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New species of Palaeontinidae (Insecta: Cicadomorpha) from the Lower Cretaceous Crato Formation of Brazil

FEDERICA MENON & SAM W. HEADS

Abstract

Two new Palaeontinidae (Insecta: Cicadomorpha), *Baeocossus fortunatus* n. sp. and *Colossocossus bechlyi* n. sp. are described from the Lower Cretaceous (Aptian/Albian) Nova Olinda Member of the Crato Formation, Northeast Brazil. The diagnoses of the genera *Baeocossus* MENON, HEADS & MARTILL, and *Colossocossus* MENON, HEADS & MARTILL are revised and their phylogenetic relationships summarized. *Colossocossus bechlyi* n. sp. appears to be the most basal member of the genus as it retains the plesiomorphic condition of a distally situated M-Cu fork in the forewing.

Key words: Palaeontinidae, new species, phylogenetic relationships, Aptian/Albian, Araripe plateau.

Zusammenfassung

Zwei neue Palaeontinidae (Insecta: Cicadomorpha), *Baeocossus fortunatus* n. sp. und *Colossocossus bechlyi* n. sp. werden aus der unteren Kreide (Aptium/Albium, Crato Formation) von Nordost-Brasilien beschrieben. Die Diagnosen der Gattungen *Baeocossus* MENON, HEADS & MARTILL und *Colossocossus* MENON, HEADS & MARTILL werden überarbeitet und ihre phylogenetische Verwandtschaft dargestellt. *Colossocossus bechlyi* n. sp. ist der ursprünglichste Vertreter der Gattung, da er eine distal der Flügelbasis gelegene M-Cu-Gabelung aufweist.

1. Introduction

Palaeontinidae are an extinct group of cicadomorph insects, well known from Jurassic and Cretaceous deposits in Europe and Asia (HANDLIRSCH 1906–1908; BECKER-MIGDISOVA 1949; SHERBAKOV 1988; ZHANG 1997; REN et al. 1998; SHERBAKOV & POPOV 2002). Palaeontinidae were first recorded from the Nova Olinda Member of the Early Cretaceous Crato Formation by UEDA (1997) who described *Parawonnacottella araripensis*. Later discoveries were made by MARTINS-NETO (1998) who described a second specimen of *P. araripensis* and a new genus, *Cratocossus magnus*. MENON et al. (2005) recently reviewed the palaeontinids of the

Crato Formation and described several new taxa, including *Baeocossus* and *Colosso-cossus* (Tab. 1).

The new species described herein were discovered in the collections of the Staatliches Museum für Naturkunde Stuttgart, and are assigned to the aforementioned genera. In the current paper we revise the diagnoses of these taxa and their phylogenetic position within the group.

Stratigraphical settings and depositional environment

The Crato Formation is a stratigraphic unit of the Brazilian non-marine Cretaceous, extending over the Araripe plateau in the states of Ceará, Pernambuco and Piauí. The most important outcrops are situated in the eastern part, near Crato, Santana do Cariri, and Nova Olinda (MARTILL 1993). The lithostratigraphy of these sediments is unresolved, with the Crato limestone considered as a lower member of the Santana Formation by some authors (SILVA 1986; MAISEY 1990, 1991) and as a distinct formation by others (BEURLIN 1963; MARTILL 1993). In this paper we follow MARTILL'S (1993) subdivision of the Crato Formation into three members: the basal Nova Olinda Member and the overlying Barbalha and Jamacaru Members. The precise age of this formation is also unclear, though it is generally regarded as Upper Aptian/Lower Albian, approximately 110–120 Ma (BERTHOUS 1994) and has been dated as Upper Aptian on the basis of palynomorphs (PONS et al. 1991).

The basal Nova Olinda Member is the richest in fossils and comprises a 10–15 m sequence of millimeter-laminated limestones. The laminae (1–2 mm thick) are laterally extensive and can be traced for some distance, suggesting deposition in the calm, anoxic waters of a lagoon (MARTILL 1993). The arthropod fauna is remarkable for the exceptional preservation of soft tissues and colour patterns (MARTILL & FREY 1995; HEADS et al. 2005).

