The third skimmer dragonfly species from the Lower Cretaceous (Aptian) Crato Formation in NE Brazil (Odonata, Cavilabiata, Araripelibellulidae)

André Nel, Jean-Marc Pouillon

The third skimmer dragonfly species from the Lower Cretaceous (Aptian) Crato Formation in Brazil (Odonata, Cavilabiata, Araripelibellulidae)

André Nel[a] and Jean-Marc Pouillon[b]

[a] *Institut de Systématique, Évolution, Biodiversité, ISYEB – UMR 7205 – CNRS, MNHN, UPMC, EPHE, Muséum national d'Histoire naturelle, Sorbonne Universités, Paris, France; e-mail: anel@mnhn.fr*

[b] *Nivolas Vermelle, France; e-mail: jmpdb@wanadoo.fr*

ABSTRACT

Araripelibellula sennlaubi sp. nov., third species of this genus, is described from the Lower Cretaceous Crato Formation Araripe Basin, NE Brazil. This genus was previously known by its type species *A. martinsnetoi* from the same Formation and *A. britannica* from the Lower Cretaceous of UK. The new species is the third representative of the Cretaceous family Araripelibellulidae from Crato, and the ninth species of this family.

Keywords: Insecta; Odonata; Anisoptera; Cavilabiata; gen. et sp. nov., Early Cretaceous.

1. Introduction

The Lower Cretaceous Crato formation is a well-known Konservat Lagerstätte with a very rich entomofauna. The Odonata are especially very diverse and extensively studied (Bechly, 1998, 2000, 2007, 2010; Nel et al., 1998; Bechly et al., 2001; Bechly & Ueda, 2002) with representatives of all the extant anisopteran main subgroups. Among these, the Cavilabiata ('libelluloids' dragonflies) are especially interesting because they correspond to the first

important diversification of this group, with the five families †Araripephlebiidae Bechly, 1998, †Araripechlorogomphidae Bechly & Ueda, 2002, †Araripelibellulidae Bechly, 1996, †Cratopetaliidae Bechly, 2010, and †Magnathemidae Bechly, 2010. Among these, the Araripelibellulidae is a relatively diverse family, only known from the Early Cretaceous but quite widespread at that time as it is recorded from Brazil, UK, Spain, and China. In the Crato Formation, it is known by two genera and two species. Here we describe a third species that belongs to the type genus *Araripelibellula* Nel & Paicheler, 1994.

2. Material and methods

The specimen is stored in the collection of the Musée d'Histoire Naturelle et d'Ethnographie de Colmar, France. It was examined with a Nikon SMZ 1500 and a Nikon SMZ25. Photographs were taken with a Nikon D800 digital camera mounted on the stereomicroscopes lenses; photographs were processed using the image editing software Adobe Photoshop Element 12 software was used for stacking the different photographs.

For data on the Crato Formation and its fauna and flora and location map of the fossil locality in the vicinity of Nova Olinda, in the Araripe Basin, Ceara, northeastern Brazil, see Martill et al. (2007: figs 2.4-2.6).

The higher classification of fossil and extant Odonatoptera, as well as familial and generic characters follow the phylogenetic system proposed by Bechly (1996, 2016). Wing venation terminology follows Riek & Kukalová-Peck (1984), as amended by Nel et al. (1993) and Bechly (1996).

Abbreviation of venation: Ax1 and Ax2 primary antenodal crossveins; C costa; CuA cubitus anterior; CuP cubitus posterior; d discoidal triangle; IRxx supplementary longitudinal veins between branches of RP; MAa anterior branch of media anterior; MAb posterior branch of media anterior; MP media posterior; Mspl supplementary vein in postdiscoidal area; RA radius

anterior; RP radius posterior, Rspl supplementary vein in area between IR2 and RP3/4; PsA anterior branch of AA; ScP subcostal posterior.

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3. Systematic palaeontology

Order Odonata Fabricius, 1793

Clade Cavilabiata Bechly, 1996

Clade Paneurypalpida Bechly, 1996

Family Araripelibellulidae Bechly, 1996

Included genera: *Mesocordulia* Ren & Guo, 1996 (Lower Cretaceous, PR China); *Rencordulia* n. gen. (Lower Cretaceous, PR China); *Sopholibellula* Zhang et al., 2006 (Lower Cretaceous, PR China); *Araripelibellula* Nel & Paicheler, 1994 (Lower Cretaceous, Brazil, UK); *Cratocordulia* Bechly, 1998 (Lower Cretaceous, Brazil); *Cretaneophya* Jarzembowski & Nel, 1996 (Early Cretaceous, UK); *Condalia* Whalley & Jarzembowski, 1985 (Lower Cretaceous, Spain).

