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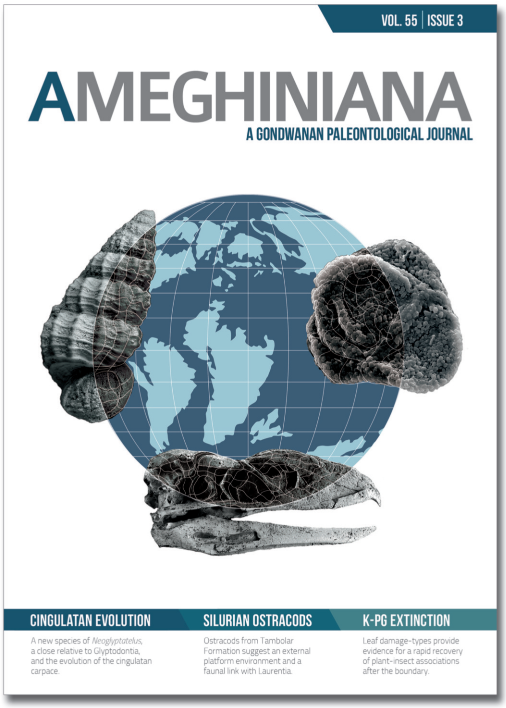

A NEW DINOFLAGELLATE FROM THE LATE CRETACEOUS OF THE COLORADO BASIN, OFF SHORE ARGENTINA

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A NEW DINOFLAGELLATE FROM THE LATE CRETACEOUS OF THE COLORADO BASIN, OFF SHORE ARGENTINA

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An extensive search for new source rocks and hydrocarbon accumulations has been carried out over the past 50 years by different oil companies in the main southwest Atlantic basins. To achieve this exploration prospect, a lot of boreholes have been drilled, mostly offshore, in the Colorado and the Salado and Punta del Este basins (Fig. 1). In this framework, several biostratigraphic studies were carried out to the better understand of the different phases of the depositional history and the evolution of these basins. The purpose of this contribution is to improve the palynological knowledge of the Colorado Basin and to introduce a new species that is considered important from a biostratigraphic point of view.

GEOLOGICAL BACKGROUND

The Colorado Basin, as other Southwest Atlantic basins (*e.g.*, Punta del Este, Salado and Rawson basins), was originated in relation to the breakup of Gondwana during the Jurassic–Early Cretaceous (Fryklund *et al.*, 1996; Juan *et al.*, 1996; Gerster *et al.*, 2011). The breakup unconformity (dated Barremian–Aptian) marks the onset of the passive margin stage, with some thermal subsidence that was accentuated in a west-east oriented trough, which was, in turn, controlled by synrift depocenters (Fig. 1). In the areas known by means of hydrocarbon exploration drilling, the sedimentation throughout the Late Cretaceous took place in fluvial to coastal and marine-shelf environments (sandstones from the Colorado Formation). A major marine transgression is recorded in the overlying marine shales of the Pedro Luro Formation, interbedded with volcanic rocks of the Ranquel Formation on the southern margin of the basin (Lesta *et al.*, 1978; Lovecchio *et al.*, 2017).

BIOSTRATIGRAPHIC SETTING

The biostratigraphy (dinocysts and calcareous nannofossils) of the YPF.BB-I-B.x-1, Bahía Blanca well and YPF.CCMI.Ra.x-1, Ranquel well are shown in Fig. 2.

The main previously published palynological contributions dealing with Cenozoic dinoflagellate cysts assemblages from the Colorado Basin include: Gamerro and Archangelsky (1981), Guerstein (1990, a, b), Archangelsky (1996), Quattrocchio and Sarjeant (1996), Guerstein and Guler (2000), Guerstein and Junciel (2001), Guerstein *et al.* (2001) and Daners *et al.* (2016).

Late Cretaceous–Paleocene dinoflagellate cysts from the Pedro Luro Formation have been documented in the papers by Gamerro and Archangelsky (1981), Archangelsky (1996), Quattrocchio and Sarjeant (1996), Guerstein and Junciel (2001) and Guerstein *et al.* (2005).

No palynological publications dealing with the Colorado Formation are known.

