



A pupal caddisfly from the Early Cretaceous of China (Trichoptera)

Steven R. Davis^{a,b,*}, Michael S. Engel^{a,b}, Dong Ren^a

^a College of Life Sciences, Capital Normal University, Beijing 100048, China

^b Division of Entomology (Paleoentomology), Natural History Museum, Department of Ecology & Evolutionary Biology, 1501 Crestline Drive – Suite 140, University of Kansas, Lawrence, KS 66049-2811, USA

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ABSTRACT

Although caddisfly (Trichoptera) cases and adults are fairly abundant in the fossil record, fossils of the immature stages, particularly insights into the pupal stage, are exceedingly rare. Herein we report the discovery of a fossil caddisfly pupa, putatively of the family Vitimotauliidae, from Early Cretaceous deposits in northeastern China. This is the first fossil trichopteran pupa to have been described from China.

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1. Introduction

Caddisflies (Trichoptera) are a moderately diverse order of holometabolous insects allied to the more familiar moths and butterflies (Lepidoptera). Species are most well known for their aquatic larvae, many of which construct elaborate cases, and which serve as frequent lures by anglers. Larvae live in a diversity of freshwater habitats, although a few have invaded the marine environment. Eventually the caddisfly larvae construct silken pupal cases, sometimes incorporating other elements such as plant debris, in which to pupate. Eventually, the pupa cuts its way free of the pupal case and rapidly moves to the water's edge whereby it quickly moults to an adult. Numerous fossil trichopterans, including larvae (Wichard, 2002; Wichard et al., 2009) and the distinctive cases produced by the larvae, have been described from both amber and compression fossils that range in age from the Triassic to the Pliocene (e.g., Ulmer, 1912; Sukatsheva, 1968, 1990; Shields, 1988; Botosaneanu, 1995; Sukatsheva and Jarzembowski, 2001; Grimaldi and Engel, 2005; Holzenthal et al., 2007; Wichard, 2007; Wichard et al., 2009). In addition, some pupal caddisflies have also been discovered (Sukatsheva, 1982, 1985; Hugueney et al., 1990; Jarzembowski, 1995; Ivanov and Sukatsheva, 2002; Wichard et al., 2009), but relatively few outside of their pupal cases. Of those few specimens captured

during the ephemeral moment after leaving the pupal case and eclosion to an adult, none thus far have been discovered from the Mesozoic. Interestingly, it has been discovered that microbial mats at the water's surface may often trap trichopteran pupa that have emerged from their pupal cases during their ascent to the surface, thus allowing for such rare cases of preservation (Nel, 1991; Peinado, 2002). Typically acts such as moulting or short-lived stages in the development of arthropods are infrequently captured in the fossil record, so the discovery of any such specimen is of significance (e.g., García-Bellido and Collins, 2004).

Herein we report the first Early Cretaceous caddisfly to be preserved after its departure from its pupal case. It is based on an exceptionally well-preserved specimen in the Jehol biota of northeastern China. The Jehol biota preserves several distinctive caddisflies among its fauna (Wang et al., 2009a,b), but hitherto no immature stages have been recovered from this or any other Chinese deposits.

2. Material and methods

The compression fossil reported herein was recovered from the Yixian Formation of the Jehol Group, northeastern China. The Yixian Formation is dated to approximately the Early Cretaceous by most authors (Late Hauterivian–Early Barremian) (Barrett, 2000; Zhou et al., 2003; Jiang and Sha, 2006), although some controversy remains. Isotopic studies indicate a rough range of ages from 132–112 Ma (Ji et al., 2004). Putatively correlative fossils from the Yixian Formation with those in the Solnhofen and Purbeck biotas (although the taxonomic assignments of a number of taxa in these

* Corresponding author. Division of Entomology (Paleoentomology), Natural History Museum, Department of Ecology & Evolutionary Biology, 1501 Crestline Drive – Suite 140, University of Kansas, Lawrence, KS 66049-2811, USA
E-mail address: steved@ku.edu (S.R. Davis).

biotas and paraphyletic groups compromises some of these interpretations), along with Yorkshire, Terori-type, and Ryoseki-type floras have led some to regard the formation as Jurassic (Wang et al., 2005). The specimen was studied using a Leica MZ 12.5 stereomicroscope and photographed using an attached Nikon DXM 1200C. Morphological terminology used herein is that of Holzenthal et al. (2007).

3. Systematic paleontology

Order: Trichoptera Kirby, 1813

Suborder: Integripalpia Martynov, 1924

Family: Vitimotauliidae? Sukatcheva, 1968

Genus and species indeterminate

Figs. 1 and 2

Material: Part and counterpart, CNU-T-LB-2009000, deposited at Capital Normal University, Beijing, China.

Locality and stratigraphic horizon: Yixian Formation in Huangbanjigou, Chaomidian Village, Beipiao City, Liaoning Province, northeast China.

