# First amber inclusion of a glaresid beetle from the Upper Cretaceous of Myanmar (Coleoptera: Scarabaeoidea)

**Article** *in* Cretaceous Research · April 2018

DOI: 10.1016/j.cretres.2018.04.022



**2 authors:**

Chenyang Cai
Nanjing Institute of Geology and Palaeontology, Chinese Academy...
**96** PUBLICATIONS **618** CITATIONS

SEE PROFILE

Diying Huang
Nanjing Institute of Geology and Palaeontology Chinese Academy...
**196** PUBLICATIONS **2,486** CITATIONS

SEE PROFILE

Cretaceous Research 90 (2018) 115–119

Contents lists available at ScienceDirect

Cretaceous Research

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

Short communication

# First amber inclusion of a glaresid beetle from the Upper Cretaceous of Myanmar (Coleoptera: Scarabaeoidea)

Chenyang Cai [a, b, c, *], Diying Huang [b, d]

[a] CAS Key Laboratory of Economic Stratigraphy and Palaeogeography, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, China
[b] Center for Excellence in Life and Paleoenvironment, Chinese Academy of Sciences, Nanjing 210008, China
[c] School of Earth Sciences, University of Bristol, Life Sciences Building, Tyndall Avenue, Bristol BS8 1TQ, UK
[d] State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing 210008, China

ARTICLE INFO

*Article history:*
Received 12 October 2017
Received in revised form
2 April 2018
Accepted in revised form 26 April 2018
Available online 30 April 2018

*Keywords:*
Palaeodiversity
Taxonomy
Scarabaeoidea
Cenomanian
Burmese amber

ABSTRACT

*Glaresis burmitica* sp. nov., the first amber inclusion of Glaresidae is described and figured based on a well preserved adult from the Upper Cretaceous Burmese amber. *Glaresis burmitica* differs from all extant and extinct congeners by its small body size, non-grooved pronotum, teeth on protibial outer margin, and unmodified outer margins of meso- and metatibia. The discovery of *Glaresis burmitica* from the Late Cretaceous suggests that the extant genus *Glaresis* is an ancient lineage, and its external morphologies changed very little through a long geological time. Together with previous findings in the Lower Cretaceous of northeastern China, it also highlights the palaeodiversity of the peculiar family Glaresidae.


## 1. Introduction

The beetle family Glaresidae is a small and widespread group of Scarabaeoidea distributed on all continents except for Australia and Antarctica. Very little is known about the biology of extant glaresids, and their immature stages remain largely unknown (Scholtz and Grebennikov, 2005; Král et al., 2017). Glaresidae includes only one extant genus *Glaresis* Erichson, comprising more than eighty extant species, most numerously represented in the Nearctic region (Král et al., 2017). Recent *Glaresis* species are found associated with sandy habitats (Ratcliffe and Paulsen, 2008). Glaresidae was regarded as the most primitive living scarabaeoids, which are sister to the rest of the Scarabaeoidea (Scholtz et al., 1994). A comprehensive phylogeny of Scarabaeoidea suggested Lucanidae and Glaresidae as the oldest lineages of Scarabaeoidea (Ahrens et al., 2014). By contrast, a recent DNA-based phylogeny showed that Glaresidae is sister either to Trogidae (*Trox*) + Geotrupidae (*Geotrupes*) or to Geotrupidae (*Taurocerastes*) + Lucanidae (including Diphyllostomatidae) (McKenna et al., 2015). The exact phylogenetic of Glaresidae among Scarabaeoidea awaits further exploration.

To date, six extinct glaresid species within three genera have been documented. They include two extinct genera: *Cretoglaresis* Nikolaev, 2007 (two species) and *Lithoglaresis* Nikolaev, 2007 (one species). The other three glaresid species, *Glaresis cretacea* Nikolajev, *G. orthochilus* Bai et al. and *Glaresis tridentata* Bai et al., are from the Lower Cretaceous Zaza Formation in Baissa of Russia and the Lower Cretaceous Yixian Formation in Beipiao, Liaoning Province, China (Nikolajev, 2007; Bai et al., 2010, 2014). The placement of some Cretaceous forms (e.g. *Cretoglaresis nana*, *Glaresis cretacea* and *Lithoglaresis ponomarenkoi*) in Glaresidae is somewhat problematic, because the holotypes of these species are incompletely preserved and show no distinct diagnostic characters of Glaresidae (Nikolaev, 2007, 2009). By contrast, two fossil species known from the Yixian Formation are nearly completely preserved; several defining features (e.g. presence of typical incision between canthus and clypeus) are clearly shown (Bai et al., 2010, 2014). All fossil glaresids

