Zootaxa 1816: 57–60 (2008)
www.mapress.com/zootaxa/

Correspondence

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

The first keroplatid (Diptera: Keroplatidae) species from the Lower Eocene amber of Vastan, Gujarat, India

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India is considered one of the biodiversity hotspots of the world (Mittermeier *et al*. 2004), being a member of the Indo-Burma hotspot, which formerly included the Himalaya chain and the associated foothills in Nepal, Bhutan and India. The great diversity of fauna and flora in India is probably due to the large diversity of ecosystems and also probably due to its complex biogeographic and geodynamic history. In this context, the fossil record can give important information on the evolution of the terrestrial biodiversity of this region.

The occurrence of Early Eocene amber in Vastan, Gujarat, India, was mentioned for the first time by Alimohammadian *et al*. (2005). The Palaeoenvironment has been interpreted by Sahni *et al*. (2006) as a freshwater to brackish water environment. The amber beds are interpreted as a marginal marine to very shallow marine environment, even probably with mangrove vegetation (Bandana & Phadtare 1997, Sahni *et al*. 2006). The amber has been dated at about 52 Mya based on foraminiferal biostratigraphy and the presence of fossil otolith assemblages. The age implicates that the amber fauna must have existed before the Indian-Asian collision, which occurred at about 49–50 Ma (Bajpai & Gingerich 1998) founded on biostratigraphic and biogeographic data from vertebrates.

The family Keroplatidae comprises about 952 described extant species in 86 genera, 51 of them belonging to the Orfeliini, and is distributed worldwide (Evenhuis 2006). The larvae mostly live in slimy webs that they produce underneath the fruiting bodies of polypores or on dead wood. The larvae of some species are predaceous (Jakovlev & Siitonen 2004). Adults of extant forms are often found in dark, damp places where they occur in large numbers in the crepuscular or nocturnal hours (Evenhuis 1994). Forty-eight species in 16 genera are cataloged in the fossil record of the family. Most of the species are described from Baltic amber, nevertheless species from Dominican amber are also described (Peñalver 1995, Schmalfuss 1979) and additional material was reported from northwestern France and Burma (Blagoderov & Grimaldi 2004) and from the Mexican amber (Solórzano Kraemer 2007).

The present paper represents the first description of an especially well preserved keroplatid species (tribe Orfeliini) from Indian amber, which opens a new window of opportunity for a comparison of the Indian fossil fauna with the extant fauna.

Materials and Methods. The amber used for the present study derives from the Vastan lignite mine deposited about 30 km northeast of Surat between the rivers Narmada and Tapti in western India (Alimohammadian *et al*. 2005). The type specimen will be deposited in Department of Geology at the Lucknow University, India. (MLGDLU/NS)

As with almost all of the Vastan amber, the piece of amber with the inclusion described here is very dark. The specimen itself appears cleared and as such some detailed features are not evident, but all the salient characters are clear enough to allow description and comparison with other keroplatids. The amber is very brittle, thus preparation was required that included initial embedding of the piece in epoxy resin [Araldite 2020 (XW396/XW397)] to avoid the risk of fracturing the inclusion during examination. Once the amber piece was embedded in the resin it was cut and then polished with emery paper (800, 1200 and 2500). Illustrations were made with a Leica MZ12 stereomicroscope and camera lucida. The photographs were taken with digital cameras (KY-F70B JVC70 and Nikon Coolpix 8800 VR) through a Leica MZ16 stereomicroscope. The photographs were edited with Adobe Photoshop©.

Vastaplatyura electrica Solórzano Kraemer & Evenhuis, gen. nov., sp. nov.

