



## A new genus and species of Heptageniidae (Ephemeroptera) from Borneo, with revisions to the classification of the Ecdyonurinae

J.M. WEBB<sup>1</sup> & W.P. MCCAFFERTY<sup>2</sup>

<sup>1</sup>Department of Entomology, Purdue University, West Lafayette, Indiana 47907-2089, USA. E-mail: jmw975@yahoo.com

<sup>2</sup>Department of Entomology, Purdue University, West Lafayette, Indiana 47907-2089, USA. E-mail: mccafferty@purdue.edu

### Abstract

*Darthus vadorus* n. gen. n. sp. is described from larvae and eggs from Borneo, Indonesia. Larvae are differentiated from those of all other genera of Heptageniidae by the combination of the absence of lamellae on gills 1, sickle shaped lamellae on gills 2–6, a median ridge terminated with a sharp spine on abdominal terga 2–9, a slightly thickened anterior margin of the head capsule, two rows of long, fine setae on the mid and hindtibiae, and scattered simple setae on the ventral surface of galealaciniae. *Darthus* is included in the tribe Afronurini Webb & McCafferty n. trib. with *Afronurus* Lestage and *Parafronurus* Zhou & Braasch. Atopopini Wang & McCafferty is restricted to the genera *Atopopus* Eaton, *Thalerosphyrus* Eaton, and *Asionurus* Braasch & Soldán.

**Key words:** Ephemeroptera; *Darthus*; Heptageniidae; new genus; new species; Afronurini; Atopopini

### Introduction

Heptageniidae (Ephemeroptera) is a relatively species rich family distributed throughout the Holarctic, Afrotropical, and Oriental biogeographical realms. Due to the recent revisions of the family (Kluge 2004; Wang & McCafferty 2004; Webb *et al.* 2006) most genera can now be relatively easily recognized. The diversity of the Ecdyonurinae Ulmer remains poorly explored, however, particularly in southeast Asia, and the generic placement of many species is uncertain. In a review of the knowledge mayflies from East Kalimantan, Borneo, Sartori *et al.* (2003) reported a species possibly related to *Notacanthurus* Tshernova. We examined a series of these distinctive larvae and found they could not be placed to any known genus. Herein, we describe these larvae as a new genus and species and hypothesize their phylogenetic relationship to other Ecdyonurinae genera.

Material examined is housed in the following collections: Purdue Entomological Research Collection, West Lafayette, Indiana (PERC); Royal Ontario Museum, Toronto, Ontario (ROM); Museum Zoologi Bogor, Bogor, Indonesia (MZB); and Musée de zoologie, Lausanne, Switzerland [MZL].

### *Darthus* Webb & McCafferty n. gen.

**Larval description: Head:** Subquadrate, anterior margin of head capsule slightly thickened (Fig. 2). Outer incisor of planate mandible with single terminal denticle. Hypopharynx with well developed lateral projections. Maxilla with scattered simple setae on ventral surface of galealacinia, distal dentiseta branched near base (Fig. 7). Labium with palps pointed apically, glossae subquadrate (Fig. 8).

