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Three new species of *Gollumiella* Hedqvist (Hymenoptera: Eucharitidae)

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Abstract

Three new species of *Gollumiella*, *G. buffingtoni* **sp. nov.** from the People's Republic of China and Japan, *G. ochreata* **sp. nov.** from Malaysia (Malaya), and *G. darlingi* **sp. nov.** from Indonesia (Kalimantan) are described. The biology and phylogenetic position of *Gollumiella* is discussed.

Key words: Hymenoptera, Chalcidoidea, taxonomy, morphology, behavior, Indo-Pacific, phylogeny

Introduction

Currently two subfamilies of Eucharitidae are recognized, the Oraseminae and Eucharitinae (Heraty 2002). Two additional subfamilies, Akapalinae and Philomidinae, have been tentatively placed within the family (Bouček 1988), but only Oraseminae and Eucharitinae are known to be ant parasites. Philomidinae are parasites of solitary bees and the host of Akapalinae remains unknown (Michener 1969, Heraty 1994, 2002). Eucharitinae was divided into two tribes, Psilocharitini and Eucharitini, with *Gollumiella* Hedqvist and *Anorasema* Bouček placed as basal genera within the Eucharitini (Heraty 1994, 2002). *Gollumiella* was first described by Hedqvist (1978). At the time of its description, *Gollumiella* included only a single species, *G. longipetiolata* Hedqvist, which was placed as a junior synonym of *Losbanus* Ishii by Bouček (1988). *Gollumiella* was resurrected by Heraty (1992) in a revision of six species distributed throughout the Indo-Pacific Region from southeast Asia to northeastern Australia.

Clausen (1940) described the oviposition behavior of *G. antennata* (Gahan). Adults deposit a ring of erect eggs around a newly deposited egg of *Selenothrips rubrocinctus* (Giard) (Thripidae). Both hatch at the same time and the first-instar larvae of *G. antennata* attach to the young thrips until their first molt. The ant host for *Gollumiella* was not

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known, but it was assumed that the thrips acted as an intermediate carrier to the ant host in a manner similar to that found in Oraseminae (Johnson et al. 1986; Heraty 2000). No other Eucharitinae use thrips as an intermediate host (Clausen 1940, Heraty 2000). Recent studies of the behavior of *G. longipetiolata* in Malaysia have shown that at least this species does not use thrips to gain access to their host ant, *Paratrechina* sp. (Formicinae) (Heraty, unpublished). *Gollumiella* also are unique among the Eucharitinae in that they are the only member known to attack an ant host without a cocoon. The host of *Anorasema* is unknown, but the remaining host records for Eucharitinae are for ants that have a cocoon. Within the Oraseminae, all but one species (*Orasema coloradensis* Gahan) are known to attack myrmicine ants that lack a cocoon (Johnson *et al*. 1986; Heraty 2002).

Phylogenetic hypotheses based on morphological analyses place *Gollumiella* in the Eucharitini (Eucharitinae), either as the sister group of all remaining Eucharitini (Heraty 2002) or in a monophyletic group with *Anorasema* that is a sister group of the remaining Eucharitini (Heraty 1994, 2000, Heraty & Quicke 2003). The primary morphological character placing *Gollumiella* and *Anorasema* as basal in the tribe is the retention of an anellus (plesiomorphic), which has been lost in all other Eucharitini (Heraty 2002). The small, ringlike anellus of *Anorasema* is typical of most chalcidoids, whereas in *Gollumiella*, the basal flagellomere is elongate and resembles the adjacent flagellomere except for a lack of multiporous plate sensilla (Fig. 4). The absence of these sensilla is considered important for diagnosing an anellus, even though the following flagellar segments may not necessarily have these sensilla. The form of the anellus in *Gollumiella* is not found in any of the outgroups or other Eucharitidae, and its homology is based on its position within a 13-segmented antenna (Heraty 2002). Also unique for *Gollumiella* is the tendency for fusion of the anellus (F1) with the second flagellomere (F2) (Figs 3, 11), either in some individuals of the same species or as a fixed characteristic of a species (Heraty 1992). *Gollumiella* and *Anorasema* are also the only Eucharitinae that have the prepectus and pronotum fused in different planes of orientation and have a first gastral tergite that is much shorter than the second (Figs 1, 2; Heraty 1992, 2002).

