THE BASAL LINEAGES OF MYMARIDAE (HYMENOPTERA) AND DESCRIPTION OF A NEW GENUS, *BORNEOMYMAR*

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Abstract – Mymaridae with 5-segmented tarsi and an 8-segmented antennal funicle in females are putatively primitive. They include the extant genera *Boudiennyia*, *Eustochomorpha*, *Gonatocerus*, *Ooctonus*, and one new genus, *Borneomymar*, **gen. nov.**, with three new species *B. discus* **sp. nov.**, from Borneo, *B. madagascar* **sp. nov.**, from Madagascar, and *B. primitivum* **sp. nov**., from Sulawesi. Relationships of these genera are discussed and summarized in an intuitive cladogram.

Key words: *Borneomymar*, new genus, primitive Mymaridae, relationships

Introduction

About 15 of the approximately 100 extant genera of Mymaridae have 5-segmented tarsi. They have often being grouped together because they share this feature (e.g. Förster 1847; Debauche 1948; Schauff 1984; Yoshimoto 1990). Annecke & Doutt (1961), and Subba Rao & Hayat (1983), however, placed them in two subfamilies and Viggiani (1989) placed them in three subfamilies. Four of the genera, *Boudiennyia*, *Eustochomorpha*, *Gonatocerus*, and *Ooctonus* have females with an 8-segmented antennal funicle. The former two genera were so poorly known that they have been mentioned only once each since their description (Annecke & Doutt 1961; Yoshimoto 1975). The latter two genera, both widespread, were generally treated as the most primitive in the family and were grouped or keyed together, though Schauff (1984) correctly recognized that such a grouping is based on symplesiomorphies. I recently examined the types and a few additional specimens of *Boudiennyia* and *Eustochomorpha* as well as specimens representing one new genus, described below, that also has an 8-segmented funicle and 5-segmented tarsi. Studying this material has helped resolve relationships among the primitive genera. Their putative relationships are discussed and summarized in a cladogram.

Methods

Specimens received in ethanol were critical point dried and card mounted. Three males and one female of one of the new species and a female of another were dissected and slide mounted in Canada balsam for description. Terminology follows Gibson (1997): fu_n refers to funicle segment and Gt_n, St_n refer to gastral terga and sterna, respectively. Measurements are in micrometers.

Type specimens are deposited in the following institutions: BMNH, The Natural History Museum, London; CNCI, Canadian National Collection of Insects, Ottawa; MZLU, Museum of Zoology, Lund University, Lund; and UCDC, Bohart Museum of Entomology, University of California, Davis.

Borneomymar Huber, gen. nov.

Diagnosis. Female antenna with 8 funicle segments and 1-segmented clava. Forewing venation at least 0.6 X wing length. Marginal vein 2.0 X as long as submarginal vein, with hypochaeta much closer to proximal than to distal macrochaeta. Stigmal vein short, ending in triangular stigma at least half as wide as long. Postmarginal vein as thick as marginal vein, at least 5 X as long as stigmal vein. Tarsi 5-segmented. Gastral petiole of female shorter than wide.

Description. Female. Head length 0.6-0.8 X width. Face without subantennal grooves. Toruli at least half their length from transverse trabecula. Pronotum entire. Propleura abutting anteriorly. Prosternum divided longitudinally. Prepectus a uniformly broad band reaching midline ventrally. Mesoscutum 1.3-1.7 X as wide as long, with straight or slightly curved notauli. Scutellum about 0.66-0.89x mesoscutal length, with posterior scutellum slightly shorter to slightly longer than anterior scutellum. Axillae in line with anterior margin of scutellum or, in *B. primitivum*, advanced. Dorsellum distinct, diamond-shaped. Forewing 3.8-4.4 X as long as broad, with venation extending at least 0.6 X wing length. Stigma distinct, triangular. Marginal vein much longer than submarginal vein. Postmarginal vein over 5 X stigmal vein length. Propodeum about half length of mesoscutum. Gt_1 length at most 1.3 X Gt_2. Gaster with spiracle on Gt_6. Cerci exserted, on digit-like protruberance.