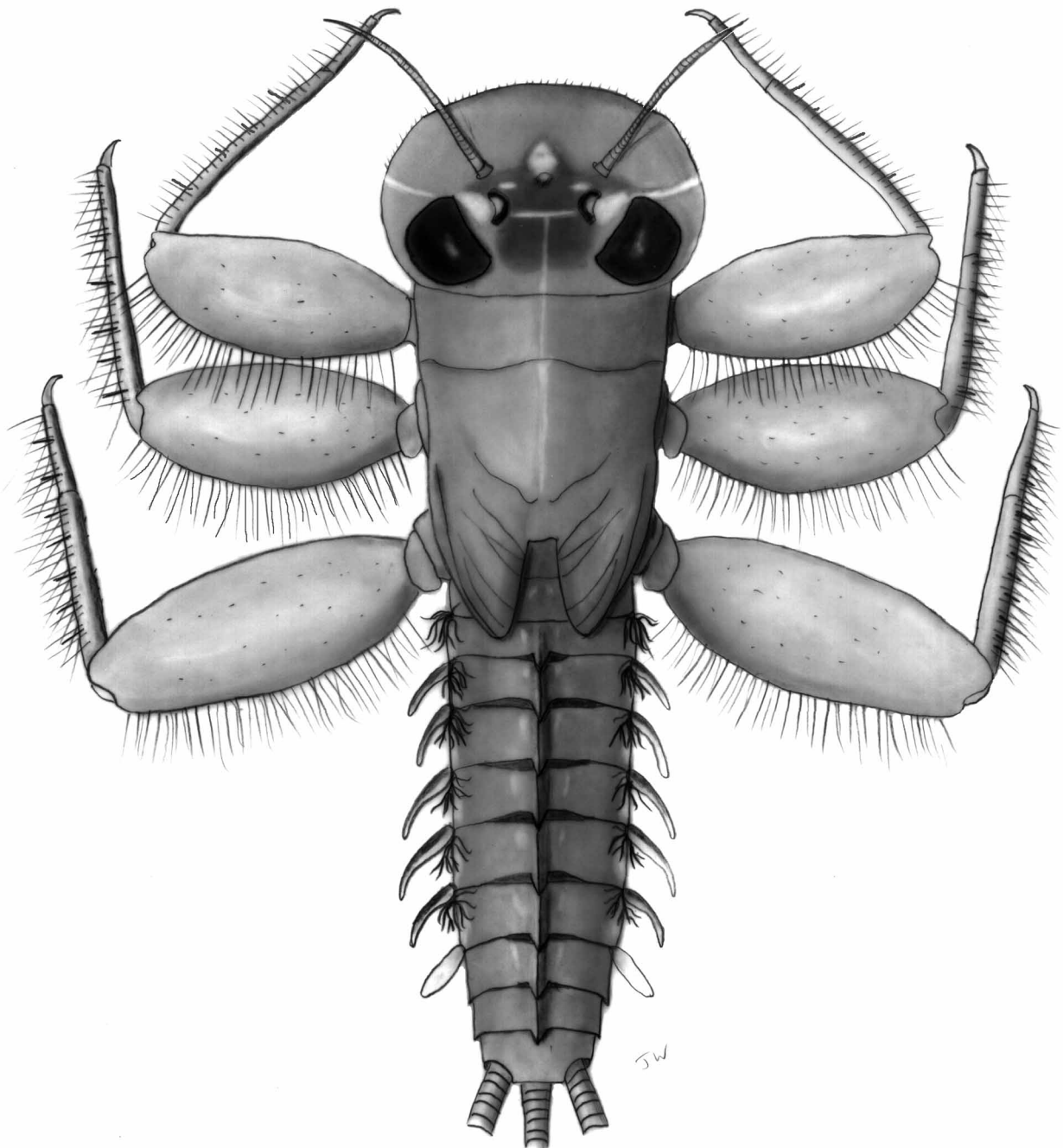
**Thorax:** Pronotum without posterolateral extensions. Hind supracoxal sclerites rounded. Femora with regular row of strong setae (Fig. 9). Middle and hindtibiae with two rows of long, fine setae and row of long, clavate setae on lateral ridge (Fig. 9).

**Abdomen:** Tergum with median ridge on segments 2–9 (Figs. 1, 12). Lamellae of gills 1 absent; lamellae of gills 2–6 sickle-shaped (Fig. 10); lamellae of gills 7 oval, anal rib serrate (Fig. 11). Fibrils well developed on gills 1–6, absent on gills 7. Caudal filaments with short robust setae and sparse fine setae, intersegmental setae absent.

