



A mid-Cretaceous female scale insect (Hemiptera: Sternorrhyncha: Coccoomorpha) in Burmese amber

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Abstract

A new genus and species of scale insect (Hemiptera: Coccoomorpha) is described from a female specimen in mid-Cretaceous Burmese (Myanmar) amber. Fossil female scales are rare and the present species, described as *Paleolepidotus macrocolus* **gen. et sp. n.**, has such an unusual assortment of morphological features that it could not be assigned to any particular extant or extinct family. The small, ferruginous specimen exhibits a series of long wax pencils that extend around the body, including the head. The antennae and legs are quite long compared to other extant and extinct scale fossils. Of special interest are the protruding eyes, and a conical-triangular rostrum arising from between the forelegs; the claws with bifid apices are also unique. The ovisac contains immature stages.

Key words: Coccoidea, female coccoid, fossils, Myanmar, scale insect, taxonomy, wax pencil

Introduction

Scale insects (Hemiptera: Sternorrhyncha: Coccoomorpha) consist of 55 families and about 8,350 described species (Williams & Hodgson 2014; Veá & Grimaldi 2016; García Morales *et al.* 2016). This ancient group is estimated to have originated during the Triassic, about 245 Mya, based on divergence-time estimates (Veá & Grimaldi 2016) and consistent with paleontological evidence (Koteja, 1985; Gullan & Kosztarab, 1997). Scale insects can be found in a range of habitats, where they feed on vascular fluids or cell contents from above- and below-ground parts of plants, mostly angiosperms, to which they can cause serious damage (Comstock 1950; Gill 1993; Veá & Grimaldi 2016). In addition, scales are among the most invasive insects, causing serious economic losses to crops if they are accidentally introduced to countries outside their native ranges (Miller *et al.* 2005, 2014).

Due to their sedentary habits and lack of wings, female scale insects are much rarer as fossils than are the winged males (Koteja 2004). Although most scale insect fossils from amber are males (Koteja 2004; Veá & Grimaldi 2015), there are some examples of adult females. Wang *et al.* (2015) recently described a female scale insect with released nymphs in Burmese amber. Additionally, as reviewed in Veá & Grimaldi (2015), a list of adult female fossils includes *Arctorthezia antiqua* Koteja & Zak-Ogaza, 1988, *Mixorthezia kozari* Veá & Grimaldi, 2012, *Newsteadia succini* Koteja & Zak-Ogaza, 1988, *Electromyrmococcus abductus* Williams 2001, *E. inclusus* Williams & Agosti, 2001, and *E. reginae* Williams, 2001 (Johnson *et al.*, 2001; Koteja & Zak-Ogaza, 1988a, 1988b; Veá & Grimaldi, 2012). Here, we describe an adult female of a new genus and species of scale insect from Burmese amber.

Materials and methods

The specimen described below originated from the Noiye Bum 2001 Summit Site mine excavated in the Hukawng Valley in 2001; the mine is located southwest of Maingkhwan in Kachin State (26° 20' N, 96° 36' E), Myanmar. Based on paleontological evidence, this site was dated to the late Albian of the Early Cretaceous by Cruickshank & Ko (2003), placing the age at 97–110 Mya. A more recent study using U-Pb zircon dating determined the age to be 98.79 ± 0.62 Mya, at the Albian/Cenomanian boundary (Shi *et al.* 2012). Nuclear magnetic resonance (NMR) spectra and the presence of araucaroid wood fibers in amber samples from the Noiye Bum 2001 Summit Site indicate an araucarian tree source for the amber (Poinar *et al.* 2007).

Observations and photographs were made with a Nikon SMZ-10 R stereoscopic microscope and Nikon Optiphot compound microscope with magnifications up to 800 X. Illustrations were made using a Cintiq 22HD Touch tablet (Wacom, Portland, Oregon, U.S.A.).

Systematic paleontology

Order: Hemiptera Linnaeus, 1758

Suborder: Sternorrhyncha Amyot & Audinet-Serville, 1843

Infraorder: Coccoomorpha Williams & Hodgson, 2014

Family: *incertae sedis*

Genus: *Paleolepidotus* gen. n.

LSID: urn:lsid:zoobank.org:act:FF0C1AF7-EA04-4DA6-8FC9-3C73C61E8E40

Diagnosis: Body small and rectangular with long wax pencils arising around margin of entire body, including head; antennae long and 7-segmented, each with terminal antennomere knobbed at tip and with apical spine at apex; legs elongate, each sub-equal to body length; tarsi long and slender, each bearing single claw with bifid tip; one digitule present at inner base of claw; small plantar denticle situated near middle of claw; rostrum large, conical to triangular, 3-segmented, with tip slender and acute; ovisac present, containing developing immatures.

Type species: *Paleolepidotus macrocolus* gen. et sp. n.

Etymology: The generic name is derived from the Greek “*palaios*” meaning old, and the Greek “*lepidotos*” meaning scaly.

Comment: The genus is monotypic at present.

***Paleolepidotus macrocolus* sp. n.**

LSID: urn:lsid:zoobank.org:act:51BB873E-9738-4E28-A7BF-32D3C1CF57DF

(Figs. 1–10)

Holotype: MYANMAR (Burma) / state of Kachin / Noiye bum 2001 Summit Site amber mine in the Hukawng Valley / SW of Maingkhwan (26° 20' N, 96° 36' E). A single specimen in one piece of amber, accession number B/He/34, deposited in the Poinar amber collection maintained at Oregon State University, Corvallis, Oregon, U.S.A.

Diagnosis: as for genus.

