J. Nannoplankton Res., **41**(2), 2023, pp. 106–109 https://doi.org/10.58998/jnr3615
 ISSN 1210-8049 Printed by The Sheridan Press, USA

A new *Markalius* species from the Cretaceous/Paleogene boundary of the Neuquén Basin (Argentina)

Rodrigo do Monte Guerra*

ittOceaneon, Instituto Tecnológico de Paleoceanografia e Mudanças Climáticas, Universidade do Vale do Rio dos Sinos (UNISINOS), Av. UNISINOS, 950, B. Cristo Rei/CEP: 93.022-000, São Leopoldo, RS, Brazil: rmguerra@unisinos.br

Museu Itinerante de Ciências Naturais, Carlos Barbosa, RS, Brazil

Andrea Concheyro

IDEAN-CONICET, Departamento de Ciências Geológicas, Universidad de Buenos Aires, Pabellón II, Ciudad Universitaria, 1428 - Buenos Aires, Argentina

Instituto Antártico Argentino (IAA), Buenos Aires, Argentina

*Corresponding author

Manuscript received 5 July 2023; revised manuscript accepted 16 August 2023

Available online 27 October 2023

DOI: 10.58998/jnr3615

Abstract Study of a Cretaceous/Paleogene (K/Pg) boundary section in the Jagüel Formation, Neuquén Basin, Argentina, has revealed a new calcareous nannofossil species, *Markalius neuquenesis* sp. nov. This new species is medium to large in size (7.3 to 8.03 µm), with a broad, birefringent tube cycle divided into four sectors, each with at least one small perforation. The species is rare to few in abundance in the upper Maastrichtian through lower Danian Jagüel Formation and has also been observed in the Danian of the North Atlantic Ocean.

Keywords Calcareous nannofossils, *Markalius*, taxonomy, Atlantic Ocean, Neuquén Basin, K/Pg

1. Introduction

Markalius is a Late Cretaceous to Oligocene calcareous nannofossils genus first described by Bramlette & Martini (1964). The type species, *Markalius inversus*, is usually common to abundant immediately above the K/Pg boundary, and thus was used by Martini (1971) as the nominative taxon for his lowermost Paleogene nannofossil zone, the *Markalius inversus* Zone (NP1). Currently, *Markalius* species are known to have consistent occurrences from the base of the Campanian to the lower Rupelian (Young et al., 2023). According to Bown et al. (2004), 93% of nannofossil species went extinct at the K/Pg boundary; *Markalius* is one of the few surviving Mesozoic genera.

The Neuquén Basin in Argentina (Figure 1) is one of the best locations for investigating Upper Cretaceous to lower Paleocene southern hemisphere sections (Ballent et al., 2011; Guerra et al., 2021). During the Maastrichtian, the Neuquén Basin was flooded by an extensive sea connecting the basin to the South Atlantic Ocean. The marine environment persisted into the Paleocene (Bertels, 1969; Uliana & Biddle, 1988; Barrio, 1990; Camacho, 1992; Malumián & Náñez, 2011; Del Río &

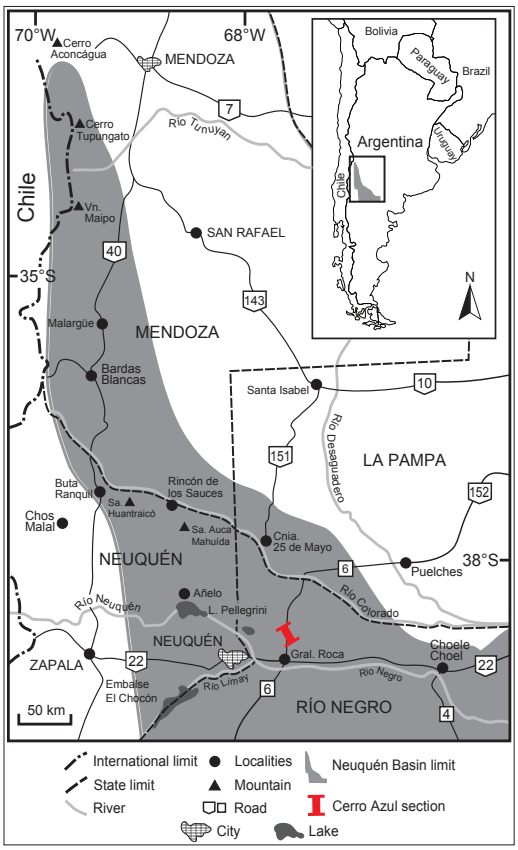


Figure 1: Cerro Azul Section location in the Neuquén Basin (modified from Del Río et al., 2011).