MATERIALS AND METHODS

This paper is based on the analysis of cutting and core samples recovered from the YPF.BB-I-B.x-1, Bahía Blanca well, and the YPF.CCMI.Ra.x-1, Ranquel well, both drilled on the Argentine continental shelf (Fig. 1).

The herein studied material from the Colorado Formation was mainly recovered from cutting samples 2560–2570 m, and 2950–2665 m from the YPF.BB-I-B.x-1, Bahía Blanca well, and 2279–2291 m of the YPF.CCMI.Ra.x-1, Ranquel well. Laboratory procedures followed conventional practices. Carbonates and silicates were removed by a hydrochloric and hydrofluoric acid treatment. Residues were sieved on a 10 µm mesh and mounted in unstained glycerin jelly on glass slides. Specimens were examined under a Leitz Orthoplan binocular microscope. Photomicrographs were taken with a Sony Cyber-shot DSC-P93A camera. Palynological slides are prefixed YT.RMP. The illustrated specimens are identified with a slide number and England Finder coordinates. The slides are stored at the Biostratigraphy Laboratory, Geoscience Management, YPF Tecnología. The terms used for the characterization for the shape and indexes of the dinoflagellate archeopyle follow the schemes by Evitt (1985).

SYSTEMATIC PALEONTOLOGY

Division Dinoflagellata (Bütschli, 1885) Fensome *et al.*, 1993
Subdivision Dinokaryota Fensome *et al.*, 1993
Class Dinophyceae Pascher, 1914
Subclass Peridiniphycidae Fensome *et al.*, 1993
Order Peridiniales Haeckel, 1894
Suborder Peridiniineae Autonym
Family Peridiniaceae Ehrenberg, 1831
Subfamily Deflandreoideae Bujak and Davies, 1983

Genus ***Andalusiella*** Riegel, 1974 emend. Masure *et al.*, 1996

Type species. *Andalusiella mauthei* Riegel, 1974.

Andalusiella guersteiniae sp. nov.
Figure 3.1–4

Derivation of name. Named after Dr. Raquel Guerstein, in recognition of her contribution to the knowledge of fossil dinoflagellates.

