the length of the aedeagus. **Sternum IX:** With heavily pigmented, broad median and narrow lateral areas; 4–6 stout setae pos-

teriorly, 2 long and 2–4 short to moderately long; narrowly connected laterally to tergum IX.

Pupa (Figs. 2D–2F). Setal branching as in Table 1. **Cephalothorax:** Integument pale tan with some darker areas. **Trumpet:** Moderately pigmented; apex relatively broad and tapering to narrow base; tracheoid area small, basal, and poorly developed; index 1.74–3.25, shortest in male; pinna 0.32–0.38 the length of the trumpet. **Abdomen:** Integument pale tan with some darker areas on terga I–IV. **Pad-**

Table 1. Observed branching of setae on pupae of *Ochlerotatus (Bruceharrisonius) greenii* (5 specimens).¹

Seta no.	Cephalo-thorax	Abdominal segments								Paddle			
		I	II	III	IV	V	VI	VII	VIII				
0													
1	3-5 (3)	23-38 (35)	1	1	1	1	1	1	1	1	1	1	1
2	3-5 (3)	1-3 (1)	21-40 (35)	4-11 (7)	3-5 (4)	2-4 (2)	1,2 (1)	1	1	1	1	1	1
3	1	2	1	1	1	1	1	1	1	1	1	1	1
4	4-7 (5)	7-13 (8)	1-5 (2)	6-10 (9)	3,4 (3)	2,3 (2)	2-4 (3)	2-4 (3)	2-4 (3)	2-4 (3)	2-4 (3)	2-4 (3)	2-4 (3)
5	3-5 (4)	2-4 (3)	4-8 (6)	2,3 (3)	5-8 (7)	4-7 (5)	1-4 (2)	1-4 (2)	1-4 (2)	1-4 (2)	1-4 (2)	1-4 (2)	1,2 (2)
6	2-4 (3)	1	5-9 (6)	2-4 (2)	1,2 (1)	1	2-4 (2)	2-4 (2)	2-4 (2)	2-4 (2)	2-4 (2)	2-4 (2)	2-4 (2)
7	4-6 (5)	3,4 (3)	3-6 (5)	3-5 (4)	2-4 (2)	1,2 (1)	1	1	1	1	1	1	1
8	3,4 (4)	1	4-7 (4)	2-4 (2)	4-8 (6)	5-7 (5)	3-7 (5)	3-7 (5)	3-7 (5)	3-7 (5)	3-7 (5)	3-7 (5)	3-7 (5)
9	3,4 (4)	1	5-9 (6)	3-6 (5)	4-6 (5)	5-7 (5)	4-7 (5)	4-7 (5)	4-7 (5)	4-7 (5)	4-7 (5)	4-7 (5)	4-7 (5)
10	4-9 (6)	1	3-5 (3)	1-4 (3)	1	1,2 (1)	1	1	1	1	1	1	1
11	1-3 (3)		1	1	1	1	1	1	1	1	1	1	1
12	6-9 (7)		1	1	1	1	1	1	1	1	1	1	1
14			1	1	1	1	1	1	1	1	1	1	1

¹ Range of setal branching is followed by mode in parentheses.

dle: Relatively narrow; outer buttress on basal 0.57-0.68 of outer margin; margins of distal area with few small spicules; index 1.58-1.69.

