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PALAEOSIRO BURMANICUM N. GEN., N. SP., A FOSSIL CYPHOPHTHALMI (ARACHNIDA: OPILIONES: SIRONIDAE) IN EARLY CRETACEOUS BURMESE AMBER

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Abstract — A mite harvestman, *Palaeosiro burmanicum* n. gen., n. sp. (Opiliones: Cyphophthalmi: Sironidae), is described from Early Cretaceous Burmese amber. Diagnostic characters are: small size, elongate type 2 ozophores, round spiracles, small claws sharply curved at the base, and a large gland on the first sternite. A thick cuticular lens and numerous microvilli suggest that the ozophores function as light-sensitive organs in addition to supporting the ducts of the "scent glands". This is the first Mesozoic fossil of the suborder Cyphophthalmi and represents a lineage that occurred in Laurasia some 100 m.y.B.P.

Key words: Mite harvestman, Opiliones, Cyphophthalmi, Sironidae, Early Cretaceous, Burmese amber, *Palaeosiro burmanicum*

INTRODUCTION

The suborder Cyphophthalmi of the order Opiliones, commonly called mite harvestmen, consists of some 26 genera and 113 species of small to medium-sized arachnids that occur in soil or decomposing organic matter (Giribet, 2000). The fossil record of this group is quite sparse, with only a single specimen (*Siro platypedibus* Dunlop & Giribet, 2003) described from Tertiary Bitterfeld amber. The present study describes a cyphophthalmid from Early Cretaceous Burmese amber.

Records of Burmese amber date back to AD 100, when an amber trade route was established between Myanmar and China, but it was not until 1896 that the amber was discovered to contain a variety of insect and plant fossils (Poinar et al., 2006). In 2001, a new amber mine was excavated in the Hukawng Valley, southwest of Maingkhwan in the state of Kachin (26º20´N, 96º36´E). The fossil cyphophthalmid was obtained from this amber site, now known as the Noije Bum 2001 Summit Site. Amber from this locality was dated to the Upper Albian (100 to 105 m.y.B.P.) of the Early Cretaceous (Cruickshank and Ko, 2003). Both nuclear magnetic resonance (NMR) spectra and the presence of araucaroid wood fibers in the amber samples from this site indicate an araucarian (probably *Agathis*) tree source for the amber (Poinar et al., 2007).

This paper is dedicated to Božidar Ćurčić for his outstanding scientific achievements in the field of arachnology

MATERIALS AND METHODS

The piece of amber containing the fossil (Fig. 1) is rectangular in shape, measuring 10 mm long, 2 mm wide and 2 mm in depth. The specimen is complete, although the body has undergone some distortion during the fossilization process and the legs are bent back under the ventrum, thus obscuring some diagnostic characters. Observations, drawings, and photographs were made with a Nikon SMZ-10 R stereoscopic microscope and Nikon Optiphot compound microscope (with magnifications up to 1000x).

RESULTS

Because there are no teeth on the claw of leg II, nor a saddlelike opisthosomal sternal apophysis with associated gland pores, this specimen is tentatively placed in the family Sironidae Simon, 1879 (Pinto-da-Rocha and Giribet, 2007). Since the specimen could not be placed in an extant genus (de Bivort and Giribet, 2004), it is described below in a new genus. Unless otherwise specified, all measurements in the description are in microns.

PALAEOSIRO N. GEN.

Order Opiliones

Suborder Cyphophthalmi

Family Sironidae Simon, 1879

Type species: *Palaeosiro burmanicum* Poinar

Diagnosis

Dorsum: Body oval, with eight visible tergites; ozophores of type 2 (dorsal-lateral in position); prosoma and opisthosoma not clearly differentiated, forming a scutum completum; dorsal region granulated with lines lacking ornamentation delimiting the opisthosomal segments; tergite VIII shallowly excavated at tip.

Venter: All coxae appear to be fused, but this character is difficult to determine in the fossil; spiracles circular, located in normal position; terminal sternites (presumably 8-9) free; anal plate transverse, with a faint carina.

Chelicerae: Short, robust type; further details obscured by leg and pedipalp segments.

Pedipalps: Small, narrow, without ventral process on trochanter.

Legs: Bearing granules; claws simple, smooth, thin; adenostyle not evident.

Genitalia: Gonopore wider than long, surrounded by raised portions of adjacent coxae.