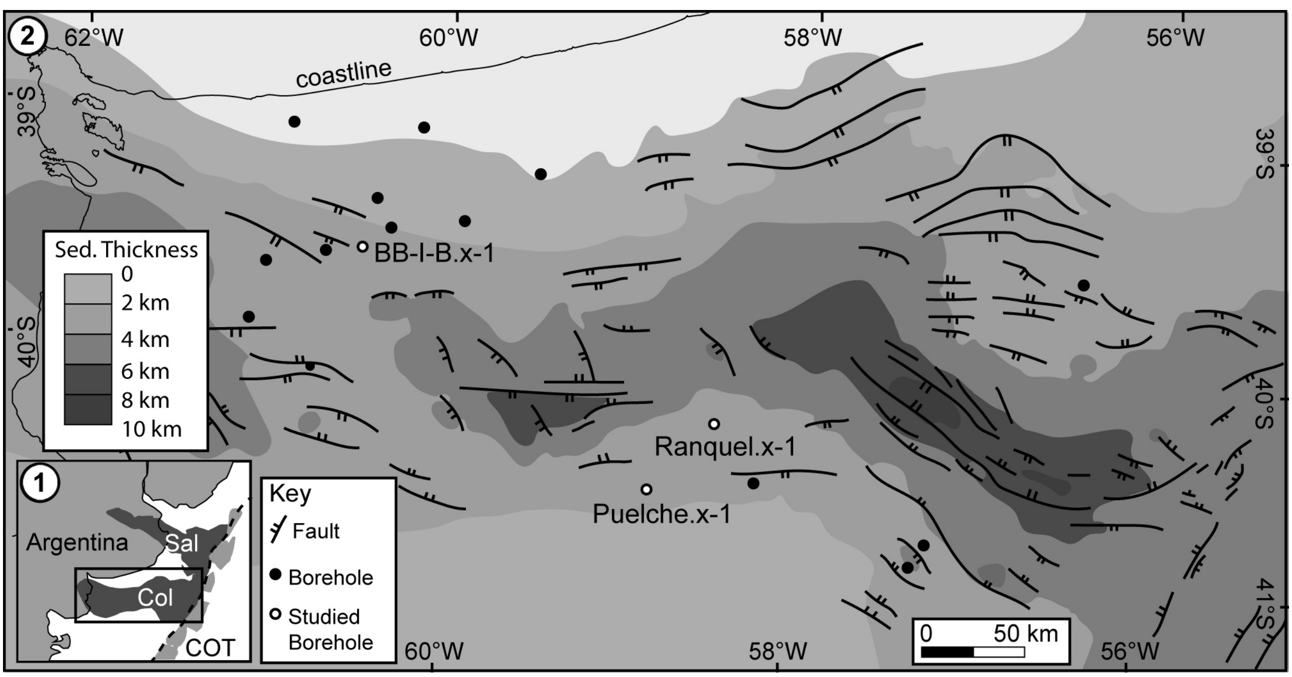

Figure 1. 1, The Colorado (**Col**) and Salado (**Sal**) basins. **COT,** Continental-Oceanic crust Transition zone. **2,** Basemap for the Colorado basin depicting the main depocenters and the location of the Bahía Blanca.B.x-1 well, Puelche.x-1 well and Ranquel.x-1 well. Modified after Lovecchio *et al.* (in press).

