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THE THIRD PETALURID DRAGONFLY FROM THE LOWER CRETACEOUS OF BRAZIL (ODONATA: CRETAPETALURIDAE)

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Abstract.— *Cratopetalura petruleviciusi* **gen.** et **sp. nov.** is the third genus and species of the Mesozoic petalurid family Cretapetaluridae from the Lower Cretaceous of Brazil. With the recent discovery of another representative of this family in the Lower Cretaceous of England, it demonstrates the great diversity of this group during this period.

Key words.— Insecta, Odonata, Crato Formation, Petalurida, palaeobiodiversity.

INTRODUCTION

Living petalurid dragonflies, represented by the sole family Petaluridae, are very few compared to large anisopteran families like the Aeshnidae, Gomphidae, or Libellulidae, comprising just five genera with semi-aquatic larvae and a mostly circum-Pacific distribution. The clade was much more diverse and disparate during the Mesozoic; no fewer than four families being present in the Late Jurassic-Early Cretaceous: the Protolindeniidae, the Cretapetaluridae, the Aktassiidae, and even possible representatives of the Petaluridae, with *Argentinopetala archangelskyi* Petrulevičius et Nel, 2003 (Nel *et al*. 1998, Petrulevičius and Nel 2003). Their fossils are known from South America, Europe and Asia. The Aptian Crato Formation of Brazil has previously yielded two genera attributed to the family Cretapetaluridae Nel *et al*., 1998. This family is also now recorded from the Lower Cretaceous of UK (Coram and Nel, in press). We describe herein the third new genus and species attributable to this family from the Crato Formation, on the basis of a very well preserved complete hindwing. Bechly 2007 (p. 218, Fig. 111.16d, Plate 10j) already described and figured without naming, another, less complete, hindwing from the same outcrop, that belongs to the same new taxon.

METHODS

In the description below we follow the wing venation nomenclature of Riek and Kukalová-Peck (1984), amended by Nel *et al*. (1993) and Bechly (1996). The higher classification of fossil and extant Odonatoptera, as well as familial and generic characters followed in the present work, are based on the phylogenetic system proposed by Bechly (1996) and Nel *et al*. (1998) for the Mesozoic Petalurida.

We use the following standard abbreviations: AA anal anterior vein, Ax1 Ax2 primary antenodal crossveins, CuAa distal branch of cubitus anterior, CuAb proximal branch of cubitus anterior, IRi intercalary radial veins, MA median anterior, MAb posterior branch of median anterior, MP median posterior, N nodus, O oblique vein, Pt pterostigma, RA radius anterior, RP radius posterior, tp trigonal planate (a vein emerging directly from the distal side of the discoidal triangle and situated between RP3/4 and MA).

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Order Odonata Fabricius, 1793

Clade Petalurida Bechly, 1996

Family Cretapetaluridae Nel *et al*., 1998

Cratopetalura gen. nov

Type species. *Cratopetalura petruleviciusi* sp. nov.

Etymology. Named after the Crato Formation, and *Petalura*. Gender: feminine.

Diagnosis. Hind wing characters only. second oblique cross-vein between RP2 and IR2 present distal of lestine oblique vein 'O'; true lestine oblique vein shifted basally, separated by only one cell from subnodus; postnodal space very narrow, with many cells distal of pterostigma; pterostigma not very elongate; pterostigmal brace vein weakly oblique, shifted to basal 3/4 of wing, about midway between nodus and apex; IR1 well-defined, only weakly zigzagged, and rather long; wing space between RP1 and RP2 strongly expanded; two rows of cells in basal part of postdiscoidal area between level of distal angle of discoidal triangle and level of midfork; CuAb very distinctly curved at its base in male hind wings, strongly approaching secondary anal vein AA1b; MP somewhat shortened, and terminating at posterior margin opposite level of nodus; distal side of discoidal triangle (MAb) distinctly angulated, correlated with a strongly developed trigonal planate in postdiscoidal space; concave Mpsl and Rspl distinct if zigzagged; subdiscoidal triangle free; anal loop posteriorly closed and two- or three-celled; veins RP3/4 and MA moderately undulate; RP3/4 not distally strongly diverging from MA.

Cratopetalura petruleviciusi sp. nov.
(Figs 1–2)

Material. Holotype specimen WDC-CCFB-5 (two hind wings attached to fragments of thorax, female), Wyoming Dinosaur Center-Crato, Wyoming, USA. Paratype specimen SMNS 66567 (a nearly complete hindwing), Staatliches Museum für Naturkunde in Stuttgart, Germany).

Etymology. Named after our friend and colleague Dr. Julián F. Petrulevičius.

Type locality. Chapada do Araripe, vicinity of Nova Olinda, southern Ceará, north-east Brazil.

Type horizon. Lower Cretaceous, Upper Aptian, Crato Formation – Nova Olinda Member.

Diagnosis. As for the genus.