Male. Known only for *B. discus*. Antenna with 11 flagellar segments, the basal segment without longitudinal sensilla, the others with about 4 unevenly arranged, short longitudinal sensilla (6 on last segment). Head length about 0.8 X width. Gena in lateral view twice as wide as small eye. Pronotum visible in dorsal view, about 0.4 as long as mesoscutum. Metasoma 1.6 X length of mesosoma. Petiole at most 1.7 X as long as wide. Gt_1 shorter than Gt_2. Spiracle absent. Genitalia encapsulated.

Type species: *Borneomymar discus* Huber.

Etymology. The genus is named from Borneo, the island of origin of the type species plus *Mymar*. Gender: neuter.

Discussion. *Borneomymar* contains two similar species and a third, morphologically quite different one. *Borneomymar discus* and *B. madagascar* look like many *Australomymar* species, particularly because of ovipositor length. In contrast, *B. primitivum* looks more like a species of *Arescon*, based on wing structure, number of mandibular teeth, and the advanced axillae. Initially, I considered placing *B. primitivum* in a separate new genus because it seemed to be more closely related to *Arescon* than to *Australomymar*. However, variation in size and body shape in *Australomymar* and perhaps also among *Arescon* can be as great as among the three *Borneomymar* species. I therefore conclude that it is best at present to place all three new species in *Borneomymar*. *Australomymar* spp. differ from *Borneomymar* by having 4-segmented tarsi and, in females, 6-segmented funicle. *Borneomymar discus* and *B. madagascar* appear to form a link between *Eustochomorpha*, the most primitive genus of Mymaridae, and *Australomymar*, probably the most primitive genus with 4-segmented tarsi. *Arescon* spp. differ from *Borneomymar* by having a 5-segmented funicle in females and by lacking a postmarginal vein. Males of *B. primitivum* are needed to compared their genitalia with the distinctive male genitalia of *Arescon* (Viggiani 1988) to better determine whether *B. primitivum* forms a link with *Arescon* and might better be classified as its sister genus. The biology of *Borneomymar* spp. is unknown. The large body size, extremely long ovipositor, and the fact that one species of the related genus *Australomymar* is known to

parasitize Tettigoniidae suggests that *B. discus* and *B. madagascar*, at least, might parasitize Orthoptera eggs deeply imbedded in plant tissue.

Borneomymar discus Huber, sp. nov.

(Figs 1, 3, 4)

Type material. Holotype (BMNH) on card labelled: 1."Sarawak: Gunong Mulu Nat. Park R.G.S. Exped. 1979". 2. "Holotype *Borneomymar magnificum* Huber 2001". **Paratypes**. Malaysia: Sabah, Sipitang Mendolong. T1B/W4 31.III.1989 leg. S. Adebratt (1? on card, MZLU); Sarawak, sw. Gunung Buda, 64 km S. Limbang, 4º13'N 114º56'E, 8-15, 16-21, and 22-28.xi.1996, S.L. Heydon & S. Fung, MT (1 & 2 on points, 1 & 2 on slides, CNCI, UCDC).

Description. Female. Body length 1562-2200 (n=4). Head, mesosoma, except brown lateral panel of mesoscutum, and legs, except sometimes hind tibia, honey yellow; antenna, except yellowish pedicel and fu_1, hind tibia and metasoma brown. Forewing (Fig. 3) mainly brown except base behind submarginal vein, and anterior and posterior margins beyond stigma hyaline. Hind wing brown.

