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CENOZOIC MICROFOSSIL (FORAMINIFERA AND CALCAREOUS NANNOFOSSILS) ASSEMBLAGES FROM THE SUBSURFACE MAGALLANES BASIN, TIERRA DEL FUEGO ISLAND, CHILE

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Abstract. Foraminifera and calcareous nannofossils from washed drill-cuttings of three wells in the Chilean sector of the Magallanes Basin were studied. This contribution aims to identify, characterize and illustrate microfossil assemblages throughout the Cenozoic sedimentary record to integrate foraminiferal and nannofossil data, and improve further biostratigraphic studies in the basin. The analyzed Paleogene and Neogene successions in these three wells correspond to five discrete foraminiferal and nannofossil assemblages, which were recognized and are described here: the early–middle Paleocene assemblage is mainly characterized by agglutinated foraminifera and few nannofossil species like *Chiasmolithus danicus* and *Prinsius tenuiculus*; the early Eocene assemblage is represented by low diversity and oceanic species, consisting of planktic foraminifera like *Subbotina triloculinoides*, radiolarians and calcareous nannofossils including *Chiasmolithus bidens* and *Toweius pertusus*; the middle–late Eocene assemblage is the most diverse of all those distinguished in this study, as it contains a rich microfauna of benthic and planktic foraminifera including the species *Elphidium saginatum*, *Virgulinella severini*, and *Globigerinatheka index*, as well as numerous nannofossils like *Chiasmolithus solitus*, *C. oamaruensis* and *Reticulofenestra reticulata*; the early Oligocene marks the turnover to a reduced assemblage including *Subbotina angiporoides* and *Chiasmolithus altus*; and ultimately, the late Oligocene–early Miocene assemblage, characterized by a low species richness of mainly nonionid foraminifera and reticulofenestrid nannofossils. A detailed systematic list of both foraminiferal and nannofossil species is presented, intended to serve as a catalogue that will help to identify the different Cenozoic assemblages of the basin in future studies.

Key words. Foraminifera. Nannofossils. Paleogene. Austral Basin. Taxonomy.

Resumen. ENSAMBLES DE MICROFÓSILES (FORAMINÍFEROS Y NANOFÓSILES CALCÁREOS) CENOZOICOS DEL SUBSUELO DE LA CUENCA DE MAGALLANES, ISLA DE TIERRA DEL FUEGO, CHILE. Se estudiaron los foraminíferos y nanofósiles calcáreos de recortes de perforación lavados de tres pozos en el sector chileno de la Cuenca de Magallanes. El objetivo de esta contribución es identificar, caracterizar e ilustrar los ensambles de microfósiles a lo largo del registro sedimentológico cenozoico con el fin de integrar los datos de foraminíferos y nanofósiles y optimizar futuros estudios bioestratigráficos en la cuenca. Las sucesiones del Paleógeno y del Neógeno analizadas corresponden a cinco ensambles discretos de foraminíferos y nanofósiles que se describen aquí: el ensamble del Paleoceno temprano–medio se caracteriza principalmente por foraminíferos aglutinados y pocas especies de nanofósiles como *Chiasmolithus danicus* y *Prinsius tenuiculus*; el ensamble del Eoceno temprano está representada por especies oceánicas y baja diversidad, consiste en foraminíferos planctónicos como *Subbotina triloculinoides*, radiolarios y nanofósiles calcáreos que incluyen a *Chiasmolithus bidens* y *Toweius pertusus*; el ensamble del Eoceno medio–tardío es el más diverso y contiene una rica microfauna de foraminíferos bentónicos y planctónicos que incluyen las especies *Elphidium saginatum, Virgulinella severini* y *Globigerinatheka index*, así como diversos nanofósiles como *Chiasmolithus solitus*, *C. oamaruensis* y *Reticulofenestra reticulata*. El Oligoceno temprano marca el cambio a un ensamble empobrecido que incluye *Subbotina angiporoides* y *Chiasmolithus altus* y finalmente, el ensamble del Oligoceno tardío–Mioceno temprano, está caracterizado por una baja riqueza de especies con dominio de foraminíferos noniónidos y nanofósiles representados por reticulofenestras. Se presenta una lista sistemática detallada de las especies de foraminíferos y nanofósiles, que ayudará a identificar las diferentes asociaciones cenozoicas de la cuenca en estudios futuros.

Palabras clave. Foraminíferos. Nanofósiles. Paleógeno. Cuenca Austral. Taxonomía.

THE MAGALLANES or Austral Basin (as it is known in the Argentinian sector) is one of the most prolific depositional environments in the southernmost part of South America and is of particular interest for hydrocarbon exploration. The Magallanes Basin began as an extensive basin during the Triassic and evolved during the Jurassic with the opening of a small marginal sea behind a developing magmatic arc, that closed in the middle Cretaceous (Biddle *et al.*, 1986;

Robbiano *et al.*, 1996; Nullo *et al.*, 1999; Malumián, 1999; Ramos, 2002; Rodríguez & Miller, 2005). Since the Late Cretaceous and during the Cenozoic, it transformed into a foreland basin (Malumián *et al.*, 2013). Due to its location, the basin is important for the understanding of the orogeny of the southern and Fuegian Andes as well as the connection of South America with Antarctica. Furthermore, it represents an important archive of the diversity and evolution of foraminifera and calcareous nannofossils in southern high latitudes.

In this contribution, we have studied the foraminifera and calcareous nannofossil assemblages from well cuttings of a Cenozoic succession in the Chilean sector of the Isla Grande de Tierra del Fuego. The objective of this study is to identify, characterize and illustrate microfossil assemblages in order to integrate foraminiferal and nannofossil data to improve biostratigraphic studies in the basin. For reasons of confidentiality, the wells will simply be referred to as West, North, and East, according to their relative geographical location in the study area (Figure 1). The analyses

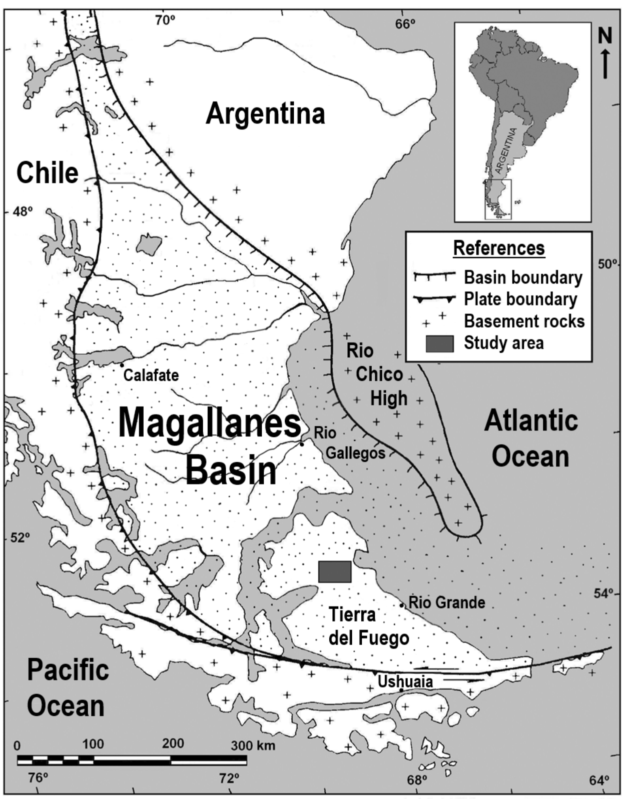

Figure 1. Map of the Magallanes Basin and the study area on Tierra del Fuego Island.

of the Cretaceous succession of these wells were presented in a separate contribution (Thissen & Pérez Panera, 2020a).

MATERIAL AND METHODS

A total of 244 samples of washed well cuttings were processed and analyzed for foraminiferal and calcareous nannofossils investigation. The samples were processed according to the standard methodologies for this type of analysis, which are detailed below for each discipline. The recovered material and nannofossil fertile slides are housed in the Y-TEC Laboratory of Biostratigraphy Micropaleontological Repository under the acronym YT.RMP_M (Y-TEC. Repositorio Micropaleontológico. Microfósiles) and numbers 000011.1 to 000011.41 (West well), 000008.1 to 000008.31 (North well), 000010.1 to 000010.34 (East well) for foraminifera; and YT.RMP_N (Y-TEC. Repositorio Micropaleontológico. Nanofósiles) numbers 000011.1 to 000011.45 (West well), 000008.1 to 000008.32 (North well), 000010.1 to 000010.28 (East well) for calcareous nannofossils.

All the foraminifera present, as well as other microfossils of interest, were extracted by means of the picking technique and arranged into slides for identification. To determine the foraminiferal fauna, references were compiled for the study area and related areas. The generic classification by Loeblich and Tappan (1987, 1992) and the Catalogue of Foraminifera by Ellis and Messina (1940 and subsequent) were used. The suprageneric systematics were adapted from The World Foraminifera Database (Hayward *et al.*, 2020). Geological ranges of planktic foraminifera were obtained from the Mikrotax website (Bown *et al.*, 2020). For detailed analyses and obtaining high definition photographs a FEI Quanta 200 Scanning Electron Microscope was used. Indeterminable specimens were classified by their wall structure and *modus vivendi* (agglutinated, calcareous, and planktic taxa) (Murray, 1991).

For nannofossil analysis, a simplification of the gravity settling technique was carried out (Gardet, 1955; Bramlette & Sullivan, 1961). All species found in this study are systematically listed and most of them illustrated. In some cases, taxonomic or biostratigraphic remarks are given. Systematic criteria follow Silva *et al.* (2007) for Subclass level and up, and Young and Bown (1997a, 1997b) for Order to Genus categories. The biozonation by Martini (1971) for the Cenozoic was used as a reference. For each sample, at least 300 individuals or 450 FoV (Field of View) in samples where calcareous nannofossils presented low abundance were set to examine.

GEOLOGICAL HISTORY

The Magallanes Basin is a vast sedimentary structure located between the Andean Cordillera to the West and the Río Chico High on the Patagonian Shelf to the East (Nullo *et al.,* 1999) (Fig. 1). Together with the adjacent offshore Malvinas Basin, it developed near a complex tectonic area, which was highly affected by interaction processes between the South American, Scotia and Antarctic plates (Galeazzi, 1998). These tectonic activities led to the extensive deposition of volcaniclastic rocks of the Jurassic Tobífera Series (Natland & González, 1974), which marks the syn-rift phase of the basin's evolution (Sachse *et al.,* 2015). The overlying mainly marine sedimentary sequence of Cretaceous to Miocene age, which reaches a maximum thickness of up to 7,000 m (Galeazzi, 1998), originates in the break-up of Gondwana and the opening of the South Atlantic Ocean (Peroni *et al.*, 2002). During the Late Cretaceous, the Magallanes Basin transformed into a foreland basin, that accumulated mainly fine-grained sediments of the *Inoceramus*-strata (Olivero & Malumián, 2008; Sachse *et al.,* 2015). Since the Maastrichtian, the basin was subject to several transgression-regression cycles, with the main Atlantic transgressions occurring during the Maastrichtian–Danian, the middle Eocene, the late Oligocene–early Miocene, and the middle Miocene (Malumián & Náñez, 2011; Pérez Panera, 2013).

PREVIOUS STUDIES

Todd and Kniker (1952) were the first to study microfossils from the Agua Fresca shale of southernmost Chile. Their report provided a large number of newly described foraminiferal species, many of them endemic to the Magallanes Basin. Charrier and Lahsen (1968, 1969) described the first assemblage of planktic foraminifera and calcareous nannofossils from the same formation in the basin. Malumián (1968) and Malumián *et al.* (1971) were the first to compile complete biostratigraphic interpretations of wells from the Santa Cruz Province, southern Argentina. Natland and González (1974) summarized the analyses of several sedimentary sequences from the Chilean sector of the basin in their "system of stages". Bertels (1977, 1980), Malumián (1982, 1989, 1990a, 1990b, 1994), Malumián and Náñez (1988), Malumián and Caramés (1989), Náñez (1989, 1990), Hromic (1991), Mostajo (1991), Concheyro (1991, 1995), Caramés (1993, 1996), Caramés and Malumián (1999), Malumián and Scarpa (2005), Malumián and Olivero (2005, 2006), Pérez Panera (2007, 2009), Scarpa and Malumián (2008), Jannou (2009), Marchant (2011), Malumián *et al.* (2013) and Bedoya Agudelo *et al.* (2016, 2018) further studied Tertiary successions from the basin. Finally, Ronchi and Angelozzi (1994), Malumián and Caramés (1997), Concheyro and Angelozzi (2002), Malumián and Jannou (2010), Malumián and Náñez (1996, 2002, 2011), Pérez Panera (2012, 2013) and Bedoya Agudelo (2019) compiled integrated biostratigraphic and paleoecological studies of the basin's marine sediments from the Lower Cretaceous to the Miocene. However, no integrated systematic analysis of foraminifera and calcareous nannofossils from the entire Cenozoic record of the Magallanes Basin has been assembled yet.

RESULTS

Due to the nature of the studied material, which consists of drill-cuttings, the results are presented from the top to the bottom of the wells. Assemblages were identified by the occurrences of marker species (especially planktic foraminifera and calcareous nannofossils), giving priority to the last occurrences (LO). However, in some cases, the first occurrences (FO) are highlighted as they are considered to have enough reliability and because they are important events for global and local correlation. Microfossil preservation and abundances were highly varying between samples and wells. Two major and three minor assemblages were identified in the three wells. The most representative microfaunal elements of the analyzed succession are illustrated in Figures 2 to 6.

The late Oligocene–early Miocene assemblage was recognized in all three wells and is characterized by an extremely low number of microfossils. The presence of the planktic foraminifer *Trilobatus sicanus* in the uppermost sample of the well West restricts the youngest age of this succession close to the early/middle Miocene boundary. The first samples of all three wells are characterized by a very low quantity and poor preservation of the foraminifers. The recovered nannofossil assemblage shows low diversity, low abundance and poor preservation as well. The most abundant nannofossil remains are fragments of *Cervisiella* spp., a group of opportunistic calcareous dinoflagellates. The middle part of the section is characterized by a well-developed assemblage of mainly benthic foraminifera such as *Nonion boueanum*, *N. deceptrix*, *Globobulimina pacifica*, *Nonionella auris*, *Astrononion echolsi*, *Buccella peruviana*, and *Globocassidulina subglobosa*, among others (Fig. 3). Among the most conspicuous planktic forms are *Globigerina bulloides* and *Globigerinella obesa*. This part of the section reveals a low abundance and low diversity assemblage of nannofossils, some samples were barren. However, diversity increases towards the lower levels. The nannofossils are represented by reticulofenestrids as *Reticulofenestra minuta, R. bisecta,* and *Coccolithus pelagicus*, among others. The most important nannofossil of early Miocene age recorded in this part was *Helicosphaera carteri.* The lower part of the section, marked by the LO of *Globoturborotalita euapertura*, is characterized by an increase of radiolarians, agglutinated and planktic foraminifera, as well as calcareous nannofossils. The recovered calcareous nannofossils in this section exhibit poor to moderate preservation and low to medium abundance and diversity. Typical taxa are *Reticulofenestra filewiczii, R. dictyoda, R. stavensis,* and *R. lockeri,* which indicate an Oligocene to early Miocene age (Náñez & Pérez Panera, 2017; Parras *et al*., 2020). Other accompanying taxa are *Cyclicargolithus abisectus*, *C. floridanus*, and *Sphenolithus moriformis* (Fig. 5).

The early Oligocene assemblage was recognized in all three wells and is characterized by *Globoturborotalita labiacrassata*, *Catapsydrax unicavus*, *Subbotina angiporoides*, and *Paragloborotalia nana*. The fact that *G. labiacrassata* and *S. angiporoides* only co-existed in the Rupelian, allows assigning an early Oligocene age to this part of the succession (see Bown *et al*., 2020). The benthic taxa in these strata are *Sphaeroidina bulloides*, *Bulimina alsatica,* and *Uvigerina gallowayi,* associated with agglutinated foraminifera such as *Spirosigmoilinella compressa*, *Haplophragmoides* spp., *Spiroplectammina* spp., and *Trochammina* spp. (Figs. 2–3). The nannofossil assemblage in this section shows moderate abundance and diversity as well as poor preservation. *Chiasmolithus altus, Reticulofenestra hillae, R. umbilicus, R. circus, R. oamaruensis, Zygrhablithus bijugatus, Chiasmolithus oamaruensis, C. altus, Helicosphaera ethologa* and *Isthmolithus recurvus* indicate an early Oligocene age (Figs. 4–6).

The middle–late Eocene assemblage was recognized in all three wells and displays a moderate state of preservation and the highest species richness of the studied sections. The benthic fauna is constituted by typical Eocene forms of the Magallanes Basin, such as *Virgulinella severini*, *Lenticulina alatolimbata*, *Bathysiphon eocenicus*, *Heterolepa perlucida*, *Elphidium saginatum,* together with cosmopolitan species like *Pullenia bulloides*, *Hoeglundina elegans*, *Oridorsalis umbonatus*, *Gyroidinoides zelandica,* and *Anomalinoides pinguiglaber,* among others (Figs. 2–3). The most representative planktic elements include *Globigerinatheka* spp., *Catapsydrax unicavus*, *C. dissimilis*, *Subbotina* spp., and *Acarinina primitiva.* This foraminiferal assemblage is accompanied by other planktic elements including radiolarians and diatoms. Considering the microfaunal assemblage, especially the presence of *Globigerinatheka* spp., a middle–late Eocene age can be assigned to these sediments. The LO of *Acarinina primitiva* marks the top of the middle Eocene (Bown *et al*., 2020). The section yields a diverse and abundant calcareous nannofossil assemblage with moderate preservation. At the top, the LO of *Reticulofenestra reticulata* indicates the latest Eocene. Also, *Pontosphaera pulchra*, has its LO at the top of this sequence. Although *P. pulchra* is not a traditional marker species, it has a proven value as a marker for the Eocene in the Austral and Colorado basins (Pérez Panera, 2013; Pérez Panera *et al*., 2019). *Isthmolithus recurvus* has its FO in the upper part of this section, which also indicates the late Eocene. Finally, the presence of *Chiasmolithus oamaruensis* confirms a late Eocene age for this assemblage. Other taxa that exhibit high abundance are *Reticulofenestra minuta*, *R. bisecta*, *R. dictyoda*, *R. daviesii* and *Coccolithus pelagicus* (Fig. 5). The LO of *Chiasmolithus modestus* marks the top of NP17 biozone, middle Eocene. *Chiasmolithus* is a common genus in the early to middle Eocene assemblages of the Magallanes Basin (Pérez Panera, 2009, 2013) and it is quite represented in this section. The LO of *Chiasmolithus* *solitus*, a marker species for the top of NP16 biozone and *Neococcolithes protenus* confirm a middle Eocene age. Also, the sporadic presence of the warm-water species *Discoaster saipanensis* in the middle part of this interval may be related to the Middle Eocene Climatic Optimum (MECO) and allows correlation with the Man Aike (Concheyro, 1991) and Cerro Colorado (Bedoya Agudelo, 2019) formations.

