

A new genus of whip-scorpions in Upper Cretaceous Burmese amber: Earliest fossil record of the extant subfamily Thelyphoninae (Arachnida: Thelyphonida: Thelyphonidae)



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ABSTRACT

Mesozoic whip-scorpions are very rare, with only two Cretaceous species known to date. Here we describe a new genus and species of Thelyphonidae, *Mesothelyphonus parvus* gen. & sp. nov., based on a very well-preserved male in Upper Cretaceous amber from Myanmar. *Mesothelyphonus* is firmly placed in the extant subfamily Thelyphoninae as supported by the abdominal tergites with a median longitudinal suture. *Mesothelyphonus* differs from other fossil and recent genera primarily by its very small body size, the absence of ommatoids on abdominal segment XII, and the elongate, slender and toothed patellar apophysis of the male pedipalp. The new discovery represents the oldest definitive fossil record for Thelyphoninae, highlighting the antiquity of the whip-scorpion group.

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1. Introduction

Thelyphonida is an arachnid order comprising invertebrates known as whip-scorpions or vinegaroons. Whip-scorpions are distinctive creatures (Fig. 1), easily recognized by their long, slender, whip-like tail (or flagellum). They share some superficial resemblance to true scorpions, but unlike the latter, whip-scorpions are not venomous (Dunlop and Penny, 2012). The catalogue of Harvey (2003) listed 103 living species in sixteen genera placed in a single family. Prendini (2011) updated the species number to 110. They are carnivorous, nocturnal hunters feeding mostly on insects, millipedes, scorpions, and terrestrial isopods. Whip-scorpions are found throughout the tropics (excluding Central and East Africa) and tend to occur in forest habitats (Dunlop and Penny, 2012).

Fossil whip-scorpions are very rare and only nine valid species are known to date. The fossil record of whip-scorpions are restricted to seven Late Carboniferous and two Cretaceous species.

Six of the Palaeozoic species from the Late Carboniferous were revised by Tettie and Dunlop (2008). Six valid species in four genera have been recognized. Five of them represent a distinctive grade, basal to the Recent Thelyphonidae. The reason for this placement is that the pedipalps of those Palaeozoic species are not fully subchelate and lack a projection (apophysis) which give their pedipalps a distinctly more chelate appearance (Dunlop and Tettie, 2008; Selden et al., 2016). The sixth Coal Measures species may belong to the stem-group of Schizomida (Dunlop and Tettie, 2008). Recently, Selden et al. (2016) described another fossil whip-scorpion, *Parageralinura marsiglioi* Selden et al., 2016, from the Late Carboniferous of the Carnic Alps, Friuli, Italy, which possibly represents the youngest Palaeozoic thelyphonid. Selden et al. (2014) described a thelyphonid carapace (unnamed) from the Late Carboniferous (Kasimovian) of the Donets Basin of Ukraine.

Mesozoic whip-scorpions are comparatively rare. Only two species are known to date. Dunlop (1998) reported the first Mesozoic thelyphonid, *Mesoproctus rowlandi* Dunlop, 1998, from the Lower Cretaceous Crato Formation (ca. 115 Ma) of Brazil. The Cretaceous species has a modern-looking appearance with the well-developed pedipalpal apophyses defining the crown group, and those Cretaceous fossils are undoubtedly assigned to Thelyphonidae

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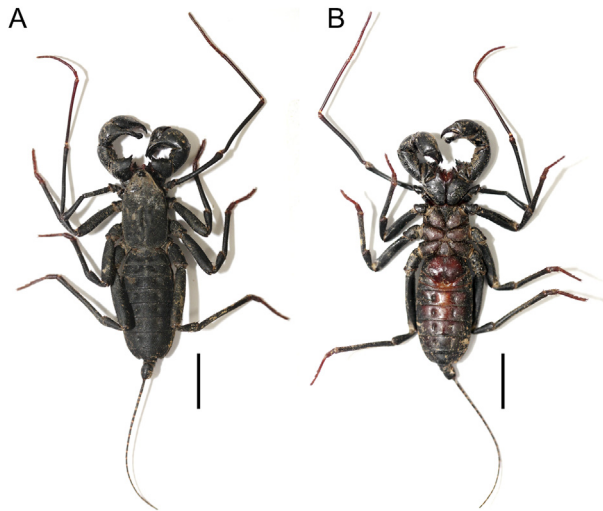


Fig. 1. A recent representative of whip-scorpions, *Typopeltis sinensis* (Butler), male, collected from the campus of Nanjing Institute of Geology and Palaeontology, CAS, where the holotype of *Mesothelyphonus parvus* gen. & sp. nov. is housed. A, dorsal view; B, ventral view. Scale bars: 10 mm.

(Dunlop and Martill, 2002). Based on the large body size (largest carapace over 30 mm long) and the biogeographical distribution of *Mesoproctus*, it was suggested that the Cretaceous genus is closely related to the extant *Mastigoproctus* Pocock (Dunlop and Martill, 2002). Recently, Wunderlich (2015) described the first fossil whip-scorpion, *Burmathelyphonia prima* Wunderlich, 2015, from the Upper Cretaceous Burmese amber. In addition, Pierce (1945) reported a putative fossil whip-scorpion, *Thelyphonus hadleyi* Pierce, 1945, from the middle to late Miocene Monterey Formation of Cabrillo Beach, San Pedro, California, but it was later proved to be an unidentifiable organic fragment (Dunlop and Tetlie, 2008).

