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Descriptions of two new species of *Tarachoptera* from Burmese amber (Insecta, Amphiesmenoptera: Tarachoptera)

With 11 figures

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Abstract

During examination of new material of Burmese amber three individuals of Tarachoptera were discovered. The inclusions are sufficiently well preserved and allow identification and description of these rare, fossil insects. The species belong to the family Tarachocelidae and are described as *Kinitocelis macroptera* spec. nov. (†) and *Retortocelis spicipalpia* spec. nov. (†). The species and their preservations are described in detail, and photos and line drawings are provided for wing venation, head, mouthparts, and abdomen. The hitherto described species of Tarachoptera are summarized in a checklist.

Taxonomic acts

Kinitocelis macroptera Mey & Wichard, spec. nov. – urn:lsid:zoobank.org:act:E0B1624A-C69E-4B53-851F-4368-AC21C614

Retortocelis spicipalpia Mey & Wichard, spec. nov. – urn:lsid:zoobank.org:act:9778E7E2-EEFE-4DC5-B891-54DF11-4D525C

Key words

Cretaceous, fossil taxa, Tarachoptera, insect taxonomy, taxonomic diversity, Tarachoptera checklist

Zusammenfassung

Bei der Untersuchung von Inklusen des Burma Bernsteins wurden drei Exemplare aus der Ordnung Tarachoptera gefunden. Die Tiere sind hinreichend gut erhalten und erlauben die Bestimmung und Beschreibung dieser fossilen Insekten. Sie gehören zur Familie Tarachocelidae und werden hier beschrieben als *Kinitocelis macroptera* spec. nov. (†) und *Retortocelis spicipalpia* spec. nov. (†). Die bisher aufgestellten Taxa der Tarachoptera werden in einer checklist zusammengefasst.

1 Introduction

The fossil order Tarachoptera was established by Mey et al. (2017a, 2017b) on the basis of some insect inclusions of Burmese (= Myanmar) amber. Additional species and genera were described subsequently by Mey et al. (2018). To date, Tarachoptera are known by about 15 specimens exclusively from inclusions of Burmese amber preserved in collections of Europe and China (Ross 2019). Tarachoptera are tiny insects and are uncommon in inclusions, which may have been a reason of its late discovery. Burmese amber originates predominantly from the Hukawng Valley near Myitkyina, Kachin State, Myanmar. It derives from an amber bearing layer, which is not exposed to surface but is extending in a depth of 2–15 m (Cruickshank & Ko Ko 2003). The amber deposits have been dated in detail by Shi et al. (2012). We tentatively follow the age determination as early Cenomanian (98.8 ± 0.6 Ma) given by U-Pb dating of zircons from the volcanoclastic matrix of the amber (Shi et al. 2012).

In recent years, many new mines have been opened to satisfy the strong desire for amber in China. Amber pieces with fossils are offered for sale permanently, and it was not surprising to find further specimens of Tarachoptera in recently presented material. Three pieces containing specimens of Tarachoptera were sent to us for scientific study by Bo Wang and Patrick Müller. The specimens are relatively well preserved and allow the observation of important character complexes. As a result, the specimens studied are recognized as undescribed species. They are described as two new species in the genera *Kinitocelis* Mey et al. 2017 and *Retortocelis* Mey et al. 2018 respectively.

2 Material and Methods

Photos were taken using a Leica stereomicroscope M 420 Apozoom in combination with a Canon EOS 80D, EOS utility software and the Zerene Stacker software.
The fossils were examined under incident and transmitted light using a stereomicroscope (Leica MZ125). Line drawings were produced with a Leica camera lucida and digitally processed using Adobe Photoshop CS4. Measurements were made with the ocular micrometer of the stereomicroscope.
All taxonomic acts established in the present work have been registered in ZooBank (see below), together with the electronic publication: urn:lsid:zoobank.org:pub:72652F5A-3BA4-444C-AB17-D825F073C61B.

