Mecyclothorax kavanaughi sp. n. (Coleoptera: Carabidae) from the Finisterre Range, Papua New Guinea

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Mecyclothorax kavanaughi sp. n. is described from the Finisterre Range, eastern Papua New Guinea. *Mecyclothorax kavanaughi* and *M. toxopei* Darlington synapomorphously exhibit setae on the fifth elytral interval, supporting their recognition as adelphotaxa. *Mecyclothorax toxopei* is known only from a unique male collected on Puncak Trikora, or Mt. Wilhelmina, Papua, Indonesia; a locality highly disjunct from the only known locality of *M. kavanaughi*. The precinctive distribution of *M. kavanaughi* supports recognition of the Finisterre Range as a distinct area of endemism, previously indicated by distributions of Cicadidae (Homoptera), Lycaenidae (Lepidoptera), and birds of paradise (Aves: Paradisaeidae). The geological accretion of the Finisterre terrane 3.0-3.7 Ma establishes a vicariance-based maximum age of origin for the clade including *M. kavanaughi* and *M. toxopei*.

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Introduction

Mecyclothorax Sharp, 1903 comprises species distributed across Australia, New Guinea, Java, Borneo, St. Paul's and Amsterdam Islands, Lord Howe and Norfolk Islands, New Caledonia, and the Society and Hawaiian Islands (Baehr 2008, Liebherr 2008). Though the Society Islands' and Hawaiian Islands' radiations are most diverse, with 67 species described from the former (Perrault 1992) and 125 from the latter (Britton 1948, Liebherr 2005, 2006, 2008), the greatest morphological disparity and greatest number of generalized species, characterized by macroptery, occur in Australia (Moore 1984). As presently constituted, *Mecyclothorax* contains the bulk of the species comprising the tribe Mecyclothoracini; part of the subfamily Psydrinae as classified by Moore (1963).

Knowledge of the New Guinea *Mecyclothorax* fauna has been developed by sequential descriptions of species, often known from only single specimens, with each species known from only single or nearby localities (summarized in Baehr 2008). This highly allopatric, indeed disjunct array of species localities is consistent with our extremely incomplete knowledge of the New Guinea fauna. In this paper I describe a species discovered in the Finisterre Range, Papua New Guinea by D. H. Kavanaugh, California Academy of Sciences. This species' adelphotaxon is distributed far away on Puncak Trikora, Papua, Indonesia.

Criteria supporting the recognition of the Finisterre Range as a distinct area of endemism are reviewed, with the geological history of this portion of New Guinea used to establish an age of origin for the clade comprising the new species and its adelphotaxon, *M. toxopei* Darlington.

Material and methods

Taxonomic material was obtained from the California Academy of Sciences (CASC). Resultant paratypes are deposited in the CASC, Cornell University Insect Collection (CUIC), and the National Museum of Natural History, Naturalis (formerly Rijksmuseum van Natuurlijke Historie), Leiden (RMNH). Diagnosis of the new species was facilitated by

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photographs of the unique male holotype of the closest putative relative, *M. toxopei*, held in the RMNH.

Dissection and staining techniques follow Liebherr (2005, 2006, 2008). Male specimens were relaxed in near boiling water including a drop of Kodak Photo-flo® detergent. The genital bulb was removed with fine forceps after cutting intersegmental membranes with sharpened minuten nadeln. The aedeagus and associated structures were cleared in cold 10% KOH overnight, neutralized in dilute acetic acid, and viewed in glycerine. Female reproductive tracts were dissected and cleared using like techniques, and then the reproductive tract and hindgut associated with the eighth abdominal segment were stained using Kodak Chlorazol Black® dissolved in methyl cellosolve. The stained dissections were cleaned of tracheae and mounted in glycerine on a microslide.

Photographs of *M. kavanaughi* were taken using a Microptics Inc. photographic apparatus, using transmitted light for the genitalia, and transmitted plus direct light for the external views of the specimens. Stacked digital images were merged using ComposeZ5 (Hadley 2006). Comparison photographs of the *M. toxopei* male holotype were provided by Dr. Jan van Tol (RMNH).

