Cretaceous Research 104 (2019) 104178

Contents lists available at ScienceDirect

Cretaceous Research

journal homepage: www.elsevier.com/locate/CretRes

Short communication

New genus and species of the Psyllipsocidae (Psocodea: Trogiomorpha) from mid-Cretaceous Burmese amber

Ruiqian Wang, Sheng Li, Dong Ren, Yunzhi Yao*

Key Lab of Insect Evolution and Environmental Change, College of Life Sciences, Capital Normal University, 105 Xisanhuanbeilu, Haidian District, Beijing, 100048, China

ARTICLE INFO

Article history:
Received 18 December 2018
Received in revised form
18 May 2019
Accepted in revised form 7 July 2019
Available online 11 July 2019

Keywords:
Myanmar
Psyllipsocids
Psocoptera
Fossil
Forewing asymmetry

ABSTRACT

A new genus and species, *Concavapsocus parallelus* gen. et sp. nov., is assigned to the Psyllipsocidae (Trogiomorpha). Claws with preapical tooth and forewing with nodulus may not be suitable for diagnostic characters of the Psyllipsocidae. Wing polymorphism increase the difficulty of taxonomic position of psocids based on barely visible wing venation, especially in the suborder Trogiomorpha. *Globopsocus aquilonius* Azar and Engel may belong to the Psyllipsocidae and be closely related with the new species.

1. Introduction

Psyllipsocidae, members of the suborder Trogiomorpha, comprising more than 70 species within nine genera, are widely distributed all over the world (Hakim et al., 2018). Among records of fossil psyllipsocids, only four genera with five species are incontrovertible: *Annulipsyllipsocus andreneli* Hakim et al., 2018 and *A. inexspectatus* Hakim et al., 2018 from the mid-Cretaceous Burmese amber; *Khatangia inclusa* Vishnikova, 1975 from the Upper Cretaceous Tymair amber; the others are from the lower Eocene, Cenozoic, comprising *Sinopsyllipsocus fushunensis* Zhang et al., 2016 from Fushun amber (China), and *Psyllipsocus eocenicus* Nel et al., 2005 from Oise amber (France). One equivocal species from the Lower Cretaceous Lebanon amber is *Libanopsyllipsocus alexanderasnitsyni* Azar and Nel, 2011, originally placed into the Psyllipsocidae. After examining the type material Mockford et al. (2013) transferred it to Pachytroctidae, and recently Hakim et al. (2018) replaced it to the Psyllipsocidae, after also examining the type material.

Recently, we collected nine specimens from the Hukawng Valley, Myitkyina District of Kachin State in Myanmar, which can be assigned to the Psyllipsocidae, and one new genus is erected here to accommodate them. These ambers have retained many well-preserved structures of Psyllipsocidae, such as claws, antennae, gonapophyses, etc. One of the most interesting phenomenon is the asymmetry of the left and right forewing venations in one specimen (CNU-PSO-MA2018003). Up to date, nine families, nine genera, and fifteen species of Psocodea from Burmese amber have been reported (Ross, 2018), besides, this deposit has yielded innumerous well-preserved insect fossils (Li et al., 2018; Chen et al., 2018; Zhang et al., 2018; Du and Yao, 2018).

2. Material and methods

Herein, we reported nine specimens collected from the amber deposits of Kachin (Hukawng Valley) in northern Myanmar (Zhang et al., 2018: fig. 1). The studied specimens are housed in the Key Lab of Insect Evolution and Environmental Changes, College of Life Sciences, Capital Normal University, Beijing, China (CNUB, Curator: Yunzhi Yao). The age of Burmese amber is attributed to the earliest Cenomanian (ca. 98.79 ± 0.62 Ma) (Shi et al., 2012).

Specimens were examined and photographed under a Nikon SMZ25 microscope, with an attached Nikon DS-Ri2 digital camera system. The line drawings were edited by Adobe Illustrator CC and Adobe Photoshop CC. The morphological and wing venation terminology follows mainly Smithers (1990) and Mockford (1993).

* Corresponding author.
E-mail address: yaoyz100@126.com (Y. Yao).

https://doi.org/10.1016/j.cretres.2019.07.008
0195-6671/

Abbreviations involved in the article: mx, maxillary palp; Sc, subcostal vein; R, radius vein; Rs, radial sector; M, median vein; Cu, cubital vein; A, anal vein; ep, epiproct; p, paraproct; V1, ventral valve; V2, dorsal valve; V3, external valve.