Methods

All the fossils described here were recovered from the Nova Olinda Member of the Crato Formation and then deposited in the Staatliches Museum für Naturkunde Stuttgart (SMNS), Germany. The exact provenance of the specimens is unknown, but it is likely that they were obtained from local miners in or around Nova Olinda. They are preserved as limonitic replacements after pyrite (MARTILL & FREY 1995) on slabs of cream coloured limestone. The specimens appear to have been (we cannot be certain) prepared on site by the collectors. Drawings were made using a camera lucida attached to a Wild stereomicroscope; photographs were taken with a Sony DCS-717 digital camera.

Venation terminology is as follow: Sc, subcosta; R, radius; Rs, radial sector; M, media; CuA, anterior cubitus; CuP, posterior cubitus; discal cell is intended as the cell formed of medial and anterior cubital systems and the m-cua cross vein. The discal cell is the area enclosed among M, CuA and m4-cua1, bisected by the nodal line into antenodal and postnodal regions. The morphology of this region is considered of great taxonomic importance (MENON et al. 2005).

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2. Systematic Palaeontology

Infraorder Cicadomorpha EVANS, 1946
Family Palaeontinidae HANDLIERSCH, 1906

Genus *Baeocossus* MENON, HEADS & MARTILL, 2005

Type species: *Baeocossus finchae* MENON, HEADS & MARTILL, 2005

Revised diagnosis. – Relatively small palaeontinid (forewing 31–35 mm long) with M3+4 bifurcating at midwing or just basally of midwing; discal cell large, at least one third of total wing length; antenodal discal region triangular, not reaching wing base, free of cross veins; postnodal discal region large and rhomboid.

Baeocossus finchae MENON, HEADS & MARTILL, 2005

Holotype: Near complete adult specimen, no. SMNS 65501 (MENON et al. 2005).

Type locality: Chapada do Araripe, Nova Olinda, Ceará, Brazil.

Type horizon: Nova Olinda Member, Crato Formation (Aptian/Albian).

Revised diagnosis. – *Baeocossus* (forewing length 31 mm) with M3+4 fork situated exactly at midwing; medial margin of antenodal discal cell straight; discal cell large, greater than 1/3 wing length; hindwing large (length 16.8 mm).

Baeocossus fortunatus n. sp.

Figs. 1–3

Holotype: Complete adult specimen, no. SMNS 65546.

Paratype: Complete adult specimen, no. SMNS 65547.

Type locality: Chapada do Araripe, Nova Olinda, Ceará, Brazil.

Type horizon: Nova Olinda Member, Crato Formation (Aptian/Albian).

Derivation of name: From Latin 'fortunatus' = lucky, in reference to the 'luck' or 'chance' of preserving such detailed morphological characters.

Diagnosis. – *Baeocossus* (forewing length 35 mm) with M3+4 fork situated basally of midwing; medial margin of antenodal discal cell curved; discal cell exactly 1/3 of wing length; hindwing small (length 15 mm).

Description of holotype SMNS 65546. – Complete adult in dorsal or ventral aspect, with all four wings preserved (Fig. 1a); head, thorax and abdomen strongly compressed; no fine details of the cuticle are preserved; total body length is 17 mm.

Forewings. – 35 mm long × 14 mm wide (width at nodus), triangular (Fig. 2); costal margin almost straight, indented at nodus and slightly curved at apex; posterior margin straight, anal margin slightly curved; Sc straight, origin at wing base, terminating at nodus; Sc obscured by sediment in right wing; R straight, origin at wing base; Rs origin from R at nodus; R curved, reaching the margin anteriorly of apex; Rs curved posteriorly, reaching margin posteriorly of apex; M+Cu origin probably at wing base;