Molecular studies of relationships propose *Gollumiella* + *Anorasema* as a monophyletic group basal to Oraseminae + Eucharitinae (Heraty 2002, Heraty *et al.* in press). This proposal is contrary to the morphological hypothesis and an additional 13 morphological steps are required to recover the molecular hypothesis (combined 28S-D2&D3 and 18S-E23 regions); and conversely, an additional 38 molecular steps are required to match the morphological hypothesis (Heraty *et al.* in press). Because *Gollumiella* and *Anorasema* are potentially basal to all of the ant-parasitic Eucharitidae, additional information about the group is critical for understanding the morphological and behavioral evolution of the family. In this paper, three new species of *Gollumiella* are described to make their names available for a companion paper on the aforementioned molecular studies. This paper also includes detailed descriptions of the external morphology of the antenna, labrum and ovipositor.

Terms used in the descriptions follow Heraty (1992, 2002). Abbreviations are: POL, posterior ocellar line; OOL, ocellar ocular line; FL, flagellomere. Museum depositories include Canadian National Collection of Insects, Ottawa, Canada (CNC), Chinese Academy of Sciences Institute of Zoology, Beijing, People's republic of China (IZCAS), Museum Zooloicum Bogoriense, Bogor, Java, Indonesia (MZB), the Royal Ontario Museum, Toronto, Canada (ROME), and the University of California, Riverside, U.S.A. (UCRC).

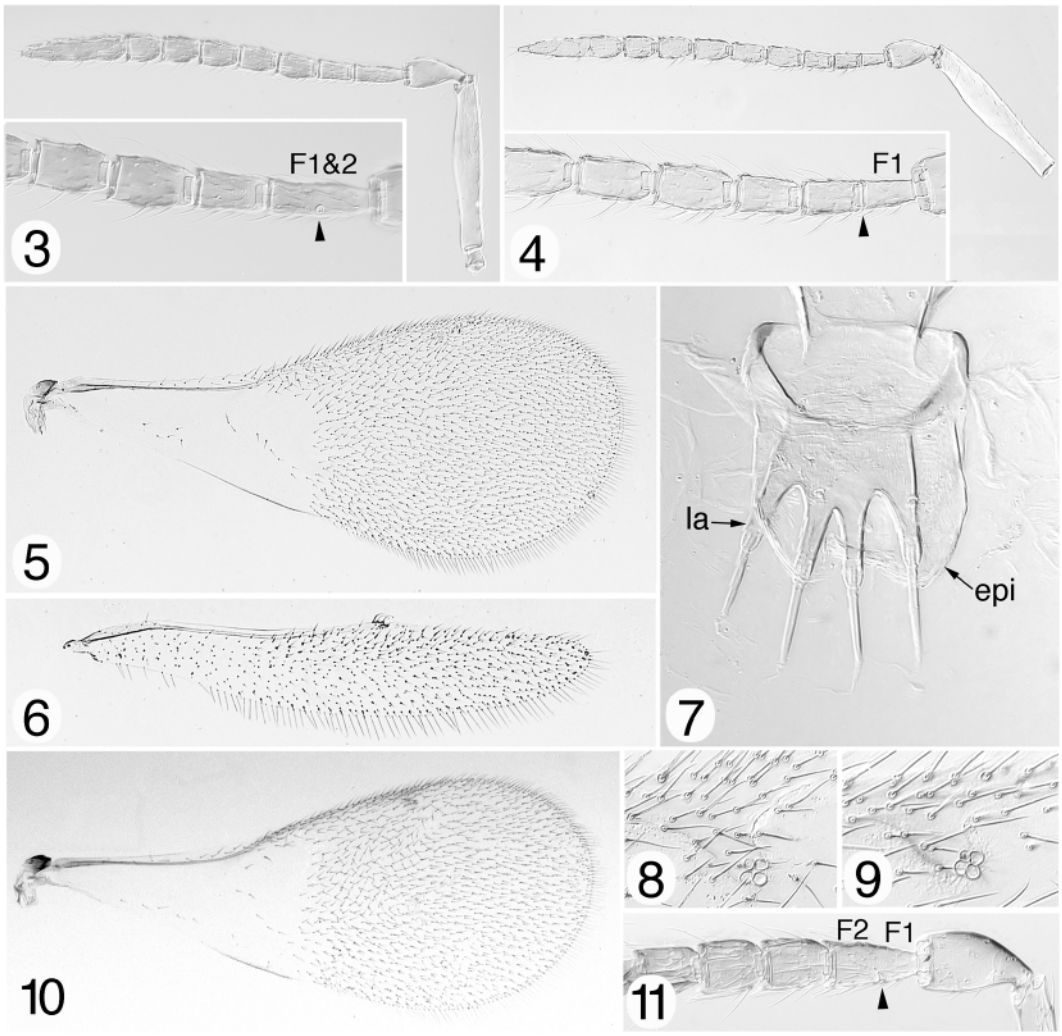
Gollumiella buffingtoni new species (Figs 1, 3–8, 12–14)