Description. Holotype. Wings hyaline; hind wing 55.5 mm long, 17.0 mm wide; distance from base to arculus 6.0 mm; from arculus to nodus 19.0 mm; from arculus to base of RP3/4 11.0 mm; no secondary antenodal cross-vein basal of primary antenodal cross-vein Ax1, three complete antenodal cross-veins between Ax1 and Ax2, six of first row and five of second row distal of Ax2; distance from wing base to Ax1 6.0 mm, between Ax1 and Ax2 7.0 mm; Ax2 one cell distal of apex of discoidal triangle; RP and MA strongly separated in arculus; hypertriangle 5.8 mm long, free; discoidal triangle 2.5 mm distal of arculus, free, not very elongate but rather transverse, with basal side 2.0 mm long, anterior side 3.0 mm long, and MAb 4.5 mm long; a distinct angle in MAb and a very well defined convex trigonal planate tp; postdiscoidal area with two rows of cells distal of discoidal triangle and distally greatly widened; a distinct concave but slightly zigzagged Mspl; no pseudo-ScP distal of nodus; basal part of area between RA and RP with three cross-veins basal of RP3/4, and three distal of base of RP3/4 and basal of subnodus; area between RP and MA with four cross-veins basal of RP3/4; two oblique veins 'O', first one cell distal of base of RP2 and second two cells distally; RP2 and IR2 parallel and weakly curved; one row of cells between RP2 and IR2 but two rows near wing margin; area between RP1 and RP2 basal of pterostigma narrow but with two rows of cells; IR1 long, straight and well defined; four rows of cells between IR1 and RP2 and six rows between IR1 and RP1; a distinct concave but slightly zigzagged Rspl; RP3/4 and MA with a double curve and with the space between them not distinctly widened but with two rows of cells near posterior wing margin; pterostigma narrow elongate, 5.0 mm long, 0.9 mm wide, covering one cell and a half; pterostigmal brace weakly oblique, three cells basal of basal side of pterostigma, 12.0 mm distal of subnodus; eight postnodal cross-veins not aligned with nine postsubnodal cross-veins; space between C and RA distal of pterostigma elongate with about 13 cross-veins; one row of cells between MP and CuAa (but two near posterior wing margin); median area free; submedian area crossed by CuP-crossing; subdiscoidal space free, PsA curved; posterior wing margin rounded at base (female specimen); anal area broad, with three posterior branches of AA directed towards posterior wing margin, and six rows of cells between AA and posterior wing margin; anal loop rather small, not elongate, pentagonal, posteriorly closed, divided into three cells; CuAb very distinctly curved at its base, strongly approaching secondary anal vein AA1b; cubito-anal area broad, with six rows of cells between CuAa and posterior wing margin; CuAa with seven posterior branches.

Discussion. The paratype specimen was already described in Bechly (2007: 218, Fig. 111.16d, Plate 10j) as a putative new petalurid species from Crato.

Figure 1. *Cratopetalura petruleviciusi* gen., sp. nov., holotype WDC-CCFB-5, photograph of right hind wing, under alcohol (scale bar represents 10 mm).

Figure 2. *Cratopetalura petruleviciusi* gen. et sp. nov., holotype WDC-CCFB-5, photograph of left hind wing, under alcohol (scale bar represents 10 mm).

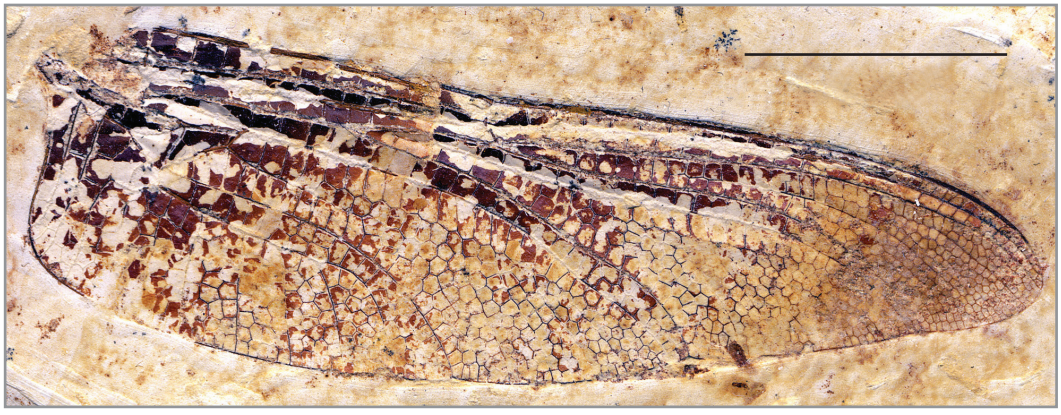

Figure 3. *Cratopetalura petruleviciusi* gen. et sp. nov., paratype SMNS 66567, photograph of hind wing (scale bar represents 15 mm).