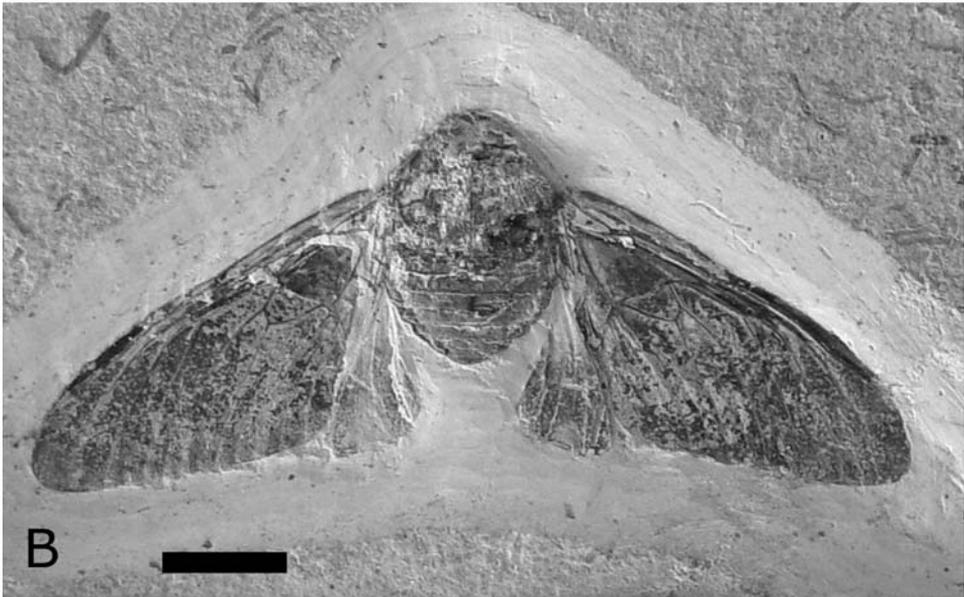
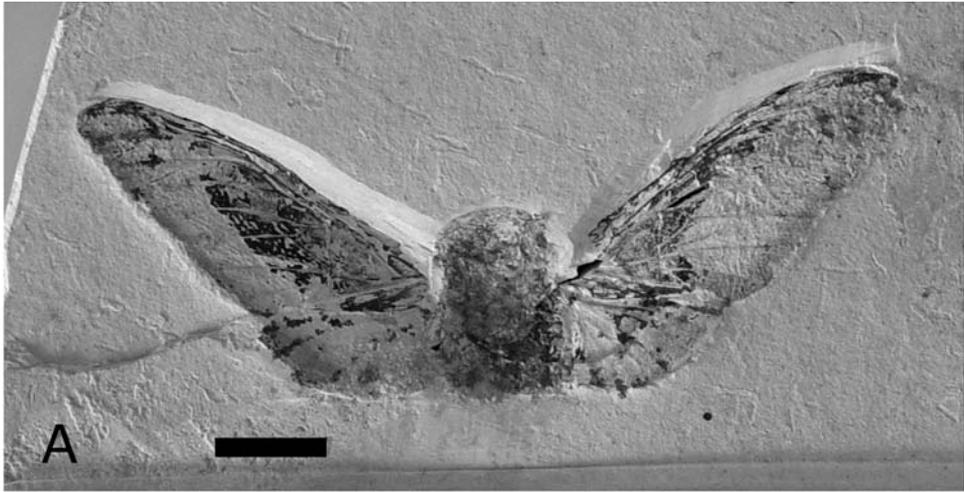


Fig. 1. *Baeocossus fortunatus* n. sp.; **a:** holotype, SMNS 65546; **b:** paratype, SMNS 65547. – Scale bar: 10 mm.

M is basally slightly curved to form the medial margin of the antenodal discal cell, branching at nodal line; M1+M2 straight, slightly undulated for 6 mm and branching 16 mm from wing base; M1 is curved basally, straight distally (Fig. 2); M2 fairly straight; rs-m1 strong, oblique; M3+M4 straight, forming anterior margin of the postnodal discal cell; M3 slightly curved posteriorly; M4 straight; all branches of M reaching wing margin distally of midwing. CuA curved, forming anal side of the antenodal discal region, branching at nodal line; CuA1 straight; CuA2 sigmoidal, both reaching margin proximally of midwing; CuP straight, reaching margin at nodal line;