3. Systematic palaeontology

Suborder Trogiomorpha Roesler, 1940
Infraorder Psyllipsocetae Smithers, 1972
Family Psyllipsocidae Kolbe, 1884

Genus ***Concavapsocus*** gen. nov.
Etymology. The generic name is a combination of Latin '*concavus*' meaning 'concave' and '*psocus*', the common stem of most psocopteran genera. Gender masculine.
Type species. *Concavapsocus parallelus* sp. nov.

Diagnosis: Ocelli absent; antennae with 23 flagellomeres; mx2 and mx4 without conical sensillum; lacinia developed, with two preapical teeth. Forewings membranous, with several setae on veins and posterior margin; *apex of forewing margin concave inward*; basal portion of Sc short, ending free in membrane; *basal part of R_1 fused with R_{2+3}; A fused with Cu_2 near middle of the forewing*. Hind wing present, membranous. Coxae with several setae; one coxal rasp present; tibiae with two apical spurs; tarsi with three segments. *V2 reduced to needle-like; V1 rod-like, unsclerotized; V3 broad, without seta;* subgenital plate short, covering at most basal part of V3. (Autapomorphies of new genus are given in italics).
Remarks. *Concavapsocus* gen. nov. shares a series of characters of the Trogiomorpha (Mockford, 1993; Yoshizawa et al., 2006; New and Lienhard, 2007): (1) antennae generally with more than twenty segments; (2) labial palps two-segmented, with minute basal segment and rounded or elongated distal segment; (3) tarsi three-segmented; (4) forewing with pterostigma not thickened, sometime slightly opaque; (5) ventral and dorsal valves of female gonapophyses strongly reduced or absent, external valves developed; (6) subgenital plate short, covering at most basal part of external valves. Furthermore, according to the systematic analysis of Yoshizawa et al. (2006), the last two characters are synapomorphies.
The new genus and species can be clearly classified into the Psyllipsocetae by these characters (Yoshizawa et al., 2006): mx2 without conical sensillum; lacinia developed; basal part of Sc short, ending free in membrane; wing pilosity developed; paraproct with anal spine; external valve of female gonapophyses broad. Moreover, *Concavapsocus parallelus* sp. nov. should be assigned to the Psyllipsocidae according to the following characters: brachypterous; tarsi with three segments; body, and wing rudiments when present, without scales; forewings not thickened, translucent; venation apparent; forewing venation consisting of more than a single longitudinal vein; paraproct with posterior spine; claws without preapical tooth (Smithers, 1990).
Concavapsocus gen. nov. is different from any genera of the Psyllipsocidae. Its' brachypterous occurs in *Annulipsyllipsocus*, *Dorypteryx*, *Pseudorypteryx*, *Psocatropos* and *Psyllipsocus*; but the new genus can be distinguished from *Annulipsyllipsocus* by having 23 segmented antennae (vs. 16 segmented antennae), and reduced forewing veins (vs. complex forewing veins) (Hakim et al., 2018). The broad forewing concave at apex (vs. slender forewing which pointed at apex) differs from the genus *Dorypteryx* (Morkford, 1993; Li and Liu, 2009). Based on the mx4 without any sensillum (vs. versus with several small sensilla on outer margin) (Mockford, 1993; Li, 2002) *Concavapsocus* can be distinguished from *Pseudorypteryx, Psocatropos* or *Psyllipsocus.* It also differs from *Pseudopsyllipsocus* by having a femora without any tumor (vs. with tumor), and female gonapophyses with ventral and dorsal valves (vs. female gonapophyses with only external valves). Meanwhile, the genus *Concavapsocus* can be easy distinguished from other fossil psyllipsocids. For instance, pterostigma and aroela postica absent in forewing (vs. pterostigma and aroela postica present) (Vishnikova, 1975) are different from *Khatangia. Concavapsocus* can also be distinguished from *Libanopsyllipsocus* by the simple Rs in hind wing (vs. Rs branched in hind wing) (Azar and Nel, 2011). However, *Libanopsyllipsocus* should be assigned to the Pachytroctidae instead of the Psyllipsocidae. The phallosome in the original illustrations may be the T-shape sclerite on the subgenital plate of the Pachytroctidae (Azar and Nel, 2011; Azar et al., 2015).