Fourth-stage larva (Figs. 2G-2J). *Head*: Seta 1-C relatively long, single, simple; 3-C short, single, simple; 4-C short, with 9-11 slender branches; 5-C long, approximately 0.5 the median length of the dorsal apotome, with 3 stout, acuminate branches, mesad and posterior to 6-C; 6-C exceptionally long, approximately 1.5 the median length of the dorsal apotome, single, stout; 7-C moderately long, with 7-11 stout, acuminate branches; 8-C with 3,4 slender branches; 9-C with 5-9 slender branches; 10-C with 3-6 slender branches; 11-C with 5-7 stout, acuminate branches; 12-C short, with 6-10 slender branches; 13-C moderately long, with 4-6 slender branches; 14-C short, single, near anterior margin of lateralla; 15-C with 3-7 branches; 18,19-C tiny. *Antenna*: Shaft long, slender, few spicules on proximal area; seta 1-A moderately stout, single, simple, inserted approximately 0.50-0.55 from base of the shaft; 2-5-A inserted at apex of the shaft. *Mouthparts*: Seta 6-Mx short, single or 2-branched; lateral palatal brush with simple filaments; dorsomentum with 25,26 posterior teeth. *Thorax*: Seta 0-P short, with 25-35 slender, dendritic branches; 1-P with 2,3 branches; 2-P single; 3-P with 4,5 branches; 2-P > 1-P > 3-P length; 4-P with 3,4 branches; 5-P with 3 stout, acuminate branches; 6-P single, stout, simple; 7-P with 2,3 stout, acuminate branches; 8,11,14-P short, with 2,3 branches; 9,10,12-P single; 1-M with 2,3 branches; 2,11-M with 2-4 branches; 3,5,7,10,12-M single, 5-M stout, very long, acuminate; 4-M with 3-6 branches; 6-M with 3,4 stout, acuminate branches; 8-M with 4,5 stout, acuminate branches; 9-M with 4 branches; 13-M short, with 19-23 slender, dendritic branches; 1-T with 3-8 branches; 2-T with 3-8 branches; 3-T with 5-7 branches; 4-T with 6-9 branches; 5-T single to 4-branched; 6,10,12-T single; 7-T with 6-9 stout, acuminate branches; 8-T short, with 10-16 slender, dendritic branches; 9-T with 4,5 stout, acuminate branches; 11-T with 2,3 branches; 13-T short, with 7-14 slender, dendritic branches. *Abdomen*: Much of abdominal segments III-VI were badly twisted or damaged in the available specimens. Seta 1-I short, with 5-12 slender branches; 2,10-I single, 2-I short, 10-I moderately long; 3-I with 3-6 branches; 4-I with 12-29 branches; 5-I with 5-8 branches; 6-I relatively short, with 3 stout, acuminate branches; 7-I with 2 stout, acuminate branches; 9-I with 3-5 branches; 11-I with 5,6 branches; 12-I with 2-4 branches; 13-I single or 2-branched; 1-II with 2-4 branches; 2,9-II single; 3-II with 5,6 branches; 4-II with 13-19 branches; 5-II with 8,9 branches; 6-II relatively short with 2 stout, acuminate branches; 7-II with 5-8 branches; 8,10-II with 3,4 branches; 11-II with 2 branches; 13-II with 25-29 branches; 6-III-VI single; 1-VII very long, single, stout; 2-VII single; 3-VII with 3-9 branches; 4-VII with 4,5 branches; 5-

VII with 6–9 branches; 6-VII with 21–30 branches; 7-VII with 3 branches; 8-VII with 17–31 branches; 9-VII with 3–5 branches; 10-VII with 3,4 branches; 11-VII single; 12-VII with 4–6 branches; 13-VII with 9–11 branches; 1-VIII with 4–7 slender branches; 2-VIII with 3–5 slender branches; 3-VIII with 2–4 stout, aciculate branches; 4-VIII with 2,3 slender branches; 5-VIII with 4–6 slender branches; segment VIII with comb of 47–68 scales in patch, scales moderately long, apex rounded, with slender spicules on apical and lateral margins; saddle heavily pigmented, incomplete ventrally, few short, stout spicules along upper, posterior margin, short rows of 3–5 minute spicules scattered over entire surface, saddle/siphon index 3.23–3.60; seta 1-X short, with 2 (rarely 3) branches, inserted on saddle near posterior margin; 2-X with 3 branches, dorsal branch noticeably shortest; 3-X very long, single, noticeably longer than 2-X; ventral brush with 8 (occasionally 9) setae attached to grid, setae fanlike with 6–8 branches, and 2 short, 5- or 6-branched, precratal setae, grid with both lateral and transverse bars; 4 anal papillae, dorsal pair longer than ventral pair. *Siphon*: Index 3.18–3.39 (dorsal length to width at 0.5 length); acus small, at base of pecten; pecten on proximal approximately 0.39 of siphon, comprised of 25–30 evenly spaced spines, basal 2 or 3 spines reduced in size, remainder of spines heavily pigmented with 2,3 small spicules near mid ventral margin; seta 1-S with 4–7 aciculate branches, borne distal to pecten; 2,6-S single; 8-S with 3–9 branches.

Type data. The holotype female is mounted on a minuten pin attached to a circular paper stage attached to an insect pin and has 5 paper labels with the following data: /93, Ceylon, E. E. Green/ /Peradeniya, Ceylon, II.1900/ /133/ /Holotype/ and /*Aedes greenii* Type FVT/. The holotype is deposited in The Natural History Museum (NHM), London, United Kingdom.

Discussion. The above description of *Oc. greenii* is based on the holotype female (see above) and numerous topotypic males and females with associated pupal and 4th-stage larval exuviae and 4th-stage larvae (♀ = female; ♂ = male; p = pupal exuviae; l = larval exuviae; L = larva) with the following collection data: Sri Lanka, Central Province, Kandy District, Peradeniya, Royal Botanic Garden, E. L. Peyton and Y.-M. Huang collectors, immatures collected from small bamboo stumps, 30 June 1975, collection number 142 (3♀pl, 8♀p, 7♂p), collection number 145 (5♀pl, 1♀p, 2♂p), collection number 162 (2♀pl, 2L), collection number 167, 1 July 1975 (1♀p, 1♀), collection number 180, 1 July 1975, immatures collected from leaf axils of ground bromeliad (1♀pl, 4♂pl, 2♂p, 1pl, 3L). The topotypic specimens are deposited in the National Museum of Natural History, Washington, DC.

