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First Frenguelliidae (Insecta: Odonata) from the middle Eocene of Río Pichileufú, Patagonia, Argentina.

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Abstract: A new genus, *Treintamilun gen. nov.*, based on *Treintamilun vuelvenlucha sp. nov.* is described from Río Pichileufú (Lutetian), Río Negro province, Patagonia, Argentina. The new genus is assigned to Frenguelliidae. The finding of a second genus and third species of Frenguelliidae is noteworthy, contributing to the better knowledge of this little known family and bear out its presence in the Eocene of Patagonia. While the previous species of Frenguelliidae were recorded from the Ypresian (52 Ma) of Laguna del Hunco, the new one comes from the neighbour locality 160 Km far and 48 Ma old. The Frenguelliidae share a nodal furrow reduced, a ScP reaching costal margin very obliquely at nodus, a nodal Cr sub-vertical and subnodus vertical, and one of the groundplan apparent characters of the Epiproctophora, a curved CuP.

Key words: Odonata, Frenguelliidae, *Treintamilun vuelvenlucha gen. nov. et sp. nov.*, Lutetian, Patagonia, Argentina.

Resumen: Primer Frenguelliidae (Insecta: Odonata) del Eoceno de Río Pichileufú, Patagonia, Argentina. Se describe un nuevo género, *Treintamilun gen. nov.*, basado en *Treintamilun vuelvenlucha sp. nov.* de la localidad de Río Pichileufú (Luteciano), Provincia de Río Negro, Patagonia, Argentina. El nuevo género se asigna a Frenguelliidae. El hallazgo de un segundo género y tercera especie de Frenguelliidae es digno de mención, contribuyendo a un mejor conocimiento de esta pequeña familia y confirma su presencia en el Eoceno de la Patagonia. Mientras las especies previamente registradas de Frenguelliidae son del Ypresiano (52 Ma) de Laguna del Hunco, la nueva especie viene de la localidad vecina a 160 Km y con una edad de 48 Ma. Los Frenguelliidae comparten un surco nodal reducido, una ScP llegando al margen alar muy oblicua al nodus, una Cr nodal subvertical y un nodus vertical, y uno de los caracteres aparentes del plan básico de los Epiproctophora, una CuP curvada.

Palabras clave: Odonata, Frenguelliidae, *Treintamilun vuelvenlucha gen. nov. et sp. nov.*, Luteciano, Patagonia, Argentina.

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Introduction

The family Frenguelliidae was previously composed by two species, *Frenguella patagonica* Petrulevičius & Nel, 2003 and *F. iglesiasi* Petrulevičius & Nel, 2013. Frenguelliidae is a very interesting group controversially considered an Epiproctophora, basal to Euepiproctophora by Petrulevičius & Nel (2003, 2007, 2013) and Petrulevičius *et al.* (2011), nor a Zygopteran by Nel & Arillo (2006), Nel *et al.* (2008), Lak *et al.* (2009) and Bechly & Poinar (2013). Only the Epiproctophoran hypothesis was discussed and based principally in a putative character of the group, the curved CuP (Petrulevičius & Nel, 2003, 2007, 2013). The Zygopteran hypothesis could be reasonably adopted by the presence in Frenguelliidae of one character absent in the basal Epiproctophora that is the IR2 aligned with the subnodus. Other characters present in Frenguelliidae and other Zygopteran are homoplastic and present also in some Epiproctophora, i.e., arculus nearer to Ax2 than to Ax1 in Cyclothemistidae: *Triassoneura* (Fujiyama,

1991) and Epiophlebiidae: *Mesoepiophlebia* (Nel & Jarzembowski, 1996); the lack of pterostigmal brace in Campterochlebiidae: *Ctenogampsophlebia* (Petrulevičius *et al.*, 2011); absence of secondary antenodals could occur also on *Triassoneura*. The morphology of the new species does not contradict the hypothesis postulated by Petrulevičius & Nel (2003, 2007, 2013) about the phyletic position of the group which remains uncertain and its resolution exceeds the possibility of present work but is a nice topic for future research.

