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Two new species of *Aphanogmus* (Hymenoptera: Ceraphronidae) of economic importance reared from *Cybocephalus nipponicus* (Coleoptera: Cybocephalidae)

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Abstract

Two new species, *Aphanogmus albicoxalis* and *Aphanogmus inamicus* are described and illustrated from specimens reared from *Cybocephalus nipponicus*, a cybocephalid beetle that feeds upon *Aulacaspis yasumatsui*, a newly introduced pest of cycads in Florida.

Key words: Ceraphronidae, new species, *Cybocephalus*, biological control

Introduction

The armored scale, *Aulacaspis yasumatsui* Takagi [Hemiptera: Diaspididae], was described from specimens found on a *Cycas* species in Bangkok, Thailand (Takagi 1977). In 1996, severe infestations of this species were discovered on *Cycas* species in the Montgomery Foundation, located in Coral Gables in southern Florida, which contains one of the largest and finest collections of palms and cycads in the world. Since then, *A. yasumatsui* has spread throughout most of Florida. Its host range includes the following genera of plants: *Ceratozamia*, *Cycas*, *Dioon*, *Encephalartos* [Cycadaceae], *Zamia* [Zamiaceae], and *Stangeria* [Stangeriaceae].

Dr. Richard Baranowski, in collaboration with Banpot Naponpeth, Director of the Natural Biological Control Research Center at Kasetsart University, found a cybocephalid (formerly Nitidulidae) beetle feeding on *A. yasumatsui* in Thailand and subsequently introduced it into Florida. The beetle was originally identified by S. Endrödy-Younga as *Cyb-*

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ocephalus binotatus Grouvelle and was reported as such to the ROBO (Releases of Beneficial Organisms in the United States and Territories) database. Later, after examining the genitalia of specimens of the introduced beetles, Trevor Smith –determined that the species was actually *Cybocephalus nipponicus* Endrödy-Younga, a species introduced into several states of the eastern USA in 1988 from South Korea (Drea & Carlson 1988); (Jefferson *et al*. 1995) for the control of the euonymus scale, *Unaspis euonymi* (Comstock). Species of *Cybocephalus* have been very effective predators of whiteflies (Kirejtshuk *et al*. 1997; Ramani *et al*. 2002) and scale insects (Blumberg & Swirski 1982; Labuschagne *et al*. 1997) and are also known to feed on spider mites on citrus (Tanaka & Inoue, 1980).

A new species, *Aphanogmus inamicus,* emerged in quarantine from the specimens of *C. nipponicus* collected in Thailand. Later, when the beetle was released in Florida, another new species, *Aphanogmus albicoxalis,* presumably native to Florida, was discovered parasitizing the beetle. *Aphanogmus inamicus* searches for beetle cocoons that usually are attached to the leaves and lays its eggs through the beetle cocoon on the prepupal and pupal stages of the beetle. The eggs, larva, prepupa and pupa develop in 2, 5, 1 and 5-7 days, respectively. Usually two or three parasitoids emerge from each cocoon.

Very little work has been done on the taxonomy of the New World fauna of the genus *Aphanogmus* Thomson as well that of other ceraphronid genera. Ashmead (1883) provided the only key to Nearctic species of *Aphanogmus*. The genus can be separated into three species groups based upon: 1) the presence or absence of a longitudinal, median furrow on the mesoscutum and 2) the presence or absence of the basal rim or carina on the first gastral (3rd abdominal) tergite. Three species groups are recognized based on combinations of these characters:

1. clavicornis group: mesoscutal median furrow and gastral basal carina absent.
2. tenuicornis group: mesoscutal median furrow absent, gastral basal carina present.
3. fumipennis group: mesoscutal median furrow and gastral basal carina present.

Aphanogmus species are usually parasitoids of cecidomyiid flies and are sometimes reared as hyperparasitoids through hosts belonging to various insect orders. This is the second record of *Aphanogmus* parasitizing a cybocephalid beetle. Ishii (1937) reported an unidentified species of *Aphanogmus* parasitizing a *Cybocephalus* species preying on *Unaspis* (=*Prontaspis*) *yanonensis* (Kuwana) on citrus in Japan.

Both *A. inamicus* and *A. albicoxalis* are of economic importance for their detrimental effect on predators of economically important pests. Conceivably, if these parasitoid species are able to survive the colder temperatures of the northeastern and north-central United States (Indiana, Maryland, New Jersey, Pennsylvania, Virginia) where the beetle was released for control of the euonymus scale, *Unaspis euonymi,* they could adversely effect the beetle's ability to control the scale insect in those areas. Figures 1, 4, 5, 6, 7, 10, 11, and 12 are digital photographs taken using AutoMontage (Synchroscopy) system; fig-

ures 2, 3, 8, and 9 are images taken by a Scanning Electron Microscope (SEM). All measurements are given in microns (μm).