Size is measured using standardized body length: the sum of the median length of the head from anterior margin of labrum to cervical ridge, plus median pronotal length, plus distance from the juncture of the raised scutellar apex with its flattened base to the apex of the longer elytron (if different bilaterally). Eye convexity is described using the ocular ratio; the maximum lateral distance between the outer surfaces of the eyes over the minimum width of the frons between the eyes. Male genitalic terminology follows Liebherr (2006, 2008), whereas female genitalic terminology is based on Shpeley et al. (1985).

Taxonomy

Mecyclothorax Sharp

Mecyclothorax Sharp, 1903: 243 (type species *Cyclothorax montivagus* Blackburn by Andrewes 1939).

A complete generic synonymy is provided in Liebherr (2008).

Mecyclothorax kavanaughi Liebherr, sp. n.

Figs 1, 3, 4–8

Type material. Holotype ♂, **Papua New Guinea,** Madang Province, Finisterre Range massif 7.1 air km WSW of Teptep, 3450 m, 27 Mar. 1989, Stop #89-48 // D.H. Kavanaugh collector, CALIF. ACADEMY OF SCIENCES COLL. // PAPUA NEW GUINEA EXPEDITION – 1989 // HOLOTYPE ♂ Mecyclothorax kavanaughi J.K. Liebherr 2008 (red bordered label) (CASC).

Paratypes: 7♂,5♀. Same data as holotype (5♂ 4♀ CASC, 1♂ 1♀ CUIC, 1♂ RMNH).

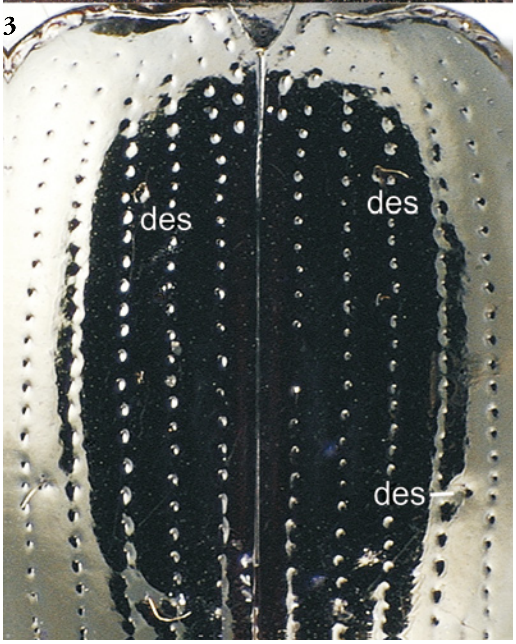
Fig. 1. *Mecyclothorax kavanaughi* sp. n., ♀ paratype (CUIC); scale bar, 1.0 mm.

Diagnosis

Shiny, piceous beetles with convex, oviform elytra (Fig. 1), standardized body length 4.0-4.8 mm. This species shares with *M. toxopei* Darlington, among all other known *Mecyclothorax* species, the presence of dorsal elytral setae in both the third and fifth elytral intervals. In addition, both species are characterized by a very short sinuation of the basolateral pronotal margin anterad the basal pronotal seta. The new species differs from *M. toxopei* in: 1, very reduced

2

3



Figs 2-3. Elytral conformations of *Mecyclothorax* spp. – 2, Scutellum and basal portions of *M. toxopei* median elytral intervals illustrating isodiametric microsculpture, bilateral presence of parascutellar seta (pss, right seta broken off), and shallow, smooth elytral striae; 3, *M. kavanaughi* scutellum and median elytral intervals illustrating reduced microsculpture, absence of parascutellar setae, and punctate elytral striae. Dorsal elytral setae (des) in third and fifth elytral intervals characterize both species.

microsculpture on the dorsal body surface, with head, pronotum and elytral surfaces shiny (Figs. 1, 3), not with evident microsculpture (Fig. 2); 2, pronotal base covered with distinct punctures, each separated from the adjacent punctures by shiny cuticle, versus pronotal base smooth with indistinct punctures in deepest portions of laterobasal depressions in *M. toxopei*; and 3, male aedeagal tip acutely angulate (Fig. 4) versus bluntly rounded in *M. toxopei*.

