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BRIEF COMMUNICATION

Establishment of some clade names for Amphiesmenoptera (Insecta: Holometabola)

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Abstract. Classificatory notes are presented for various stem lineages relative to the Trichoptera + Lepidoptera clade. The following new groups are established for clades above the family-group ranks: **Protomeroptera** Engel, **Metamphiesmenoptera** Engel, **Cladochoroptera** Engel, **Euamphiesmenoptera** Engel, **Eocoronoptera** Engel, **Panendymenoptera** Engel, **Necrotrichoptera** Engel, **Endymenoptera** Engel, **Stelloptera** Engel. Additionally, the new families **Marimeroibiidae** Engel, new family, and **Microptysmatellidae** Engel, new family, are proposed along with *Anecrotaulius* Engel, new genus, and *Paranecrotaulius* Engel, new genus.

INTRODUCTION

The clade Amphiesmenoptera includes some of the most iconic of all insects among the Lepidoptera, and has been a lineage of considerable interest from a paleontological perspective (Grimaldi & Engel, 2005). In recent years, the concept of Amphiesmenoptera has had to be expanded to accommodate a number of extinct stem lineages (*e.g.*, Grimaldi & Engel, 2005; Minet *et al.*, 2010; Mey *et al.*, 2017), necessitating a rethinking of the group's overall classification. Some notes are provided here on certain clades that appear to be well supported among an expanded Amphiesmenoptera. Although some of these names were to be used in a forthcoming review chapter, some are need-

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ed for another work (Wang *et al.*, in press) that will appear prior to the review. Accordingly, brief accounts are presented here so that they can be used without elaboration in the aforementioned article. Given that I am often asked as to my general view of Holometabola classification, I have summarized these Amphiesmenoptera in the broader context of the subcohort (Table 1: I have also provided a hierarchical listing of ranks I currently recognize in an appendix).

SYSTEMATICS

Superorder Amphiesmenoptera Kiriakoff, *s.l.* (a.k.a. Panamphiesmenoptera Engel)

DIAGNOSIS: Forewing PCu and A veins forming double loop (a.k.a. “double-Y-shaped anal veins” *sensu auctorum*), albeit primitively developed as “proto-double-loop” in Protomeroptera nov. and Cladochoroptera nov. (*vide infra*) (synapomorphy); CuA originally forked (symplesiomorphy; CuA simple in groundplan of Antliophora).

REMARKS: Note that what have been traditionally considered as A3 arching into A2, which then arches into A1 are here treated as A2 arching into A1, which then arches into PCu. What appears as apical arches to form the lower and upper loops are, in fact, crossveins as evidenced by the sometimes presence of an apical abscissa of A1 (A2 in earlier systems whereby PCu is identified as A1) beyond the otherwise oblique crossvein that completes the apex of the loop. In the typical double loop of the Metamphiesmenoptera nov. (*vide infra*), the apical abscissa of A1, if present, does not reach the wing margin. In the proto-double-loop forms, the apical abscissa of A1 typically reaches the wing margin. By looking at the transition series across Protomeroptera, Permotrictoptera, Cladochoroptera, and other early Amphiesmenoptera, it seems that formation of the double-loop may result from the progressive loss of the apical abscissae for A1 and A2, along with other marginal and interveinal crossveins.

Protomeroptera Engel, new order

DIAGNOSIS: Forewing Sc with four or more terminal branches; Rs and M with supplementary veins at wing margin (*i.e.*, Rs and M with more than four terminal branches) (symplesiomorphy of Panorpida and subsequently lost independently in Dipterida, Metamphiesmenoptera, and some Mecopterida *s.str.*: *sensu* Table 1); CuA stem sinusoidal; forewing with proto-double-loop, *i.e.*, A1 arching into PCu and A2 arching into A1, but with some terminal spurs and/or A2 crossveins meeting posterior wing margin, and sometimes with a_1 - a_2 crossveins.

CURRENTLY INCLUDED CLADES: Protomeropidae Tillyard.

ETYMOLOGY: The name is an artificial combination of Protomeropidae (*i.e.*, Protomer-, which is the stem Protomerop- after removal of “op”), with *pterón* (πτερόν, meaning, “wing”).