Description: Total length 29.7 mm (head to apex of anal processes); maximum abdominal width 5.1 mm; antenna with c. 33 antennomeres; scape approximately as long as maxillary palpal segments 2+3; pedicel similar in size to basal antennomeres; scape

and pedicel slightly thicker than flagellum. Maxillary palpus 5-segmented; segments roughly of equal size and densely setose, except apical segment is slightly longer and narrower than preceding segment. Labial palpus with segments indistinct. Antennal setal warts indistinct as preserved; ocellar setal warts faint, subcircular. Pronotal setal warts elongate and elliptical; mesoscutal setal warts with indistinct margins (though setae present and visible); mesoscutellar warts indistinct. Wings densely setose, not fully expanded. Abdomen with distinct lateral fringe apparently along all segments, proceeding slightly mesally on posterior margin of sternite VIII; tergites distinct; anterior of tergite I with transverse setal fringe (Fig. 1d); paired, elliptical, dorsal hook plates present anteriorly on tergites III–VII; posterior margin of tergite V with elongate, rectangular, paired hook plates with c. 6–8 hooks (Figs. 1c and 2b); small clusters of simple, elongate, larval gills present antero-laterally at least on tergites III–VII, apparently also on postero-lateral margins; paired anal processes parallel, approximately as long as tergite VI (Figs. 1a, b, e, 2a and c). Pupal case not preserved.

4. Discussion

Placement of the current fossil is challenging given the dearth of polarized apomorphic features among pupal caddisflies. While pupal case architecture can be informative of phylogenetic placement, the Yixian specimen exhibits mostly generalized and plesiomorphic features for clades of Integripalpia. Some features are

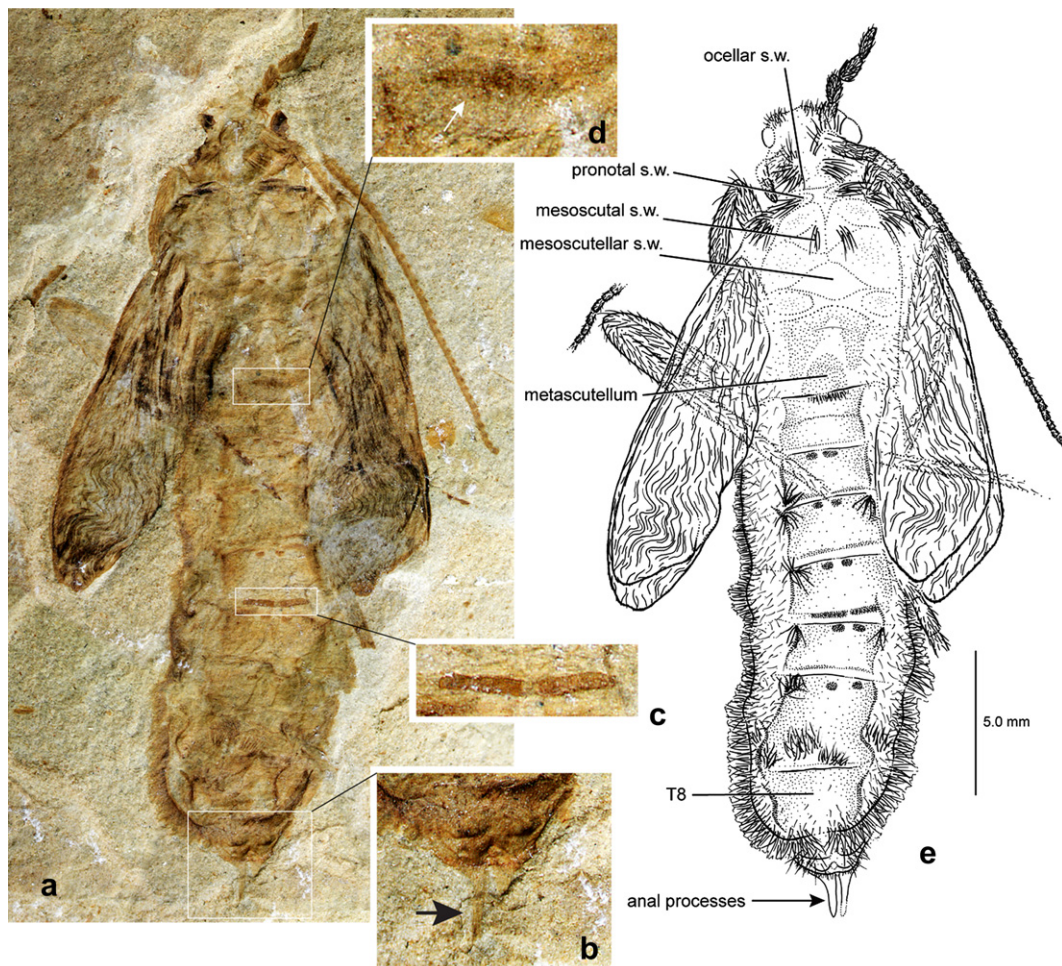


Fig. 1. Photomicrograph and line illustrations of vitimotauliid pupa from the Yixian Formation (specimen CNU-T-LB-2009000). a, photomicrograph. e, line illustration. d, detail of transverse fringe of setae on abdominal tergite I. c, posterior hook plate on abdominal tergite V. b, tergite IX and anal processes.