Description of holotype female

Specimen complete. Body ferruginous; with about 25 long, broad lateral wax pencils extending radially around entire margin, appearing to have 12 lateral pairs and one arising from posterior apex of body; base of each pencil supported by 2 or 3 long flagellate setae (Figs. 1–3). Dorsal and ventral surfaces apparently lacking large wax structures; wax-producing pores and ducts indiscernible. Body length, including wax pencils, 4.0 mm; body length without pencils, 1.8 mm; body width including wax pencils 3.3 mm; body width without pencils, 0.8 mm. Length

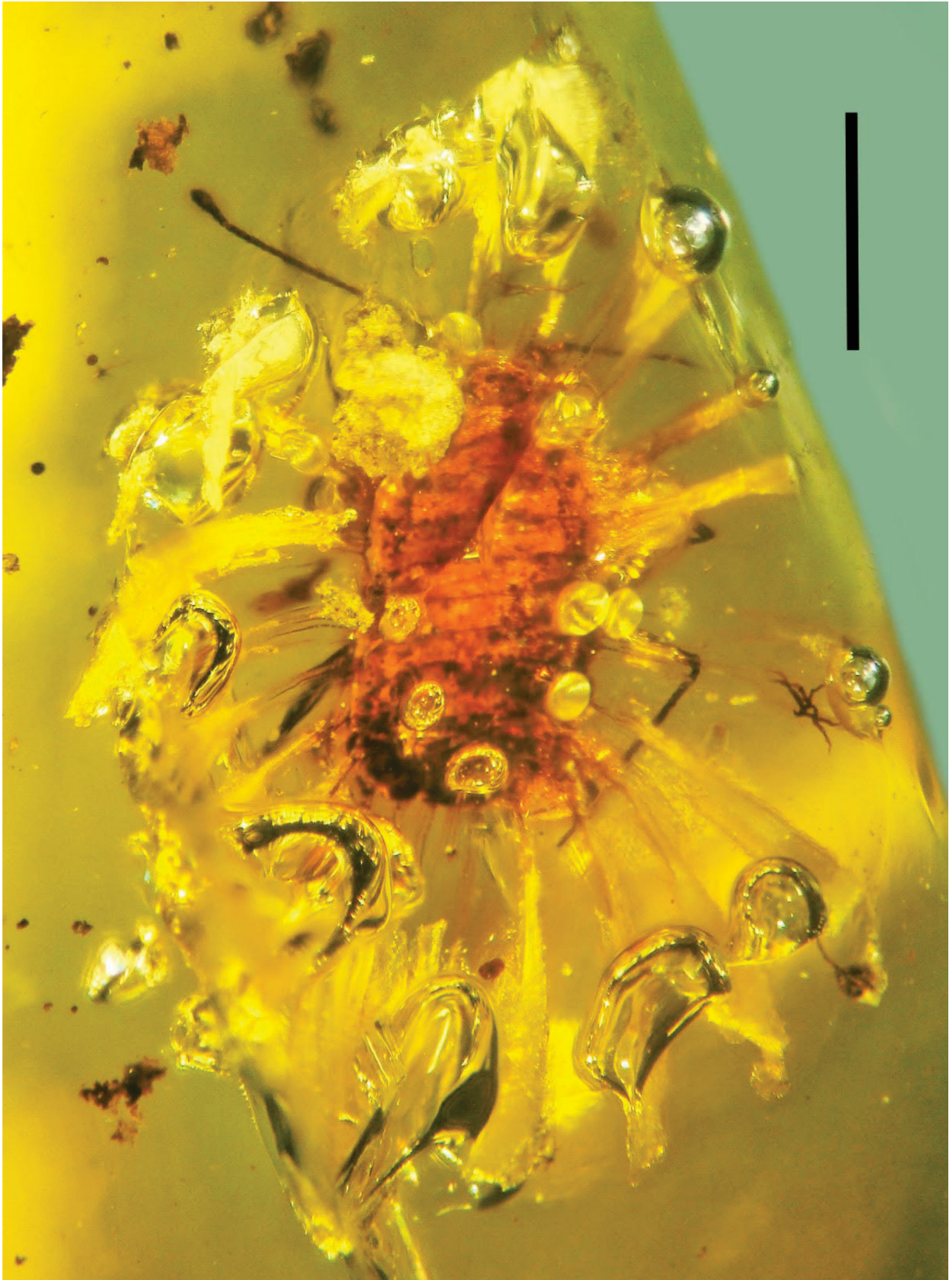


FIGURE 1. Dorsal view of *Paleolepidotus macrocolus* **gen. et sp. n.** in Burmese amber. Scale bar = 1.0 mm.

