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ABSTRACT

The Early Cretaceous mydid genus and species *Cretomydas santanensis* is revised on the basis of a new specimen, allowing to precise its relationships within the 'advanced Mydidae', probably close to the subfamily Diochlistinae. This extant group has a 'Gondwanan' distribution, known from Southern South America and Australia, in accordance with its possible great antiquity in the Early Cretaceous. The presence of an 'advanced Mydidae' during the Cretaceous also suggests a greater antiquity for this family.

Keywords:

Insecta; Diptera; paleobiogeography; revision; dating.

1. Introduction

The Mydidae is a relatively small family of flies, with about 471 extant species in 63 genera. Their fossil record is limited to date to two taxa, *Cretomydas santanensis* Willkommen &

Grimaldi, 2007 (Lower Cretaceous, Brazil) and *Mydas miocenicus* Cockerell, 1913 (Lower Oligocene, USA). The type specimen (UCM IP 8556, University of Colorado Museum of Paleontology) of *M. miocenicus* is an incomplete wing, currently in a poor state of preservation (see photograph in the internet site https://www.idigpaleo.org/Detail/objects/9b5a8677-090f-11e3-af8d-50faf7e7a06b), on which the main structures are hardly visible. Therefore *Cretomydas santanensis* is quite important for dating the Mydidae (Winterton & Ware, 2015). If it is based on a much more complete fossil than for *M. miocenicus*, with body and wings preserved, its original description lacks some information that could be important for its placement in the Mydidae. Here we describe a new specimen, allowing to complete our knowledge on this taxon.

2. Material and methods

The fossil was photographed with a CanonG12 Powershot. The holotype is deposited in the amber collection of the Musée d'Histoire Naturelle et d'Ethnographie de Colmar (MHNEC), France under collection number MHNE.2020.8.1. We follow the wing venation nomenclature of Dikow (2017: fig. 47.16-19).

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3. Systematic palaeontology

Order: Diptera

Family Mydidae

Genus ***Cretomydas*** Willkommen & Grimaldi, 2007

Type species

Cretomydas santanensis Willkommen & Grimaldi, 2007

Revised diagnosis

Scape and first flagellomere short; hind tibia with a long longitudinal carina; hind basitarsomere slightly less than five times longer than its width; R4 ending at apex of R1(+R2+3); R5 ending on anterior wing margin; M1 and M2 well-separated, ending on anterior wing margin before wing apex; vein A1 strongly marked, ending on posterior wing margin (putative autapomorphy).

Cretomydas santanensis Willkommen & Grimaldi, 2007

(Fig. 1)

New material

Plesiotype MHNE.2020.7.1 (JMP.4147, Coll. Jean-Marc Pouillon); repository Musée d'Histoire Naturelle et d'Ethnographie de Colmar, France.

Locality and horizon

Crato Formation (Araripe Group), upper Aptian (122.5 – 112.6 Ma); Ceará, Brazil.

Description

A nearly complete fly, with wings, thorax, abdomen and a hind leg well-preserved; only head incomplete, partly hidden in rock; thorax 5.4 mm long, 4.5 mm wide; no insertion of bristles on scutellum; abdomen 9.1 mm long, 4.5 mm wide; hind tibia with a long longitudinal carina; wing clearly corrugate, 13.0 mm long, 4.3 mm wide; dc cell 4.1 mm long, 0.8 mm wide; cell between R1 and R2+3 7.7 mm long, 0.6 mm wide; R4 and R5 parallel, curved; R4 ending at apex of R1(+R2+3); R5 ending on anterior wing margin; M1 and M2 well-separated; M1 emerging from cell d while M2 emerging from cell m3, parallel and curved ending on anterior wing margin before wing apex; M3 nearly straight; R4 curved; a short veinlet between it and posterior wing margin near apex of cell m3, not aligned with M1+2; r-m near apex of cell d, with vein M1+2 making a strong curve before r-m; cell cua close, near wing margin; vein A1 concave, strongly marked and reaching posterior wing margin.

4. Discussion

This fossil has the same wing venation and the same proportions in the main cells as the type of *Cretomydas santanensis*. It has just slightly shorter wings (13 mm long and 4.3 mm wide in our fossil while 14 mm long and 4.6 mm wide in holotype; dc cell 4.1 mm long, 0.8 mm wide for our fossil instead of 4.1 mm long, 0.8 mm wide in holotype; cell between R1 and R2+3 7.7 mm long, 0.6 mm wide in our fossil while 9.0 mm long, 0.6 mm wide in holotype). Thus, we can consider that they correspond to the same species, although different extant species in the same genus of Mydidae can have very similar venations (see *Eumylas itapibura* and *Eumylas wilcoxi* in Almeida et al., 2014: fig. 4B–C). The venation of the plesiotype is better preserved than that of the holotype, especially in the cubito-anal area. It allows to precise the relationships of *Cretomydas*.

