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A new genus and species of pygidicranid earwigs from the Upper Cretaceous of southern Asia (Dermaptera: Pygidicranidae)

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ABSTRACT

A third genus and species of fossil pygidicranid earwigs from Burmese amber is described and figured as *Stonychopygia leptocerca* Engel, Huang, Thomas, and Cai, gen. et sp. nov. (type species of *Stonychopygia* Engel and Huang, gen. nov.; Stonychopygiinae Engel and Huang, subfam. nov.). *Stonychopygia* have features similar to the subfamily Echinosomatinae such as the combination of shorter, subequal second and third flagellomeres and femora that are neither compressed or keeled. However, the new fossil species differs from echinosomatines in many details, particularly the slender form, head longer than wide, slender scape, slender and elongate forceps, and absence of stout, short bristles over the integument. The new fossil is compared with its contemporaneous and modern relatives, and comments are provided regarding the classification of Pygidicranoidea, with the genus *Haplodiplatys* Hincks removed from Diplatyidae to Haplodiplatyidae Engel, fam. nov.

1. Introduction

Earwigs (Dermaptera) comprise approximately 2000 modern species of polyneopteran insects and of controversial phylogenetic placement, perhaps related to the 'orthopteroids' (Grimaldi and Engel, 2005). Species are particularly characteristic for the modification of the cerci into pincer-like forceps, as well as the reduction and modification of the forewings into sclerotized tegmina, although the wings are frequently vestigial or lacking in many earwigs. Additional features of modern earwigs include the loss of venation in the tegmina; a highly specialized anal fan, venation, and folding mechanism to the hind wing; trimerous tarsi; and the loss of ocelli (Grimaldi and Engel, 2005). The modern diversity historically was grouped into three distinct suborders, the epizoic Hemimerina and Arixeniina and the remainder classified in Forficulina (e.g., Burr, 1911a; Hincks, 1959; Günther and Herter, 1974; Sakai, 1982; Popham, 1985; Haas, 1995). Abundant evidence demonstrates that such an arrangement is artificial, and the former epizoic taxa are merely derived subsets of the latter (Klass, 2001; Schneider and Klass, 2012; Kocarek et al., 2013; Tworzydlo et al., 2013; Naegle et al., 2016). Instead, more modern treatments have placed all of the extant lineages of earwigs into the suborder Neodermaptera, and set apart from two extinct groups, Archidermaptera and Eodermaptera, that are known only from Mesozoic and together form a grade to the Neodermaptera (Engel and Haas, 2007; Zhao et al., 2010; Nel et al., 2012). Archidermaptera are recorded from the Upper Triassic through to the lowermost Cretaceous, while Eodermaptera are known only from Middle Jurassic to Lower Cretaceous deposits (Grimaldi and Engel, 2005; Wappler et al., 2005; Nel et al., 2012). Many diverse forms of earwigs have been described from Jurassic and Lower Cretaceous compression fossils, and these have documented a wide variety of families,

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including the earliest occurrences of the Neodermaptera (Popham, 1990; Engel et al., 2002, 2011; Engel and Chatzimanolis, 2005; Haas, 2007; Yang et al., 2015). Earwigs are similarly represented as inclusions in amber, with a large number of specimens recorded from the Cenozoic, albeit representing comparatively few species (Burr, 1911b; Nel et al., 2003; Ross and Engel, 2013; Engel, 2016: interestingly, more work has been undertaken on earwigs preserved as compressions from the Palaeogene: e.g., Brown, 1984; Willmann, 1990; Nel et al., 1994; Wappler et al., 2005; Chatzimanolis and Engel, 2010), and a steadily growing abundance from the Cretaceous. Presently, there are 11 formally named Cretaceous amber species, some of which have been established for nymphs with good characters, and any number of morphospecies from early instar nymphs or specimens that are too fragmentary to permit more extensive comparisons (Cockerell, 1920; Engel and Grimaldi, 2004; Engel, 2009, 2011; Engel et al., 2011, 2015; Perrichot et al., 2011; Engel and Perrichot, 2014). All of the Cretaceous amber species are of the Neodermaptera, although there is no reason why at least Eodermaptera might not be eventually found in Lower Cretaceous resins.

The diversity of earwigs preserved in Burmese amber is quite remarkable, with five species described up to the present (Cockerell, 1920; Engel and Grimaldi, 2004, 2014; Engel, 2011), and several others awaiting documentation (pers. obs.). To this diversity we add a sixth species from these deposits, the third to represent the plesiomorphic neodermapteran family Pygidicranidae Verhoeff, 1902. In addition, we provide comments on the familial arrangement of the infraorder Protodermaptera, and remove the genus *Haplodiplatys* Hincks, 1955 to its own family outside of Diplatyidae Verhoeff, 1902.