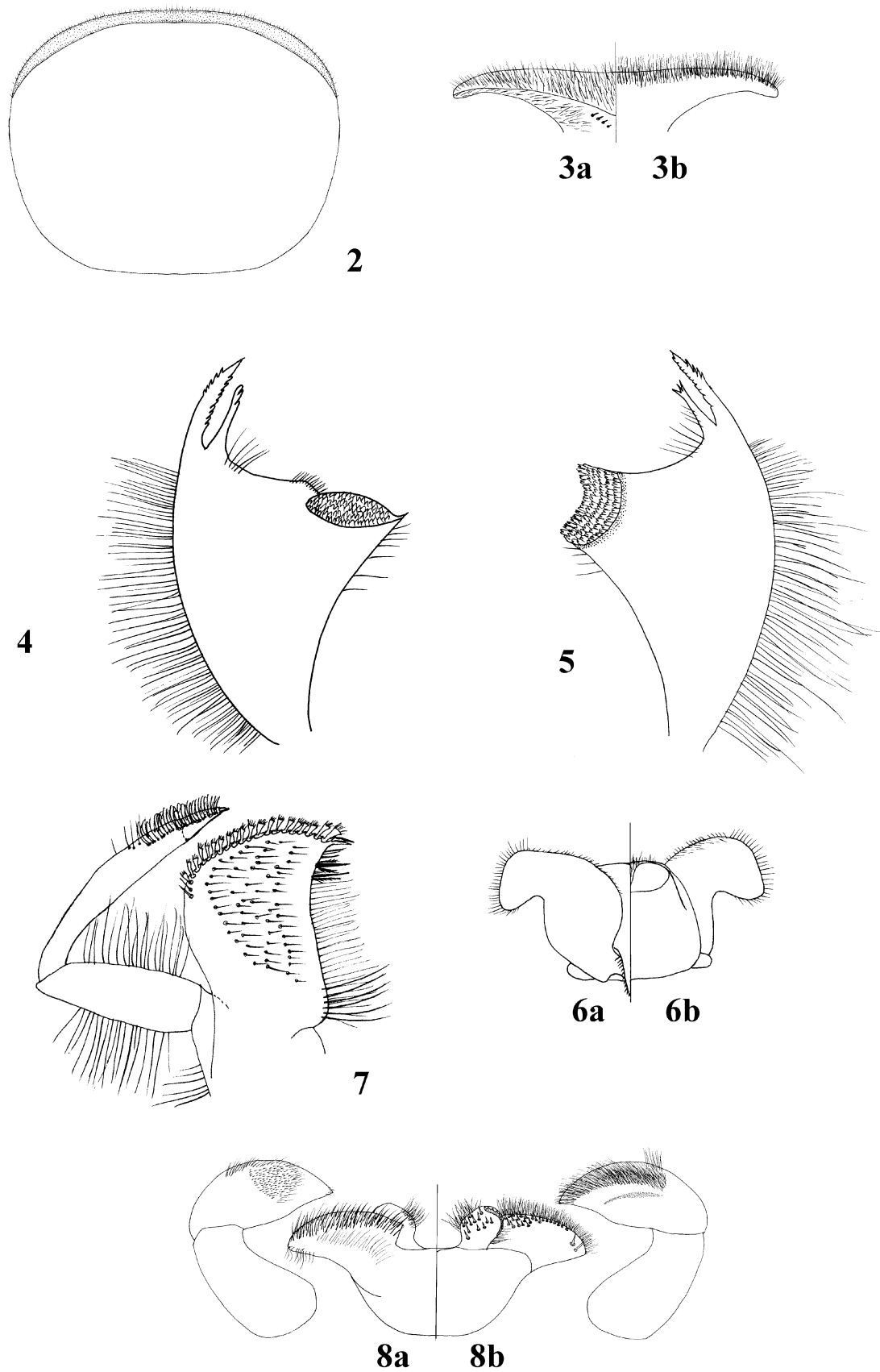
**Adult:** Unknown.

**Etymology:** The generic name is an allusion to the sir name of the fictional character Darth Vader. The gender is masculine.

