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A NEW SPECIES OF THE GENUS *DILAR* RAMBUR (NEUROPTERA: DILARIDAE) FROM BORNEO

JOHN D. OSWALD AND NATHAN M. SCHIFF

(JDO) Department of Entomology, Texas A&M University, College Station, TX 77843-2475, U.S.A. (e-mail: j-oswald@tamu.edu); (NMS) Southern Research Station, Center for Bottomland Hardwood Research, U.S. Forest Service, U.S. Department of Agriculture, P.O. Box 227, Stoneville, MS 38776, U.S.A. (e-mail: nschiff@fs.fed.us)

Abstract.—***Dilar macleodi*** is described as a new species from lowland rainforest habitat in the Malaysian state of Sarawak on the island of Borneo. Diagnoses are provided to distinguish *D. macleodi* from the four other dilarid species that have been reported from the peninsula of Indochina or the Malay Archipelago.

Key Words: Insecta, Dilaridae, pleasing lacewings, Borneo, Sarawak, taxonomy

The small neuropterous family Dilaridae, "pleasing lacewings," presently includes 67 extant species, with a combined distribution encompassing parts of North and South America, Europe, Asia and Africa (Oswald 1998). No extant dilarids are known from Australia or New Guinea. Engel (1999) recently described the only known fossil dilarid, *Cascadilar eocenicus,* an adult male from Baltic amber. Dilarids are associated with woodland and forest environments, where their larvae live in corticolous or terricolous microhabitats and feed on small arthropod prey. Old World dilarid species are currently placed in four genera—three in the subfamily Dilarinae: *Berothella* Banks (2 spp.; China, continental Malaysia), *Dilar* Rambur (45 spp.; widespread throughout the Oriental and southern Palearctic regions) and *Neonallachius* Nakahara (1 sp.; India), and one genus in the subfamily Nallachiinae: *Nallachius* Navás (2 spp.; Vietnam, southeastern Africa). The adults of most species are relatively rarely collected and larvae are known for only five species (Oswald 1998).

The purpose of the present paper is to describe *Dilar macleodi* as a new species from the Malaysian state of Sarawak, on the island of Borneo. Illustrations of male and female terminalia were prepared with the aid of a drawing tube from abdomens macerated in KOH and stained with Chlorozol Black. Male terminalic structures are described with the gonopons, hemigonarcus, 9th gonocoxite terminology of Oswald (1993a, b), rather than the gonarcus, gonocoxite, paramere terminology of some recent European authors (e.g., Aspöck and Aspöck 1995, Monserrat 1988).

Dilar macleodi Oswald and Schiff, new species
(Figs. 1–10)

Diagnosis.—*Dilar macleodi* is readily distinguishable from other dilarids known from Indochina and the Malay Archipelago by the following characters [*D. macleodi* character states in square brackets]: *D. vietnamensis* Zakharenko: forewing with distinct transverse bars [not barred], dorsoprocessus of male terminalia absent [present], apices of male 9th gonocoxites not opposable on hemigonarcus [opposable]; *D.*

grandis (Banks): male forewing 11–16 mm long [much shorter, ca. 6 mm], dorsoprocessus of male short and membrane-margined to a rounded apex [dorsoprocessus elongate, apex not membrane margined but well sclerotized and truncate], apices of male 9th gonocoxites bicuspate [unicuspate]; *D. marmoratus* (Banks): dorsoprocessus absent [present and elongate], apices of male 9th gonocoxites lanceolate, not opposable on hemigonarcus [recurved and opposable]; dorsodistal angles of hemigonarcus prolonged as a pair of very slender, elongate, processes [no analogous processes]; *Berothella phantoma* Banks (not seen, comparison by Steve Brooks, see acknowledgements): gonarcus less massive [more massive, with proximolateral regions broad in dorsal view], dorsoprocessus larger and more prominent relative to 9t + ectoproct, apex quadrate [smaller with apex expanded]. Other details of the male terminalia, e.g., the conformation and armature of the supraanal, also differ considerably among these species.

Description (from specimens in ethyl alcohol).—*Head:* Head capsule, mouthparts and antenna yellowish white; vertex with three distinct, setose, pulvini, two posterolateral, one dorsomedial; eye dark brown.