Notes: While there is no clear evidence of a specialized adenostyle, a long seta is positioned in the area of the hind tarsus where an adenostyle would normally be found. While some extant adenostyles are narrow, none are in the form of a seta and therefore the specimen is probably a female, although this is not certain. The

combination of following characters separate *Palaeosiro* from extant genera in the family Sironidae as presented by Giribet and Boyer (2002) and de Bivort and Giribet (2004): small size; long, narrow, type 2 ozophores that probably serve as photoreceptors as well as outlets for defensive secretions; round spiracles; and a large sternal gland on the first sternite.

Palaeosiro burmanicum sp. n. (Figs. 1- 9)

Description: (with characters listed under generic diagnosis).

Size and sex: Sex probably female; 1.2 mm long.

Dorsum: Body oval shaped; dorsal scutum flattened; with raised anterior-medial V-shaped crest; greatest width (in opisthosoma region), 552; ozophores long and narrow; length of ozophores, 132; distance across ozophores, 574; distance between base of ozophores, 346; tips of ozophores dome-shaped, clear, body of ozophores containing numerous microvilli (see discussion section for further comments on the likely light sensitivity of these structures) and scent gland excretory duct extending to subterminal orifice (Fig. 2); posterior margin (corresponding to tergite VIII) slightly bifid; dorsal scutum bearing granules that decrease in density towards posterior end.

Venter: Covered with coarse granules with rounded tips 12-16 in height; with large sternal opisthosomal gland on medial-distal portion of sternite I.

Chelicerae: Short, robust type; dorsal crest not observed; teeth on moveable finger obscured.

Pedipalps: Lengths of articles: first, 76; second, 137; third, 76; fourth, 137; fifth, 114.

Legs: (for lengths of leg segments, see Table 1); all leg segments except tarsi and metatarsi 1 and 2 bearing granules; claws small, simple, sharply curved at base, 30 long; long seta positioned in middle of tarsus.

Genitalia: Gonopore transverse, sides surrounded by folded up edges of coxae.

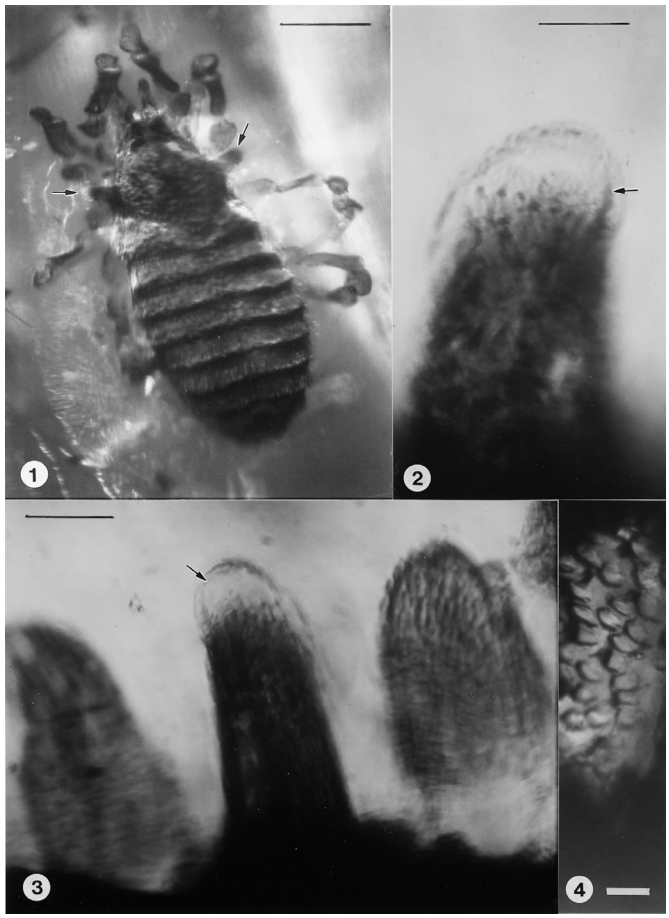
Color: Brownish-orange.

Material examined: Holotype: Amber from the Noije Bum 2001 Summit Site mine (26º20´N, 96º36´E) located in the Hukawng Valley (Northern Myanmar), SW of Maingkhwan, September 2005. Specimen deposited in the Poinar amber collection (accession # B-1-17) maintained at Oregon State University, Corvallis, OR.

Diagnosis: *Palaeosiro* can easily be differentiated from the only other fossil member of the suborder, *Siro platypedibus* Dunlop & Giribet (2003), by its long ozophores and slender claws. It is also smaller (1.2 mm) than *S. platypedibus* (2.0 mm).

