

# A new species of *Baeomorpha* (Hymenoptera, Rotoitidae) from mid-Cretaceous Burmese amber

John T. Huber<sup>1</sup>, Chungkun Shih<sup>2,3</sup>, Dong Ren<sup>2</sup>

**1** Natural Resources Canada, c/o Canadian National Collection of Insects, K.W. Neatby Building, 960 Carling Avenue, Ottawa, ON, K1A 0C6, Canada **2** College of Life Sciences, Capital Normal University, 105 Xisanhuanbeilu, Haidian District, Beijing 100048, China **3** Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, DC 20013, USA

Corresponding author: John T. Huber ([john.huber2@canada.ca](mailto:john.huber2@canada.ca))

Academic editor: P. Jansta | Received 16 April 2019 | Accepted 22 September 2019 | Published 31 October 2019

<http://zoobank.org/7B54E5F9-1B2E-422D-B744-81DC129359AC>

**Citation:** Huber JT, Shih C, Ren D (2019) A new species of *Baeomorpha* (Hymenoptera, Rotoitidae) from mid-Cretaceous Burmese amber. Journal of Hymenoptera Research 72: 1–10. <https://doi.org/10.3897/jhr.72.35502>

## Abstract

A fossil species from mid-Cretaceous Burmese amber, *Baeomorpha liorum* Huber, Shih & Ren, **sp. nov.** (Rotoitidae: Hymenoptera), is described and illustrated. Its relationship to other extinct and extant taxa of Rotoitidae is discussed. The location of the amber deposits in which this species was found is well south of the “*Baeomorpha* Realm” proposed by previous authors who suggested that the origin and diversification of Rotoitidae occurred in North Laurasia. Based on the Burmese specimens, we suggest instead that the most parsimonious explanation for the past and present distribution of the family is to assume that Rotoitidae is an ancient lineage of Chalcidoidea that was originally widespread in suitable habitats across both Laurasia and Gondwana and later became extinct everywhere except Chile and New Zealand where the two extant genera occur.

## Keywords

Chalcidoidea, Rotoitidae, Burmese amber, Laurasia, Gondwana

## Introduction

Two extant genera of Rotoitidae (Hymenoptera), each containing one described species, are known: *Rotoita* Bouček & Noyes, 1987 and *Chiloe* Gibson & Huber, 2000. Gibson and Huber (2000) reviewed the family, at the time thought to be known only

from extant taxa, and discussed its relationships to other families of Chalcidoidea. Gumovsky et al. (2018) transferred to Rotoitidae the genus *Baeomorpha* Yoshimoto, with four species from Canadian Cretaceous amber classified by Yoshimoto (1975) in Baeomorphinae (Tetracampidae). They described from Cretaceous Taimyr amber 11 new species of *Baeomorpha* and 1 species of a new genus, *Taimyromorpha* Gumovsky. They also placed Baeomorphinae as a junior synonym of Rotoitidae and synonymized two of the four Cretaceous Canadian species of *Baeomorpha*. The world fauna of Rotoitidae thus contains two described extinct genera with 13 described extinct species from northern Laurasia and two described extant genera with one described species each, one in Chile and one in New Zealand. Here, a new fossil species is described from mid-Cretaceous Burmese amber and its relationships to extinct and extant taxa are discussed.

## Methods

The new species is described from two specimens in a polished piece of Burmese amber from a deposit dated at about 99 ma (Shi et al. 2012). The amber piece also contains a few fragments of debris and an incomplete specimen of a nematoceran fly (Diptera). Morphological terms used in the descriptions mostly follow Gumovsky et al. (2018). Measurements of the two specimens, taken with an ocular micrometer attached to a Leitz binocular microscope at 100× magnification, are given in micrometers (µm) except for antennal segments, which are given as ratios. For the most part body sculpture and setation, especially of the mesosoma, is not clearly visible so is not described. Photographs of slide mounts were taken with a ProgRes C14<sup>plus</sup> digital camera attached to a Nikon Eclipse E800 compound microscope, and a selection of the resulting layers combined electronically in Zerene Stacker. Abbreviations used in the descriptions are: fl for funicle segment. The amber piece containing the type specimens is deposited in the collection of Key Lab of Insect Evolution and Environmental Changes, Capital Normal University, Beijing, China (CNUB).

