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## Pupal exuvia of an adelid case-bearing moth (Lepidoptera) from Bitterfeld Amber (Eocene)

Thilo C. Fischer\*

*Technical University Munich, Biotechnology of Natural Products, Liesel-Beckmann Str. 1,  
D-85354 Freising, Germany*

\*E-mail: thilo.fischer@tum.de

### Abstract

A pupal exuvia of an adelid case-bearing caterpillar is described from Eocene Bitterfeld amber. The dumbbell-shaped case differs from the more abundant conical cases of bagworms (Psychidae), and is typical of either Longhorn Moths (Adelidae) or Clothes Moths (Tineidae). Based on the large antennal scape and elongate flagellomers of the pupal antennas the fossil is tentatively affiliated to Adelidae. This discovery represents the first record of a fossil pupa of this type from amber. The fossil indicates that the site of Bitterfeld/Baltic amber formation was the natural habitat of these case-bearing caterpillars, and also the site where they finally pupated and hatched.

**Key words:** Eclosion, Glossata, hatching process, microlepidoptera, pupation

### Zusammenfassung

Eine Puppen-Exuvie einer Sack-tragenden Adeliden-Raupe aus dem Eozänen Bitterfelder Bernstein wird beschrieben. Die hantelförmigen Säcke unterscheiden sich von den häufiger vorkommenden konischen Säcken der Sackträger (Psychidae) und sind typisch sowohl für Langhornmotten (Adelidae) als auch Echte Motten (Tineidae). Basierend auf dem großen Antennenschaft und gestreckten Flagellomeren wird der Fund eher den Adelidae zugeordnet. Dies ist die erste Beschreibung einer solchen Puppe in Bernstein. Der Fund unterstreicht, dass derartige Sack-tragenden Raupen am Bildungsort des Bitterfeld bzw. Baltischen Bernsteins lebten und sich dann auch dort verpuppten und schlüpften.

**Schlüsselwörter:** Eclosion, Glossata, Schlupf, Microlepidoptera, Verpuppung

## 1. Introduction

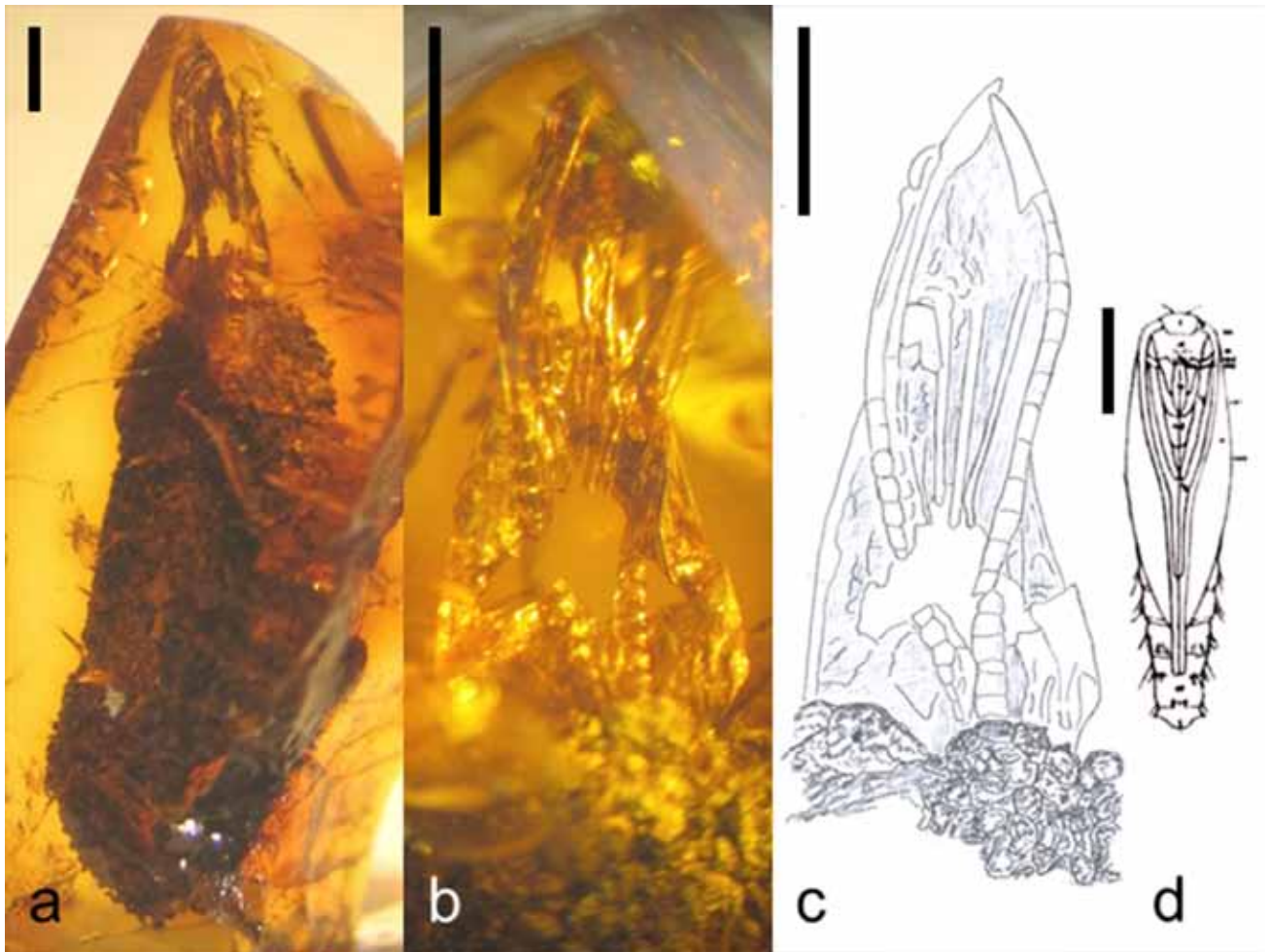
Cases are among the more common lepidopteran remains preserved in Baltic and Bitterfeld amber. However, only the variously sized and shaped conical cases of Psychidae that are constructed of various materials (Sobczyk and Kobbert 2009) are frequently observed. Much less abundant are dumbbell-shaped cases; only a few specimens have been described to date from Baltic and Bitterfeld amber (Sobczyk & Kobbert 2009; Fischer 2014). Other fossils of Tineidae larvae or pupae are known from the Oligocene phosphorites of Quercy, France (Handschin 1944; Sohn et al. 2012). In contrast, fossil Adelidae larvae or pupae, which also produce dumbbell-shaped cases, are apparently unknown as amber fossils to date (Sohn et al. 2012). This paper describes a fossil Adelid pupal exuvia from Eocene Bitterfeld amber that is associated with a dumbbell-shaped case.