***Aphanogmus albicoxalis* Evans and Dessart, n. sp.**
(Figs. 1–6).

Diagnosis

Aphanogmus albicoxalis n. sp. is placed in the *fumipennis* group based on the presence of a longitudinal mesoscutal furrow and basal carina on the first gastral tergite. It differs from other species in the genus by its white hind coxae; no other species in this genus are known to have white or clear hind coxae, although species with similarly colored hind coxae are known in other genera of the superfamily. *A. albicoxalis* also differs from other species of the *fumipennis* group by having a subapical carina that connects the lateral carinae of the scutellum (Fig. 2). Certain species in the *fumipennis* group have the lateral carina ending in an ellipse, but in *A. albicoxalis* it is separated from the peripheral carina.

Description

Holotype female (Figs. 1–4).

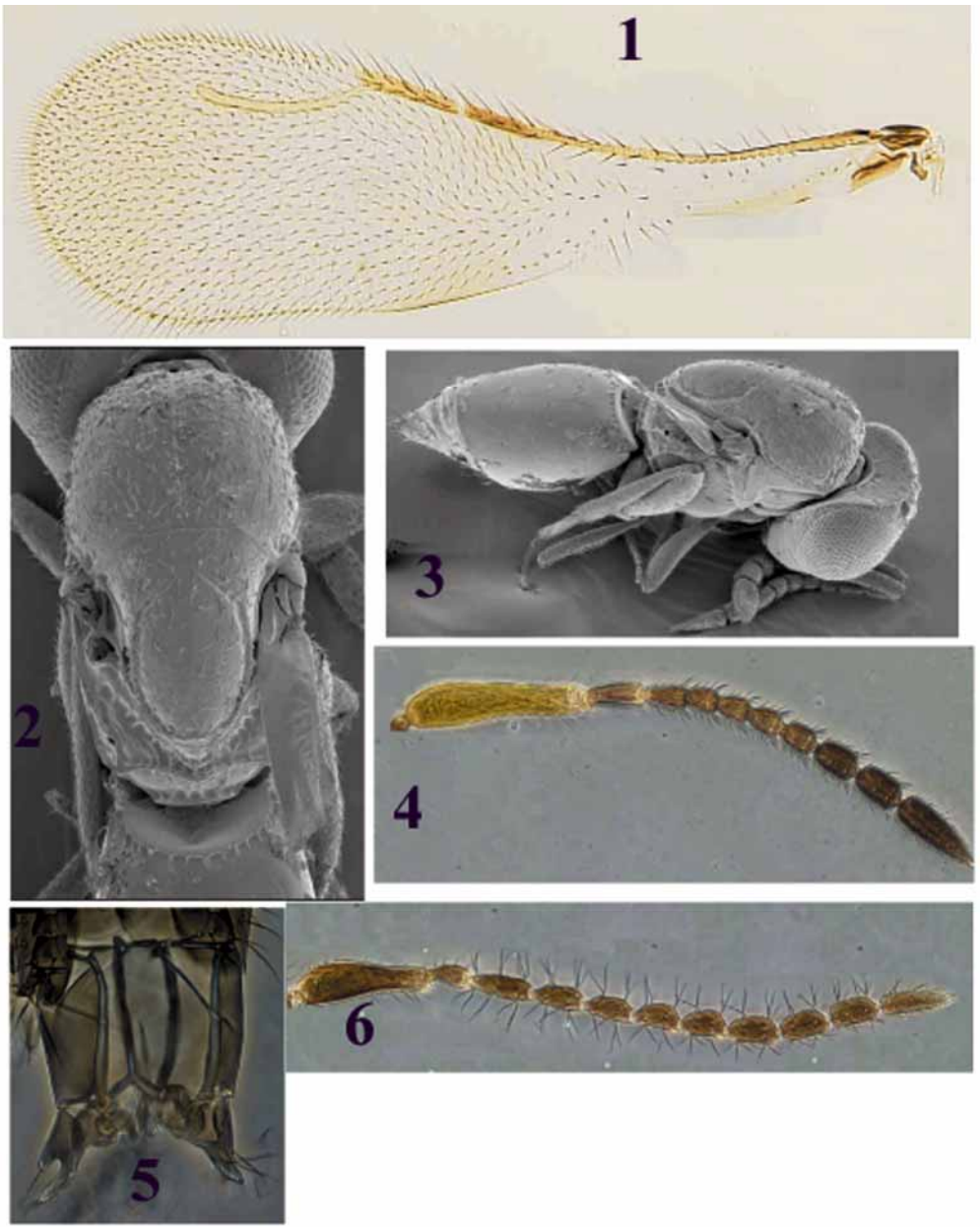
Color: Body dark brown to black, gaster usually slightly lighter than head and thorax; antennal scape light brownish yellow; pedicel and flagellum dark brown; legs light brown, except white hind coxae and fore and middle tibiae which are relatively darker brown; wings hyaline, slightly infuscate basally on the posterior margin.