Antenna: Scape prominent, simple; pedicel small, annular, simple; female flagellum filiform, flagellomeres (mean = 18, n = 2 antennae) cylindrical, decreasing in length distally; male flagellum pectinate, flagellomeres (mean = 19.5, range = 18–23, n = 8 unbroken antennae) bipectinate (basal flagellomere only [= two fused flagellomeres?]), unipectinate (central flagellomeres) or simple (apical 5–7 flagellomeres).

Thorax.—*Coloration:* Yellowish white with 13 consistently-placed, contrasting brown maculae as follows: Pronotum, lateral margins (2 maculae); mesonotum, anterior margin (3); mesoscutum, lateral (2); mesoscutum, posterior parasagittal (2); mesanepisterna (2); metanepisterna (2). Metascutum sometimes also with a pair of less-distinct lateral brown maculae. Female specimen also with a posteromedian pronotal macula. Legs pale, apices of podomeres generally narrowly embrowned.

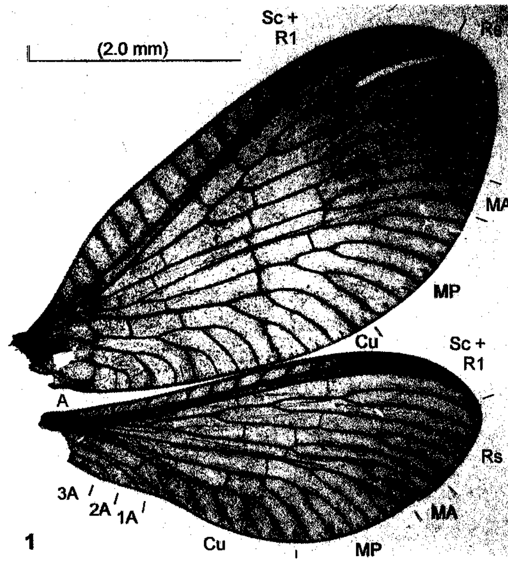
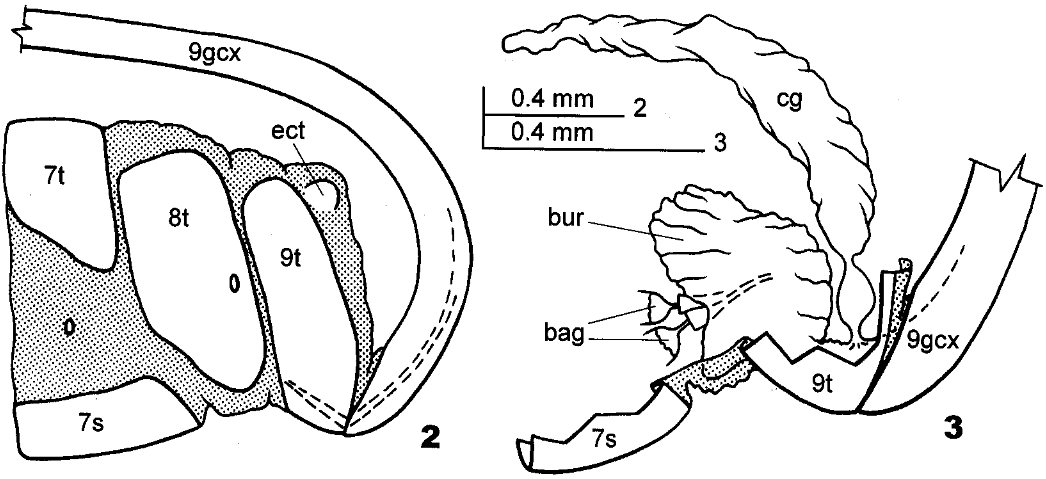


Fig. 1. *Dilar macleodi,* male, wings.

Forewing (Fig. 1).—*Length:* Male 5.0–7.3 mm (mean = 5.9 mm, n = 10 wings), female 8.2 mm (n = 1 wing). *Coloration:* Subcostal veinlets and most crossveins brownish; longitudinal veins with irregularly alternating brownish and pale segments; membrane hyaline with narrow brownish margining adjacent to some dark vein segments, not distinctly cross-banded as in some *Dilar* species.

Vestiture (dorsal surface): Longitudinal veins and subcostal veinlets densely setose [but severely rubbed from storage in alcohol]; crossveins asetose; membrane evenly microtrichose; anal angle of forewing with a patch of stout microtrichia on ventral surface.