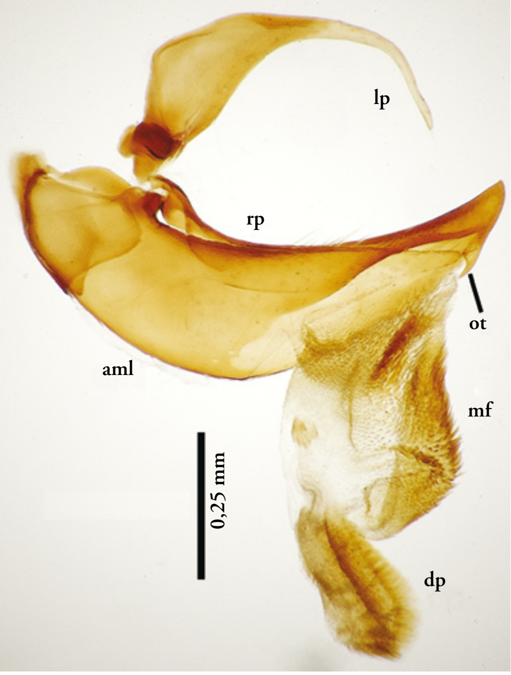


Fig. 4. *Mecyclothorax kavanaughi* male aedeagus, right view: aml, aedeagal median lobe; dp, dorsal plate; lp, left paramere; mf, microtrichial field of internal sac; ot, ostial triangle; rp, right paramere.

Description

Coloration. Dorsal body surface uniformly shiny piceous, with margins of elytral margins and epipleura dark rufous; mandibular apices, maxillary and labial palps, and antennomeres 1-3 smoky brunneous, apical antennomeres piceous; ventral surface with piceous basal coloration, legs and posterior margins of visible abdominal ventrites 3-6 paler, rufobrunneous.

Head. Vertex broadly convex, frontal grooves shallow but distinct, linearly convergent from anterior supraorbital seta to fronto-clypeal suture which is obsolete between frontal grooves, frontal area laterad frontal groove longitudinally convex, bordered laterally by deep clypeo-ocular prolongation (Larochelle & Larivière 2007); two supraorbital setae present each side; eyes small, moderately convex, ocular lobe behind eyes broad and separated from gena by narrow but evident groove, ocular ratio 1.39-1.42; antennae robust, pubescent from fourth antennomere to apex, antennomeres 7-10 about 1.5× long as broad; mentum tooth well developed, apex extended nearly as far anterad as lateral lobes, subacute, very narrowly rounded.

Pronotum. Broad, lateral marginal depressions narrow, disc convex nearly to margin in apical ¾ of length (Fig. 1); basolateral margin very briefly sinuate immediately anterad articulatory socket of basal seta; base evenly convex between hind angles, unmargined, covered with deep, distinct punctures that extend to very small, nearly smooth laterobasal depressions; median longitudinal impression consisting of linear row of punctures on pronotal base, obsolete though traceable on disc, terminated anteriorly at very deep, smooth anterior transverse impressions that define a strongly convex anterior callosity; front angles rounded, slightly extended anteriorly, lateral marginal depression widest just behind front angle. Prosternal projection medially depressed between broad lateral margins that are continuous with marginal bead of procoxal cavity.

Elytra. Disc convex, elevated relative to lateral margins; elytral striae 1-6 and 8 basally punctate (Fig. 3), though very shallow to coplanar with adjoining intervals between the large punctures, striae shallower, smoother apically, obsolete at elytral apex; seventh stria obsolete, evidenced basally by a series of minute, very shallow punctures; parascutellar striole indicated by series of five to six punctures in some individuals (e.g. Fig. 3), by a smooth impression in others; parascutellar seta absent in most individuals (present bilaterally in one, and present on left side only in a second individual) (single known specimen of *M. toxopei* has parascutellar seta bilaterally present, Fig. 2); dorsal elytral setae present in both third and fifth intervals in nearly all individuals, from 3-5 (usually 4) setae in third interval, and from 0-3 setae in fifth interval (single specimen lacking seta in fifth interval on left side has one seta present on right side); eighth stria with series of lateral elytral setae divided into two groups, an anterior series of 5-7 setae and a posterior series of 6 setae, posterior seta in anterior series may be in a relatively isolated position between the two series; both a subapical and apical seta present near elytral apex.

Pterothorax. Mesepisternal concavity ventrad elytral humerus lined with 10-12 minute, isolated punctures, intervening surface shiny, several more diffusely distributed punctures posteriorly near mesepimeron; metepisternum short, quadrate, medial and anterior margins of subequal length. Metathoracic flight wings vestigial, the flaplike vestigium about as wide as long, not extended beyond posterior margin of metathorax (two dissected females examined).