Martínez, 2015). One of the outcrops known for the K/Pg boundary in the Neuquén Basin is the Cerro Azul section (Musso et al., 2012; Ceolin et al., 2015; Guerra et al., 2021) (38°50'48''S, 67°52'20''W), where the Jagüel Formation crops out. This section is one of the most complete records of the K/Pg boundary interval known in Argentina (Guerra et al., 2021).

2. Materials and Methods

This study was performed on 18 samples from two lithofacies described by Musso et al. (2012): an uppermost Maastrichtian yellow grayish calcareous mudstone, which is overlain by a Paleocene olive gray calcareous mudstone (Figure 2).

Samples were prepared following the simple smear-slide technique described by Bown & Young (1998) and analyzed using a Zeiss Axio Imager A2 petrographic microscope at 1000× magnification. The descriptive terminology and taxonomy follow Bown & Young (1997) and Young et al. (1997). Photomicrographs were taken using a Zeiss AxioCam MRc camera in cross-polarized light (XPL), plane-polarized light (PPL), and using a gypsum plate (GP) (Plate 1). Illustrated specimens are housed in the micropaleontological collections of the Facultad de Ciencias Exactas y Naturales, Universidad de Buenos Aires, under catalogue numbers BAFC-NP4364 to 4382.

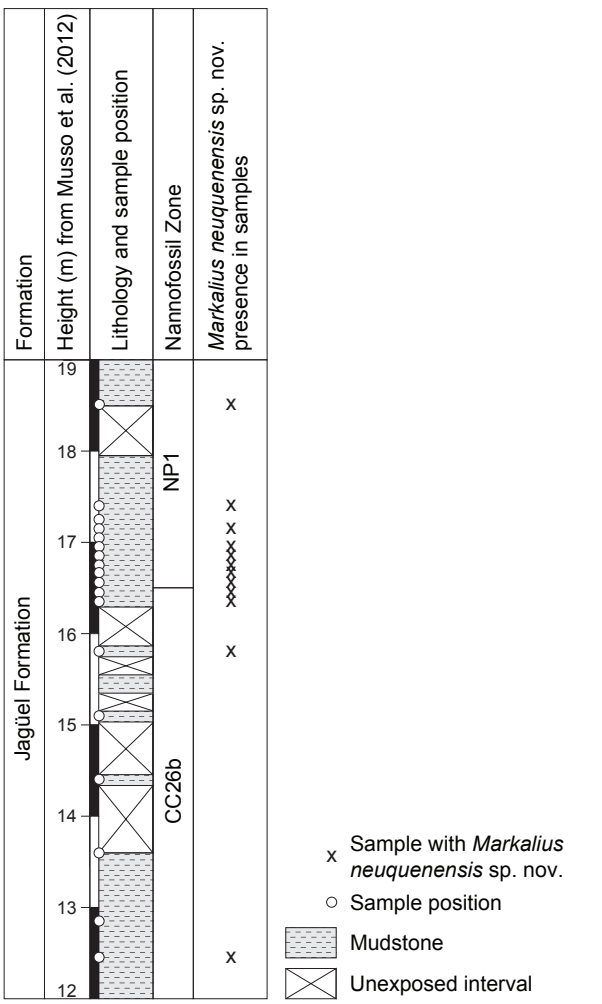


Figure 2: Studied stratigraphic section with the position of samples (empty circles) and the distribution of *Markalius neuquenensis* sp. nov. within the samples (x).

3. Systematic Paleontology

Genus ***Markalius*** Bramlette & Martini, 1964

Markalius neuquenensis sp. nov.

Plate 1, figs. 1–9

Derivation of name: After the section located in the Neuquén Basin where the species was first described.

Diagnosis: A *Markalius* species characterized by a broad, birefringent tube cycle divided into four sectors in XPL, each with at least one small perforation. The coccolith shape is circular to subcircular and it is medium to large in size. The tube cycle width is similar or slightly greater than the rim/shield and there is no central opening. The tube cycle is brighter at the edges where it connects to the shield.

Remarks: *M. neuquenensis* is distinguished from other *Markalius* species by the wide tube cycle with perforations. *Markalius inversus* and *M. latus* show no perforations. In *M. walvisensis*, the tube cycle is much reduced and *M. apertus* has a central area opening.

Holotype: Sample CA8, slide BAFC-NP4371 (Plate 1, figures 1–3).

Holotype dimension: length = 8.03 µm; width = 8.05 µm; tube cycle = 3.48 µm.

Paratype: Sample CA12 / slide BAFC-NP4375 (length = 7.91 µm; width = 6.62 µm; tube cycle = 2.81 µm) and sample CA18 / slide BAFC-NP4381 (length = 7.39 µm; width = 7.33 µm; tube cycle = 3.05 µm).

Type locality: Jagüel Formation, Neuquén Basin, Argentina.