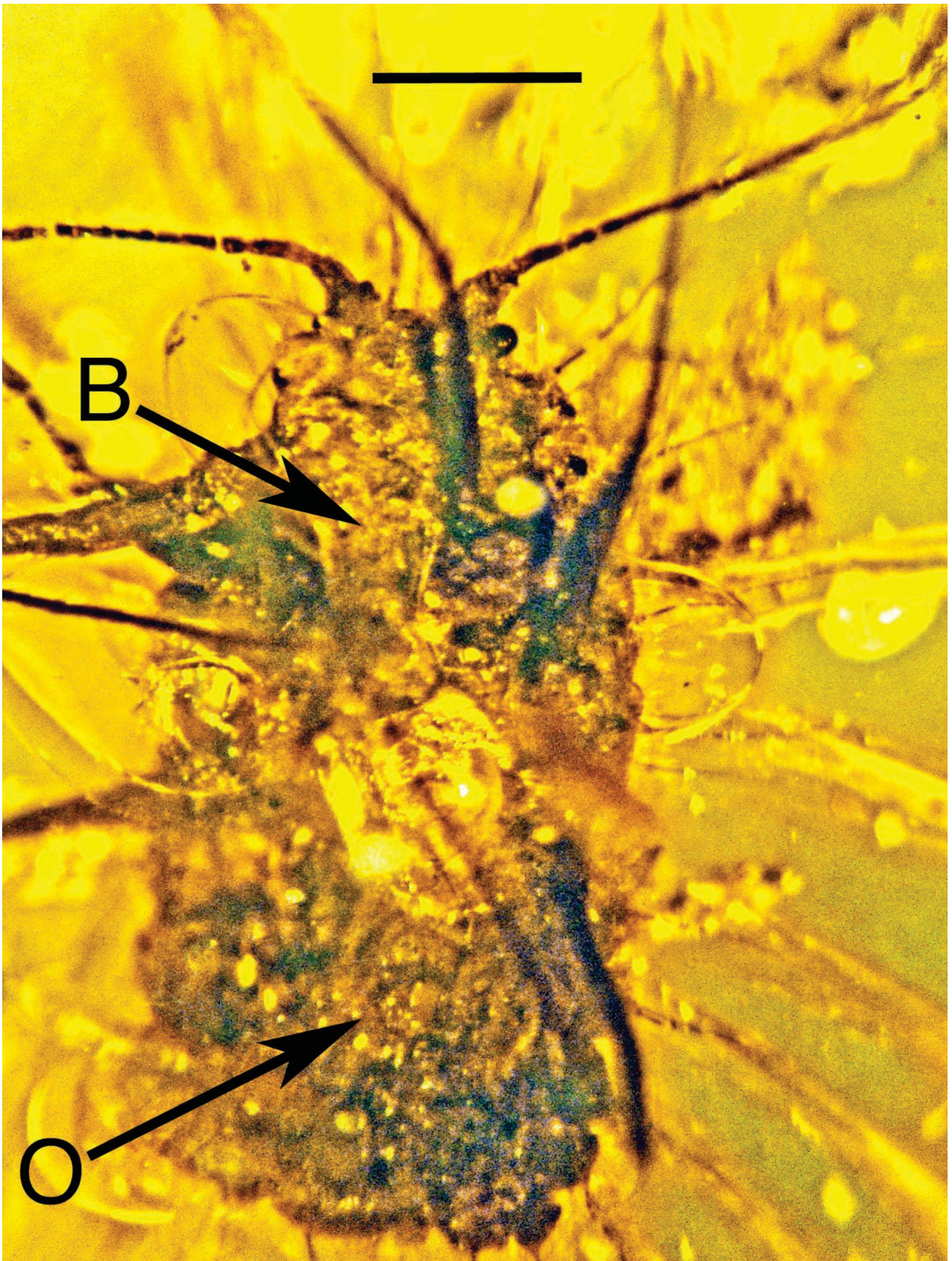


FIGURE 2. Ventral view of *Paleolepidotus macrocolus* gen. et sp. n. in Burmese amber. B= rostrum. O = ovisac. Scale bar = 0.2 mm.

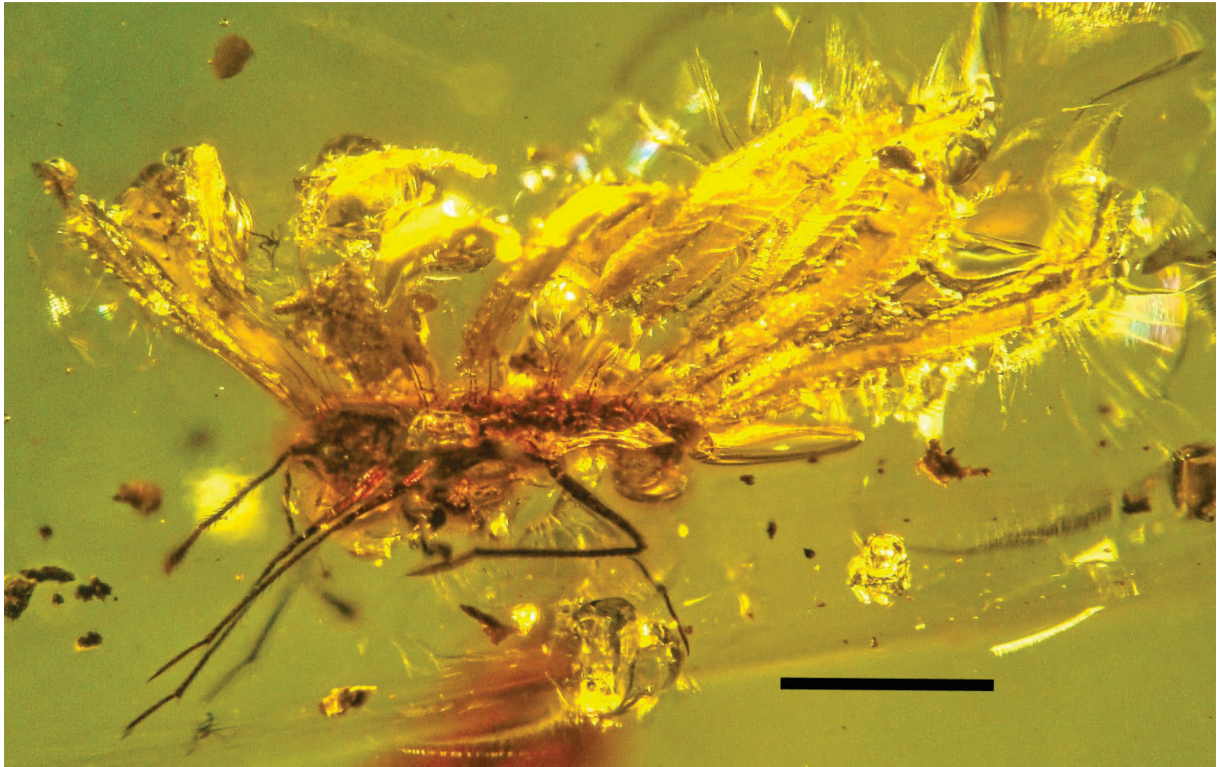


FIGURE 3. Lateral view of *Paleolepidotus macrocolus* **gen. et sp. n.** in Burmese amber. Scale bar = 1.0 mm.