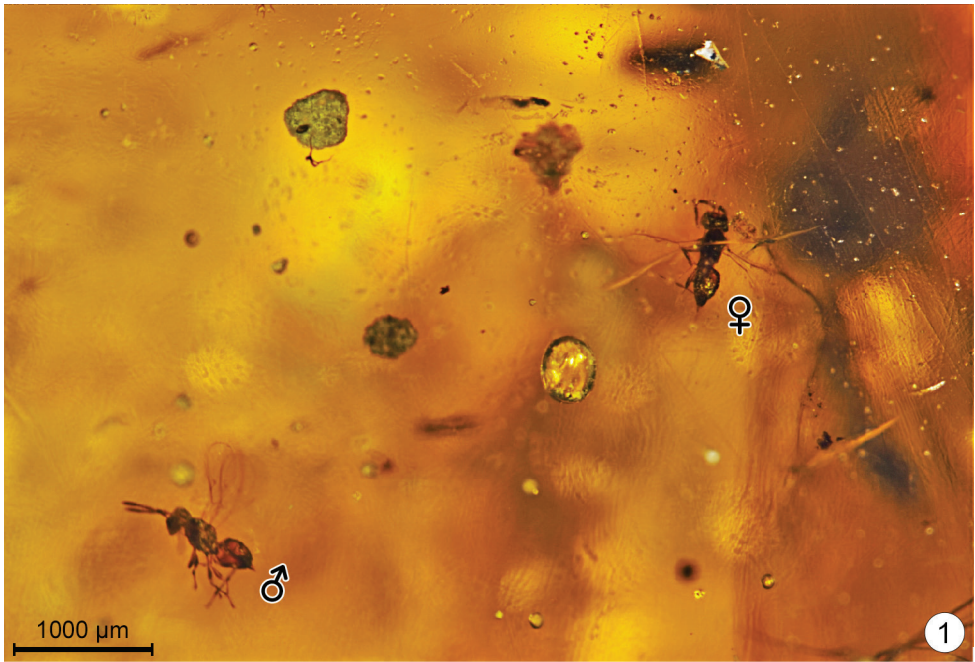
## Taxonomy

### *Baeomorpha liorum* Huber, Shih & Ren, sp. nov.

<http://zoobank.org/1B11F935-B7E7-4B2B-9DC1-8B8C45E529C5>

Figs 1–7

**Type material.** Holotype female (Fig. 2, CNU-HYM-MA-2015007) and allotype male (Fig. 5, CNU-HYM-MA-2015008) (CNUB), in a single piece of polished amber (Fig. 1). Two labels are added to the container: “Holotype ♀ *Baeomorpha liorum* Huber, Shih & Ren” [red label] and “Allotype ♂ *Baeomorpha liorum* Huber, Shih & Ren” [yellow label].



**Figures 1, 2.** **1** Amber piece containing the holotype and allotype of *Baeomorpha liorum* **2** *Baeomorpha liorum*, holotype female, habitus.