Concavapsocus parallelus sp. nov (Figs. 1–4)

Etymology. The specific name is the Latin term '*parallelus*', meaning 'parallel', derived from parallel distal main longitude veins.
Type material. All specimens are adult. Holotype, CNU-PSO-MA2018001, male, well preserved. Paratype, CNU-PSO-MA2018002, female, well preserved; CNU-PSO-MA2018003, male, thorax broken; CNU-PSO-MA2018004, female, well preserved, ventral view covered by a gas bubble; CNU-PSO-MA2018005, sex unknown, abdomen broken; CNU-PSO-MA2018006, sex unknown, wings well preserved, abdomen broken, ventral view covered by a gas bubble; CNU-PSO-MA2018007, female, well preserved, ventral view covered by a crack; CNU-PSO-MA2018008, female, well preserved, body covered by many impurities; CNU-PSO-MA2018009, sex unknown, abdomen broken, dorsal view covered by a crack.
Locality and horizon. Hukawng Valley, Kachin State, Northern Myanmar. mid-Cretaceous, lowermost Cenomanian.

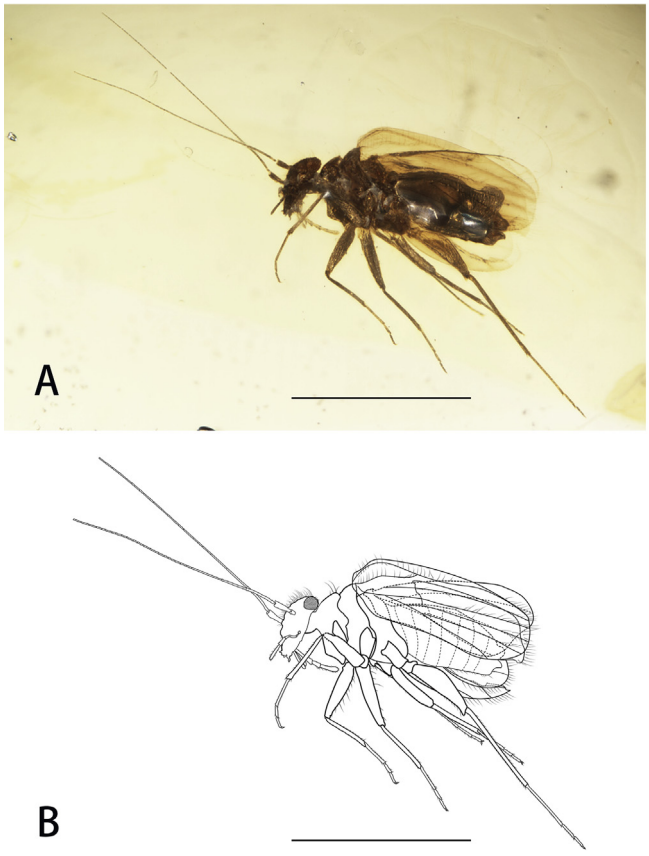

Fig. 1. Holotype of *Concavapsocus parallelus* sp. nov., CNU-PSO-MA2018001, male. (A) Photographs in left lateral view; (B) Line drawings in left lateral view. Scale bars: 0.5 mm.