Diagnosis. This species keys to *G. longipetiolata* in Heraty (1992). *G. buffingtoni* can be distinguished from all other species of *Gollumiella* by the combination of all yellow coxae, yellowish white legs, a basally dark brown and striate petiole, and an elongate scape exceeding the median ocellus (Fig. 1). Some females of *G. longipetiolata* also have the apex of the petiole lighter in color and the scape may exceed the median ocellus, but their coxae are always dark brown.

FIGURES 1–2. 1, *Gollumiella buffingtoni*, habitus of holotype female, inset is dorsolateral view of petiole; arrow points to pale apical coloration of petiole. **2**, *Gollumiella ochreata*, habitus of holotype male. Scale bar is 0.5 mm.

Discussion. Hedqvist (1978) referred to the female holotype of *G. longipetiolata* (Philippines) as having a brown petiole, yellowish brown coxae, and pale yellow legs and antennae (type not examined). Hedqvist reported the paratype male as having a brown femur and flagellum, but this specimen was later attributed to *Anorasema pallidipes* (Walker) (Bouček 1988, and verified by my examination of the paratype). Bouček (1988)

questioned whether the holotype was actually a male. It is impossible to determine this from the description, but in general, males and females of *Gollumiella* have the same color pattern. All of the specimens attributed to *G. longipetiolata* (male and female) by Heraty (1992) had brown coxae, a yellow or an evenly yellowish-brown femur, and a completely brown petiole or at most with the apex of the petiole slightly lighter.



FIGURES 3–11. **3–8,** *Gollumiella buffingtoni*: 3, female antenna; 4, male antenna; 5, fore wing of female; 6, hind wing of female; 7, labrum (la) and epipharynx (epi); 8, stigmal vein; **9–11,** *G. darlingi*; 9, stigma of female; 10, fore wing of female; 11, base of antennal flagellum of female. Arrowheads point to homologous point of separation between flagellomeres F1 and F2.

Female. Length 1.7–2.1 mm. Brown; flagellum and pedicel pale brown; scape and legs including coxae yellowish white; mandibles except for brown outer edge, ovipositor

and third valvulae pale brown to yellowish white; distal tarsomere dark brown; petiole mostly dark brown but with apex pale brown to yellow (Fig. 1). Wings hyaline.