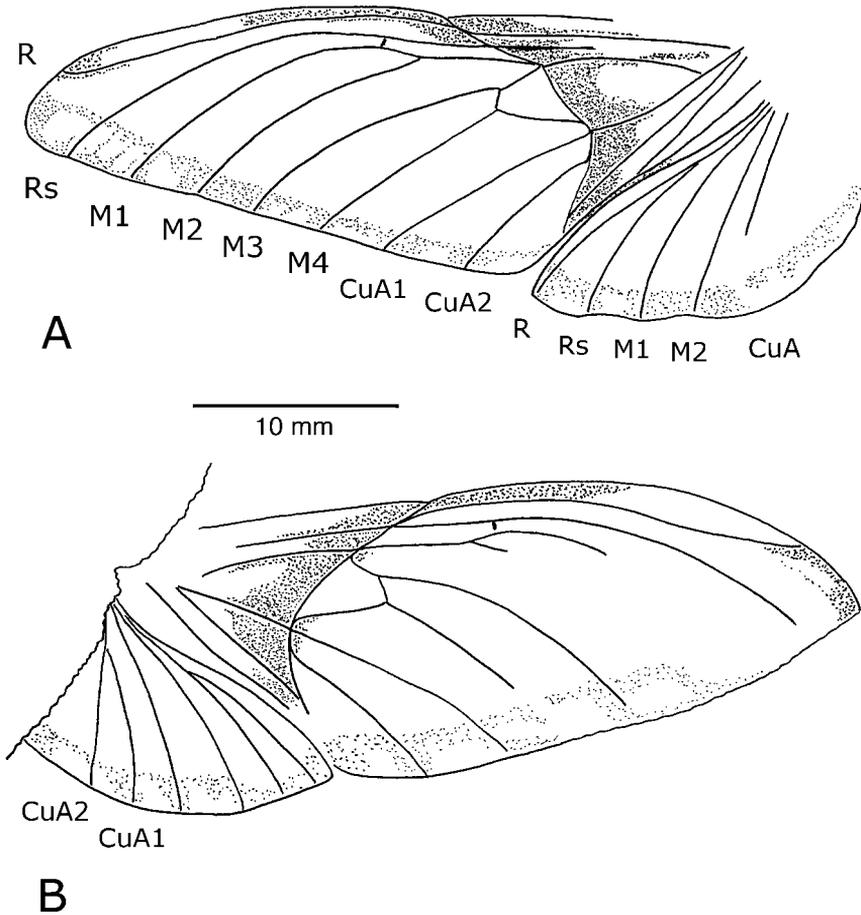


Fig. 2. *Baecossus fortunatus* n. sp.; holotype, SMNS 65546; a: left fore- and hindwings; b: right fore- and hindwings.

anal vein both strongly convex and straight; discal cell 10 mm long; antenodal region 7 mm long, postnodal 3 mm long; antenodal region triangular; the postnodal region quadrangular with slightly curved margins, except for m4-cua1, which is slightly sigmoidal and 4.5 mm long; three dimensional, pitted texture visible throughout the wing surface. Remigium thickly sclerotised, postnodal region mostly hyaline with prominent pigment band on posterior margin. The colouration present in both wings as mirror image suggests that this was the original colour pattern (Fig. 1a).

Hindwing. – Sub-triangular, 15 mm long \times 5 mm wide, at its widest point, with slightly undulated margins, pointed apex (Fig. 2); R origin probably at wing base, branching at midwing; R and Rs curved, reaching the margin posteriorly of apex; M and Cu origin probably at base, although this cannot be confirmed as the wing base is not entirely preserved; M1 curved, M2 nearly straight; CuA not complete, apparently straight basally (Fig. 2b); CuA1 and CuA2, slightly curved; anal area is not preserved; three-dimensional pitted texture visible throughout the wing surface. Original colour pattern preserved along the posterior margin.

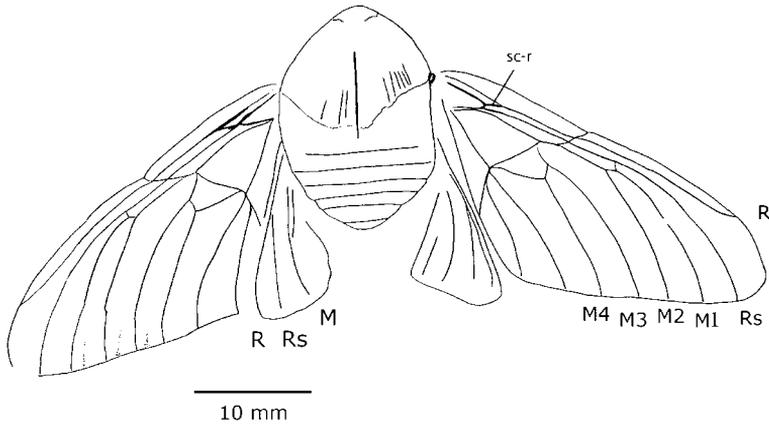


Fig. 3. *Baeocossus fortunatus* n. sp.; paratype, SMNS 65547.