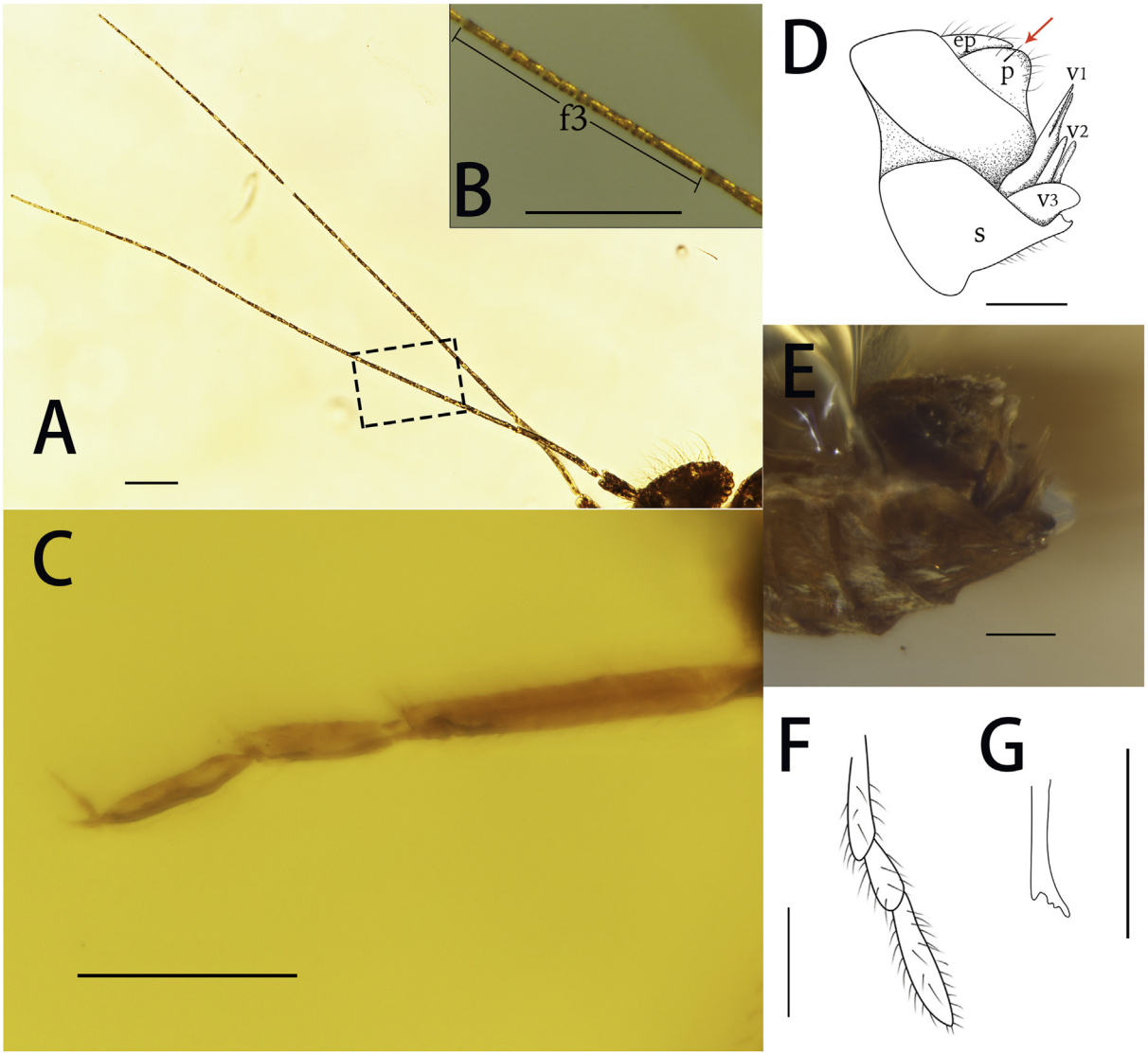

Fig. 2. Details of *Concavapsocus parallelus* sp. nov. (A) Antennae, holotype, CNU-PSO-MA2018001, male; (B) Cuticular sculpture on antenna, holotype, CNU-PSO-MA2018001, male; (C) tarsi and claws, paratype, CNU-PSO-MA2018005; (D) Line drawing of the female genitalia in left lateral view, (arrow are pointing to anal spine of paraproct), paratype, CNU-PSO-MA2018002; (E) photo of the female genitalia in left lateral view, paratype, CNU-PSO-MA2018002; (F) Mx2-Mx4, paratype, CNU-PSO-MA2018002, female; (G) Lacinia, paratype, CNU-PSO-MA2018002, female. Scale bars: 0.1 mm.

Diagnosis: Antennae with 23 flagellomeres. Brachypterous. Forewing: M and Cu_1 not branched; basal part of Cu_1 evanescent. Leg with setae; tibiae and tarsi with two rows of setae; pretarsal claws without preapical tooth; no puvillus.

Description. Male. Body length 1.24 mm. Vertex narrow, 0.13 mm; ecdysial cleavage line absent; head with dense setae; compound eyes well developed; ocelli absent; antennae with 23 flagellomeres, about 1.33 mm long; scape short, pedicel tubular; first flagellomere longest; at least third flagellomere with cuticular sculpture; Mouthpart chewing type; maxillary palps with four segments, mx4: 0.08 mm−mx2:0.07 mm−mx3: 0.05 mm−mx1: 0.04 mm, from longest to shortest in length, with setae on the mx4; mx2 and mx4 without conical sensillum; labial palps two segmented; lacinia tip with apical teeth.