The early Eocene assemblage was recognized in all three wells and has reduced diversity and poor preservation. This section is characterized by the planktic foraminifera *Subbotina patagonica*, *Globanomalina* spp., *Subbotina triloculinoides* and *Acarinina collactea* accompanied by poorly preserved benthic elements like *Chilostomella cylindroides* (Figs. 2–3). In general, there is a decrease in foraminiferal abundance together with a remarkably high abundance of radiolarians. In this section, nannofossil assemblages display poor preservation and low abundance. In the upper part, abundance and diversity are higher. The LO of *Chiasmolithus bidens* marks the top of NP11 Biozone (Ypresian). Along this section, some early Eocene events were also identified, like the LOs of *Lanternithus simplex*, *Toweius rotundus*, *T. occultatus*, *T. pertusus*, *T. serotinus*, *Prinsius martini*, and *Fasciculithus tympaniformis* (Figs. 4, 6). Most reticulofenestrids exhibit a decrease in their relative abundance and most of their presences might be due to contaminants from caving. In this section, the *Toweius/Reticulofenestra* turnover of the early Eocene is evidenced.

The early–middle Paleocene assemblage was recognized in all three wells and is characterized by a very low content of microfossils. The foraminifera are represented by exclusively indeterminable agglutinated forms which impede the differentiation from the underlying Maastrichtian (see Thissen & Pérez Panera, 2020a). There are abundant radiolarians in this part, though they are probably caved from the early Eocene. In the well West, this part is basically barren of foraminifera. The nannofossil assemblage shows poor preservation, low abundance and low diversity. Contamination due to caving processes is recognized (mostly reticulofenestrids from the Eocene intervals). However, some marker species of the early–middle Paleocene could be identified. *Hornibrookina edwardsii, Chiasmolithus danicus, Cruciplacolithus primus,* and *Prinsius dimorphosus* indicate a Danian to Selandian age (Figs. 4–6). The absence of a Thanetian assemblage marks an unconformity between the middle Paleocene and the early Eocene.

SYSTEMATIC PALEONTOLOGY

Kingdom CHROMISTA Cavalier-Smith, 1981
Phylum FORAMINIFERA d'Orbigny, 1826
Class MONOTHALAMEA Haeckel, 1862
Order ASTRORHIZIDA Lankester, 1885
Suborder ASTRORHIZINA Lankester, 1885
Superfamily ASTRORHIZOIDEA Brady, 1881
Family RHABDAMMINIDAE Brady, 1884
Subfamily BATHYSIPHONINAE Avnimelech, 1952

Genus ***Bathysiphon*** Sars, 1872

Type species. *Bathysiphon filiformis* Sars, 1872. Late Triassic–Holocene; cosmopolitan.

Bathysiphon eocenicus Cushman & Hanna, 1927

1927 *Bathysiphon eocenica* – Cushman & Hanna, p. 210, pl. 13, figs. 2–3.
1952 *Bathysiphon eocenicus* Cushman & Hanna – Todd & Kniker, p. 5, pl. 1, figs. 3–4.

Occurrence. Early Eocene–early Oligocene (West well), middle Eocene–late Eocene (North and East wells).

Bathysiphon spp.

Occurrence. Middle Eocene–late Oligocene (East well).

Genus ***Nothia*** Pflaumann, 1964

Type species. *Rhizammina grilli* Noth, 1951. Late Cretaceous–Holocene; cosmopolitan.

Nothia spp.

Occurrence. Late Eocene (North well).

Subfamily RHABDAMMININAE Brady, 1884

Genus ***Rhabdammina*** Sars in Carpenter, 1869

Type species. *Rhabdammina abyssorum* Sars in Carpenter, 1869. Paleocene–Holocene; cosmopolitan.

Rhabdammina eocenica Cushman & Hanna, 1927

1927 *Rhabdammina eocenica* – Cushman & Hanna, p. 209, pl. 13, fig. 1.
1952 *Rhabdammina eocenica* Cushman & Hanna – Todd & Kniker, p. 4, pl. 1, figs. 1–2.
1989 *Rhabdammina eocenica* Cushman & Hanna – Malumián, p. 349, pl. 1, fig. 10.

Occurrence. Early Oligocene (East well).

Rhabdammina spp.

Occurrence. Middle Eocene–late Oligocene (West and North wells), late Eocene–early Oligocene (East well).

Superfamily KOMOKIOIDEA Tendal & Hessler, 1977
Family RHIZAMMINIDAE Wiesner, 1931

Genus ***Rhizammina*** Brady, 1879

Type species. *Rhizammina algaeformis* Brady, 1879. Paleocene–Holocene; cosmopolitan.

Rhizammina spp.

Occurrence. Early Eocene (West well), middle Eocene–late Oligocene (East well).

Class TUBOTHALAMEA Pawlowski, Holzmann & Tyszka, 2013
Order SPIRILLINIDA Hohenegger & Piller, 1975
Suborder AMMODISCINA Mikhalevich, 1980
Superfamily AMMODISCOIDEA Chapman, Parr & Collins, 1934
Family AMMODISCIDAE Reuss, 1862
Subfamily AMMODISCINAE Reuss, 1862

Genus ***Ammodiscus*** Reuss, 1862

Type species. *Involutina silicea* Terquem, 1862. Silurian–Holocene; cosmopolitan.

Ammodiscus spp.

Occurrence. Late Eocene–early Oligocene (West well), middle Eocene–late Oligocene (North well), late Eocene–late Oligocene (East well).

Order MILIOLIDA Delage & Hérouard, 1896
Family MILIAMMINIDAE Saidova, 1981

Genus ***Spirosigmoilinella*** Matsunaga, 1955

Type species. *Spirosigmoilinella compressa* Matsunaga, 1955. Oligocene–Miocene; cosmopolitan.

Spirosigmoilinella compressa Matsunaga, 1955
Figure 1.1

1955 *Spirosigmoilinella compressa* – Matsunaga, p. 50, text-figs. 1–2.
1987 *Spirosigmoilinella compressa* Matsunaga – Loeblich & Tappan, p. 55, pl. 40, figs. 10–11.
2006 *Spirosigmoilinella compressa* – Caramés & Malumián, p. 660, figs. 3.Aa–b.

Occurrence. Early Oligocene–late Oligocene (West and East wells), late Oligocene (North well).

Suborder MILIOLINA Delage & Hérouard, 1896
Superfamily MILIOLOIDEA Ehrenberg, 1839
Family SPIROLOCULINIDAE Wiesner, 1920

Genus ***Spiroloculina*** d'Orbigny, 1826

Type species. *Spiroloculina depressa* d'Orbigny, 1826. Late Cretaceous–Holocene; cosmopolitan.

Spiroloculina cf. ***orbicularis*** d'Orbigny, 1852

cf. 1852 *Spiroloculina orbicularis* – d'Orbigny, p. 195.

Remarks. One single specimen was recorded from the North well, which shows many similarities with *Spiroloculina orbicularis* d'Orbigny. However, our specimen presents a bifid tooth, while d'Orbigny (1852) depicts a simple one.

Occurrence. Early Miocene (North well).

Family HAUERINIDAE Schwager, 1876
Subfamily HAUERININAE Schwager, 1876

Genus ***Quinqueloculina*** d'Orbigny, 1826

Type species. *Serpula seminulum* Linnaeus, 1758. Cretaceous–Holocene; cosmopolitan.

Quinqueloculina akneriana d'Orbigny, 1846
Figure 1.2

1846 *Quinqueloculina akneriana* – d'Orbigny, p. 290, pl. 18, figs. 16–21.
1980 *Quinqueloculina akneriana* d'Orbigny – Bertels, p. 221, pl. 1, figs. 1a–b.
1982 *Quinqueloculina akneriana* d'Orbigny – Malumián, p. 45, pl. 2, figs. 7–8.
2005 *Quinqueloculina akneriana* d'Orbigny – Malumián & Scarpa, p. 376, fig. 3.L.
2013 *Quinqueloculina akneriana* d'Orbigny – Finger, p. 387, pl. 3, fig. 16.

Occurrence. Early Miocene (East well).

Quinqueloculina spp.

Occurrence. Early Miocene (West, North, and East wells).

Subfamily MILIOLINELLINAE Vella, 1957

Genus ***Triloculina*** d'Orbigny, 1826

Type species. *Miliolites trigonula* Lamarck, 1804. Eocene–Holocene; cosmopolitan.

Triloculina cf. ***bulbosa*** Cushman, 1918

cf. 1918 *Triloculina bulbosa* – Cushman, p. 83, pl. 32, figs. 3a–c.

Remarks. Our specimen shows many similarities with *Triloculina bulbosa* Cushman but possesses significantly less excavated sutures.

Occurrence. Early Miocene (North well).

Triloculina cf. ***scapha*** d'Orbigny, 1846

cf. 1846 *Triloculina scapha* – d'Orbigny, p. 276, pl. 17, figs. 4–6.

Remarks. Our specimen shows many similarities with *Triloculina scapha* d'Orbigny, but presents a less compressed test, which is not as sharply keeled as the one described by d'Orbigny (1846).

Occurrence. Early Miocene (West well).

Triloculina trigonula (Lamarck, 1804)

1804 *Miliolites trigonula* – Lamarck, p. 351, pl. 17, fig. 4.
1982 *Triloculina trigonula* (Lamarck) – Malumián, p. 46, pl. 3, figs. 1–2.
1987 *Triloculina trigonula* (Lamarck) – Loeblich & Tappan, p. 344, pl. 351, figs. 19–21.
2013 *Triloculina trigonula* (Lamarck) – Finger, p. 394, pl. 5, fig. 9.

Occurrence. Early Miocene (North and East wells).

Triloculina spp.

Occurrence. Early Miocene (East well).

Class NODOSARIATA Mikhalevich, 1992 *emend.*
Rigaud *et al.*, 2015
Subclass HORMOSINANA Mikhalevich, 1992
Suborder HORMOSININA Haeckel, 1894
Superfamily HORMOSINOIDEA Haeckel, 1894
Family REOPHACIDAE Cushman, 1927

Genus ***Reophax*** Montfort, 1808

Type species. *Reophax scorpiurus* Montfort, 1808. Middle Ordovician–Holocene; cosmopolitan.

Reophax sp.

Occurrence. Early Oligocene (West well).

Subclass NODOSARIANA Mikhalevich, 1992
Order NODOSARIIDA Calkins, 1926
Suborder NODOSARIINA Calkins, 1926
Superfamily NODOSARIOIDEA Ehrenberg, 1838
Family GLANDULONODOSARIIDAE Silvestri, 1901

Genus ***Neugeborina*** Popescu in Cicha *et al.*, 1998

Type species. *Nodosaria longiscata* d'Orbigny, 1846. Eocene–Miocene; cosmopolitan.

Neugeborina longiscata (d'Orbigny, 1846)

1846 *Nodosaria longiscata* – d'Orbigny, p. 32, pl. 1, figs. 10–12.
1952 *Nodosaria longiscata* d'Orbigny – Todd & Kniker, p. 16, pl. 3, figs. 9–10.
1990a *Nodosaria longiscata* d'Orbigny – Malumián, p. 351, pl. 2, fig. 10.
2008 *Nodosaria longiscata* d'Orbigny – Scarpa & Malumián, p. 8, fig. 5.18.
2013 *Neugeborina longiscata* (d'Orbigny) – Finger, p. 398, pl.

6, fig. 9.

Occurrence. Middle Eocene (West and East wells).

Family LAGENIDAE Reuss, 1862

Genus ***Lagena*** Walker & Jacob in Kanmacher, 1798

Type species. *Serpula* (*Lagena*) *sulcata* Walker & Jacob in Kanmacher, 1798. Jurassic–Holocene; cosmopolitan.

Lagena substriata Williamson, 1848

1848 *Lagena substriata* – Williamson, p. 15, pl. 2, fig. 12.
1952 *Lagena substriata* Williamson – Todd & Kniker, p. 17, pl. 3, fig. 19.
1980 *Lagena substriata* Williamson – Bertels, p. 226, pl. 1, fig. 15.
1989 *Lagena* ex gr. *substriata* Williamson – Malumián & Caramés, p. 121, pl. 3, figs. 7–11.
2008 *Lagena substriata* Williamson – Scarpa & Malumián, p. 8, fig. 5.8.
2013 *Lagena substriata* Williamson – Finger, p. 422, pl. 11, fig. 10.

Occurrence. Early Eocene–early Oligocene (West well), middle Eocene (East well).

Lagena spp.

Occurrence. Late Eocene (North well), middle Eocene (East well).

Family NODOSARIIDAE Ehrenberg, 1838
Subfamily NODOSARIINAE Ehrenberg, 1838

Genus ***Dentalina*** Risso, 1826

Type species. *Nodosaria cuvieri* d'Orbigny, 1826. Late Jurassic–Holocene; cosmopolitan.

Dentalina cf. ***elgansoensis*** Todd & Kniker, 1952

cf. 1952 *Dentalina elgansoensis* – Todd & Kniker, p. 15, pl. 3, figs. 7, 14.

Remarks. Due to the generally poor preservation in the Eocene, only broken specimens were recorded, which nevertheless possess many similar characteristics to *Dentalina elgansoensis* Todd & Kniker.

Occurrence. Middle Eocene (West well).

Dentalina spp.

Occurrence. Early Eocene–middle Eocene (North well), early Eocene–early Miocene (East well).

Genus ***Laevidentalina*** Loeblich & Tappan, 1986

Type species. *Laevidentalina aphelis* Loeblich & Tappan, 1986. Cretaceous–Holocene; cosmopolitan.

Laevidentalina aff. ***advena*** (Cushman, 1923)

aff. 1923 *Nodosaria advena* – Cushman, p. 79, pl. 14, fig. 12.
aff. 1994 *Laevidentalina advena* (Cushman) – Jones, p. 74, pl. 63, fig. 1.
aff. 2013 *Laevidentalina advena* (Cushman) – Finger, p. 400, pl. 6, fig. 33.

Remarks. The specimens recorded here show some affinity with *Laevidentalina advena* (Cushman) but are significantly shorter with less elongated chambers.

Occurrence. Middle Eocene–early Oligocene (West well).

Laevidentalina spp.

Occurrence. Late Eocene (East well).

Genus ***Nodosaria*** Lamarck, 1816

Type species. *Nautilus radicula* Linnaeus, 1758. Early Jurassic–Holocene; cosmopolitan.

Nodosaria spp.

Occurrence. Early Eocene–early Miocene (West and East wells), middle Eocene–late Eocene (North well).

Genus ***Pandaglandulina*** Loeblich & Tappan, 1955

Type species. *Pandaglandulina dinapolii* Loeblich & Tappan, 1955. Eocene–Holocene; cosmopolitan.

Pandaglandulina sp.

Occurrence. Middle Eocene (East well).

Genus ***Pseudonodosaria*** Boomgaart, 1949

Type species. *Dentalina brevis* d'Orbigny, 1846. Cretaceous–Holocene; cosmopolitan.

Pseudonodosaria spp.

Occurrence. Early Eocene–middle Eocene (West well).

Superfamily STILOSTOMELLOIDEA Finlay, 1947
Family STILOSTOMELLIDAE Finlay, 1947

Genus ***Toddostomella*** Hayward *et al.*, 2012

Type species. *Siphonodosaria chileana* Todd & Kniker, 1952. Eocene–Holocene; cosmopolitan.

Toddostomella chileana (Todd & Kniker, 1952)

1952 *Siphonodosaria chileana* – Todd & Kniker, p. 23, pl. 3, figs. 31–32.
1990a *Siphonodosaria chileana* Todd & Kniker – Malumián, p. 358, pl. 3, fig. 11.
2012 *Toddostomella chileana* (Todd & Kniker) – Hayward *et al.*, p. 195, pl. 24, figs. 1–7.

Remarks. Type species of the genus *Toddostomella* which as demonstrated by Hayward *et al.* (2012) differs from *Siphonodosaria* in possessing a Y-shaped tooth in the aperture.

Occurrence. Late Eocene (West well), middle Eocene (North well).

Order VAGINULINIDA Mikhalevich, 1993
Family VAGINULINIDAE Reuss, 1860
Subfamily LENTICULININAE Chapman, Parr, & Collins, 1934

Genus ***Lenticulina*** Lamarck, 1804

Type species. *Lenticulites rotulata* Lamarck, 1804. Triassic–Holocene; cosmopolitan.

Lenticulina alatolimbata (Gümbel, 1868)

1868 *Robulina alato-limbata* – Gümbel, p. 641, pl. 1, fig. 70.
1952 *Robulus alato-limbatus* (Gümbel) – Todd & Kniker, p. 13, pl. 2, figs. 22–23.
1980 *Robulina alato-limbata* (Gümbel) – Bertels, p. 227, pl. 2, figs. 1a–b.
1990a *Lenticulina alatolimbata* (Gümbel) – Malumián, p. 348, pl. 1, fig. 8.