REMARKS: This group is often referred to as “Protomeropina” (and a suborder of Mecoptera), but this is the standard name and suffix for the rank of subtribe in the ICZN-regulated family-group series and therefore explicitly refers to a group subordinate to Protomeropidae, Protomeropinae, and Protomeropini, and not a higher clade of Amphiesmenoptera. This form of name leaves the classification confused as it indicates a group not actually employed by those attempting to use the name, and one may therefore be left unable to ascertain which level of inclusiveness is indicated. Anyone wishing to use typified names for higher groups must avoid suffices that overlap with

those already employed within the family-group ranks. Names above superfamily are not regulated by the ICZN but one must continue to strive for stability in the application of unregulated names, and avoidance of forms that are already standardized is paramount.

Marimerobius Zalesky, traditionally placed in Protomeropidae, is here removed to a separate family and outside of Protomeroptera. **Marimerobiidae** Engel, new family (type genus: *Marimerobius* Zalesky, 1946) are placed as *incertae sedis* among the Mecopterida (*sensu* Table 1) and diagnosed by the presence of siphonate mouthparts; the lack of a pronouncedly sinusoidal stem to CuA; the lack of a proto-double loop in the forewing (all veins terminate independently on posterior wing margin); M1 and M4 branched apically (thus producing “6” branches to M: M2 and M3 simple); and CuA with three terminal branches, all of which serves to distinguish the family from Protomeropidae.

ZooBank: urn:lsid:zoobank.org:act:E817EAD8-8433-4B7E-897B-F330D0D1934E

Order Permotrichoptera Martynova

REMARKS: This group has been nicely summarized by Minet *et al.* (2010), and is not repeated here.

Microptysmella Kukalová-Peck & Willmann is here placed in its own family, **Microptysmellidae** Engel, new family (type genus: *Microptysmella* Kukalová-Peck & Willmann, 1990) as it differs from Microptysmatidae in the secondary loss of costal crossveins; R1 with apical fork (also present in some Microptysmatidae); numerous r-rs, interrarial, and intermedial crossveins; presence of complete apical abscissae of A1 and A2 (A2 stem absent in Microptysmatidae); several pcu-a₁ crossveins, apicalmost of which is not strongly oblique.

ZooBank: urn:lsid:zoobank.org:act:EE50695C-CBA8-4585-8CCB-0CDC5014112E

Metamphiesmenoptera Engel, new

DIAGNOSIS: Forewing with true double-loop; loss of nygmata (except secondarily present in Trichoptera).

INCLUDED CLADES: Order Cladochoroptera and euorder Euamphiesmenoptera nov.

Cladochoroptera Engel, new order

DIAGNOSIS: Forewing with true double-loop combined with numerous c-sc crossveins (four at minimum); wings without covering of setae.

INCLUDED CLADES: Cladochoristidae Riek.

ETYMOLOGY: The name is an artificial combination of Cladochoristidae (*i.e.*, Cladochor-, which is the stem Cladochorist- after removal of “ist”), with *pterón* (πτερόν, meaning, “wing”).

Euamphiesmenoptera Engel, new euorder

DIAGNOSIS: Reduction of subcostal crossveins to two or fewer distad humeral crossvein; dense setae covering wings (sometimes as scales in Endymenoptera nov.).

INCLUDED CLADES: Order Eocoronoptera nov. and dysorder Panendymenoptera nov.

Eocoronoptera Engel, new order

DIAGNOSIS: Euamphiesmenoptera with combination of Sc forked apically and M3 and M4 distinct in both forewing and hind wing.

INCLUDED CLADES: Eocoronidae Tindale.

Panendymenoptera Engel, new dysorder

DIAGNOSIS: Eumphiesmenoptera in which hind wing M3 and M4 are fused as M3+4; Sc typically simple, at least in hind wing (secondarily forked in some basal Trichoptera and Lepidoptera).

INCLUDED CLADES: Order Necrotrichoptera nov. and mirorder Endymenoptera nov.

Necrotrichoptera Engel, new order

DIAGNOSIS: Sc simple (sometimes with c-sc crossvein giving “forked” appearance); loss of crossveins in apical half of wing (uncommonly present secondarily); CuA straight apically (CuA arched apically in Trichoptera except in some derived groups where it is secondarily straight); wings without nygmata (present in Trichoptera); wings with setae but never with scales.