Antenna (Fig. 4) with radicle about 0.33 X as long as scape. Scape enlarged in basal half. Length measurements (n=1): scape 402, pedicel 86, fu_1-fu_8 139, 187, 135, 114, 103, 96, 94, 88, clava 248. Fu_4-fu_8 each with 2 longitudinal sensilla. Clava with 7 longitudinal sensilla in apical

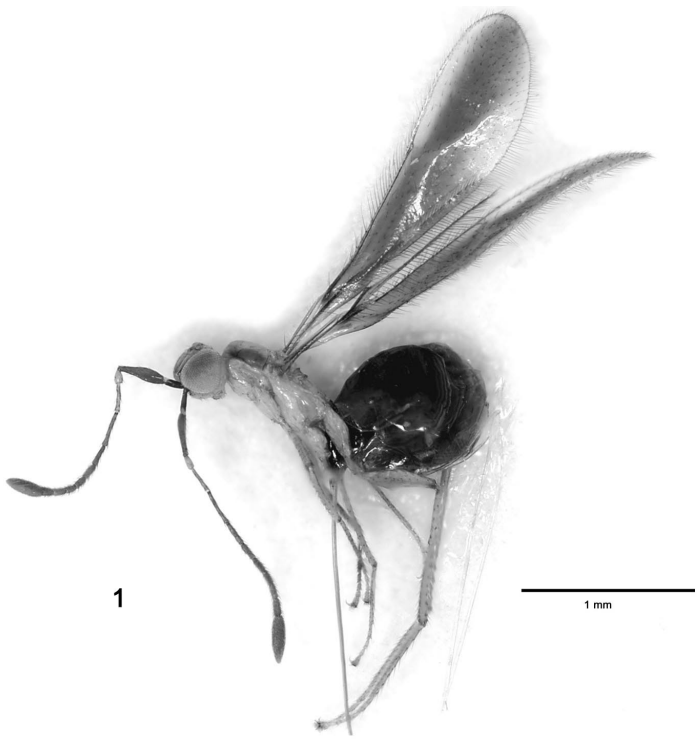


Figure 1 *Borneomymar discus,* paratype female, lateral, habitus digital image

half. Gena about 0.13 X eye width (28: 217). POL 1.1 X OOL and 1.6 X LOL. Mandibles with 3 teeth. Pronotum mostly hidden in dorsal view. Setae of thorax short, with 2 or 3 pairs on pronotum and 1 pair on each of mid- and lateral lobes of mesoscutum, axilla, anterior scutellum and metanotum. Propodeum with 1 pair of setae. Forewing (Fig. 3) length (n=1) 2134, width 493, with venation 0.61 X wing length. Submarginal vein 455, marginal vein 814 and with 1 distal macrochaeta, stigmal vein 52, postmarginal vein 333 (from pinned paratype, UCDC). Hypochaeta next to proximal macrochaeta. Petiole length 20, width 80. Gaster about 1.8 times mesosomal length, in dorsal view strongly compressed, in lateral view circular (Fig. 1), its length 1152, width 168, height 960. Lengths of Gt_1 - Gt_6 (measured along lateral midline): 363, 275, 216, 242, 130, 47. Cercus with two of the setae over 2.5 X as long as the remainder. Ovipositor forming a large loop inside gaster, then extending about 4500–5000 beyond hypopygial apex.

Male. Body length 1675-2760 (n=4). Colour as for female but top of head brown. Lengths of petiole and Gt_1 – Gt_8: 104, 187, 229, 256, 238, 220, 232, 148, 38. Anterior and posterior margins of terga strongly sinuate.

Specific epithet. Latinized from the Greek noun *diskos*, a flat, circular plate, referring to the shape of the gaster.