Occurrence. Middle Eocene–early Oligocene (West well), middle Eocene (North and East wells).

Lenticulina foliata (Stache, 1864)

1864 *Robulina foliata* – Stache, p. 245, pl. 23, figs. 24a–b.
1971 *Robulus foliatus* (Stache) – Hornibrook, p. 42, pl. 9, figs. 151–152.
2013 *Lenticulina foliata* (Stache) – Finger, p. 407, pl. 8, fig. 1.

Occurrence. Early Miocene (East well).

Lenticulina gyroscalprum (Stache, 1864)

1864 *Cristellaria gyroscalprum* – Stache, p. 243, pl. 23, figs. 22a–b.
1971 *Robulus gyroscalprus* (Stache) – Hornibrook, p. 43, pl. 9, figs. 160–161.
1979 *Lenticulina gyroscalpra* (Stache) – Hayward & Buzas, p. 63.

Occurrence. Middle Eocene (East well).

Lenticulina spp.

Occurrence. Early Eocene–early Miocene (West, North, and East wells).

Genus ***Saracenaria*** Defrance, 1824

Type species. *Saracenaria italica* Defrance, 1824. Late Jurassic–Holocene; cosmopolitan.

Saracenaria spp.

Occurrence. Middle Eocene (East well).

Subfamily MARGINULININAE Wedekind, 1937

Genus ***Vaginulinopsis*** Silvestri, 1904

Type species. *Vaginulina soluta* var. *carinata* Silvestri, 1898. Late Triassic–Holocene; cosmopolitan.

Vaginulinopsis hochstetteri (Stache, 1864)
Figure 1.3

1864 *Marginulina hochstetteri* – Stache, p. 221, pl. 22, figs. 55a–b.
1971 *Vaginulinopsis hochstetteri* (Stache) – Hornibrook, p. 39, pl. 8, fig. 127.

1990a *Marginulina hochstetteri* (Stache) var. *nodulocostulata* – Malumián, p. 350, pl. 2, figs. 2–3.

Occurrence. Middle Eocene (West and North wells).

Subfamily VAGINULININAE Reuss, 1860

Genus ***Vaginulina*** d'Orbigny, 1826

Type species. *Nautilus legumen* Linnaeus, 1758. Early Jurassic–Holocene; cosmopolitan.

Vaginulina spp.

Occurrence. Early Oligocene (West well).

Order POLYMORPHINIDA Mikhalevich, 1980
Suborder POLYMORPHININA Mikhalevich, 1980
Superfamily POLYMORPHINOIDEA d'Orbigny, 1839
Family ELLIPSOLAGENIDAE Silvestri, 1923
Subfamily ELLIPSOLAGENINAE Silvestri, 1923

Genus ***Fissurina*** Reuss, 1850

Type species. *Fissurina laevigata* Reuss, 1850. Cretaceous–Holocene; cosmopolitan.

Fissurina sp.

Occurrence. Early Miocene (West well).

Subfamily OOLININAE Loeblich & Tappan, 1961

Genus ***Pseudofavulina*** Margerel, 2016

Type species. *Entosolenia scalariformis* Williamson, 1848. Eocene–Holocene; cosmopolitan.

Pseudofavulina catenulata (Jeffreys in Williamson, 1848)

1848 *Entosolenia squamosa* (Montagu) var. α, *catenulata* – Jeffreys in Williamson, p. 19, pl. 2, fig. 20.
1952 *Oolina squamosa* (Montagu) var. *catenulata* (Jeffreys in Williamson) – Todd & Kniker, p. 22, pl. 4, fig. 16.
2016 *Pseudofavulina catenulata* (Jeffreys in Williamson) – Margerel, p. 574, fig. 9A–G.

Occurrence. Middle Eocene (West well).

Genus ***Oolina*** d'Orbigny, 1839

Type species. *Oolina laevigata* d'Orbigny, 1839. Jurassic–Holocene; cosmopolitan.

Oolina spp.

Occurrence. Middle Eocene (West well), early Oligocene (East well).

Subfamily PARAFISSURININAE Jones, 1984

Genus ***Parafissurina*** Parr, 1947

Type species. *Lagena ventricosa* Silvestri, 1904. Eocene–Holocene; cosmopolitan.

Parafissurina spp.

Occurrence. Early Miocene (East well).

Family GLANDULINIDAE Reuss, 1860
Subfamily GLANDULININAE Reuss, 1860

Genus ***Glandulina*** d'Orbigny, 1839

Type species. *Nodosaria* (*Glanduline*) *laevigata* d'Orbigny, 1826. Paleocene–Holocene; cosmopolitan.

Glandulina laevigata (d'Orbigny, 1826)
Figure 1.4

1826 *Nodosaria* (*Glanduline*) *laevigata* – d'Orbigny, p. 252, pl. 10, figs. 1–3.
1846 *Glandulina laevigata* – d'Orbigny, p. 29, pl. 1, figs. 4–5.
1952 *Glandulina laevigata* d'Orbigny – Todd & Kniker, p. 18, pl. 3, figs. 29–30.
2008 *Glandulina laevigata* d'Orbigny – Scarpa & Malumián, p. 8, fig. 4.5.
2013 *Glandulina laevigata* d'Orbigny – Finger, p. 430, pl. 13, figs. 2–5.

Occurrence. Early Eocene–early Oligocene (West well), early Eocene–middle Eocene (North well), middle Eocene–early Oligocene (East well).

Family POLYMORPHINIDAE d'Orbigny, 1839
Subfamily POLYMORPHININAE d'Orbigny, 1839

Genus ***Globulina*** d'Orbigny, 1839

Type species. *Polymorphina* (*Globuline*) *gibba* d'Orbigny, 1826. Middle Jurassic–Holocene; cosmopolitan.

Globulina spp.

Occurrence. Early Eocene–middle Eocene (West well), early Oligocene (East well).

Genus ***Guttulina*** d'Orbigny, 1839

Type species. *Polymorphina* (*Guttuline*) *communis* d'Orbigny, 1826. Middle Jurassic–Holocene; cosmopolitan.

Guttulina communis (d'Orbigny, 1826)

1826 *Polymorphina* (*Guttuline*) *communis* – d'Orbigny, p. 266, pl. 12, figs. 1–4.
2008 *Guttulina problema* d'Orbigny – Scarpa & Malumián, p. 8, fig. 4.18.

Occurrence. Early Oligocene (West well).

Genus ***Sigmomorphina*** Cushman & Ozawa, 1928

Type species. *Sigmomorpha* (*Sigmomorphina*) *yokoyamai* Cushman & Ozawa, 1928. Paleocene–Holocene; cosmopolitan.

Sigmomorphina trinitatensis Cushman & Ozawa, 1930

1930 *Sigmomorphina trinitatensis* – Cushman & Ozawa, p. 134, pl. 36, figs. 1–2.
1952 *Sigmomorphina trinitatensis* Cushman & Ozawa – Todd & Kniker, p. 17, pl. 3, figs. 23–24.
1990a *Sigmomorphina* cf. *S. trinitatensis* Cushman & Ozawa – Malumián, p. 354, pl. 2, figs. 27–28.
2013 *Sigmomorphina trinitatensis* Cushman & Ozawa – Finger, p. 425, pl. 11, fig. 34.

Occurrence. Middle Eocene–early Oligocene (West well).

Class GLOBOTHALAMEA Pawlowski, Holzmann & Tyszka, 2013
Order ROBERTINIDA Loeblich & Tappan, 1984
Suborder ROBERTININA Loeblich & Tappan, 1984
Superfamily CERATOBULIMINOIDEA Cushman, 1927
Family EPISTOMINIDAE Wedekind, 1937

Genus ***Hoeglundina*** Brotzen, 1948

Type species. *Rotalia* (*Turbinuline*) *elegans* d'Orbigny, 1826. Paleocene–Holocene; cosmopolitan.

Hoeglundina elegans (d'Orbigny, 1826)
Figure 1.5

1826 *Rotalia (Turbinuline) elegans* – d'Orbigny, p. 276.
1974 *Hoeglundina elegans* (d'Orbigny) – Cañón & Ernst, p. 88, pl. 5, figs. 8a–c.
1987 *Hoeglundina elegans* (d'Orbigny) – Loeblich & Tappan, p. 446, pl. 478, figs. 1–5.
2013 *Hoeglundina elegans* (d'Orbigny) – Finger, p. 432, pl. 13, fig. 9.

Occurrence. Middle Eocene–late Oligocene (West well), late Eocene (North well), late Oligocene–early Miocene (East well).

Subclass TEXTULARIANA Mikhalevich, 1980
Order LITUOLIDA Lankester, 1885
Suborder LITUOLINA Lankester, 1885
Superfamily LITUOLOIDEA Blainville, 1827
Family HAPLOPHRAGMOIDIDAE Maync, 1952

Genus ***Haplophragmoides*** Cushman, 1910

Type species. *Nonionina canariensis* d'Orbigny, 1839. Cretaceous–Holocene; cosmopolitan.

Haplophragmoides spp.

Occurrence. Late Eocene–early Miocene (West well), middle Eocene–early Miocene (North well), early Eocene–early Miocene (East well).

Family LITUOLIDAE Blainville, 1827
Subfamily AMMOMARGINULININAE Podobina, 1978

Genus ***Ammobaculites*** Cushman, 1910

Type species. *Spirolina agglutinans* d'Orbigny, 1846. Early Mississippian–Holocene; cosmopolitan.

Ammobaculites spp.

Occurrence. Middle Eocene (North well).

Superfamily RECURVOIDOIDEA Alekseychik-Mitskevich, 1973

Family AMMOSPHAEROIDINIDAE Cushman, 1927
Subfamily RECURVOIDINAE Alekseychik-Mitskevich, 1973

Genus ***Cribrostomoides*** Cushman, 1910

Type species. *Cribrostomoides bradyi* Cushman, 1910. Paleocene–Holocene; cosmopolitan.

Cribrostomoides spp.
Figure 1.6

Occurrence. Middle Eocene–early Miocene (North), middle Eocene–early Oligocene (East well).

Genus ***Recurvoides*** Cushman, 1910

Type species. *Recurvoides contortus* Earland, 1934. Cretaceous–Holocene; cosmopolitan.

Recurvoides spp.

Occurrence. Early Eocene–middle Eocene (West well), early Eocene–early Oligocene (North well), middle Eocene–early Oligocene (East well).

Suborder SPIROPLECTAMMININA Mikhalevich, 1992
Superfamily SPIROPLECTAMMINOIDEA Cushman, 1927
Family SPIROPLECTAMMINIDAE Cushman, 1927
Subfamily SPIROPLECTAMMININAE Cushman, 1927

Genus ***Spiroplectammina*** Cushman, 1927

Type species. *Textularia agglutinans* var. *biformis* Parker & Jones, 1865. Carboniferous–Holocene; cosmopolitan.

Spiroplectammina adamsi Lalicker, 1935

1935 *Spiroplectammina adamsi* – Lalicker, p. 9, pl. 2, figs. 5a–c.
1952 *Spiroplectammina adamsi* Lalicker – Todd & Kniker, p. 6, pl. 1, figs. 18–19.
1974 *Spiroplectammina adamsi* Lalicker – Cañón & Ernst, p. 68, pl. 1, figs. 6a–b.
2011 *Spiroplectammina adamsi* Lalicker – Marchant, p. 10, fig. 2.8.

Occurrence. Early Eocene (West well).

Spiroplectammina spectabilis (Grzybowski, 1898)
emend. Kaminski, 1984

1898 *Spiroplecta spectabilis* – Grzybowski, p. 293, pl. 12, fig. 12.
1952 *Spiroplectammina brunswickensis* – Todd & Kniker, p. 6, pl. 1, fig. 16.
1974 *Spiroplectammina brunswickensis* Todd & Kniker – Cañón & Ernst, p. 69, pl. 1, figs. 7a–b.
1974 *Spiroplectammina grzybowskii* Frizzell – Cañón & Ernst, p. 69, pl. 1, figs. 8a–b.
1984 *Spiroplectammina spectabilis* (Grzybowski) – Kaminski, p. 31, pl. 12, figs. 1–9, pl. 13, figs. 1-8.
2011 *Spiroplectammina grzybowski* Frizzell – Marchant, p. 8, fig. 2.2.

Remarks. Kaminski (1984) synonymized several species into *Spiroplectammina spectabilis* (Grzybowski, 1898), including two species previously recognized from the Magallanes Basin, *Spiroplectammina brunswickensis* Todd & Kniker, 1952, and *Spiroplectammina grzybowskii* Frizzell, 1943.

Occurrence. Late Eocene (North well).

Spiroplectammina spp.

Occurrence. Early Eocene–early Oligocene (West well), middle Eocene–early Oligocene (North well), middle Eocene–late Oligocene (East well).

Suborder TROCHAMMININA Saidova, 1981
Superfamily TROCHAMMINOIDEA Schwager, 1877
Family TROCHAMMINIDAE Schwager, 1877
Subfamily TROCHAMMININAE Schwager, 1877

Genus ***Tritaxis*** Schubert, 1921

Type species. *Rotalina fusca* Williamson, 1858. Eocene–Holocene; cosmopolitan.

Tritaxis spp.

Occurrence. Early Oligocene (East well).

Genus ***Trochammina*** Parker & Jones, 1859

Type species. *Nautilus inflatus* Montagu, 1808. Carboniferous–Holocene; cosmopolitan.

Trochammina spp.

Occurrence. Early Eocene–early Oligocene (West well), early

Eocene–early Miocene (North and East wells).

Suborder VERNEUILININA Kaminski & Mikhalevich in Kaminski, 2004
Superfamily VERNEUILINOIDEA Cushman, 1911
Family VERNEUILINIDAE Cushman, 1911
Subfamily VERNEUILININAE Cushman, 1911

Genus ***Gaudryina*** d'Orbigny, 1840

Type species. *Gaudryina rugosa* d'Orbigny, 1840. Late Triassic–Holocene; cosmopolitan.

Gaudryina sp.

Occurrence. Middle Eocene–late Eocene (North well).

Order LOFTUSIIDA Kaminski & Mikhalevich in Kaminski, 2004
Suborder LOFTUSIINA Kaminski & Mikhalevich in Kaminski, 2004
Superfamily LOFTUSIOIDEA Brady, 1884
Family CYCLAMMINIDAE Marie, 1941
Subfamily ALVEOLOPHRAGMIINAE Saidova, 1981

Genus ***Alveolophragmium*** Shchedrina, 1936

Type species. *Alveolophragmium orbiculatum* Shchedrina, 1936. Eocene–Holocene; cosmopolitan.

Alveolophragmium spp.
Figure 1.7

Occurrence. Middle Eocene–late Eocene (West well), early Eocene–early Miocene (North well), late Oligocene (East well).

Genus ***Reticulophragmium*** Maync, 1955

Type species. *Alveolophragmium venezuelanum* Maync, 1952. Eocene–Miocene; cosmopolitan.

Reticulophragmium amplectens (Grzybowski, 1898)

1898 *Cyclammina amplectens* – Grzybowski, p. 292, pl. 12, figs. 1–3.
2005 *Reticulophragmium amplectens* Grzybowski – Kaminski & Gradstein, fig. 123–1, 1–3.

Occurrence. Middle Eocene (East well).

Reticulophragmium spp.

Occurrence. Early Eocene–early Oligocene (West well), middle Eocene–early Oligocene (North and East wells).

Subfamily CYCLAMMININAE Marie, 1941

Genus ***Cyclammina*** Brady, 1879

Type species. *Cyclammina cancellata* Brady, 1879. Paleocene–Holocene; cosmopolitan.

Cyclammina incisa (Stache, 1864)
Figure 1.8

1864 *Haplophragmium incisum* – Stache, p. 165, pl. 21, fig. 1.
1971 *Cyclammina incisa* (Stache) – Hornibrook, p. 34, pl. 6, figs. 88–91.
1989 *Cyclammina incisa* (Stache) – Malumián, p. 346, pl. 1, fig. 3.
1990b *Cyclammina incisa* (Stache) – Malumián, p. 380, pl. 1, fig. 1.
2008 *Reticulophragmium incisum* (Stache) – Scarpa & Malumián, p. 10, fig. 6.2.

Occurrence. Early Miocene (North well).

Cyclammina spp.

Occurrence. Middle Eocene–early Oligocene (West well), late Oligocene–early Miocene (North well), early Eocene–early Miocene (East well).

Suborder ORBITOLININA Kaminski, 2004
Superfamily COSKINOLINOIDEA Moullade, 1965
Family COSKINOLINIDAE Moullade, 1965

Genus ***Coskinolina*** Stache, 1875

Type species. *Coskinolina liburnica* Stache, 1875. Paleocene–Oligocene; cosmopolitan.

Coskinolina sp.

Occurrence. Late Eocene (West well).

Order TEXTULARIIDA Delage & Hérouard, 1896
Suborder TEXTULARIINA Delage & Hérouard, 1896
Superfamily TEXTULARIOIDEA Ehrenberg, 1838
Family TEXTULARIIDAE Ehrenberg, 1838
Subfamily TEXTULARIINAE Ehrenberg, 1838

Genus ***Textularia*** Defrance, 1824

Type species. *Textularia sagittula* Defrance, 1824. Cretaceous–Holocene; cosmopolitan.

Textularia spp.

Occurrence. Late Eocene (North well), early Oligocene–late Oligocene (East well).

Superfamily EGGERELLOIDEA Cushman, 1937
Family EGGERELLIDAE Cushman, 1937
Subfamily DOROTHIINAE Balakhmatova, 1972

Genus ***Dorothia*** Plummer, 1931

Type species. *Gaudryina bulletta* Carsey, 1926. Early Cretaceous–Eocene; cosmopolitan.

Dorothia spp.

Occurrence. Early Eocene (West well), late Eocene (East well).

Subfamily EGGERELLINAE Cushman, 1937

Genus ***Eggerella*** Cushman, 1933

Type species. *Verneuilina bradyi* Cushman, 1911. Eocene–Holocene; cosmopolitan.

