A New *Nelala* (Odonata: Frenguelliidae) from the Eocene of Arroyo Chacay, Patagonia, Argentina[1]

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Abstract: A new species of Odonata, *Nelala chacay* sp. nov., from the Eocene of Northern Patagonia, Argentina, is described. The new species is the sixth one of the endemic Patagonian Eocene family Frenguelliidae. *Nelala chacay* sp. nov. is characterized mainly by the five postdiscoidal cells between MA and MP, and a RP3+4 only two cells and a half basal to subnodus.

Key Words: Insecta, Odonata, Frenguelliidae, *Nelala*, fossil, Eocene, Arroyo Chacay, Patagonia, Argentina

Introduction

Frenguelliidae Petrulevičius and Nel, 2003 is an endemic group from the Eocene of northern Patagonia (Petrulevičius 2022). They are registered from a volcanic complex in three caldera lake localities: Laguna del Hunco from the lower Eocene (52 Ma), Río Pichileufú from the middle Eocene (48 Ma), and Arroyo Chacay (no absolute dating). These localities are relatively well surveyed and show high diversity of plants (Wilf et al. 2005, Wilf 2012) and insects (Viana and Haedo Rossi 1957; Petrulevičius 2009, 2013, 2015, 2016, 2017a, b, 2018, 2019, 2022; Petrulevičius and Nel 2003, 2005, 2013; Petrulevičius and Popov 2014; Petrulevičius et al. 2010). The family Frenguelliidae was hitherto known from four genera and five species: *Frenguellia patagonica* Petrulevičius and Nel, 2003, *F. iglesiasi* Petrulevičius and Nel, 2013, *Treintamilun vuelvenlucha* Petrulevičius, 2017, *Chacayala campeona* Petrulevičius, 2022, and *Nelala chori* Petrulevičius, 2019. The aim of this work is to describe a new Frenguelliidae consisting of a mainly complete wing, herein placed in the genus *Nelala*, from Arroyo Chacay.

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Methods

The fossil is housed at the Museo Asociación Paleontológica Bariloche (repository prefix BAR), 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 and Kukalová-Peck (1984), Nel et al. (1993), Bechly (1996), as well as Petrulevičius and Gutiérrez (2016). The specimen was drawn with a camera lucida and photographed with a digital camera (DMC5400) both attached to a Wild M8 stereomicroscope.

Systematic Palaeontology

Order Odonata Fabricius, 1793

Family Frenguelliidae Petrulevičius and Nel, 2003

Genus *Nelala* Petrulevičius, 2019
Type species. *Nelala chori* Petrulevičius, 2019

Nelala chacay sp. nov.

Figures 1 and 2

Type material. Holotype BAR 8750, Museo Asociación Paleontológica Bariloche, Río Negro, Argentina.

Etymology. Named after the locality Chacay.

Diagnosis. (1) discoidal cell almost vertical, very narrow; (2) terminal kink of CP in a slightly distal position of nodal Cr; (3) two rows of cells between CuA and posterior wing margin; (4) AA separating from AP basal to level of Ax1; (5) CuP nearer to level of Ax1 than to Ax2; (6) at least 11 postnodal crossveins aligned with postsubnodals; (7) five postdiscoidal cells between MA and MP; (8) RP3+4 two cells and a half basal to subnodus. Characters (1) to (6) are shared with *Nelala chori*. Characters 7 and 8 are from the new species.

Type locality and horizon. Arroyo Chacay, province of Río Negro, Patagonia, Argentina, palaeolatitude ~46°S.

Description. A mainly complete wing; preserved part 26 mm long, 69.5 mm wide; distance between arculus and nodus 4.3 mm; nodus basally recessed; Ax2 just distal to arculus; Ax1 1.0 mm basal to arculus; discoidal cell basally closed, almost vertical, very narrow, anterior side (MA) 0.2 mm long, distal side (crossvein = ddcv) 0.8 mm long, basal side (crossvein = bdcv) 0.4 mm long, posterior side 1 mm long; no antesubnodal crossveins; arculus short; RP getting free in base of arculus; MP+CuA with strong angle just distal to base of CuP; base of RP3+4 between arculus and nodus, two cells and a half (2.2 mm) basal

to subnodus, and two cells and a half (2.2 mm) distal to discoidal cell; base of IR2 just basal to subnodus; base of RP2 six and a half cells and 5.1 mm distal to subnodus; base of RP2 14 and a half cells and 8.95 mm distal to pterostigma; base of IR1 three veins distal to RP2; nodal crossvein (Cr) sub-vertical just distal to 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; ~20 postnodal crossveins between C and RA, at least 6 aligned with postsubnodal ones; cubito-anal area with two rows of cells between CuA and posterior wing margin; CuA slightly curved posteriorly reaching posterior wing margin well distal (about 6.5 mm) to nodus level; postdiscoidal area with a large and irregular quadrangular cell just distal to discoidal cell, and only one row of cells; area between RP1 and IR1 with one row of broad cells; area between IR1 and RP2 distally widened with four? rows of cells and three? secondary longitudinal veins; area between MP and CuA widened at the posterior margin; two rows of cells between CuA and posterior margin; 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 area between it and RP1 and a broadening of area between it and RP2; pterostigma, 2.2 mm long, 0.7 mm wide; no significant increase of spine-density on apical costal margin.