FIGURE 4. Detail of terminal antennomere of *Paleolepidotus macrocolus* **gen. et sp. n.** in Burmese amber; image and illustration of claw. Arrow shows constricted “knob” at tip. Scale bar = 57 μ m.

of individual wax pencils, 0.5–1.8 mm. Antenna appears to be 7-segmented; segment I 175 μm long, segment II 159 μm , segment III 169 μm , segment IV 175 μm , segment V 159 μm , segment VI 175 μm , and terminal segment VII 284 μm long, overall length 1.3 mm; each segment with numerous stout flagellate setae; unusual sensilla or empty setal collars present near base of segment VII at juncture with VI, with dual sockets (Fig. 4); distal half of terminal antennomere swollen, with slight constriction near apex forming knob-like tip 23 μm long; apex of antennomere with lanceolate terminal spine 22 μm long and 3 or 4 falcate sensory setae (Figs. 4 and 5). Legs long, each sub-equal in length to body; each leg segment distinct, without fusion between trochanter and femur or between tibia and tarsus; hind femur 641 μm long, hind tibia 770 μm long, hind tarsus 346 μm long (Fig. 3); tibial and tarsal segments each with numerous stout flagellate setae; each tarsus slender and articulated at base, bearing a single claw with bifid tip and well-developed plantar denticle near middle; hind claw 95 μm long; with single pointed digitule present at inner base of claw, 26 μm long (Fig. 6); trochanteral pores indiscernible. Eyes round, black, protruding from head, detached from base of antenna, each about 58 μm in diameter (Fig. 7). Rostrum 3-segmented, conical to triangular, arising between forelegs, 590 μm long (Fig. 8). Anal opening with tube-like structure, probably constructed of wax, arising from anal ring at posterior apex of body, wax tube curved ventrally (Fig. 9). Apparent waxy ovisac present, with evidence of immature forms within (Figs. 9 and 10). Abdominal and thoracic spiracles and cuticular pores and ducts not discernible.

Etymology: The specific epithet is derived from the Greek “*macro*” = long and the Greek “*kolon*” = leg, in reference to the long legs of the fossil.