The following description concentrates on characters, which have diagnostic values at the species level, and thus, provide the basis for a correct placement of the new species into the contemporary system of Tarachoptera.

Abbreviation of depositories

MfN Museum für Naturkunde, Berlin, Germany
NIGP Nanjing Institute of Geology and Palaeontology, Nanjing, P.R. of China

3 Systematic palaeontology

Tarachoptera Mey, Wichard, Müller & Wang, 2017

Tarachocelidae Mey, Wichard, Müller & Wang, 2017

Kinitocelis Mey, Wichard, Müller & Wang, 2017

Fossil Record 20: 131-132. Type species. *K. hennigi* Mey, Wichard, Müller & Wang, 2017, Burmese amber [NIGP].

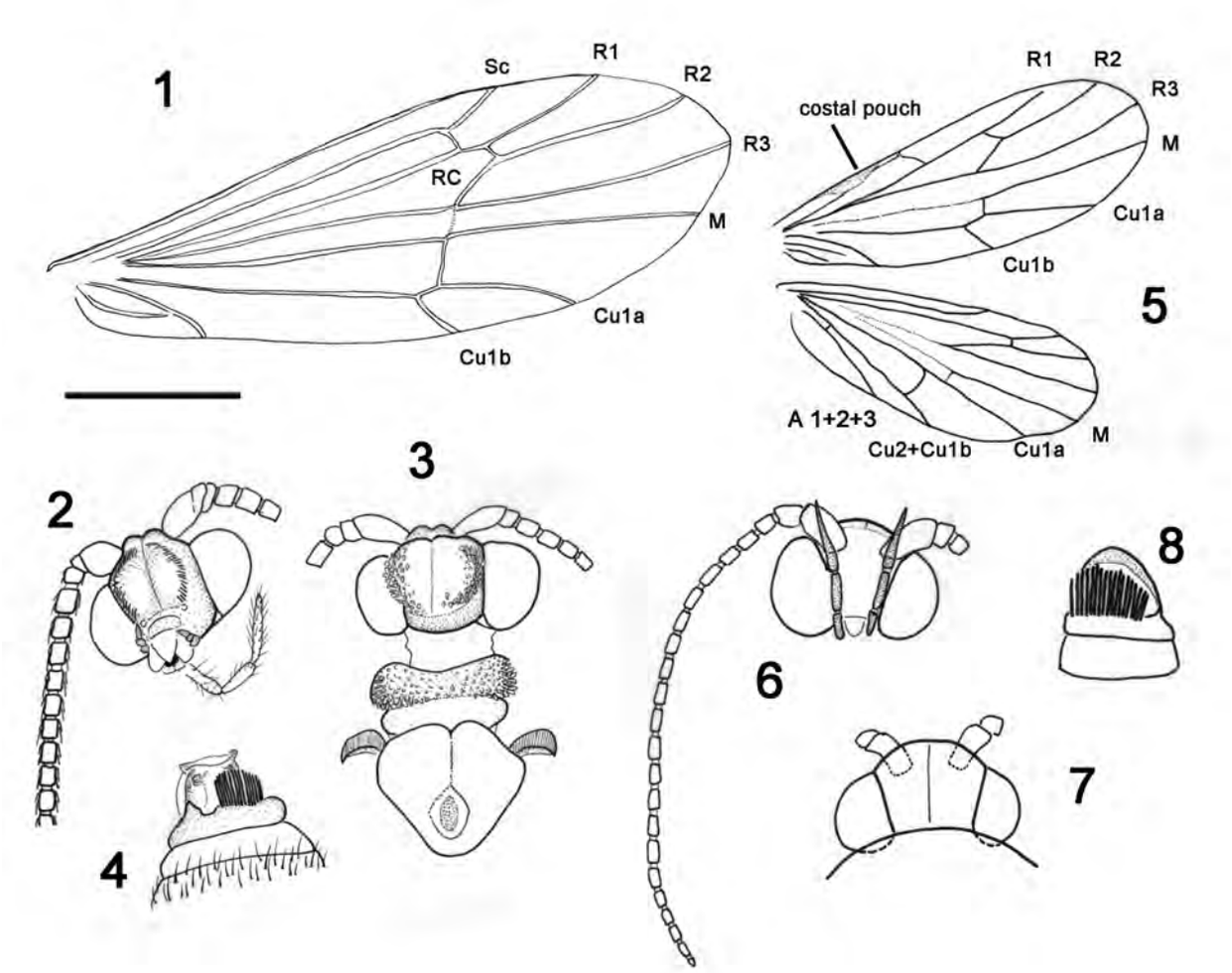
Kinitocelis macroptera Mey & Wichard, spec. nov.
urn:lsid:zoobank.org:act:E0B1624A-C69E-4B53-851F-4368AC21C614
(Figs 1–4, 9)