Head subtriangular, 1.18–1.29 X as broad as high. POL 0.71–0.97 X OOL. Face rounded and smooth with scattered fine setae, genae nearly straight in frontal view; occiput glabrous, dorsal angle with occiput abrupt and with only faint transverse-aciculate sculpture. Clypeal margin truncate and with scattered fine setae. Eyes separated by 1.6–1.8 X their height. Malar space 0.70–0.90 X height of eye. Labrum with 4 long digits, epipharynx with 2 minute setae (Fig. 7). Antenna 10–11 segmented (Fig. 3); scape exceeding median ocellus, length 1.04–1.16 X distance between torulus and upper margin of median ocellus, scape slightly expanded medioventrally; 7–8 funicular segments, FL1 and FL2 completely fused (holotype and some paratypes, Fig. 3 inset) or separated, combined length 3 X as long as broad, if separate, FL1 1.3–2.0 X as long as FL2; flagellum 0.9–1.1 X height of head, setae of flagellum long, dense and semi-erect; clava tapering to acute point.

Mesosoma with rugose-alveolate sculpture, scutoscutellar sulcus deeply impressed and weakly carinate; scutellum as long as broad, frenal carina either poorly developed and arcuate dorsally (holotype, Japan and some China specimens) or prominent and bisinuate (China). Propleuron with several irregular oblique carinae. Coxae smooth and semi-globose, hind coxa 1.8–2.0 X as long as broad; hind femur with scattered short inclinate setae laterally, tibia sparsely setose. Fore wing 2.3–2.5 X as long as broad (Fig. 5), 3.1–3.4 X length of mesothorax; speculum open basally; veins poorly defined; submarginal vein dorsally with few minute setae basally but otherwise bare; stigmal vein 1.5–2.0 X as long as broad and equal in width to apical group of sensilla (Fig. 8); postmarginal vein poorly defined, 1.5–3.2 X as long as stigmal vein.

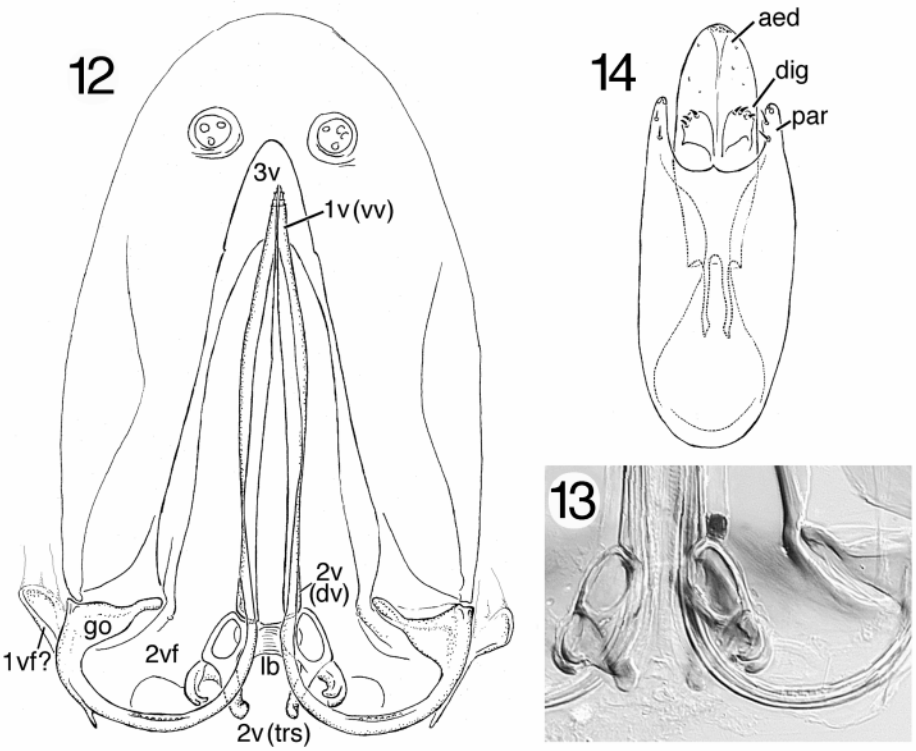
Petiole 2.1–2.5 X as long as hind coxa, straight in profile, irregularly longitudinally striate but with distal fifth mostly smooth. Hypopygium with 6 long hairs along apical margin. Dorsal valve of ovipositor broad (dv, Fig. 12) and with a distinct median keel dorsally (not shown); base of second valvula expanded into tripartite structures (triangular sclerites) joined by a laminar bridge (Figs 12, 13).