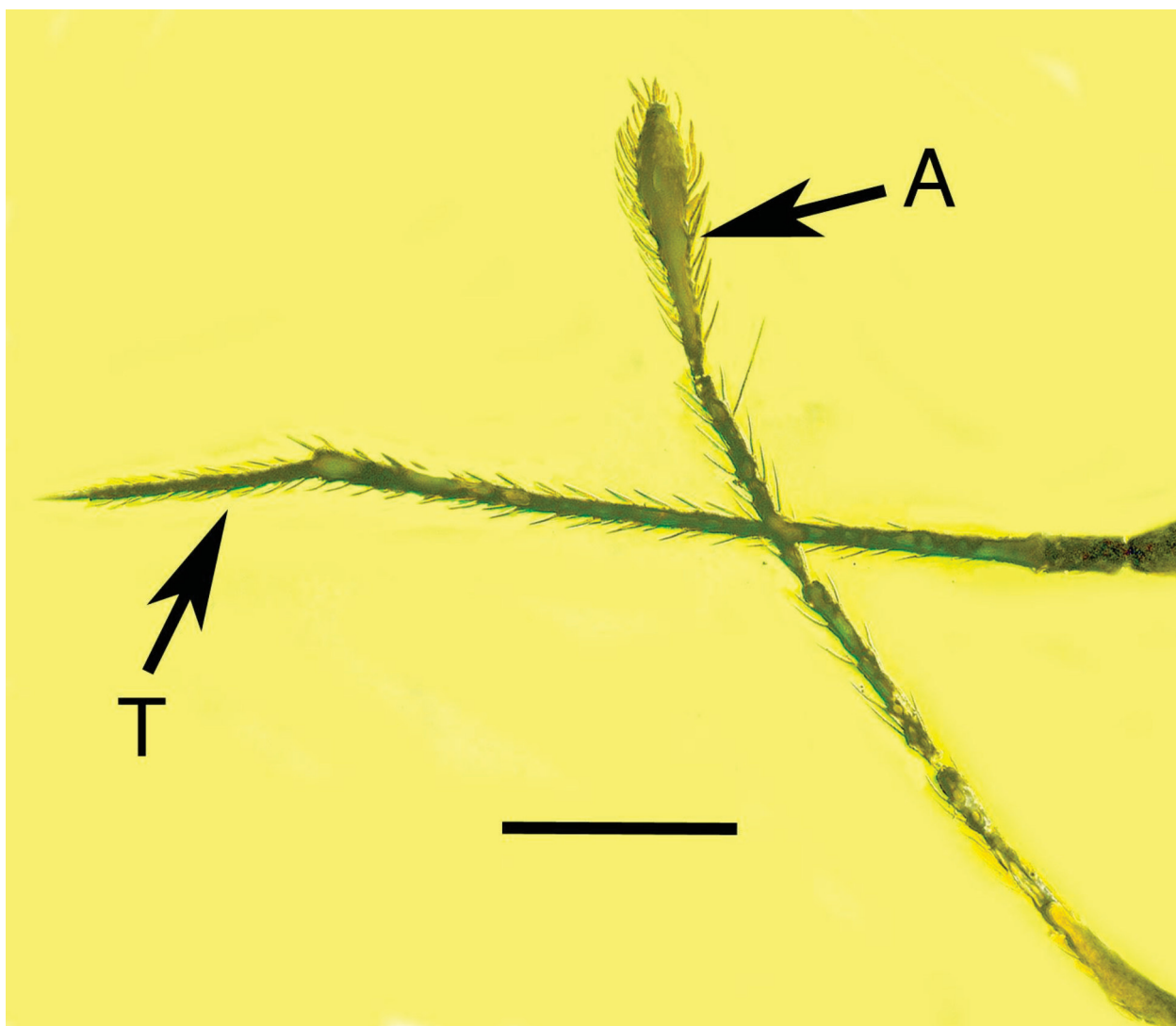


FIGURE 5. Protarsus (T) and terminal antennomere (A) of *Paleolepidotus macrocolus* gen. et sp. n. in Burmese amber. Scale bar = 235 μm .

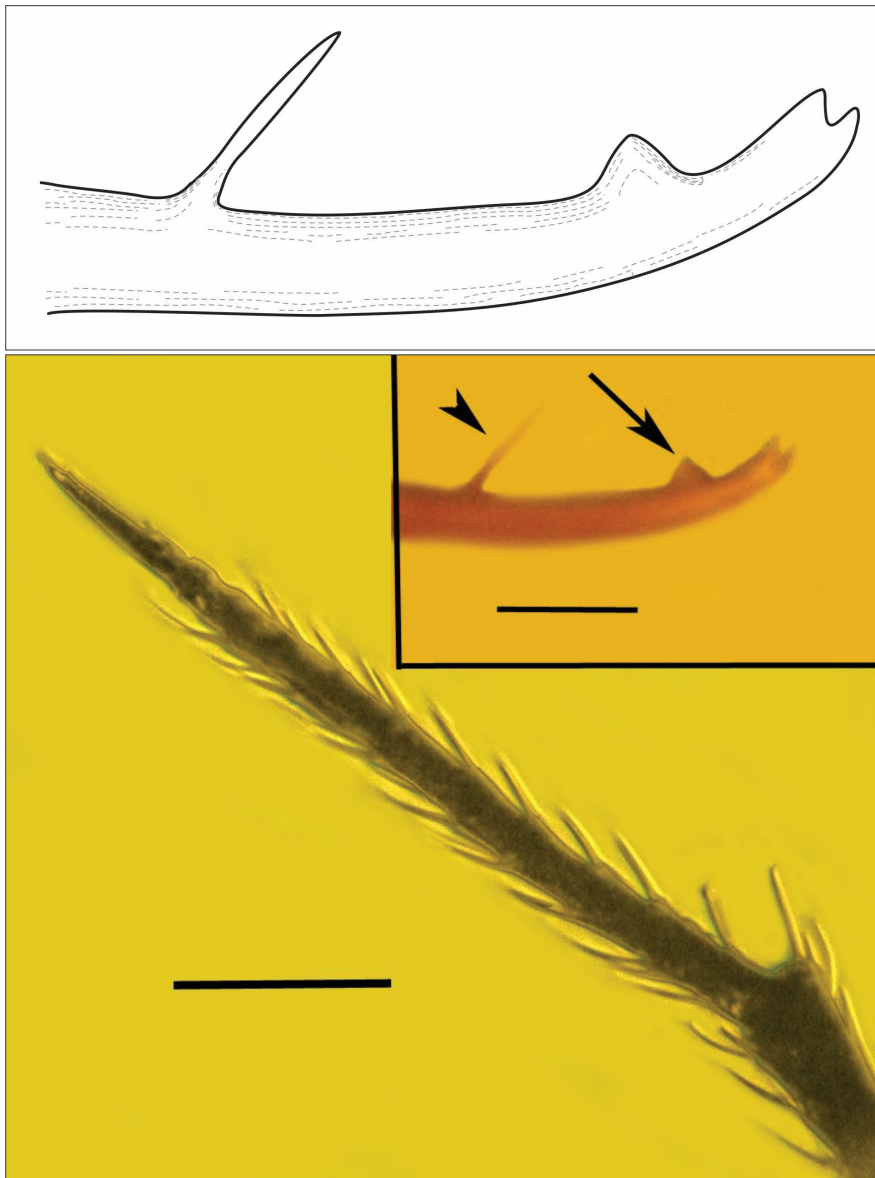


FIGURE 6. Tarsus with single claw of *Paleolepidotus macrocolus* **gen. et sp. n.** in Burmese amber; image and illustration. Scale bar = 84 μm . Insert shows detail of bifid claw. Arrowhead shows digitule. Arrow shows denticle. Scale bar = 32 μm .