Forepart of protothorax attenuate to neck. Brachypterous, apex of forewing beyond abdomen slightly. Forewings quadrangle, membranous, 1.02 mm long, 0.38 mm wide; with several setae on veins and posterior margin; apex of wing margin concave inward; Sc short, spur-like, ending free; pterostigma absent; R_1 fused into R_{2+3}; M separate from R at 1/7 distal to wing base; M and Cu_1 not branched; 1/5 basal Cu_1 evanescent; Cu_2 fused with A near 1/2 distal to wing base, Cu_2+A curved back ending on margin. Hind wing membranous, triangular, 0.93 mm long; posterior margin with dense setae, R and M not branched, Cu_1 divided into Cu_{1a} and Cu_{1b} near middle of hind wing.

Leg with dense setae; coxal rasp present; tibiae with two apical spurs; tarsi three segmented; pretarsal claws without preapical tooth; no pulvillus.

Female. Epiproct with setae; paraproct with an anal spine. V1 reduced to rod-like, not sclerotized, V2 slender, needle-like, V3 broad without posterior seta. Subgenital plate with dense setae, covering at most part of basal V3.

4. Discussion

Mockford (1993) proposed that pretarsal claw with preapical tooth was an important diagnostic character for the Psyllipsocidae.

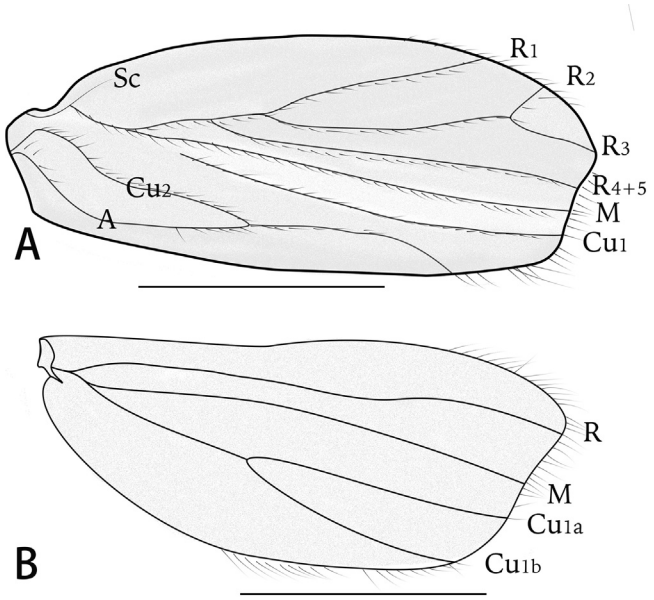

Fig. 3. Line drawings of wings of *Concavapsocus parallelus* sp. nov., paratype, CNU-PSO-MA2018004, female. (A) Forewing; (B) Hindwing. Scale bars: 0.5 mm.

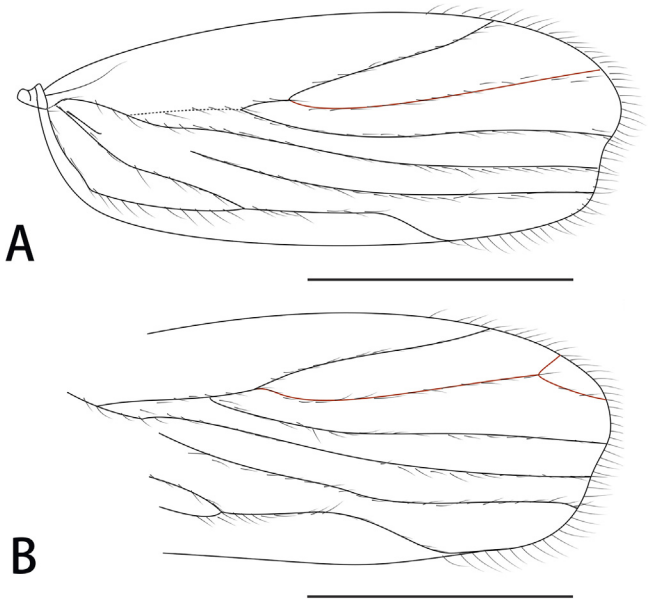

Fig. 4. Line drawings of forewings of *Concavapsocus parallelus* sp. nov., paratype, CNU-PSO-MA2018003, male. (A) Right; (B) Left. Scale bars: 0.5 mm.