(Figs. 1–5)

Diagnosis: *Vastaplatyura* is most similar to the orfeliine genera *Trigemma* Hardy, 1960, *Pyrtulina* Matile, 1977, and

Accepted by J. Moulton: 28 May 2008; published: 4 Jul. 2008

Asynaphleba Matile, 1974 on the basis of the common possession of regular rows of setae on the tibiae and the bare longitudinal strips on the mesonotal disc. It can be separated from *Trigemma* by the absence of setae on the laterotergite (present in *Trigemma*) and separated from *Pyrtulina* and *Asynaphleba* by the possession of a single spur on the hind tibia (2 spurs present in *Pyrtulina* and *Asynaphleba*). Using the key in Søli *et al*. (2000), *Vastaplatyura* keys to *Laurypta* Edwards, 1929 but it is easily distinguished from it by the presence of the bare areas on the mesonotum (the mesonotum is uniformly setose in *Laurypta*).

Type species: *Vastaplatyura electrica*, by monotypy.

Description: Lengths: Body: 2.3 mm; wing: 2.4 mm. **Female**. *Head*. Occiput brownish black. Three ocelli near middle of frons, all subequal in size. Frons, face, and clypeus dark brown. Antenna with scape and pedicel discoid, brownish; flagellomores yellowish, cylindrical. Flagellomere segment 1 widest (length subequal to width), tapered to narrowest segments 12 and 13 (length ca. 2.5 times width), palpus brownish (Fig. 2).

Thorax. Prothorax brown; mesoscutum, scutellum, and mediotergite yellow, brown on extreme lateral and anterolateral portions of mesoscutum. Mesoscutum with short erect dark hairs, bare longitudinal strips admedially and supra-laterally. Pleurae yellow, bare. Mediotergite and laterotergite bare. Halteres pale yellow.

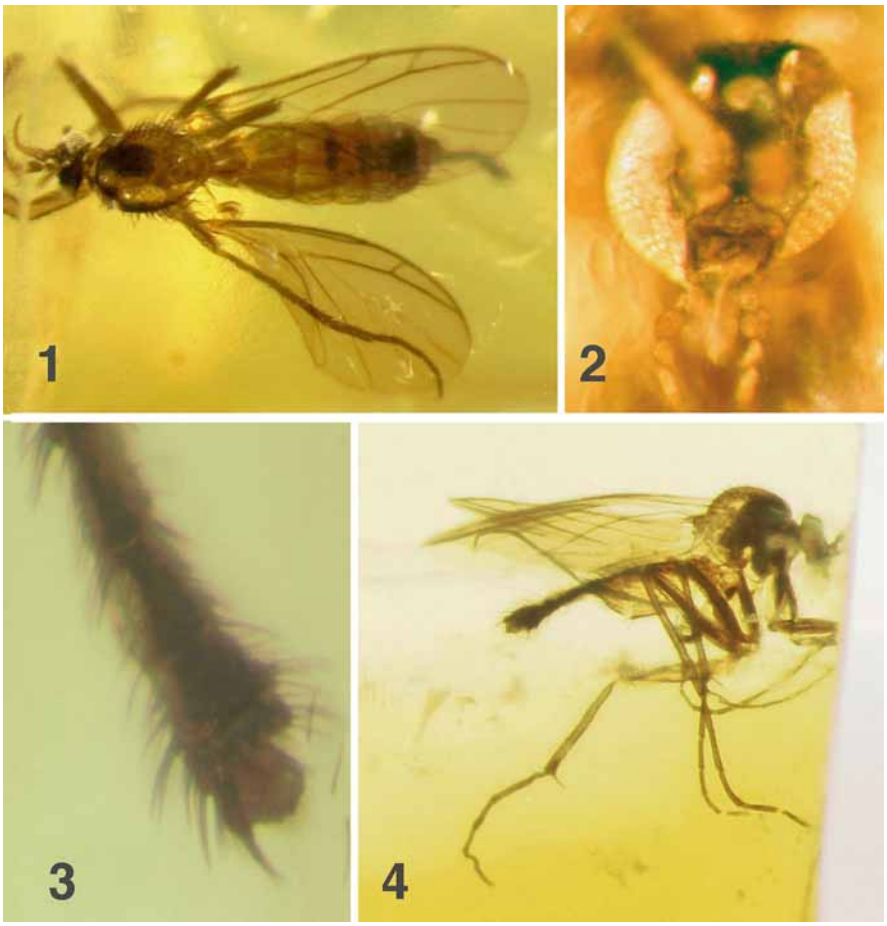
Legs. yellowish brown. Spurs black, single on each tibia; those on fore and mid legs minute, on hind leg very long. Tibiae with regular rows of setae.