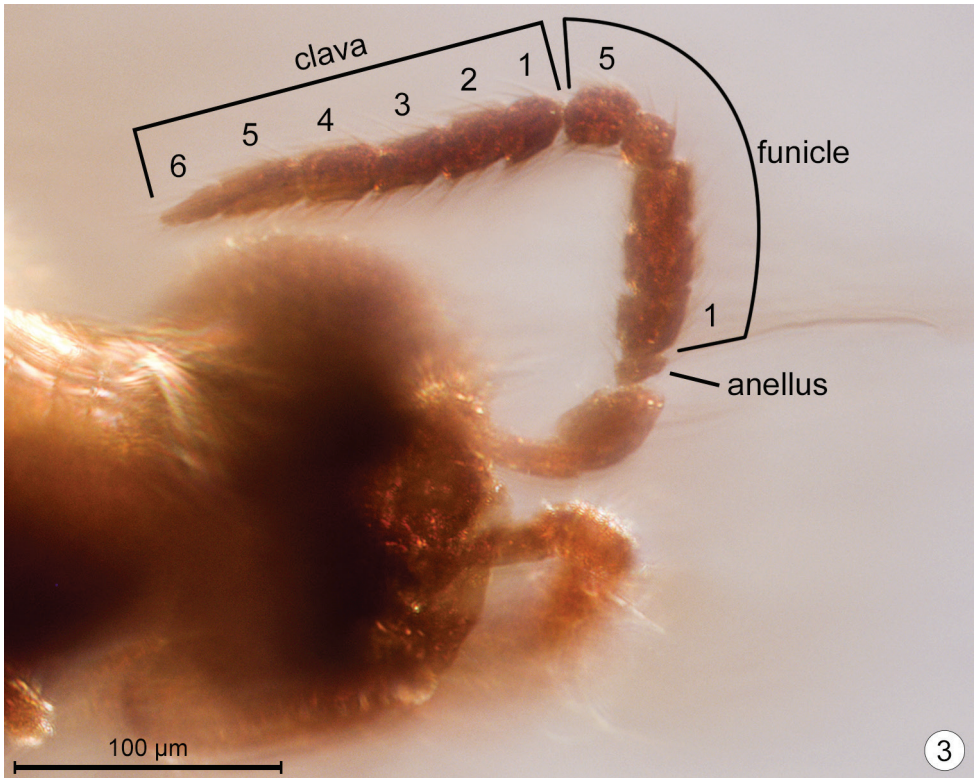
**Diagnosis. Female.** Antenna (Fig. 3) with 1 anellus, 5-segmented funicle and 6-segmented clava;  $fl_1$ – $fl_3$  with wider junctions than those between  $fl_3$ – $fl_5$ , and  $fl_5$  and clava;  $fl_4$  the smallest funicle segment. **Male.** Antenna (Fig. 6) with 1 anellus, 5-segmented funicle and 5-segmented clava.

**Description. Female.** Body length 645. Colour fairly uniformly brown, with slight green metallic tinge (may be an artefact) under certain angles of reflected light; legs slightly lighter. Sculpture and setation not visible. Wings hyaline, with venation, including basal vein, brown. **Head** width 210, length  $\approx 125$ . **Antenna.** Scape (not clearly visible) in dorsal view narrow (Fig. 3); pedicel slightly wider than long (40: 30) and slightly wider than any flagellar segment; clava slightly longer than funicle + anellus (160: 140). Anellus  $0.5\times$  as long as wide and somewhat triangular;  $fl_1$ – $fl_3$  and  $fl_5$  distinctly longer and wider than either anellus or  $fl_4$ ;  $fl_1$  about  $0.95\times$  as long as wide,  $fl_2$  about  $0.88\times$  as long as wide,  $fl_3$  about as long as wide,  $fl_4$  about  $0.85\times$  as long as wide and the smallest funicle segment, and  $fl_5$   $1.2\times$  as long as wide. Multiporous plate sensilla (mps) visible on  $fl_1$ – $fl_3$ ,  $fl_4$ ,  $fl_5$  and at least the apical three claval segments (not clear on remaining claval segments, but probably present); mps absent on anellus and  $fl_4$ . The number of mps cannot be ascertained but there are at least two on each segment that has mps. **Mesosoma** length  $\approx 250$ , metasoma length  $\approx 335$ . Pronotum length  $\approx 50$ , mesonotum length  $\approx 140$ , metanotum length  $\approx 20$ , propodeum length  $\approx 40$ . **Wings.** Fore wing length 600, width 220, longest marginal setae 70; hind wing length 355, width 30, longest marginal setae 30. Submarginal vein 190, parastigma + marginal vein 100, stigmal vein 50, with uncus distinct; postmarginal vein  $\approx 150$ ; postmarginal vein about  $3.4\times$  stigmal vein length. **Metasoma** length 340. Ovipositor not clearly visible, slightly exerted beyond apex of gaster (Fig. 4) (a slight deformity/crack? in the amber makes it difficult to determine the true extent of the exerted part).