The new finding is the most complete wing, and only one not wrinkled of the family preserving a complete arculus, nodus and pterostigma. The single specimen of *Treintamilun vuelvenlucha* gen. et sp. nov. comes from the Patagonian locality of Río Pichileufú, Río Negro, Argentina (Petrulevičius, 2013). The locality was dated using $^{40}\text{Ar}/^{39}\text{Ar}$ analyses in Wilf *et al.* (2005) and recalculated in Wilf (2012), giving an age of 47.74 ± 0.05 Ma (million years ago). The locality is renowned for its very high plant diversity (Wilf *et al.*, 2005; Wilf, 2012). Previously reported insects from the same site are the Myrmeciinae ant, *Archimyrmex piatnitzkyi* (Viana & Haedo Rossi, 1957; Dlussky & Perfilieva, 2003) and the pentatomoid bug, *Acanthocephalonotum martinsnetoi* Petrulevičius & Popov, 2014. Patagonian Eocene localities are exponentially increasing their known plant and insect diversity in recent years through sustained efforts to collect and describe their fossils (Wilf *et al.*, 2003, 2005; Wilf, 2012; Petrulevičius & Nel, 2005; Petrulevičius *et al.*, 2010; Petrulevičius, 2001, 2009, 2013, 2015, 2016).

Materials and methods

The fossil is housed at the Museo Asociación Paleontológica Bariloche (repository prefix MAPBAR), San Carlos de Bariloche, Río Negro, Argentina.

In this work, I follow the wing venation nomenclature of Kukalová-Peck (1983), amended by Kukalová-Peck (1991, 2009), also contributions by Riek & Kukalová-Peck (1984), Nel *et al.* (1993), Bechly (1996), and Petrulevičius & Gutiérrez (2016). The higher classification of fossil and extant Odonata is based on the phylogenetic system of Bechly (1996, 2007).

The new species was drawn and photographed in details with a camera lucida and a Leica digital camera (DMC2900) attached to a Leica M205C stereomicroscope, respectively. Habitus of the specimen was photographed with a Nikon Coolpix 7100.

Systematic Paleontology

Odonata Fabricius, 1793

Frenguelliidae Petrulevičius and Nel, 2003

Treintamilun gen. nov.

Type species: *Treintamilun vuelvenlucha* sp. nov.

Diagnosis. (1) CuP curved, looking like an anterior branch of AA; (2) terminal kink of the CP very weak, not aligned with nodal Cr; (3) nodal furrow reduced; (4) ScP reaching costal very obliquely at nodus; (5) nodal Cr sub vertical; (6) subnodus vertical; (7) midfork symmetrical and recessed basally to a position between 12 and 26% of wing length; (8) pterostigma elongate and broad; (9) discoidal cell basally closed in hindwings, quite broad, distinctly widened distally; (10) antesubnodal space without cross-veins; (11) petiole short and broad; (12) base of IR2 slightly closer to arculus than to nodus; (13) base of RP2 8 cells from nodus; (14) terminal kink of the CP in a slightly distal position of the nodal Cr.

Characters (1) to (12) are diagnostic characters of the family. Characters (13) and (14) are unique from the new genus.

Etymology. In Castilian, 30,001 (*treintamilun*). Dedicated to the 30,000 (*treintamil*) Detained-Disappeared (*Detenidos-Desaparecidos*) by the last Argentinean Military-Civil-Ecclesiastic Dictatorship (1976-1983) to which followed the Enforced Disappeared in democracy (1983-2017). Gender neuter.

Treintamilun vuelvenlucha sp. nov. (Figs. 1-3)

Diagnosis. As for the genus (*see above*).

