

Short communication

A mantis-type ootheca from mid-Cretaceous Burmese amber (Insecta: Dictyoptera)

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ABSTRACT

We report a fossil ootheca of Dictyoptera from mid-Cretaceous Burmese (Myanmar) amber. This ootheca resembles those of extant mantises, particularly *Chaeteessa*, and it is provisionally identified to Mantodea. Whilst Blattodea (Blattaria and Isoptera, or 'true' cockroaches and termites) are ruled out as the owner of this ootheca, Alienoptera and basal Dictyoptera remain possible. This is the first fossil described of the mantis-type ootheca, and also direct evidence of Dictyoptera in Cretaceous.

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1. Introduction

Some insects protect their eggs by covering them with secretions, sometimes combined with sand or soil. The covering, along with the enclosed eggs or not, is referred to as ootheca or egg case/pod. Oothecae are common among 'true' cockroaches (Blattaria, see Roth, 1968) and mantises (Mantodea, see Brannoch et al., 2017), and also found in termites (Isoptera, see Nalepa and Lenz, 2000), grasshoppers (Orthoptera: Caelifera, see Chapman and Robertson, 1958), tortoise and leaf-mining beetles (Coleoptera: Chrysomelidae: Cassidinae, see Chaboo, 2007), heelwalkers (Mantophasmatodea, see Roth et al., 2014), and stick and leaf insects (Phasmatodea, see Goldberg et al., 2015). Unlike others, the typical oothecae (produced by oviparous species) of cockroaches and mantises are hardened without mixing with sand or soil, and have aligned egg chambers (Roth, 1968; Brannoch et al., 2017); this suggests a close relationship between the two groups. Oothecae of

this type are autapomorphic for Dictyoptera (Ax, 1999; Klass and Meier, 2006; Inward et al., 2007), and associated with very short or even internal ovipositors (Roth, 2003; Hörnig et al., 2018). A few fossil oothecae of Blattaria have been found (Gao et al., 2018; Hörnig et al., 2018), whereas that of other Dictyoptera (Mantodea, Isoptera, Alienoptera, and basal lineages) remain unknown. Here we report a mantis-type ootheca preserved in mid-Cretaceous Burmese (Myanmar) amber.

2. Material and methods

The amber is from deposits in the Hukawng Valley of northern Myanmar (see Grimaldi et al., 2002, fig. 1). An amazing diversity of insects is preserved in Burmese ambers (Ross, 2019), of which the age is considered to be around the Albian-Cenomanian boundary (Ross et al., 2010; Shi et al., 2012; Rasnitsyn et al., 2016; Smith and Ross, 2018; Mao et al., 2018), likely latest Albian. We refer to the age as mid-Cretaceous until more precise data are available. The specimen is deposited in Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, with accession number NIGP169071.

The amber was filed with abrasive papers and polished with polishing powder. Photos were taken with a Zeiss AxioZoom V16

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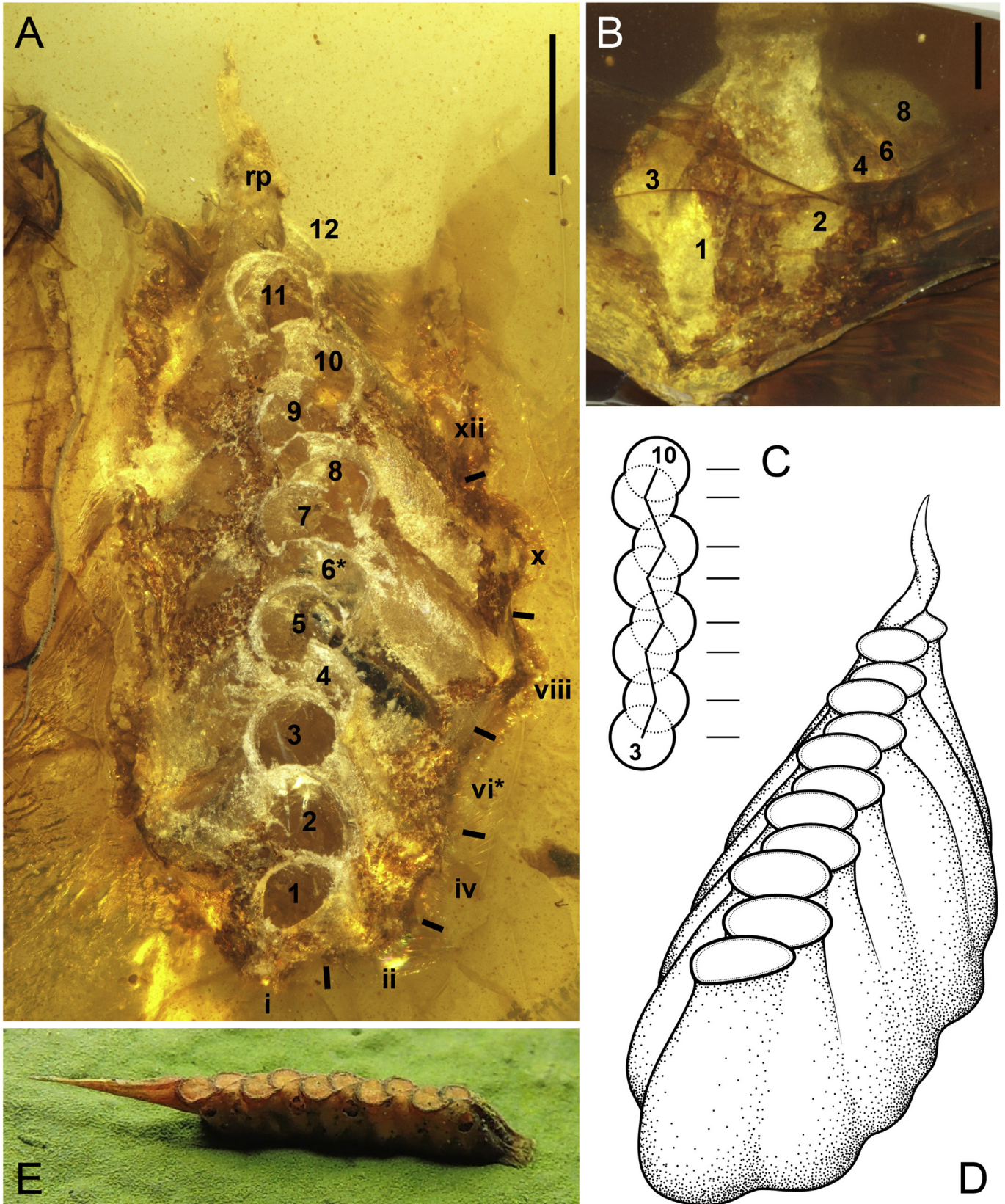