Figure 1. Photograph of *Nelala chacay* sp. nov. Holotype BAR 8750 from Arroyo Chacay (Río Negro, Argentina). Eocene. Species habitus. Scale bar = 2 mm.

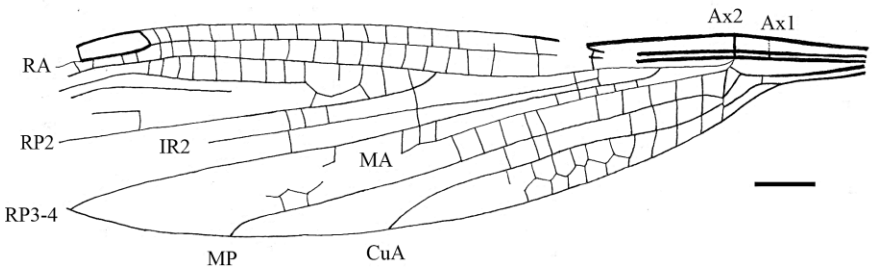

Figure 2. Line drawing of *Nelala chacay* sp. nov. Holotype BAR 8750 from Arroyo Chacay (Río Negro, Argentina). Eocene. Species habitus. Scale bar = 2 mm.

Discussion

The specimen can be included into the Frenguelliidae because of the following characters: terminal kink of CP very weak, not aligned with nodal Cr, but distal; nodal furrow reduced; ScP reaching costal margin very obliquely at nodus; nodal Cr sub-vertical; subnodus sub-vertical; midfork symmetrical and recessed basally to a position between 12–26% of wing length; all secondary antenodal crossveins between ScP and RA suppressed; antesubnodal space without crossveins; pterostigma elongate and broad; cubito-anal area broad; nodus in basal third of wing.

The specimen could not be included into *Frenguellia* Petrulevičius and Nel, 2003 because of its terminal kink of CP in a slightly distal position of nodal Cr (*contra* in a very distal position). The specimen could not be included into *Treintamilun* Petrulevičius, 2017 by having only two rows of cells between CuA and posterior wing margin (*contra* three) and a discoidal cell almost vertical, very narrow (*contra* oblique and wide). The specimen could be included into the genus *Nelala* from Arroyo Chacay because of the presence of the terminal kink of CP in a slightly distal position of nodal Cr, two rows of cells between CuA and posterior wing margin, AA separating from AP basal to level of Ax1, and CuP nearer to level of Ax1 than to Ax2.

The specimen represents a new species differing from *Nelala chori* by having five postdiscoidal cells between MA and MP (*contra* six), and a RP3+4 only two cells and a half basal to subnodus (*contra* three and a half). *Nelala chacay* sp. nov. also has 20 (*contra* 17) postnodal veins; and two rows of cells between CuA and posterior wing margin four cells distal to the discoidal cell (*contra* two).

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Literature Cited

Bechly, G. 1996. *Morphologische Untersuchungen am Flügelgeäder der rezenten Libellen und deren Stammgruppenvertreter (Insecta; Pterygota; Odonata), unter besonderer Berücksichtigung der Phylogenetischen Systematik und des Grundplanes der Odonata. Petalura*. Special Volume 2. 402 pp.

Kukalová-Peck, J. 1983. Origin of the insect wing and wing articulation from the arthropodan leg. *Canadian Journal of Zoology* 61:1618–1669. https://doi.org/10.1139/z83-217

Kukalová-Peck, J. 1991. Fossil history and the evolution of hexapod structures. pp. 141-179. In, Naumann, I. D. (Editor). *The Insects of Australia: A Textbook for Students and Research Workers*. Volume 1. Second Edition. Melbourne University Press. Melbourne, Australia. 1137 pp. (in two volumes).