**Male.** Body length 600. Colour as in female. **Head** width not measurable, length  $\approx 90$ . Mandibles crossing when closed, apparently with 3 equal teeth. Vertex with sculpture consisting of isodiametric reticulations. **Antenna.** Scape width  $\approx 30$ , length  $\approx 90$ , in lateral view (Fig. 6) as wide as pedicel and about  $2\times$  as long; pedicel about  $1.0\times$  as long as wide; anellus  $1.5\times$  as long as wide;  $fl_1$ – $fl_3$  and  $fl_5$  distinctly longer and wider (on one antenna) than or subequal (on other antenna) to  $fl_4$  and distinctly longer and wider than anellus (probably on both antennae, the anellus not clearly visible on one antenna). **Mesosoma.** Slightly shorter than metasoma (250:270); sculpture of dorsum apparently consisting of small isodiametric reticulations. Pronotum not clearly visible, presumably short; mesonotum  $\approx 50$ ; scutellum  $\approx 90$ ; metanotum  $\approx 20$ ; propodeum  $\approx 50$ . **Wings.** Fore wing length  $\approx 590$ , width  $\approx 240$ , longest marginal setae  $\approx 50$ ; postmarginal vein  $\approx 3.2\times$  stigmal vein length; hind wing length 375, width 40, longest marginal setae about width of hind wing. **Metasoma.** Gaster 270, with gastral terga subequal in length (Fig. 7), each  $\approx 40$ – $50$  (measured along dorsal margin). Genitalia  $\approx 60$  (almost entirely exerted).

**Etymology.** The specific epithet is a patronym honoring Mr. Li Jun and his wife from Jinan, Shandong Province, who obtained the fossil and kindly donated it to CNU.





**Figures 3, 4.** **3** *Baeomorpha liorum*, holotype antenna **4** *Baeomorpha liorum*, holotype metasoma.

**Discussion.** The new species belongs clearly in *Baeomorpha* as defined by Gumovsky et al. (2018). They distinguished it from the other extinct genus, *Taimyromorpha*, by the stigmal vein long and narrower than stigma, and uncus present (stigmal vein short, as wide as stigma and uncus absent in *Taimyromorpha*). *Baeomorpha* differs from the two extant genera as follows: both sexes fully winged (micropterous in *Chiloe*), with notauli (only visible in male) complete and linear (notauli absent in *Rotoita*).

On the basis of the pedicel being about as wide as  $fl_1$ , the female of *B. liorum* keys fairly well to *B. yantardakh* Gumovsky but their images of the female antenna (Gumovsky et al. 2018, fig. 17) are very different so we conclude the Burmese female cannot be that species. If one continues past couple 9, their key becomes difficult to use because not all features mentioned, e.g., scape length and width and head width, can be seen properly or accurately measured on the female of *B. liorum*. Similarly, at their couplet 10, not all features can be assessed properly but the most likely species in those couplets are either *B. zherikhini* Gumovsky or *B. gracilis* Gumovsky. The male of *B. liorum* keys best to *B. gracilis* because it has the distance between the junction of the stigmal vein with the marginal vein and the junction of the basal vein with the submarginal vein (PSM of Gumovsky et al. 2018) about 3.2× as long as stigmal vein, exactly as in *B. gracilis*. Assuming the two sexes of *B. liorum* are conspecific, we doubt that *B. liorum* is the same as any previously described *Baeomorpha* species. The distribution and possibly time of occurrence in the geological record (Taimyr amber is dated as Upper Cretaceous, 84–100 ma) also suggests that it is unlikely that *B. liorum* is the same as one of the previously described species of *Baeomorpha* from western Canada (Medicine Hat area, Alberta) or Taimyr amber.

Gumovsky et al. (2018) noted the unusual variation in number of funicular and claval segments among the fossil *Baeomorpha*. While this meristic variation among species within a given genus is uncommon, it occurs widely among families of extant Chalcidoidea, notably, in females and sometimes in males, in several genera of Mymaridae, the most ancestral lineage of Chalcidoidea (Heraty et al. 2013). Thus, the meristic differences seen among the various *Baeomorpha* species are not particularly unusual. In the male of *B. liorum* the size of  $fl_4$  differs between the antennae, a bilateral variation that occurs not infrequently in individuals of Mymaridae. Given this sort of variation we question whether Gumovsky et al. (2018) have not over split the species of *Baeomorpha* so far found in Taimyr amber.