Male. Length 1.7–2.1 mm. Agrees with female except as follows: antenna (Fig. 4) with scape 1.08–1.31 X distance between torulus and upper margin of median ocellus; flagellum 1.0–1.1 X height of head. Genitalia (Fig. 14); elongate parameres with two subapical setae, digiti each with 3 marginal spines, aedeagus broadly rounded.

Distribution. Japan (Honshu and Kyushu), People's Republic of China (Beijing).

Type Material. Holotype, ♀, "JAPAN: Niigata Kurokawa, Tainai Riv. 29.viii.1996 500m 38°17'N 139°44'E 29.viii.1996, 500m L.Masner, s.s. J-34", deposited in CNC. ***Paratypes***: from same collection as holotype, 2 ♀ with additional label "DNA Voucher D#994 UCR, J. Heraty" (8 ♀ 12 ♂, CNC, UCRC); "Japan Aichi Pref. Douzuki, Obara, 15–22.vii.1990, K. Yamagishi" (3 ♀, CNC); "JAPAN: Kyushu, 750m Fukoka, Mt. Hiko 21–29.vii.1989 A.Takanao, M. Sharkey" (1♀, CNC); "CHINA: Beijing, Fragrant Hills Park

near Glazed Pagoda, 23–24.vii.2002, M.L. Buffington sweep riparian vegetation and juniper (including ferns)" with additional label "DNA Voucher D#853 UCR, J. Heraty" (5 ♀ 5 ♂, slide # 1-13-012-01, UCRC, IZCAS).



FIGURES 12–14. *Gollumiella buffingtoni*. 12, ovipositor, ventral view; 13, montage image of ovipositor base; 14, male genitalia, ventral view. Abbreviations: aed = aedeagus, dig = digitus, dv = dorsal valve, go = gonangulum, lb = laminar bridge, par = paramere, trs = triangular sclerite, v = valvula, vf = valvifer, vv = ventral valve.

Molecular information. Three gene regions were sequenced for 2 individuals from China and 3 individuals from Japan (Masner collection). The 5 individuals were identical for all regions. Data for the ribosomal transcript regions 28S-D2&D3 and 18S–E23 are deposited on GenBank as assession numbers AY552570 and AY552193. Differs from *G. longipetiolata* by 6 nucleotide differences (28S-D2:5; 28S-D3:1) (Heraty *et al*. in press).

Etymology. Named after Matt Buffington for his collection of part of the type series.

Gollumiella ochreata new species (Fig. 2)

Diagnosis. This species keys to *G. longipetiolata* in Heraty (1992). *G. ochreata* can be distinguished from all other species by the combination of dark brown coxae, yellowish white

legs, basally striate and completely yellow petiole, and an elongate scape exceeding the ventral margin of the median ocellus, but not the dorsal margin. As well, the fore wing is 2.36–2.38 X as long as broad, as compared to *G. longipetiolata*, in which it is greater than 2.4 X as long as broad, and more than 2.5 X in the same gardens where the holotype of *G. ochreata* was collected. *G. antennata* also has a yellow petiole, but differs by having yellow coxae, smooth and curved petiole, nearly circular head in frontal view, and a short scape that reaches only 0.8 X the distance to the median ocellus.

Male. Length 2.17 mm. Dark brown; antennae, legs excluding coxae, petiole, and mandibles except for brown outer edge, pale yellow (Fig. 2); distal tarsomere dark brown. Wings hyaline.