However, among records of fossil psyllipsocids, the two species of the genus *Annulipsyllipsocus* known from Burmese amber, only *A. andreneli* has preapical tooth (Hakim et al., 2018). Nevertheless, *Concavapsocus parallelus* have neither preapical tooth nor pulvillus. Based on the following characteristics: antennae with 23 flagellomeres, mx2 without sensory spur; lacinia developed; forewing basal Sc short, ending free in membrane; paraproct with anal spine; female with V3 broad, V1, V2 reduced, the new species apparently belong to the Psyllipsocidae. According to the current taxonomic system, forewing with nodulus also was considered as a vital diagnostic character for the Psyllipsocidae (Smithers, 1972; Yoshizawa et al., 2006; New and Lienhard, 2007). However, the nodulus is not consistently present in the same family, for example, nodulus are absent in forewings of *Khatangia inclusa*. In the meantime, most of the Lepidopsocidae (Trogiomorpha: Atropetae) nodulus are absent in the forewing, but are present in some genera (Baz and Ortuño, 2000). Obviously, as the above evidence indicates, the pretarsal claw with preapical tooth and the presence of nodulus may not be an appropriate diagnostic character for the Psyllipsocidae.

In the classification of extant psocids, venation is usually not considered as family diagnosis (Smithers, 1972; Mockford, 1993; Li, 2002; New and Lienhard, 2007). However, due to badly-preserved fossil psocids, useful information is missing. For example, many fossil species are erected based only on forewing characters, even with broken forewing (Cockerell, 1921; Martynov, 1926; Prerrichot et al., 2003; Azar, 2014). Kucerova (1997) showed that the environmental factors in individual development may directly affect the phenotype of veins. Hence, the venation of psocids show polymorphism. Interestingly, the specimen CNU-PSO-MA2018003 has asymmetry of the forewings: R_{2+3} not branched on right forewing (Fig. 4A), but R_{2+3} forked into R_2 and R_3 distally on left forewing (Fig. 4B). Thus, extreme caution should be taken over the taxonomic assignment based on wing venation of psocids. A new taxon which is established based only on characters of venations may be dubious.

Globopsocus aquilonius described by Azar and Engel in 2008, was assigned to the Sphaeropsocidae (Troctomorpha) according to the elytriform forewings; crossveins, claval suture, and hindwing absent. However, Mockford et al. (2013) proposed that this species should be assigned to the Electrentomoidea (Troctomorpha), based on its general morphology and large compound eyes. They considered that the elytrous forewing with modified venation cannot be used as evidence to assign it to the Sphaeropsocidae, seeing that this character is also present in several extant genera of Electrentomoidea. For instance: *Chelyopsocus* and *Reticulopsocus* of the Protroctopsocidae (Lienhard, 2005; Mockford et al., 2013) and *Coleotroctellus* of the Troctocidae (Lienhard and Mockford, 1997; Mockford et al., 2013). *Globopsocus aquilonius* can be distinguished from all species of the Electrentomoidea by lacking closed cells in the forewing. Moreover, in troctopsocids the antennae have at most 15 segments, while *Globopsocus aquilonius* has 17 segments (Mockford et al., 2013). Among all psocids, only the Trogiomorpha have long antennae, usually more than 20 segments. Therefore, the taxonomic position of *Globopsocus aquilonius* is still uncertain. Trogiomorpha can be readily distinguished from Troctomorpha by having: antennae with more than 18 flagellomeres (vs 13 flagellomeres); filaments of hypopharynx never fused on midline (vs filaments of hypopharynx fused on midline for part of their length, separate distally) paraproct with strong posterior spine (vs paraproct without strong posterior spine). However, these characters are not visible in the original descriptions, line drawings, nor in the photographs (Azar and Engel, 2008). Unfortunately, Mockford et al. (2013) also did not mention the above characters. Thus the higher phylogeny position of *Globopsocus aquilonius* remains elusive.