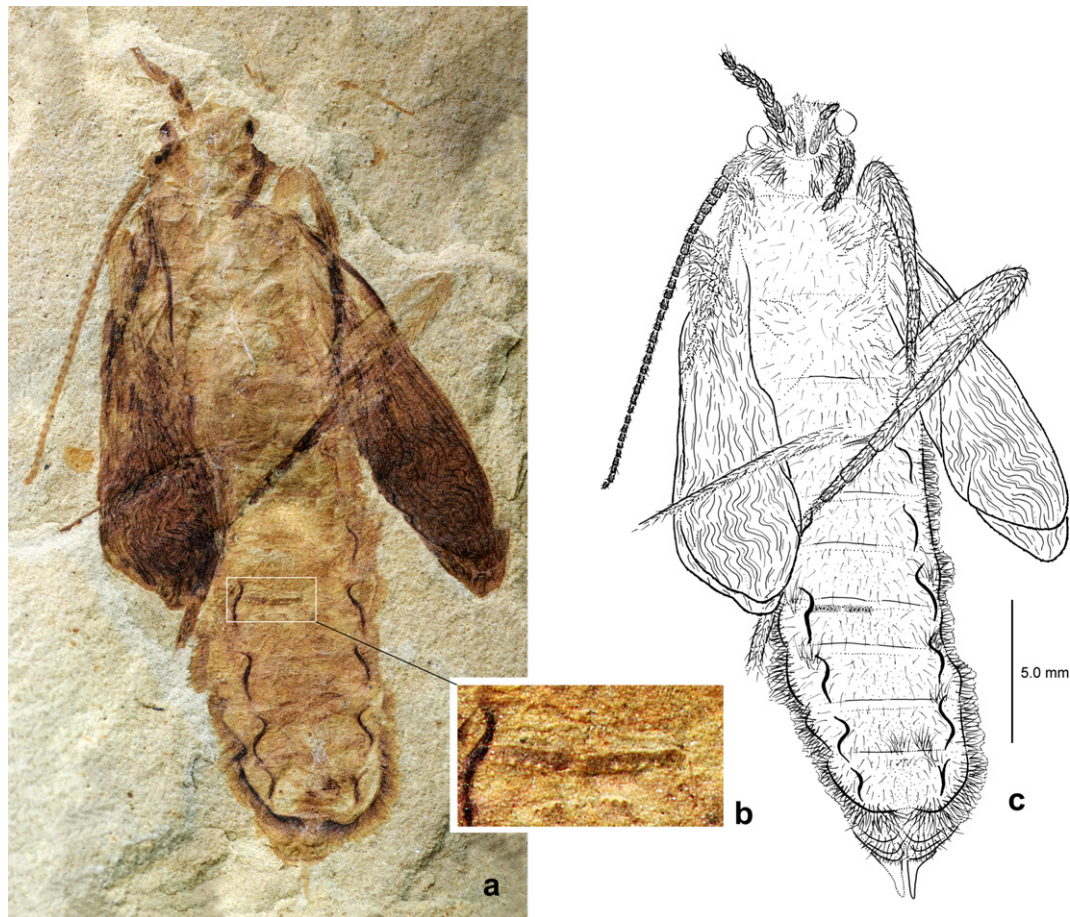


Fig. 2. Photomicrographs and line illustration of counterpart. a, photomicrograph. c, line illustration. b, photomicrograph enlargement of posterior hook plate on abdominal tergite V.

reminiscent of the Limnephiloidea, such as the elongate lateral fringe that extends along several segments, two pairs of dorsal hook plates on tergite V, and fairly elongate, slender, and parallel anal processes. Diagnostic pupal features have not been resolved for the families of limnephiloids (Wiggins and Currie, 2008) and the current specimen could easily be placed in any number of integripalpiian families. The roughly equal maxillary palpal segments excludes definitive assignment to Limnephilidae and related families. Based on the diversity of caddisflies in the Jehol biota and those of similar proportions (most similar to *Sinomodus spatiosus* Wang and Ren) and generalized morphology, there is a strong possibility that the specimen belongs to the Vitimotauliidae. Vitimotauliids are possibly stem-group Integripalpia or basal to one of the superfamilies of Plenitentoria (Phrygaenoidea and Limnephiloidea). The maxillary palpal segments are roughly equivalent although the most apical segment is slightly longer and narrower than the immediately preceding article. The distribution of setal warts is basically as in adult vitimotauliids except for the apparent reduction of the mesoscutellar pair (which may be an artifact owing to the preservation condition). In addition, like vitimotauliids, the antennae are slightly thickened at the base and slightly shorter than the forewings (nearly as long as the unexpanded forewing in the pupa, but when the wing is fully dried and expanded it would distinctly exceed the antennal length).

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