Type level: Sample CA8 (upper Maastrichtian)

Occurrence: The species has rare to few occurrences in the upper Maastrichtian through lower Danian samples (Subzone CC26b [Perch-Nielsen, 1985] to Zone NP1 [Martini, 1971]) from the Jagüel Formation, Neuquén Basin, Argentina. The species is also present in the lower Danian of the North Atlantic Ocean (P. Bown, pers. comm.)

Acknowledgements

The authors are indebted to T. Musso and D. Ceolin for helping with the field work and to D. Watkins, P. Bown, and L.M. Bybell for their valuable suggestions for the manuscript. This is the contribution R-460 of the Instituto de Estudios Andinos "Don Pablo Groeber".

References

Ballent, S., Concheyro, A., Náñez, C., Pujana, I., Lescano, M., Carignano, A.P., Caramés, A., Angelozzi, G. & Ronchi, D. 2011. *Microfósiles mesozoicos y cenozoicos. Asociación Geológica Argentina, Relatorio del XVIII Congreso Geológico Argentino*, **17**: 489–528.

Barrio, C. 1990. Late Cretaceous–Early Tertiary sedimentation in a semi-arid foreland basin (Neuquén Basin, western Argentina). *Sedimentary Geology*, **66**: 225–275. https://doi.org/10.1016/0037-0738(90)90063-Y

Bertels, A. 1969. Estratigrafia del límite Cretacico–Terciario en Patagonia Septentrional. *Revista de la Asociación Geológica Argentina*, **24**(1): 40–54.

Bown, P.R. & Young J.R. 1997. Proposals for a revised classification system for calcareous nannoplankton. *Journal of Nannoplankton Research*, **19**(1): 15–47. https://doi.org/10.58998/jnr2280

Bown, P.R. & Young, J.R. 1998. Techniques. *In*: P.R. Bown (Ed). *Calcareous Nannofossil Biostratigraphy*. British Micropalaeontological Society Series. Kluwer Academic Publishers, London: 16–28.

Bown, P.R., Burnett, J.A. & Young, J.R. 2004. Calcareous nannoplankton evolution and diversity through time. *In*: H.R. Thierstein & J.R. Young (Eds), *Coccolithophores – From molecular processes to global impact*. Springer Verlag, Berlin: 481–505.

Bramlette, M.N. & Martini, E. 1964. The great change in calcareous nannoplankton fossils between the Maastrichtian and Danian. *Micropalaentology*, **10**: 291–322. https://doi.org/10.2307/1484577

Camacho, H.H. 1992. Algunas consideraciones acerca de la transgresión marina paleocena en la Argentina. Academia Nacional de Ciencias en Córdoba. *Miscelánea*, **85**: 1–41.

Ceolin, D., Whatley, R.C., Fauth, G. & Concheyro, A. 2015. New genera and species of Ostracoda from the Maastrichtian and Danian of the Neuquén Basin, Argentina. *Papers in Palaeontology*, **1**(4): 425–495. https://doi.org/10.1002/spp2.1023

Del Río, C.J., Concheyro, A. & Martínez, S.A. 2011. The Maastrichtian – Danian at General Roca (Patagonia, Argentina): a reappraisal of the chronostratigraphy and biostratigraphy of a type locality. *Neues Jahrbuch für Geologie und Paläontologie*, **259**(2): 129–156. https://doi.org/10.1127/0077-7749/2011/0103

Del Río, C.J. & Martínez, S.A. 2015. Paleobiogeography of the Danian molluscan assemblages of Patagonia (Argentina). *Palaeogeography, Palaeoclimatology, Palaeoecology*, **417**: 274–292. https://doi.org/10.1016/j.palaeo.2014.10.006

Guerra, R.M., Concheyro, A., Kochhann, K.G.D., Bom, M.H.H., Ceolin, D., Musso, T., Savian, J. & Fauth, G. 2021. Calcareous microfossils and paleoenvironmental changes across the Cretaceous-Paleogene (K-Pg) boundary in Cerro Azul Section, Neuquén Basin, Argentina. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **567**: 1–13. https://doi.org/10.1016/j.palaeo.2021.110217

Malumián, N. & Náñez, C. 2011. The Late Cretaceous–Cenozoic transgressions in Patagonia and the Fuegian Andes: foraminifera, palaeoecology, and palaeogeography. *Biological Journal of the Linnean Society*, **103**: 269–288. https://doi.org/10.1111/j.1095-8312.2011.01649.x

Martini, E. 1971. Standard Tertiary and Quaternary Calcareous Nannoplankton Zonation. *In*: A. Farinacci (Ed). *Proceedings of the Second Planktonic Conference Roma 1970*. Edizioni Tecnoscienza, Roma, **2**: 739–785.