Eggerella bradyi (Cushman, 1911)

1911 *Verneuilina bradyi* – Cushman, p. 54, pl. 55, text-fig. 87.
1994 *Eggerella bradyi* (Cushman) – Jones, p. 51, pl. 47, figs. 4–6.
2013 *Eggerella bradyi* (Cushman) – Finger, p. 381, pl. 2, fig. 6.

Occurrence. Early Eocene (North well).

Genus ***Karreriella*** Cushman, 1933

Type species. *Gaudryina siphonella* Reuss, 1851. Eocene–Holocene; cosmopolitan.

Karreriella bradyi (Cushman, 1911)

1911 *Gaudryina bradyi* – Cushman, p. 67, text-fig. 107.
1983 *Karreriella bradyi* (Cushman) – Basov & Krasheninnikov, p. 761, pl. 16, fig. 3.
1994 *Karreriella bradyi* (Cushman) – Jones, p. 50, pl. 46, figs. 1-4.
2008 *Karreriella bradyi* (Cushman) – Scarpa & Malumián, p. 8, fig. 6.1.
2013 *Karreriella bradyi* (Cushman) – Finger, p. 382, pl. 2, fig. 8.

Occurrence. Middle Eocene–late Eocene (North well).

Karreriella cylindrica Finlay, 1940

1940 *Karreriella* (*Karrerulina*) *cylindrica* – Finlay, p. 452, pl. 63, figs. 43–46.

Occurrence. Late Oligocene (East well).

Karreriella spp.

Occurrence. Early Eocene–middle Eocene (West well), middle Eocene (East well).

Genus ***Martinottiella*** Cushman, 1933

Type species. *Clavulina communis* d'Orbigny, 1846. Paleocene–Holocene; cosmopolitan.

Martinottiella cf. ***antarctica*** (Parr, 1950)

cf. 1950 *Schenckiella antarctica* – Parr, p. 284, pl. 5, fig. 27.
cf. 1978 *Martinottiella antarctica* (Parr) – Boltovskoy, p. 55, pl. 7, fig. 21.
cf. 1983 *Martinottiella antarctica* (Parr) – Basov & Krasheninnikov, p. 761, pl. 16, figs. 4–5.

Remarks. Only broken specimens were recovered from the sample material, so a determination with absolute certainty was not possible.

Occurrence. Late Oligocene (East well).

Martinottiella cf. ***occidentalis*** (Cushman, 1922a)

cf. 1922a *Clavulina occidentalis* – Cushman, p. 87, pl. 17, figs. 1–2.
cf. 1978 *Martinottiella occidentalis* (Cushman) – Boltovskoy, p. 56, pl. 8, fig. 1.

cf. 1983 *Martinottiella occidentalis* (Cushman) – Basov & Krasheninnikov, p. 761, pl. 16, fig. 6.

Remarks. Only broken specimens were recovered from the sample material, so a determination with absolute certainty was not possible.

Occurrence. Late Oligocene (West well).

Martinottiella spp.

Occurrence. Late Eocene–late Oligocene (West well), late Oligocene–early Miocene (North well), middle Eocene–late Oligocene (East well).

Subclass ROTALIANA Mikhalevich, 1980
Order ROTALIIDA Delage & Hérouard, 1896
Suborder GLOBIGERININA Delage & Hérouard, 1896
Superfamily GLOBIGERINOIDEA Carpenter, Parker, & Jones, 1862
Family GLOBANOMALINIDAE Loeblich & Tappan, 1961

Genus ***Globanomalina*** Haque, 1956

Type species. *Globanomalina ovalis* Haque, 1956. Paleocene–Eocene; cosmopolitan.

Globanomalina australiformis (Jenkins, 1966)

1966 *Globorotalia australiformis* – Jenkins, p. 1112, fig. 11, 92–96.
1999 *Globanomalina australiformis* (Jenkins) – Olsson *et al.*, p. 38, pl. 33, figs. 1–13.
2006 *Globanomalina australiformis* (Jenkins) – Olsson & Hemleben, p. 415, pl. 14.1, figs. 11-16.

Occurrence. Early Eocene (West and East wells).

Globanomalina chapmani (Parr, 1938)
Figure 1.9

1938 *Globorotalia chapmani* – Parr, p. 87, pl. 3, figs. 8–9.
1999 *Globanomalina chapmani* (Parr) – Olsson *et al.*, p. 39, pl. 34, figs. 1–7.

Occurrence. Early Eocene (West well).

Globanomalina spp.

Occurrence. Early Eocene (East well).

Genus ***Turborotalia*** Cushman & Bermúdez, 1949

Type species. *Globorotalia centralis* Cushman & Bermúdez, 1949. Eocene–Oligocene; cosmopolitan.

Turborotalia frontosa (Subbotina, 1953)

1953 *Globigerina frontosa* – Subbotina, p. 84, pl. 12, figs. 3–7.
2006 *Turborotalia frontosa* (Subbotina) – Pearson *et al.*, p. 452, pl. 15.5, figs. 1–15.

Occurrence. Late Eocene (East well).

Family GLOBIGERINIDAE Carpenter, Parker & Jones 1862

Genus ***Catapsydrax*** Bolli *et al.*, 1957

Type species. *Globigerina dissimilis* Cushman & Bermúdez, 1937. Eocene–Miocene; cosmopolitan.

Catapsydrax dissimilis (Cushman & Bermúdez, 1937)

1937 *Globigerina dissimilis* – Cushman & Bermúdez, p. 25, pl. 3, figs. 4–6.
1971 *Catapsydrax dissimilis* (Cushman & Bermúdez) – Postuma, p. 256–257.
1983 *Catapsydrax dissimilis* (Cushman & Bermúdez) – Kennett & Srinivasan, p. 22, pl. 2, figs. 1, 3–8.
2006a *Catapsydrax dissimilis* (Cushman & Bermúdez) – Olsson *et al.*, p. 71, pl. 5.3, figs. 18–20.
2018 *Catapsydrax dissimilis* (Cushman & Bermúdez) – Coxall & Spezzaferri, p. 83, pl. 4.1, figs. 1–16.

Occurrence. Middle Eocene–late Eocene (West well).

Catapsydrax unicavus Bolli *et al.*, 1957
Figure 1.10

1957 *Catapsydrax unicavus* – Bolli *et al.*, p. 37, pl. 7, fig. 9a–c.
1983 *Catapsydrax unicavus* Bolli *et al.* – Kennett & Srinivasan, p. 26, pl. 3, figs. 4–6.
2006a *Catapsydrax unicavus* Bolli *et al.* – Olsson *et al.*, p. 75, pl. 5.3, figs. 1–17.
2008 *Catapsydrax unicavus* Bolli *et al.* – Scarpa & Malumián, p. 10, figs. 7.15–16.
2018 *Catapsydrax unicavus* Bolli *et al.* – Coxall & Spezzaferri, p. 88, pl. 4.3, figs. 1–16.

Occurrence. Early Eocene–early Oligocene (West well), early Eocene–late Oligocene (North well), early Eocene–middle Eocene (East well).

Genus ***Paragloborotalia*** Cifelli, 1982

Type species. *Globorotalia opima* subsp. *opima* Bolli, 1957. Eocene–Miocene; cosmopolitan.

Paragloborotalia nana (Bolli, 1957)

Figure 1.11

1957 *Globorotalia opima* Bolli subsp. *nana* – Bolli, p. 118, pl. 28, fig. 3a–c.
1971 *Globorotalia nana nana* (Bolli) – Jenkins, p. 123, pl. 11, figs. 303–308.
1971 *Globorotalia nana* (Bolli) – Postuma, p. 340–341.
2006b *Paragloborotalia nana* (Bolli) – Olsson *et al.*, p. 95, pl. 5.8, figs. 1–16.
2008 *Paragloborotalia nana nana* (Bolli) – Scarpa & Malumián, p. 13, figs. 7.12–13.
2018 *Paragloborotalia nana* (Bolli) – Leckie *et al.*, p. 149, pl. 5.7, figs. 1–16.

Occurrence. Early Oligocene (West well).

Genus ***Subbotina*** Brotzen & Pozaryska, 1961

Type species. *Globigerina triloculinoides* Plummer, 1927. Paleocene–Oligocene; cosmopolitan.

Subbotina angiporoides (Hornibrook, 1965)

Figure 1.12

1965 *Globigerina angiporoides* – Hornibrook, p. 836, text-figs. 1a–i, 2.
1971 *Globigerina* (*Subbotina*) *angiporoides angiporoides* (Hornibrook) – Jenkins, p. 160, pl. 20, figs. 588–594.
2006a *Subbotina angiporoides* (Hornibrook) – Olsson *et al.*, p. 126, pl. 6.6, figs. 1–13.
2006 *Subbotina angiporoides angiporoides* (Hornibrook) – Scarpa & Malumián, p. 13, figs. 7.17–19.
2018 *Subbotina angiporoides* (Hornibrook) – Wade *et al.*, p. 309, pl. 10.1, figs. 1–8.

Remarks. Excellent marker species of the middle Eocene–early Oligocene of southern high latitudes (Jenkins, 1971).

Occurrence. Middle Eocene–early Oligocene (West well), late Eocene (North well), late Eocene–early Oligocene (East well).

Subbotina eocaena (Gümbel, 1868)

1868 *Globigerina eocaena* – Gümbel, p. 662, pl. 2, fig. 109a–b.
2006a *Subbotina eocaena* (Guembel) – Olsson *et al.*, p. 134, pl. 6.9, figs. 1–16.
2018 *Subbotina eocaena* (Guembel) – Wade *et al.*, p. 315, pl. 10.3, figs. 1–16.

Occurrence. Middle Eocene–early Oligocene (West well), early Oligocene (North well).

Subbotina patagonica (Todd & Kniker, 1952)

Figure 1.13

1952 *Globigerina patagonica* – Todd & Kniker, p.26, pl. 4, fig. 32.
2006a *Subbotina patagonica* (Todd & Kniker) – Olsson *et al.*, p. 154, pl. 6.15, figs. 1–16.

Remarks. A common element of middle Paleocene–middle Eocene planktic assemblages of the southern hemisphere (Olsson *et al.*, 2006a).

Occurrence. Early Eocene (West well), early Eocene–middle Eocene (East well).

Subbotina roesnaesensis Olsson & Berggren in Olsson *et al.*, 2006

2006a *Subbotina roesnaesensis* Olsson & Berggren – Olsson *et al.*, p. 157, pl. 6.16, figs. 1–15.

Occurrence. Early Eocene (East well).

Subbotina triloculinoides (Plummer, 1927)

Figure 1.14

1927 *Globigerina triloculinoides* – Plummer, p. 134, pl. 8, fig. 10.
1971 *Globigerina (Subbotina) triloculinoides* (Plummer) – Jenkins, p. 163, pl. 13, figs. 505–508.
1971 *Globigerina triloculinoides* (Plummer) – Postuma, p. 160–161.
1974 *Globigerina triloculinoides* (Plummer) – Cañón & Ernst, p. 83, pl. 4, figs. 4a–b.
1999 *Subbotina triloculinoides* (Plummer) – Olsson *et al.*, p. 31, pl. 9, figs. 13–15; pl. 14, figs. 15–16; pl. 27, figs. 1–13.

Remarks. Although widely considered to be restricted to the Paleocene (see Olsson *et al.*, 1999), the range of this species extends into the lowermost Eocene in sediments of the Magallanes Basin, which is confirmed by accompanying nannofossils and has previously been documented from New Zealand (see Jenkins, 1971).

Occurrence. Early Eocene (West, North, and East wells).

Subbotina velascoensis (Cushman, 1925a)

1925a *Globigerina velascoensis* – Cushman, p. 19, pl. 3, fig. 6.
1999 *Subbotina velascoensis* (Cushman) – Olsson *et al.*, p. 33, pl. 29, figs. 1–12.

Occurrence. Early Eocene (East well).

Subbotina spp.

Occurrence. Early Eocene–early Oligocene (West well), early Eocene–late Eocene (North and East wells).

Subfamily GLOBIGERININAE Carpenter, Parker & Jones 1862

Genus ***Globigerina*** d'Orbigny, 1826

Type species. *Globigerina bulloides* d'Orbigny, 1826. Eocene–Holocene; cosmopolitan.

Globigerina bulloides d'Orbigny, 1826
Figure 1.15

1826 *Globigerina bulloides* – d'Orbigny, p. 40, pl. 7, figs. 1a–c.
1983 *Globigerina (Globigerina) bulloides* d'Orbigny – Kennett & Srinivasan, p. 36, pl. 6, figs. 4–6.
1987 *Globigerina bulloides* d'Orbigny – Loeblich & Tappan, p. 489, pl. 535, figs. 1–7.
2018 *Globigerina bulloides* d'Orbigny – Spezzaferri *et al.*, p. 182, pl. 6.2, figs. 1–16.

Occurrence. Early Miocene (West well).

Globigerina officinalis Subbotina, 1953

1953 *Globigerina officinalis* – Subbotina, p. 78, pl. 11, figs. 1–7.
2006a *Globigerina officinalis* Subbotina – Olsson *et al.*, p. 114, pl. 6.1, figs. 1–16.
2018 *Globigerina officinalis* Subbotina – Spezzaferri *et al.*, p. 186, pl. 6.3, figs. 1–13.

Occurrence. Early Miocene (North well).

Globigerina spp.

Occurrence. Early Oligocene–early Miocene (West well), early Miocene (East well).

Genus ***Globigerinella*** Cushman, 1927

Type species. *Globigerina aequilateralis* Brady, 1879. Oligocene–Holocene; cosmopolitan.

Globigerinella obesa (Bolli, 1957)

1957 *Globorotalia obesa* – Bolli, p. 119, pl. 29, figs. 2a–c, 3.
1971 *Globorotalia obesa* Bolli – Postuma, p. 342–343.
1983 *Globigerinella obesa* (Bolli) – Kennett & Srinivasan, p. 234, pl. 59, figs. 2–5.
2018 *Globigerinella obesa* (Bolli) – Spezzaferri *et al.*, p. 198, pl. 6.1, figs. 14–17; pl. 6.8, figs. 1–23.

Occurrence. Early Miocene (West and East wells), late Oligocene (North well).

Genus ***Globigerinoides*** Cushman, 1927

Type species. *Globigerina rubra* d'Orbigny, 1839. Miocene–Holocene; cosmopolitan.

Globigerinoides spp.

Occurrence. Early Miocene (West well).

Genus ***Globoturborotalita*** Hofker, 1976

Type species. *Globigerina rubescens* Hofker, 1956. Eocene–Holocene; cosmopolitan.

Globoturborotalita euapertura (Jenkins, 1960)
Figure 1.16

1960 *Globigerina euapertura* – Jenkins, p. 351, pl. 1, fig. 8a–c.
1971 *Globigerina* (*Globigerina*) *euapertura* Jenkins – Jenkins, p. 147, pl. 15, figs. 457–461; pl. 16, fig. 462.
2008 "*Globigerina*" *euapertura* Jenkins – Scarpa & Malumián, p. 13, figs. 7.20–21.
2018 *Globoturborotalita euapertura* (Jenkins) – Spezzaferri *et al.*, p. 244, pl. 8.6, figs. 1–16.

Remarks. Together with its sister taxon *Globoturborotalita labiacrassata* (Jenkins, 1966) a very useful marker of Oligocene–early Miocene sediments of southern high latitudes (Jenkins, 1971; Spezzaferri *et al.*, 2018).

Occurrence. Early Oligocene–early Miocene (West well), early Miocene (North and East wells).

Globoturborotalita labiacrassata (Jenkins, 1966)

1966 *Globigerina labiacrassata* – Jenkins, p. 1102, fig. 8. 64–71.

1971 *Globigerina* (*Globigerina*) *labiacrassata* Jenkins – Jenkins, p. 151, pl. 16, figs. 474–484.
2008 *Zeaglobigerina labiacrassata* (Jenkins) – Scarpa & Malumián, p. 13, fig. 7.5.
2018 *Globoturborotalita labiacrassata* (Jenkins) – Spezzaferri *et al.*, p. 250, pl. 8.8, figs. 1–16.

Remarks. Together with its sister taxon *Globoturborotalita euapertura* (Jenkins, 1960) is a very useful marker of Oligocene–early Miocene sediments of southern high latitudes (Jenkins, 1971; Spezzaferri *et al.*, 2018).
Occurrence. Early Oligocene (West well).

Globoturborotalita woodi (Jenkins, 1960)

1960 *Globigerina woodi* – Jenkins, p. 352, pl. 2, fig. 2a–c.
1971 *Globigerina* (*Globigerina*) *woodi woodi* Jenkins – Jenkins, p. 159, pl. 18, figs. 548–550.
1983 *Globigerina* (*Zeaglobigerina*) *woodi* Jenkins – Kennett & Srinivasan, p. 43, pl. 7, figs. 4–6.
2008 *Zeaglobigerina woodi* (Jenkins) – Scarpa & Malumián, p. 13, fig. 7.9.
2018 *Globoturborotalita woodi* (Jenkins) – Spezzaferri *et al.*, p. 262, pl. 8.14, figs. 1–17.

Occurrence. Early Miocene (East well).

Globoturborotalita spp.

Occurrence. Early Oligocene (East).

Genus ***Trilobatus*** Spezzaferri *et al.*, 2015

Type species. *Globigerina triloba* Reuss, 1850. Oligocene–Holocene; cosmopolitan.

Trilobatus sicanus (De Stefani, 1952)

1952 *Globigerinoides sicana* – De Stefani, p. 9.
1971 *Globigerinoides sicanus* De Stefani – Postuma, p. 304–305.
1983 *Globigerinoides sicanus* De Stefani – Kennett & Srinivasan, p. 62, pl. 13, figs. 4–6.
2015 *Trilobatus sicanus* (De Stefani) – Spezzaferri *et al.*, p. 16.