**Species included:** *Darthus vadorus* Webb & McCafferty **n.sp.** (type species).



**PLATE I.** *Darthus vadorus*. Fig. 1, Dorsal habitus.

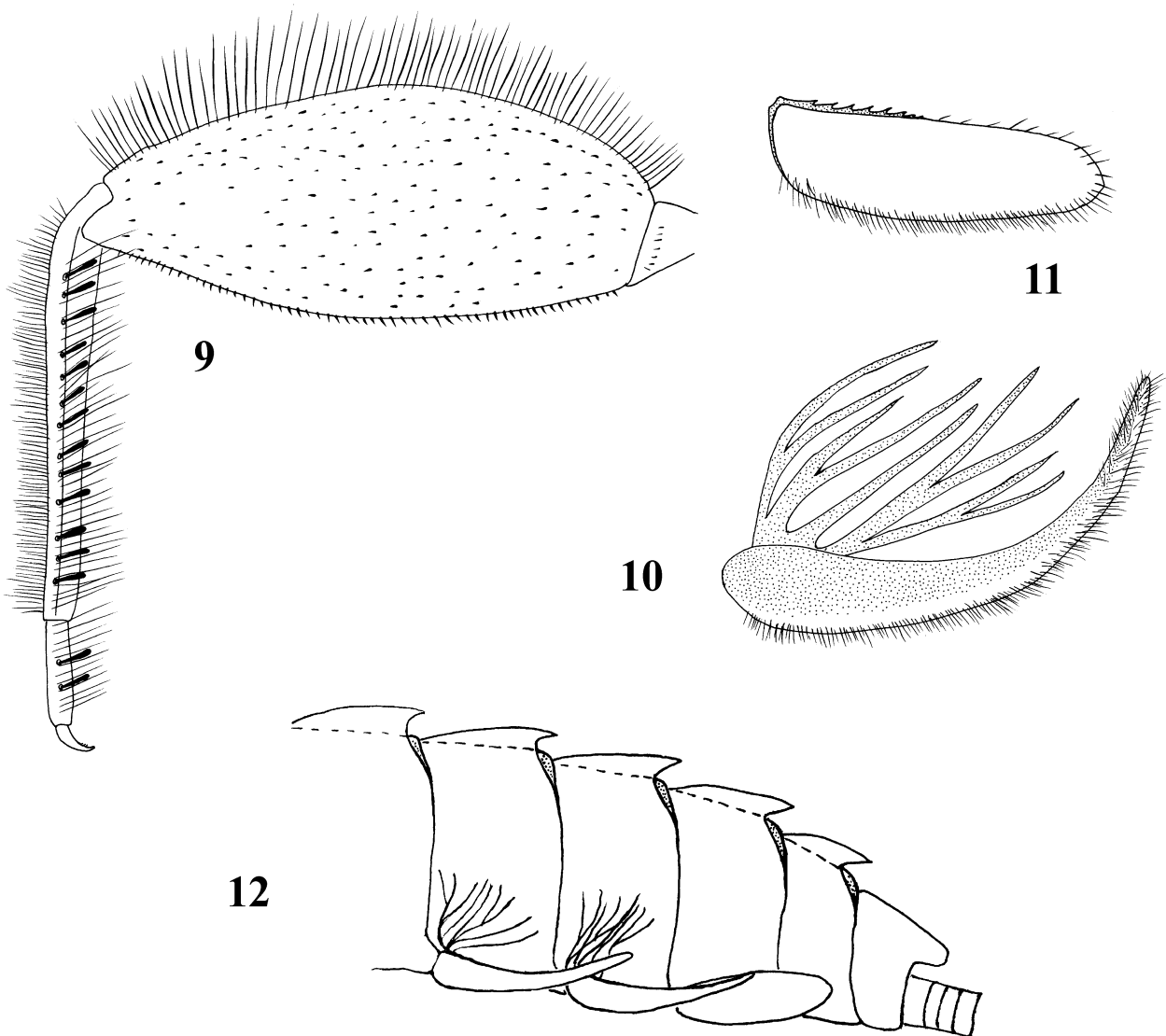


**PLATE II.** *Darthus vadorus*. Fig. 2, Head capsule, ventral view showing enlarged anterior margin (mouthparts removed). Fig. 3, Labrum: a. ventral b. dorsal. Fig. 4, Right mandible. Fig. 5, Left mandible. Fig. 6, Hypopharynx: a. dorsal b. ventral. Fig. 7, Maxilla: ventral. Fig. 8, Labium a. dorsal b. ventral.