Body. Length: 1420 μm. Head length/width/height 255/415/375; eye-torulus: 80; eye length/width: 260/200; DFIm (minimal interocular facial distance) 40–42% of the head width; preoccipital lunule limited anteriorly by a sharp edge, well separated from the posterior ocelli, and laterally fusing with the orbits; preoccipital furrow linear, surpassing the anterior edge, and not terminating in the intraocellar pit; ocellar triangle almost a right angle, POL/ LOL/OOL measurements: 135(60)/80(40)/45, where the maximum distance is the first number, followed by the minimal distance in parentheses; LOL slightly longer than the axis of the posterior ocellus; posterior ocelli flanked with a very narrow external lunule, anterior ocellus preceded by a large pit with a cover over the pit that is observed using diffused light.

Antenna (Fig. 4). Length/width ratios: scape (233/55), pedicel (82/33), F1 (33/27), F2 (36/27), F3 (33/38), F4 (33/44), F5 (27/49), F6 (47/52), F7 (47/49); club, 3-segmented (110/55).

Mesosoma (Figs. 2 & 3). Longitudinal mesoscutal furrow present; posterior margin unarmed, without spurs and with transverse carina slightly extending beyond scutellar apex; (length/width/height): 480/320/455; mesoscutum (length/width): 180/415; axilla (length): 40; scutellum (length/width) 195/145, very convex with lateral carinae joining separately the peripheral margin of the scutellum before its apex, but interconnected sub-

apically by a thin transverse carina, which may give the impression that the lateral carinae end in preapical ellipse; metanotum (length at center) 10; propodeum (length at center of dorsum): 15; mesepimeron, side of pronotum clearly depressed anteriorly, alutaceous behind the furrow, without the hind branch or forming a "Y" and practically bent at right angle; mesopleuron and metapleuron fused (without mesopleuro-metapleural furrow), upper part covered with fine striae, interspersed with fine reticulations; mesopleuron with an smooth area adjacent to carina which separates it from the venter.



FIGURES 1–6. *Aphanogmus albicoxae* 1) female forewing, 2) female mesosoma 3) female habitus, 5) female antenna, 5) male genitalia, 6) male antenna.

Fore wing (Fig. 1). Length (877), width (274), disc length (329), width 0.84x disc length, stigmal vein elongate (170), marginal vein divided, distal part (110) shorter than basal part (206) and costal cell (234); submarginal vein with 6 setae; marginal vein with 12 + 6 setae along the anterior margin; wing with uniformly spaced long setae; longest seta of marginal fringe (27), 0.1x forewing width.

Metasoma (Fig. 3). Length/width/breadth: 680/320/185; large tergite (T3): 365 slightly over half gastral length), with basal carina present.

Allotype male (Figs. 5–6).

Similar to female in coloration and structure, except antennae entirely yellowish brown and generally body smaller in size. Length/width measurements of antennal segments (Fig. 6): scape (241/58), pedicel (82/44), F1 (132/41), F2 (101/44), F3 (93/41), F4 (96/47), F5 (96/47), F6 (99/55), F7 (96/58), F8 (93/55); F9 (club), 1-segmented (145/41); genitalia shown in Fig 5.

Specimens examined and deposition

Holotype female (on card), USA: Florida, Miami-Dade County, Homestead, 13.ii.1998, Holly Glenn, *Cybocephalus nipponicus* feeding on *Aulacaspis yasumatsui* on *Cycas revoluta,* deposited in the United States National Museum of Natural History, Washington, DC, USA (USNM). Paratypes (2 females and 3 males on microscope slides, 20 females and 15 males on cards, same data as holotype, deposited in the USNM and in the Florida State Collection of Arthropods, Gainesville, Florida, USA.

Etymology

This species is named for its white coxae.