Material: Holotype, male, Burmese Amber, BUB 2746, deposited in Museum für Naturkunde, Berlin, Germany, MfN, (MB.I. 7341).

Preservation: The fossil is embedded in an oval and polished piece of amber. The adult insect is completely preserved and clearly visible in dorso-ventral aspect. The hindwings are covered by the somewhat bent forewings. Some bubbles of air are present on the ventral side close to the abdominal tip.

Etymology: The name refers to the large size of the wings qualifying the species as the largest one in Tarachoptera.

Description: Length of forewing 5.1 mm, length of hindwing 4.8 mm; head elongate and somewhat flattened dorso-ventrally, with erect scales on vertex, starting above tentorial pits and encircling an oval, smooth area with a medial depression; vertex with semi-erect scales on both sides of epicranial suture; eyes rounded, hemispherical; antenna long, scape short, as long as eye diameter, scaled dorsally, flagellum with 29 broad and scaled flagellomeres, barrel-shaped in the first half, becoming shorter apically; maxillary palpi very short, three segmented, of equal length, last segment pointed; labial palpi long, three-segmented, terminal segment longest, not enlarged apically, with long hairs, apex pointed; mandibles not visible; labrum large, produced medially as a quadrangular and voluminous organ with triangular tip, maxilla besides maxillary palpi with lobes (galea?) close to peroral cavity.



Figs 1–4: *Kinitocelis macroptera* spec. nov.: (**1**) forewing venation; (**2**) head and mouthparts, ventral; (**3**) head and pronotum, dorsal; (**4**) abdominal tip, ventro-lateral. – **Figs 5–8**: *Retortocelis spicipalpia* spec. nov.: (**5**) wing venation; (**6**) head, ventral; (**7**) head, dorsal; (**8**) abdominal tip, ventral.

Cervix without visible, dorsal sclerites; pronotum divided into anterior and posterior, transversal plates; mesonotum with triangular scutellum and broadly rounded tegulae. Legs without spurs and smaller spines on all tibiae, tarsal segments with terminal pair of ventral bristles, praetarsus with slender ungues; wings with rounded apices and short fringes on termen, forewings densely scaled at costal and subcostal veins (Fig. 9c), and in radial cell (RC), jugum not visible, venation as in Fig. 1: forewing with long, undivided Sc and subapical crossvein sc-r; radial cell (RC) somewhat arched between bases of R2 and R3, media (M) undivided, crossvein r-m weak, hardly visible, crossvein m-cu1a long, fused to Cu1a after bifurcation of Cu1a and Cu1b; two anal veins (A1, A2) present, apparently with basal loop.

Male genitalia (Figs 4, 9b): comb of stiff spines present on ventro-caudal margin of segment VIII or IX; dorsal side of genitalia roof-like and quadrangulate, slightly curved ventrad.

