Redescription of *Armigeres* (*Armigeres*) *hybridus* (Diptera: Culicidae) based on specimens collected in Lanjak, Sarawak, Malaysia

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**Abstract:** Pupa and larva of *Armigeres* (*Armigeres*) *hybridus* Edwards are described and illustrated for the first time on the basis of specimens collected from the Lanjak Entimau Wildlife Sanctuary, Sarawak, Malaysia. These specimens are compared with *Armigeres* (*Armigeres*) *conjungens* Edwards. The larvae breed in water with inflorescence bracts of the wild ginger *Hornstedtia reticulata* in a tropical rain forest.

Key words: *Armigeres hybridus* Edwards, mosquito, description, pupa, larva, Malaysia

**INTRODUCTION**

Species belonging to the subgenus *Armigeres* of the genus *Armigeres* are mostly well defined and can be identified easily by coloration of the abdominal sternae and male genital structures (Edwards, 1917; Toma et al., 2010). During mosquito surveys from February 27 to March 6, 2011 in Lanjak Entimau Wildlife Sanctuary (LEWS), south western Sarawak, many larvae of *Armigeres* species were collected from water with inflorescence bracts of the wild ginger *Hornstedtia reticulata* K. Schum (Fig. 1D, H) from a tropical rain forest. We reared these larvae to adults in the laboratory of the Sarawak Museum and examined all stages. After careful comparison with the descriptions of *Armigeres* species from the Oriental region (Delfinado, 1966; Edwards, 1914, 1917; Leicester, 1908; Ramalingam, 1987; Steffan, 1968; Thurman, 1959; Toma and Miyagi, 2005; Toma et al., 2010) and the type specimens of the Malaysian species preserved in the Natural History Museum (NHM), London, we concluded that the male genitalia are identical to the syntypes of *Armigeres* (*Armigeres*) *hybridus* Edwards. The original description of *Ar. hybridus* is very simple without illustrations of the male genitalia and the immature stages (Edwards, 1914). Since then, no one has reported on this species. In this paper, we describe the adult, pupa and larva of these species with illustrations of adult male genitalia, larva and pupa. Terminology follows Harbach and Knight (1980, 1981).

**MATERIALS**

*Specimens examined.* The following specimens were collected as larval and pupal stages
from flower bracts of ginger (*Hornstedtia reticulata*) at the head-quarter (N 01° 38.777' and E 112° 16.709') of Lanjak Entimau Wildlife Sanctuary, Sarawak on March 3 (20110303–5) and 4 (20110304–14), 2011 and reared in the laboratory of the Sarawak Museum by Miyagi and Okazawa. 1♂ on pin with genitalia 8 (G8) on slide, 3 ♀♀ on pins with pupal exuviae (62, 96 and 130), 4 whole larvae on slides; 1♂ with (G2) and larval and pupal exuviae (34), 2 ♀♀ with pupal exuviae (18, 26), 6 whole larvae on slides. Syntypes; 1♀, 1♂ (1914–287), 25 II, 1914, Kuching, J. C. Moulton and 1♂ 15 VII, 1953, Singapore, D. Colles, preserved at NHM.

**Armigeres (Armigeres) hybridus Edwards, 1914**

(Figs. 1–3, Tables 1, 2)


**Description.**

Female (Fig. 1G).

Wing, 3.40–3.75 mm. Proboscis, 2.30–2.50 mm. Forefemur, 2.05–2.35 mm. Abdomen, about 3.55 mm.

*Head*: Narrow band of white scales along ocular line, broadening ventrally in postgenal area. Vertex covered with flat, broad, dark scales, small central patch of pale scales absent. Erect scales all dark, forked and restricted to occiput region of the head. Clypeus dark, bare. Antenna pedicel integument dark, with small white scales on inner and lower sides. Palpi short, about 0.16 as long as the proboscis. Antenna pilose 2.0 mm long.

*Thorax*: Integument brown to dark brown. Scutum covered densely with narrow, curved, dark brown scales. A lateral narrow white scale line on scutum absent. A few white scales present at center of prescutellar area. Acrostichal, dorsocentral and scutal fossal setae absent. A few prescutellar and supraalar setae present. Scutellum covered with flat, dark brown scales and 5–8 conspicuous setae on 3 lobes; a few white scales at the posterior margin of the mid lobe. Meso-postnotum bare, integument brown. Anepisternum with a patch of white scales; 8 pale setae on the prealar knob. Mesepimeron with a large patch of white scales; several upper mesepimeral pale setae present. Postprocoxal membrane with white scales. Mesoscutum bare.

*Legs*: All coxae with a patch of white scales and yellowish setae on anterior side; fore and mid femora with a line of white scales on ventral side to knee; hind femur with a broad line of white scales on outer aspect to knee. Rest of legs covered with dark scales. Ungues of fore leg as small as mid and hindunges, subequal in size, both with submedian tooth.