Venation: Trichosores prominent along wing margin from pterostigma through cubital region, less distinct or absent on more proximal wing margins; subcostal veinlets simple, rarely forked; subcosta free from, or just touching, R1 in pterostigmal region; subcostal crossveins weak and inconspicuous, irregular in number and position (often 4 or more); anterior Rs trace with 3–5 pec-



Figs. 2–3. *Dilar macleodi,* female. 2, Abdominal apex, lateral. 3, Internal genitalia, lateral (apices of bursal accessory glands damaged and lost during preparation, only the bases of these glands are illustrated). Abbreviations: 7s, seventh sternite; 7t, 8t, 9t, tergites; 9gcx, ninth gonocoxite; bur, bursa; bag, bursal accessory gland; cg, colleterial gland; ect, ectoproct.

tinate branches proximal to pterostigma (including MA); MA arising from radial stem, basal "b" crossvein generally present only as a short stub from base of MA; MP deeply two-branched; two distinct series of gradate crossveins present.

Nygmata: Two present, proximal nygma located between MA and MP near base of MA, distal nygma located between Rs and MA near base of proximalmost Rs branch.

Hind wing (Fig. 1).—*Length:* Male 3.9–6.1 mm (mean = 4.9 mm, n = 10 wings), female 6.4 mm (n = 1 wing).

Coloration: Generally similar to forewing, but paler.

Venation: Basal piece of MA present, nearly linear (not markedly sinuous), joined distally to RS.

Nygmata: One present, located between MA and Rs near base of proximalmost Rs branch.

Female terminalia.—*Tergite and sternite 7* (Fig. 2: 7t, 7s): Hemiannular, unmodified. *Tergite 8* (Fig. 2: 8t): Membranously divided dorsally into a pair of lateral hemitergites, hemitergites prolonged ventrolaterally and enclosing spiracles of 8th somite.

Sternite 8: Apparently absent.

Tergite 9 (Fig. 2: 9t): Membranously divided dorsally into a pair of elongate lateral hemitergites, hemitergites articulated posteroventrally to ipsilateral 9th gonocoxites, each hemitergite braced by a strong internal costa that runs anterodorsally from point of articulation.

Ectoproct (Fig. 2: ect): A small [vestigial] pulvinate prominence, cercal callus and trichobothria absent [lost].

9th gonocoxites (Fig. 2: 9gcx): Paired, slender and greatly elongate, together forming a flexible ovipositor, each gonocoxite bearing proximally a weak costa that runs longitudinally from point of articulation with ipsilateral 9th hemitergite, apical stylus absent [lost].

Postgenitalia: Absent.

Subgenitale: Absent.

Bursa copulatrix (Fig. 3: bur): Membranous or weakly sclerotized, without discrete lobes; colleterial gland present (cg), colleterial accessory gland apparently absent, one pair of bursal accessory glands (bag) present.

Insemination/fertilization canal: Apparently absent; floor of bursa apparently lacking the well-sclerotized, median, "fertilization canal" found in many other neuropteran families [possibly an artifact of the single, somewhat over-cleared, female available for study].

Male Terminalia.—*Tergite and sternite 8* (Fig. 4: 8t, 8s): Weakly sclerotized, hemiannular, unmodified.

Tergite 9 + ectoproct (Figs. 4, 5: 9t + ect): Ectoproct completely fused to 9th hemitergite, suture line lacking, combined sclerite broad and evenly rounded distally, cercal callus and trichobothria absent [lost], contralateral sclerites joined dorsally by a distinct dorsoprocessus (dor).

Dorsoprocessus (Figs. 4–6: dor): A well-sclerotized, slender, longitudinal process; slightly broadened distally to a shallowly concave, truncate apex (Fig. 6); joined to dorsal margins of 9th tergite + ectoproct sclerites by a pair of narrow arms (Fig. 5); each arm underlain internally by a stout costa; costae fused distally and together providing primary rigidity of dorsoprocessus.

Sternite 9: Strongly reduced (often not visible in lateral view), transverse, distal margin rounded.

Supraanal (Figs. 4, 7: spa): Bipartite, with dorsal and ventral parts divided by a transverse sulcus; dorsal part consisting principally of a transverse subquadrangular plate, proximodorsal margin of plate shallowly emarginate medially, lateral margins narrowly flanged, distoventral margin bearing a pair of slender, sharply-pointed, parasagittal processes, plate surface with a pair of shallow lateral depressions separated by a weak sagittal ridge, surface asetose but partially microtrichose; ventral part of supraanal consisting of a pair of rounded, ventrally papillate, lobes, each of which bears a sharply-pointed process dorsally.