Remarks. Very useful marker due to its short species range across the early/middle Miocene boundary. *Trilobatus* is apparently an objective junior synonym of *Trilobigerina* Popescu, 1987 (see Hayward *et al.*, 2020), and therefore should be reclassified. However, the authors were not able to obtain the original description of *Trilobigerina* to verify its validity over *Trilobatus*. Recently, this issue was brought before the ICZN under case number 3837, pending a decision by the time of writing.
Occurrence. Early–middle? Miocene (West well).

Subfamily PORTICULASPHAERINAE Banner, 1982

Genus ***Globigerinatheka*** Brönnimann, 1952

Type species. *Globigerinatheka barri* Brönnimann, 1952. Eocene; cosmopolitan.

Globigerinatheka index (Finlay, 1939)
Figure 1.17

1939 *Globigerinoides index* – Finlay, p. 125, pl. 14, figs. 85–88.
1971 *Globigerapsis index* (Finlay) – Postuma, p. 136–137.
2006 *Globigerinatheka index* (Finlay) – Premoli Silva *et al.*, p. 183, pl. 7.5, figs. 1–20.

Remarks. Though usually rare in sediments from the Magallanes Basin and adjacent areas, and difficult to recognize due to undeveloped secondary apertures (Premoli Silva *et al.*, 2006), the LO of this species allows the closest approximation of the Oligocene/Eocene boundary at southern high latitudes (Thissen & Pérez Panera, 2020b).
Occurrence. Middle Eocene–late Eocene (North well).

Globigerinatheka spp.

Remarks. Specimens compiled under this denomination probably belong to *Globigerinatheka index* (Finlay, 1939), but are very poorly preserved and therefore remain unspecified. However, its classification under this genus still gives them stratigraphic value as markers of the middle–late Eocene.
Occurrence. Middle Eocene–late Eocene (West and East wells).

Family TRUNCOROTALOIDIDAE Loeblich & Tappan, 1961

Genus ***Acarinina*** Subbotina, 1953

Type species. *Acarinina acarinata* Subbotina, 1953. Paleocene–Oligocene; cosmopolitan.

Acarinina collactea (Finlay, 1939)
Figure 1.18

1939 *Globorotalia collactea* – Finlay, p. 327, pl. 29, figs. 164–165.
1971 *Globigerina collactea* (Finlay) – Postuma, p. 146–147.
2006 *Acarinina collactea* (Finlay) – Berggren *et al.*, p. 276, pl. 9.8, figs. 1–16.
2018 *Acarinina collactea* (Finlay) – Wade & Kucenjak, p. 395, pl. 13.1, figs. 1–16.

Remarks. Although registered from sediments as young as the uppermost Oligocene (Wade & Kucenjak, 2018), this species is restricted to the early–middle Eocene in the Magallanes Basin.

Occurrence. Early Eocene–middle Eocene (West and East wells), middle Eocene (North well).

Acarinina primitiva (Finlay, 1947)
Figure 1.19

1947 *Globoquadrina primitiva* – Finlay, p. 291, pl. 8, figs. 129-134.
1971 *Globigerina primitiva* (Finlay) – Postuma, p. 154–155.
2006 *Acarinina primitiva* (Finlay) – Berggren *et al.*, p. 302, pl. 9.17, figs. 1–16.

Remarks. Common species of southern high latitudes (Berggren *et al.*, 2006). When the LO of this species is considered reliable or confirmed by accompanying nannofossils, it can serve as a useful marker of the middle/late Eocene boundary.

Occurrence. Middle Eocene (North and East wells).

Acarinina spp.

Occurrence. Early Eocene (East well).

Superfamily GLOBOROTALIOIDEA Cushman, 1927
Family GLOBOROTALIIDAE Cushman, 1927

Genus ***Globorotalia*** Cushman, 1927

Type species. *Pulvinulina menardii* var. *tumida* Brady, 1877. Miocene–Holocene; cosmopolitan.

Globorotalia spp.

Occurrence. Early Miocene (West well).

Superfamily BULIMINOIDEA Jones, 1875
Family BULIMINIDAE Jones, 1875

Genus ***Bulimina*** d'Orbigny, 1826

Type species. *Bulimina marginata* d'Orbigny, 1826. Late Cretaceous–Holocene; cosmopolitan.

Bulimina alsatica Cushman & Parker, 1937
Figure 1.20

1937 *Bulimina alsatica* – Cushman & Parker, p. 39, pl. 4, figs. 6–7.
1952 *Bulimina alsatica* Cushman & Parker – Todd & Kniker, p. 22, pl. 4, fig. 3.
1990a *Bulimina alsatica* Cushman & Parker – Malumián, p. 355, pl. 3, fig. 3.

Occurrence. Late Eocene–early Oligocene (West well), middle Eocene–late Eocene (North well).

Bulimina cf. ***asperoaculeata*** Brotzen, 1948

cf. 1948 *Bulimina aspero-aculeata* – Brotzen, p. 60, pl. 6, fig. 4, pl. 10, figs. 6–7.

Remarks. Only one very small specimen was recovered, which however shows the typical costae on the early chambers.

Occurrence. Middle Eocene (West well).

Bulimina inflata Seguenza, 1862

1862 *Bulimina inflata* – Seguenza, p. 109, pl. 1, fig. 10.
2008 *Bulimina inflata* Seguenza – Scarpa & Malumián, p. 6, fig. 4.20.

Occurrence. Early Oligocene (West well).

Bulimina spp.

Occurrence. Early Eocene–late Eocene (West), middle Eocene–early Oligocene (North well).

Genus ***Protoglobobulimina*** Hofker, 1951

Type species. *Bulimina pupoides* d'Orbigny, 1846. Paleocene–Holocene; cosmopolitan.

Protoglobobulimina pupoides (d'Orbigny, 1846)

1846 *Bulimina pupoides* – d'Orbigny, p. 185, pl. 11, figs. 11–12.
1952 *Bulimina pupoides* d'Orbigny – Todd & Kniker, p. 19, pl.

4, figs. 1–2.
1974 *Praeglobobulimina pupoides* (d'Orbigny) – Cañón & Ernst, p. 77, pl. 2, figs. 14a–b.
2008 *Globobulimina pupoides* (d'Orbigny) – Scarpa & Malumián, p. 8, fig. 4.14.
2013 *Protoglobobulimina pupoides* (d'Orbigny) – Finger, p. 445, pl. 17, fig. 2.

Occurrence. Early Eocene–early Miocene (West and East wells), middle Eocene–early Miocene (North well).

Superfamily CASSIDULINOIDEA d'Orbigny, 1839

Family BOLIVINITIDAE Cushman, 1927

Subfamily FURSENKOININAE Loeblich & Tappan, 1961

Genus ***Fursenkoina*** Loeblich & Tappan, 1961

Type species. *Virgulina squamosa* d'Orbigny in Deshayes, 1832. Late Cretaceous–Holocene; cosmopolitan.

Fursenkoina bradyi (Cushman, 1922a)

1922a *Virgulina bradyi* – Cushman, p. 115, pl. 24, fig. 1.
2013 *Fursenkoina bradyi* (Cushman) – Holbourn *et al.*, p. 256.

Occurrence. Early Miocene (West well).

Fursenkoina pontoni (Cushman, 1932)

1932 *Virgulina pontoni* – Cushman, p. 17, pl. 3, fig. 7.
1964 *Fursenkoina pontoni* (Cushman) – Akers & Dorman, p. 35, pl. 8, fig. 32.

Occurrence. Early Miocene (West well).

Family CASSIDULINIDAE d'Orbigny, 1839

Subfamily CASSIDULININAE d'Orbigny, 1839

Genus ***Globocassidulina*** Voloshinova, 1960

Type species. *Cassidulina subglobosa* Brady, 1881. Eocene–Holocene; cosmopolitan.

Globocassidulina subglobosa (Brady, 1881)

Figure 2.1

1881 *Cassidulina subglobosa* – Brady, p. 60.
1980 *Globocassidulina subglobosa* (Brady) – Bertels, p. 242, pl. 7, fig. 1.
1994 *Globocassidulina subglobosa* (Brady) – Jones, p. 60, pl. 54, figs. 17a-c.
2005 *Globocassidulina subglobosa* (Brady) – Malumián & Scarpa, p. 375, fig. 3.N.
2008 *Globocassidulina subglobosa* (Brady) – Scarpa & Malumián, p. 8, fig. 4.8.

Occurrence. Early Miocene (West, North, and East wells).

Family GLOBOBULIMINIDAE Hofker, 1956

Genus ***Globobulimina*** Cushman, 1927

Type species. *Globobulimina pacifica* Cushman, 1927. Paleocene–Holocene; cosmopolitan.

Globobulimina pacifica Cushman, 1927

1927 *Globobulimina pacifica* – Cushman, p. 67, pl. 14, fig. 12.
1987 *Globobulimina pacifica* Cushman – Loeblich & Tappan, p. 521, pl. 571, figs. 4–12, 17–19.

Occurrence. Middle Eocene–early Miocene (West well), early Miocene (North and East wells).

Globobulimina sp. A

Figure 2.2

2013 *Globobulimina pacifica* Cushman – Finger, p. 444, pl. 16, figs. 21–22.

Remarks. Differs from *Globobulimina pacifica* Cushman, 1927, in the less embracing ultimate chambers, similar to the specimens depicted by Finger (2013). This distinction appears clear enough to classify this taxon as a separate species from *G. pacifica* or as a subspecies of the latter.

Occurrence. Late Oligocene–early Miocene (West well).

Globobulimina spp.

Occurrence. Middle Eocene–late Oligocene (East well).

Family SPHAEROIDINIDAE Cushman, 1927

Genus ***Sphaeroidina*** d'Orbigny, 1826

Type species. *Sphaeroidina bulloides* d'Orbigny, 1826. Eocene–Holocene; cosmopolitan.

Sphaeroidina bulloides d'Orbigny, 1826

Figure 2.3

1826 *Sphaeroidina bulloides* – d'Orbigny, p. 267, pl. 2, fig. 58.
1974 *Sphaeroidina bulloides* d'Orbigny – Cañón & Ernst, p. 75, pl. 2, figs. 9a–b.
1980 *Sphaeroidina bulloides* d'Orbigny – Bertels, p. 233, pl. 3, fig. 7.
2011 *Sphaeroidina bulloides* d'Orbigny – Marchant, p. 13, fig. 2.19.
2013 *Sphaeroidina bulloides* d'Orbigny – Finger, p. 454, pl. 19, fig. 8.

Occurrence. Early Oligocene–late Oligocene (West well), early Miocene (North well), early Oligocene (East well).

Family UVIGERINIDAE Haeckel, 1894
Subfamily ANGULOGERININAE Galloway, 1933

Genus ***Trifarina*** Cushman, 1923

Type species. *Trifarina bradyi* Cushman, 1923. Paleocene–Holocene; cosmopolitan.

Trifarina angulosa fueguina
Malumián, 1982

1974 *Trifarina angulosa* (Williamson) – Cañón & Ernst, p. 77, pl. 2, figs. 16a–b.
1982 *Trifarina angulosa fueguina* – Malumián, p. 63, pl. 6, figs. 4–6.
1991 *Trifarina angulosa* (Williamson) – Hromic, p. 107, pl. 1, figs. 5a–b.

Occurrence. Early Miocene (North well).

Trifarina sp.

Occurrence. Early Miocene (West well).

Subfamily UVIGERININAE Haeckel, 1894

Genus ***Neouvigerina*** Thalmann, 1952

Type species. *Uvigerina asperula* var. *ampullacea* Brady, 1884. Oligocene–Holocene; cosmopolitan.

Neouvigerina cf. ***hispida*** (Schwager, 1866)

cf. 1866 *Uvigerina hispida* – Schwager, p. 249, pl. 7, fig. 95.
cf. 1984 *Uvigerina hispida* Schwager – Lamb & Miller, p. 3, pls. 1–3.
cf. 2012 *Neouvigerina hispida* (Schwager) – Debenay, p. 181, p. 303.
cf. 2013 *Neouvigerina hispida* (Schwager) – Finger, p. 448, pl. 17, figs. 8–9.
cf. 2013 *Uvigerina hispida* Schwager – Holbourn *et al.*, p. 592.
cf. 2013 *Siphouvigerina hispida* (Schwager) – Patarroyo & Martínez, p. 41.

Remarks. Only a few broken specimens were recovered. This species is here placed under *Neouvigerina* Thalmann, 1952, despite being considered a synonym of *Siphouvigerina* Parr, 1950 by some authors (see Loeblich & Tappan, 1964; Hayward *et al.*, 2020). However, *Neouvigerina* differs from *Siphouvigerina* in possessing inflated instead of umbrella-like chambers and a hispid instead of a smooth surface (Loeblich & Tappan, 1987), and therefore should be considered a valid genus (see also Schweizer, 2006).

Occurrence. Early Miocene (East well).

Neouvigerina proboscidea (Schwager, 1866)

1866 *Uvigerina proboscidea* – Schwager, p. 250, pl. 7, fig. 96.
1984 *Uvigerina proboscidea* Schwager – Lamb & Miller, p. 3, pls. 5–6.
2012 *Neouvigerina proboscidea* (Schwager) – Debenay, p. 181, p. 303.
2013 *Uvigerina proboscidea* Schwager – Holbourn *et al.*, p. 602.
2013 *Siphouvigerina proboscidea* (Schwager) – Patarroyo & Martínez, p. 41.

Remarks. Like its sister taxon described above, this species is here placed under *Neouvigerina* Thalmann, 1952, following the validation by Loeblich & Tappan (1987) as a separate genus from *Siphouvigerina* Parr, 1950 (see also Schweizer, 2006).

Occurrence. Middle Eocene (East well).

Genus ***Uvigerina*** d'Orbigny, 1826

Type species. *Uvigerina pygmaea* d'Orbigny, 1826. Eocene–Holocene; cosmopolitan.

Uvigerina canariensis d'Orbigny, 1839

1839 *Uvigerina canariensis* – d'Orbigny, p. 138, pl. 1, figs. 25–27.
1960 *Uvigerina canariensis* d'Orbigny – Jones, p. 85, pl. 74, figs. 1–3.

Occurrence. Early Miocene (West well).

Uvigerina gallowayi Cushman, 1929
Figure 2.4

1929 *Uvigerina gallowayi* – Cushman, p. 94, pl. 13, figs. 33–34.
1984 *Uvigerina gallowayi* Cushman – Lamb & Miller, p. 12, pl. 35.
2013 *Neouvigerina gallowayi* Cushman – Finger, p. 448, pl. 17, fig. 10.

Occurrence. Early Oligocene (West well).

Uvigerina miozea Finlay, 1939

1939 *Uvigerina miozea* – Finlay, p. 102, pl. 12, figs. 12–14.

Occurrence. Early Oligocene (West well), middle Eocene (North well).

Uvigerina peregrina Cushman, 1923
Figure 2.5

1923 *Uvigerina peregrina* – Cushman, p. 166, pl. 42, figs. 7–10.
1984 *Uvigerina peregrina* Cushman – Lamb & Miller, p. 6, pls. 8–9.
2013 *Uvigerina peregrina* Cushman – Finger, p. 449, pl. 17, fig. 15.

Occurrence. Early Oligocene–early Miocene (West well), late Eocene (North well), middle Eocene–early Miocene (East well).

Uvigerina schwageri Brady, 1884

1884 *Uvigerina schwageri* – Brady, p. 575, pl. 74, figs. 8–10.
1984 *Uvigerina schwageri* Brady – Lamb & Miller, p. 12, pl. 36.
2013 *Neouvigerina schwageri* Brady – Finger, p. 448, pl. 17, fig. 11.

Occurrence. Early Oligocene (West and East wells).

Uvigerina spp.

Occurrence. Early Oligocene (West well), late Eocene–early Miocene (East well).

Superfamily VIRGULINELLOIDEA Loeblich & Tappan, 1984
Family VIRGULINELLIDAE Loeblich & Tappan, 1984

Genus ***Virgulinella*** Cushman, 1932

Type species. *Virgulina pertusa* Reuss, 1861. Eocene–Holocene; cosmopolitan.

Virgulinella severini Cañón & Ernst, 1974
Figure 2.6

1974 *Virgulinella severini* – Cañón & Ernst, p. 85, pl. 4, figs. 9a–b.
1990a *Kolesnikovella severini* (Cañón & Ernst) – Malumián, p. 356, pl. 3, fig. 5.
1990b *Kolesnikovella severini* (Cañón & Ernst) – Malumián, p. 381, pl. 1, fig. 17.
2011 *Kolesnikovella severini* (Cañón & Ernst) – Marchant, p. 12, fig. 2.13.

Remarks. According to Malumián *et al.* (2013), this species disappears together with *Globigerinatheka index* (Finlay, 1939) during the late Eocene from the Argentinian part of the basin. However, in wells from the Chilean sector, its LO is always slightly above that of the planktic species, and co-occurring nannofossils like *Reticulofenestra oamaruensis* (Deflandre, 1954) suggest a species range that extends into the earliest Oligocene (Thissen & Pérez Panera, 2020b).

Occurrence. Late Eocene–early Oligocene (West, North, and East wells).

Superfamily PLEUROSTOMELLOIDEA Reuss, 1860
Family ELLIPSOIDINIDAE Silvestri, 1923

Genus ***Ellipsoglandulina*** Silvestri, 1900

Type species. *Ellipsoglandulina laevigata* Silvestri, 1900. Late Cretaceous–Holocene; cosmopolitan.

Ellipsoglandulina spp.

Occurrence. Middle Eocene (West and East wells).

Family PLEUROSTOMELLIDAE Reuss, 1860

Genus ***Pleurostomella*** Reuss, 1860

Type species. *Dentalina subnodosa* Reuss, 1851. Early Cretaceous–Holocene; cosmopolitan.

Pleurostomella acuta Hantken, 1875

1875 *Pleurostomella acuta* – Hantken, p. 44, pl. 13, fig. 18.

1952 *Pleurostomella aguafrescaensis* – Todd & Kniker, p. 23, pl. 4, fig. 17.
2012 *Pleurostomella acuta* Hantken – Hayward *et al.*, p. 227, pl. 35, figs. 9–18.