Legs. Tarsomeres short, moderately expanded apically (Fig. 1), the fourth metatarsomere with very short apical lobes; tarsomeres 1-4 with inner and outer ventrolateral series of three to four long, stout setae, the setae slightly longer than depth of tarsomeres at setal insertion.

Male genitalia. Aedeagal median lobe robust, broad, apex extended to an acuminate tip (Fig. 4); a small ostial triangle (Liebherr 2006) present; aedeagal internal sac with broad diffuse field of microspicules covering euventral surface; dorsal plate large, its length about 0.5× distance from parameral apices to aedeagal tip. Parameres diagnostic for Mecyclothoracini (*sensu* Moore 1963), with right paramere broader, though elongate, and with setae lining ventral surface, and left paramere attenuated apically, with only two short setae at apex.

Female reproductive tract. Bursa copulatrix elongate, about 4× as long as gonocoxal length, apically expanded (Fig. 5); spermatheca fusiform, spermathecal duct joined to bursa dorsad juncture of bursa and common oviduct. Gonocoxae with basal gonocoxite bearing three apical setae, two laterally and one medially, plus smaller microsetae along medial margin, one at the apicomedial margin (Fig. 6); apical gonocoxite subtriangular, with two lateral ensiform setae plus a dorsal ensiform seta, and two apical nematiform setae.

Distribution (Fig. 7)

Known only from the type locality in the Finisterre Range, Huon Peninsula, eastern Papua New Guinea.

Habitat (Fig. 8)

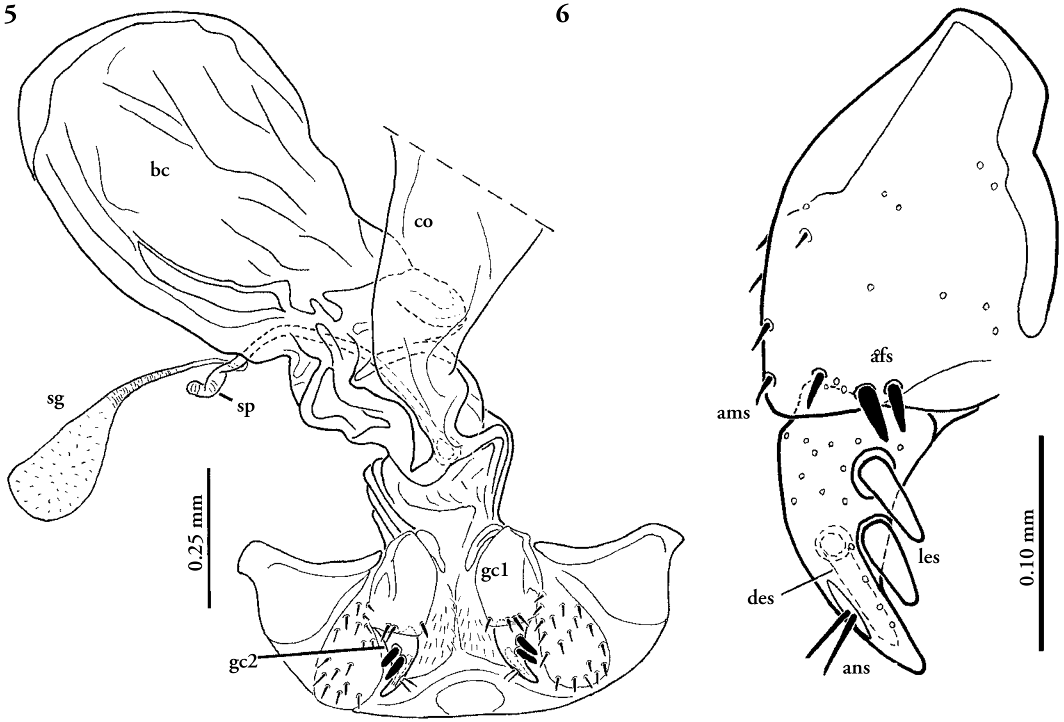
D.H. Kavanaugh (pers. comm.): “The specimens … were collected along a small, swift-flowing stream at the bottom of a deep V-shaped valley above treeline. The valley itself was on a North-facing slope, with perhaps an artificially low treeline. Vegetation on the slopes and ridges of the valley was low and dense and included *Spinifex* and other grass-forms, low shrubs, and scattered tree ferns. The *Mecyclothorax* were found in gravel and under small rocks on flat banks about 0.5 m back from the water’s edge, in areas where tussocks of grasses were interspersed with open gravelly/rocky flats (hence relatively stable bars).”