Discussion

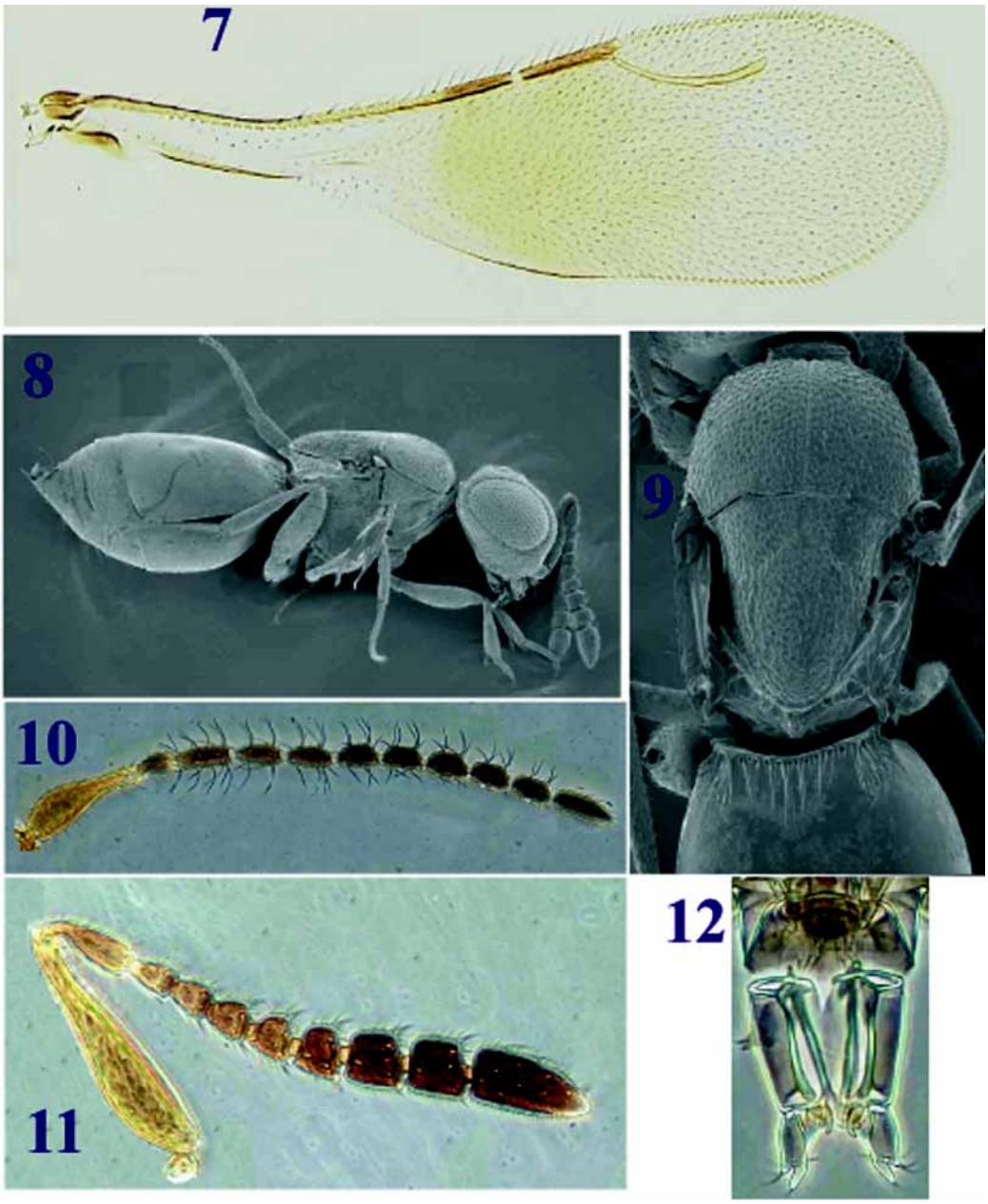
This species was reared from *Cybocephalus nipponicus* released in Homestead, Florida and is presumed to be a species native to Florida.

Aphanogmus inamicus Evans and Dessart, n. sp.

Female (Figs. 7–9, 11). Length: 1350 μm

Diagnosis.

Aphanogmus inamicus is placed in the *fumipennis* group. It is most similar to *Aphanogmus rufus* Szelenyi, a Palearctic species which exhibits similar sexual dichromism where the female is reddish yellow and male is dark brown, and differs from the latter species by having the mesosoma more slender (1.54–1.72x as long as wide); the pedicel and first flagellar segment more slender; facial furrow and long propodeal spurs present; gastral fluting with characteristic lateral carinula; the flank with fine striae; and first gastral tergite distinctly longer than wide.