* Corresponding author. Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, 39 East Beijing Road, Nanjing 210008, China.
*E-mail address:* cycai@nigpas.ac.cn (C. Cai).

https://doi.org/10.1016/j.cretres.2018.04.022
0195-6671/

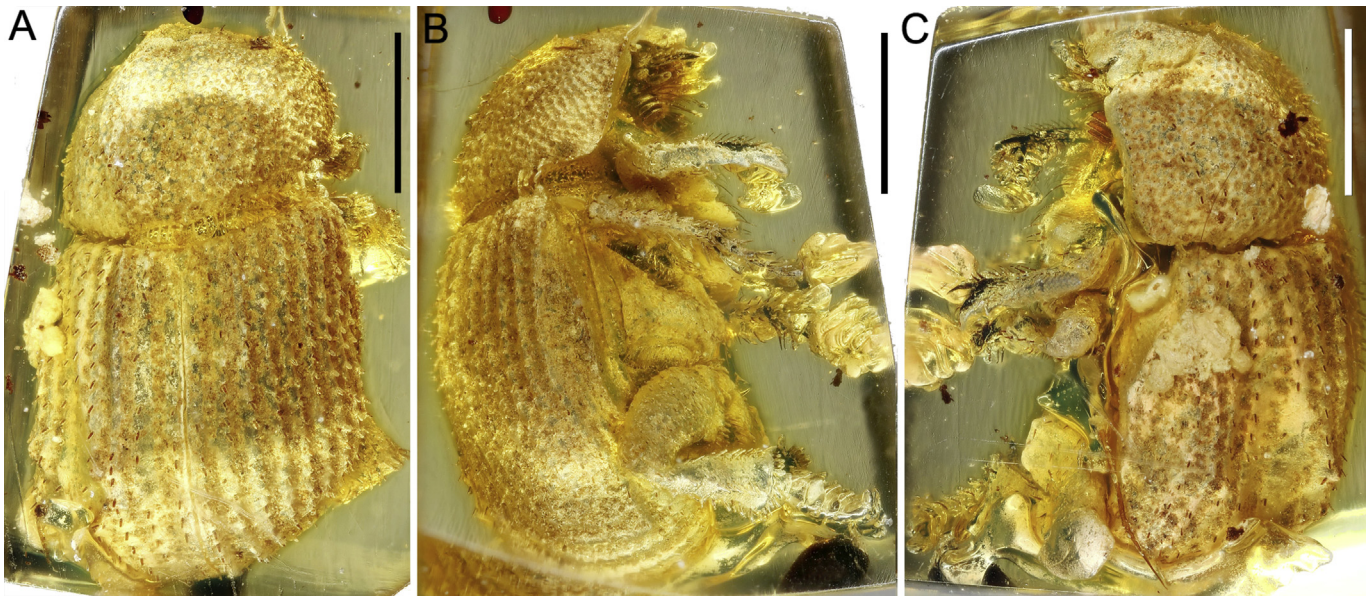


**Fig. 1.** Microphotographs of holotype (NIGP166866) of *Glaresis burmitica* sp. nov. from Upper Cretaceous Burmese amber; under normal reflected light. A. dorsal view; B. lateral view of right side; C. lateral view of left side. Scale bars: 1 mm.

are known from compression fossils. Here we describe the first fossil glaresid preserved in Upper Cretaceous amber from northern Myanmar.

## 2. Material and methods

The new species is described on the basis of a single specimen preserved in Burmese amber (Hukawng Valley, northern Myanmar, e.g., Yin et al., 2018: fig. 1A). Observations and photographs were made using a Zeiss Discovery V20 stereo microscope and a Zeiss Axio Imager 2 light microscope with a digital camera attached respectively. The Zeiss Axio Imager 2 microscope was equipped with a mercury lamp and specific filters for DAPI, eGFP and rhodamine. Photomicrographs with green background were taken under the eGFP mode. Extended depth of field images were digitally compiled using Helicon Focus 3.10 software, and arranged in Adobe Photoshop CS5. The nomenclatural acts established herein are registered under ZooBank LSID urn:lsid:zoobank.org:pub:C202097B-8345-44B8-8758-C0BF2B8E3B88.