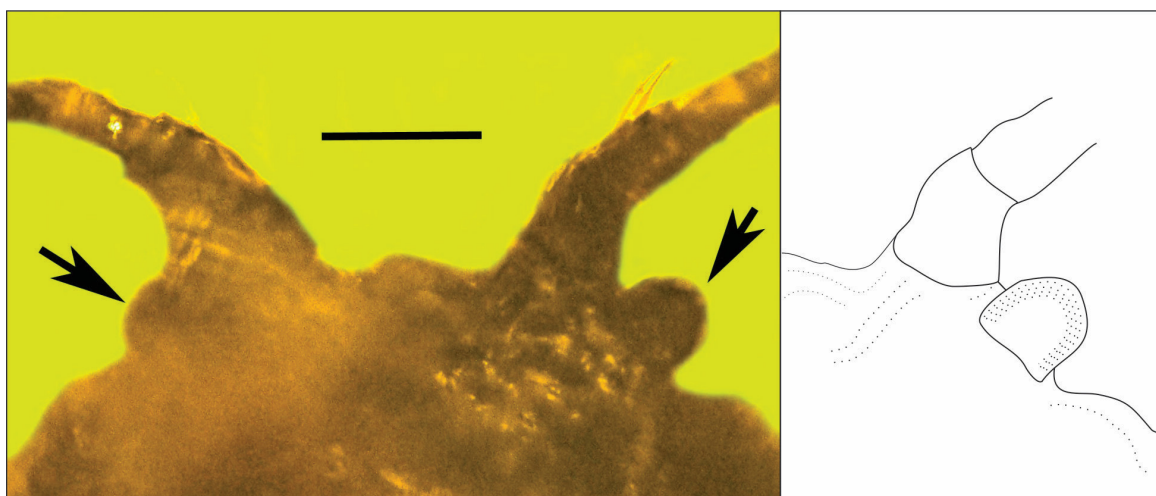


FIGURE 7. Eyes of *Paleolepidotus macrocolus* **gen. et sp. n.** in Burmese amber; image and illustration of eye. Scale bar = 22 μm .

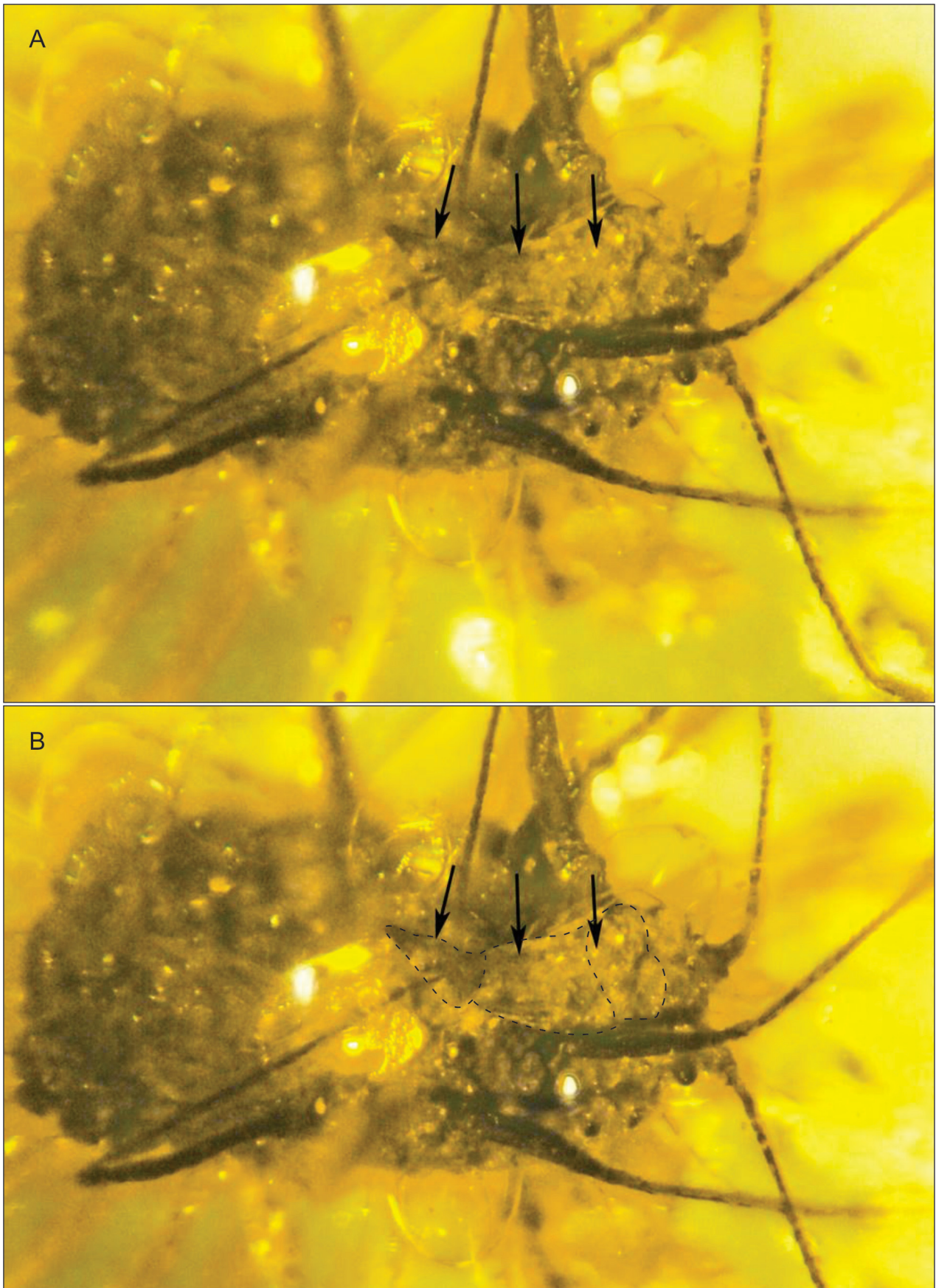


FIGURE 8. **A** Rostrum (arrows) of *Paleolepidotus macrocolus* **gen. et sp. n.** in Burmese amber; **B** duplicate image with overlaid dotted outline of rostrum and interpretation of segmentation adopted in description. Scale bar = 560 μ m.