Willkommen & Grimaldi (2007: 381) attributed *Cretomydas* to the Mydidae on the basis of the following characters: 'two-segmented antennal flagellum'; 'veins R5, M1 and M2 join the wing margin before the wing tip'; 'crossvein r-m is located at middle of the discal cell or close to the apex of discal cell'; 'cell m3 closed'. Four families of flies have wing venation similar to that of *Cretomydas*, with veins appearing 'tangled', with branches of the medial vein curved forward and convergent with radial branches before apex, viz. the Nemestrinidae, Mydidae, Apioceridae, and the Mesozoic family Protapioceridae.

Willkommen & Grimaldi (2007) precised that the 'first flagellomere long and slender, three times longer than wide; second flagellomere club-shaped' for *Cretomydas*. The extant Mydidae have longer first and second flagellomeres, and the Apioceridae has a rather short second flagellomere, as in *Cretomydas*. Thus we need to discuss more precisely on the affinities of *Cretomydas*.

Affinities with the Nemestrinidae are excluded because these flies have a composite diagonal vein 'diag vn' straight from the discal cell to the outer wing margin, which is not the case in *Cretomydas*. The Apioceridae are also excluded because the discal cell and the cell m3 are narrow in *Cretomydas*. The Protapioceridae have also a discal cell broader and shorter than in *Cretomydas* (Ren, 1998; Zhang et al., 2007; Zhang, 2015). Nevertheless, *Cretomydas* shares with these last two families the presence of two separated branches M1 and M2, while the majority of Mydidae have a vein M1+2. The character M1 and M2 separated is currently considered as a plesiomorphy in Apioceridae and Mydidae (Artigas & Papavero, 1990; Yeates & Irwin, 1996). Few extant Mydidae have their two veins M1 and M2 separated, viz. the three genera *Triclonus* Gerstaecker, 1868, *Diochlistus* Gerstaecker, 1868 (both Australia), and *Mitrodetus* Gerstaecker, 1868 (Argentina and Chile) which Artigas & Papavero (1990) considered as a subfamily Diochlistinae, plus *Rhaphiomidas* Osten Sacken, 1877. Notice that Hardy (1942: 201) considered *Triclonus* as a junior synonym of *Diochlistus* without clear argument, but he was not followed by Artigas & Papavero (1990) who separated the two genera. In the 'Mydidae species catalog' (https://asiloidflies.si.edu/species-catalog-mydidae), the two genera are also synonymized.

Yeates & Irwin (1996) made the unique phylogenetic analysis of the Mydidae on the basis of morphological character and proposed a series of synapomorphies of the Mydidae, the majority of which are not discernable in *Cretomydas*. But the new specimen of *Cretomydas* has no insertion of bristles on the scutellum, as in the extant Mydidae, unlike the Apioceridae, confirming its attribution to the Mydidae. Notice that Dikow et al. (2017) confirmed the sister group relationships between Apioceridae and Mydidae proposed by Yeates & Irwin (1996), supporting the polarizations of the characters proposed by these last authors.

Within the Mydidae, the wing venation of *Cretomydas* is very similar to those of the Diochlistinae and *Rhaphiomidas*, especially in the shape of the discal and m3 cells, and that of

crossveins at apex of discal cell and cell m3. The main differences with these genera are in the organization of the distal parts of veins R4, R5, M1, and M2.

Ovtshinnikova (2003) confirmed the transfer of the genus *Rhaphiomidas* from the Apioceridae into the Mydidae, as proposed by Yeates & Irwin (1996) who reinstated the subfamily Rhaphiomidinae for this genus. These last authors indicated that the vein R4 is ending into R1(+R2+3) at wing margin of before it in a clade that comprises the 'advanced Mydidae' (incl. *Diochlistus*) + Megascelinae, unlike *Rhaphiomidas*. In *Rhaphiomidas*, R4 is ending in the wing margin (Cazier, 1941; Van Dam, 2010).