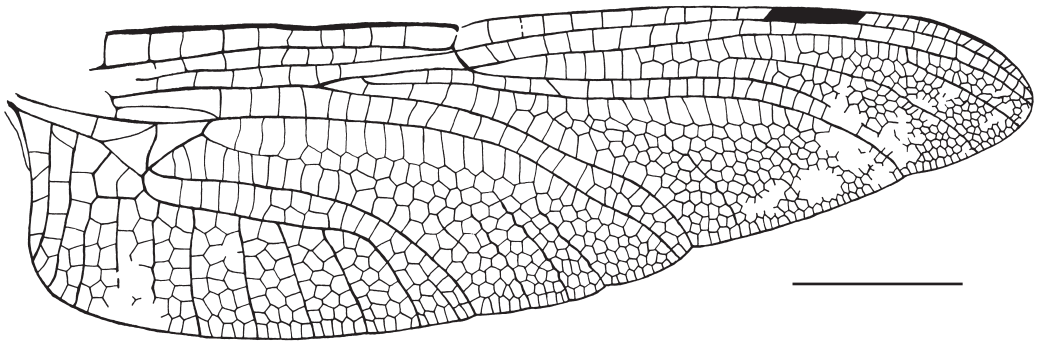

Figure 4. *Cratopetalura petruleviciusi* gen. et sp. nov., paratype SMNS 66567, drawing of hind wing (scale bar represents 10 mm).

It differs from the holotype in very few characters: anal loop two-celled instead of being three-celled; slightly different number of antenodal and postnodal crossveins. Both fossils share the diagnostic characters of the genus and species listed above.

The attribution of *Cratopetalura* gen. nov. to the clade Petalurida Bechly, 1996 is supported by the following apomorphies: postnodal space with many cells distal of pterostigma; pterostigmal brace vein shifted in the basal 3/4 of the wing, midway between nodus and apex; IR1 is a well-defined, and rather long vein; wing space between RP1 and RP2 strongly expanded, with numerous rows of cells; more than two rows of cells in basal part of postdiscoidal area between level of distal angle of discoidal triangle and level of midfork. The presence of a closed anal loop together with a trigonal planate, Mspl and Rspl exclude affinities with the Mesozoic Protolindeniidae Handlirsch, 1906. On the contrary *Cratopetalura* has the synapomorphies of the Petalurodea Bechly, 1996 (= Cretapetaluridae Nel *et al*., 1998 + Petaluroidea Needham, 1903), i.e. wings falcate, slender, and distinctly longer than 50 mm; the Bqs-area between RP and IR2 basal of subnodus distinctly narrowed; hindwing MP at least somewhat shortened, and terminating at posterior margin opposite level of nodus. But *Cratopetalura* has not the main synapomorphies of the Petaluroidea: its pterostigmata is not very long; the area between RP3/4 and MA is not widened near posterior wing margin, with less than three rows of cells between them. Also *Cratopetalura* has not the vein CuA with few branches, unlike the Petaluridae (Fraser 1929). *Cratopetalura* shares with the Cretapetaluridae the following synapomorphies: the true lestine oblique vein (basal oblique vein between RP2 and IR2) is shifted basally (convergent to *Phenes* and Petalurinae), only separated by one cell from the subnodus; the distal side of the discoidal triangle (MAb) is very strongly angulated, correlated with a strongly developed trigonal planate in the postdiscoidal space.

Nevertheless, *Cratopetalura* differs from *Cretapetalura* Nel *et al*., 1998 in the hindwing subdiscoidal triangle not traversed by a crossvein; hindwing anal loop not longitudinal elongated; and presence of a distinct Mspl and a distinct Rspl (both zigzagged), as in the recent Tachopteryginae Fraser, 1933. *Cratopetalura* differs from *Eotanypteryx* Bechly, 2007 and *Anglopetalura* Coram and Nel, in press in the presence of two oblique crossveins, and presence of Mspl and Rspl (Nel *et al*. 1998, Bechly 2007, Coram and Nel, in press).

With the recent discovery of another Cretapetaluridae in the Lower Cretaceous of England, *Cratopetalura* confirms the great diversity of the Petalurida during the Cretaceous, with representatives of the two other families Aktasiidae and Petaluridae (Petrulevičius and Nel 2003, Lin *et al*. submitted), and no less than seven Lower Cretaceous genera, i.e. more than the recent Petaluridae. They were also distributed in a very broad area (at least known from South America, Central Asia, China, Europe). On the contrary there is no known Cenozoic Petalurida (Nel and Paicheler 1993), despite the numerous potential outcrops and numerous other Cenozoic Anisoptera, showing that the group had a very important regression between the end of the Lower Cretaceous and the Lower Paleogene. This regression could have been contemporaneous with the extinction of several other Lower Cretaceous anisopteran families (Aeschnidiidae, Proterogomphidae, Liupanshaniidae, etc.), and the appearance of the first Libellulidae around the beginning of the Upper Cretaceous (Cenomanian).

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