Gonarcus (Figs. 4, 8–10: gon): U-shaped in overall from (dorsal view, Fig. 9); gonopons (gps) short and narrow; extrahemigonarcus (ehgs) large, revolute, directed posteriorly and lying adjacent to length of 9th gonocoxites; intrahemigonarcus (ihgs) restricted to a narrow band at anterior end of extrahemigonarcus; revolute hemigonarcus broad proximally, narrowed distally.

Mediuncus: Absent.

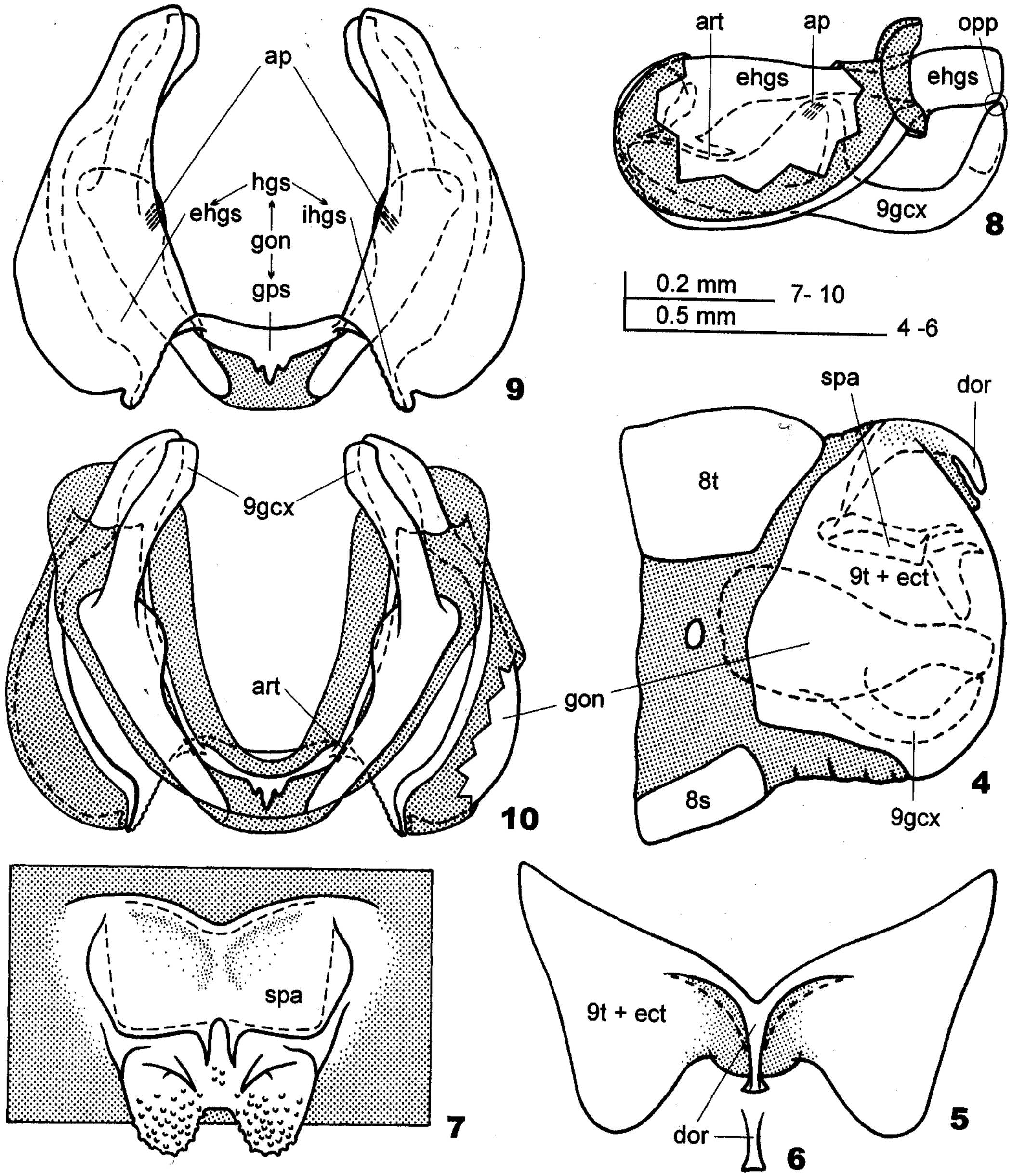
9th gonocoxites (Figs. 4, 8, 10: 9gcx): Paired, each composed of an elongate basal plate and a free distal process; basal plate membrane-margined, its dorsal, subbasal, margin articulated to gonarcus (art), its dorsal, subapical margin bearing a field of slender apodemal filaments (ap) indicative of a muscle attachment; distal process arched dorsally, its apex opposable on distoventral surface of ipsilateral hemigonarcus (Fig. 8: opp).