Remarks. Hayward *et al.* (2012) compared the holotypes of *Pleurostomella acuta* Hantken, 1875, and *Pleurostomella aguafrescaensis* Todd & Kniker, 1952, and considered them synonymous, with *P. aguafrescaensis* displaying an aberrant and smaller final chamber.

Occurrence. Early Eocene–early Oligocene (West well), middle Eocene (North well).

Pleurostomella spp.

Occurrence. Early Eocene (North and East wells).

Superfamily DISCORBOIDEA Ehrenberg, 1838
Family CANCRISIDAE Chapman, Parr & Collins, 1934

Genus ***Gyroidinoides*** Brotzen, 1942

Type species. *Rotalina nitida* Reuss, 1850. Late Cretaceous–Holocene; cosmopolitan.

Gyroidinoides zelandica (Finlay, 1939)
Figure 2.7

1939 *Gyroidina zelandica* – Finlay, p. 323, pl. 28 figs. 138–140.
1961 *Gyroidinoides zelandica* (Finlay) – Hornibrook, p. 113, pl. 16, figs. 339, 344.
1982 *Gyroidinoides zelandicus* (Finlay) – Malumián, p. 58, pl. 5, figs. 1–2.
1990b *Gyroidinoides* ex gr. *G. zelandicus* (Finlay) – Malumián, p. 381, pl. 2, fig. 13.

Occurrence. Early Eocene–early Oligocene (West well), early Eocene–early Miocene (North well), middle Eocene (East well).

Gyroidinoides spp.

Occurrence. Early Eocene–early Oligocene (West well), early Eocene–Middle Eocene (East well).

Genus ***Valvulineria*** Cushman, 1926

Type species. *Valvulineria californica* Cushman, 1926. Cretaceous–Holocene; cosmopolitan.

Valvulineria miocenica Cushman, 1926

1926 *Valvulineria miocenica* – Cushman, p. 61, pl. 8, figs. 9–10., pl. 9, fig. 3.
1992 *Valvulineria miocenica* Cushman – Finger, p. 85, pl. 26, figs. 1–9, 19–30.

Occurrence. Early Miocene (East well).

Valvulineria spp.

Occurrence. Early Oligocene (West well).

Family DISCORBIDAE Ehrenberg, 1838

Genus ***Discorbis*** Lamarck, 1804

Type species. *Discorbites vesicularis* Lamarck, 1804. Eocene–Holocene; cosmopolitan.

Discorbis sp.

Occurrence. Late Oligocene (West well).

Family EPONIDIDAE Hofker, 1951
Subfamily EPONIDINAE Hofker, 1951

Genus ***Eponides*** Montfort, 1808

Type species. *Nautilus repandus* Fichtel & Moll, 1798. Eocene–Holocene; cosmopolitan.

Eponides duprei Cushman & Schenck, 1928

1928 *Eponides duprei* – Cushman & Schenck, p. 313, p. 44, fig. 8.
1952 *Eponides duprei* Cushman & Schenck – Todd & Kniker, p. 24, pl. 4, fig. 24.

Occurrence. Early Oligocene (West well).

Superfamily PLANORBULINOIDEA Schwager, 1877
Family CIBICIDIDAE Cushman, 1927

Genus ***Cibicides*** Montfort, 1808

Type species. *Cibicides refulgens* Montfort, 1808. Paleocene–Holocene; cosmopolitan.

Cibicides cf. ***parki*** Finlay, 1939

cf. 1939 *Cibicides parki* – Finlay, p. 528, pl. 69, fig. 1a–b.
cf. 1952 *Cibicides parki* Finlay – Todd & Kniker, p. 27, pl. 4, fig. 41.

Remarks. Only a few broken specimens were recovered, which however presented a similar chamber arrangement as depicted by Finlay (1939).

Occurrence. Middle Eocene (East well).

Cibicides vortex Dorreen, 1948

1948 *Cibicides vortex* – Dorreen, p. 299, pl. 41, fig. 5.
1961 *Cibicides vortex* Dorreen – Hornibrook, p. 160, pl. 24, figs. 490–492.

Occurrence. Middle Eocene (East well).

Cibicides spp.

Occurrence. Early Eocene–early Miocene (West and East wells), late Eocene–early Miocene (North well).

Genus ***Cibicidoides*** Thalmann, 1939

Type species. *Truncatulina mundula* Brady *et al.*, 1888. Paleocene–Holocene; cosmopolitan.

Cibicidoides pseudoungeriana (Cushman, 1922b)

1922b *Truncatulina pseudoungeriana* – Cushman, p. 97, pl. 20, fig. 9.
1952 *Cibicides* sp. cf. *C. pseudoungerianus* (Cushman) – Todd & Kniker, p. 28, pl. 4, fig. 36.
1972 *Cibicidoides pseudoungeriana* (Cushman) – Berggren, p. 974, pl. 7, figs. 1–4.
1980 *Cibicides pseudoungerianus* (Cushman) – Bertels, p. 6, figs. 2a–c.

Occurrence. Middle Eocene–early Oligocene (West well).

Cibicidoides wuellerstorfi (Schwager, 1866)
Figure 2.8

1866 *Anomalina wüllerstofi* – Schwager, p. 258, pl. 7, figs 105, 107.
1987 *Fontbotia wuellerstorfi* (Schwager) – Loeblich & Tappan, p. 583, pl. 634, figs. 10–12; pl. 635, figs. 1-3.
2009 *Cibicidoides wuellerstorfi* (Schwager) – Schweizer *et al.*, p. 311, fig. 1.q.

Occurrence. Middle Eocene (West and East wells).

Cibicidoides spp.

Occurrence. Early Eocene–middle Eocene (West well), middle Eocene–early Miocene (North well), middle Eocene–late Eocene (East well).

Genus ***Heterolepa*** Franzenau, 1884

Type species. *Heterolepa simplex* Franzenau, 1884. Late Cretaceous–Holocene; cosmopolitan.

Heterolepa perlucida (Nuttall, 1932)
Figure 2.9

1932 *Cibicides perlucida* – Nuttall, p. 33, pl. 8, figs. 10–12.
1952 *Cibicides perlucidus* Nuttall – Todd & Kniker, p. 27, pl. 4, fig. 40.
1983 *Cibicidoides perlucidus* Nuttall – Basov & Krasheninnikov, p. 765, pl. 14, figs. 4–5.
1990b *Heterolepa perlucida* (Nuttall) – Malumián, p. 381, pl. 2, figs. 8–9.

Remarks. This species was originally described as *Cibicides perlucidus* Nuttall, 1932, and is apparently still accepted under this genus (see Hayward *et al.*, 2020). However, it is here listed under *Heterolepa* due to its convex spiral side and the equally coarse perforation on both sides.

Occurrence. Middle Eocene–late Eocene (West well), early Eocene (North well), middle Eocene (East well).

Superfamily CHILOSTOMELLOIDEA Brady, 1881
Family CHILOSTOMELLIDAE Brady, 1881
Subfamily CHILOSTOMELLINAE Brady, 1881

Genus ***Allomorphina*** Reuss in Cžjžek, 1849

Type species. *Allomorphina trigona* Reuss, 1850. Late Cretaceous–Holocene; cosmopolitan.

Allomorphina conica
Cushman & Todd, 1949

1949 *Allomorphina conica* – Cushman & Todd, p. 62, pl. 11, fig. 8.
1952 *Allomorphina conica* Cushman & Todd – Todd & Kniker, p. 25, pl. 4, fig. 33.
1974 *Allomorphina conica* Cushman & Todd – Cañón & Ernst, p. 85, pl. 4, figs. 11a–b.

2011 *Allomorphina conica* Cushman & Todd – Marchant, p. 10, fig. 2.7.

Occurrence. Middle Eocene (West and East wells).

Allomorphina macrostoma Karrer, 1862

1952 *Allomorphina macrostoma* Karrer – Todd & Kniker, p. 25, pl. 4, fig. 25.

Occurrence. Middle Eocene (East well).

Genus ***Chilostomella*** Reuss in Cžjžek, 1849

Type species. *Chilostomella ovoidea* Reuss, 1850. Late Cretaceous–Holocene; cosmopolitan.

Chilostomella cylindroides Reuss, 1851
Figure 2.10

1851 *Chilostomella cylindroides* – Reuss, p. 80, pl. 6, fig. 43.
1952 *Chilostomella cylindroides* Reuss – Todd & Kniker, p. 25, pl. 4, fig. 26–27.
2011 *Chilostomella cylindroides* Reuss – Marchant, p. 10, fig. 2.10.

Occurrence. Early Eocene (West, North, and East wells).

Family QUADRIMORPHINIDAE Saidova, 1981

Genus ***Quadrimorphina*** Finlay, 1939

Type species. *Valvulina allomorphinoides* Reuss, 1860. Late Cretaceous–Holocene; cosmopolitan.

Quadrimorphina advena (Cushman & Siegfus, 1939)

1939 *Valvulineria advena* – Cushman & Siegfus, p. 31, pl. 6, fig. 22.
1949 *Quadrimorphina advena* (Cushman & Siegfus) – Cushman & Todd, p. 71, pl. 12, fig. 13.
1952 *Quadrimorphina advena* (Cushman & Siegfus) – Todd & Kniker, p. 25, pl. 4, fig. 19.

Remarks. This species was originally described as *Valvulineria advena* Cushman & Siegfus, 1939, but was later reassigned to the genus *Quadrimorphina* by Cushman & Todd (1949) due to its open umbilicus and the narrow, overhanging lip.

Occurrence. Early Eocene–middle Eocene (North well).

Quadrimorphina allomorphinoides (Reuss, 1860)

1860 *Valvulina allomorphinoides* – Reuss, p. 223, pl. 11, fig. 6.
1987 *Quadrimorphina allomorphinoides* (Reuss) – Loeblich & Tappan, p. 627, pl. 705, figs. 6–9.

Occurrence. Early Eocene (West well), middle Eocene (East well).

Family ALABAMINIDAE Hofker, 1951

Genus ***Alabamina*** Toulmin, 1941

Type species. *Alabamina wilcoxensis* Toulmin, 1941. Late Cretaceous–Holocene; cosmopolitan.

Alabamina atlantisae (Cushman, 1939)

1939 *Pulvinulinella atlantisae* – Cushman, p. 72, pl. 12, fig. 16.
1952 *Alabamina atlantisae* (Cushman) – Todd & Kniker, p. 24, pl. 4, fig. 21.
1990b *Alabamina atlantisae* (Cushman) – Malumián, p. 374, pl. 2, fig. 1.
1980 *Epistominella atlantisae* (Cushman) – Bertels, p. 237, pl. 4, fig. 6.

Remarks. This species was originally described as *Pulvinulinella atlantisae* Cushman, 1939, under a genus now accepted as *Pseudoparrella* Cushman & Ten Dam, 1948 (see Hayward *et al.*, 2020). However, due to its aperture forming an elongate slit at the base of the final chamber within the excavated and folded apertural face, as described by Todd & Kniker (1952), it must be placed under the genus *Alabamina*.

Occurrence. Middle Eocene (East well).

Alabamina spp.

Occurrence. Early Oligocene–late Oligocene (West well), early Miocene (East well).

Genus ***Oridorsalis*** Andersen, 1961

Type species. *Oridorsalis westi* Andersen, 1961. Eocene–Holocene; cosmopolitan.

Oridorsalis umbonatus (Reuss, 1851)
Figure 2.11

1851 *Rotalina umbonata* – Reuss, p. 75, pl. 5, fig. 35.

2008 *Oridorsalis umbonatus* (Reuss) – Scarpa & Malumián, p. 8, fig. 5.10.

Occurrence. Early Eocene–early Oligocene (West well), middle Eocene–early Oligocene (North well), middle Eocene (East well).

Oridorsalis spp.

Occurrence. Late Oligocene (East well).

Family ANOMALINIDAE Cushman, 1927

Genus ***Anomalina*** d'Orbigny, 1826

Type species. *Anomalina ariminensis* d'Orbigny in Fornasini, 1902. Cretaceous–Holocene; cosmopolitan.

Anomalina chileana Todd & Kniker, 1952

1952 *Anomalina chileana* – Todd & Kniker, p. 26, pl. 4, fig. 34.

Occurrence. Middle Eocene (East well).

Anomalina parvula Grzybowski, 1896

1896 *Anomalina parvula* – Grzybowski, p. 302, pl. 11, figs. 6a–b.
1941 *Anomalina pompiloides* – Galloway & Heminway, p. 389, pl. 22, fig. 3

Occurrence. Early Oligocene (East well).

Genus ***Anomalinoides*** Brotzen, 1942

Type species. *Anomalinoides plummerae* Brotzen, 1942. Early Cretaceous–Holocene; cosmopolitan.

Anomalinoides danicus (Brotzen, 1940)

1940 *Cibicides danicus* – Brotzen, p. 25, text-fig. 2.
1948 *Anomalinoides danica* – Brotzen, p. 87, pl. 14, fig. 1.

Occurrence. Early Eocene (East well).

Anomalinoides orbiculus (Stache, 1864)
Figure 2.12

1864 *Rosalina orbiculus* – Stache, p. 285, pl. 24, fig. 34.
1971 *Anomalinoides orbiculus* (Stache) – Hornibrook, p. 51, pl. 1, figs. 191–193.
1990b *Anomalinoides orbiculus* (Stache) – Malumián, p. 376, pl. 2, fig. 2.

Occurrence. Early Eocene–early Miocene (West well), middle Eocene–early Miocene (East well).

Anomalinoides pinguiglaber (Finlay, 1940)
Figure 2.13

1961 *Anomalinoides pinguiglabra* (Finlay) – Hornibrook, p. 156, pl. 23, figs. 464–466.
2011 *Epistomaroides pinguiglabra* (Finlay) – Marchant, p. 13, fig. 2.16.

Occurrence. Middle Eocene (West and North wells), early Eocene–middle Eocene (East well).

Anomalinoides spp.

Occurrence. Middle Eocene–early Miocene (West well), early Eocene–late Eocene (East well).

Family GAVELINELLIDAE Hofker, 1956
Subfamily GAVELINELLINAE Hofker, 1956

Genus ***Gyroidina*** d'Orbigny, 1826

Type species. *Gyroidina orbicularis* d'Orbigny, 1826. Cretaceous–Holocene; cosmopolitan.

Gyroidina spp.

Occurrence. Middle Eocene–early Miocene (East well).

Genus ***Hansenisca*** Loeblich & Tappan, 1987

Type species. *Gyroidina soldanii* d'Orbigny, 1826. Oligocene–Holocene; cosmopolitan.

Hansenisca soldanii (d'Orbigny, 1826)
Figure 2.14

1826 *Gyroidina soldanii* – d'Orbigny, p. 278.
1952 *Gyroidina soldanii* d'Orbigny – Todd & Kniker, p. 24, pl. 4, fig. 20.
1974 *Gyroidina soldanii* d'Orbigny – Cañón & Ernst, p. 87, pl. 5, figs. 4a–c.
1987 *Hansenisca soldanii* (d'Orbingy) – Loeblich & Tappan,

p. 639, pl. 719, figs. 5–9.
2005 *Gyroidinoides soldanii* (d'Orbigny) – Malumián & Scarpa, p. 375, figs. 4.M, N.
2013 *Hansenisca soldanii* (d'Orbingy) – Finger, p. 469, pl. 23, fig. 11.

Occurrence. Early Miocene (West, North, and East wells).

Subfamily GYROIDINOIDINAE Saidova, 1981

Genus ***Rotaliatina*** Cushman, 1925b

Type species. *Rotaliatina mexicana* Cushman, 1925b. Eocene–Oligocene; cosmopolitan.

Rotaliatina mexicana Cushman, 1925b

1925b *Rotaliatina mexicana* **–** Cushman, p. 4, pl. 1, fig. 1.
1987 *Rotaliatina mexicana* Cushman – Loeblich & Tappan, p. 634, pl. 715, figs. 1–3.

Occurrence. Middle Eocene (West well).

Family TRICHOHYALIDAE Saidova, 1981

Genus ***Buccella*** Andersen, 1952

Type species. *Eponides hannai* Phleger & Parker, 1951. Oligocene–Holocene; cosmopolitan.

Buccella peruviana (d'Orbigny, 1839)
Figure 2.15

1839 *Rotalina peruviana* – d'Orbigny, p. 35, pl. 2, figs. 3–5.
1980 *Buccella peruviana* (d'Orbigny) – Boltovskoy *et al.*, p. 19, pl. 4, figs. 5–22.
2005 *Buccella peruviana* (d'Orbigny) – Malumián & Scarpa, p. 374, fig. 4.F.
2013 *Buccella peruviana* (d'Orbigny) – Finger, p. 470, pl. 24, figs. 4–5.

Occurrence. Early Miocene (West and North wells).

Buccella spp.

Occurrence. Early Miocene (North and East wells).

Superfamily NONIONOIDEA Schultze, 1854
Family ASTRONONIONIDAE Cushman & Edwards, 1937
Subfamily ASTRONONIONINAE Saidova, 1981

Genus ***Astrononion*** Cushman & Edwards, 1937

Type species. *Nonionina stelligera* d'Orbigny, 1839. Eocene–Holocene; cosmopolitan.

Astrononion echolsi Kennett, 1967
Figure 2.16

1967 *Astrononion echolsi* – Kennett, p. 134, pl. 11, figs. 7a–b, 8.
1980 *Astrononion echolsi* Kennett – Bertels, p. 243, pl. 7, figs. 5a–b, 6.
1982 *Astrononion echolsi* Kennett – Malumián, p. 47, pl. 3, figs. 6–8.
2005 *Astrononion echolsi* Kennett – Malumián & Scarpa, p. 374, fig. 4.S.

Occurrence. Early Miocene (West, North, and East wells).

Astrononion spp.

Occurrence. Early Oligocene–early Miocene (West), early Miocene (East).