Wing (Fig. 5). Grayish yellow hyaline. Macrotrichia present on upper surface on radial veins, absent on M and Cu veins and wing field. Vein R_4 ending in costa beyond end of R_1. Anal vein incomplete. Anal lobe well developed.

Abdomen. Yellow, with black color laterally; black hairs on all segments, longest on segments VI and VII (Fig 3).

Type: Holotype female from India (Fig. 1–5): MLGDLU/NS/1002. Housed in the Department of Geology at Lucknow University, Lucknow, India.

Etymology: The generic name derives from *Vasta*, which refers to the Vastan amber deposits and *-platyura*, which refers other orfeliines related to *Platyura*, sensu lato. The specific name derives from the Greek, *elektra*; which refers to amber.



FIGURES 1–4. *Vastaplatyura electrica*, in situ. **1**. Habitus, dorsal view. **2**. Head, anterior view. **3**. Detail of abdominal terminalia. **4**. Habitus, lateral view. Angularly truncated right edge is edge of amber piece.

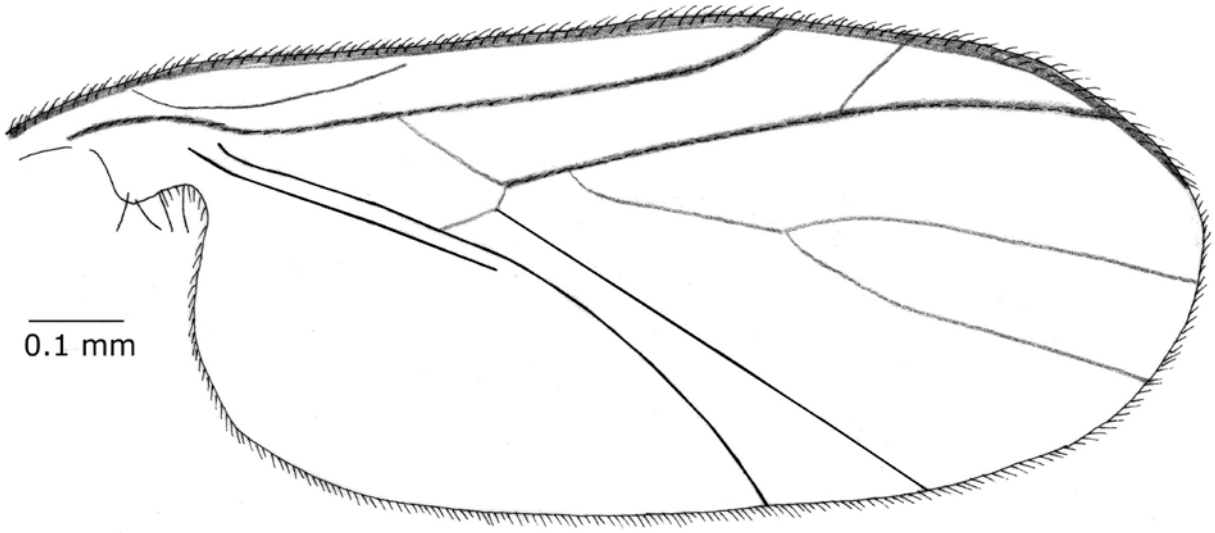


FIGURE 5. *Vastaplatyura electrica*, wing.