On the other hand, *Globopsocus aquilonius* is similar with *Concavapsocus parallelus* sp. nov. as follows: vertex narrow, no coronal ecdysial cleavage lines evident; compound eyes developed, ocelli absent; maxillary palps four segments; labial palps two segments; tibiae with two apical spurs, tarsi with three segments; pretarsal claws without preapical tooth; dorsal valves slender and needle-like, ventral valves shorter than the dorsal valves; brachypterous (a little before or beyond abdomen). In addition, veins very simple, distal of main longitude veins nearly parallel. Besides, it can be seen from the original figures that the antennae of *Globopsocus aquilonius* are discontinuous, the preservation of the antennae in the specimen may be incomplete, and the number of antennal articles may be more. Therefore, it is possible that *Globopsocus aquilonius*

most likely belongs to the Psyllipsocidae (Trogiomorpha), and may be a close relative to *Concavapsocus parallelus* gen. et sp. nov.

5. Conclusions

Concavapsocus parallelus gen. et sp. nov. from mid-Cretaceous Burmese amber is assigned to the Psyllipsocidae. The pretarsal claw with preapical tooth and the presence of nodulus may not be an appropriate diagnostic character for the Psyllipsocidae. The wing polymorphism makes it difficult to define some psocids taxa based only on wing venation, especially in Trogiomorpha. *Globopsocus aquilonius* may be a close relative to *Concavapsocus parallelus* gen. et sp. nov.

Acknowledgements

We are grateful to the editor and anonymous reviewers for constructive criticism and valuable comments on the manuscript. This project is supported by grants from the National Natural Science Foundation of China (41688103, 31730087), Joint Fund of the Beijing Municipal Natural Science Foundation and Beijing Municipal Education Commission (KZ201810028046), the Support Project of High-level Teachers in Beijing Municipal Universities in the Period of 13th Five-year Plan (IDHT20180518), the Program for Changjiang Scholars and Innovative Research Team in University (IRT-17R75) and Capacity Building for Sci-Tech Innovation – Fundamental Scientific Research Funds (No. 19530050144).

References

Azar, D., Engel, M.S., 2008. A sphaeropsocid bark louse in Late Cretaceous amber from Siberia (Psocoptera: Sphaeropsocidae). Transactions of the Kansas Academy of Science 111, 141–146.

Azar, D., 2014. Tertiary barklice (Insecta:Psocodea) from the Insect Limestone (Bembridge Marls, Late Eocene) of the Isle of Wight, UK. Earth and Environmental Science Transactions of the Royal Society of Edinburgh 104, 1–10.

Azar, D., Nel, A., 2011. The oldest psyllipsocid booklice, in Lower Cretaceous amber from Lebanon (Psocodea, Trogiomorpha, Psocathropetae, Psyllipsocidae). Zookeys 130, 153–165.

Azar, D., Huang, D., Cai, C., Nel, A., 2015. The earliest records of pachytroctid booklice from Lebanese and Burmese Cretaceous ambers (Psocodea, Troctomorpha, Nanopsocetae, Pachytroctidae). Cretaceous Research 52, 336–347.

Baz, A., Ortuño, V.M., 2000. Archaeatropidae, a new family of Psocoptera from the Cretaceous amber of Alava, Northern Spain. Annals of the Entomological Society of America 93 (3), 367–373.

Chen, S., Deng, S.W., Shih, C., Zhang, W.W., Zhang, P., Ren, D., Zhu, Y.N., Gao, T.P., 2018. The earliest Timematids in Burmese amber reveal diverse tarsal pads of stick insects in the mid-Cretaceous. Insect Science 1–13. https://doi.org/10.1111/1744-7917.12601, 00.

Cockerell, T.D.A., 1921. Fossil Arthropods in the British Museum. VI. Oligocene Insects from Gurnet Bsy, Isle of Wight. Annals and Magazine of Natural History 7, 453–480, 9.

Du, S.L., Yao, Y.Z., 2018. A new genus and species of Tingidae (Heteroptera: Cimicomorpha) from Myanmar, with the analysis of the evolution of hood, carinae and paranota. Zoological Systematics 43 (3), 283–293.

Hakim, M., Azar, S., Maksoud, S., Huang, D., Azar, D., 2018. New polymorphic psyllipsocids from Burmese amber (Psocodea: Psyllipsocidae). Cretaceous Research 84, 389–400.