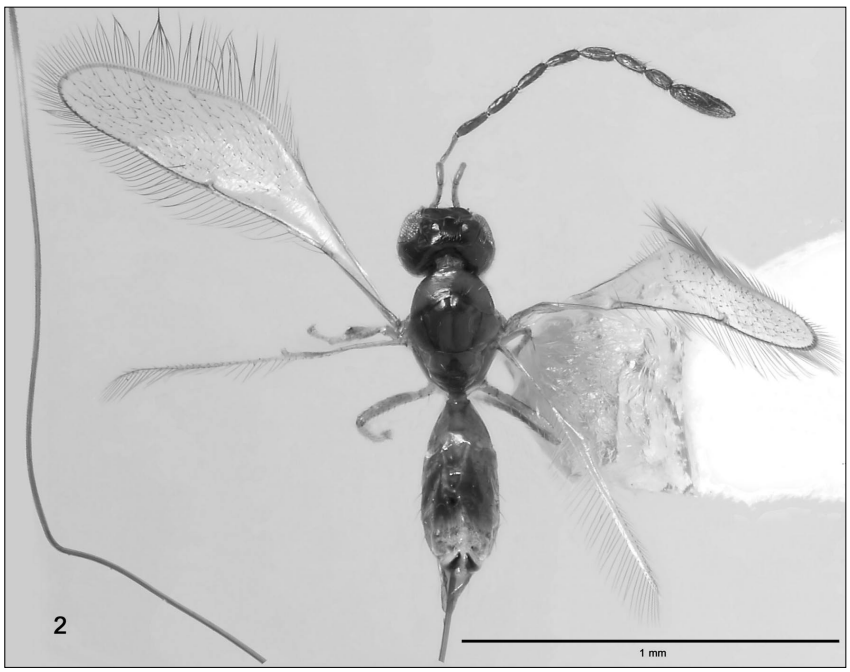


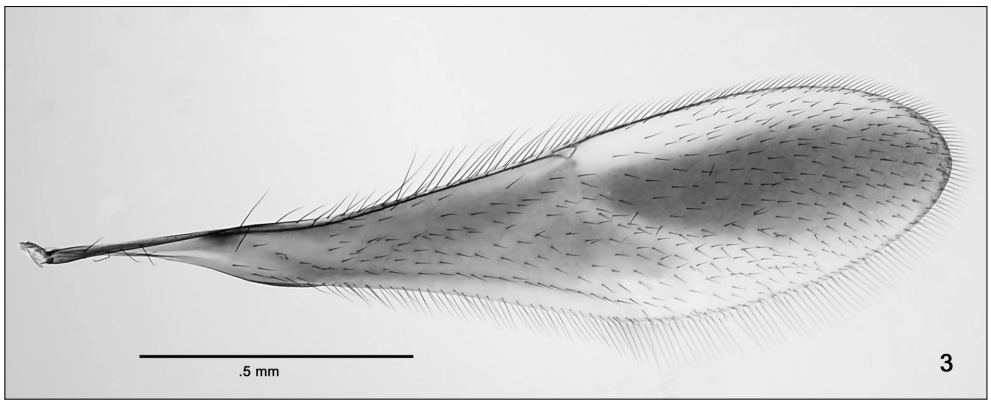
Figure 2 *Borneomymar madagascar,* holotype, dorsal, habitus digital image

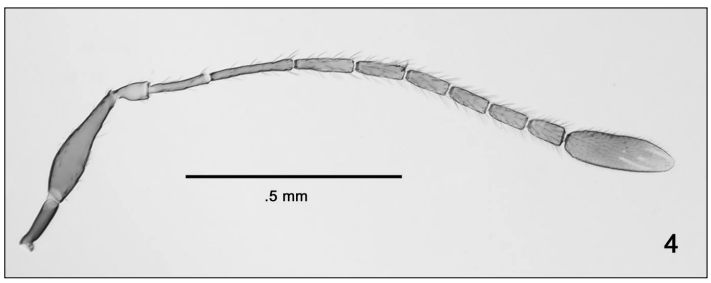
***Borneomymar madagascar* Huber, sp. nov.**
(Fig. 2)

Type material. Holotype ?(UCDC) glued to a card point and labelled: 1."Madagascar, Antsiranana, 11 km WSW. Befingotra Res. Anjanaharibe-Sud 14º45'S 49º27'E, 16-22.XI.1994 B.L. Fisher #1231". 2."Holotype *Borneomymar madagascar* Huber 2001". The holotype has the right antenna beyond the pedicel missing.