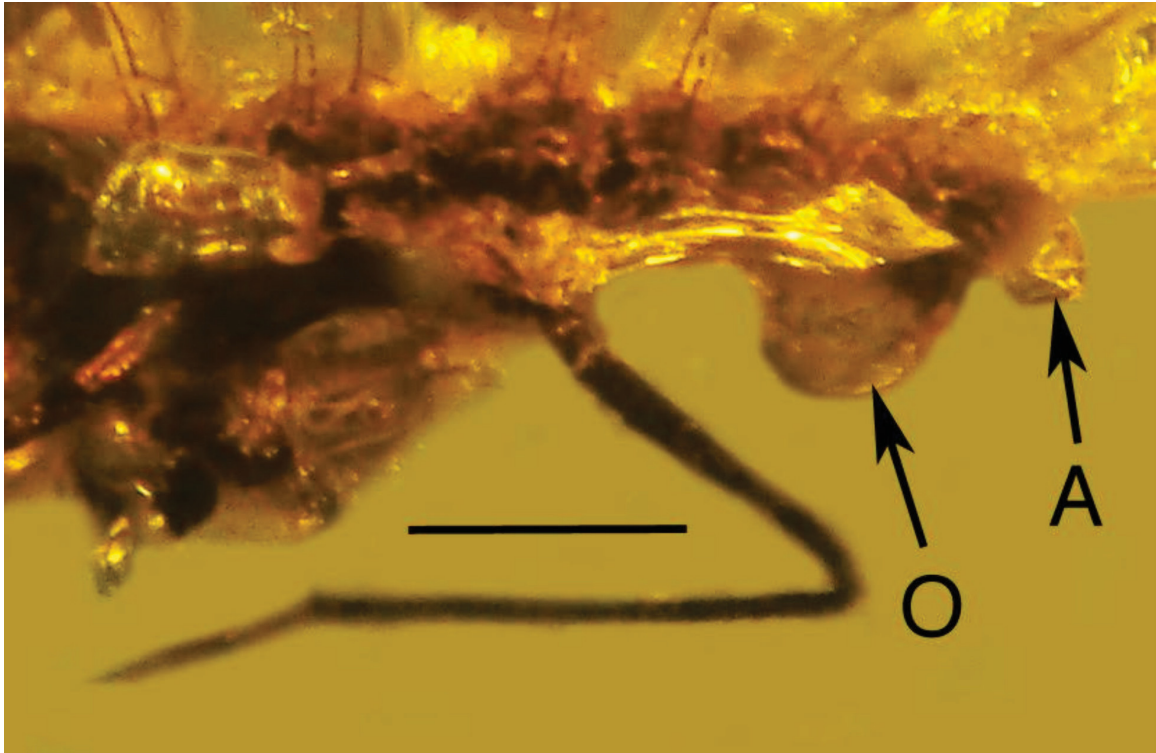


FIGURE 9. Posterior body portion of *Paleolepidotus macrocolus* **gen. et sp. n.** in Burmese amber. A = Anal opening. O = ovisac with developing larvae. Scale bar = 685 μm .

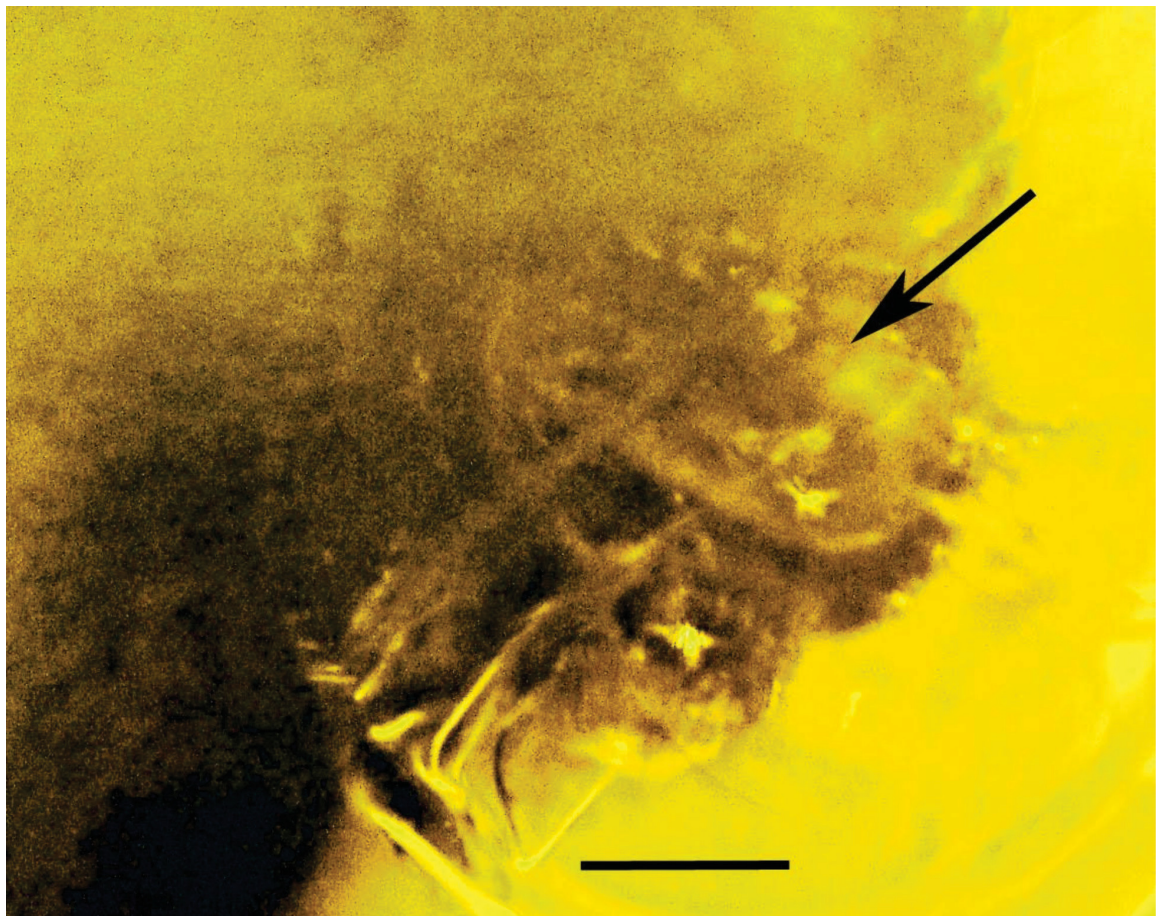


FIGURE 10. Section of ovisac of *Paleolepidotus macrocolus* **gen. et sp. n.** in Burmese amber showing outline of a larva (arrow). Scale bar = 140 μm .