Description of paratype SMNS 65547. – Complete adult in ventral aspect with all four wings preserved at each side of the body (Fig. 3); total body length 21 mm; head small, oval, 3 mm long; beak not complete, 8 mm long; thorax 8.5 mm long, obscured by mesonotum, with longitudinal carinae; abdomen composed of seven segments, 1.1 mm long, except the the last one which is reduced; legs not preserved (Fig. 1b).

Forewings. – 35 mm long \times 15 mm wide (width at nodus), triangular; costal margin almost straight, indented at nodus and slightly curved at apex; posterior margin straight, anal margin straight basally, slightly curved distally; Sc straight, origin at wing base, terminating at nodus; R origin at wing base; R is strongly convex basally and sigmoidal, straight to nodal line, then curving anteriorly, reaching margin anteriorly to apex; Rs curved, reaching margin posteriorly to apex; R and Sc are connected near the wing base by a strong oblique crossvein; M+Cu origin at wing base; M basally curved forming medial margin of antenodal discal cell, straight branching at nodal line; M1+M2 straight, branching after 6.5 mm; M1 curved basally; M2 fairly straight; rs-m1 oblique; M3+M4 nearly straight, forming anterior margin of postnodal discal cell; M3 is slightly curved towards the posterior margin; M4 basally straight, curved distally; all branches of M reaching wing margin distally of midwing; CuA curved, forms the anal side of the antenodal discal cell, branching at nodal line; CuA1 curved, CuA2 sigmoidal, both reaching the margin basally of midwing; CuP straight, reaching the margin at nodal line; anal area not preserved, obscured by hindwings; the discal cell 10.5 mm long; antenodal region 8 mm long; postnodal region 2.5 mm long; antenodal region triangular with slightly curved medial margin; postnodal region quadrangular with curved margins, except for m4-cua1, which is sigmoidal. No three-dimensional texture detected in the wing surface, in this specimen, except along the posterior margin where the wings appear to be slightly pitted; no colour patterns preserved.

Hindwings. – Sub-triangular, 15 mm long; full width cannot be measured as the wings are not extended; costal margin straight; posterior and anal margin rounded; R origin at base; Rs origin from R at midwing, curved, reaching margin posteriorly of apex; M straight basally, curved near the margin. Other venation indistinct due to partial folding of wings; colour patterns absent or not preserved (Fig. 1b).

Remarks. – *Baeocossus fortunatus* n. sp. differs from *B. finchae* in the following: (1) discal cell exactly one third of wing length (larger in *B. finchae*); (2) medial margin of antenodal discal cell curved (straight in *B. finchae*); (3) M3+4 origin basally of midwing (exactly at midwing in *B. finchae*); (4) hindwings shorter (in *B. fortunatus* 43 % of forewing length in contrast to over 50 % in *B. finchae*). The most peculiar feature is the presence of the short crossvein sc-r near wing base in the paratype, which seems to be missing in the holotype and not preserved in the holotype of *B. finchae*.

Genus *Colossocossus* MENON, HEADS & MARTILL, 2005

Type species: *Colossocossus loveridgei* MENON, HEADS & MARTILL, 2005

Revised diagnosis. – Large palaeontinids (forewing 57–71 mm long); forewing with pointed or nearly pointed apex and strongly indented nodus; large, triangular antenodal discal region reaching wing base or with proximal end close to wing base, free of crossveins or with one crossvein; reduced, lozenge-shaped post-nodal discal region; M1+2 bifurcating distally of nodal line; M3+4 very short, bifurcating at nodal line; M4 straight; CuA2 sigmoidal posteriorly.

Colossocossus bechlyi n. sp.

Figs. 4–5

Holotype: Disarticulated forewing, no. SMNS 65548.

Type locality: Chapada do Araripe, Nova Olinda, Ceará, Brazil.