Description. A complete hindwing (?) with two dark zones crossing the wing (Figs. 1-2), one beneath the pterostigma and the other covering the area distal to the nodus to the height of RP2; other areas hyaline; petiole short, about 3 mm long; wing 32.6 mm long, 7.6 mm wide; petiole short and broad, 3 mm long and 1.5 mm wide; wing 32.6 mm long, 7.6 mm wide; distance between base and arculus, 4.5 mm, between arculus and nodus, 5.2 mm, between nodus and pterostigma, 16 mm, between pterostigma and apex, 2.3 mm; nodus basally recessed; pterostigma long (4.1 mm) and broad (0.9 mm), covering four and a half cells (Fig. 3C); pterostigmal brace reduced, anterior side of pterostigma slightly oblique; Ax2 just distal to arculus; Ax1 1.6 mm basally; discoidal cell basally closed, broad, distinctly widened distally, anterior side, 0.7 mm long, posterior side, 0.9 mm long, basal side, 0.3 mm long, distal side, 1.3 mm long; no antesubnodal cross-veins; discoidal cell basally closed, broad, distinctly widened distally, anterior side (MA), 0.3 mm long, posterior side (cross-vein = ddcv), 1.3 mm long, basal side (cross-vein = bdcv), 0.7 mm long, distal side, 0.9 mm long; arculus short; RP get free nearer anterior side of arculus; ddcv about 80° to MA; MP + CuA with a strong angle just distal of the base of CuP; CuP curved (Fig. 3A); base of RP3+4 between arculus and nodus, about 2.8 mm basal to subnodus, 2.3 mm distal to arculus; base of IR2 below subnodus; base of RP2 six cells, 6 mm distal of subnodus; base of IR1 2-3 veins distal to RP2; nodal cross-vein (Cr) sub-vertical (Fig. 3B), 0.1 mm distal of point of fusion of ScP with costal margin; subnodus vertical; posterior bent of CP not aligned with Cr but in a slightly distal position, at the point of fusion between ScP and costal margin; 17 postnodal cross-veins between C and RA, only aligned the four basal ones with the corresponding cross-veins between RA and RP1; cubito-anal area broad, with three rows of cells between CuA and posterior wing margin; CuA zigzagged reaching posterior wing margin well distal (about 8 mm) of nodus level; postdiscoidal area with only one row of cells and distally narrowed; area between MA and RP3+4 distally widened; area between RP3+4 and IR2 narrow, with one row of cells; areas between IR2 and RP2 and between RP2 and IR1 distally widened with two long secondary longitudinal veins; area between IR1 and RP1 with only one row of cells, broader than long; MA and CuA distally zigzagged; MP, RP3+4, IR2 and RP2 more or less straight or slightly curved; IR1 with a distinct but smooth curve opposite pterostigma, corresponding to a narrowing of the area between it and RP1 and a broadening of the area between it and RP2; no significant increase of spine-density at the apical costal margin.

Etymology. From the Castilian "*vuelve en lucha*", meaning returning in fight. In homage to the 30,001, alive in the dreams and commitment of the People. The specific epithet is to be considered as a noun in apposition.

Type material. MAPBAR 4139, Museo de la Asociación Paleontológica de Bariloche, San Carlos de Bariloche, Río Negro, Argentina.

Type locality. Volcanic caldera-lake beds, Río Pichileufú, quarry RP4 (= to field numbers "PichiPrem"), new locality discovered by Ariana "Premgi" Paulina Carabajal in 2016 and lateral equivalent to RP3 from Wilf et al. (2005), Pilcaniyeu, province of Río Negro, Patagonia Argentina, palaeolatitude ~46°S.

Discussion. The new specimen could be included into Frenguelliidae because they share some characters as the terminal kink of the CP very weak, not aligned with nodal Cr; nodal furrow reduced; ScP reaching costal very obliquely at nodus; nodal Cr sub-vertical; subnodus vertical; midfork symmetrical and

recessed basally to a position between 12 and 26% of wing length; pterostigma elongate and broad; discoidal cell basally closed in hindwing, quite broad, distinctly widened distally; all secondary antenodal cross-veins between ScP and RA suppressed; antesubnodal space without cross-veins; cubito-anal area broad, with three rows of cells between CuA and posterior wing margin; nodus in the basal third of the wing, postnodal area very elongate; postnodal and postsubnodal cross-veins very numerous; and the petiole short and broad. The new genus could be distinguished from *Frenguella* Petrulevičius & Nel, 2003, the other genus of Frenguelliidae, because it has the terminal kink of the CP not aligned with nodal Cr but in a slightly distal position (contra in a very distal position in *Frenguella*); and the base of RP2 8 cells from nodus (contra 2–4 cells).