DISCUSSION

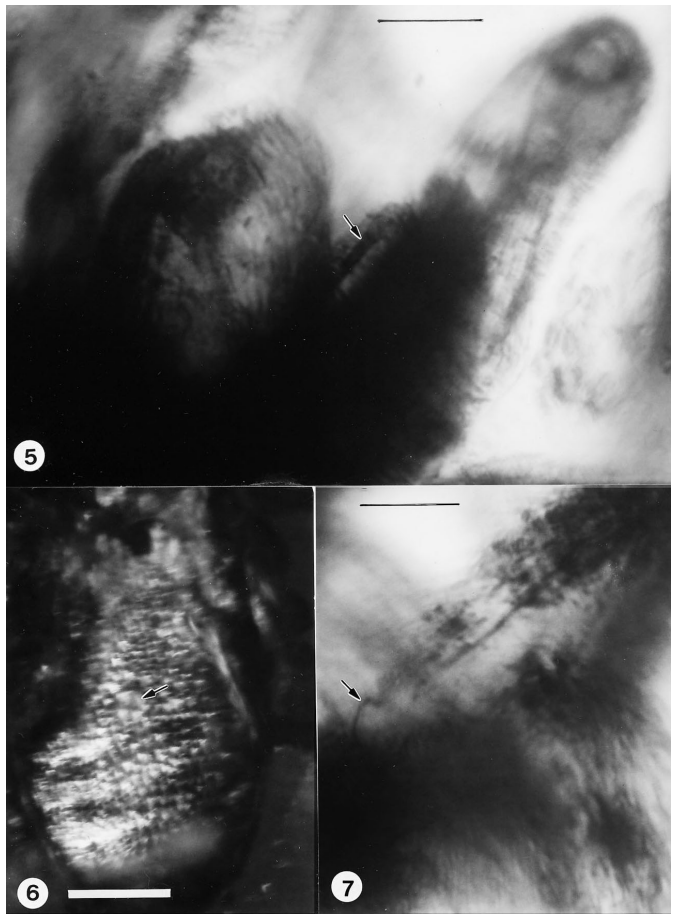
Palaeosiro is the first Mesozoic cyphophthalmid and more than doubles the previous fossil record of this group. It also establishes the family Sironidae on the Laurasian



Figs. 1-4. *Palaeosiro burmanicum*. 1. Dorsal view of holotype male. Arrows show ozophores. Bar = 304 μm. 2. Ozophore. Arrow shows exit duct of stink gland. Bar = 20 μm. 3. Ozophore. Arrow shows transparent, domed tip. Bar = 35 μm. 4. Granules on ventrites. Bar = 10 μm.

landmass in the Early Cretaceous, since the Burmese amber mines are situated on the Burma Plate (Mitchell, 1993; Cruickshank and Ko, 2003).

The fossil shows that in the Early Cretaceous, the basic body plan of the cyphophthalmids was already established, including the presence of ozophores, which are of particular interest on *Palaeosiro*. All members in the six recognized families of cyphophthalmids possess these unique body projections (Giribet and Kury, 2007; Gnaspini and Hara, 2007; Pinto-da-Rocha and Machado, 2007). In extant cyphophthalmids, these "scent glands" , "odoriferous glands", or "repugnatorial glands" contain the canals and exit pores of defensive secretions produced by exocrine glands located in the body proper (Hansen and Sørensen, 1904; Gnaspini and Hara, 2007). It is obvious that this also occurs in *Palaeosiro*, since a duct can be seen extending toward the subterminal orifice of the ozophore (Fig. 2).



Figs. 5-7. *Palaeosiro burmanicum*. 5. Short robust chelicera (arrow shows movable finger) and portion of palp (on right). Bar = 28 μm. 6. Venter with sternal gland (arrow). Bar = 223 μm. 7. Tarsus of leg 1 with claw (arrow). Bar = 67 μm.

However, in *Palaeosiro*, the ozophores also contain numerous microvilli, some of which project into the transparent cuticular zone (Fig. 2). Microvilli have not been reported in ozophores of extant cyphophthalmids and are typically receptors and not secretory structures. Juberthie (1961) found no microvilli when he examined the anatomical structure of the scent glands and ozophores of two cyphophthalmids. He showed that each scent gland was composed of a storage sac lined with glandular cells (located in the body proper of the arachnid) and a transport duct that extended from the gland up through the ozophore, where it exited at a subterminal orifice. Aside from these structures, there were only muscles that controlled the opening of the duct and contraction of the gland.