INCLUDED CLADES: Necrotauliidae Handlirsch.

REMARKS: Absence of pronotal warts excludes the group from Stelloptera nov., while the absence of scales at least partly excludes them from Endymenoptera (but, while scales are presumably a groundplan feature, sensu Wang *et al.*, in press, they are lost extensively in Trichoptera).

Two new genera are here recognized in Necrotauliidae, diagnosed below.

Anecrotaulius Engel, new genus

ZooBank: urn:lsid:zoobank.org:act:DEEDF1EA-BD17-4A07-83DA-DE1C5BF78DFC

TYPE SPECIES: *Necrotaulius qingshilaense* Hong, 1984.

DIAGNOSIS: The type species is here removed from *Necrotaulius* Handlirsch owing to the peculiar features of an apical connection between Sc and R and the meeting of CuP and PCu at the posterior wing margin (the latter like some *Austaulius* Thomson *et al.*).

ETYMOLOGY: The new generic name is a combination of the Ancient Greek alpha privative *a-* (α^- , indicating negation) and the genus *Necrotaulius*. The gender of the name is masculine.

REMARKS: The establishment of the new genus necessitates the new combination and emendation *Anecrotaulius qingshilaensis* (Hong).

Paranecrotaulius Engel, new genus

ZooBank: urn:lsid:zoobank.org:act:FC2BF591-79DB-411E-8315-221C327C8255

TYPE SPECIES: *Necrotaulius proximus* Sukatsheva, 1973.

DIAGNOSIS: This species removed from *Necrotaulius* owing to the presence of a pro-

- Subcohort Holometabola Burmeister (=Endopterygota Sharp)
- Magnorder Hymenoptera Pearce (= Hymenoptera Boudreaux)
 - Order** †Apatohymenoptera Engel, nov. (†Avioxyelidae)
 - Order** Hymenoptera Linnaeus
 - Magnorder Aparaglossata Peters *et al.*
 - Hyperorder Neuropteriformia Engel, nov.
 - Superorder Neuropterida Pearce
 - Order** Raphidioptera Navás
 - Grandorder Metaxyneuroptera Engel, nov.
 - Order** †Protoneuroptera Grimaldi & Engel (†Permoberothidae)
 - Euorder Eidoneuroptera Engel *et al.*
 - Order** Megaloptera Latreille
 - Order** Neuroptera Linnaeus
 - Superorder Coleopterida Pearce (= Elytrophora Packard, Pancoleoptera Crampton)
 - Order** Coleoptera Linnaeus
 - Suborder †Alphacoleoptera Engel *et al.*
 - Capaxorder Zacoletoptera Engel *et al.*
 - Suborder †Metaxycoleoptera Engel *et al.*
 - Hyporder Eucoleoptera Engel *et al.* (all other Coleoptera)
 - Order** Strepsiptera Kirby
 - Hyperorder Panorpida Hinton (= Panmecoptera Crampton, Mecopteriformia Ax)
 - Superorder Antliophora Hennig
 - Grandorder Mecopterida Pearce, *s.str.*
 - Order** Neomecoptera Crampton (= Raphioptera MacLeay)
 - Euorder Homomecoptera Engel, nov.
 - Order** Nannomecoptera Hinton
 - Mirdorder Apomecoptera Engel, nov.
 - Order** Mecoptera (Packard), *s.str.* (= Pistillifera Willmann, *s.str.*)
 - Epiorder Siphonomecoptera Engel, nov.
 - Order** †Aneuretopera Engel, nov. (= †Aneuretopsychidae)
 - Order** Siphonaptera Latreille
 - Suborder †Protosiphonaptera Engel (Pseudopulicidae, Tarwiniidae)
 - Suborder Eusiphonaptera Engel, nov. (all other Siphonaptera)
 - Grandorder Dipterida Pearce
 - Order** Diptera Linnaeus
 - Superorder Amphiesmenoptera Kiriakoff, *s.l.* (= Panamphiesmenoptera Engel)
 - Order** †Protomeroptera Engel, nov. (†Protomeropidae & others)
 - Order** †Permotrichoptera Martynova (†Microptysmatidae & others)
 - Grandorder Metamphiesmenoptera Engel, nov.
 - Order** †Cladochoroptera Engel, nov. (†Cladochoristidae)
 - Euorder Euamphiesmenoptera Engel, nov. (= Amphiesmenoptera Kiriakoff, *s.str.*)
 - Order** †Eocoronoptera Engel, nov. (†Eocoronidae)
 - Dysorder Panendymenoptera Engel, nov.
 - Order** †Necrotrichoptera Engel, nov. (†Necrotauliidae)
 - Mirorder Endymenoptera Engel, nov.
 - Order** †Tarachoptera Mey *et al.*
 - Epiorder Stelloptera Engel, nov.
 - Order** Trichoptera Kirby
 - Capaxorder †Kalasiroptera Engel, nov. (†Lepidochlamidae)
 - Capaxorder Eutrichoptera Engel, nov. (all other Trichoptera)
 - Order** Lepidoptera Linnaeus
 - Capaxorder †Paralepidoptera Engel, nov. (†Mesokristenseniidae)
 - Capaxorder Zalepidoptera Engel, nov. (all other Lepidoptera)