Etymology

The species epithet honors the collector, Dr. David H. Kavanaugh, who has greatly enhanced our knowledge of the world’s montane and alpine carabid beetle diversity.

Identification

This species can be identified by modifying the most recent key to New Guinea *Mecyclothorax* (Baehr 2008). Reiterating what Baehr noted for all other previously known species, this species is allopatric



Figs 5-6. *Mecyclothorax kavanaughi* female reproductive tract and gonocoxae, ventral view. 5, bursa copulatrix and gonocoxae: bc, bursa copulatrix; co, common oviduct; gc1 and gc2, basal and apical gonocoxites; sg, spermathecal gland; sp, spermatheca. 6, female gonocoxa: afs, apical fringe setae of gonocoxite 1; ams, apicomedial seta of gc1; ans, apical nematiform setae of gonocoxite 2; des, dorsal ensiform seta; les, lateral ensiform setae.

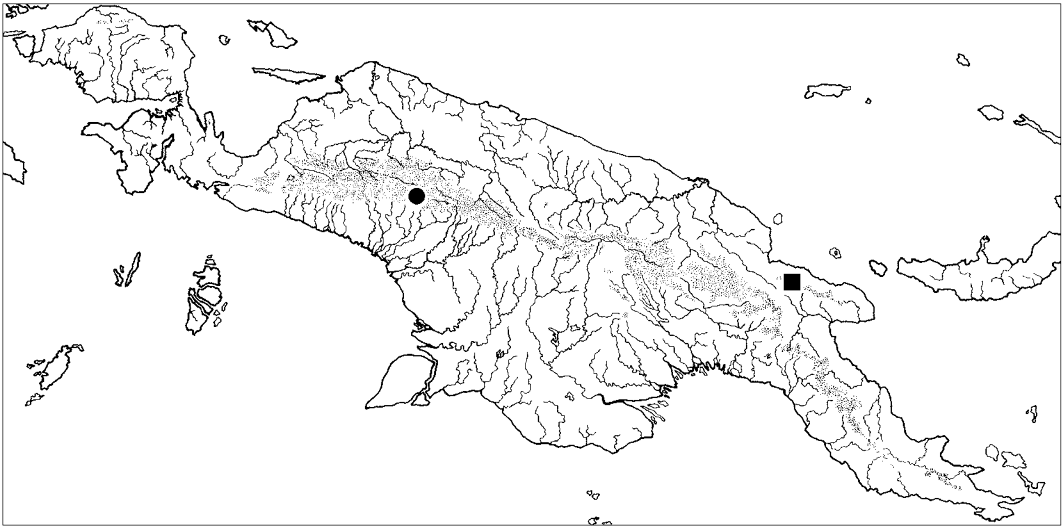


Fig. 7. Distributional ranges of *M. toxopei* (●) and *M. kavanaughi* (■).

Fig. 8. Habitat surrounding alpine stream type locality of *M. kavanaughi*, Finisterre Range, Papua New Guinea. Collecting locale was along stream just above white water rapids in center right of photo. Photograph courtesy David H. Kavanaugh.

with all other New Guinea *Mecyclothorax* species. Insertion of the following couplets will provide trouble-free identification of the described taxon, but the great geographic distance between the ranges of this species and its adelphotaxon *M. toxopei*, coupled with the demonstrated flight-wing vestigialization of *M. kavanaughi*, strongly suggest that further species of this clade remain to be discovered.

1\. Elytral intervals 3 and 5 with setiferous punctures (rarely individuals unilaterally lacking setae in fifth interval) 1a
\- Only elytral stria 3 with setiferous punctures .. 2
1a. Dorsal body surface with well-developed microsculpture, the median elytral intervals covered with isodiametric mesh (Fig. 2); pronotal median base smooth, with indistinct punctures present only laterally mesad laterobasal depressions; parascutellar seta present. Wilhelmina Top (Puncak Trikora), central Papua (former Irian Jaya), at 4200 m (Fig. 7) .... *M. toxopei* Darlington
\- Dorsal body surface shiny, microsculpture obsolete on dorsum of head, and on pronotal and elytral discs (Fig. 1); pronotal median base covered with distinct punctures; parascutellar seta absent in most individuals (Fig. 3). Finnistere Range, eastern Papua New Guinea (Fig. 7) .... *M. kavanaughi* sp. n.