Mymaridae is the most ancestral lineage of Chalcidoidea followed by Rotoitidae and then the remaining Chalcidoidea (Heraty et al. 2013). Mymaridae are well known in the fossil record, with the earliest species occurring in 99 my old Burmese amber (Poinar and Huber 2011) and the family is worldwide and especially well represented in generic diversity in the Southern Hemisphere. In contrast, Rotoitidae, as old as Mymaridae based on the age of *B. liorum*, are now restricted as extant species to New Zealand and southern Chile.

Gumovsky et al. (2018) proposed that Rotoitidae originated in Laurasia, based on the fossil evidence then available. This contrasts with Gibson and Huber (2000) who hypothesized a Gondwanan origin of Rotoitidae. Huber (2017) suggested that Chalcidoidea, or at least Mymaridae, originated in the Jurassic and perhaps the latter taxon was





**Figure 5.** *Baeomorpha liorum*, allotype male, habitus.

already present even earlier and possibly was widespread in Pangaea. If so, the distribution of Mymaridae and Rotoitidae, both as mid-Cretaceous fossils in northern Laurasia and in Burmese amber, and the present day distribution of both families as extant genera, either worldwide (Mymaridae) or in remnants of Gondwana (Rotoitidae), would then be explained simply as their expected distribution after the breakup of Pangaea began 200



**Figures 6, 7.** *Baeomorpha liorum*, allotype antenna. **7** *Baeomorpha liorum*, allotype metasoma.



million years ago. The distribution of *B. liorum* disproves the hypothesis that Rotoitidae originated in North Laurasia, specifically in their “*Baeomorpha* Realm” (Gumovsky et al. 2018, fig. 22) but does not exclude the possibility that *B. liorum*, perhaps together with other Burmese amber fossils, originated partly or entirely from somewhere in the southeast Laurasia mainland before or during the mid-Cretaceous. Rasnitsyn and Ölm-Kühnle (2018) supported the theory that the mid-Cretaceous Burmese biota, which includes *B. liorum*, was of a long-standing insular nature, the area having been separated from the rest of Laurasia for up to 140 ma according to one hypothesis (but not two other hypotheses) before the collision between the West Burma plate and Proto-Southeast Asia mainland. They proposed that the Burmese amber fossil assemblage reflects a pre-collision rather than post-collision date. Geologists such as Acharyya (1998, 2010), Audley-Charles et al. (1988) and Metcalfe (2017) discussed the complex of areas that broke off from Gondwana and drifted north to collide eventually with the main Laurasian landmass. Audley-Charles (1988, fig. 2) showed the position of Burma as separated by ocean from mainland Laurasia in the early Cretaceous. Metcalfe (2017) showed the collision and accretion of the Sibumasu plate (which includes Burma) to the Laurasian mainland in the Carboniferous-Permian. This is much earlier than the mid-Cretaceous, suggesting that the Burmese amber fossil assemblage reflects a post-collision date. Regardless, the close similarity of *B. liorum* to the Taimyr *Baeomorpha* species suggests that it probably derived from somewhere in Laurasia north of the southeastern area formed by accretion of the various land areas to form the area that is present day Indochina.

It is notable that *Archaeoteleia* (Scelioninae, Platygasteridae) (Talamas et al. 2016) has a very similar distribution to Rotoitidae, being present as an extant genus only in South America and New Zealand and as an extinct genus (with some morphological differences from extant species) in mid-Cretaceous Burmese amber. Incidentally, this is yet another example in Hymenoptera in which a given genus appears to have existed from the mid-Cretaceous to the present; the others belong to Chrysidoidea (Ross 2019, Martynova et al. 2019). The most parsimonious and, we believe, the best explanation for the extinct and extant distribution of Rotoitidae, *Archaeoteleia*, Mymaridae and perhaps the other, unrelated, taxa as well, is to assume they all evolved earlier than currently thought, perhaps sometime in the Jurassic and were widespread across Pangaea in suitable habitats. For example, hosts of *Archaeoteleia* are members of Macropathinae (Orthoptera: Rhaphidophoridae), thought to have originated prior to the tectonic separation of the supercontinent Gondwana (Beasley-Hall et al. 2018).

## Acknowledgements

We sincerely thank Jun Li (Jinan, Shandong) for donating the fossil piece to CNU. The photos were taken by J. Read, Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa.