Hypandrium internum: Present.

Distribution.—Currently known only from the Malaysian state of Sarawak on the island of Borneo.

Primary type.—Holotype, male (Texas A&M University Insect Collection). MALAYSIA: Sarawak: Borneo [island], Gunung [= Mt.] Buda, ca. 64 km S of Limbang, 4°13′N 114°56′E. Verbatim label data: "MALAYSIA: Sarawak: / Borneo, Gunung [= Mt.] / Buda, ca. 64 km S of Limbang / 4°13′N 114°56′E Malaise [trap] / 5–25.xi.1996 N[athan]. Schiff" [white rectangle], "Holotype / Dilar / macleodi Oswald & / Schiff / J.D. Oswald 1999" [red rectangle]. Condition: excellent, no parts missing, critical point dried from ethyl alcohol, point mounted, terminalia not dissected.

Other material examined.—28♂, 1♀ paratypes, collection data identical to that of the holotype. Deposited as follows: California Academy of Sciences, San Francisco, California, USA (2 specimens); Florida State Collection of Arthropods, Gainesville, Florida, USA (2); Nathan Schiff, private collection (2); National Museum of Natural History, Smithsonian Institution, Washington, DC, USA (2); The Natural History Museum, London, Great Britain (2); Naturhistorisches Museum, Wien [Vienna], Austria (2); Texas A&M University Insect Collection (TAMUIC), College Station, Texas, USA (15, including the single female); University of California, Davis (UCD), California, USA (2). To facilitate long-term preservation of the specimens, the holotype



Figs. 4–10. *Dilar macleodi,* male. 4, Abdominal apex, lateral. 5, Ninth tergite + ectoproct and dorsoprocessus, dorsal. 6, Dorsoprocessus, apex detail. 7, Supraanal, dorsal. 8, Gonarcus/ninth gonocoxite complex, lateral (membrane covering gonarcus partially removed). 9, Gonarcus/ninth gonocoxite complex, dorsal (sites of membrane attachments to gonarcus not shown, for these see Fig. 10). 10, Gonarcus/ninth gonocoxite complex, ventral (membrane covering gonarcus partially removed on right side of figure). Abbreviations: 8s, eighth sternite; 8t, 9t, tergites; 9gcx, ninth gonocoxite; ap, apodemal filaments; art, gonarcus/ninth gonocoxite articulation; dor, dorsoprocessus; ect, ectoproct; ehgs, extrahemigonarcus; hgs, hemigonarcus; ihgs, intrahemigonarcus; gon, gonarcus; gps, gonopons; opp, opposable region of extrahemigonarcus and ninth gonocoxite; spa, supraanal.

and most of the paratype specimens were critical point dried from alcohol after the preceding description was written.

Etymology.—From the surname of American entomologist Ellis G. MacLeod (1928–1997).

Discussion.—All of the *D. macleodi* specimens were collected using Malaise traps (with alcohol collection heads) placed in lowland tropical rainforest around Gunung Buda (Mount Buda) near the Sungai Medalam (Medalam River), approximately 64 km south of Limbang, Sarawak, Malaysia. Nine malaise traps were sampled for the four-week period 5–25 November, 1996. The dilarid specimens were taken in several different traps. All traps were located in the same general area, but were positioned to take advantage of natural and unnatural flyways in secondary forest—the three or four largest trees per hectare having been selectively harvested at an earlier date. The Malaise trap samples were collected as part of a survey of the insects inhabiting the cave and forest habitats in and around Gunung Buda, with the goal of evaluating the sampled sites as part of a potential new national park adjacent to Gunung Mulu National Park. For a popular account of this expedition see Webster (1998).