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REFERENCES CITED

- Amerasinghe FP. 1982. Observations on the mosquitoes (*Diptera: Culicidae*) of Udawattakele Forest, Sri Lanka. *J Natl Sci Counc Sri Lanka* 10:81–97.
- Amerasinghe FP, Munasinghe NB. 1984–85. Further observations on the mosquito fauna of Udawattakele Forest, Sri Lanka. *Ceylon J Sci (Bio Sci)* 17 and 18:1–21.
- Amerasinghe FP, Munasinghe NB. 1988. A predevelopment mosquito survey in the Mahaweli Development Project area, Sri Lanka: adults. *J Med Entomol* 25:276–285.
- Apiwatnasorn C. 1986. *A list of mosquito species in Southeast Asia* Bangkok, Thailand: Museum and Reference Centre, SEAMEO-TROPED Nature Centre of Thailand, Mahidol University.
- Barraud PJ. 1923. A revision of the culicine mosquitoes of India. Part VII. The larvae of some species of *Stegomyia* (Theo.), the larvae of some species of *Finlayia* (Theo.), the larva of *Christophersiomia thomsoni* (Theo.), the larva of *Mimomyia chamberlaini* (Ludl.), the larva of *Aedomyia* [sic] *catacticta* (Knab.). *Indian J Med Res* 11:495–505 + pl. XXXIV–XL.
- Barraud PJ. 1924. A revision of the culicine mosquitoes of India. Part VIII. Further descriptions of Indian species of *Finlayia* Theo. *Indian J Med Res* 11:845–865 + pl. XLVIII–LVII.
- Barraud PJ. 1934. *The fauna of British India, including Ceylon and Burma. Diptera* Volume V *Family Culicidae. Tribes Megarhinini and Culicini* London, United Kingdom: Taylor and Francis.
- Bhat HR. 1975. A survey of haematophagous arthropods in western Himalayas, Sikkim and Hill Districts of West Bengal: records of mosquitoes collected from Himalayan region of Uttar Pradesh with ecological notes. *Indian J Med Res* 63:1583–1608.
- Blanchard R. 1905. *Les moustiques histoire naturelle et medicale* Paris, France: F. R. de Rudeval, Imprimeur-Editeur. [In French.]
- Bohart RN. 1946. New species of mosquitoes from the Marianas and Okinawa (Diptera, Culicidae). *Proc Biol Soc Wash* 59:39–46.
- Bohart RN. 1959. A survey of the mosquitoes of the southern Ryukyus. *Mosq News* 19:194–197.
- Bohart RN, Ingram RL. 1946a. Four new species of mosquitoes from Okinawa (Diptera: Culicidae). *J Wash Acad Sci* 36:46–52.
- Bohart RN, Ingram RL. 1946b. *Mosquitoes of Okinawa and islands in the Central Pacific* NAVMED 1055. Washington, DC: Bureau of Medicine and Surgery Navy Department.
- Bonne-Wepster J. 1954. *Synopsis of a hundred common non-anopheline mosquitoes of the Greater and Lesser Sundas, the Moluccas and New Guinea* Royal Tropical