**Distribution:** *Darthus* is known only from East Kalimantan, Indonesia on the island of Borneo.

**Diagnosis:** Larvae of *Darthus* can be differentiated from those of all other Heptageniidae by the following combination of characteristics: ventral surface of maxillae with scattered, simple setae; gills 1 without lamellae; gills 2–6 with sickle-shaped lamellae; abdominal terga 2–9 each with median ridge produced into sharp spine posteriorly; anterior margin of headcapsule slightly thickened; and hindtibiae with two rows of long, fine setae.

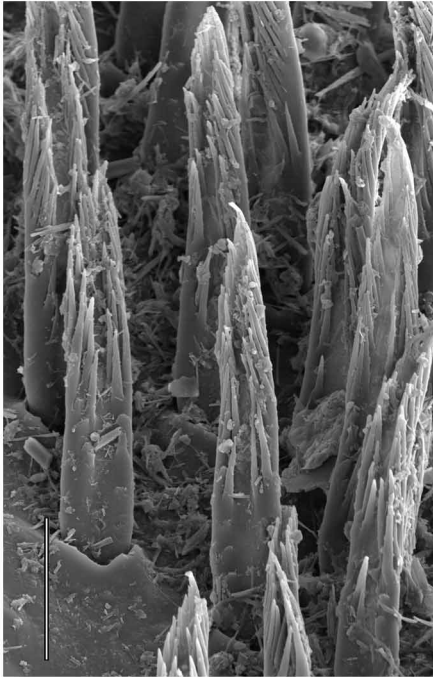
**Discussion:** Due to the presence of a slightly thickened anterior margin of the head capsule and two rows of long, fine setae on the hindtibiae, *Darthus* appears to be most closely related to *Afronurus* Lestage and *Parafronurus* Zhou & Braasch. *Darthus* lacks large, equatorial knob-terminated coiled threads (KCTs) on the eggs that are an autapomorphy of *Afronurus* as well as the whorls of fine setae at the articulations of the caudal filaments characteristic of *Parafronurus*. Because *Darthus* lacks the autapomorphies of each of the other two genera, and itself possesses many autapomorphies, a new genus is justified. Although the adult of *Darthus* is unknown, a male that may belong to this genus (see the species discussion, below) lacks titillators, indicating *Darthus* and *Afronurus* may be sister taxa.



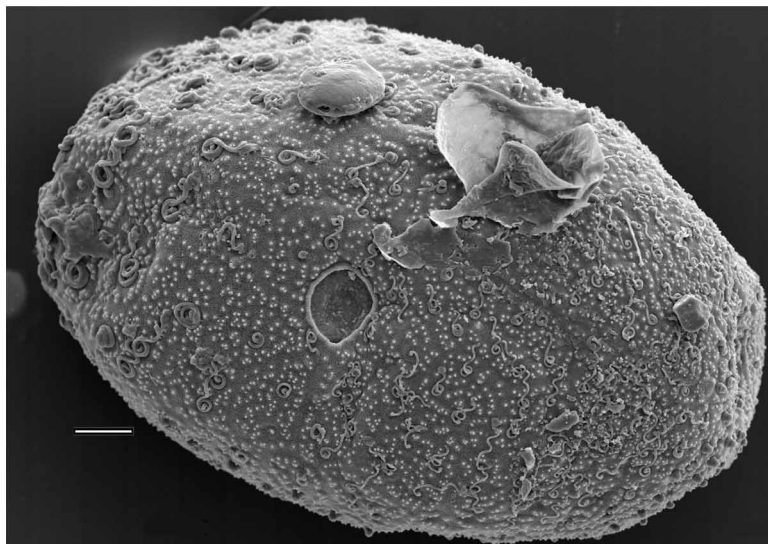
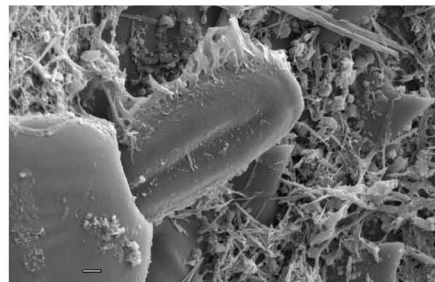
**PLATE III.** *Darthus vadorus*. Fig. 9, Hindleg. Fig. 10, Gill 4. Fig. 11, Gill 7. Fig. 12, Posterior abdominal segments, lateral view.