*Wing*: Cell R₃ about 1.67 times the length of its stem. Anal vein ending well beyond fork of Cu. Alula with a row of small scales; upper calypter with a row of long hair-like scales.

*Halter*: Capitellum dark, rest light in color.

*Abdomen* (Fig. 1G): Terga I–VII dark scaled on dorsal aspect, with small patches of white scales laterally; tergum VIII dark scaled entirely. Sterna I–V entirely white scaled without apical dark bands; VI white with apical dark band, VII, VIII dark scaled entirely.

Male (Fig. 1A–C, E).

Wing, about 3.33 mm. Proboscis, about 2.0 mm. Palpus, about 2.1 mm. Forefemur, about 2.0 mm. Resembles the female except in the following characters.

*Head*: Palpus as long as the length of the proboscis. Antenna 1.3–1.5 mm long.
Fig. 1. Adult male (A–C, E), pupa (F), adult female (G) of *Armigeres* (*Armigeres*) *hybridus* and host plant (D,H). A, structures of genitalia (ventral aspect); B, phallosome (ventral aspect); C, gonostylus; D, water-holding inflorescence bracts of host plant, *Hornstedtia reticulata* with mosquito larvae; E, basal dorsomesal lobe (BDL) with elliptical setae; F, trumpet; G, abdominal sterna (ventral aspect); H, *Hornstedtia reticulata*. Scales: mm.
Fig. 2. Pupal exuviae (A, B) and male genitalia (C) of *Armigeres (Armigeres) hybridus*. A, metathoracic wing (MtM) and abdominal segments I–VIII and paddle; B, Cephalothorax (CT); C, male genitalia based on specimens from Singapore (15 VII, 1953 D. Colles). Scales: mm.
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Thorax: Postpronotum with numerous narrow pale scales on upper half; pale scales in lower half are slightly broader. Paratergites entirely covered with white scales.

Abdomen: Sternal setae more conspicuous than in female.

Legs: Foreungues much larger than mid- and hindungues, unequal in size, larger one about 1.5 times length of the smaller one and the larger one with submedian blunt-tipped tooth, the smaller one with submedian small tooth.

Genitalia (Figs. 1A–C, E): Tergum IX with apical area partly sclerotized and divided into two lobes by a shallow V shaped depression with 2–4 fine setae on each lobe. Sternum IX broad and membranous; central area with 3–5 fine setae. Gonocoxite (Fig. 1A) about 3.3–4.1 as long as its breadth at center; lateral and ventral aspects with many long setae and scales. Basal dorsomesal lobe (BDL) with 2 or 3 stout elliptical and one lanceolate setae with 1 or 2 fine setae (Fig. 1E). Gonostylus (Fig. 1C) 0.64–0.67 as long as the gonocoxite; comb of 12–15 teeth in a row of apical 0.38–0.44, each tooth flat with rounded apices; apical teeth slightly larger than basal teeth. Phallosome (Fig. 1B) round.

Pupa (Figs. 1F, 2A, B, Table 1).

Abdomen, 3.55–4.63 mm. Trumpet, 0.8–0.91 mm. Paddle, 0.8–0.91 mm. Integument colored yellow to light brown. Setae light to dark brown. Prominent setae marked with an asterisk.

Cephalothorax: Yellow to light brown pigmentation. Trumpet brown pigmentation, long, index 2.9–3.5. Setae 1-C single, longer than others; 6-C well developed, bifid; 7-C single, stout and long.

Abdomen: Segments I–VIII with fine spicules. Seta 1-I long, fanlike with 6–10 main branches; setae 1-II, III 2–6 branches, 3-II, III long, usually single; setae 6 well developed with 2, 3 branches; 9-VII 5–8 branched. Paddle: Lightly pigmented except at base, with strong midrib from base to apex and with marginal filamentous spicules; paddle seta (1-P) single, very fine. Male genital lobe extending to about 0.6 of paddle, female genital lobe to 0.26–0.29 of paddle.

Fourth-instar Larva (Figs. 3A–F, Table 2).

Head, 0.71–0.76 mm. Siphon, 0.8–0.92 mm. Seta yellow to light brown. Stellate setae and

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* dendritic with many branches. ** weakly aciculated.

Obsolete and missing setae shown with a hyphen (—).

Specimens examined: 4 pupal exuviae from Lanjak Entimau, Sarawak.

Table 1. Numbers of branches for pupae of Ar. hybridus Edwards.


Fig. 3. Fourth-instar larva of *Armigeres (Armigeres) hybridus*. A, abdominal segments I–VI (dorsal and ventral aspects); B, thorax; C, dorsomentum (ventral aspect); D, head (dorsal and ventral aspects); E, comb scales; F, abdominal segments VII, VIII, X and siphon (S) (lateral aspect). Scales: mm.
spicules absent.