Description. Female. Body length 1211 (n=1). Body brown (Fig. 2) with following yellowish: scape, pedicel, fu_1, legs except hind tibia, apex and base of gaster. Wings hyaline. Antenna with radicle about 0.12 X as long as scape. Scape symmetrical, widest at midpoint. Length measurements: scape 84, pedicel 59, fu_1–fu_8 89, 99, 109, 99, 89, 89, 89, 84, clava 188. Longitudinal sensilla not visible under stereoscope at 160X. Gena about 0.4 X eye width (59: 138). POL 1.2 X OOL and 2.0 X LOL. Mandibles with 3 teeth. Pronotum visible in dorsal view, about 0.4 X mesoscutal length (69: 168). Setae of mesosoma very short (not clearly visible at 160 X). Propodeum with 1 pair of setae. Forewing length 1280, width 282, with venation 0.68 X wing length. Submarginal vein 277, marginal vein 386 and with 1 distal macrochaeta, stigmal vein 27, postmarginal vein 217. Hypochaeta about one fifth distance from proximal macrochaeta towards distal macrochaeta. Petiole length 20, width 45. Gaster about 1.1 X mesosomal length, its length 538, width 205, height 256. Cercus with setae subequal in length. Ovipositor exserted 2660 beyond hypopygial apex.

Specific epithet. The species is named from Madagascar, the island of origin.



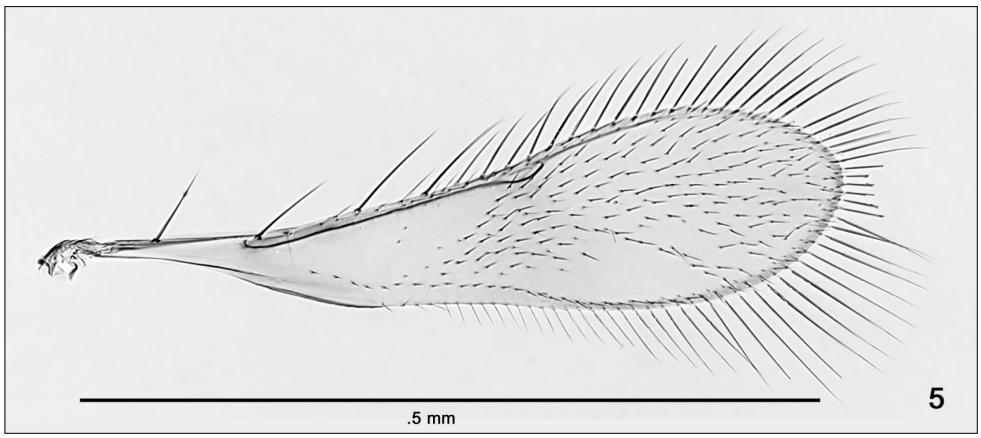


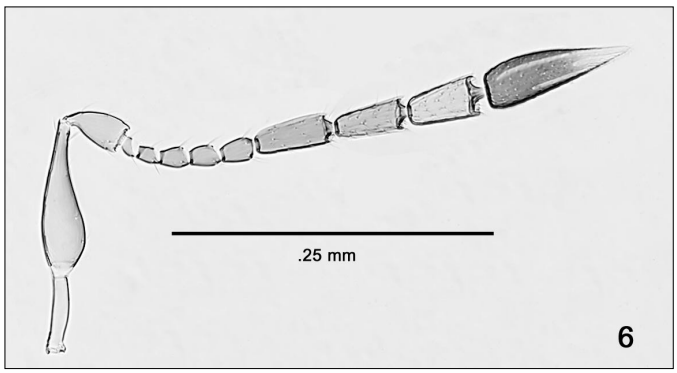
Figures 3–4 *Borneomymar discus,* paratype female: 3, forewing; 4, antenna

***Borneomymar primitivum* Huber, sp. nov.**
(Figs 5, 6)

Type material. Holotype (BMNH) dissected under 4 coverslips on slide in Canada balsam and labelled: 1."Indonesia: Sulawesi, Utara, Dumoga-Bone NP, Toraut, v.1985, 210 m, J.S. Noyes, swept". 2."*Borneomymar primitivum* Huber 2001". **Paratype**. Same data as holotype but vii.1985, N.E. Stork, canopy fog #13" (1? on point, BMNH).