*Afronurus* is currently considered to be the basal genus in the Ecdyonurinae tribe Atopopini Wang & McCafferty (Wang and McCafferty 2004). In order to maintain a strict phylogenetic classification (Wiley 1981; Schuh 2000) of the Ecdyonurinae and to maintain the generic status of the Atopopini genera, a new tribe (=Afronurini **n.trib.**) must be established for the *Darthus*, *Parafronurus*, *Afronurus* clade. The new tribe is characterized in the larvae by the combination of a slightly thickened headcapsule and two rows of long setae on the mid and hindtibiae. Atopopini is restricted to include the genera *Thalerosphyrus* Eaton, *Atopopus* Eaton, and *Asionurus* Braasch & Soldán and is the sister tribe to Afronurini. The relationship of *Asionurus* to the other genera remains tenuous, however, because larvae share some apomorphies with *Compsoneuria* Eaton, such as narrowed glossae and enlarged lamellae on gills 1.

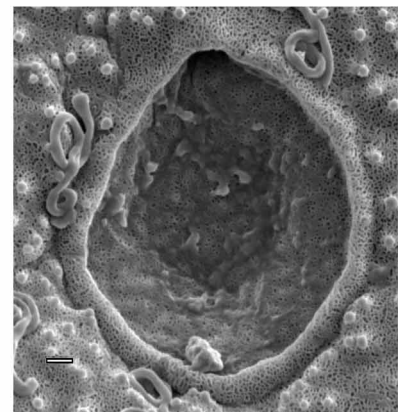
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**PLATE IV.** *Darthus vadorus*. Fig. 13, Bipectinate setae on ventral side of glossa: scalebar = 10  $\mu$ m. Fig. 14, Robust setae and small spines of hind femur: scalebar = 1  $\mu$ m. Fig. 15, Egg: scalebar = 10  $\mu$ m. Fig. 16, Micropyle of egg: scalebar = 1  $\mu$ m.

***Darthus vadorus* Webb & McCafferty n. sp.**

**Larval description:** Body length 6.5 – 8.5 mm; caudal filaments slightly longer than body. General color yellowish brown to brown.

**Head:** Head capsule brown with pale stripe from lateral ocelli to lateral margin and pale spot anterior of median ocellus; anterior margin slightly thickened and with row of fine setae (Fig. 2). Labrum (Fig. 3) 5X wider than long, dorsal surface with dense brush of highly fimbriate setae, ventral surface with anterior portion with dense, fine setae, and posterior portion with somewhat stouter setae. Mandibles as in Figs. 4 and 5. Hypopharynx (Fig. 6) expanded distolaterally, posterolateral corners rounded. Maxillae (Fig. 7) ventrally with scattered simple setae; apical margin with 20 comb setae and two simple setae; distal dentisetae branched near base; palps with numerous fine setae on first segment, second and third segments mostly fused, with dense brush of setae apically and with terminal spine. Labium as in Fig. 8; glossae subquadrate with numerous robust, bipectinate setae ventrally (Fig. 13); paraglossae ventrally with numerous robust, bipectinate setae apically, and dorsally with numerous long, fine setae.