The presence of a discoidal cell distinctly widened distally and a much less oblique and more transverse distal side (ddcv) like in the forewing of *Frenguella* correspond to an apomorphy of the clade Epiproctophora Bechly, 1996. Also, the presence of a CuP strongly curved and apparently beginning on AA (Petrulevičius & Nel, 2003), potential synapomorphy of the group and also discussed in Fleck *et al.* (2004) support its attribution to Epiproctophora.

The base of the vein IR2 of Frenguelliidae is below the subnodus while it is nearly midway between the nodus and the arculus in all the Epiproctophora. This is probably an autapomorphy of Frenguelliidae within this clade (Petrulevičius & Nel, 2007). This structure could be correlated to the basal recession of the nodus. Also, the short petiolation together with the broadened wing and the subvertical nodal cross-vein and subnodus is a character present in some Zygoptera (Thaumatoneuridae: Dysagrioninae) and in the Oligocene-Miocene family Sieblosiidae of enigmatic phylogenetic position, but considered Epiproctophora in several publications (Fleck *et al.*, 2004; Nel & Fleck, 2012). Differences with the Sieblosiidae are in the shape of the discoidal cells and position of the bases of RP3+4 and IR2 (Petrulevičius & Nel, 2007).

The Austroperilestidae Petrulevičius & Nel, 2005 also present in the Eocene of Patagonia are based in a single wrinkled specimen that shows some shared characters with Frenguelliidae which could indicate its synonymy with Frenguelliidae. Only the discovery of new and more complete material is awaited to a fine comparison. Both families differ strongly in the characters of the discoidal cell placing Austroperilestidae into the Zygoptera (Petrulevičius & Nel, 2005). In this way, *Austroperilestes* Petrulevičius & Nel, 2005 could be differentiated with *Treintamilun* gen. nov. by having the arcular cross-vein reaching RP+MA basal to its separation (contra after RP separation in *Treintamilun* gen. nov.); the RP and MA strongly approximated at their base in discoidal quadrangle (contra very distant); the pterostigma braced (contra not braced); and a curved vein between and near MA and ddcv forming a little triangle.

If Frenguelliidae are Epiproctophorans, they are not Euepiproctophorans (Epiophlebiidae + Anisopteromorpha Bechly, 1996) because they have a different, derived pattern of alternating width of wing spaces between the longitudinal veins, and a tendency to a triangular hind wing discoidal cell traversed by one cross-vein. The Frenguelliidae are probably in a very inclusive position within the Epiproctophora, either sister group of all other Epiproctophora or sister group of the Isophlebioptera, as it shares some potential synapomorphies with this last group (Petrulevičius & Nel, 2007).

