



Identity of the insect larva described by Zippel *et al.* (2022) in the mid-Cretaceous Burmese (Kachin) amber (Hymenoptera, Tenthredinoidea, Blasticotomidae = Xyelotomidae syn. nov.)

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The fossil in consideration, a small insect larva some 4 mm long, has been described, illustrated and left unnamed by Zippel *et al.* (2022) as a larva of the beetle family Mordellidae. The same year it was re-identified, unnamed as yet, as a sawfly larva of the family Pamphiliidae (Batelka & Engel, 2022). In our opinion, re-interpretation of the fossil by the latter authors was only partially correct. It demonstrates diagnostic characters of a sawfly larva, but the family attribution of the larva to Pamphiliidae is questionable: in our opinion it is most similar to larval Blasticotomidae (Tenthredinoidea).

Blasticotomidae is a small family with three genera and 13 species (including one extinct genus and species) found living widely in the Palaearctic and extinct only in the latest Eocene of USA (Taeger *et al.*, 2010). The biology of Blasticotomidae is peculiar, with the larva boring a short tunnel in the stem of a fern frond and feeding mainly on fern sap with excretes, including abundant honeydew, disposed through a special orifice using sophisticatedly modified ninth and tenth abdominal segments. Honeydew attracts various insects, mainly ants which establish stable trophobiotic connections with sawfly larvae (Biryukova *et al.*, 2006; Shcherbakov, 2006; Novgorodova *et al.*, 2011).

Adult Blasticotomidae are most similar to the extinct family Xyelotomidae with 13 genera and 19 species known only from Eurasia, ranging from Toarcian (Early Jurassic) through Aptian (Early Cretaceous; Gao *et al.*, 2009, 2016). Adult Xyelotomidae differ from Blasticotomidae essentially in two plesiomorphic characters, that is, in the antennal thread (segments distal to enlarged basal flagellar segment) polymerous (vs. with only one or no segments in Blasticotomidae), and in preserved forewing vein 2-RS (lost in Blasticotomidae) (Rasnitsyn, 1988). Additionally two larvae, *Kuengilarva inexpectata* Rasnitsyn, 1990 from the Late Jurassic of Transbaikalia and *Vitimilarya paradoxa*

Rasnitsyn, 1969 from the Aptian of Transbaikalia, have been questionably ascribed to Xyelotomidae (Rasnitsyn, 1969, 1990), which show no specific similarity with the present larva. *Kuengilarva inexpectata* displays semiprognathous head, segmented subanal appendages, few transverse abdominal folds and abdominal terga 9 and 10 not distinctly modified in blasticotomid-like form (not sclerotised, nor concave, cf. Rasnitsyn, 1990: fig. 143, 2002: fig. 340), and so could belong to a more basal branch within the xyelotomid-blasticotomid lineage. *Vitimilarya paradoxa* represents an incomplete moulting cast of an early tenthredinoid larva with stemma placed far dorsal to the antennal foramen and with a short three-segmented antenna: these characters are characteristic of the main tenthredinoid lineage (all extant families but Blasticotomidae) and not to the xyelotomid-blasticotomid lineage. At the same time *V. paradoxa* has the antennal foramen touching the frontal suture (distant from this suture in the above families) and so may belong to a stem of the main tenthredinoid lineage. The larva described from the Late Eocene Baltic amber as *Electrotoma succini* Rasnitsyn, 1977 (Tenthredinoidea: Electrotomidae) is more advanced within the main tenthredinoid clade comparing *Vitimilarya* because of its antennal foramen is placed apart from the frontal suture (Rasnitsyn, 1977).

The aim of the present publication is to explore the identity of the Burmese larva and particularly its taxonomic position in respect of Blasticotomidae and Xyelotomidae, as well as its bearing on the status of Xyelotomidae.

Material and methods

The publication is based on the description and illustrations presented by Zippel *et al.* (2022), which are considered

good enough to permit a sufficiently reliable interpretation of morphology of the unique fossil. The fossil itself, the holotype of the new species, comes from the collection of the junior author and is kept permanently at Staatliches Naturhistorisches Museum, Braunschweig, Germany (SNHMB). It originates from the mid-Cretaceous Burmese amber collected in Kachin State of Myanmar and was legally acquired on 22 June 2016 (Zippel *et al.*, 2022). Morphological terminology follows Rasnitsyn (1969).