## 2. Material and Methods

The specimen containing the inclusion was made available by Walter Ludwig (Oberesslingen). The inclusion was photographed using a stereo-microscope (Zeiss) equipped with a digital camera (Canon Ixus). The specimen was preserved by treatment with an acryl varnish, and is kept in the author's private collection (accession number 6024) in a plastic container within a metal box, so that oxygen and light are excluded, and at constant temperature.

## 3. Results

The case is 8.5 mm long (Fig. 1a,c), the exposed front part of the pupal exuvia is 3.5 mm long (Fig. 1b); the estimated total length of the pupa is 7 mm. The pupa is dorsally ruptured in longitudinal direction, starting from the head region and progressing



**Figure 1:** (a) Case of Tineidae containing a pupal exuvia, dorsal view, no 6024. (b) Pupal exuvia, ventral view, detail of same specimen as in Fig. 1a. (c) Same as in Fig. 1b, as a line drawing. (d) Pupa of *Tinea pellionella* (Tineidae), changed from Mosher (1915). All scale bars = 1 mm

downwards. Most of the dorsal body parts of the pupal membrane are ruptured and rolled up, hiding structural details such as spines. In contrast, the pupal membrane on the ventral side covering the fused legs and antennae is largely preserved intact. The abdominal region below is free from fused extremities, and there is a crossways forward-bending which led to breaking off of almost the whole pupal exuvia.

#### 4. Discussion

The morphology of the dumpbell-shaped case and pupal exuvia are in agreement with an affiliation either to the Tineidae (Mosher 1915; Lepiforum – Tineinae) (Fig. 1d) or Adelidae. Both taxa have previously been recorded for Eocene amber in the form of imagos (Skalski 1976; Sohn et al. 2012). Both taxa have similar dumpbell-shaped cases and a comparable hatching process and pupal exuvia (Lepiforum – Adelineae, Tineinae). Typical Adelidae characters, which can be recognized from the antennae of the pupal exuvia, are a large and long scapus and elon-

gate flagellomers (Davis 1999; Kuchlein & Bot 2010). On the other hand, Adelidae cases are typically built from leaf fragments or plant litter (Lepiforum – Adelineae; Scoble 2002; Sterling & Parsons 2012), but cases built from small particles like many Tineidae cases do also occur (Parenti 2000: pl. 3, fig. 5). In consequence, the pupa is tentatively affiliated with the Adelidae based primarily on antennal characters, even though the case material is not the most typical building material used in this family.

The hatching process can be reconstructed from the remnants of the pupal exuvia: The pupa left the case with its front part, this way exposing all body regions with fused antennae and legs. The dorsal and lateral parts of the pupal membrane, which covered the front and hindwings, are ruptured and rolled up; consequently, the spines on the dorsal side that help the pupa in escaping from a case or cocoon cannot be observed. The cremaster, as an informative structure, is hidden within the non-transparent case. Upon exposure of head, thorax, and all abdominal segments with fused extremities the dorsal suture ruptured and the imago was able to hatch. By unfolding of the imago's legs the pupal exuvia

became bent to its ventral side and broke crossways, resulting in the state in which this specimen is preserved. This hatching process, characterized by the escape of the animal from the case from one end, is in contrast to the interpretation of central slits of comparable Tineidae cases as tracks of hatching by rupturing the cases for escape (specimens 5394 and 5761 in Fischer 2014). Two explanations seem plausible for these different conditions: Different taxa may have developed different hatching processes. On the other hand, the central slits may also have been caused by predation of, or parasitizing on, the caterpillars, with subsequent hatching of the parasite (Robinson 1979); both processes would leave the cases ruptured. Cases with slits are now interpreted as resulting from predation or parasitism.

The fragile association between the case and pupal exuvia indicate that the specimen has not been transported over a long distance between the site of pupation and embedding in amber. This suggests that the habitat of this case-bearing moth was close to or at the site of resin flow and amber origin.

## 5. Summary

A first Adelidae pupal exuvia associated with the case of the caterpillar is described from Bitterfeld amber. This discovery further supports the assumption that case-bearing caterpillars were part of the amber forest and lived close to the sites of amber formation.

## Acknowledgement

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