Artigas & Papavero (1990) proposed a phylogenetic analysis of the Diochlistinae, based on an 'a priori' polarization of the characters, thus without real outgroup. They found *Mitrodetus* as sister group of (*Triclonus* + *Diochlistus*). The new specimen of *Cretomydas* shares the putative synapomorphy of a carinate hind tibia with the later subclade, character not indicated by Willkommen & Grimaldi (2007). Nevertheless, this character is also present in some other 'advanced Mydidae', viz. the two genera *Paramydas* Carrera & d'Andretta, 1948 and *Apiophora* Philippi, 1865 (Artigas & Palma, 1979). Yeates & Irwin (1996) also considered this character state as an apomorphy of a clade (*Diochlistus* + (*Apiophora* & *Mydas* & *Ectypus*). Thus *Cretomydas* would rather fall in the 'advanced Mydidae' than close to *Rhaphiomidas*, and (because of the venation) in the Diochlistinae. Notice that Yeates & Irwin (1996) did not include *Mitrodetus* in their analysis. Thus the monophyly of the Diochlistinae needs to be confirmed.

In *Mitrodetus*, M2 ends well above wing apex, while in *Cretomydas*, it ends slightly above it; and R4 is fused to R5 apically and R4+5 is ending into R1(+R2+3), while they are well-separated in *Cretomydas* (Artigas & Palma, 1979; Artigas & Papavero, 1990). Nevertheless, Paramonov (1950: 8) noticed that in *Triclonus*, the 'apices of R4 and R5 can be either confluent or separated'. Thus this difference of *Triclonus* with *Mitrodetus* is quite weak.

Also Séguy (1928, 1930) indicated that these two genera have the character of distal fusion of R4 and R5.

In *Cretomydas*, R4 is ending into R1+(R2+3) and R5 is ending in the wing apex, while, in *Triclonus* and *Diochlistus*, R4 and R5 are ending independently into R1(+R2+3), after the key to Diochlistinae of Artigas and Papavero (1990). Séguy (1928: 133, fig. 11) also indicated that the two veins M1 and M2 end near wing apex in *Diochlistus* as in *Cretomydas*, while in *Triclonus*, M1 ends into R1(+R2+3).

Willkommen & Grimaldi (2007: 381) proposed the following diagnosis for *Cretomydas*: (1) 'both scape and first flagellomere short'; (2) 'wing venation resembling that of the Recent genus *Rhaphiomidas*'; (3) 'end of vein M2 free'; (4) 'crossvein r-m located close to apex of discal cell'; (5) 'hind basitarsomere is slightly less than five times longer than it is wide'. Character (1) is unclear as the relative lengths of the antennomeres are not precised, after the photograph of the type specimen it seems that the scape and first flagellomere are relatively short too in *Rhaphiomidas*. Character (2) is clearly too vague because the venation of the Diochlistinae resembles that of *Rhaphiomidas*. Character (3) is present in *Rhaphiomidas* and all Diochlistinae, and cannot separate *Cretomydas* from these genera. Character (4) is present in many Mydidae. Concerning character (5), while in the *Rhaphiomidas* spp., the hind basitarsomeres are nearly 8-10 times as long as wide; the proportions width/length are nearly the same in *Diochlistus tenebrosus* and *Cretomydas* (see internet site https://www.flickr.com/photos/insectcollection/4217468792/). As a result, there is still no very clear autapomorphy to define *Cretomydas*.

One further difference between *Cretomydas* and the Diochlistinae & *Rhaphiomidas* is the presence of a very long and well-marked vein A1 ending on posterior wing margin in *Cretomydas*, while it is reduced and distally vanishing in *Rhaphiomidas*, *Mitrodetus* and *Diochlistus*, and absent in *Triclonus* (Artigas & Palma, 1979; Artigas & Papavero, 1990;

Rogers, 2007). In the Apioceridae, the vein A1 is also vanishing distally, suggesting that this character could be an autapomorphy of *Cretomydas*.

5. Concluding remark

Cretomydas would rather fall in the 'advanced Mydidae', suggesting that this family was already well-diversified during the Early Cretaceous. The extant *Mitrodetus* is from the Southern part of South America, while *Diochlistus* (and *Triclonus*) are Australian. This 'Gondwanan' distribution suggests a great antiquity for the Diochlistinae (see Artigas & Papavero, 1990: text-fig. 3), in accordance with the possible affinities of *Cretomydas* with this group of genera.

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248 **Fig. 1.** ***Cretomydas santanensis*** Willkommen & Grimaldi, 2007, specimen MHNE.2020.7.1.

249 **A**, habitus. **B**, left wing. Scale bars: 10 mm.

250

251

252


A
B
C
Sc
R1
R2
R4
R4+5
M
M1+2
R5
CuA
M3+4
M1
M3
A1
M2
M4
m-cu