2. Material and methods

The female earwig reported herein was found in a somewhat square piece of Burmese amber, the block measurement approximately 12 × 11.5 mm, and about 7 mm in thickness. The earwig is well preserved and extends across the piece, with its head near one of the edges. The integument is partially and slightly cleared in various places, and there has been some compression to the legs and antennae, but these do not alter the overall structure and characters are easily discerned in the fossil. The amber itself has scattered particulate debris and some partial inclusions of other organisms (e.g., a small scelionid wasp, a barklouse, and a field of what appear to be small fungal spores near the head) (Fig. 1A). The amber from the Hukawng Valley in northern Myanmar preserves an extensive biota from the Cenomanian (Grimaldi et al., 2002; Ross et al., 2010). The age of the amber has been dated to approximately 98 Ma, based on radiometric analysis of zircons (Shi et al., 2012), while maps and further geological details are summarized by Cruickshank and Ko (2003). The specimen is deposited in the Burmese amber collection of the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing.

The morphological terminology employed here is largely based on that of Giles (1963) and Günther and Herter (1974), while the format for the descriptions is modeled after other recent accounts of Cretaceous Dermaptera (e.g., Engel et al., 2011, 2015; Engel and Grimaldi, 2014). The higher classification referenced is generally that of Engel and Haas (2007), while the taxonomic actions established herein are registered under ZooBank LSID urn:lsid:zoobank.org:pub:4866A335-1131-4759-9FF7-1D446DC1648E. Measurements were taken using an Olympus SZX-12 stereomicroscope, and photographs prepared with a Canon EOS7 digital camera system.

3. Systematic palaeontology

Suborder Neodermaptera Engel, 2003
Infraorder Protodermaptera Zacher, 1910
Superfamily Pygidicranoidea Verhoeff, 1902

Comments. The present classification of Protodermaptera is less than satisfactory and the group as a whole is assuredly paraphyletic (Haas, 1995; Jarvis et al., 2005; Naegle et al., 2016). The infraorder is only retained at present as a conservative measure and pending a comprehensive reclassification of the plesiomorphic Neodermaptera. Engel and Haas (2007) included two superfamilies within the group, the Karschielloidea Verhoeff, 1902 and the Pygidicranoidea, the former with only Karschiellidae and the latter with Diplatyidae and Pygidicranidae. It has been known for some time that the inclusion of the genus *Haplodiplatys* within Diplatyidae likely renders this family paraphyletic (Haas, 1995). For example, many species of *Haplodiplatys* lack the overlapping, asymmetrical tegmina characteristic of Diplatyidae and all other Neodermaptera, instead having the primitive condition found among Karschiellidae (Haas, 1995), as well as thoracic sternal forms of the latter family. Accordingly, the higher classification of pygidicranoids is here augmented to reflect this reality and the species of *Haplodiplatys* are segregated into their own family.

Haplodiplatyidae Engel, fam. nov.
Type genus: *Haplodiplatys* Hincks, 1955

Diagnosis. Somewhat dorsoventrally compressed earwigs with matt integument and scattered setae; head typically not well differentiated into frontal and occipital regions, with ecdysial cleavage scars lacking, integument smooth; compound eyes prominent; antenna comparatively short, with less than 25 flagellomeres, flagellomeres slender, longer than wide, flagellomere I usually not longer than flagellomere III; anterior and posterior ventral cervical sclerites of approximately similar sizes, not touching, posterior sclerite and prosternum not contacting medially; pronotum narrower than head, with lateral-caudal regions flange-like, usually hyaline, and often differently colored; metasternum with posterior margin straight (frequently concave in Diplatyidae); tegmina and hind wings well developed, large, tegmina typically symmetrical (for this reason it is possible that some species currently placed within *Haplodiplatys* will require transfer elsewhere); femora compressed, ventrally carinulate; abdomen cylindrical, apically slightly expanded, with terminal tergum large and rounded apically; forceps comparatively narrow (sometimes slender), straight except at apex, tapering in width from base to apex, basally close together, often with serrations or minute dentition; female with gonapophyses present and developed (not vestigial); male with simple parameres articulating on anterior or anterolateral margins of parameral plate (penes), inner margins of parameres without dentition, paramere lacking epimerite; parameral plate wide, with paired, unidirectional genital lobes and paired virgae (four virgae), lobes directed posteriorly; basal vesicle lacking; nymphs with elongate, filamentous, multisegmented cerci.
Comments. This is a pantropical family of primitive neodermapteran earwigs which, as here defined, has a single fossil record – *Haplodiplatys crightoni* Ross and Engel, 2013 in lower Miocene amber from Chiapas, Mexico (Ross and Engel, 2013). The family-group name is registered under ZooBank LSID urn:lsid:zoobank.org:act:33C68096-DC38-412C-B32B-72C9AAFDE414.

Family Pygidicranidae Verhoeff, 1902

Stonychopygiinae Engel and Huang, subfam. nov.
Type genus: *Stonychopygia* Engel and Huang, gen. nov.