Diagnosis: By using the identification key of Mey et al. (2018) the new species runs to *Kinitocelis sparsella* Mey et al. (2018) and *K. divisinotata* Mey et al. (2017). Both species are morphologically similar and seems to be the closest relatives of *K. macroptera* spec. nov. The new species is distinguished from *K. sparsella* by uniform coloration of wing scales, the larger number of flagellomeres and by the length of the crossvein m-cu1a in the forewings, which is as long as Cu1b. From *K. divisinotata* the new species differs by the much shorter labial palpi with a pointed terminal segment and by the short scape length, which is not longer than the following two segments together. The absence or presence of forked Sc in the hindwings would provide an additional, distinguishing character of the new species, but the venation is not visible. Finally, *K. macroptera* spec. nov. is clearly larger than all congeneric species. It is the largest of all Tarachoptera species described to date.

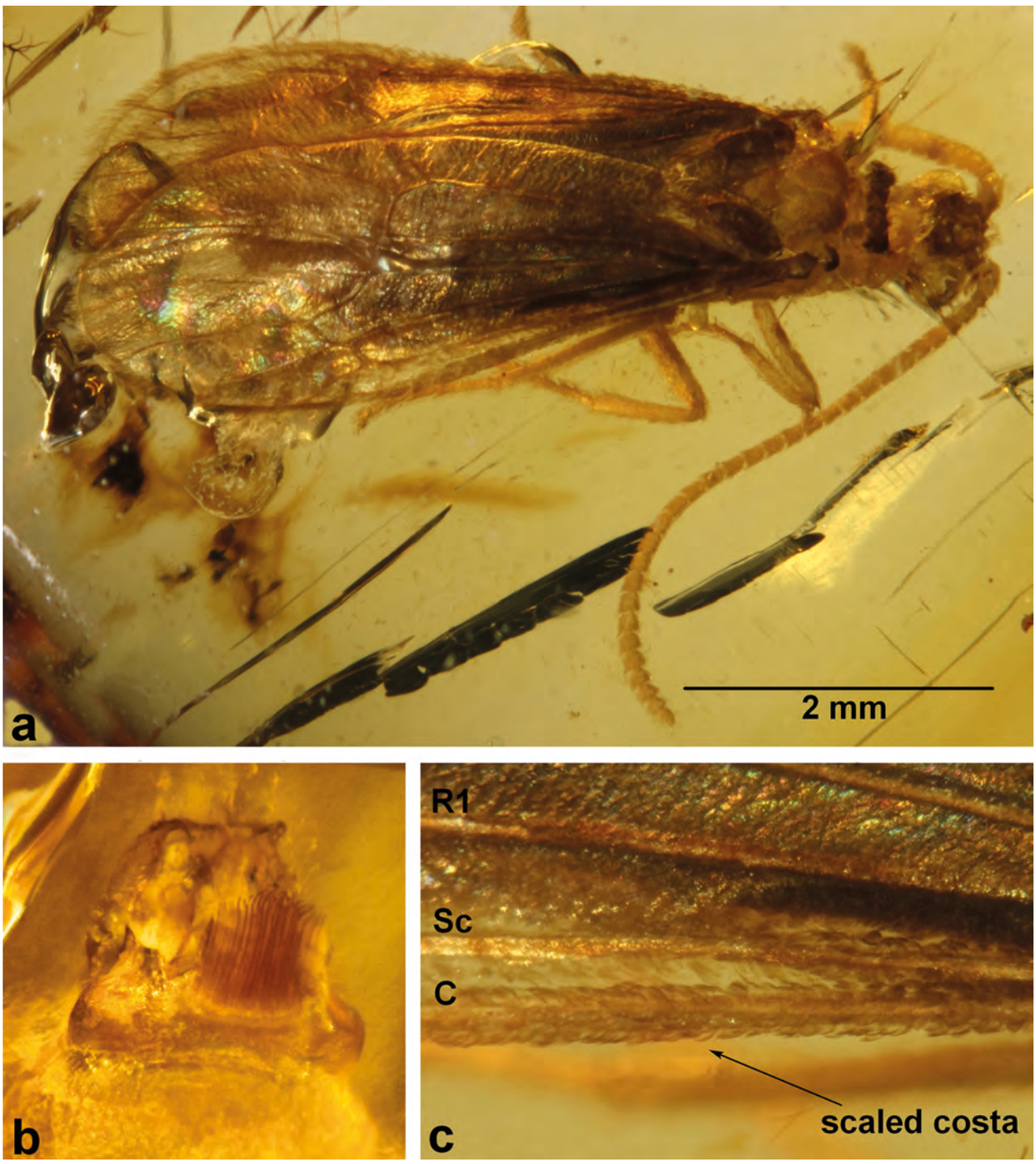


Fig. 9: Microphoto of *Kinitocelis macroptera* spec. nov., holotype: (**a**) dorsal view; (**b**) tip of abdomen, ventro-lateral view; (**c**) scaled costal region of forewing.

Retortocelis Mey, Wichard, Müller, Ross & Ross, 2018

Cretaceous Research 90: 156–158. Type species. *R. longella* Mey, Wichard, Müller, Ross & Ross, 2018, Burmese amber [MfN].

Retortocelis spicipalpia Mey & Wichard, spec. nov.

urn:lsid:zoobank.org:act:9778E7E2-EEFE-4DC5-B891-54DF114D525C

(Figs 5–8, 10, 11)

Material: Holotype, male, Burmese Amber, BW0027, deposited in deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences. NIGP 170800;