Systematic palaeontology

Order Hymenoptera Linnaeus, 1758

Suborder Symphyta Gerstaecker, 1867

Superfamily Tenthredinoidea Latreille, 1802

Family Blasticotomidae Thomson, 1871 (= Xyelotomidae Rasnitsyn, 1968, *syn. nov.*)

Remarks. For reasons of synonymisation see Discussion.

Genus *Zippelia* gen. nov.

Type species. *Zippelia engeli* gen. et sp. nov.

Species included. Type species only.

Etymology. Genus name is derived from the name of the first author of the original larval description.

Diagnosis. Larva (probably an early one because of small size). Body segments soft, smooth, naked, with only head capsule and ninth and particularly tenth abdominal terga sclerotised. Head position oblique (semiprognathous). Stemma small, touching antennal foramen dorsally. Antenna setiform, 7-segmented, touching mandibular base or nearly so. Mandibles with at least three teeth. Maxillary and labial palps 4- and 3-segmented, respectively, with large palpigers. 9 spiracles visible (on pronotum and abdominal segments 1–8). Legs setiform, 6-segmented, with terminal segment (pretarsus) long but apparently soft, not claw-like. Abdominal terga with three (basal ones) through no (8th to 10th) transverse folds. Separated lateral lobes bearing spiracles and so non-homologous to those in other symphytan larvae; delimited area below them apparently participating in incipient prolegs distinct at least in segments 5–8 (basal segments are not visible from below). Sternal area (between incipient prolegs) variable in having two, one or no transverse folds. Tergum 9 distinctly sclerotised, convex, tergum 10 strongly sclerotised, concave, pentagonal, with two lateral prongs and long posteromedial tooth, recalling incipient concavity of terga 9–10 in larval Blasticotomidae. Sternum 10 with elongate subanal lobe bearing lateroapically two-segmented appendages long enough to be visible dorsally.

***Zippelia engeli* sp. nov.**

Holotype. SNHMB.G 8194; Burmese (Kachin) amber, mid-

Cretaceous; well preserved small larva with ventral aspect partially obscured with air bubble.

Etymology. Species is named after Dr Michael S. Engel in appreciation of his identification of the symphytan nature of the holotype.

Diagnosis. As for the genus.

Description (Zippel *et al.*, 2022: figs. 2, 3). Early larva. Body surface finely reticulate except that head capsule apparently smooth; no vestiture discernible except for strong setae on basal segments of maxillary palp mentioned by Zippel *et al.* (2022). Body length 3.9 mm. Head capsule 0.40 mm long, 0.25 mm high, antenna 0.28 mm, with segments growing gradually narrower and longer toward apex, with scape and pedicel transverse, somewhat elongate dorsally, and apical segment almost needle-like. Clypeus apparently short, with transverse impression. Mandibles short, with teeth apparently short and of similar length. Maxillary and labial palps both some 1.3 mm long (palpiger included), rather thick, conical. Mid leg 0.38 mm long (coxa to pretarsus lengths in mm respectively 0.085, 0.06, 0.055, 0.055, 0.055, 0.055), with three apical segments almost cylindrical. Abdominal tergum 10 with lateral teeth slightly longer than wide, rounded apically, medial tooth slightly bent upward, with wider base and narrow main part, 0.23 mm long, narrowly rounded apically, much longer than main part of tergum (visible length 0.14 mm). Subanal lobe 1.25× as long as wide basally, tapering toward truncated apex, with apicolateral processes as long as lobe apex wide, with two segments of equal length, much longer than wide, basal one subcylindrical, apical one conical.

Discussion

As Batelka & Engel (2022) demonstrated convincingly, the larva in question belongs to Hymenoptera and not to Coleoptera. However the features that it displays are characteristic of the basal tenthredinoid family Blasticotomidae rather than of the pamphilioid families Pamphiliidae and Megalodontesidae (the only ones with known larvae) (*cf.* Rasnitsyn, 1969, figs 252 vs. 256), as follows:

- Head is semiprognathous, that is, with mouthparts directed obliquely forward (*vs.* orthognathous, with mouthparts directed below, in all Pamphilioidea and Tenthredinoidea except Blasticotomidae with similar head position, and except mining tenthredinoid larvae with prognathous head);
- Stemma is placed dorsal in respect to antenna like in all Tenthredinoidea including Blasticotomidae (placed ventral to antenna in Pamphilioidea);
- Segmented subanal appendages are attached to subanal lobe distally like in Blasticotomidae (attached basally to subanal lobe in Pamphilioidea);