Family MELONIDAE Holzmann & Pawlowski, 2017

Genus ***Melonis*** Montfort, 1808

Type species. *Melonis etruscus* Montfort, 1808. Eocene–Holocene; cosmopolitan.

Melonis pompilioides (Fichtel & Moll, 1798)

1798 *Nautilus pompilioides* – Fichtel & Moll, p. 31, pl. 2, figs. a–c.
1980 *Melonis pompilioides* (Fichtel & Moll) – Bertels, p. 251, pl. 10, figs. 5a–b.
1991 *Melonis pompilioides* (Fichtel & Moll) – Hromic, p. 105, pl. 1, fig. 2b.
2005 *Melonis pompilioides* (Fichtel & Moll) – Malumián & Scarpa, p. 375, fig. 4.O.
2008 *Melonis pompilioides* (Fichtel & Moll) – Scarpa & Malumián, p. 8, fig. 5.13.
2013 *Melonis pompilioides* (Fichtel & Moll) – Finger, p. 465, pl. 22, fig. 6.

Occurrence. Early Miocene (West and North wells).

Family NONIONIDAE Schultze, 1854
Subfamily NONIONINAE Schultze, 1854

Genus ***Nonion*** Montfort, 1808

Type species. *Nautilus faba* Fichtel & Moll, 1798. Late Cretaceous–Holocene; cosmopolitan.

Nonion boueanum (d'Orbigny, 1846)

1846 *Nonionina boueana* – d'Orbigny, p. 108, pl. 5, figs. 11–12.
1974 *Florilus* cf. *boueanus* (d'Orbigny) – Cañón & Ernst, p. 85, pl. 4, figs. 12a–b.
1991 *Nonion boueanum* (d'Orbigny) – Hromic, p. 107, pl. 2, fig. 3.
2005 *Nonion boueanum* (d'Orbigny) – Malumián & Scarpa, p. 376, fig. 4.C.

Remarks. Together with other nonionids representing the dominant morphogroup of the early Miocene in the Magallanes Basin (see also Natland & González, 1974).

Occurrence. Early Miocene (West well).

Nonion commune (d'Orbigny, 1846)

1846 *Nonionina communis* – d'Orbigny, p. 106, pl. 5, figs. 7–8.
1985 *Nonion commune* (d'Orbigny) – Papp & Schmid, p. 45, pl. 34, figs. 1–5.

Occurrence. Late Oligocene–early Miocene (West well).

Nonion deceptrix Hornibrook, 1961
Figure 2.17

1961 *Nonion deceptrix* – Hornibrook, p. 92, pl. 11, figs. 218–219.
1980 *Florilus deceptrix* Hornibrook – Bertels, p. 245, pl. 8, figs. 2a–b.
1982 *Florilus deceptrix* Hornibrook – Malumián, p. 55, pl. 4, fig. 10.

Remarks. Together with other nonionids representing the dominant morphogroup of the early Miocene in the Magallanes Basin (see also Natland & González, 1974).

Occurrence. Early Miocene (West, North, and East wells).

Nonion spp.

Occurrence. Early Oligocene–early Miocene (West well).

Genus ***Nonionella*** Cushman, 1926

Type species. *Nonionella miocenica* Cushman, 1926. Late Cretaceous–Holocene; cosmopolitan.

Nonionella auris (d'Orbigny, 1839)
Figure 2.18

1839 *Valvulina auris* – d'Orbigny, p. 47, pl. 2, figs. 15–17.
1974 *Nonionella auris* (d'Orbigny) – Cañón & Ernst, p. 86, pl. 4, figs. 14a–c.
1991 *Nonionella auris* (d'Orbigny) – Hromic, p. 107, pl. 2, figs. 1a–c.
2011 *Nonionella auris* (d'Orbigny) – Marchant, p. 13, fig. 2.20.

Remarks. Together with other nonionids representing the dominant morphogroup of the early Miocene in the Magallanes Basin (see also Natland & González, 1974).

Occurrence. Early Miocene (West, North, and East wells).

Nonionella magnalingua Finlay, 1940

1940 *Nonionella magnalingua* – Finlay, p. 456, pl. 65, figs. 144, 146.
1980 *Nonionella magnalingua* Finlay – Bertels, p. 246, pl. 8, fig. 4.
1982 *Nonionella magnalingua* Finlay – Malumián, p. 60, pl. 5, fig. 7.

Occurrence. Early Miocene (West well).

Nonionella spp.

Occurrence. Early Miocene (West and North wells).

Family PULLENIIDAE Schwager, 1877
Subfamily PULLENIINAE Schwager, 1877

Genus ***Pullenia*** Parker & Jones in Carpenter *et al.*, 1862

Type species. *Nonionina bulloides* d'Orbigny, 1846. Late Cretaceous–Holocene; cosmopolitan.

Pullenia alazanensis Cushman, 1927

1927 *Pullenia alazanensis* – Cushman, p. 168, pl. 26, figs. 14–15.
1952 *Pullenia alazanensis* Cushman – Todd & Kniker, p. 26, pl. 4, fig. 30.
2011 *Pullenia alazanensis* Cushman – Marchant, p. 8, fig. 2.4.

Occurrence. Middle Eocene–early Oligocene (West well), middle Eocene (North and East wells).

Pullenia bulloides (d'Orbigny, 1846)
Figure 2.19

1846 *Nonionina bulloides* – d'Orbigny, p. 107, pl. 5, figs. 9–10.
1974 *Pullenia bulloides* (d'Orbigny) – Cañón & Ernst, p. 86, pl. 5, figs. 1a–b.
1980 *Pullenia bulloides* (d'Orbigny) – Bertels, p. 247, pl. 8, figs. 6a–b.
1982 *Pullenia bulloides* (d'Orbigny) – Malumián, p. 62, pl. 5, fig. 17.
2005 *Pullenia bulloides* (d'Orbigny) – Malumián & Scarpa, p. 376, fig. 4.L.
2011 *Pullenia bulloides* (d'Orbigny) – Marchant, p. 8, fig. 2.5.
2013 *Pullenia bulloides* (d'Orbigny) – Finger, p. 465, pl. 21, fig. 9.

Occurrence. Early Eocene–early Oligocene (West well), middle Eocene–late Eocene (North well), middle Eocene–early Miocene (East well).

Pullenia quinqueloba (Reuss, 1851)

1851 *Nonionina quinqueloba* – Reuss, p. 71, pl. 5, fig. 31.
1961 *Pullenia quinqueloba* (Reuss) – Hornibrook, p. 90, pl. 11, figs. 207–208.
1983 *Pullenia quinqueloba* (Reuss) – Basov & Krasheninnikov, p. 766, pl. 14, figs. 10–11.

Occurrence. Early Eocene (West well), early Eocene–middle Eocene (North well).

Pullenia spp.

Occurrence. Early Miocene (East well).

Superfamily ROTALIOIDEA Ehrenberg, 1839
Family ELPHIDIIDAE Galloway, 1933
Subfamily ELPHIDIINAE Galloway, 1933

Genus ***Elphidium*** Montfort, 1808

Type species. *Nautilus macellus* var. *beta* Fichtel & Moll, 1798. Eocene–Holocene; cosmopolitan.

Elphidium saginatum Finlay, 1939
Figure 2.20

1939 *Elphidium saginatum* – Finlay, p. 457.
1990a *Elphidium saginatum* Finlay – Malumián, p. 359, pl. 4, figs. 7–8.
2011 *Elphidium saginatum* Finlay – Marchant, p. 12, fig. 2.9.

Remarks. Typical and characteristic member of the Eocene assemblages from the Magallanes Basin. Easily identified by the circular depressions surrounding the umbilici.

Occurrence. Early Eocene–middle Eocene (West well), middle Eocene–late Eocene (North well), middle Eocene (East well).

Elphidium spp.

Occurrence. Early Eocene (East well).

Division HAPTOPHYTA Hibberd *ex* Edvardsen & Eikrem in Edvardsen *et al.,* 2000
Class COCCOLITHOPHYCEAE Rothmaler, 1951
Subclass PRYMNESIOPHYCIDAE Cavalier-Smith, 1986
"HETEROCOCCOLITHS"
Order ZYGODISCALES Young & Bown 1997
Family HELICOSPHAERACEAE Black, 1971

Genus ***Helicosphaera*** Kamptner, 1954

Type species. *Helicosphaera carteri* (Wallich, 1877) Kamptner, 1954. Early Miocene–Holocene; cosmopolitan.

Helicosphaera carteri (Wallich, 1877) Kamptner, 1954

1877 *Coccosphaera carterii* Wallich, p. 348.
1954 *Helicosphaera carterii* (Wallich) Kamptner, p. 21, text-figs. 17–19.
1967 *Helicosphaera kamptneri* Hay & Mohler in Hay *et al.,* 1967, p. 448, pls. 10–11, fig. 5.
1971 *Helicosphaera granulata* Bukry & Percival, p. 132, pl. 5, figs 1–2.
1977 *Helicosphaera colombiana* Gartner, p. 22, pl. 2, fig. 5 (a–c).
1984 *Helicosphaera acuta* Theodoridis, p. 119-120, pl. 18, figs. 9–11, pl. 25, fig. 8.
1984 *Helicosphaera paleocarteri* Theodoridis, p. 131, pl. 23, figs. 1–4, pl. 27, fig. 6.
2019 *Helicosphaera carteri* (Wallich) Kamptner – Bedoya Agudelo, p. 182–183, pl. 4.7, fig. d.

Remarks. *H. carteri* is a reliable marker of the Oligocene/Miocene boundary. Its FO has been used to identify the NN1 Biozone of Martini (1971) in other localities of the Austral Basin (Náñez & Pérez Panera, 2017), where $^{87}Sr/^{86}Sr$ datings support an Aquitanian age for the uppermost part of

the San Julián Formation and lowermost part of the Monte León Formation (Parras *et al.*, 2012, 2016, 2020). In this study, late Oligocene–early Miocene nannofossil assemblages are of low abundance, so it is hard to say if the FO in the succession corresponds to the true FO of the species, making it difficult to identify the Paleogene/Neogene boundary. However, its presence allows correlations with the Monte León, Irigoyen and Carmen Silva surface formations of the Magallanes Basin.
Occurrence. Early Miocene (West well).

Helicosphaera ethologa Bown, 2005

1996 *Helicosphaera* aff. *H. carteri* (Wallich, 1877) Kamptner 1954 – de Kaenel & Villa, p. 125, pl. 8, figs. 21–24; pl. 10, figs. 14–15.
1998 *Helcisopahera carteri* (Wallich) Kamptner – Vathi, pl. 1, figs. 1–19.
2005 *Helicosphaera ethologa* Bown, p. 31, pl. 13, figs. 16–22.
2013 *Helicosphaera ethologa* Bown – Pérez Panera, pl. 4, fig. 15.
2017 *Helicosphaera ethologa* Bown – Boesiger *et al.*, p. 149, pl. 1, figs. 21–24.

Remarks. This species is rare and was found only in the well West. However, this species has been reported only in the early Oligocene (*i.e.*, de Kaenel & Villa, 1996; Bown, 2005; Pérez Panera, 2013), and according to Boesiger *et al.* (2017) it is restricted to the NP23 Biozone; so, its presence is useful for biostratigraphic interpretations in the Magallanes Basin.
Occurrence. Early Oligocene (West well).

Helicosphaera lophota (Bramlette & Sullivan, 1961) Locker, 1973
Figure 4.1

1961 *Helicosphaera seminulum lophota* Bramlette & Sullivan, p. 144, pl. 4, figs. 3, a–b, 4.
1971 *Helicopontosphaera lophota* (Bramlette & Sullivan) Bukry *et al.*, p. 1300.
2013 *Helicosphaera lophota* Bramlette & Sullivan – Pérez Panera, p. 139.

Occurrence. Early–middle Eocene (North well).

Helicosphaera cf. ***vedderi*** Bukry, 1981

Occurrence. Late Oligocene–early Miocene (West well).

Family PONTOSPHAERACEAE Lemmermann, 1908

Genus ***Pontosphaera*** Lohmann, 1902

Type species. *Pontosphaera syracusana* Lohmann, 1902. Late Miocene–Holocene; cosmopolitan.

Pontosphaera discopora Schiller, 1925

1925 *Pontosphaera discopora* Schiller, p. 11, pl. 1, fig. 4
2019 *Pontosphaera discopora* Schiller – Bedoya Agudelo, p. 187, pl. 4.15, fig. k.

Occurrence. Late Oligocene–early Miocene (West well).

Pontosphaera multipora (Kamptner, 1948 *ex* Deflandre in Deflandre & Fert, 1954) Roth, 1970
Figure 4.2

1948 *Discolithus multiporus* Kamptner, p. 5, pl. 1, figs. 9 a–b.
1970 *Pontosphaera multipora* (Kamptner) Roth, p. 799–881.
2013 *Pontosphaera multipora* (Kamptner *ex* Deflandre in Deflandre & Fert) Roth – Pérez Panera, pl. 4, fig. 24.
2019 *Pontosphaera multipora* (Kamptner) Roth – Bedoya Agudelo, p. 189, pl. 4.5, fig. q, pl. 4.11, fig. s, pl. 4.13, fig. i, pl. 4.14, fig. f, pl. 4.15, fig. m.

Occurrence. Middle Eocene–early Miocene (West well), early Oligocene (North well), late Eocene–early Oligocene (East well).

Pontosphaera obliquipons (Deflandre in Deflandre & Fert, 1954) Romein, 1979

1954 *Discolithus obliquipons* Deflandre in Deflandre & Fert, p. 115–176.
1967 *Transversopontis parva* Locker, p. 761, pl. 1, fig. 1, pl. 2, figs. 1, 15.
1970 *Transversopontis latus* Müller, p. 117, pl. 1, figs. 1–3.
1979 *Pontosphaera obliquipons* (Deflandre in Deflandre & Fert, 1954) Romein, p. 231.
1991 *Transversopontis obliquipons* (Deflandre) Hay *et al.* – Concheyro, p. 394, pl. 2, fig. 7.
2019 *Pontospahera obliquipons* (Deflandre in Deflandre & Fert, 1954) Romein – Bedoya Agudelo, p. 189–190, pl. 4.5, fig. r, pl. 4.10, fig. q, non. pl. 4.11, fig. t, non. pl. 4.14, fig. g.

Occurrence. Late Eocene–early Oligocene (West well).

Pontosphaera plana (Bramlette & Sullivan, 1961) Haq, 1971

1961 *Discolithus planus* Bramlette & Sullivan, p. 143, pl. 3, figs. 7 a–c.
1967 *Discolithina ovata* Levin & Joerger, p. 167, pl. 2, figs. 6 a–d.
1971 *Pontosphaera plana* (Bramlette & Sullivan) Haq, p. 22, pl. 10, fig. 1, pl. 12, fig. 6.
2019 *Pontosphaera plana* (Bramlette & Sullivan) Haq – Bedoya Agudelo, p. 191–192.

Occurrence. Late Eocene–Oligocene (West well), early–middle Eocene (North well), middle Eocene (East well).

Pontosphaera pulchra (Deflandre in Deflandre & Fert, 1954) Romein, 1979
Figure 4.3

1954 *Discolithus pulcher* Deflandre in Deflandre & Fert, p. 142, pl. 12, figs. 17–18.
1979 *Pontosphaera pulchra* (Deflandre in Deflandre & Fert) Romein, p. 178, pl. 8, fig. 2.
1991 *Transversopontis pulcher* (Deflandre) Perch-Nielsen – Concheyro, p. 394-395, pl. 1, figs. 1, 2 a–b, pl. 2, fig. 8.
2009 *Pontosphaera pulchra* (Deflandre in Deflandre & Fert) Romein – Pérez Panera, pl. 3, fig. 16.
2019 *Pontosphaera pulchra* (Deflandre in Deflandre & Fert) Romein – Bedoya Agudelo, p. 192, pl. 4.2, fig. k, pl. 4.3, fig. l, pl. 4.9, fig. e, pl. 4.10, fig. r.

Remarks. This species is frequent in the Argentine offshore basins throughout the Eocene. In the Colorado Basin, its LO is in the latest Eocene (Pérez Panera *et al.*, 2019). In this study, it was continuously recorded throughout the Eocene in the three studied wells and its LO coincides with the LO of *Reticulofenestra reticulata,* a good marker for the late Eocene. The LO of *Pontosphaera pulchra* is here highlighted as a reliable secondary event to approximate the Eocene/Oligocene boundary in the Argentine offshore basins.

Occurrence. Middle Paleocene–late Eocene (West well), Eocene (North and East wells).

Pontosphaera pygmaea (Locker, 1967) Bystricka & Lehotayova, 1974
Figure 4.4

1967 *Discolithina pygmaea* Locker, 761, pl. 1, fig. 2, pl. 2, figs. 2–3.
1967 *Transveropontis zigzag* Roth & Hay, 1967 in Hay *et al.*, p. 450, pl. 7, fig. 4.
1984 *Transversopontis pygmaea* (Locker) Perch-Nielsen, p. 42.
2019 *Pontospahera obliquipons* (Deflandre in Deflandre & Fert, 1954) Romein – Bedoya Agudelo, pl. 4.11, fig. t, pl. 4.14, fig. g.

Occurrence. Eocene (West well), Eocene–Oligocene (North and East wells).

Pontosphaera sp.

Remarks. Unidentified species of *Pontosphaera* due to strong dissolution and/or overgrowth.

Occurrence. Early Oligocene (West well), late Eocene (East well).

Family ZYGODISCACEAE Hay & Mohler, 1967

Genus ***Isthmolithus***
Deflandre in Deflandre & Fert, 1954

Type species. *Isthmolithus recurvus* Deflandre in Deflandre & Fert,1954. Late Eocene–early Oligocene; cosmopolitan.

Isthmolithus recurvus Deflandre in Deflandre & Fert, 1954
Figure 4. 5–8

1954 *Isthmolithus recurvus* Deflandre in Deflandre & Fert, p. 169, pl. 12, figs. 9–13, text-figs. 119–122.
2019 *Isthmolithus recurvus* Deflandre in Deflandre & Fert – Bedoya Agudelo, p. 194, pl. 4.5, fig. o, pl. 4.11, fig. p, pl. 4.13, fig. h.