## 3. Systematic palaeontology

Order Coleoptera Linnaeus, 1758
Family Glaresidae Semenov-Tian-Shanskij and Medvedev, 1932

Genus *Glaresis* Erichson, 1848
(Type species: *Glaresis rufa* Erichson, 1848)

***Glaresis burmitica*** sp. nov.
Figs. 1–3

*Etymology.* The specific epithet refers to the occurrence of the fossil in Burmite (Burmese amber). The species is registered under LSID urn:lsid:zoobank.org:act:595A5389-CA87-4F25-9817-DC1DABCEAC2B.
*Holotype.* NIGP166866, sex undetermined. Lowermost Cenomanian (ca. 99 Ma), Hukawng Valley, northern Myanmar; the type specimen is deposited in the Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, China.
*Diagnosis.* Body small (ca. 3.47 mm long); anterior margin of clypeus with several small incisions; pronotum convex, without grooves (foveae); outer margin of protibia with one large apical tooth and two inconspicuous obtuse teeth; and outer margins of meso- and metatibia nearly straight, without spines, dentiform processes, or ridges.
*Description.* Body (Fig. 1) robust, strongly convex, slightly widened toward apex, brownish yellow in color; macrosetation pale. Body small, 3.47 mm long (as preserved, measured from anterior margin of head to abdominal apex).

Head (Fig. 3) strongly deflexed; head surface finely rugose. 0.88 mm wide (across canthus) and 0.94 mm long (from mandibular apex to posterior margin of head). Eye (Fig. 3) concealed under pronotum, with a large canthus. Mandible (Fig. 3A) robust, with sharp apex and strong lateral prominence, with one large obtuse preapical tooth. Anterior margin of clypeus (Fig. 3B) nearly straight; lateral margin nearly perpendicular to anterior margin. Surface of frons and clypeus (Fig. 3) covered with relatively dense punctures. Antenna (Fig. 2B) very short, asymmetric, with apical three antennomeres forming a large club; surface of antennomeres 8 and 9 densely armed with peg-like olfactory sensilla (c.f. Figs. 30–33 in Anton and Beutel, 2012). Maxillary palpus with apical palpomere elongate.

Pronotum (Fig. 2A) transverse, 1.23 mm long and 1.73 mm wide, strongly convex, without medial longitudinal groove (fovea) or anterior transverse groove. Surface covered with small dense round punctures and stiff scale-like macrosetae. Lateral margin not bordered, not serrate, with a row of setae; posterior angle rounded. Scutellum small, sub-triangular, smooth, glabrous. Hind wing, if present, not visible.

Elytra (Fig. 2A, D) strongly convex, 1.29 mm long, and each about 1.10 mm wide; with ten striae and ten intervals; each stria with a row of coarse punctures; all bearing a row of short, erect,