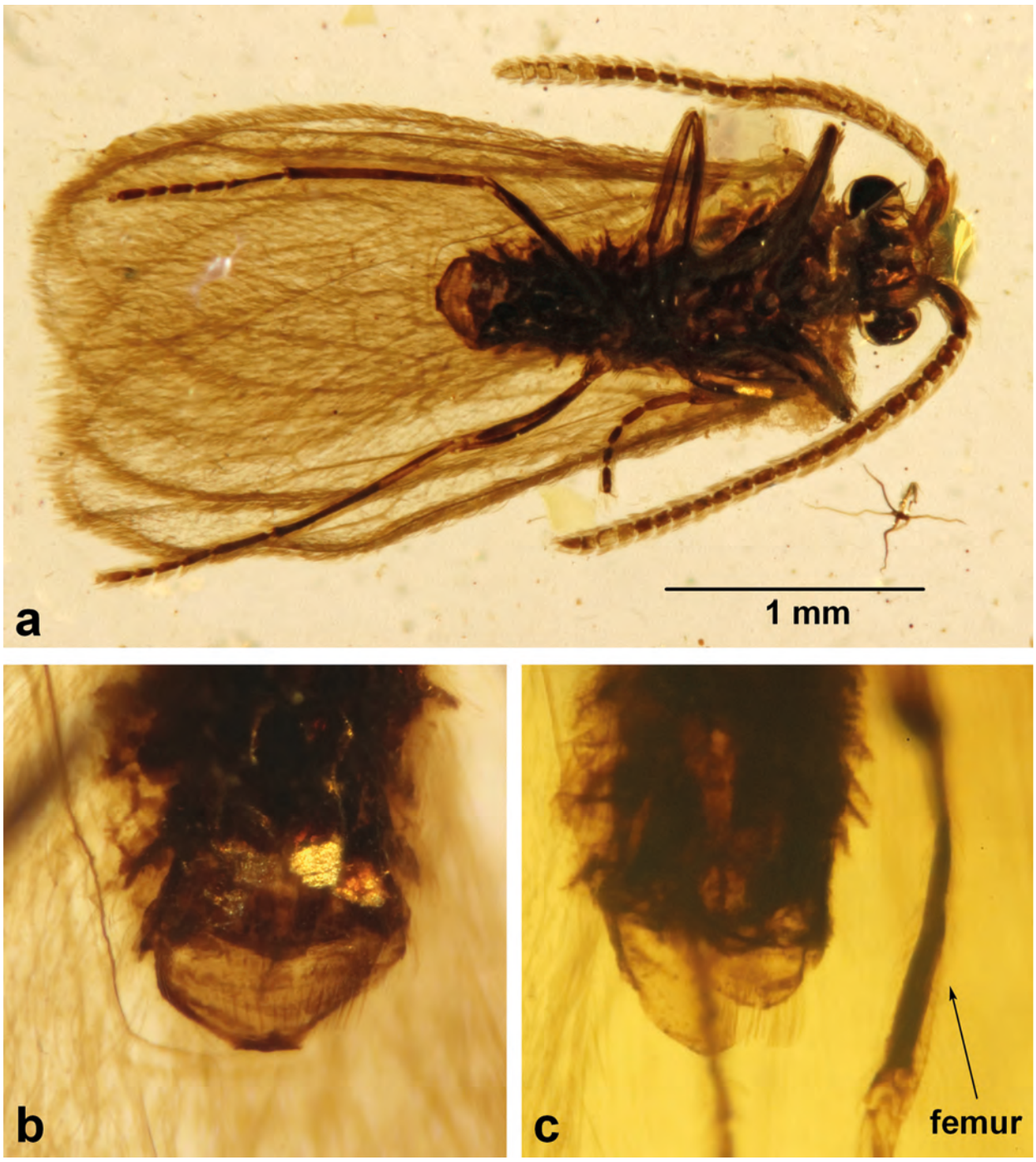


Fig. 10: Microphoto of *Retortocelis spicipalpia* spec. nov., paratype: (**a**) ventral view; (**b**) abdominal tip, ventral aspect; (**c**) holotype, abdominal tip, ventral aspect.

Paratypus, male, Burmese Amber, BUB 2286, deposited in Museum für Naturkunde, Berlin, Germany, MfN (MB.I. 7342).

Preservation: The holotype is embedded in a small, polished and flat amber block cut out from a larger amber piece. The adult insect is nearly completely preserved and clearly visible from a dorso-ventral view. The mouthparts are largely macerated. The hindwings are covered by the forewings. The paratype is more completely preserved in a large, rounded piece of amber together with some other small insects (Coleoptera, Diptera, Hymenoptera, Cicadina). It takes a position with all wings horizontally spread making the venation well visible.

Etymology: The name refers to the pointed terminal segment of the labial palpi, which are rounded in other species.