FIGURES 7–12. *Aphanogmus inamicus* 7) female forewing, 8) female habitus, 9) female mesosoma, 10) male antenna, 11) female antenna, 12) male genitalia.

Description

Holotype female. (Figs. 7–9, 11)

Color: Body reddish-yellow with posterior margin of scutellum and central portion of posterior segments of gaster suffused; eyes, ocelli and carinae (longitudinal muscular traces along the mesoscutal furrow) darker red; fore wing clear at the base, with a large infuscate area from the marginal vein to the posterior margin of the wing; scape orangish, pedicel dark brown with pale apex, flagellum dark brown; legs yellow.

Body length. 1350 μm. Head length/width/height: 175/280/265; eye-torulus: 80; eye: 260/200; preoccipital lunule limited anteriorly by a sharp carina, well-separated from the hind ocelli and fusing laterally into the orbits; preoccipital furrow complete; intraocellar pit absent; ocellar triangle small, posterior ocelli separated from the anterior ocellus by distance shorter than their greatest axis: POL/LOL/OOL: 80(35)/105(20)/35. DFIm 0.40-0.42x head width.

Antenna (Fig. 11). F1 much shorter and narrower than pedicel, flagellum broadening apically with several transverse flagellomeres. Length/width measurements of antennal segments: scape (151/36), pedicel (52/19), F1 (19/16), F2 (19/16), F3 (14/22), F4 (19/30, F5 (19/32, F6 (30/32), F7 (30/32), and F8-F10 (club), 3-segmented club (69/36).

Mesosoma (Fig. 9). Length/width/height: 360/235/295; mesoscutum: 135/235; interaxillar space: 20; scutellum: 175/145 with fine, lateral carinae dividing the clearly sculptured dorsum from the smooth and shiny sides; flank with a scapular furrow lacking the hind branch (not forming a "Y"); meso-metapleuron finely microsculptured with a sharp ventral mesopleural carina. Propodeum with a short, broadly transverse carina extending to the median point (extending beyond the apex of the scutellum) and with small lateral spurs (difficult to observe).

Fore wing (Fig. 7). Length (959), width (307), disc length (343), width 0.84x disc length, uniformly setose with short setae; longest seta of marginal fringe (27) very short, 0.02x forewing width; stigmal vein elongate (170), marginal vein divided, distal part (115) shorter than basal part (208) and costal cell (247).

Metasoma. First gastral tergite relatively short, as long as wide (280/280); with short fluting.

Male (Figs. 10, 12).

Head and thorax dark red, gaster yellow with posterior apex dark red; eyes reddish-yellow; fore wing clear basally, with a large infuscate area from the marginal vein to the posterior margin of the wing; legs yellow with base of metacoxae dark brown; antenna with radicle and scape yellow, and pedicel and flagellum dark brown. Length/width measurements of antennal segments: scape (162.5/25), pedicel (55/42.5), F1 (80/27.5), F2 (62.5/27.5), F3 (62.5/30), F4 (57.5/30), F5 (57.5/30), F6 (57.5/30), F7(60/30), F8 (62.5/30), F9 (club) 1-segmented (92.5/27.5). Flagellar setae very long, about 1.5x the width of the antennal segment; genitalia shown in Fig. 12.

Specimens examined and deposition

Holotype female, from parental stock of specimens collected in Thailand, Nakhon, Sawan, 28.i.1997, *ex. Cybocephalus nipponicus* feeding on *Aulacaspis yasumatsui* on *Cycas* sp., R. M. Baranowski and A. Winotai, deposited in the USNM. Paratypes (6 females and 6 males on microscope slides; 16 females and 8 males on cards, same data as holotype, deposited in the USNM; Kasetsart University, Bangkok, Thailand; Florida State Collection of Arthropods, Gainesville, Florida, USA; and the Entomology Department, Faculty of Agriculture, Kyushu University, Fukuoka, Japan.

Etymology

This species name is a combination of two Latin words: *in* (against) + *amicus* (friend), referring to its being an enemy of our friend, the beetle that is feeding on this pest.

Discussion

This species was reared from specimens of *Cybocephalus nipponicus* (parental stock from Thailand), and may be the same species of *Aphanogmus* that Ishii (1937) reported as a parasitoid of *Cybocephalus* species found feeding on *Unaspis* (=*Prontaspis*) *yanonensis* (Kuwana) on citrus in Japan.

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