Head subtriangular, 1.23 X as broad as high. POL 0.75–0.85 X OOL. Face rounded and smooth with scattered fine setae, genae slightly convex in frontal view; occiput glabrous, dorsal angle with occiput abrupt and without sculpture. Clypeal margin truncate and with scattered fine setae. Eyes separated by 1.5–1.6 X their height. Malar space 0.70 X height of eye. Labrum with 4 long digits. Antenna 11 segmented; scape exceeding ventral margin of median ocellus, but length reaching only 0.88–0.96 X distance between torulus and upper margin of median ocellus, scape slightly expanded medioventrally; 8 funicular segments, FL1 and FL2 separated, combined length 2.3–2.6 X as long as broad, FL1 0.6–0.8 X as long as FL2; flagellum 0.87 X height of head, setae of flagellum long, dense and semi-erect; clava tapering to acute point.

Mesosoma with rugose-alveolate sculpture, scutoscutellar sulcus deeply impressed and strongly transverse-carinate; scutellum as long as broad, frenal carina prominent and bisinuate. Propleuron with 4–5 transverse carinae. Coxae smooth and semi-globose, hind coxa 1.9–2.0 X as long as broad; hind femur bare laterally, tibia sparsely setose. Fore wing 2.36–2.38 X as long as broad, 2.88–3.03 X length of mesothorax; speculum closed basally by broad band of dense setae, basal area mostly pilose; venation distinct (Fig. 2); submarginal vein dorsally with few minute setae basally, but otherwise bare; stigmal vein 2.0–2.5 X as long as broad and equal in width to apical group of sensilla; postmarginal vein 3.6–4.0 X as long as stigmal vein.

Petiole 2.1–2.4 X as long as hind coxa, straight in profile, irregularly longitudinally striate but with distal fifth mostly smooth. Aedeagus broadly rounded.

Female. Unknown.

Distribution. Malaysia (Malaya).

Type Material. Holotype, ♂, “Malaysia: Selangor, K.L., Univ. Malaya, Rimba Ilmu 03°07’43”N 101°39’29”E, 17.ix.2001 J. Heraty, 75m, sweep bot. gard. H01-045 / DNA voucher D# 426, UCR, J.M. Heraty”, deposited in USNM. ***Paratype***: from same collection as holotype (1 ♂, UCRC);

Molecular information. Three gene regions were sequenced for 1 individual. Data for the ribosomal transcript regions 28S-D2&D3 and 18S-E23 are deposited on GenBank as assession numbers AY552269 and AY552192. Differs from *G. longipetiolata* that were

collected sympatrically by 3 nucleotide differences (28S-D2:2; 28S-D3:1), and from *G. buffingtoni* by 9 differences (28S-D2:7; 28S-D3:2).

Etymology. From the Greek *ochros*, referring to the pale yellow petiole.

Gollumiella darlingi new species (Figs 9–11)

Diagnosis. This species keys to *G. longipetiolata* in Heraty (1992), from which it can be differentiated by the short antennal flagellum (0.7–0.82 X height of head) and scape (0.7–0.81 X distance to top of median ocellus), and whitish yellow mid and hind coxae. The short scape and evenly brown petiole distinguishes this species from *G. buffingtoni*.

Female. Length 1.5–2.0 mm. Dark brown; flagellum and pedicel pale brown; scape yellowish white to pale brown; mandibles yellowish brown; legs including coxae yellowish white, but with fore coxae pale (holotype) or dark brown basally; ovipositor and third valvulae pale brown; distal tarsomeres brown; petiole evenly brown. Wings hyaline.

Head rounded, 1.14–1.20 X as broad as high. POL 0.8–1.05 X OOL. Face rounded and smooth with scattered fine setae, genae slightly convex in frontal view, sunken adjacent to clypeus; occiput glabrous or very finely aciculate, dorsal angle with occiput abrupt and with a single transverse carina. Clypeal margin broadly convex apically and with scattered fine setae. Eyes separated by 1.3–1.4 X their height. Malar space 0.58–0.75 X height of eye. Labrum with 4 long digits. Antenna 10–11 segmented; scape slightly expanded medioventrally, not reaching median ocellus, length 0.71–0.81 X distance between torulus and upper margin of median ocellus; 7–8 funicular segments, FL1 and FL2 separated (holotype and some paratypes) or partially fused (Fig. 11), combined length 3–3.2 X as long as broad, FL1 0.5–1.0 X as long as F2; flagellum 0.74–0.82 X height of head, setae of flagellum long, dense and semi-erect; clava tapering to acute point.