Petrulevičius, J. F. 2009. A Panorpoidea (Insecta: Mecoptera) from the lower Eocene of Patagonia, Argentina. *Journal of Paleontology* 83:994–997. https://doi.org/10.1666/08-073.1

Petrulevičius, J. F. 2013. Palaeoenvironmental and palaeoecological implications from body fossils and ovipositions of Odonata from the Eocene of Patagonia, Argentina. *Terrestrial Arthropod Reviews* 6:53–60. https://doi.org/10.1163/18749836-06021057

Petrulevičius, J. F. 2015. A new Synlestidae damselfly (Insecta: Odonata: Zygoptera) from the early Eocene of Nahuel Huapi Este, Patagonia, Argentina. *Arquivos Entomolóxicos* 14:287–294. https://www.researchgate.net/publication/316158546_A_new_Synlestidae_damselfly_Insecta_Odonata_Zygoptera_from_the_early_Eocene_of_Nahuel_Huapi_Este_Patagonia_Argentina

Petrulevičius, J. F. 2017a. A new burmagomphid dragonfly from the Eocene of Patagonia, Argentina. *Acta Paleontologica Polonica* 62(4):779–783. https://doi.org/10.4202/app.00427.2017

Petrulevičius, J. F. 2017b. First Frenguelliidae (Insecta: Odonata) from the middle Eocene of Río Pichileufú, Patagonia, Argentina. *Arquivos Entomolóxicos* 18:367–374. https://www.researchgate.net/publication/322160781_First_Frenguelliidae_Insecta_Odonata_from_the_middle_Eocene_of_Rio_Pichileufu_Patagonia_Argentina

Petrulevičius, J. F. 2018. A new malachite damselfly (Synlestidae: Odonata) from the Eocene of Patagonia, Argentina. *Life: The Excitement of Biology* 6(2):36–43. https://blaypublishers.files.wordpress.com/2018/12/Petrulevicius-A-New-Malachite-Damselfly.pdf

Petrulevičius, J. F. 2019. A new Frenguelliidae (Insecta: Odonata) from the Eocene of Arroyo Chacay, Patagonia, Argentina. *Palaeoentomology* 002:591–595. https://doi.org/10.11646/palaeoentomology.2.6.9

Petrulevičius, J. F. 2022. A new genus of Frenguelliidae (Insecta: Odonata) from Arroyo Chacay, Eocene of Patagonia, Argentina. *Life: The Excitement of Biology* 10(2):102-106. https://blaypublishers.files.wordpress.com/2022/12/petrulevicius_leb_102.pdf

Petrulevičius, J. F. and A. Nel. 2003. Frenguelliidae, a new family of dragonflies from the earliest Eocene of Argentina (Insecta: Odonata). Phylogenetic relationships within Odonata. *Journal of Natural History* 37:2909–2918. https://doi.org/10.1080/0022293021000007543

Petrulevičius, J. F. and A. Nel. 2005. Austroperilestidae, a new family of damselflies from the earliest Eocene of Argentina (Insecta: Odonata). Phylogenetic relationships within Odonata. *Journal of Paleontology* 79:658–662. https://doi.org/10.1666/0022-3360(2005)079[0658:AANFOD]2.0.CO;2

Petrulevičius, J. F. and A. Nel. 2007. Enigmatic and little known Odonata (Insecta) from the Paleogene of Patagonia and northwest Argentina. *Annales de la Société Entomologique de France* (n. s.) 43:341–347. https://doi.org/10.1080/00379271.2007.10697530

Petrulevičius, J. F. and A. Nel. 2013. A new Frenguelliidae (Insecta: Odonata) from the early Eocene of Laguna del Hunco, Patagonia, Argentina. *Zootaxa* 3616:597–600. https://doi.org/10.11646/zootaxa.3616.6.6

Petrulevičius, J. F., A. Nel, and J.-F. Voisin. 2010. Discovery of a new genus and species of darnerdragonfly (Aeshnidae: Odonata) from the lower Eocene of Laguna del Hunco, Patagonia, Argentina. *In*, Nel, A., D. Azar, and J. F. Petrulevičius. (Editors). Fossil insects, systematics, phylogeny and palaeoecology. Special issue. *Annales de la Société Entomologique de France* (n. s.) 46:271–275. https://doi.org/10.1080/00379271.2010.10697668

Riek, E. F. and J. Kukalová-Peck. 1984. A new interpretation of dragonfly wing venation based upon early Carboniferous fossils from Argentina (Insecta: Odonatoidea) and basic character states in pterygote wings. *Canadian Journal of Zoology* 62:1150–1166. https://doi.org/10.1139/z84-166

Wilf, P. 2012. Rainforest conifers of Eocene Patagonia: attached cones and foliage of the extant southeast-Asian and Australasian genus *Dacrycarpus* (Podocarpaceae). *American Journal of Botany* 99:562–584. https://doi.org/10.3732/ajb.1100367

Wilf, P., N. R. Cúneo, K. R. Johnson, J. F. Hicks, S. L. Wing, and J. D. Obradovich. 2003. High plant diversity in Eocene South America: Evidence from Patagonia. *Science* (American Association for the Advancement of Science, Washington, District of Columbia, USA) 300:122–125. https://doi.org/10.1126/science.1080475