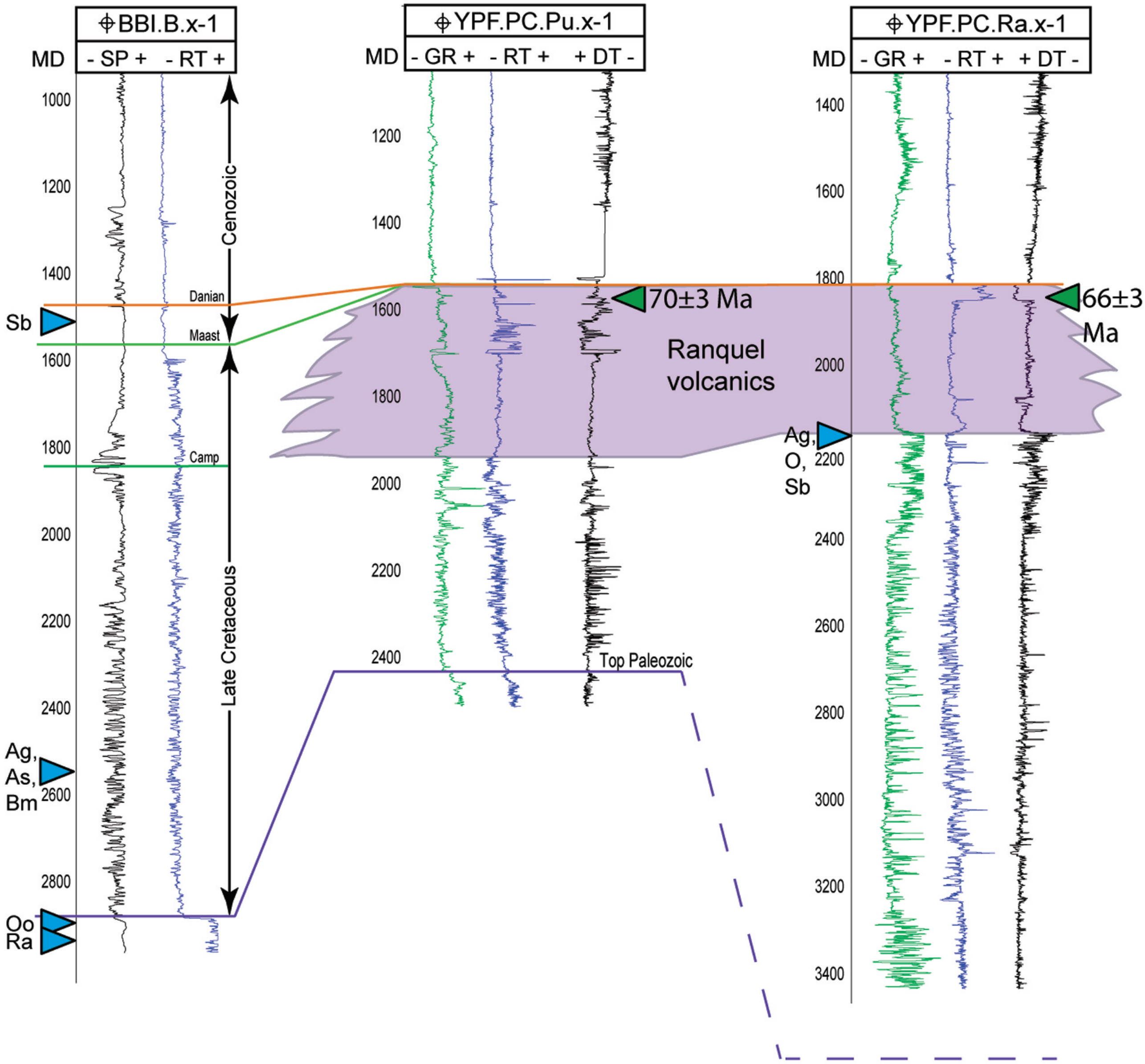

Figure 2. Schematic stratigraphic sections of the Bahía Blanca.B.x-1 well, Puelche.x-1 well and Ranquel.x-1 well, showing the last occurrence (left arrows) of *Andalusiella guersteinae* sp. nov.; Abbreviations: **Ag,** and key associated species (dinocysts and calcareous nannofossils: **Sb,** *Senegalinium bicavatum*; **As,** *Acuturris scoutis*; **Bm,** *Biscutum magnum*; **Oo,** *Odontochitina operculata*; **Ra,** *Reinhardtites anthophorus*; **O,** *Odontochitina* spp.), radiometric ages (right arrows) and tentative correlations. **MD,** Measured Depth; **SP,** Spontaneous Potential; **RT,** Resistivity Log; **GR,** Gamma Ray; **DT,** Sonic Log; **Danian,** top Danian; **Maast,** top Maastrichtian; **Camp,** top Campanian. Modified from Lovecchio *et al.* (2017).

Type material. Well: YPF.BB-I-B.x-1, Bahía Blanca (2560–2570 m), slide: YT.RMP– P.000002.17(1), England Finder Graticule: O41/0.

Geographic occurrence. Bahía Blanca.B.x-1 well, and Ranquel.x-1 well, Colorado Basin.

Stratigraphic occurrence. Late Campanian–Early Maastrichtian of the Colorado Formation.

Diagnosis. Proximate, acrocavate organic-walled dinoflagellate cyst, with a rhomboidal to ellipsoidal central body lengthened by a long apical horn and a single undivided antapical horn. Wall composed of a periphragm and an endophragm, the latter extends into the horns. A peridinioid paratabulation is suggested by the intercalary 2a hexa iso-deltaform archeopyle and a paracingulum. Parasulcus with a flagellar scar.

Description. Long cyst with a rhomboidal to ellipsoidal central body. The apical horn is longer than the single undivided antapical horn which is the left one. The periphragm is smooth to chagrinate and markedly thinner than the endophragm. The endophragm develops thickenings in horn areas. The wall of the endophragm is smooth. The periphragm and the endophragm are closely pressed on the central body. The paracingulum is currently bordered by folds. The parasulcus bears a flagellar scar. Intercalary archeopyle 2a hexa, iso-deltaform. The operculum is adherent or free.

Dimensions. (19 specimens) Overall length 185 (196) 208 μm, overall width 70 (81) 91 μm, apical horn 41–67 μm, antapical horn 36–38 μm, overall length/wide ratio ≈ 2.5–2.8, endophragm length/wide ratio ≈ 1.2–1.6, apical/antapical horns ratio ≈ 1.1–1.7, archeopyle ratio (**AR**) ≈ 1, archeopyle signum (**AS**) = 0.3–0.6, transverse archeopyle index = 0.5, longitudinal archeopyle index = 0.7.