Description. Female. Body length 717. Body pale yellow and creamy-white; dark brown are clava except apex, mouth rim, pro-, meso- and metapleura, and apical tarsomere of each leg; creamy white are fu_6 and fu_7, pronotum, scutellum, coxae, and gaster except brown Gt_5 and ovipositor. Forewing hyaline except for pale brown setose area behind apex of venation and along posterior margin at base. Hind wing hyaline. Antenna (Fig 6) with radicle 62, about 0.34 X as long as scape. Scape enlarged in basal half. Length measurements (n=1): scape 184, pedicel 50, fu_1 –fu_8 16, 16, 23, 26, 29, 62, 59, 63, clava 120. Fu_6-fu_8 each with 2 longitudinal sensilla. Clava with 5 longitudinal sensilla. Gena about 0.1 X eye width. POL ≈ 0.5 X OOL and ≈ 2.0 X LOL (under stereoscope at 160X). Mandibles with 4 teeth. Mesosoma length 98. Pronotum clearly visible in





Figures 5–6 *Borneomymar primitivum,* holotype: 5, forewing; 6, antenna

dorsal view. Setae of thorax short, with 3 pairs on pronotum and 1 pair on each of mid- and lateral lobes of mesoscutum and on metanotum. Propodeum with 1 pair of setae. Forewing (Fig 5) length 583, width 154, without microtrichia along hind margin beyond venation and in triangular area behind marginal vein, except for cubital setal line. Venation ˜445. Submarginal vein 105, marginal vein 212 and with two distal macrochaeta, stigmal vein 30, postmarginal vein ≈128. Hypochaeta about one quarter distance from proximal macrochaeta towards first distal macrochaeta. Petiole length 14, width 37. Gaster length 356, width 198, height 180, about 1.2 X length of mesosoma. Lengths of Gt_1–Gt_6: 45, 40, 49, 66, 59, 80. Anterior and posterior margins of terga straight. Cercus with one of the setae crooked and over 2.5 X as long as the next longest seta. Ovipositor straight, extending slightly (about 80) beyond gastral apex.

Specific epithet. Latin adjective, primitivus -a, -um, meaning first.

Discussion

Finding apomorphies to demonstrate that the various supraspecific taxa of Mymaridae are monophyletic is difficult. Many of the character states observed result from reductions, fusions, or loss, so they are prone to homoplasy. Schauff (1984) recognized this when he presented the first and only cladogram of relationships within Mymaridae. Because he treated only the 26 genera known at that time from the Holarctic region only two of the putatively primitive genera, (those with 8 funicle segments and 5 tarsomeres) were included: *Gonatocerus* and *Ooctonus*. Only one intuitive cladogram is proposed here (Fig. 7). It includes the five described, extant genera with the above combination of symplesiomorphies, and *Triadomerus*, represented by cretaceous fossils from Canada, and extant (but undescribed) Australian species. The non-terminal stems are labelled from 1-13 and discussed. Other relationships among the primitive genera could be hypothesized and supported by apomorphies (mostly as homoplasies), but a detailed analysis cannot be done until all useful characters are discussed and their states coded for all mymarid genera.

Stem 1 is based on a unique, apomorphic state that defines the family Mymaridae. The vertex is separated as a distinct sclerite from the face by sutures and associated cuticular thickenings, the trabecula, above the toruli and next to the dorsal orbit of each eye.

Stem 2 leads to two genera. I have found no apomorphies to define the lineage, hence the trifurcation. The genus *Triadomerus*, the most primitive genus of the family, retains the putative ground plan flagellar formula of 11 segments in both males and females (8 funicular and 3 claval segments in females). *Eustochomorpha* is separated from *Triadomerus* by one homoplasy: reduction in number of claval segments from 3 to 2. This Australian genus, with one species, is known only from females. *Triadomerus* may be a synonym of *Eustochomorpha*.

Stem 3 has one apomorphic state change: reduction in number of flagellar segments in females to at most 9. The flagellum may consist of 4 to 8 funicular segments and 1-3 claval segments. Genera with 8 funicle segments, however, only have a single claval segment. Females of all mymarids except *Triadomerus* thus have fewer flagellar segments than males. Males of a few genera may also have a reduced number of flagellar segments (as few as 7 in some *Camptoptera*).