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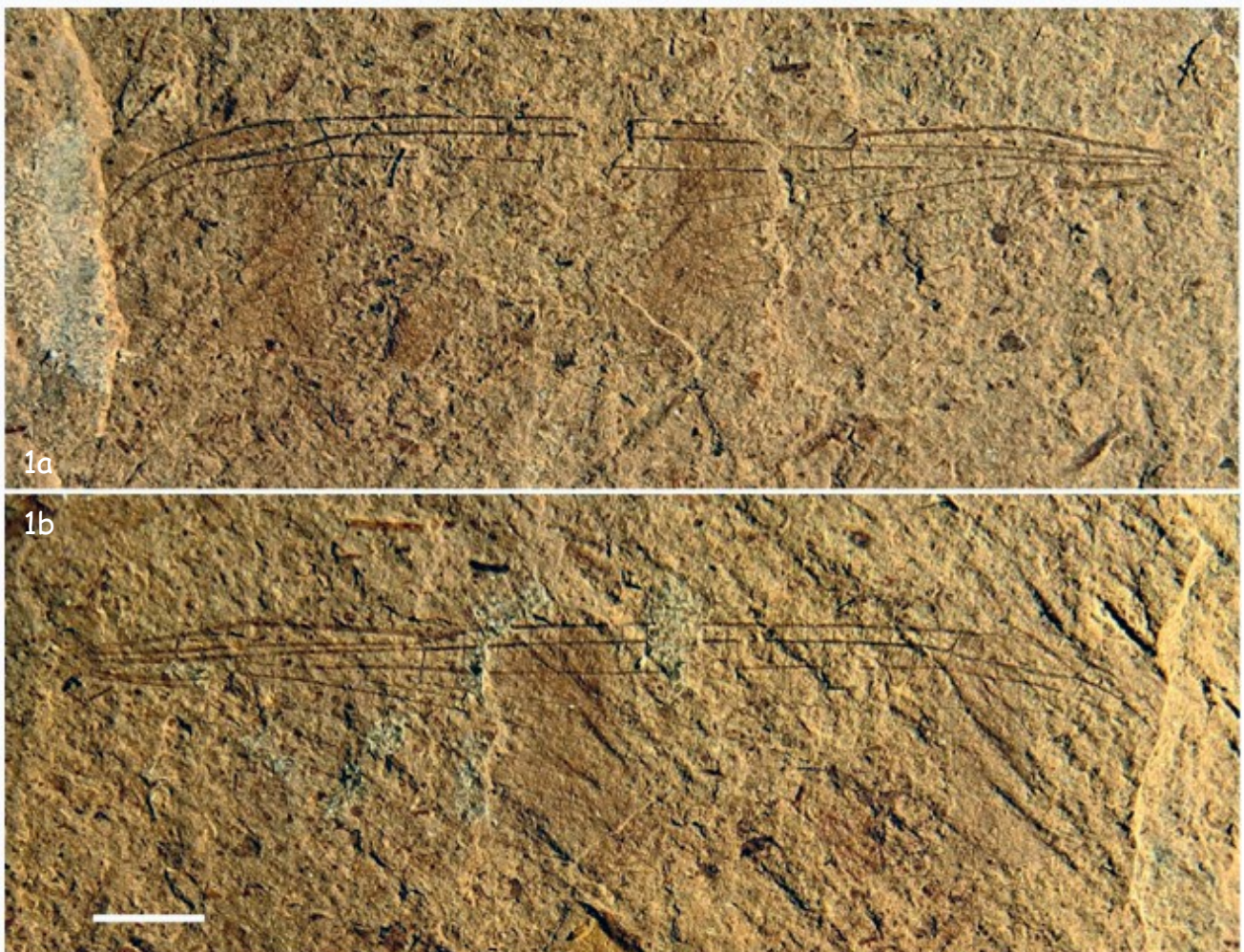


Fig. 1.- Photographs of *Treintamilun vuelvenlucha* gen. et sp. nov., holotype MAPBAR 4139 from Río Pichileufú (Río Negro, Argentina); Lutetian, middle Eocene. a. - Part. b. - Counterpart. Scale bar = 3 mm.

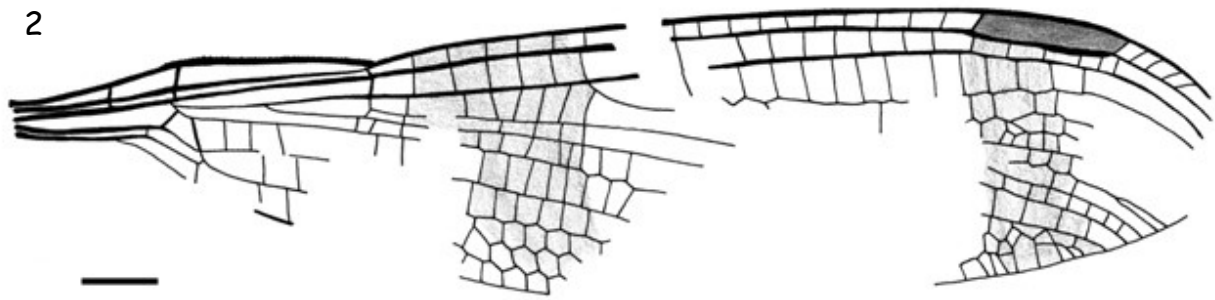


Fig. 2.- Composite camera lucida drawing of *Treintamilun vuelvenlucha* gen. et sp. nov., holotype MAPBAR 4139 from Río Pichileufú (Río Negro, Argentina); Lutetian, middle Eocene. Scale bar = 2 mm.