## References

- Acharyya SK (1998) Break-up of the greater Indo-Australian continent and accretion of blocks framing South and East Asia. *Journal of Geodynamics* 26: 149–170. [https://doi.org/10.1016/S0264-3707\(98\)00012-X](https://doi.org/10.1016/S0264-3707(98)00012-X)
- Acharyya SK (2010) Tectonic evolution of the Indo-Burma Range with special reference to Nag-Manipur Hills. *Memoir of the Geological Society of India* 75: 25–43.
- Audley-Charles MG, Ballantyne PD, Hall R (1988) Mesozoic-Cenozoic rift-drift sequence of Asian fragments from Gondwanaland. *Tectonophysics* 155: 317–330. [https://doi.org/10.1016/0040-1951\(88\)90272-7](https://doi.org/10.1016/0040-1951(88)90272-7)
- Beasley-Hall PG, Tierney S, Weinstein P, Austin AD (2018) A revised phylogeny of macropathine cave crickets (Orthoptera: Rhaphidophoridae) uncovers a paraphyletic Australian distribution. *Molecular Phylogenetics and Evolution* 126: 153–161. <https://doi.org/10.1016/j.ympev.2018.04.024>
- Gibson GAP, Huber JH (2000) Review of the family Rotoitidae (Hymenoptera: Chalcidoidea), with description of a new genus and species from Chile. *Journal of Natural History* 34(12): 2293–2314. <https://doi.org/10.1080/002229300750037901>
- Gumovsky A, Perovsky E, Rasnitsyn A (2018) Laurasian ancestors and “Gondwana” descendants of Rotoitidae (Hymenoptera: Chalcidoidea): What a review of Late Cretaceous *Baeomorpha* revealed. *Cretaceous Research* 84: 286–322. <https://doi.org/10.1016/j.cretres.2017.10.027>
- Heraty JM, Burks BD, Cruaud A, Gibson G, Liljeblad J, Munro J, Rasplus J-Y, Delvare G, Janšta P, Gumovsky AV, Huber JT, Woolley JB, Krogmann L, Heydon S, Polaszek A, Schmidt S, Darling DC, Gates MW, Mottern JL, Murray E, Dal Molin A, Triapitsyn S, Baur H, Pinto JD, van Noort S, George J, Yoder M (2013) A phylogenetic analysis of the megadiverse Chalcidoidea (Hymenoptera). *Cladistics* 29: 466–542. <https://doi.org/10.1111/cla.12006>
- Martynova KV, Olmi M, Müller P, Perkovsky EE (2019) Description of the first sclerogibbid wasp (Hymenoptera: Sclerogibbidae) from Burmese (Myanmar) amber and its phylogenetic significance. *Journal of Systematic Palaeontology* 17(21): 1791–1803. <https://doi.org/10.1080/14772019.2018.1551250>
- Metcalf I (2017) Tectonic evolution of Sundaland. *Bulletin of the Geological Society of Malaysia* 63: 27–60. <https://doi.org/10.7186/bgsm63201702>
- Poinar G Jr, Huber JT (2011) A new genus of fossil Mymaridae (Hymenoptera) from Cretaceous amber and key to Cretaceous mymarid genera. *ZooKeys* 130: 461–472. <https://doi.org/10.3897/zookeys.130.1241>
- Rasnitsyn AP, Öhm-Kühnle C (2018) Three new female Aptenoperissus from mid-Cretaceous Burmese amber (Hymenoptera, Stephanoidea, Aptenoperissidae): Unexpected diversity of paradoxical wasps suggests insular features of source biome. *Cretaceous Research* 91: 168–175. <https://doi.org/10.1016/j.cretres.2018.06.004>
- Ross AJ (2019) Burmese (Myanmar) amber checklist and bibliography 2018. *Palaeoentomology* 2(1): 22–84. <https://doi.org/10.11646/palaeoentomology.2.1.5>
- Shi GH, Grimaldi DA, Harlow GE, Wang J, Wang J, Yang MC, Lei WY, Li QL, Li XH (2012) Age constraint on Burmese amber based on U-Pb dating of zircons. *Cretaceous Research* 37: 155–163. <https://doi.org/10.1016/j.cretres.2012.03.014>