- Institute of Amsterdam Special Publication CXI. Amsterdam, The Netherlands: Elsevier Publishing Co.
- Brug SL. 1926. The geographical distribution of mosquitoes in the Malayan Archipelago. *Meded Volksgezondheid Ned-Ind* 4:471-482.
- Brug SL. 1931. Culicines der Deutschen Limnologischen Sunda-Expedition. *Trop Binnengewass* 2:1-42. [In Dutch.]
- Brug SL. 1934. Notes on Dutch East Indian mosquitos. *Bull Entomol Res* 25:501-519.
- Brug SL, Bonne-Wepster J. 1947. The geographical distribution of the mosquitoes of the Malay Archipelago. *Chron Nat* 103:179-197.
- Brug SL, Edwards FW. 1931. Fauna Sumatrensis (Bijdrage nr. 68), Culicidae (Diptera). *Overgedrukt Tijdschrift Entomol* 74:251-261.
- Brunetti E. 1907. XXV.—Annotated catalogue of Oriental Culicidae. *Rec Indian Mus (Calcutta)* 1:297-377.
- Brunetti E. 1912. X. Annotated catalogue of Oriental Culicidae—supplement. *Rec Indian Mus (Calcutta)* 4:403-517.
- Brunetti E. 1920. I. Catalogue of Oriental and south Asiatic Nemoera. *Rec Indian Mus (Calcutta)* 17:1-300.
- Carter HF. 1950. Ceylon mosquitoes: lists of species and names of mosquitoes recorded from Ceylon. *Ceylon J Sci (B)* 24:85-115.
- Chow CY, Thevasagayam ES, Tharumarajah K. 1954. Insects of public health importance in Ceylon. *Rev Ecuat Entomol Parasitol* 2:105-150.
- Chu F. 1957. Collection of megarhine and culicine mosquitoes from Hainan Island, south China, with description of a new species. *Acta Zootax Sin* 9:145-163 + pl. I-III. [In Chinese.]
- Chu F-I. 1958. Advances in the study of culicine mosquitoes of Hainan, south China. *Indian J Malariol* 12:109-112.
- da Costa Pinhao R. 1974. Sobre a situacao zoogeografica de Timor. *An Inst Hig Med Trop* 1:467-470.
- Danilov VN. 1977. On the synonymy of species names of *Aedes* [sic] mosquitoes (subgenera *Finlaya* [sic] and *Neomelaniconion* [sic]) in the Far East fauna. *Parazitologiya* 11:181-184. [In Russian.]
- Darsie RF Jr, Pradhan SP. 1990. The mosquitoes of Nepal: their identification, distribution and biology. *Mosq Syst* 22:69-130.
- Darsie RF Jr, Pradhan SP, Vaidya RG. 1991. Notes on the mosquitoes of Nepal I. New country records and revised *Aedes* keys (Diptera, Culicidae). *Mosq Syst* 23:39-49.
- Doleschall CL. 1857. Tweede bijdrage tot de kennis der dipterologische fauna van Nederlandsche Indie. *Natuurk Tijdschr Ned-Ind* 14:377-418. [In Dutch.]
- Edwards FW. 1917. Notes on Culicidae, with descriptions of new species. *Bull Entomol Res* 7:201-229.
- Edwards FW. 1922a. A synopsis of adult Oriental culicine (including megarhinine and sabethine) mosquitoes. Part I. *Indian J Med Res* 10:249-293.
- Edwards FW. 1922b. A synopsis of adult Oriental culicine (including megarhinine and sabethine) mosquitoes. Part II. *Indian J Med Res* 10:430-475.
- Edwards FW. 1924. A synopsis of the adult mosquitos of the Australasian Region. *Bull Entomol Res* 14:351-401.
- Edwards FW. 1932. *Genera insectorum. Diptera, fam. Culicidae* Fascicle 194. Bruxelles, Belgium: Desmet-Vertereuil, Imprimeur-Editeur.
- Evenhuis NL, Gon SM III. 1989. Family Culicidae. In: Evenhuis NL, ed. *Catalog of the Diptera of the Australasian and Oceanian regions* Honolulu, HI: Bishop Museum Press. p 191-218.
- Giles GM. 1900. *A handbook of the gnats or mosquitoes giving the anatomy and life history of the Culicidae* London, United Kingdom: John Bale, Sons and Danielsson, Ltd.
- Giles GM. 1902. *A handbook of the gnats or mosquitoes giving the anatomy and life history of the Culicidae* 2nd ed. London, United Kingdom: John Bale, Sons and Danielsson, Ltd.
- Gutsevich AV. 1955. New and little known forms of mosquitoes (Diptera, Culicidae). *Akad Nauk Zool Inst (Trudy)* 18:320-324. [In Russian.]
- Gutsevich AV. 1975. The determination of mosquito females (Culicidae) by microscopic preparations of the head IV. A key to species of the genus *Aedes*. *Mosq Syst* 7:164-173. [Originally published in Russian in *Parazitologiya* 8:329-335, 1974.]
- Gutsevich AV, Dubitsky AM. 1981. *New species of mosquitoes in USSR fauna* Leningrad, USSR: USSR Academy of Science, Zoological Institute.
- Gutsevich AV, Monchadskii AS, Shtakel'berg AA. 1974. *Fauna of the U.S.S.R. Diptera. Mosquitoes family Culicidae* Jerusalem, Israel: Israel Program Scientific Translations. [Translation from Russian.]
- Hara J. 1959. Two new mosquito records from Japan (Diptera: Culicidae). *Jpn J Sanit Zool* 10:225-229.
- Harbach RE, Knight KL. 1980. *Taxonomists' glossary of mosquito anatomy* Marlton, NJ: Plexus Publishing, Inc.
- Harbach RE, Knight KL. 1982. Corrections and additions to *Taxonomist's glossary of mosquito anatomy*. (1981) *Mosq Syst* 13:201-217.
- Harrison BA, Rattanarithikul R, Peyton EL, Mongkolpanya K. 1990. Taxonomic changes, revised occurrence records and notes on the Culicidae of Thailand and neighboring countries. *Mosq Syst* 22:196-227.
- Hochman RH, Reinert JF. 1974. Undescribed setae in larvae of Culicidae (Diptera). *Mosq Syst* 6:1-10.
- Horsfall WR. 1955. *Mosquitoes their bionomics and relation to disease* New York, NY: Ronald Press Co.
- Huang Y-M. 1968. A new subgenus of *Aedes* (Diptera, Culicidae) with illustrated key to the subgenera of the Papuan Subregion (Diptera: Culicidae). *J Med Entomol* 5:169-188.
- Iyengar MOT. 1955. *Distribution of mosquitoes in the South Pacific Region* Technical Paper 86. Noumea, New Caledonia: South Pacific Commission.
- Iyengar MOT. 1960. *A review of the mosquito fauna of the South Pacific* (Diptera: Culicidae). Technical Paper 130. Noumea, New Caledonia: South Pacific Commission.
- Jayasekera N, Chelliah RV. 1981. *An annotated checklist of mosquitoes of Sri Lanka* (Diptera: Culicidae). Publication 8. MAB-UNESCO—Man and the Biosphere Nat Committee of Sri Lanka
- Joshi G, Pradhan S, Darsie RF Jr. 1965. Culicine, sabethine and toxorhynchitine mosquitoes of Nepal including new country records (Diptera: Culicidae). *Proc Entomol Soc Wash* 67:137-146.
- Kaur R. 1992. Mosquito types present in the collections of National Institute of Communicable Diseases, Delhi (Diptera: Culicidae). *Orient Insects* 26:367-382.
- Kaur R. 2003. An update on the distribution of mosquitoes of the tribe Aedini in India (Diptera: Culicidae). *Orient Insect* 37:439-455.
- King WV, Hoogstraal H. 1946. Species of *Aedes* (*Finlaya*) [sic] of the papuensis group in the Australasian Region