Kolbe, H.J., 1884. Der Entwickelungsgang der Psociden im Individuum und in der Zeit. Berliner Entomologische Zeitschrift 28, 35–38.

Kucerova, Z., 1997. Macropterous form of *Dorypteryx domestica* (Psocoptera: Psyllipsocidae). European Journal of Entomology 94, 567–573.

Li, F., Liu, X., 2009. Discovery in China of *Dorypteryx* Aaron (Psocoptera: Trogiomorpha: Psyllipsocidae), with one new species. Zootaxa 1983 63–65.

Li, F.S., 2002. Psocoptera of China. National Natural Science Foundation of China, Science Press, Beijing xlvi + 1976 pp.(two volumes).(in Chinese, with English summary).

Li, S., Zhang, W., Shih, C., Ren, D., 2018. A new species of hangingfly (Insecta: Mecoptera: Bittacidae) from the mid-Cretaceous Myanmar amber. Cretaceous Research 89, 92–97.

Lienhard, C., 2005. Description of a new beetle-like psocid (Insecta: Psocoptera: Protroctopsocidae) from Turkey showing an unusual sexual dimorphism. Revue Suisse de Zoologie 112, 333–349.

Lienhard, C., Mockford, E.L., 1997. New taxa and records of Troctopsocidae (Psocoptera). Mitteilungen der Schweizerischen Entomologischen Gesellschaft 70, 361–385.

Martynov, A., 1926. Jurrassic fossil insects from Turkestan. 6. Homoptera and Psocoptera. Bulletin of the Academy of Sciences of the U.S.S.R. 1926 1349–1366.

Mockford, E.L., 1993. North American Psocoptera (Insecta). Flora & Fauna Handbook 10, 455.

Mockford, E.L., Lienhard, C., Yoshizawa, K., 2013. Revised classification of "Psocoptera" from Cretaceous amber, a reassessment of published information. Insecta Matsumurana 69, 1–26.

Nel, A., Prokop, J., De Ploëg, G., Millet, J., 2005. New Psocoptera (Insecta) from the lowermost Eocene amber of Oise, France. Journal of Systematic Palaeontology 3, 371–391.

New, T.R., Lienhard, C., 2007. The Psocoptera of Tropical South-east Asia. Fauna Malesina Handbook 6. National Museum of Natural History Naturalis, Leiden, pp. 48–168.

Prerrichot, V., Azar, D., Néraudeau, D., Nel, A., 2003. New Psocoptera in the Early Cretaceous amber of SW France and Lebanon (Insecta: Psocoptera: Trogiomorpha). Geological Magazine 140 (6), 669–683.

Roesler, R., 1940. Neue und wenig bekannte Copeognathengattungen. I. Zoologischer Anzeiger 129 (9/10), 225–243.

Ross, A.J., 2018. Burmese (Myanmar) amber taxa. on-line checklist v.2018.2 from. https://www.nms.ac.uk/explore-our-cllections/stories/natural-would/burmese-amber.

Shi, G., Grimaldi, D.A., Harlow, G.E., Wang, J., Wang, J., Wang, M., Lei, W., Li, Q., Li, X., 2012. Age constraint on Burmese amber based on U-Pb dating of zicons. Cretaceous Research 37, 155–163.

Smithers, C.N., 1972. The classification and phylogeny of the Psocoptera. Memoirs of the Australian Museum 14, 1–349.

Smithers, C.N., 1990. Keys to the family and genera of Psocoptera (Arthropoda: Insecta). Technical Reports of Australian Museum 1–82.

Vishnikova, V.N., 1975. Psocoptera in Late Cretaceous insect-bearing resins from Taimyr. Entomologicheskoe Obozrenie 54, 94–96.

Yoshizawa, K., Lienhard, C., Johnson, K.P., 2006. Molecular systematics of the suborder Trogiomorpha (Insecta: Psocodea: "Psocoptera"). Zoological Journal of the Linnean Society 146, 287–299.

Zhang, Q., Nel, A., Azar, D., Wang, B., 2016. New Chinese psocids from Eocene Fushun amber (Insecta:Psocodea). Alcheringa 40 (3), 366–372.

Zhang, X., Ren, D., Yao, Y.Z., 2018. A new genus and species of Mimarachnidae (Hemiptera: Fulgoromprpha: Fulgoroidea) from mid-Cretaceous Burmese amber. Cretaceous Research 90, 168–173.