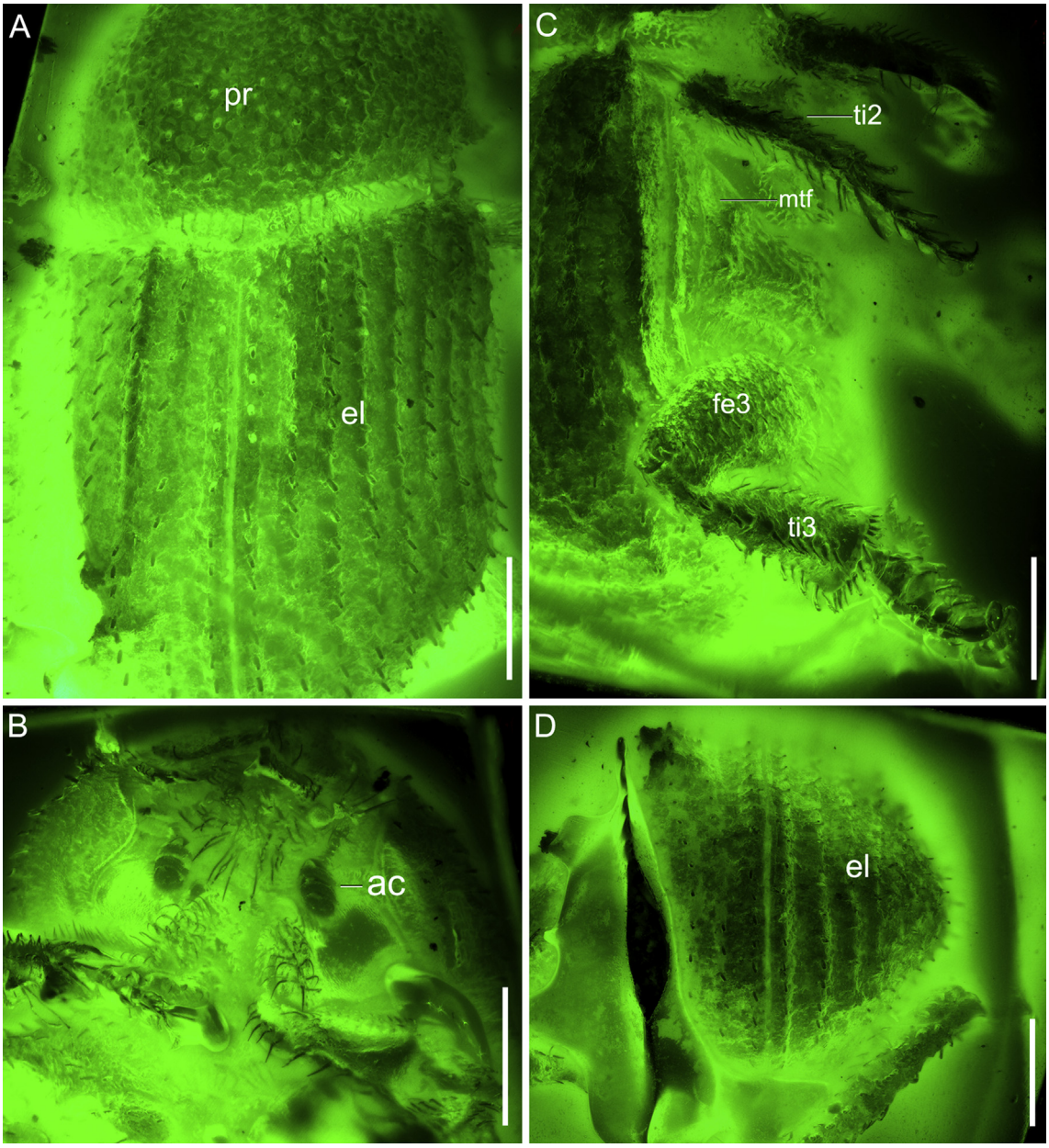


**Fig. 2.** Enlargements of holotype (NIGP166866) of *Glaresis burmitica* sp. nov., under green fluorescence. A. dorsal view of pronotum and elytra; B. ventral view of head and prothorax; C. lateral view of middle and hind legs; D. posterior view of elytra, showing strongly convex body shape. ac, antennal club; el, elytron; fe3, metafemur; mtf, mesotibial fossa; pr, pronotum ti2–3, meso- and metatibia. Scale bars: 500 μm. (For interpretation of the references to color/colour in this figure legend, the reader is referred to the Web version of this article.)

scale-like macrosetae. Metaventrite short, with sparse macrosetae. Mesotibial fossa of meso-metaventrum present, distinctly impressed.

Legs robust. Procoxae (Fig. 2B) large, setose, contiguous. Protibia with at least three rows of longitudinal macrosetae and one large spur; anterior margin of protibia oblique, with three small stiff macrosetae near spur; outer margin of protibia with three teeth: apical one elongate, obtuse at apex; middle one sub-triangular, obtuse; basal-most one very indistinct, obtuse. Mesocoxae contiguous. Mesotibia (Fig. 2C) long, nearly straight, with four longitudinal rows of long macrosetae; outer edge of mesotibia not emarginate, without spines. Mesotarsus with basal four tarsomeres elongate, each with four macrosetae at apex; mesotarsomere longest. Metacoxae contiguous. Metatrochanter subtriangular, with sparse setae. Metafemur (Fig. 2C) very robust, with dense short macrosetae; posterior margin of metafemur without teeth. Metatibia (Figs. 2C and 4) broadly triangular, with four regular longitudinal rows of long macrosetae; outer margin nearly straight, not serrate; apex of metatibia with a circle of dense macrosetae and two large spurs. Metatarsus stout, with basal four tarsomeres slightly elongate, each with four macrosetae at apex; mesotarsomere longest.