It is proposed that the ozophores of *Palaeosiro* function as light-sensitive organs that contain the exit ducts and orifices of the scent glands. The curved, transparent

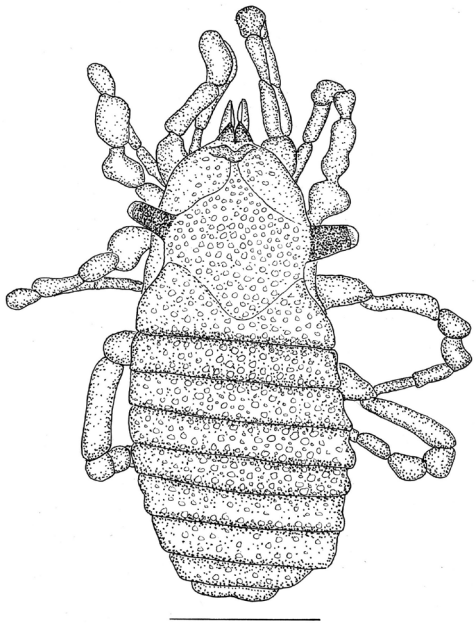


Fig. 8. Dorsum of *Palaeosiro burmanicum*. Bar = 368 μm.

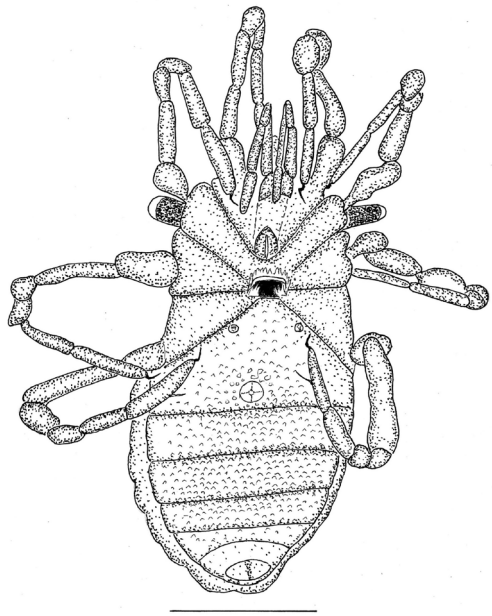


Fig. 9. Ventrum of *Palaeosiro burmanicum*. Bar = 380 μm.

cuticular domes on the tips of the ozophores in *Palaeosiro* (Figs. 1, 2) are similar to the cuticular covering on the body eyes at the base of the ozophores in members of the genus *Stylocellus* (Gnaspini and Hara, 2007, p. 388, Fig. 10.2a; Giribet, 2002; Shear, 1993).

Convex, cuticular tops of ozophores are found in extant cyphophthalmids that lack body eyes (Gnaspini and Hara, 2007), but anatomical investigations of these ozophores have not revealed the presence of microvilli (Juberthie, 1961; Giribet and Kury, 2007). Ozophores that both function as eyes and contain the exits of the scent glands have not been reported in modern cyphophthalmids.

Arthropods from Burmese amber are known to have unusual traits. Examples of these chimeras are an ant-like stone beetle with both front legs equipped with six instead of the normal five segments, similar to legs of some Paleozoic insects that contain patellae (Poinar and Brown, 2004); a tick with terminal palpal claws,

Table 1. Leg article lengths in *Palaeosiro burmanicum* (these values are approximate, since it was not possible to view all articles in one plane).

	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus
Leg 1	114	181	136	113	152	144
Leg 2	152	160	85	191	144	190
Leg 3	160	220	129	76	152	213
Leg 4	129	304	99	91	139	205

a character lacking on modern ticks, but present on some predatory mites (Poinar and Brown, 2003); and a small protobee, *Melittosphex*, which contains characters found in both modern bees and hunting wasps (Poinar and Dancroft, 2006).

A clear cuticular lens and numerous microvilli, as found on the ozophores of *Palaeosiro*, are characteristic of invertebrate photoreceptors (Wolken, 1995). The transparent cuticle on the tip of the ozophore could function as a cuticular lens and the microvilli as light receptors (rhabdomeres). The functional unit in invertebrate eyes is the rhabdom, which is composed of several parts, the major one being the rhabdomere, which is an organized array of microvilli positioned under the lens (Wolken, 1995). Since eyes are considered a pleisiomorphic character of cyphophthalmids (Shear, 1993), they would not be unexpected in a fossil of this age.

All evidence indicates that the Burmese amber forest was a tropical-subtropical rainforest. *Palaeosiro* could have lived in debris at the base of the amber-producing tree or on the bark or branches, possibly in association with various epiphytes.

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