Here we describe a new whip-scorpion species based on an exceptionally well preserved specimen in the Upper Cretaceous amber from northern Myanmar. The fossil is definitely placed in the extant family Thelyphonidae (Arachnida).

2. Material and methods

The new species is known from one individual preserved in a piece of relatively opaque amber from north Myanmar. The amber contains cracks inside, which hinders observations of the thelyphonid fossil from certain angles. The amber piece was ground and polished in order to make all anatomical features accessible for observation. The type specimen is housed in the Nanjing Institute of Geology and Palaeontology, CAS, Nanjing, China. Observations and photographs were taken using a Zeiss Axio Imager 2 compound microscope with a digital camera attached. Photomicrographs with red and green background were taken using fluorescence as a light source attached to a Zeiss Axio Imager 2 compound microscope. The Recent thelyphonid specimen was photographed using a Canon EOS 5D Mark II with a Canon EF 100 mm f/2.8 Macro lens. Images were then digitally compiled using Helicon Focus software, and arranged in Adobe Photoshop.

3. Systematic palaeontology

Order Thelyphonida Latreille, 1804
 Family Thelyphonidae Lucas, 1835
 Subfamily Thelyphoninae Lucas, 1835

Genus *Mesothelyphonus* gen. nov.
 Type species: *Mesothelyphonus parvus* sp. nov.

Etymology. The genus name is a combination of *Meso-*, for its Mesozoic age, and the supposed related genus *Thelyphonus*; it is masculine in gender.

Diagnosis. *Mesothelyphonus* differs from all other whip-scorpions on the basis of the following combination of characters: Body small (ca. 10 mm). Carapace with pair of well-developed anterolateral keels. Median ocelli separated by superciliary carina. Abdominal tergites with median longitudinal suture; segment XII (anal) without ommatoids. Abdominal sternite III of male with a median projection. Patellar apophysis of male pedipalp not enlarged or elaborated, long and slender; pedipalpal femur almost as long as pedipalpal patella; pedipalpal trochanter with five teeth. Flagellum long.

***Mesothelyphonus parvus* sp. nov.**
 (Figs. 2–5)

Etymology. Derived from the Latin adjective *parvus*, meaning small.
Material. Holotype, NIGP164039. The fossil whip-scorpion is a completely preserved male adult.

Occurrence. Earliest Late Cretaceous (ca. 99 Ma; Shi et al., 2012) amber, near Tanai, Hukawng Valley, northern Myanmar.

Diagnosis. As for the genus (*vide supra*).

Description. Male. Total body length (measured from anterior carapace margin to posterior edge of pygidium [segment XII]) 10.25 mm, brown; legs and flagellum light brown.

Carapace: Carapace with pair of well-developed anterolateral keels, apparently extending from lateral ocelli. Surface of carapace, including anterior part, transversely wrinkled, becoming densely and finely granular posteriorly. Median ocular tubercle fusiform (Fig. 3A); distance between ocelli 0.9 times ocular diameter. Lateral ocelli, if present, not visible.

Pedipalps (Figs. 3A, 4A, 5): Cuticle strongly spiny. Trochanter rounded, as wide as long; dorsointernal surface with five teeth and several setae (Figs. 3F, 5), all different in size, the first proximal one small and pointed (I), the second (II) pointed, with broad base and sharp apex, the third (III) pointed, as long as the second but narrower, the fourth tooth (IV) largest, elongate and pointed, the fifth (distal one, V) much shorter than the fourth, more separated from the fourth than the third. Femur elongate, slightly widened toward apex; apical femoral margin oblique, as long as trochanter; ventroexternal surface with no teeth; ventrointernal surface with one small strong tooth apically. Patella as long as femur, strongly spiny. Patellar apophysis (Figs. 3D, E, 5) very elongated, slender and unmodified, gradually narrowed toward apex; internal edge with two relatively long teeth near apex and relatively small at base; external edge with five small teeth. Tibia, external edge flattened; internal surface with numerous long macrosetae; ventrointernal surface with one long tooth distally. Fixed finger, dorsal edge smooth; ventral edge with serrate row of denticles; strongly curved downwards.

Legs: Femora of all legs toothed internally and externally (e.g., Fig. 4C). Tarsi of all legs (except leg I) 3-segmented (Fig. 4E, F), tarsomere I longest, tarsomere II much shorter than tarsomere I, tarsomere III longer than tarsomere II, but distinctly shorter than tarsomere I. Claws curved, sharp at apex, simple (Fig. 4E). Leg I, basitarsus and telotarsus (Figs. 3B, C), tarsomeres I–III gradually decreasing in size, tarsomere IV as long as tarsomere III, tarsomeres IV–VII gradually decreasing in size; tarsomere VIII almost as long as I; femur 2.09 mm long; patella 4.02 mm long; tibia 4.84 mm long; basitarsus-tarsus 3.66 mm long. Legs II–IV, basitarsus with two ventrodistal spurs.

Trichobothria: Leg I with two trichobothria; other legs with one trichobothrium (Fig. 6A); present at distal end of leg tibiae, similar to that on extant species (Fig. 6B).

Opisthosoma: Abdominal tergites finely granular; tergites divided by median longitudinal suture (Fig. 4B); tergite XII (Fig. 3G)

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