Genitalia not visible.

## 4. Discussion

The fossil can be assigned to the extant Glaresidae based on its general robust body form, declined head, 10-segmented antennae, presence of typical macrosetae on body surface, and more importantly, the presence of a deep incision (Fig. 3B) between the canthus

and clypeus (e.g. Gordon, 1970). Both probable autapomorphies for Glaresidae (wing veins RP1 reduced, RP3+4 reduced) are not preserved in the fossil (Scholtz and Grebennikov, 2005).

The body size of *Glaresis burmitica* sp. nov. (3.47 mm long) is comparatively small among all known Glaresidae. The body lengths of extant glaresids range from 2.5 mm to 6 mm (Scholtz et al., 1987; Scholtz and Grebennikov, 2005). By contrast, with a body length of over 8 mm, two extinct species from the Early Cretaceous (*G. orthochilus* and *G. tridentate*) are significantly larger than extant taxa and this new species. If the small body of Glaresidae is a derived condition as suggested by Bai et al. (2014), the new fossil also possesses many ancestral characters.

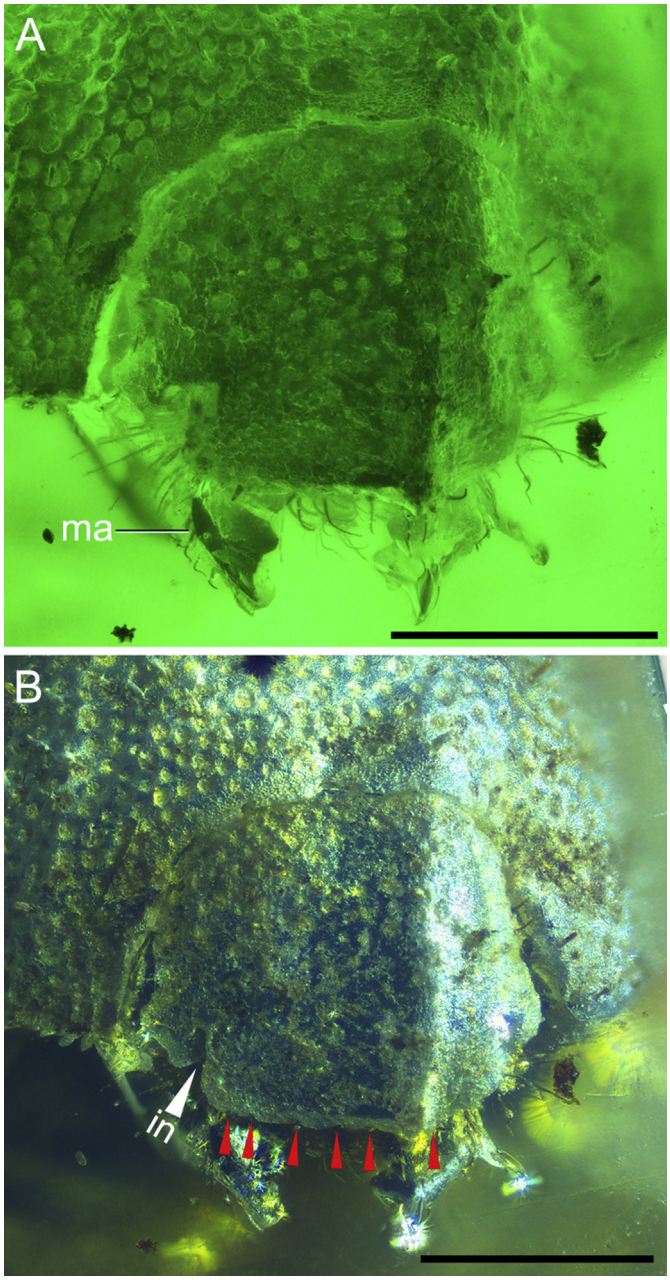


**Fig. 3.** Head morphology of *Glaresis burmitica* sp. nov., frontal view. A. under green fluorescence; B. under normal reflected light, with white arrow indicating deep incision between canthus and clypeus and red arrows indicating small incisions in anterior margin of clypeus. in, incision; ma, mandible. Scale bars: 500 μm. (For interpretation of the references to color/colour in this figure legend, the reader is referred to the Web version of this article.)