Genus *Araripelibellula* Nel & Paicheler, 1994

Type species: *Araripelibellula martinsnetoi* Nel & Paicheler, 1994.

Further species: *Araripelibellula britannica* Fleck et al., 2008, *Araripelibellula sennlaubi* sp. nov.

Araripelibellula sennlaubi sp. nov.

Fig. 1

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Material. Holotype MHNE.2020.10.1. (Collection Markus Seenlaub, a body with thorax, abdomen, two legs and basal parts of the wings preserved), stored at the Musée d'Histoire Naturelle et d'Ethnographie de Colmar, France.

Locality and horizon. Vicinity of Nova Olinda (precise outcrop is unknown), Araripe Basin, Ceara, NE Brazil. Lower Cretaceous, Aptian (ca. 115 Ma), Crato Formation (Martill & Heimhofer, 2007).

Etymology. Named after Markus Sennlaub, owner of the holotype, who allowed us to study it, and donated it.

Diagnosis. Hind wing ca. 17 mm long; five postnodal crossveins in hind wing; three rows of crossveins between anal loop and posterior wing margin; male anal triangle divided into three cells.

Description. Thorax 6.6 mm long, 3.4 mm wide. Two legs preserved. Forewing. Total length unknown; width opposite nodus ca. 5.6 mm; distance from base to arculus 2.2 mm, from base to nodus 8.4 mm, from nodus to pterostigma and to apex unknown; length and width of pterostigma unknown; four antenodal crossveins, with distal one complete; primary antenodal crossveins slightly stronger than secondaries; arculus in a rather proximal position, 1.0 mm basal of discoidal triangle; MA and RP clearly separated at their base in arculus; discoidal triangle free, triangular with anterior and distal sides not angled; anterior side 1.3 mm long, proximal side 1.4 mm, distal side 1.8 mm; hypertriangle and median space free, basal part of MA arcuate; submedian space crossed by CuP; submedian and subdiscoidal spaces clearly separated by a strong oblique PsA; subdiscoidal space unicellular, 1.4 mm long, 1.0 mm wide; anal area not very wide, with two rows of cells; CuA not very long, with three very short posterior branches; two rows of cells in cubito-anal area, 1.0 mm wide; postdiscoidal area narrow, 1.4 mm wide, with only one row of cells in preserved part; probably no Mspl; MA and

RP3/4 more or less parallel; no Bq crossvein and only one crossvein in proximal part of area between RP3/4 and IR2, basal of nodus; base of RP2 opposite subnodus.

Hind wing ca. 17 mm long, 7.0 mm wide, width opposite nodus 6.4 mm; distance from base to arculus 1.6 mm, from base to nodus 6.2 mm, from nodus to pterostigma 7.4 mm; pterostigma 1.4 mm long, 0.8 mm wide, short, covering less than one cell; pterostigmal brace oblique; three antenodal crossveins, with distal antenodal crossvein complete and nearly as strong as two primaries; five postnodal crossveins, with two proximal postnodals incomplete and other postnodals not well aligned with corresponding postsubnodals; arculus in a rather proximal position, nearly aligned with Ax1 and with discoidal triangle; MA and RP clearly separated at their bases in arculus, 0.3 mm apart; discoidal triangle free of crossveins, with anterior side arched, anterior side 1.4 mm long, proximal side 1.0 mm long, distal side 1.2 mm long; hypertriangle and median space free; MA strongly arcuate at base; submedian space crossed by CuP without any defined subdiscoidal space nor oblique vein PsA; anal area wide, with three-four rows of cells between AA and posterior wing margin; AA with two posterior branches directed towards posterior wing margin, a distinct three-celled anal triangle, 2.4 mm long and 1.2 mm wide; an anal angle; distal branch of AA provides basal side for a narrow two-celled anal loop, 3.0 mm long, 1.0 mm wide; anal loop without midrib (Cuspl), but closed posteriorly by AA and CuAb; CuA weakly zigzagged, not very long, with no distinct posterior branches and reaching posterior wing margin just basal of nodus; only three rows of cells in cubito-anal area, 3.2 mm wide; postdiscoidal area narrow, 0.96 mm wide distal of triangle, distinctly broader distally, with only one row of cells in its proximal part; a rudimentary Mspl; MA and RP3/4 parallel; no Bq crossvein; no crossvein in proximal part of area between RP3/4 and IR2, basal of nodus level; base of RP2 opposite subnodus; oblique crossvein ‘O’, delimiting distal part of bridge space, 1.0 mm and one cell distal of subnodus, with a narrowing of area between

IR2 and RP2 at its level; area between IR2 and RP2 broadened distally; an oblique crossvein in proximal part of area between RP2 and RP1.