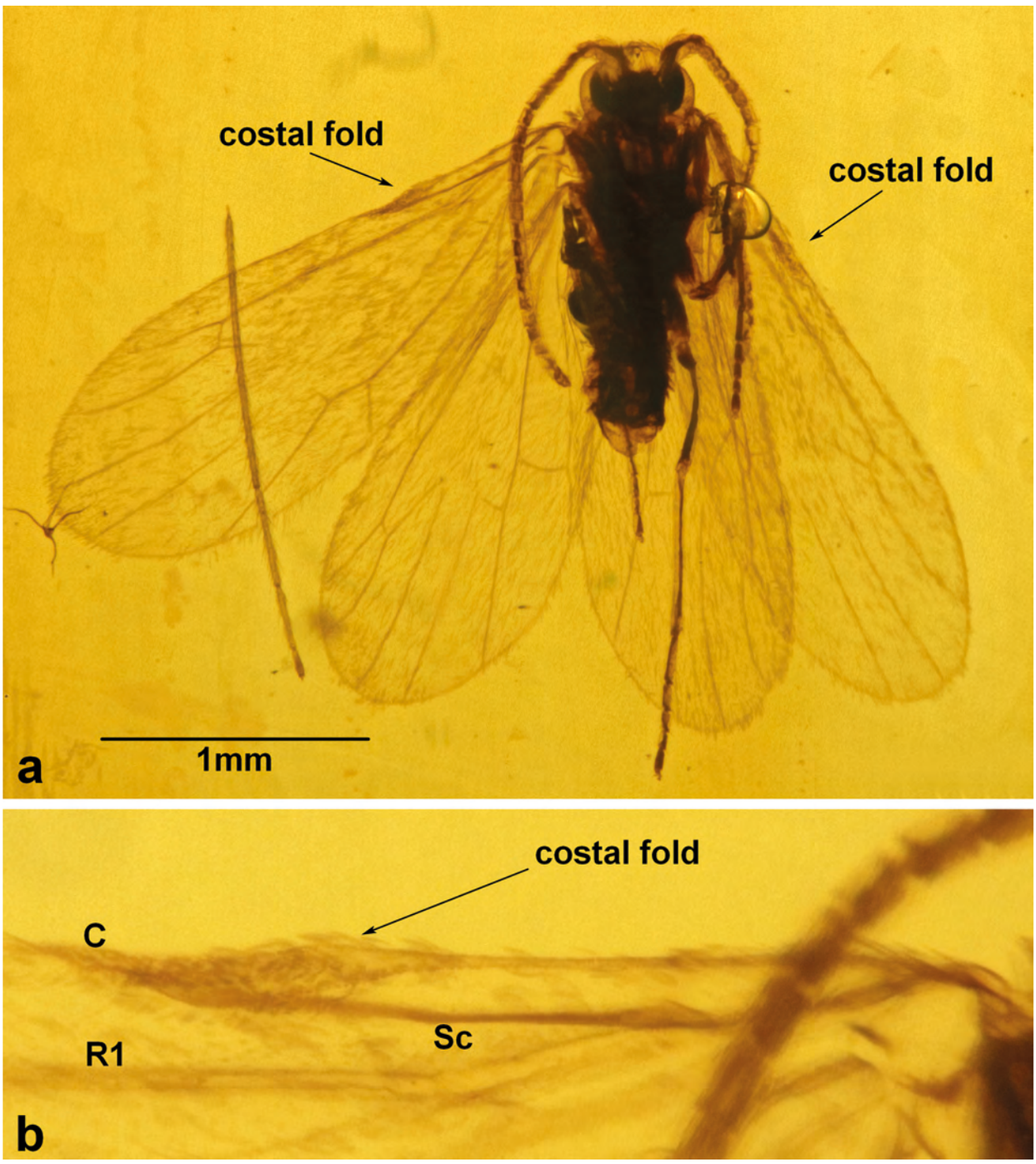


Fig. 11: Microphoto of *Retortocelis spicipalpia* spec. nov., holotype: (**a**) ventral view, (**b**) forewing with costal pouch.

Description: Length of forewing 3.4–3.5 mm, length of hindwing 3.1 mm; head rounded and with convex surface on dorsal side; vertex broad with epicranial suture; eyes rounded, hemispherical, scape short, as long as eye diameter, flagellum with 21 filiform and scaled flagellomeres, barrel-shaped from base to tip of antenna; labial palpi long, straight, three-segmented, terminal segment longest with acute apex; mouthparts not visible.

Legs without smaller spines on all tibiae, tarsal segments with terminal pair of ventral bristles; praetatarsus with slender ungues. Wings with rounded apices and short fringes on termen, fore- and hindwings sparsely scaled with piliform scales; venation as in Figs 5, 11a–b: forewing with minute costal fold and short Sc terminating at base of crossvein sc-r beyond costal fold; basal bifurcation of radial cell (RC) opposite the costal fold; media (M) undivided, crossvein r-m not visible, crossvein m-cu1a short,

fused to Cu1a after bifurcation of Cu1 and Cu1b; two anal veins (A1 and A2) present, apparently with basal loop; hindwing with long Sc and crossvein sc-r; Cu1b curved at a right angle and fused with Cu2.
Male genitalia (Figs 8, 10b–c): comb of stiff spines present on ventro-caudal margin of broad segment VIII or IX; dorsal side of genitalia roof-like and rounded, slightly narrowed in middle and curved ventrad.