First, the pronotum of *G. burmitica* completely lacks grooves, a character only found in a few species of *Glaresis*, such as extant members of the *Glaresis*-Ecostata Group (Gordon and Hanley, 2014). Most extant glaresids are characterized by a distinct or indistinct medial longitudinal groove and usually an anterior transverse groove (Gordon and Hanley, 2014). It is unfortunate that this character is not shown in both Early Cretaceous species (Bai et al., 2010, 2014), making it difficult to make a critical comparison among fossil species.

Second, the outer margins of meso- and metatibiae are not modified in *G. burmitica*. By contrast, the margins of both tibiae, especially of the mesotibiae, are moderately to highly modified in extant species, viz. the meso- and metatibiae are variously armed with dentiform processes, ridges and seta (e.g., Scholtz et al., 1987; Gordon and Hanley, 2014; Paulsen, 2016; Král et al., 2017). These characters are regarded as morphological adaptions for a fossorial existence (Scholtz et al., 1987). It is probable that unmodified meso- and metatibiae represent an ancestral condition.

It is noteworthy that the outer protibial teeth of *G. burmitica* is obtuse and inconspicuous, rather than relatively large and sharp as in most glaresids. The morphology of the protibial teeth of *G. burmitica* is very similar to that of *G. pardoalcaidei* from South America (Gordon and Hanley, 2014). By contrast, in the two slightly older Early Cretaceous species, the teeth are conspicuous and sharp (Bai et al., 2010, 2014) when compared to those in *G. burmitica*.

Most modern glaresids currently occur in sandy areas in arid regions (Scholtz et al., 1987; Scholtz and Grebennikov, 2005; Paulsen, 2016), although some species are collected from habitats apparently lacking sand (Gordon and Hanley, 2014). It is interesting that there are other reports about the occurrence of sand-associated arthropods discovered in Burmese amber. Cai et al. (2017) reported the first representative, *Protonicagus tani* Cai et al., belonging to the extant stag beetle tribe Nicagini (subfamily Aesalinae). Unlike typical lucanids, all modern species of the closely related extant *Nicagus* are known from sandy habitats along bodies of water (Paulsen and Smith, 2005). Another typical sand-related arthropods from Burmese amber are Solifugae, or camel spiders (Dunlop et al., 2015; Bartel et al., 2016). As implied by their common name, solifuges are mainly found in arid environments, including all desert regions of the world (except Australia) (Dunlop et al., 2015). Along with the facts mentioned above, our discovery of a sandy-habitat-associated beetle suggests that there were sandy habitats near the Late Cretaceous amber forest (Cai et al., 2017). Therefore, the Cretaceous solifuges from the ancient Burmese forest are not necessarily a forest-dweller as hypothesized by Dunlop et al. (2015).

## 5. Concluding remarks

Our discovery of *Glaresis burmitica* sp. nov. from Burmese amber represents the first amber-preserved representative for Glaresidae. The new species displays many ancestral characters of Glaresidae, and it may be important in further phylogenetic studies. The close morphological similarities to its extant counterparts suggest that *G. burmitica* may have lived in a similar sandy habitats in the Late Cretaceous. The find also reinforces the hypothesis that *Glaresis* is a very ancient group, which originated before the Early Cretaceous, likely in the Late Jurassic.