Discussion

The hypothesized adelphotaxon relationship of *M. kavanaughi* and *M. toxopei* is based on shared possession of dorsal elytral setae in the fifth elytral interval. Such extraneous setae are not known from any other *Mecyclothorax* species. In addition, these two species exhibit three to five setae in the third elytral interval. Such increased setal numbers in the third interval, over the plesiomorphic presence of two dorsal elytral setae, are also observed in several other New Guinea species; *M. kubor* Baehr (2008) with five, *M. julianae* Baehr (1995) with four, and *M. bilaianus* Baehr (1998) and *M. sedlaceki* Darlington (Baehr 1995) with two or three setae present. However, the similarities in body size, pronotal shape and setation, and elytral setation shown between *M. kavanaughi* and *M. toxopei* all point to their closest phylogenetic affinity among described species.

The occurrence of *M. kavanaughi* in the Finisterre Range supports recognition of this range as an area of endemism (Crisci et al. 2003). This mountain range has been long recognized as housing precinctive species. Heads (2001) summarized the distributions of birds of paradise (Aves: Paradisaeidae), interpreting the disjunct occurrence of several species in the Finisterre Range and the Vogelkop region in a vicariance framework. *Astrapia rothschildi* Foerster of the Finisterre Range is advanced as the adelphotaxon to *A. nigra* (Gmelin) of the Vogelkop. Similarly, *Paradisaea guilielmi* Cabanis of the Finisterre is placed as sister species to the Vogelkop's *P. rubra* Daudin. These latter two species, in turn, share synapomorphous feather characters with *P. decora* Salvin and Godman of the D'Entrecasteaux Islands. Heads interprets these distributions and phylogenetic relationships as the results of vicariance mediated by lateral strike-slip movements of Melanesian terranes that have sequentially accreted onto the northern margin of the New Guinea orogen. Among already docked terranes, that bearing the current Finnisterre Range is estimated to have accreted onto New Guinea most recently, about 3.0-3.7 Ma.

The distributions and phylogenetic relationships of cicadas have also been interpreted in such a vicariance framework, with the Huon Peninsula or

Finisterre Range being the possible source of the generic-level radiation classified as the genus *Scottotympana* Boer (Boer & Duffels 1996).

Among lycaenid butterflies, three species in the *Psychonotis caelius* species group share similar patterns of distribution and endemism (Müller 2003); *P. hebes* (Druce) distributed in the New Guinea central highlands, *P. finisterre* Müller in the Finisterre Range, and *P. marginalis* Müller in the Owen Stanley Range.

Though our knowledge of *Mecyclothorax* diversity is no doubt in a very primitive state, the vicariance model incorporating accretion of Melanesian terranes onto New Guinea permits dating the common ancestor of *M. toxopei* and *M. kavanaughi* as no older than the time that the terrane bearing the currently uprising Finisterre Range sutured onto New Guinea: 3.0-3.7 Ma (Heads 2001). Given only the currently described, putative sister species we cannot determine how these taxa relate to others in New Guinea. However as the center of diversity for the remaining species is concentrated in the central highlands (Baehr 2008)—including *M. bilaianus*, *M. julianae*, and *M. kubor*, all exhibiting derived enhancement of dorsal elytral setation—the outgroup to the *M. toxopei-M. kavanaughi* clade is more likely to be distributed there. Moreover, the likelihood that additional undiscovered species closely related to *M. toxopei* and *M. kavanaughi* occupy the mountain ranges in addition to the central highlands and the Finisterre Range cannot be discounted.

Acknowledgements

David H. Kavanaugh kindly provided the detailed description and photograph of *M. kavanaughi*'s type locality. I thank Jan van Tol for photographs of the unique holotype of *M. toxopei* Darlington, which allow both diagnosis of the new species and better access to the diagnostic features of *M. toxopei*. Dan Polhemus provided the New Guinea base map. This research was supported in part by N.S.F. REVSYS grant DEB-0315504.

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