Stem 4 leads to two genera: *Borneomymar* and *Australomymar*. I have found no apomorphies to define the lineage. *Australomymar* is separated from *Borneomymar* by two homoplasies: reduction in number of tarsomeres from 5 to 4 and funicle segments from 8 to 6.

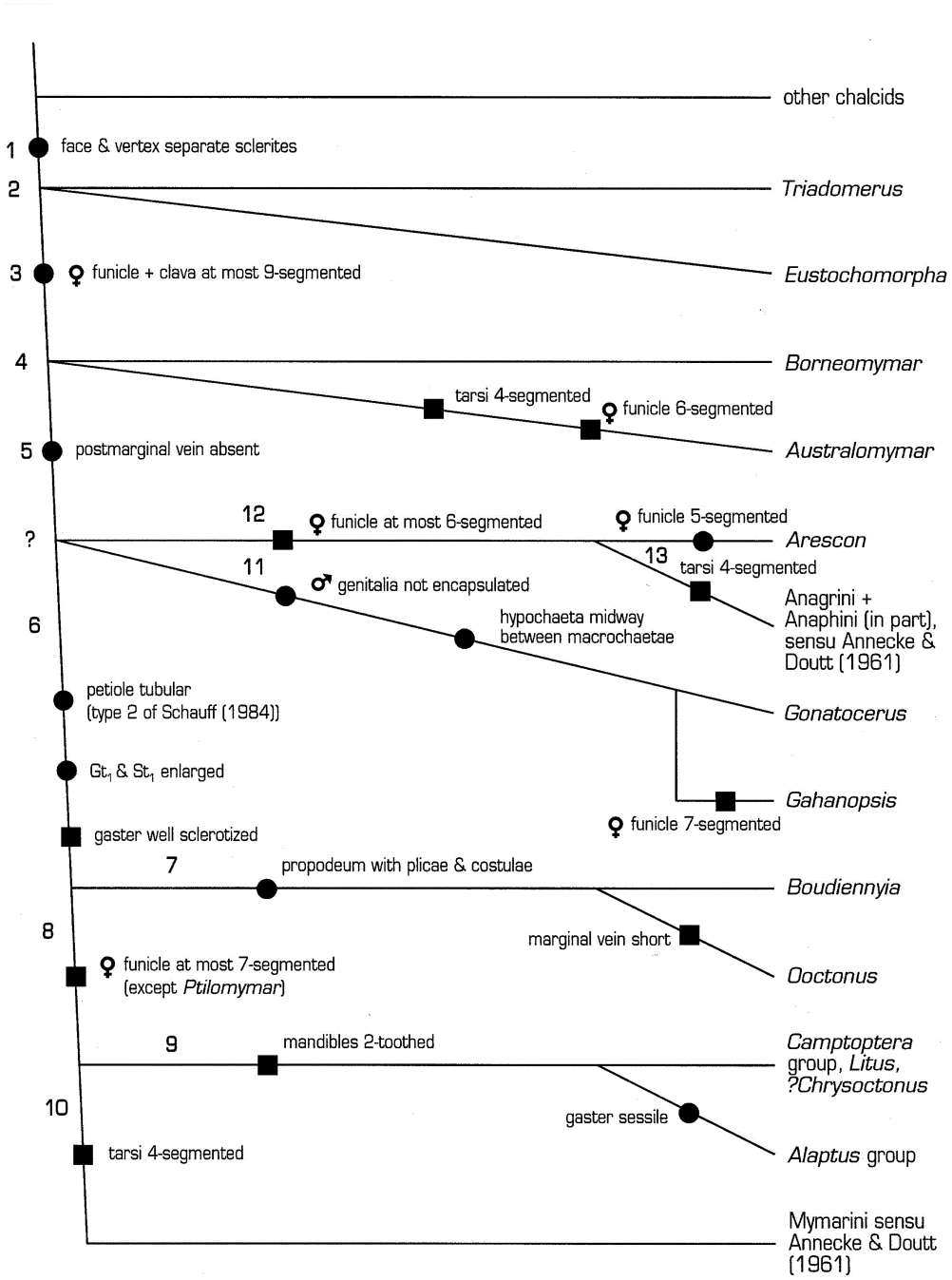


Figure 7 Cladogram of putative relationships among genera of Mymaridae with 5-segmented tarsi

Stem 5 has one apomorphic state change: loss of the postmarginal vein. It leads to an unresolved trifurcation.