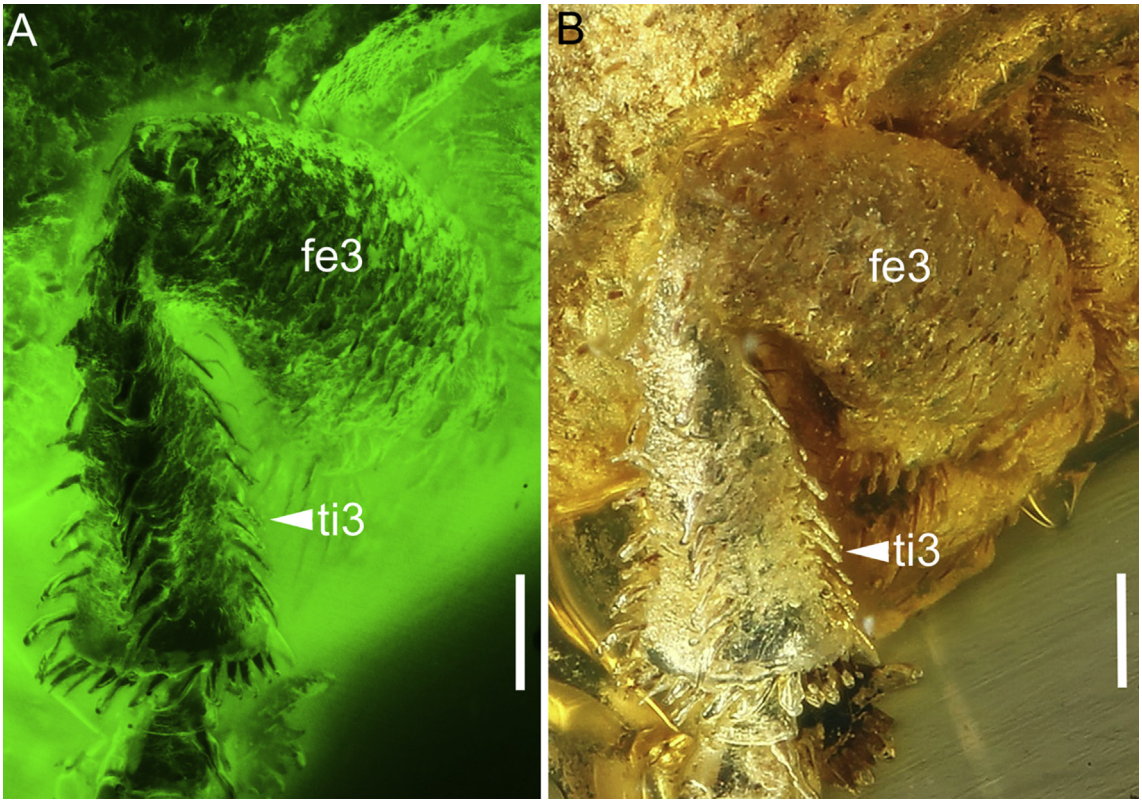


**Fig. 4.** Metatibial morphology of *Glaresis burmitica* sp. nov., lateroventral view. A. under green fluorescence; B. under normal reflected light. fe3, metafemur; ti3, metatibia. Scale bars: 200 μm. (For interpretation of the references to color/colour in this figure legend, the reader is referred to the Web version of this article.)

## Acknowledgments

We thank two anonymous reviewers for helpful comments on an earlier version of the manuscript. The work has been supported by the Ministry of Science and Technology (2016YFC0600406), the Chinese Academy of Sciences (XDPB05) the National Natural Science Foundation of China (41672011, 41602009, 91514302), and the Natural Science Foundation of Jiangsu Province (BK20161091).

## References

Anton, E., Beutel, R.G., 2012. The adult head morphology of *Dascillus* (L.) (Dascilloidea: Dascillidae) and *Glaresis* Erichson (Scarabaeoidea: Glaresidae) and its phylogenetic implications. Arthropod Systematics and Phylogeny 70, 3–42.

Ahrens, D., Schwarzer, J., Vogler, A.P., 2014. The evolution of scarab beetles tracks the sequential rise of angiosperms and mammals. Proceedings of the Royal Society of London B: Biological Sciences 281 (1791), 20141470.

Bai, M., Beutel, R.G., Liu, W.-G., Li, S., Zhang, M.-N., Lu, Y.-Y., Song, K.-Q., Ren, D., Yang, X.-K., 2014. Description of a new species of Glaresidae (Coleoptera: Scarabaeoidea) from the Jehol Biota of China with a geometric morphometric evaluation. Arthropod Systematics & Phylogeny 72, 223–236.

Bai, M., Krell, F.T., Ren, D., Yang, X., 2010. A new, well-preserved species of Glaresidae (Coleoptera: Scarabaeoidea) from the Jehol Biota of China. Acta Geologica Sinica (English Edition) 84 (4), 676–679.

Bartel, C., Dunlop, J.A., Bird, T.L., 2016. The second camel spider (Arachnida, Solifugae) from Burmese amber. Arachnology 17 (3), 161–164.

Cai, C., Yin, Z., Liu, Y., Huang, D., 2017. *Protonicagus tani* gen. et sp. nov., the first stag beetles from Upper Cretaceous Burmese amber (Coleoptera: Lucanidae: Aesalinae: Nicagini). Cretaceous Research 78, 109–112.