Comparisons. *Andalusiella guersteiniae* sp. nov. is distinguishable from most species that have two or divided antapical horns as described by Masure *et al.* (1996) and Srivastava (1995). In contrast, *Andalusiella guersteiniae* sp. nov. should be compared to species that only have a single undivided antapical horn as: *A. rhomboides, A. spinosa* and *A. basita.* All these species have shorter horns that are proportional to the central body, however, *A. rhomboides* and *A. spinosa* show an ornamented periphragm, verrucose in *A. rhomboides,* spiny in *A. spinosa*. *Andalusiella guersteiniae* sp. nov. differs from *A. basita* by virtue of its much more thickened endophragm, its apical and antapical horns of unequal length, the presence of a paracingulum and of a distinct flagellar scar, and by reaching a markedly larger size. Close comparison of *A. guersteiniae* sp. nov. with specimens from the Campanian of offshore Mauritania, referred to as *A. polymorpha* by Malloy (1972) is hindered by the fact that the African material has not been described.

BIOSTRATIGRAPHICAL RESULTS

In the YPF.BB-I-B.x-1, Bahía Blanca well and YPF.CCMI.Ra.x-1, Ranquel well, the stratigraphic associated species to *Andalusiella guersteiniae* sp. nov. (Fig. 2) that have the following ranges include: *Odontochitina costata* (Early San-

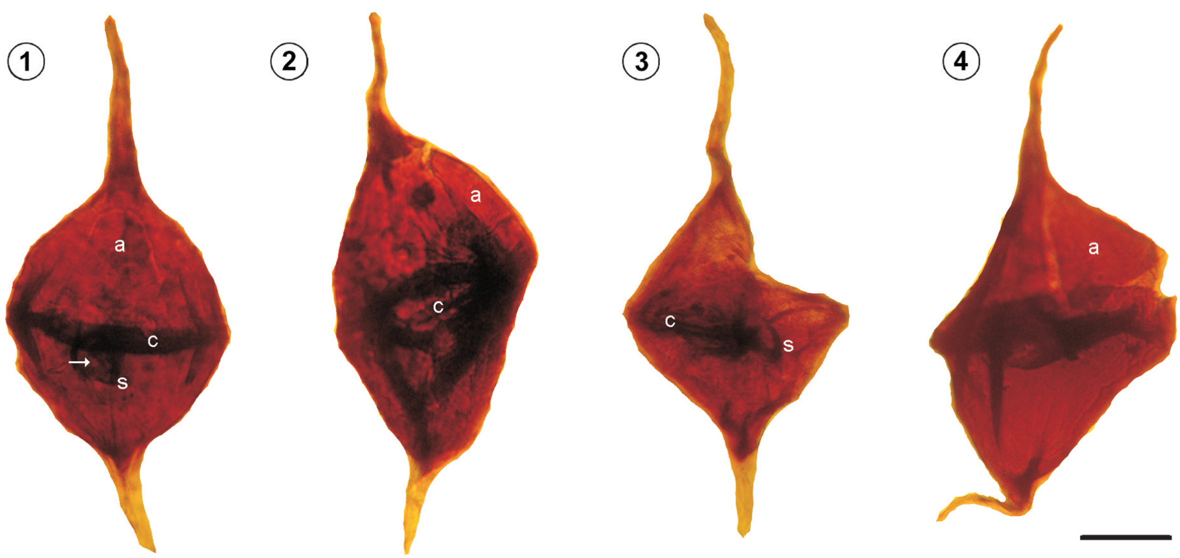

Figure 3. ***Andalusiella guersteiniae*** sp. nov. **1,** YT.RMP–P.000002.17(1) O41/0, Holotype (Bahía Blanca.B.x-1 well, 2560–2570 m). **2,** YT.RMP–P.000002.17(1) A24/4 (Bahía Blanca.B.x-1 well, 2950–2965 m). **3,** YT.RMP–P.000002.17(7) K41/0, the epicyst of this specimen is broken (Bahía Blanca.B.x-1 well, 2560-–2570 m). **4,** YT.RMP–P.000001.10(1) C39/0 (Ranquel.x-1 well, 2279–2291 m). **a,** archeopyle; **s,** parasulcus; **c,** paracingulum; arrow indicates the flagellar scar. Scale bar= 40 μm.

tonian–Early Maastrichtian: Costa and Davey, 1992), *O. operculata* (Aptian–Early Maastrichtian: Helby *et al.*, 1987; Roncaglia *et al.*, 1999), *O. spinosa* (Santonian–Early Maastrichtian: Wilson, 1984; Roncaglia *et al.*, 1999); *Senegalinium bicavatum* (Campanian–Danian: Jain and Millepied, 1973; Slimani *et al.*, 2010). The stratigraphic range of the species associated to *A. guersteiniae* sp. nov. suggests a Middle Campanian–Early Maastrichtian age.