Comments: Due to the small size of the insect and the surrounding wax pencils, it is not possible to determine certain fine morphological details like the presence or absence of abdominal spiracles or the form(s) of cuticular pores. Due to the lack of this information, and the presence of other features (the elongate antennae and legs, sturdy rostrum, and bifid claws with a single digitule) it is not possible to comfortably place the specimen in any extant or extinct family. As for its habit, the stout, heavy rostrum of *Paleolepidotus* suggests that the female was feeding on a woody substrate, such as the stem or trunk of a tree or shrub.

Discussion

The Burmese amber specimen described by Wang *et al.* (2015) as *Wathondara kotejai* Simon, Szwedó & Xia, was placed in the family Ortheziidae based on its wax secretions, ensign-like ovisac, stalked eyes and well-developed legs. *Paleolepidotus macrocolus* **gen. et sp. n.** has wax pencils and well-developed legs; however, the ovisac is not ensign-like (Figs. 9, 10) and the eyes are prominent but not stalked (Fig. 7). Additional features that separate *Paleolepidotus* from *Wathondara* include the long, stout rostrum (Fig. 8); no mention of a rostrum is made in the study of *Wathondara*, and figures of its ventral surface do not show evidence of a rostrum (Wang *et al.* 2015). The structure of the claw also differs between *Wathondara* and *Paleolepidotus*; whereas a denticle is lacking and the tip is entire in the former genus, the claw in *Paleolepidotus* has a distinct denticle and unique bifid tip (Fig. 6).

Some antennal features of *Paleolepidotus* suggest a potential affinity with the Ortheziidae. An enlarged apical spine or sensilla on the terminal antennomere is a common feature of ortheziids (Kozár 2004). Although these tend to be elongate, the lanceolate apical spine of *Paleolepidotus* (Figs. 4–5) does bear a resemblance to the short, stout coeloconic sensilla found on *Orthezia urticae* (Linnaeus) (Koteja 1980; Kozár 2004). The Carayonemidae also possess an enlarged apical spine on the terminal antennomere, but this family has distinctive dorsal setae (Kozár & Konczné Benedicty 2000) that would probably be evident on the fossil if they were present (Fig. 1). It is unclear whether the dual-socketed structure in the intersegmental area between antennal segments VI and VII of *Paleolepidotus* (Fig. 4) is a sensilla. If so, the position of this sensilla and the number of antennal segments would support a relationship with the Ortheziidae as well. In his study of antennal sensilla, Koteja (1980) noted a single species (from his representative sample) with an intersegmental sensilla between VI and VII, *Arctorthezia cataphracta* (Olafsen, 1772), but the typical forms of intersegmental sensilla differ from what is visible on *Paleolepidotus*, which looks more like two closely appressed setal sockets (Fig. 4) than a convex cone or spine. If they are setal collars, the position is unusual.

Several other features suggest a close affinity between *Paleolepidotus* and the Putoidae or Pseudococcidae. These families possess lateral cerarii, composed of groups of conical setae with associated wax-producing pores from which lateral wax pencils or broad wax structures emanate (Williams & Granara de Willink 1992; Williams *et al.* 2011). *Paleolepidotus* possesses sets of long, flagellate setae that differ in form but are similar in distribution to cerarii and also serve to support wax pencils (Figs. 1–3). The large protruding eyes (Fig. 7), long antennae (Fig. 5) and long setose legs (Fig. 3) are features that *Paleolepidotus* shares with adult female putoids (Williams *et al.* 2011). A combination of three additional features observed in *Paleolepidotus* is otherwise unique to pseudococcids and putoids: the possession of (i) three labial segments, (ii) a single subapical claw denticle, and (iii) numerous setae on the hind tibiae. In the key to extant scale insect families developed by Miller *et al.* (2014), selecting these three features eliminates all but the Pseudococcidae and Putoidae. However, it is unclear which of these families would be more suitable for holding this species because some traits provide conflicting evidence and others are entirely unique to the fossil. Putoids possess a unique basal spur on the claw (Williams *et al.* 2011) that is not apparent in *Paleolepidotus* and is lacking in pseudococcids. Conversely, *Paleolepidotus* and putoids share a similar well-defined joint between the tibia and tarsus, which tends to be less well developed in pseudococcids. The number of trochanteral pores would provide a useful clue about the relationship, but they are indiscernible in this specimen. The new fossil species is distinct in possessing a unique bifid claw with a single pointed digitule, whereas pseudococcids and putoids have claws that are entire with claw digitules paired (Williams & Granara de Willink 1992).

Due to the unique combination of characters on *Paleolepidotus* and the inability to discern some basic features, a definite family placement for the fossil could not be determined. Therefore, it is conservatively designated as *incertae sedis*.

Conclusions

The Burmese amber fossil, *Paleolepidotus macrocolus* **gen. et sp. n.**, represents an extinct lineage with unique morphological features. It provides a glimpse of mid-Cretaceous scale insects and adds to our knowledge of the morphological diversity of the Coccoomorpha.

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