- (Diptera, Culicidae). *Proc Entomol Soc Wash* 48:135-157.
- Knight KL. 1968. Contributions to the mosquito fauna of Southeast Asia.—IV. Species of the subgroup *Chryso-lineatus* of group D, genus *Aedes*, subgenus *Finlaya* Theobald. *Contrib Am Entomol Inst (Ann Arbor)* 2(5): 1-45.
- Knight KL. 1978. *Supplement to a catalog of the mosquitoes of the world* Washington, DC: Thomas Say Foundation, Entomological Society of America.
- Knight KL, Hull WB. 1951. The *Aedes* mosquitoes of the Philippine Islands I. Keys to species. Subgenera *Mucidus*, *Ochlerotatus*, and *Finlaya* (Diptera, Culicidae). *Pac Sci* 5:211-251.
- Knight KL, Marks EN. 1952. An annotated checklist of the mosquitoes of the subgenus *Finlaya* [sic], genus *Aedes* [sic]. *Proc US Natl Mus* 101:513-574.
- Knight KL, Stone A. 1977. *A catalog of the mosquitoes of the world (Diptera: Culicidae)* College Park, MD: Thomas Say Foundation, Entomological Society of America.
- Kurihara T. 1963. Comparative studies on the pleural structure of the Japanese mosquitoes. *Jpn J Sanit Zool* 14:191-207. [In Japanese with English summary.]
- Kurihara T. 1978. Collection records of mosquitoes' in Indonesia. *Teikyo J Med* 1:333-338. [In Japanese with English abstract.]
- Lee DJ. 1944. *An atlas of the mosquito larvae of the Australasian Region tribes—Megarhinini and Culicini*. Australia: North Melbourne Victorian Railways Printing Works, by authority of HQ Australian Military Forces.
- Lee DJ, Hicks MM, Griffiths M, Russell RC, Marks EN. 1982. *The Culicidae of the Australasian region* Volume II *Nomenclature, synonymy, literature, distribution, biology and relation to disease. Genera AEDEOMYIA, genus AEDES (subgenera [Aedes], Aedimorphus, Chaetocruomyia, Christophersomyia, Edwardsaedes and Finlaya)*. Monograph Series, Entomology Monograph 2. Canberra, Australia: School of Public Health and Tropical Medicine, Australian Government Publishing Service.
- Lee KW. 1987. Checklist of mosquitoes (Culicidae) in Korea. *Korean J Parasitol* 25:207-209. [In Korean with English summary.]
- Lee KW, Egan PJ. 1985. *Illustrated taxonomic keys to genera and species of female mosquitoes of Korea* Part I. San Francisco, CA: Department of the Army, 5th Preventative Medicine Unit, 18th Medical Command.
- Lee KW, Lien JC. 1970. *Pictorial keys to the mosquitos of Korea* WHO/VBC 70.196. Geneva, Switzerland: World Health Organization.
- Lee KW, Zorka T. 1987. *Illustrated taxonomic keys to genera and species of mosquito larvae of Korea. Part II* San Francisco, CA: Department of the Army, 5th Preventative Medicine Unit, 18th Medical Command.
- Lee VH, Nalim S, Olson JG, Gubler DJ, Ksiazek TG, Aep S. 1984. A survey of adult mosquitoes of Lombok Island, Republic of Indonesia. *Mosq News* 44:184-191.
- Lei X, Yang C, Lu B. 1984. Notes on *Aedes* (F) christophersi [sic] new to China (Diptera: Culicidae). *Sichuan J Zool* 9:8-9. [In Chinese with English summary.]
- Lien JC. 1967. New species of mosquitoes from Taiwan (Diptera: Culicidae) Part I. Two new species of *Aedes* (*Finlaya*) [sic]. *Trop Med* 9:177-185.
- Lien JC. 1968. New species of mosquitoes from Taiwan (Diptera: Culicidae) Part V. Three new subspecies of *Aedes* and seven new species of *Culex*. *Trop Med* 10: 217-262.