In the description above, *D. macleodi* has been differentiated from all *Dilar* species known from Indochina or the Malay Archipelago—*B. phantoma* Banks, 1934 [continental Malaysia], *D. grandis* (Banks, 1931a) [Malaysia (Sabah)], *D. marmoratus* (Banks, 1931b) [Thailand] and *D. vietnamensis* Zakharenko, 1991 [Vietnam]. Direct comparisons with specimens of these species has confirmed that *D. macleodi* is not conspecific with any of them. In addition, *D. macleodi* does not appear to be conspecific with any other East Asian *Dilar* species for which adequate descriptions or illustrations exist. It is possible, however, that *D. macleodi* is conspecific with another previously but poorly described Oriental *Dilar* species known from outside the Indochina/Malay Archipelago region. Notwithstanding, this possibility is considered remote here given the apparently highly localized distributions of most *Dilar* species—only six of 49 previously described species are known from more than one country. Definitive resolution of this question must await a comprehensive revision of the East Asian *Dilar* fauna.

Dilar species exhibit considerable interspecific variation in the form of the male dorsoprocessus, supraanal, gonarcus and 9th gonocoxites, and these structures have been utilized extensively in modern treatments to distinguish species-level taxa within this genus. A particularly interesting and prominent feature of many *Dilar* species is the enlarged and often curiously revolute proximolateral portion of the hemigonarcus (Fig. 9: hgs). At least in *D. macleodi,* the inner surface of the revolute hemigonarcus appears to serve as the origin for a muscle that inserts on the dorsal margin of the adjacent ipsilateral 9th gonocoxite. The muscle insertion site on each gonocoxite is marked by a group of slender apodemal filaments (ap). As in most other neuropteran families, each gonocoxite articulates (Figs. 8, 10: art) directly with the ventral margin of the gonarcus. In *D. macleodi,* the points of gonocoxite articulation and adductor muscle insertion are arranged in such a manner that contraction of the gonocoxite adductor closes a grasping structure in which the apex of the 9th gonocoxite is opposed against the ventrodistal surface of the ipsilateral hemigonarcus (opp).

The functional morphology of the unique male gonarcus/9th gonocoxite complex found in *Dilar* is deserving of further study. In particular, the possibility that this sclerite complex has evolved to form a structure capable of grasping the base of the slender female ovipositor during coupling (a possibility suggested by the approximately horizontal orientation and deep medial excavation of the gonarcus and the presence of a pair of potentially grasping 9th gonocoxites) should be investigated. The frequent presence of revolute hemigonarcus lobes in other *Dilar* species suggests that gonocoxite adduction schemes similar to that found in *D. macleodi* may be common in other species of this genus. Based on published illustrations of other species, however, it might be expected that the precise modes of action of such schemes may vary from the "chelate" grasping form found in *D. macleodi.*

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LITERATURE CITED

Aspöck, U. and H. Aspöck. 1995. *Dilar duelli* n. sp.—eine neue Spezies der Familie Dilaridae aus Europa (Insecta: Neuropteroidea: Neuroptera). Zeitschrift der Arbeitsgemeinschaft Österreichischer Entomologen 47: 49–54.

Banks, N. 1931a. Some neuropteroid insects from North Borneo, particularly from Mt. Kinabalu, 13,455 ft. Journal of the Federated Malay States Museums 16: 411–429.

———. 1931b. Some neuropteroid insects from the Malay Peninsula. Journal of the Federated Malay States Museums 16: 377–409.

———. 1934. Supplementary neuropteroid insects from the Malay Peninsula, and from Mt. Kinabalu, Borneo. Journal of the Federated Malay States Museums 17: 567–578.

Engel, M. S. 1999. The first fossil of a pleasing lacewing (Neuroptera: Dilaridae). Proceedings of the Entomological Society of Washington 101: 822–826.

Monserrat, V. J. 1988. Revisión de los diláridos ibéricos (Neuropteroidea, Planipennia: Dilaridae). EOS: Revista Espanola de Entomologia 64: 175–205.

Oswald, J. D. 1993a. Revision and cladistic analysis of the world genera of the family Hemerobiidae (Insecta: Neuroptera). Journal of the New York Entomological Society 101: 143–299.

———. 1993b. Phylogeny, taxonomy, and biogeography of extant silky lacewings (Insecta: Neuroptera: Psychopsidae). Memoirs of the American Entomological Society, No. 40, iii + 1–65 pp.

———. 1998. Annotated catalogue of the Dilaridae (Insecta: Neuroptera) of the World. Tijdschrift voor Entomologie 141: 115–128.

Webster, D. 1998. Searching the depths of Borneo's white mountain. National Geographic 194(3, September): 118–135.

Zakharenko, A. V. 1991. Two new species of the family Dilaridae (Neuroptera) from Vietnam. Zoologicheskii Zhurnal 70(9): 142–144.