Type horizon: Nova Olinda Member, Crato Formation (Aptian/Albian).

Derivation of name: After GÜNTER BECHLY (SMNS) for his contribution to the knowledge of the Crato Formation palaeontomofauna and palaeontomology in general.

Diagnosis. – Wing length 62 mm; discal cell 27 % of wing length; basal m-cua crossvein present; M1+2 forked proximally of midwing; distal side of discal cell sigmoidal; M-Cu fork not at wing base.

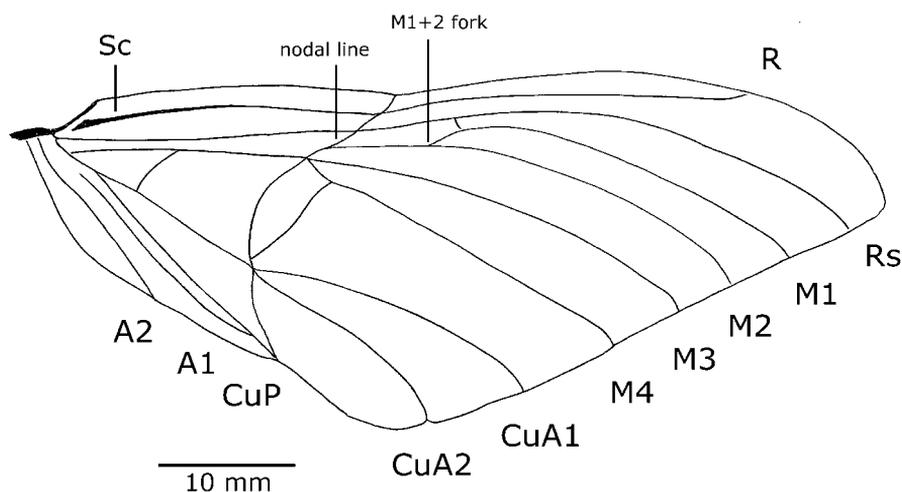


Fig. 4. *Colossocossus bechlyi* n. sp.; holotype, SMNS 65548.



Fig. 5. *Colossozocossus bechlyi* n. sp.; holotype, SMNS 65548. Scale bar: 10 mm.

Description. – Triangular, disarticulated large forewing, 62 mm long \times 25 mm wide (width at nodus); costal margin almost straight, at least basally, indented at nodus; posterior margin straight, indented at level of fusion with CuA2; anal margin mostly rounded, indented at nodal line (Fig. 4–5); nodus at 29 mm from wing base; Sc strongly convex basally, straight, terminating at nodus; R origin from wing base, straight, reaching margin anteriorly to apex; Rs origin from R at nodal line, distally curved reaching margin posteriorly to apex; M+Cu origin at wing base; M straight, branching exactly at nodal line; M1+2 straight; M1 and M2 parallel curved posteriorly towards margin; M3 and M4 origin exactly at nodal line, almost parallel; all branches of M reaching margin after midwing; rs-m1 oblique; CuA straight, branching at nodal line; CuA1 mostly curved, CuA2 sigmoidal, m-cua 4 mm long, 9 mm from wing base, curved; m4-cua1 sigmoidal. CuP origin from CuA, straight, reaching margin at nodal line; anal area wide; A1 straight, fused with CuP distally; A2 slightly curved; discal cell 17 mm long; antenodal discal region 14 mm long, triangular, divided by m-cua, with straight medial and cubital margin; postnodal discal cell lozenge-shaped, 3 mm long with sigmoidal distal margin; three-dimensional pitted texture present over the entire wing surface.

Remarks. – *Colossozocossus bechlyi* n. sp. differs from *C. loveridgei* and *C. rugosa* in the following: (1) basal m-cua crossvein present; (2) origin of M1 and M2 just before midwing (well before midwing in *C. loveridgei*); (3) m4-cua1 approximated

Table 1. Palaeontinidae species from the Crato Formation.