- Lien JC, Kawengian BA, Partono F, Lami B, Cross JH. 1977. A brief survey of the mosquitoes of south Sulawesi, Indonesia, with special reference to the identity of *Anopheles barbirostris* (Diptera: Culicidae) from the Margolemba area. *J Med Entomol* 13:719-727.
- Lu B, Chen H, Xu R, Ji S. 1988. *A checklist of Chinese mosquitoes (Diptera: Culicidae)* Guiyang, China: Guizhou People's Publishing House. [In Chinese.]
- Lu B, Ji S. 1997. Subgenus *Finlaya* Theobald, 1903. In: Lu B, Li B, Ji S, Chen H, Meng Q, Su L, Qu F, Gong Z, Zhang Z, eds. *Diptera: Culicidae I. Fauna Sinica, Insecta* Volume 8. Beijing, People's Republic of China: Science Press. p 99-173, Figs. 18-60. [In Chinese.]
- Lu B, Li P. 1982. Chapter 1. Identification of Chinese Mosquitoes. In: Lu B, ed. *Handbook for the identification of Chinese important medical zoology* Beijing, China: People's Hygiene Publishing House. p 1-159, 941-944. [In Chinese.]
- Lu B, Su L. 1987. *A handbook for the identification of Chinese aedine mosquitoes* Beijing, People's Republic of China: Science Press. [In Chinese.]
- Macdonald WW. 1957. Malaysian parasites, XVI. An interim review of the non-anopheline mosquitoes of Malaya. In: Andy, JR, ed. *Malaysian parasites XVI-XXXIV. Study no. 28* Kuala Lumpur, Malaysia: Institute for Medical Research of the Federation of Malaya. p 1-34.
- Macdonald WW, Traub R. 1960. Malaysian parasites XXXVII. An introduction to the ecology of the mosquitoes of the lowland dipterocarp forest of Selangor, Malaya. In: Macdonald WW, ed. *Malaysian Parasites XXXV-XLIX. Study no. 29* Kuala Lumpur, Malaysia: Institute for Medical Research of the Federation of Malaya. p 79-109.
- Mogi M, Miyagi I, Suzuki H. 1981. New locality records of five mosquito species in Japan. *Jpn J Sanit Zool* 32: 124-126.
- Monchadskii AS. 1951. The larvae of bloodsucking mosquitoes of the USSR and adjoining countries (subfam. Culicinae). *Tabl Anal Faune URSS Moscow Zool Inst Akad Nauk SSSR* 37:1-290.
- Nakata G. 1956. A new species of mosquito, *Aedes* (*Finlaya*) *kabayashii* n. sp.: from Kyoto, Japan. *Jpn J Sanit Zool* 7:135. [In Japanese.]
- Nakata G. 1959. Redescription of *Aedes* (*Finlaya*) *kobayashii* Nakata, 1956. *Jpn J Sanit Zool* 10:16-20 + 2 pl.
- Peyton EL, Pecor JE, Gaffigan TV, Trpis M, Rueda LM, Wilkerson RC. 1999. The Johns Hopkins University School of Hygiene and Public Health, Lloyd E. Rozeboom mosquito collection. *J Am Mosq Control Assoc* 15:526-551.
- Rao TR, Rajagopalan PK. 1957. Observations on mosquitoes of Poona District, India, with special reference to their distribution, seasonal prevalence and the biology of adults. *Indian J Malariol* 11:1-54.
- Rattanaarithikul R, Harrison BA. 1988. *Aedes* (*Finlaya*) *reineri*, a new species from northern Thailand related to *Aedes* (*Finlaya*) *formosensis* Yamada (Diptera: Culicidae). *Mosq Syst* 20:77-96.
- Reinert JF. 1990. Medical entomology studies—XVII. Biosystematics of *Kenknightsia*, a new subgenus of the mosquito genus *Aedes* Meigen from the Oriental Region (Diptera: Culicidae). *Contrib Am Entomol Inst (Gainesville)* 26(2):1-119.
- Reinert JF. 1999. Descriptions of *Zavortinkius*, a new sub-