nounced c-sc crossvein (Sc1 of Liu *et al.*, 2014; Thomson *et al.*, 2018), as in *Acisarcuatus* Liu *et al.* and *Austaulius*. Unlike *Acisarcuatus*, R and Rs1 are straight rather than broadly arcuate, and unlike *Austaulius* CuP and PCu are widely separated on the posterior wing margin.

ETYMOLOGY: The new genus-group name is a combination of the Ancient Greek preposition παρά (παρᾶ, meaning, “near”) and *Necrotaulius*. The gender of the name is masculine.

REMARKS: The following new combination results from the proposal of the genus: *Paranecrotaulius proximus* (Sukatsheva).

Endymenoptera Engel, new mirorder

DIAGNOSIS: Groundplan with scales on wings, occurring in Tarachoptera, some Trichoptera, and all Lepidoptera; groundplan with typically closed discal cell, and sometimes radial and medial cells (in Trichoptera), owing to crossveins (*e.g.*, rs-m to close discal cell) in apical half of wing; note that the double-loop is reduced in Tarachoptera, with the reduction or loss of A2 (= A3 in prior systems).

INCLUDED CLADES: Order Tarachoptera Mey *et al.* and epiorder Stelloptera Engel, nov.

ETYMOLOGY: The name is a combination of *endymenos* (ἐνδύμενος, meaning, “dressed”) and *pterón* (πτερόν, meaning, “wing”), analogous to Amphiesmenoptera, which is a combination of *emphiesmenos* (ἠμφιεσμένος, meaning, “clothed in” and itself formed of *amphiesma* / ἀμφίεσμα, meaning, “garment”, via *amphiénnymi* / ἀμφιέννυμι, meaning, “to clothe” and *-menos* / -μενος, a suffix added to verbs to form participles).

Stelloptera Engel, new epiorder

DIAGNOSIS: Pronotum vertical, with median warts (pronotum flat without median warts in other orders); metathorax with a setose sclerite in wing base membrane below subalare; female abdominal segments VIII and IX with rod-like apodemes for operation of telescoping oviscapt.

INCLUDED CLADES: Orders Trichoptera Kirby and Lepidoptera Linnaeus.

ETYMOLOGY: The epiordinal name is a combination of *stéllō* (στέλλω, meaning, “clothed”, from *stolē* / στολή, meaning, “robe”) and *pterón* (πτερόν, meaning, “wing”).

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APPENDIX

A proposed system of ranks in the order group. If additional ranks are necessary below order and above the family-group series, then a system of prefixes can be adapted for the rank of phalanx, used in vertebrate classificatory schemata.

Magnorder
 Hyperorder
 Superorder
 Grandorder
 Euorder
 Dysorder
 Mirorder
 Epiorder
 Order
 Semioorder
 Capaxorder
 Hyporder
 Suborder
 Infraorder
 Parvorder
 Minorder
 Micrororder
 Nanorder
 Aporder



Pharciphyzelus lacefieldi Beckemeyer & Engel, 2011

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