At the Bahía Blanca.B.x.1 well, the last occurrences (**LO**) of the calcareous nannofossils *Acuturris scotus* and *Biscutum magnum* stand at 2560–2570 m, and the **LO** of *Reinhardtites anthophorus* at 2950–2965 m (recovered with *O. operculata* from the same Paleozoic horizon as a product of cutting contamination by caving during drilling), are of an Early Maastrichtian and Late Campanian age, respectively. At the Ranquel x.1 well, a poorly preserved assemblage of calcareous nannofossils, including *Micula staurophora* and *M. concava* of Santonian–Maastrichtian age was recovered. Conversely, the nannofossil and foraminifer assemblages related to the Late Maastrichtian, overlie the *A. guersteiniae* sp. nov.-bearing horizons at the Bahía Blanca.B.x.1 well (Fig. 2).

Other microfossils recovered from the same stratigraphic levels include a diverse assemblage of agglutinated foraminifers that are typical of the early Maastrichtian of the Salado, the Colorado and the eastern Austral basins (Malumián and Masiuk, 1976; Malumián and Náñez, 1990, 1996; Náñez and Malumián, 2008; Pérez Panera, 2012).

At the Ranquel.x-1 well, the core sample 2156-2162 m (Lovecchio *et al.*, 2017), lacks *A. guersteiniae* sp. nov., but yields *Diconodinium lurense*, an index species from the Late Maastrichtian–Early Danian in southern South America (Guerstein *et al.*, 2005). The last occurrence of *A. guersteiniae* sp. nov., *O. operculata* and *O. spinosa* stand at 2165–2168 m (Fig. 2).

CONCLUSION

Andalusiella guersteiniae sp. nov. is a new species from the Upper Cretaceous of the Colorado Formation, at the Colorado Basin. In account of the restricted, Middle Campanian to Early Maastrichtian, stratigraphic range of key species of palynomorphs, foraminifers and nannofossils associated to *A. guersteiniae* sp. nov., a Middle Campanian–Early Maastrichtian age is suggested for the new species. A $^{40}K/^{40}Ar$ study from the volcanic intercalations of the Ranquel Formation suggests an age of 66 ± 3 Ma. On the other hand, from the same horizons, at the Puelche.x-1 well, a $^{40}Ar/^{39}Ar$ age of 74 ± 0.3 Ma was obtained from a core sample of a trachyandesitic composition (Lovecchio *et al.*, 2017, figs. 1, 2). Therefore, a Late Campanian–Maastrichtian age (66-74 Ma) is assigned to the volcanic Ranquel Formation. As the Ranquel Formation overlies the *A. guersteiniae* sp. nov.-bearing horizons, the species herein described is of Middle Campanian to Early Maastrichtian age. The restricted stratigraphic range of this form, if confirmed in more sections, would make *A. guersteiniae* sp. nov. a good local index species.

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Taxa lists

Dinoflagellate cysts:

Andalusiella basita Slimani *et al.*, 2012
A. rhomboides (Boltenhagen, 1977) Lentin and Williams, 1980 emend. Masure *et al.*, 1996
A. spinosa Guler *et al.*, 2005
Diconodinium lurense Guerstein *et al.*, 2005
Odontochitina costata Alberti, 1961
O. operculata (Wetzel, 1933) Deflandre and Cookson, 1955
O. spinosa Wilson, 1984
Senegalinium bicavatum Jain and Millepied, 1973

Calcareous nannofossils:

Acuturris scotus (Risatti, 1973) Wind and Wise in Wise and Wind, 1977
Biscutum magnum Wind and Wise in Wise and Wind, 1977
Micula staurophora (Gardet, 1955) Thierstein, 1974
M. concava (Stradner in Martini and Stradner, 1960) Verbeek, 1976
Reinhardtites anthophorus (Deflandre, 1959) Perch-Nielsen, 1968

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