- genus of *Aedes*, and the eleven included species from the Afrotropical Region (Diptera: Culicidae). *Contrib Am Entomol Inst (Gainesville)* 31(2):1-105.
- Reinert JF. 2000a. New classification for the composite genus *Aedes* (Diptera: Culicidae: Aedini), elevation of subgenus *Ochlerotatus* to generic rank, reclassification of the other subgenera, and notes on certain subgenera and species. *J Am Mosq Control Assoc* 16:175-188.
- Reinert JF. 2000b. Comparative anatomy of the female genitalia of genera and subgenera in tribe Aedini (Diptera: Culicidae). Part I. Introduction, preparation techniques, and anatomical terminology. *Contrib Am Entomol Inst (Gainesville)* 32(2):1-18.
- Reinert JF. 2002. Comparative anatomy of the female genitalia of genera and subgenera in tribe Aedini (Diptera: Culicidae). Part XIII. Genus *Ochlerotatus* Lynch Arribalzaga. *Contrib Am Entomol Inst (Gainesville)* 33(1): 1-111.
- Reisen WK, Basio RG. 1972. Oviposition trap surveys conducted on four USAF installations in the western Pacific. *Mosq News* 32:107-108.
- Saini RS, Mishra AK. 1984. Mosquito fauna of Rewa. *Geobios New Rep* 3:57-58.
- Saugstad ES. 1973. Two mosquito species new to the Ryukyu Islands. *Jpn J Sanit Zool* 23:284.
- Sazonova ON. 1981. Mosquitoes of the Soviet Far East. *Cytogenetics and genetics of vectors* Proceedings of the Symposium of the XVI International Congress of Entomology. New York, NY: Elsevier Biomedical Press. p 65-74.
- Scanlon JE, Esah S. 1965. Distribution in altitude of mosquitoes in northern Thailand. *Mosq News* 25:137-144.
- Senior-White R. 1923. *Catalogue of Indian insects part 2—Culicidae* Calcutta, India: Superintendent of Government Printing.
- Senior-White R. 1926. Physical factors in mosquito ecology. *Bull Entomol Res* 16:187-248.
- Senior-White R. 1927. Notes on Ceylon mosquitoes.—II. The larvae of the commoner non-anopheline mosquitoes. *Spolia Zeylan Bull Nat Mus Ceylon* 14:61-76.
- Stackelberg AA. 1943. A new species of *Finlaya*, Theo. (Diptera, Culicidae) from USSURI Land. *Bull Entomol Res* 34:311.
- Steffan WA. 1966. A checklist and review of the mosquitoes of the Papuan Subregion (Diptera: Culicidae). *J Med Entomol* 3:179-237.
- Stojanovich CJ, Scott HG. 1995. *Mosquitoes of Asiatic Russia* Metairie, LA: Published by Authors.
- Stojanovich CJ, Scott HG. 1996. *Mosquitoes of Korea* Metairie, LA: Published by Authors.
- Stone A. 1961. A synoptic catalog of the mosquitoes of the world supplement I (Diptera: Culicidae). *Proc Entomol Soc Wash* 63:29-52.
- Stone A. 1970. A synoptic catalog of the mosquitoes of the world, supplement IV (Diptera: Culicidae). *Proc Entomol Soc Wash* 72:137-171.
- Stone A, Delfinado MD. 1973. Family Culicidae. In: Delfinado D, Hardy DE, eds. *A catalog of the Diptera of the Oriental Region Volume I Suborder Nematocera* Honolulu, HI: The University Press of Hawaii. p 266-343.
- Stone A, Knight KL. 1956. Type specimens of mosquitoes in the United States National Museum: II, The genus *Aedes* [sic] (Diptera, Culicidae). *J Wash Acad Sci* 46: 213-228.
- Stone A, Knight KL, Starcke H. 1959. *A synoptic catalog of the mosquitoes of the world (Diptera, Culicidae)* Washington, DC: Thomas Say Foundation, Entomological Society of America.
- Tanaka K. 1971. Mosquitoes of the Ryukyu Islands. *Jpn J Sanit Zool* 21:4.
- Tanaka K. 2002. Studies on the pupal mosquitoes of Japan (6) *Aedes (Finlaya)* (Diptera, Culicidae). *Jpn J Syst Entomol* 8:137-177.
- Tanaka K, Mizusawa K, Saugstad ES. 1979. A revision of the adult and larval mosquitoes of Japan (including the Ryukyu Archipelago and the Ogasawara Islands) and Korea (Diptera: Culicidae). *Contrib Am Entomol Inst (Ann Arbor)* 16:1-987.