Musso, T., Concheyro, A. & Pettinari, G. 2012. Mineralogía de arcillas y nanofósiles calcáreos de las formaciones Jagüel y Roca en el sector oriental del lago Pellegrini, Cuenca Neuquina, República Argentina. *Andean Geology*, **39**(3): 511–540. https://doi.org/10.5027/andgeoV39n3-a08

Perch-Nielsen, K. 1985. Mesozoic calcareous nannofossils. *In*: H.M. Bolli, J.B. Saunders & K. Perch-Nielsen (Eds). *Plankton Stratigraphy*. Cambridge University Press, Cambridge: 329–426.

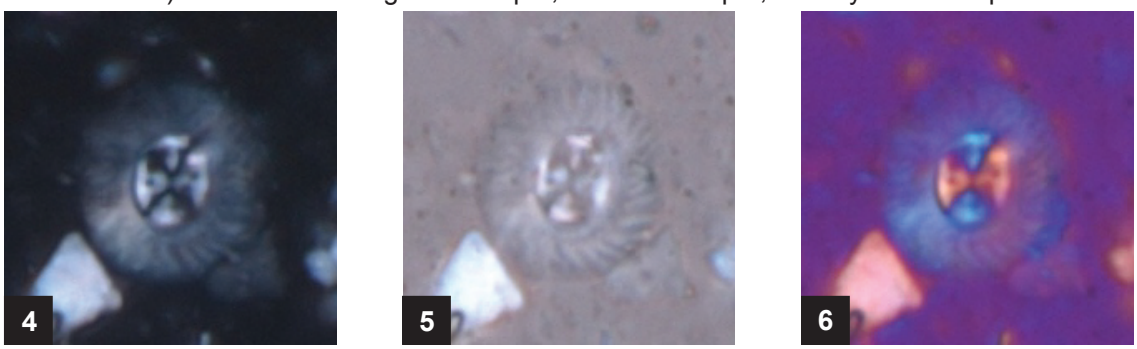
Uliana, M.A. & Biddle, K.T. 1988. Mesozoic-Cenozoic paleogeographic and geodynamic evolution of southern South America. *American Association of Petroleum Geologists, Memoirs*, **46**: 599–614.

Young J.R., Bergen J.A., Bown P.R., Burnett J.A., Fiorentino A., Jordan R.W., Kleijne A., Van Niel B.E., Romain, A.J.T & von Salis, P. 1997. Guidelines for coccolith and calcareous nannofossil terminology. *Palaeontology*, **40**(4): 875–912.

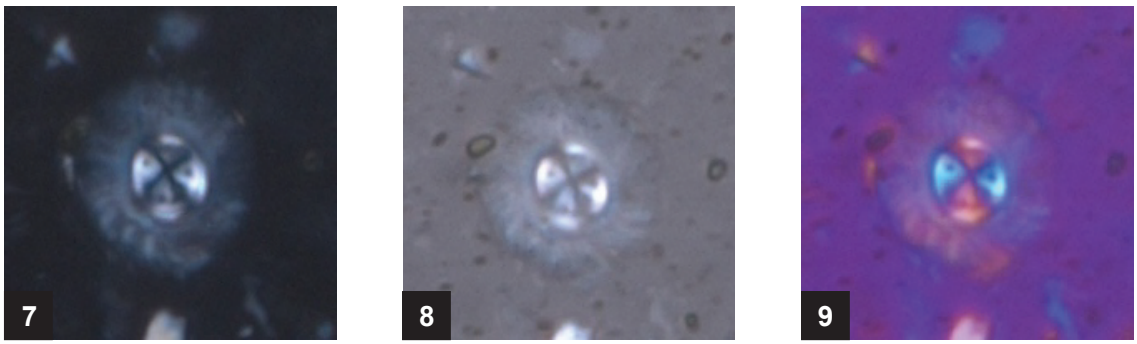
Young, J.R., Bown P.R. & Lees J.A. 2023. *Nannotax3 website*. International Nannoplankton Association. Accessed 5 July 2023. URL: https://www.mikrotax.org/Nannotax3

Plate 1

Markalius neuquenensis sp. nov. HOLOTYPE sample CA8 / slide BAFC-NP4371 (upper Maastrichtian). Dimensions: length = 8.03 µm; width = 8.05 µm; tube cycle = 3.48 µm.



Markalius neuquenensis sp. nov. PARATYPE sample CA12 / slide BAFC-NP4375 (Danian). Dimensions: length = 7.91 µm; width = 6.62 µm; tube cycle = 2.81 µm.



Markalius neuquenensis sp. nov. PARATYPE sample CA18 / slide BAFC-NP4381 (Danian). Dimensions: length = 7.39 µm; width = 7.33 µm; tube cycle = 3.05 µm.

Plate 1: *Markalius neuquenensis* sp. nov. under petrographic miroscope. Photomicrographs were taken in cross-polarized light (XPL; figs. 1, 4, 7), plane-polarized light (PPL; figs. 2, 5, 8), and using a gypsum plate (GP; figs. 3, 6, 9).