Diagnosis: The species is assigned to *Retortocelis* on account of the presence of a costal fold in the forewings. The fold is very small and contains on the inner and ventral side some scales, which are not modified into androconial scales. The form of the fold and the small size of the species are shared characters with *R. minimella* Mey, Wichard, Müller, Ross & Ross, 2018. However, the subcostal vein is shorter in *R. spicipalpia* spec. nov. and terminates at the costa and crossvein sc-r shortly behind the fold. The fold and the reduced subcosta are diagnostic characters for separating the new species from congeners. The hindwing venation of all described *Retortocelis* species was unknown so far. The venation as observed in the new species is nearly identical with the hindwings of *Kinitocelis*, with the exception of a forked subcosta, which is absent in the new species. The species exhibits two further characters, which were not observed in other species of Tarachoptera. The antennal sockets are lying on the frons close to the inner eye margin, whereas in the other species the sockets are at the frontal edge of the head. The eyes are more widely separated in dorsal view, which gives the head a broader appearance.
The mouthparts of *Retortocelis* are incompletely documented. They are barely visible in the new species as in the previously described species. Even the distinction between labial and maxillary palpi in any of the studied specimens is obscured and problematic. The labial palpi seem to be smaller in size than in other genera. Also, the structure of the pronotum is insufficiently known. We hope, that better preserved specimens become available for study in new material of Burmese amber, that permit the observation and more detailed descriptions of these characters.

4. Checklist of taxa of Tarachoptera

Tarachoptera Mey, Wichard, Müller & Wang, 2017

Tarachocelidae Mey, Wichard, Müller & Wang, 2017

Tarachocelis Mey, Wichard, Müller & Wang, 2017

T. microlepidopterella Mey, Wichard, Müller & Wang, 2017

Kinitocelis Mey, Wichard, Müller & Wang, 2017

K. brevicostata Mey, Wichard, Müller & Wang, 2017
K. divisinotata Mey, Wichard, Müller & Wang, 2017
K. hennigi Mey, Wichard, Müller & Wang, 2017
K. macroptera Mey & Wichard spec. nov.
K. sparsella Mey, Wichard, Müller, Ross & Ross, 2018

Retortocelis Mey, Wichard, Müller, Ross & Ross, 2018

R. longella Mey, Wichard, Müller, Ross & Ross, 2018
R. minimella Mey, Wichard, Müller, Ross & Ross, 2018
R. spicipalpia Mey & Wichard spec. nov.
R. tyloptera Mey, Wichard, Müller, Ross & Ross, 2018

5. Discussion

Currently, the fossil order Tarachoptera consists of ten described species assigned to one family and three genera. It is a morphologically compact group with a relatively low variation in wing venation. Tarachoptera are grouped together with Lepidoptera and Trichoptera in the superorder Amphiesmenoptera based on the presence of the basal looping or Y-configuration of anal veins in the forewings. Lepidoptera and Trichoptera are virtually impossible to separate in the fossil record on wing venation alone. This is in sharp contrast to Tarachoptera, which exhibit a unique wing venation fundamentally different from those of Lepidoptera and Trichoptera. The Media is un-branched and the radial veins are reduced to three forming a characteristic radial

cell. The stem-group taxa of Lepidoptera and Trichoptera are summarized in the suborder Protomeropina (Ivanov & Sukatsheva 2002). The wing venation of their constituent taxa consists of a larger number of radial and median veins including cross-veins than occurring in extant species. We are unable to link Tarachoptera with any of these stem-group taxa. The Tarachoptera must have diverged from stem-group Amphiesmenoptera long before the Lepidoptera-Trichoptera branch evolved. The origin of Amphiesmenoptera is dated in the Permian, a time when stem-group taxa of other orders existed (Grimaldi & Engel 2005). We did not attempt to search comprehensively the fossil record of Panorpoids for possible candidates indicating at least a remote relationship to Tarachoptera. However, we have observed the presence of the characteristic radial cell of Tarachoptera in some taxa of Permochoristidae Tillyard, 1918 (e.g. *Choristopsyche* Martynov, 1937 *Turanopsyche* Martynov, 1937) (Rohdendorf 1991). This family was very diverse and abundant from the Permian to the Jurassic. It is considered a paraphyletic group (Grimaldi & Engel 2005), perhaps also polyphyletic, if some of the included taxa were found to represent amphiesmenopteran stem-groups. The origin of the Tarachoptera still remains enigmatic.

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