- Tanaka K, Saugstad ES, Mizusawa K. 1975. Mosquitoes of the Ryukyu Archipelago (Diptera: Culicidae). *Mosq Syst* 7:207-233.
- Taylor FH. 1934. *A check list of the Culicidae of the Australian region* Service Publication (School of Public Health and Tropical Medicine) 1. Glebe, Australia: Commonwealth of Australia, Department of Health, Australasian Medical Publishing Co.
- Theobald FV. 1901. *A monograph of the Culicidae or mosquitoes. Mainly compiled from the collections received at the British Museum from various parts of the world in connection with the investigation into the cause of malaria conducted by the Colonial Office and the Royal Society* London, United Kingdom: British Museum (Natural History).
- Theobald FV. 1903. *A monograph of the Culicidae or mosquitoes. Mainly compiled from the collections received at the British Museum from various parts of the world in connection with the investigation into the cause of malaria conducted by the Colonial Office and the Royal Society* London, United Kingdom: British Museum (Natural History).
- Theobald FV. 1905. *Genera insectorum. Diptera, fam. Culicidae* Fascicle 26. Bruxelles, Belgium: M. P. Wytzman.
- Theobald FV. 1907. *A monograph of the Culicidae or mosquitoes. Mainly compiled from collections received at the British Museum* London, United Kingdom: British Museum (Natural History).
- Theobald FV. 1910. *A monograph of the Culicidae or mosquitoes. Mainly compiled from collections received at the British Museum* London, United Kingdom: British Museum (Natural History).
- Thurman EB. 1959. *A contribution to a revision of the Culicidae of northern Thailand* Bulletin A-100. College Park, MD: University of Maryland Agricultural Experiment Station.
- Thurman EB. 1963. The mosquito fauna of Thailand (Diptera: Culicidae). *Pac Sci Congr (Entomol)* 9:47-57.
- Toma T, Miyagi I. 1981. Notes on the mosquitoes collected at forest areas in the northern part of Okinawajima, Ryukyu Islands, Japan. *Jpn J Sanit Zool* 32:271-279. [In Japanese with English summary.]
- Toma T, Miyagi I. 1986. The mosquito fauna of the Ryukyu Archipelago with identification keys, pupal descriptions and notes on biology, medical importance and distribution. *Mosq Syst* 18:1-109.
- Toma T, Miyagi I. 1992. A survey of larval mosquitoes of Kume Island, Ryukyu Archipelago, Japan. *J Am Mosq Control Assoc* 8:423-426.
- Townsend FC, Chainey JE, Crosskey RW, Pont AC, Lane RP, Boorman JPT, Lowry CA. 1990. *A catalogue of the types of bloodsucking flies* Occasional Papers on Systematic Entomology 7. London, United Kingdom: Natural History Museum.
- Tsukamoto M, Miyagi I, Toma T, Sucharit S, Tumrasvin

- W, Khamboonruang C, Choochote W, Phanthumachinda B, Phanurai P. 1987. The mosquito fauna of Thailand (Diptera: Culicidae): an annotated checklist. *Jpn J Trop Hyg* 15:291-326.
- van den Assem J. 1961. Mosquitoes collected in the Hollandia area, Netherlands New Guinea, with notes on the ecology of larvae. *Tijdschr Entomol* 104:17-30.
- Wada Y, Mogi M, Oda T, Mori A, Suzuki H, Hayashi K, Miyagi I. 1976. Notes on mosquitoes of Amami-Oshima Island and the overwintering of Japanese encephalitis virus. *Trop Med* 17:187-199.
- Ward RA. 1992. Third supplement to "A catalog of the mosquitoes of the world" (Diptera: Culicidae). *Mosq Syst* 24:177-230.
- Wattal BL, Bhatia ML, Kalra NL. 1958. Some new records of culicines of Dehra Dun (Uttar Pradesh) with a description of a new variety. *Indian J Malariol* 12:217-230.