<i>Parawonnacottella araripensis</i> UEDA, 1997
<i>Parawonnacottella penneyi</i> MENON, HEADS & MARTILL, 2005
<i>Cratocossus magnus</i> MARTINS-NETO, 1998
<i>Baeocossus finchae</i> MENON, HEADS & MARTILL, 2005
<i>Baeocossus fortunatus</i> n. sp.
<i>Colossozocossus loveridgei</i> MENON, HEADS & MARTILL, 2005
<i>Colossozocossus rugosa</i> MENON, HEADS & MARTILL, 2005
<i>Colossozocossus bechlyi</i> n. sp.

with nodal line posteriorly; (4) discal cell shorter (27 % of wing length) than in *C. rugosa* (31.5 %), but longer than in *C. loveridgei* (22 %); M-Cu fork not situated at wing base.

3. Discussion

Crato Formation Palaeontinidae, including *Cratocossus* MARTINS-NETO, 1998 and *Parawonnacottella* UEDA, 1997 (Table 1) form a natural group which is closely related to forms comprising the 'Ilerdocossus-complex' (MENON et al. 2005), having in common a narrow forewing, the shift of M-Cu fork towards the wing base, apparent reduction of the venation basally and a reduced clavus (MENON et al. 2005) (Fig. 6, Characters 1, 2 and 3). In a previous study (MENON et al. 2005) we recognized a clade comprising *Baeocossus*, *Colossocossus*, and *Cratocossus*: forms with narrow forewings with pointed apex and a triangular antenodal discal region (Fig. 6, Characters 5 and 6). The new species described in this paper confirm the position of *Colossocossus* and *Baeocossus* within this clade. *C. bechlyi* n. sp. appears to be in a more inclusive position than *C. loveridgei* and *C. rugosa* (Fig. 6) in which the M-Cu fork is situated at the wing base (see Diagnosis). In *C. bechlyi* n. sp. the M-Cu fork is situated distally, at 3.5 mm from the wing base. The relationships of this group to *Parawonnacottella* and the 'Ilerdocossus-complex' remain uncertain. At present, no robust synapomorphies exist to unite *Parawonnacottella* exclusively with either groups and an unresolved trichotomy persists (see Fig. 6). The 'Ilerdocossus-complex' is currently being revised and will form the basis of a subsequent paper.

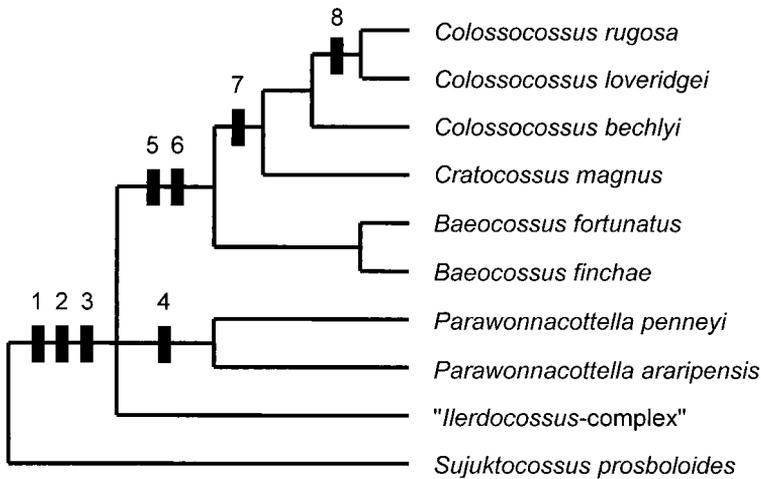


Fig. 6. Tree representing the relationships of Brazilian Palaeontinidae, inferred from the examination of the following characters: 1, increased narrowing of forewing; 2, shift of M-Cu fork towards wing base; 3, small clavus; 4, costal margin of forewing without nodal indentation; 5, narrow forewing with pointed apex; 6, antenodal region of discal cell triangular; 7, postnodal region of discal cell lozenge-shaped; 8, antenodal region of discal cell not divided. Modified from MENON et al. 2005.

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Addresses of the authors:

FEDERICA MENON, School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Oxford Road, Manchester, M13 9PL, United Kingdom
E-mail: federica.menon@postgrad.manchester.ac.uk

SAM W. HEADS, School of Earth, Atmospheric and Environmental Sciences, University of Manchester, Oxford Road, Manchester, M13 9PL, United Kingdom
E-mail: sam.heads@postgrad.manchester.ac.uk

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