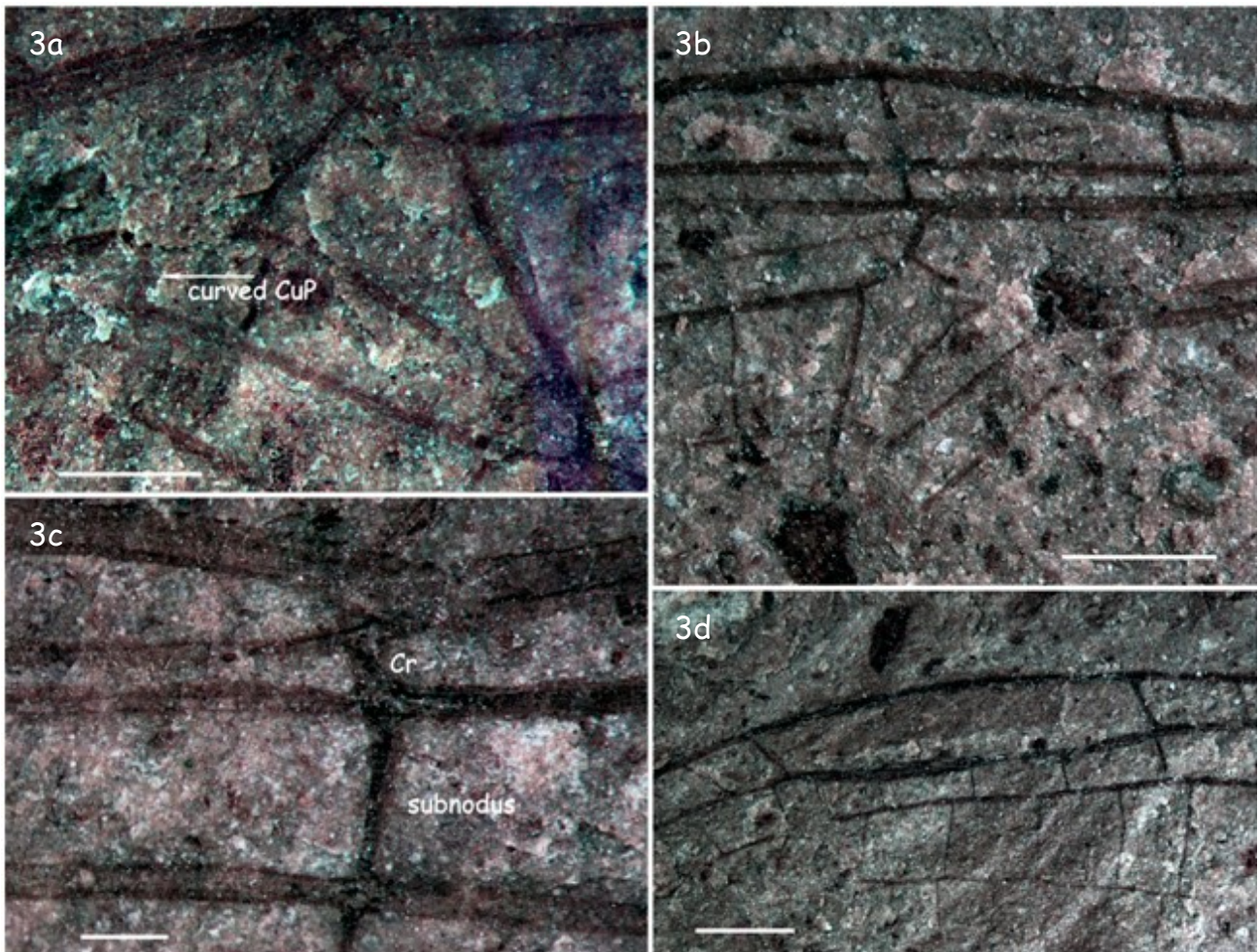


Fig. 3.- Photographs of details of *Treintamilun vuelvenlucha* gen. et sp. nov., holotype MAPBAR 4139 from Río Pichileufú (Río Negro, Argentina); Lutetian, middle Eocene. a. - Discoidal cell, scale bar = 0.5 mm. b. - Basal part, scale bar = 1 mm. c. - Nodus, scale bar = 0.25 mm. d. - Pterostigma, scale bar = 0.5 mm.