- Abdominal terga traversed with three to zero folds (with five in Pamphilioidea);
- Ventral surface of abdominal segments (at least segments 5–8) with distinct incipient prolegs delimited with sublateral longitudinal folds (also with oblique and longitudinal folds in Blasticotomidae even though with less distinct proleg homologs, vs. with simple transverse folds in Pamphilioidea);
- Tenth abdominal tergum is concave and margined with outgrowths (ninth and tenth segments modified similarly in Blasticotomidae recalling excavated elytral declivity of bark beetles: nothing similar is known in other Symphyta larvae except for a remotely similar excavated tenth tergum in unrelated and otherwise ordinary tenthredinid larva *Monardoides sinicus* Wei & Wu, 1998 (Wei & Wu, 1998; She *et al.*, 2013).

This implies a position of the fossil in the superfamily Tenthredinoidea rather than in Pamphilioidea, and their close relation to Blasticotomidae. At the same time, *Zippelia* **gen. nov.** differs considerably from blasticotomid larvae in a number of characters. Some of them are putatively plesiomorphic features characteristic of more basal Symphyta, particularly the stemma touching the ocular foramen (as in Xyelidae: Macroxyelinae; cf. Rasnitsyn, 1969: fig. 251; in Blasticotomidae these are distinctly slightly apart). Some characters are probably autapomorphic, e.g., the modified tenth tergum with long posteromedial tooth and lateral prongs, the lack of distinct abdominal lateral lobes below spiracles possibly replaced with circumspiracular areas delimited with shallow folds. The non-ungulate pretarsus could be a character of that sort as well unless it is characteristic of early larvae of these insects rather than diagnostic of *Zippelia*: the first instar larva of *Blasticotoma* sp. lacks claws as well (APR, pers. observ.). Still other characters might be interpreted as synapomorphies with Blasticotomidae, in a part only incipient ones. These are apparently driven by the unique life style of Blasticotomidae, with a larva boring a short tunnel into the stem of a fern frond and feeding mainly on fern sap, with excretes, including abundant honeydew (which serves the matter of trophobiosis with ants), disposed through a special orifice using sophisticatedly modified ninth and tenth abdominal segments (Biryukova *et al.*, 2006; Shcherbakov, 2006; Novgorodova *et al.*, 2011). These putative synapomorphies are smooth hairless body, semiprognathous head, segmented apical subanal processes and concave and sclerotised apical abdominal terga with various lateral and apical outgrowths used in manipulations with excretes.

The above results and particularly evident similarity of the described larva to Blasticotomidae imply its taxonomic position in that family. Yet the time gap between the Burmese amber and the latest Eocene age of the only known blasticotomid fossil *Parempytes ostentus* Brues, 1908 (some 65 Ma) is too long to consider the implied synonymy as

easily acceptable (for age of source deposits of Florissant in Colorado see Evanoff *et al.*, 2001, for identity of *P. ostentus* cf. Zhelochovtzev & Rasnitsyn, 1972; Taeger *et al.*, 2010). A particular reason to seek a possible alternative is the extinct (Jurassic to Early Cretaceous) family Xyelotomidae that is considered basal in Tenthredinoidea and particularly similar to Blasticotomidae, with the only two reliable diagnostic characters of imago: antennal thread (segments distal of enlarged basal flagellomere) multisegmented and forewing with 2-RS vein in Xyelotomidae, vs. antennal thread with one or no segment and 2-RS lost in Blasticotomidae (Rasnitsyn, 1988). Both *Zippelia* and Xyelotomidae are morphologically similar (mainly basal) to Blasticotomidae, and both existed near the middle of the Cretaceous (a number of Chinese and Siberian species are recorded in the Aptian of Jehol Biota, cf. Gao *et al.*, 2009; for interpretation of Jehol Biota see Kopylov *et al.*, 2020). The morphological and chronological similarities imply that *Zippelia* is a putative larva of unknown Xyelotomidae. Being putatively monophyletic with Blasticotomidae and essentially similar to it as both larva and adult, Xyelotomidae deserve in our opinion to be synonymised with it. Judging from morphology of *Zippelia* we conclude that biologically the Mesozoic and Cenozoic Blasticotomidae might be similar, but unfortunately we do not know how deep the similarity is.

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