Mesosoma with rugose-alveolate sculpture, scutoscutellar sulcus deeply impressed and strongly carinate; scutellum as long as broad, frenal carina strongly developed and emarginate dorsally. Propleuron with one or two transverse carinae. Coxae smooth and semi-globose, hind coxa 1.5–2.0 X as long as broad; hind femur with few short inclinate setae laterally but mostly bare, tibia sparsely setose. Fore wing 2.3–2.6 X as long as broad (Fig. 10), 3.1–3.2 X length of mesothorax; speculum open basally; veins well defined; submarginal vein dorsally with few minute setae basally but otherwise bare; stigmal vein 1.0–1.5 X as long as broad, and wider than apical group of sensilla (Fig. 9); postmarginal vein poorly defined, usually 3.3–7.0 X as long as stigmal vein.

Petiole 2.3–2.7 X as long as hind coxa, 5.5–7.5 X as long as broad, linear in profile, irregularly longitudinally striate but with distal third mostly smooth. Hypopygium with 6 long hairs along apical margin. Dorsal valve of ovipositor broad and with a distinct median keel.

Male. Length 1.7–2.1 mm. Agrees with female except as follows: fore coxa evenly brown; eyes separated by 1.27 X their height; malar space 0.57 X height of eye; scape

1.08–1.31 X distance between torulus and upper margin of median ocellus; flagellum 0.69 X height of head; fore wing 2.9 X length of mesothorax; petiole 4.6 X as long as broad. Genitalia not examined.

Type Material. Holotype, ♀, "INDONESIA: W. Kalimantan Gunung Palung Nat. Pk. 15 JUN–15 AUG 1991 Darling, Sutrisno, Rosichon. IIS 910116 / Cabang Panti Res. Sta. 1° rainforest, 100–400m Sandstone — light trap 1°15'S, 110°05'E Malaise trap head / ♀ 34", deposited in ROME, on loan from MZB. ***Paratypes***: "INDONESIA: Borneo, West Kalimantan, Gunung Palung Nat. Pk. 29 JUN 1991 DC Darling, Rosichon U. Sutrisno, IIS 910165 / Cabang Panti Res. Sta. 1° rainforest, 100–400m Alluvial. screen sweep 1°15'S, 110°5'E / ♂ 118" (1 ♀ [not ♂ as on label], slide # 03161, ROME); "INDONESIA: Borneo, West Kalimantan, Gunung Palung Nat. Pk. 15 JUN–15 AUG 1991 Darling, Rosichon, Sutrisno, IIS 910122, Cabang Panti Res. Sta., 1° rainforest, 100–400m Alluvial, 1°15'S, 110°5'E malaise trap" (4 ♀, ROME, UCR); "INDONESIA: Borneo, West Kalimantan, Gunung Palung Nat. Pk. 21 JUN 1991, Darling, Rosichon, Sutrisno, IIS 910105, Cabang Panti Res. Sta. 1° rainforest, Alluvial-RR5, 1°15'S, 110°5'E, screen sweep" (1 ♀, ROME) ; "INDONESIA: W. Kalimantan Gunung Palung Nat. Pk. 15–26 JUN 1991 Darling, Sutrisno, Rosichon. IIS 910154 / Cabang Panti Res. Sta. 1° rainforest, 100–400m Alluvial-light trap 1°15'S, 110°5'E Pitfall trap (dung) / ♂ 33" (1 ♂, ROME).

Etymology. Named after one of the collectors, Chris Darling.

Acknowledgements

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