**Head** (Fig. 3D): Width 0.99–1.07 of length. Light yellow-brown in color except area around mouth and collar which are slightly darker. Dorsomental plate (Fig. 3C) with a strong median tooth and with 3 or 4 teeth on each side. Seta 1-C small; setae 7 well developed, single or double, 9-C large with usually 2 branches. Antenna; integument smooth, yellow in color, length about 0.25–0.26 of head; shaft about the same breadth from base to apex, seta 1-A at 0.4 from base.

**Thorax**: Long and prominent pleural setae with barbs. Seta 1-P, 3-M long, single with barbs; 2-T long 2, 3 branches.

**Abdomen**: Setae 1-I–VII large, usually double, some time single or 3 branches; setae 13-II–V usually double, sometimes 3 branched. All these setae more or less barbed. Setae 6-I–VI long, single or double finely aciculated. Ventral patch of spicules present on segments II, III (Fig. 3A), inconspicuous on other segments. Comb scales 2–6 in a row, lightly pigmented, fringe present on apical half. Siphonal index 1.8–2.2; seta 1-S, inconspicuous, usually single arising about 0.33–0.39 from apical end. Anal segment: Saddle incomplete, pigmented brown. Anal papilla short oval, shorter than siphon, with rounded apices.

**Taxonomic Discussion.** Armigeres hybridus was originally described from 14 males and 42 females collected in Kuching, Sarawak by Moulton (Edwards, 1914). In August, 1996, we (Toma and Miyagi) examined the type specimens of Ar. hybridus and also 1 ♀ genital specimen labeled Armigeres hybridus, Singapore, 15 VII, 1953, D. Colles at the NHM (Fig. 2C). The specimens examined from Lanjak Entimau were identical with the syntypes and the specimen from Singapore. Although individual rearing was not possible in this study, it is probable that the association of the larval stage is correct, as only one species, *Ar. hybridus* was present in the same inflorescence bracts of the ginger.

Armigeres hybridus is similar to Armigeres (Armigeres) conjungens Edwards, from Kuching, Sarawak and Gombak, Peninsular Malaysia (Edwards, 1914; Toma and Miyagi, 2005) in the ornamentation of the abdominal sterna in the adults and basal dorsomesal lobe of gonocoxite of

### Table 2. Numbers of branches for fourth-instar larvae of *Ar. hybridus* Edwards.

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*Weakly aciculated.

Obsolete and missing setae shown with a hyphen (—).

Specimens examined: 5 fourth-stage larvae from Lanjak Entimau, Sarawak.
male genitalia with 3 elliptical setae, but they are easily distinguished in the adult males, pupae and larvae as shown in the following keys.

Adult male genitalia
1. Gonostylus bears 12–15 comb teeth in a row on apical 2/3 — > hybridus
   — Gonostylus bears 3–6 comb teeth in a row on apical 1/6 — > conjungens

Pupa
1. Abdominal setae 3-II, III single, longer than seta 6-VI; 5-IV weak, 2–5 branched; 9-VII, VIII 5–7 branched — > hybridus
   — Setae 3-II, III single, shorter than 6-VI; 5-IV long, single; 9-VII, VIII 2–5 branched — > conjungens

Fourth-instar larva
1. Thoracic setae 1-P, 3-M single, long with barbs; ventral patch of spicules not conspicuous, present only on segments II and III; siphonal hair 1 very weak and single; 2–6 comb teeth; anal papillae apparently shorter than the length of siphon — > hybridus
   — Setae 1-P, 3-M single, short without barbs; ventral patch of conspicuous spicules present on segments II–VI, gradually inconspicuous on segments VII and VIII; siphonal hair 1 well developed; 7–12 comb teeth in a row; anal papillae as long as or longer than siphon — > conjungens

Bionomical Notes. Immatures of Ar. hybridus were found only in the inflorescence bracts of ginger Hornstedtia reticulata (Fig. 1D, H) of the Lanjak Entimau Wildlife Sanctuary. The top of the inflorescence is wider than the bottom and contains liquid that is somewhat sticky and brown in color without any associated mosquito larvae of other species in the bracts. Most of the larvae died before pupation. The general appearance, locomotion in a group and feeding habits of the larvae of Ar. hybridus resemble Ar. conjungens bred from the bracts of the ginger Zingiber spectabile in Gombak, Malaysia (Toma and Miyagi, 2005). One genital specimen on a slide, labeled “Ar. (Arm.) hybridus 53/229 reared from a pitcher plant from Singapore, 15 VII, 1953, D. Colles” was preserved in the collection of the NHM. Although we made larval collections in many kinds of Nepenthes pitcher plants in different places of Sarawak (Miyagi and Toma, 2007; Miyagi et al., 2009), no Ar. hybridus have been found. Nothing is known of the adult bionomics as all adult specimens were reared from the larvae in the laboratory. The emerged females were never observed to bite a human arm in the cage.

Distribution. Sarawak, Malaysia and Singapore.

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References