Dunlop, J.A., Bird, T.L., Brookhart, J.O., Bechly, G., 2015. A camel spider from Cretaceous Burmese amber. Cretaceous Research 56, 265–273.

Erichson, W.F., 1848. Scaphididae-Scarabaeidae. Naturgeschichte der Insecten Deutschlands 3, 1–968.

Gordon, R.D., 1970. A review of the genus *Glaresis* in the USA and Canada (Coleoptera: Scarabaeidae). Transactions of the American Entomological Society (Philadelphia) 96, 499–517.

Gordon, R.D., Hanley, G.A., 2014. Systematic revision of American Glaresidae (Coleoptera: Scarabaeoidea). Insecta Mundi 0333, 1–91.

Král, D., Hrůzová, L., Lu, Y., Bai, M., 2017. First records of Glaresidae (Coleoptera) in China, with the description of a new species from Inner Mongolia and Shaanxi. Zootaxa 4306 (1), 145–150.

Linnaeus, C., 1758. Systema Naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis, 10th revised ed., vol. 1. Laurentius Salvius, Holmiae (Stockholm). iv + 824 pp.

McKenna, D.D., Farrell, B.D., Caterino, M.S., Farnum, C.W., Hawks, D.C., Maddison, D.R., Seago, A.E., Short, A.E.Z., Newton, A.F., Thayer, M.K., 2015. Phylogeny and evolution of Staphyliniformia and Scarabaeiformia: forest litter as a stepping stone for diversification of nonphytophagous beetles. Systematic Entomology 40, 35–60.

Nikolaev, G.V., 2007. Mezozoiskii Etap Evolyutsii Plastinchatousykh (Insecta: Coleoptera: Scarabaeoidea), 222 pp. Kazak Universiteti, Almaty, Kazakhstan [in Russian].

Nikolajev, G.V., 2009. New species of scarabaeoid beetles from the family Glaresidae (Coleoptera: Scarabaeoidea) from the Cretaceous of Transbaikalia. Paleontological Journal 43, 425–427.

Paulsen, M.J., 2016. Two new species of South American Glaresidae (Coleoptera: Scarabaeoidea). Zootaxa 4154 (5), 595–600.

Paulsen, M.J., Smith, A.D., 2005. A new species of stag beetle from sand dunes in west Texas, and a synopsis of the genus Nicagus (Coleoptera: Lucanidae: Aesalinae: Nicagini). Zootaxa 1050, 45–60.

Ratcliffe, B.C., Paulsen, M.J., 2008. The scarabaeoid beetles of Nebraska. Bulletin of the University of Nebraska State Museum 22, 1–570.

Scholtz, C.H., Browne, D.J., Kukalová-Peck, J., 1994. Glaresidae, Archaeopteryx of the Scarabaeoidea (Coleoptera). Systematic Entomology 19 (3), 259–277.

Scholtz, C.H., Dhotman, D., Nel, A., 1987. Glaresidae, a new family of Scarabaeoidea (Coleoptera) to accommodate the genus *Glaresis* Erichson. Systematic Entomology 12 (3), 345–354.

Scholtz, C.H., Grebennikov, V.V., 2005. Scarabaeoidea Latreille, 1802. In: Beutel, R.G., Leshen, R.A.B. (Eds.), Coleoptera, Beetles. Volume 1. Morphology and systematics (Archostemata, Adephaga, Myxophaga, Polyphaga partim). In: Kristensen, N.P., Beutel, R.G. (Eds.), Handbook of Zoology. A natural history of the phyla of the animal kingdom. Volume IV. Arthropoda: Insecta. Part 38. Walter de Gruyter, Berlin, pp. 366–425.

Semenov-Tian-Shanskij, A., Medvedev, S., 1932. Revisio synoptica specierum palaearcticarum novae tribus Glaresini (Coleoptera, Scarabaeidae). In: Peyerimhoff, P. (Ed.), Livre de Centenaire. Société Entomologique de France, Paris. Pp. 337–342. Pl. 21.

Yin, Z., Cai, C., Huang, D., 2018. Last major gap in scydmaenine evolution filled (Coleoptera: Staphylinidae). Cretaceous Research 84, 62–68.