Fig. 1. A–B. The ootheca preserved in amber (NIGP169071). A. Dorsal view, with Arabic numerals indicating openings, Roman numerals indicating the bottom of chambers; asterisk, the chamber containing remains; bars, boundary between chambers; rp, residual process. B. Proximal view, with numerals indicating chambers. C. Arrangement pattern of the third through tenth openings, with bars showing the distances between centres. D. Reconstruction of the ootheca with openings sealed (i.e. the insects have not hatched out); not to scale. E. An ootheca of *Chaeteessa* sp., photo courtesy of César Favacho (more photos are available from Facebook: @cesarfavacho and @ilovemantis, and from <http://euamolouvadeus.wixsite.com/mantodea/mantodeosdobrasil>). Scale bars: A, 1 mm; B, 0.5 mm.

stereoscope; stacked using CombineZP software (by Alan Hadley); and optimized using Photoshop CS6. We follow the morphological terminology of Brannoch et al. (2017). We use names of taxa with autapomorphy-based definition: Dictyoptera *sensu* Ax (1999), = *sensu* Klass and Meier (2006), = *sensu* Inward et al. (2007); Blattodea *sensu* Inward et al. (2007); and Mantodea *sensu* Klass and Ehrmann (2003). Blattodea comprise monophyletic Isoptera and paraphyletic Blattaria (Ax, 1999).

3. Systematic palaeontology

Order Dictyoptera
Suborder Mantodea

Horizon and locality. Hukawng Valley, Myanmar; mid-Cretaceous.
Description. Ootheca ovate, acuminate (Fig. 1A), width and height of cross section subequal (Fig. 1B). Attachment surface (assumed ventral) flat, emergence area (assumed dorsal) on the opposite (Fig. 1D). Exhibiting 12 egg chambers whose delimitation is visible on lateral surface (Fig. 1A–B, D). Chamber 6 contains black remains of a likely embryo (Fig. 1A). Emergence area with 12 openings arranged in a gentle zigzag (Fig. 1A, C–D). The opening pair of an odd number and the following even number is generally compact in comparison with the opening pair of an even number and the following odd number (Fig. 1C). Distal end with a tapered residual process, slightly twisted. Measurements in mm: length 6.6, length excluding residual process 5.4, width ca. 2.5, height ca. 2.2, opening diameter ca. 0.55–0.67.

4. Discussion

Judging from the large openings, which allow hatchlings to exit, instead of a keel that should be forced open by hatchlings, this ootheca is not of Blattodea ('true' cockroaches and termites) and likely belongs to a mantis (Bell et al., 2007; Brannoch et al., 2017; XRL, personal observation). Among the 13 Cretaceous mantis genera (Delclòs et al., 2016), *Burmantis* Grimaldi and *Jersimantis* Grimaldi are candidates simply because they were also discovered from Burmese ambers (Grimaldi, 2003). The body length of male adult *Burmantis* (11.5 mm, see Li and Huang, 2018) is reasonable for a conspecific ootheca that measures about 6 mm in length; whereas no adult of *Jersimantis* is recorded. This ootheca resembles that of extant *Chaeteessa* (Fig. 1E), in arrangement of the openings, large ratio of the openings to the whole ootheca, and that the emergence area is parallel with the attachment surface. Among Recent forms, *Chaeteessa*, *Mantoida* and *Metallyticus* are similar to Cretaceous mantises and possess putative plesiomorphies of Mantodea (Grimaldi, 2003; Wieland, 2013). The morphological similarity presented herein also suggests this view, provided that the fossil ootheca belongs to a mantis.

On the other hand, this ootheca might be not derived enough to be conclusively identified to Mantodea. The properties of an ootheca generally reflect the length and shape of an ovipositor (reviewed by Roth, 2003; Hörnig et al., 2018; see also Laurentiaux, 1959). The ovipositors of mantises are very short but still partially exposed; suchlike ovipositors are also found in some Cretaceous cockroaches (outside of Blattodea) and Alienoptera ('alien roaches') from Burmese ambers (Lee, 2016; Hörnig et al., 2018; Bai et al., 2018; Vršanský et al., 2018). The knowledge about the oothecae of these insects is lacking. Therefore, we cannot rule out other dictyopterans than a mantis as the owner of this ootheca, and oothecae of this type might be plesiomorphic for Dictyoptera. Nonetheless, this fossil ootheca is provisionally identified to Mantodea until demonstrated otherwise.

5. Concluding remarks

A dictyopteran ootheca is discovered from Burmese amber. Despite other possibilities, it is provisionally identified to Mantodea. This ootheca is direct evidence of the Cretaceous occurrence of Dictyoptera, which are defined by ootheca—the autapomorphy.

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