Stem 6 is defined by three apomorphies: elongate, tubular petiole into which the base of Gt_1 projects (petiole type 2 of Schauff 1984), Gt_1 and St_1 enlarged, and a well sclerotized gaster. These apomorphies may be homoplasious, occuring also in some species of *Gonatocerus* (stem 11). There is a reversal in one of them (size of Gt_1 and St_1) in the *Alaptus* group (stem 9).

Stem 7 is defined by one apomorphy: propodeum with plicae and costulae. The widespread genus *Ooctonus* is separated from *Boudiennyia*, found so far only in Australia and New Caledonia, by one homoplasy: a short marginal vein, with the venation much less than half the wing length.

Stem 8 is defined by one homoplasy: reduction in number of funicle segments from 8 to 7 or fewer, except in *Ptilomymar*, which retains an 8-segmented funicle but has 4-segmented tarsi.

Stem 9 is defined by one homoplasy: mandibles with at most 2 teeth. The *Alaptus* group of genera is separated by from the others by at least one apomorphy: a short and wide, ring-like petiole that makes the gaster appear sessile. Within the *Camptoptera* group, *Eofoersteria* is distinguished by one homoplasy: reduction (by fusion) in tarsomere number from 5 to 4. *Litus* also belongs here, and possibly other genera such as *Chrysoctonus*.

Stem 10 is defined by one homoplasy: reduction in number of tarsomere from 5 to 4. This lineage contains the putative genera placed by Annecke & Doutt (1961) in their Mymarini and others described since.

Stem 11 is a monophyletic lineage defined by two synapomorphies: male genitalia unencapsulated (Viggiani 1988) and hypochaeta midway between proximal and distal macrochaeta. *Gahanopsis*, from the Neotropical region, is separated by one homoplasy (a 7-segmented funicle) from *Gonatocerus*, which contains well over 250 nominal species in several distinct species groups.

Stem 12 is defined by one symplesiomorphy and is likely paraphyletic. No apomorphies have been found to define it. How this lineage relates to lineages 6 and 11 is uncertain. Symplesiomorphies shared with *Eustochomorpha*, *Borneomymar* and *Australomymar* include an encapsulated male genitalia, hypochaeta next to basal macrochaeta, and pronotum entire. Symplesiomorphies shared with stem 11 are the unmodified petiole, the relatively poorly sclerotized gaster, and Gt_1 and St_1 similar in size to the remaining terga and sterna. *Arescon* is the sister group to the remaining genera and is defined by one apomorphy, its 5-segmented funicle and perhaps also by structure of the male genitalia.

Stem 13 is defined by a reduction in number of tarsomeres from 5 to 4. This lineage contains all of the putative genera placed by Annecke & Doutt (1961) in their Anagrini and Anaphini (in part - *Anagroidea* belongs in lineage 6), as well as others described since.

Conclusions

Eustochomorpha is the most primitive, extant mymarid genus. Other genera with 5 tarsal segments, 8 funicle segments in females, and 11 flagellar segments in males form the bases of three separate lineages, two of which appear to be monophyletic. All extant, primitive mymarid genera are represented in the southern hemisphere, particularly in the Australian region, which contains all the genera except *Borneomymar*. This region is unlikely to be the centre of origin of Mymaridae

because Cretaceous fossils of the primitive genus *Triadomerus* (Yoshimoto 1975) have been found in Canadian amber. Instead, the Australian region, and also southern South America contains a relict fauna that survived since the Cretaceous but largely died out elsewhere. A good understanding of this Gondwanan fauna is therefore required to develop a sound higher classification within the family to update and, if necessary, replace that proposed by previous authors.

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