Abdomen 14.0 mm long, 1.2 mm wide; terminal appendages not preserved.

4. Discussion

Araripelibellula sennlaubi sp. nov. falls in the Araripelibellulidae because of the following characters: no secondary antenodal crossveins between Ax1 and Ax2, and only two or three secondary antenodal crossveins distal of Ax2; all antenodal crossveins strictly aligned in hindwing (but the two primaries Ax1 and Ax2 are still stronger than the secondaries); only one or two antesubnodal crossveins; anterior side of hind wing hypertriangle strongly curved, and posterior side at least slightly curved, too; anal loop very elongate and narrow with only a single row of 2–4 cells (reduction); PsA suppressed in hind wing; area between RP2 and IR2 very narrow near oblique vein 'O', but more distally distinctly widened. Only the characters 'forewing with only about four postnodal crossveins' and 'postdiscoidal area very narrow in the forewing' are unknown in *Araripelibellula sennlaubi*.

Araripelibellula sennlaubi differs from *Mesocordulia* in the presence of only one row of cells in postdiscoidal areas just distal of discoidal triangles, anterior side of discoidal triangle distinctly curved, area between RP2 and IR2 very narrow near oblique vein 'O', and anal loop narrow with only a single row of cells (Ren & Guo, 1996; Bechly, 1996, 2016).

Affinities of *Araripelibellula sennlaubi* with *Cratocordulia* are excluded on the basis of the following characters: sectors of arculus well separated at base; anal loop two-celled and relatively short; MA straight (at least in its basal part) (Bechly 1998; 2007). It differs from *Cretaneophya* and *Condalia* in that the sectors of the arculus are well separated at base (Whalley & Jarzembowski, 1985; Jarzembowski & Nel, 1996). *Condalia* has also a greater distance between base of RP3/4 and discoidal triangle in forewing, with three cells in-between instead

of less than one in *Araripelibellula sennlaubi*. *Sopholibellula* shares with *Araripelibellula* the sectors of arculus well-separated at base, but it has a wider anal loop with a Y-shaped veins inside and a broader postdiscoidal area in hind wing (Zhang et al., 2006).

The differences between *Araripelibellula sennlaubi* and *A. martinsnetoi* are few: five postnodal crossveins instead of 3–4 in *A. martinsnetoi* (in both male and female); in males, three rows of crossveins between anal loop and posterior wing margin instead of two; male anal triangle divided into three cells instead of two (Nel & Paicheler, 1994; Bechly, 2007; Fleck et al., 2008). These differences cannot, however, justify a generic separation between the two taxa. *Araripelibellula britannica* Fleck et al., 2008 differs from *A. sennlaubi* in the presence of seven postnodal crossveins instead of five and a larger size (*A. sennlaubi* has wings ca. 17 mm long; 16.5 mm in *A. martinsnetoi*; and 23 mm in *A. brittanica*).

Concluding remarks

Araripelibellula sennlaubi is the second Araripelibellulidae from the Crato formation. Together with the seven previously described taxa, it shows that this family was rather diverse and widespread during the Early Cretaceous. Its absence in the very rich Albian–Cenomanian insect assemblages is surprising. Maybe future discoveries in the Burmese amber will help to know when it became extinct.

CRediT authorship contribution statement

Jean-Marc Pouillon: Writing, illustrating. **André Nel:** Writing – original draft, Formal analysis, Conceptualization.

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Fig. 1. *Araripelibellula sennlaubi* sp. nov., holotype MHNE.2020.10.1. General habitus. al anal loop, arc arculus, at anal triangle, d discoidal triangle, Na nodus forewing, Np nodus hind wing, ‘O’ oblique vein, Pt pterostigma. Scale bar represents 1 mm.


Pt
Np
Ax2
Ax1
'O'
d
Arc
Na
at
al