Discussion: The continental history of India is still under discussion and the question if India really existed as an isolated continent during the late Cretaceous and Paleocene still remains.

Currently, there are three different theories about the position of India in the last 65 my. The standard *"biotic ferry model"* showing India as an isolated island, the *"land bridge model"*, which incorporates a connection with Africa, and another *"biotic bridge model"*, which includes connections to Asia, Africa and Madagascar (e. g. Hedges 2003). Together with the *"biotic ferry model"* the *"out-of-India"* theory is also discussed, which suggests an origin of Asian biotic elements from Gondwanaland and the rafting of the organisms from the Indian plate to Asia (McKenna 1973).

The fossil mammals of the Vastan mine represent mainly endemic fauna suggesting the isolation of the Indian landmass at least over the last 65 my. However, some Holarctic elements are also present advocating a possible early Tertiary out-of-India vertebrate dispersal (Rana *et al* 2005, Bajpai *et al*. 2005, Smith *et al*. 2007). The fossil record of several other organisms like sauropods dinosaurs, frog families, anguid lizards, boid snakes, pelomedusid turtles, and mammals among other examples (for a review of the historic biogeography of India see Briggs 1989) give strong evidence for land bridges or island chains between India and Asia as well as India and the Seychelles, Madagascar, and Africa during the Late Cretaceous. This is also supported by the rate of movement of the Indian plate and the notable drop of the sea level in the late Cretaceous (Briggs 2003), On the other hand recent organisms like frogs, Ichthyophiidae (Asiatic tailed caecilians) and other amphibians instead support the biotic ferry model (Bossuyt & Milinkovitch 2001, Conti *et al*. 2002, Gower *et al*. 2002, Hedges 2003). Until now, no insects or arthropod fossils have been studied with the purpose to help resolve this problem. If India was an isolated continent during most of the Cretaceous and the Paleocene, its high extant and fossil biodiversity with a distinctive endemism should also be reflected by arthropod examples.

Despite the differences in biodiversity between regions the Keroplatidae from the Oriental Region are poorly investigated, with 108 species previously described. The Neotropical Region is better explored (203) and even better the Palearctic Region (243) (Evenhuis 2006). However the precise relationship of the new genus presented in this paper with other orfeliine genera cannot be definite placed here without a cladistic analysis of all the Orfeliini.

Vastaplatyura shares synapomorphic characters with the following extant genera: *Laurypta*, *Trigemma*, *Pyrtulina*, and *Asynaphleba*. The actual distribution of these extant genera is very broad. Species of the genus *Laurypta* are distributed in the Afrotropical region of the Seychelles and Cameron, in the Oriental region in Korea, Malaysia, and Sri Lanka, and in the Australasian/Oceania region in Palau. Species of the genus *Trigemma* are endemic to the Hawaiian Islands. Species of the genus *Pyrtulina* are distributed in the Australasian/Oceanian region in New Caledonia and in the Afrotropical region in Madagascar. Species of the genus *Asynaphleba* are distributed in the Afrotropical region of South Africa.

Living families and some extant genera of Mycetophilidae appeared in the Cretaceous (Grimaldi *et al*. 2002) and by the Eocene they became very abundant and diverse inhabitants of moist temperate forest (Grimaldi & Engel 2005).

Vastaplatyura appears to be endemic to the Indian subcontinent and may not have ranged further from India. Thus *Vastaplatyura* would support a biotic ferry model for India in the last 65 my. However, in addition to further studies on the characters shared among the five genera, more studies on the extant and fossil biodiversity of insects from India, Africa and Asia are needed before any more conclusive comments can be made about hypothetical origins and ranges of this genus or the fossil Vastan arthropod fauna.

Acknowledgements

Nivedita Sarkar and Prof. Ashok Sahni are kindly acknowledged for the loan of the material for this study. Jes Rust (Institute of Palaeontology, Bonn, Germany) is sincerely thanked for comments on the manuscript.

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