**Thorax:** Forelegs yellowish brown; forefemora with regular row of long setae dorsally, anterior face with paddle-shaped setae and small spines, ventral margin with robust pointed setae; foretibiae with row of long, fine setae and 22 long, clavate robust setae on lateral ridge, posterior margin with row of short, fine setae, anterior margin with two robust setae, inner surface with four simple, robust setae and scattered fine setae; foretarsi with dense row of long fine setae and 5 long robust setae, entire surface with scattered fine setae; claws with three denticles. Midlegs similar to hindlegs but with fewer setae. Hindlegs (Fig. 9) yellowish brown; hindcoxae with subquadrate dorsal extension; hindfemora with regular row of long setae dorsally, anterior face with paddle-shaped setae (Fig. 14) and small spines, ventral margin with robust pointed setae; hindtibiae with row of long, fine setae and 15–20 long, clavate robust setae on lateral ridge, row of long, fine setae on posterior margin, 4–10 short, robust setae on anterior margin, inner surface with seven simple, short, robust setae and scattered short, fine setae; hindtarsi with dense row of long, fine setae and two long, robust setae, inner surface with three robust setae, entire surface covered with short, fine setae; claws with three denticles.

**Abdomen:** Terga brown with slightly paler spots submedially and laterally, with median ridge present on 2–9 (Figs. 1, 12); sterna yellowish brown; small posterolateral spines present on segments 8 and 9; gills 1 with lamellae absent, fibrils well developed; gills 2–6 (Fig. 10) with lamellae long, slender, and curved, 12X longer than wide, outer margin with fringe of setae, fibrils well-developed; gills 7 (Fig. 11) with lamellae 3X longer than wide, anal margin with sharp serrations in basal half, outer margin with fringe of setae, fibrils absent. Caudal filaments brown, with small robust setae and short fine setae at articulations.

**Egg:** Slightly oval, 13  $\mu\text{m}$  long, 8.75  $\mu\text{m}$  wide (Fig. 15). Chorion with numerous KCTs and small tubercles. KCTs more numerous at poles, those at one pole larger. Micropyle slightly oval and with rim slightly thickened (Fig. 16).

**Adult:** Unknown.

**Etymology:** The specific epithet is an allusion to the given name of the fictional character Darth Vader.

**Diagnosis and discussion:** Because *Darthus* is monospecific, the specific diagnosis is the same as the generic diagnosis. *Afronurus temburongensis* Braasch and *A. bruneiensis* Braasch were recently described from Borneo from adult males (Braasch 2005). We do not believe either of these is the adult of *D. vadorus* because they are both light-colored species and the mature larva of *D. vadorus* has brown abdominal segments. We have seen a male of an undescribed species collected near the type locality of *D. vadorus* that may represent the adult of *D. vadorus* because it has brown abdominal segments and genitalia that are slightly different than those of other southeast Asian species of *Afronurus*. As this association cannot be verified at this time, we choose not to describe this specimen because much confusion has been created in the past by incorrectly associated larvae and adults, as discussed, for example, by Webb *et al.* (2006).

**Material examined:** HOLOTYPE: 1 larva, Indonesia, E Kalimantan, Kayan-Mentarang Nature Reserve, Nggeng R, 2°52' N, 115°49' E, 30-March-1994, coll. B Hubley and DC Darling (ROM collecting event # IIS940510) [MZB]. PARATYPES: 1 larva, Indonesia, East Kalimantan, Malinau basin, stream Wok (Sungai Guang), tributary of the Seturan River, 2°59'12" N 116°33'11" E, April 5, 2001, coll. P Derleth [MZL]; 13 larvae (parts of 2 slide-mounted in Euparal and cellosolve), same data as holotype [PERC]; 1 larva, Indonesia, E Kalimantan, Bulungan, Kayan-Mentarang Nature Reserve, Lalut Birai Res. Stn 20, 2°51' N, 115°48' E, Feb-4 March 1993, coll DC Darling (ROM collecting event # IIS930003) [ROM] .

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