Remarks. This species is a good marker for the Eocene/Oligocene boundary in middle to high latitudes (Fioroni *et al.*, 2012). Agnini *et al.* (2014) proposed the First Common Occurrence of this species for correlation to the NP18 and base of NP19/NP20 biozones. Bedoya Agudelo (2019) found it to be useful for local correlation of biozones NP18 to NP19/20 (latest Eocene) in the Austral Basin. In this study, in the well West, we found the FO and LO of *Isthmolithus recurvus* together with other good high latitude marker species such as *Reticulofenestra reticulata*, *Reticulofenestra oamaruensis* and *Chiasmolithus oamaruensis.* In the other wells, it was only present in the earliest Oligocene (North) or absent (East). We believe both events, FO and LO, are useful for identification of the Eocene/Oligocene boundary in the Magallanes Basin, but the reliability of these events could be compromised by paleoenvironmental conditions.

Occurrence. Late Eocene–early Oligocene (West well), early Oligocene (North well).

Genus ***Neococcolithes*** Sujkowski, 1931

Type species. *Neococcolithes lososnensis* Sujkowski, 1931. Danian, Poland.

Neococcolithes minutus (Perch-Nielsen, 1967)
Perch-Nielsen, 1971a
Figure 4.9

1967 *Zygolithus minutus* Perch-Nielsen, p. 28, pl. 5, figs. 6–7.
1971a *Neococcolithes minutus* (Perch-Nielsen) Perch-Nielsen, p. 47, pl. 42, figs. 1–4.
2019 *Neococcolithes minutus* (Perch-Nielsen) Perch-Nielsen – Bedoya Agudelo, p. 197–198, pl. 4.3, fig. j, pl. 4.8, fig. w.

Occurrence. Early–middle Eocene (West, North, and East wells).

Neococcolithes protenus (Bramlette & Sullivan, 1961)
Black, 1967
Figure 4.10

1961 *Zygolithus protenus* Bramlette & Sullivan, p. 150, pl. 6, figs. 15 a–b.
1967 *Neococcolithes protenus* (Bramlette & Sullivan) Black, p. 143.
1967 *Neococcolithes protenus* (Bramlette & Sullivan) Hay & Molher, p. 1533, pl. 199, figs. 19–21, pl. 201, fig. 9.
2019 *Neococcolithes protenus* (Bramlette & Sullivan) Black – Bedoya Agudelo, p. 198.

Occurrence. Middle Paleocene–middle Eocene (West well), early–middle Eocene (North well).

Order RHABDOSPHAERALES Ostenfeld, 1899
Family RHABDOSPHAERACEAE Haeckel, 1894

Genus ***Blackites*** Hay & Towe, 1962 *emend.*
Stradner & Edwards, 1968

Type species. *Blackites spinosus* (Deflandre & Fert, 1954) Hay & Towe, 1962. Middle Eocene–early Oligocene; cosmopolitan.

Blackites dupuisii (Steurbaut, 1990)
Bown, 2005

1990 *Naninfula dupuisi* Steurbaut, p. 267, pl. 4, fig. 3.
2005 *Blackites dupuisii* (Steurbaut) Bown, p. 37, pl. 25, figs. 16–19.

Occurrence. Early–middle Eocene (West well).

Blackites inversus (Bukry & Bramlette, 1969)
Bown & Newsam, 2017

1969 *Triquetrorhabdulus inversus* Bukry & Bramlette, p.142, pl. 1, figs. 9–14.
1983 *Pseudotriquetrorhabdulus inversus* (Bukry & Bramlette) Wise & Constans in Wise, p. 505.
2017 *Blackites inversus* (Bukry & Bramlette) Bown & Newsam, p. 41, pl. 9, fig. 26.

Occurrence. Late Eocene (West well).

Blackites spinosus (Deflandre & Fert, 1954)
Hay & Towe, 1962

1954 *Discolithus spinosus* Deflandre & Fert, p. 143, pl. 14, figs. 13–15.
1962 *Blackites spinosus* (Deflandre & Fert) Hay & Towe, p. 505, pl. 4, fig. 5.
1991 *Blackites spinosus* (Deflandre & Fert) Hay & Towe – Concheyro, p. 388, pl. 1, figs. 5, 8, pl. 2, figs. 19–20.
2019 *Blackites spinosus* (Deflandre & Fert) Hay & Towe – Bedoya Agudelo, p. 199, pl. 4.6. fig. a, pl. 4.8, fig. a, pl. 4.10, fig. a, pl. 4.11, fig. a.

Occurrence. Early–middle Eocene (West well), early Eocene–early Oligocene (North well).

Order PRINSIALES Young & Bown, 1997a
Family PRINSIACEAE Hay & Mohler, 1967 *emend.*
Young & Bown, 1997b

Genus ***Hornibrookina*** Edwards, 1973

Type species. *Hornibrookina teuriensis* Edwards, 1973. Early–middle Paleocene; cosmopolitan.

Hornibrookina edwardsii Perch-Nielsen, 1977
Figure 4.11

1977 *Hornibrookina edwardsii* Perch-Nielsen, p. 750, pl. 46, figs. 2–3, 5–6, pl. 49, figs. 40–41.

Occurrence. Early–middle Paleocene (West, North, and East wells).

Hornibrookina nicolasii Pérez Panera in
Pérez Panera & Ronchi, in press
Figure 4.12

In press *Hornibrookina nicolasii* Pérez Panera in Pérez Panera & Ronchi.

Occurrence. Middle Eocene (North well).

Hornibrookina larae Pérez Panera in Pérez Panera & Ronchi, in press

2013 *Hornibrookina weimerae* Self-Trail – Pérez Panera, p. 129–130.
In press *Hornibrookina larae* Pérez Panera in Pérez Panera & Ronchi.

Occurrence. Early–middle Eocene (North well).

Genus ***Prinsius*** Hay & Mohler, 1967

Type species. *Prinsius bisulcus* (Stradner in Gohrbandt, 1963) Hay & Mohler, 1967. Paleocene; cosmopolitan.

Prinsius bisulcus (Stradner in Gohrbandt, 1963) Hay & Mohler, 1967

1963 *Coccolithus bisulcus* Stradner in Gohrbandt, p. 72, pl. 8, figs. 3–6, text-fig. 3, 1 a–b.
1967 *Prinsius bisulcus* (Stradner in Gohrbandt) Hay & Mohler, p. 1529, pl. 196, figs. 10–13, pl. 197, fig. 6.
2018 *Prinsius bisulcus* (Stradner) Hay & Mohler – Bedoya Agudelo, pl. 3, fig. 6.
2019 *Prinsius bisulcus* (Stradner) Hay & Mohler – Bedoya Agudelo, p. 162–163, pl. 4.4, fig. r.

Occurrence. Early–middle Paleocene (West well).

Prinsius dimorphosus (Perch-Nielsen, 1969) Perch-Nielsen, 1977
Figure 4.13

1969 *Biscutum*? *dimorphosum* Perch-Nielsen, p. 318, pl. 32, figs. 1–3 a, 4, text-fig. 1.
1977 *Prinsius dimorphosus* (Perch-Nielsen) Perch-Nielsen, p. 794, pl. 30, figs. 10–13.
1989 *Praeprinsius dimorphosus* (Perch-Nielsen) Varol & Jakubowski, p. 27.

Occurrence. Early–middle Paleocene (West and North wells).

Prinsius martinii (Perch-Nielsen, 1969) Haq, 1971
Figure 4.14

1969 *Ericsonia martinii* Perch-Nielsen, p. 324, pl. 32, figs. 3 b, 5–7, text-fig. 2.
1971 *Prinsius martinii* (Perch-Nielsen) Haq, p. 18, pl. 5, figs. 2, 3, 5, 10, non pl. 5, fig. 1.
1979 *Prinsius martinii* (Perch-Nielsen) Haq – Romein, p. 121, pl. 3, figs. 7–8.

Occurrence. Middle Paleocene–early Eocene (West well), early Eocene (East well).

Prinsius tenuiculus (Okada & Thierstein, 1979) Perch-Nielsen, 1984
Figure 4.15

1979 *Biscutum*? *tenuiculum* Okada & Thierstein, p. 521–522, pl. 1, figs. 1–2, pl. 9, figs. 1-8.
1981 *Prinsius africanus* Perch-Nielsen, p. 842–843, pl. 3, fig. 3.
1984 *Prinsius tenuiculus* (Okada & Thierstein) Perch-Nielsen, p. 42.
1984 *Toweius africanus* (Perch-Nielsen) Perch-Nielsen, p. 42.
1989 *Praeprinsius tenuiculus* (Okada & Thierstein) Varol & Jakubowski, p. 27.
2009 *Toweius africanus* (Perch-Nielsen) Perch-Nielsen – Pérez Panera, pl. 3, fig. 21.
2013 *Toweius africanus* (Perch-Nielsen) Perch-Nielsen – Pérez Panera, pl. 4, fig. 11.

Remarks. This species is a good marker for the Danian in the Argentine offshore basins (Pérez Panera & Angelozzi, 2006; Pérez Panera *et al.*, 2015; Guler *et al.*, 2019) and particularly in the Austral Basin (Pérez Panera, 2009, 2013; González Estebenet *et al.*, 2021).

Occurrence. Early Paleocene (West, North, and East wells).

Prinsius sp.

Remarks. Unidentified species of *Prinsius* are included here.

Occurrence. Early Eocene (West well).

Genus ***Toweius*** Hay & Mohler, 1967

Type species. *Toweius craticulus* Hay & Mohler, 1967. Early Paleocene–early Eocene; cosmopolitan.

Toweius callosus Perch-Nielsen, 1971a
Figure 4.16

1971a *Toweius callosus* Perch-Nielsen, p. 31, pl. 17, figs. 3–6, pl. 18, fig. 5, pl. 61, figs. 32–33.

2009 *Toweius callosus* Perch-Nielsen – Pérez Panera, pl. 3, fig. 12.
2011 *Toweius brusselensis* Steurbaut, p. 262, pl. 1, figs. 20–22, text-figs. 15–16.
2013 *Toweius callosus* Perch-Nielsen – Pérez Panera, pl. 4, fig. 8.
2016 *Toweius callosus* (Stradner) Perch-Nielsen – Bedoya Agudelo, p. 163, pl. 4.1, fig. c, pl. 4.3, fig. ñ, pl. 4.9, fig. ñ.

Occurrence*.* Early–middle Eocene (West and North wells), early Eocene (East well).

Toweius eminens (Bramlette & Sullivan, 1961)
Perch-Nielsen, 1971b
Figure 4.17

1961 *Coccolithus eminens* Bramlette & Sullivan, p. 139, pl. 1, figs. 3 a–d.
1971b *Toweius eminens* (Bramlette & Sullivan) Perch-Nielsen, p. 360, pl. 13, figs. 4, 6, pl. 14, figs. 3–4.
2013 *Toweius eminens* (Bramlette & Sullivan) Perch-Nielsen – Pérez Panera, pl. 4, fig. 7.
2018 *Toweius eminens* (Bramlette & Sullivan) Perch-Nielsen – Bedoya Agudelo *et al*., pl. 3, fig. 3
2019 *Toweius eminens* (Bramlette & Sullivan) Perch-Nielsen – Bedoya Agudelo, p. 163–164, pl. 4.1, fig. d, pl. 4.4, fig. t.

Occurrence*.* Early Eocene (East well).

Toweius occultatus (Locker, 1967) Perch-Nielsen, 1971a
Figure 4.18

1967 *Coccolithus occultatus* Locker, p. 764, pl. 1, fig. 5, pl. 2, figs. 9–10.
1971a *Toweius occultatus* (Locker) Perch-Nielsen, p. 32, pl. 17, figs. 1–2, 4, 7, pl. 18, fig. 6.
2009 *Toweius occultatus* (Locker) Perch-Nielsen – Pérez Panera, pl. 3, fig. 14.
2013 *Toweius occultatus* (Locker) Perch-Nielsen – Pérez Panera, pl. 4, figs. 9–10.
2018 *Toweius occultatus* (Locker) Perch-Nielsen – Bedoya Agudelo *et al*., pl. 3, fig. 4.
2019 *Toweius occultatus* (Locker) Perch-Nielsen – Bedoya Agudelo, p. 164, pl. 4.4, fig. u, pl. 4.9, fig. o.

Occurrence*.* Middle Paleocene–early Eocene (West, North, and East wells).

Toweius pertusus (Sullivan, 1965) Romein, 1979
Figure 4.19

1965 *Coccolithus pertusus* Sullivan, p. 32, pl. 3, figs. 5–6.
1967 *Toweius craticulus* Hay & Mohler, p. 1530, pl. 196, figs. 7–9, pl. 197, figs. 2–3.
1979 *Toweius pertusus* (Sullivan) Romein, p. 124–125, pl. 3, fig. 9.
2019 *Toweius pertusus* (Sullivan) Romein – Bedoya Agudelo, p. 164–165.

Occurrence*.* Early Eocene (West and North wells), early Paleocene–early Eocene (East well).

Toweius rotundus Perch-Nielsen
in Perch-Nielsen *et al.,* 1978
Figure 4.20

1978 *Toweius rotundus* Perch-Nielsen in Perch-Nielsen *et al.,* p. 352, pl. 8, figs. 34–35, pl. 18, figs. 14–15, 18–19.
2009 *Toweius rotundus* Perch-Nielsen in Perch-Nielsen *et al.* – Pérez Panera, pl. 3, fig. 13.
2019 *Toweius rotundus* Perch-Nielsen in Perch-Nielsen *et al.* – Bedoya Agudelo, p. 165, pl. 4.9., fig. p.

Occurrence*.* Early Paleocene–early Eocene (West, North, and East wells).

Toweius serotinus Bybell & Self-Trail, 1995

1995 *Toweius serotinus* Bybell & Self-Trail, p. 34, pl. 27, fig. 7, pl. 28, figs 6, 10, pl. 37, figs. 29–30, 35.
2019 *Toweius serotinus* Bybell & Self-Trail – Bedoya Agudelo, p. 165–166.

Occurrence*.* Early Eocene (East well).

Toweius sp.

Remarks*.* All unidentified *Toweius* are included here.

Occurrence*.* Early Paleocene–early Eocene (West and North wells), early Eocene (East well).

Family NOELAERHABDACEAE Jerkovic, 1970 *emend.*
Young & Bown, 1997b

Genus ***Cyclicargolithus*** Bukry, 1971

Type species*. Cyclicargolithus floridanus* (Roth & Hay in Hay *et al.,* 1967) Bukry, 1971. Middle Eocene–middle Miocene; cosmopolitan.

Cyclicargolithus abisectus
(Müller, 1970) Wise, 1973
Figure 5.1

1970 *Coccolithus abisectus* Müller, p. 92, pl. 9, figs. 9–10, pl. 12, fig. 1.
1973 *Cyclicargolithus abisectus* (Müller) Wise, p. 594.
2019 *Cyclicargolithus abisectus* (Müller) Wise – Bedoya Agudelo, p. 147–148, pl. 4.6, fig. g, pl. 4.7, fig. b, pl. 5.15, fig. 6, pl. 4.16, fig. d, pl. 4.17, fig. b.

Remarks. This species is a good marker to approximate the Oligocene/Miocene boundary in the Magallanes Basin.

Occurrence. Late Oligocene–early Miocene (North well).

Cyclicargolithus floridanus (Roth & Hay in Hay *et al.*, 1967) Bukry, 1971
Figure 5.2

1967 *Coccolithus floridanus* Roth & Hay in Hay *et al.*, p. 445, pl. 6, figs. 1–4.
1971 *Cyclicargolithus floridanus* (Roth & Hay in Hay *et al.*) Bukry, p. 312–313.
1973 *Cyclicargolithus bukryi* Wise, p. 594, pl. 9, figs. 1–4.

Occurrence. Early Eocene–early Miocene (West and East wells), early Eocene–Oligocene (North well).

Cyclicargolithus luminis (Sullivan, 1965) Bukry, 1971

1965 *Cyclococcolithus luminis* Sullivan, p. 33, pl. 3, figs. 9 a–b.
1971 *Cyclicargolithus luminis* (Sullivan) Bukry, p. 313.

Occurrence. Early Eocene (West well).

Genus ***Reticulofenestra*** Hay *et al.*, 1966

Type species. *Reticulofenestra umbilicus* (Levin, 1965) Martini & Ritzowski, 1968. Middle Eocene–early Oligocene; cosmopolitan.

Reticulofenestra bisecta (Hay *et al.*, 1966) Roth, 1970
Figure 5.3–4

1966 *Syracosphaera bisecta* Hay *et al.*, p. 393, pl. 10, figs. 1–6.
1966 *Reticulofenestra scissura* Hay *et al.*, p. 387, pl. 5, figs. 1–6.
1970 *Reticulofenestra bisecta* (Hay *et al.*) Roth, p. 847, pl. 3, fig. 6.
1971 *Dictyococcites scrippsae* Bukry & Percival, p. 128, pl. 2, figs. 7–8.
2009 *Reticulofenestra bisecta bisecta* (Hay *et al.*) Roth – Pérez Panera, pl. 3, fig. 10.
2019 *Dictyococcites bisectus* (Hay *et al.*) Bukry & Percival – Bedoya Agudelo, p. 149–150, pl. 4.5, fig. l, pl. 4.11, fig. n, pl. 4.13, fig. f., pl. 4.15, fig. g.

Remarks. This species shows a wide size range. In this study, we differentiate two forms: *R. bisecta* and *R. bisecta* (small form), the latter for specimens smaller than 5 µm. The larger form is also distinguished by a thick inner cycle distal shield and is more abundant in the Eocene and early Oligocene. The small form is less abundant during the Eocene, and the younger early Miocene specimens morphologically intergrade with *Reticulofenestra perplexa.*

Occurrence. Early Eocene–early Miocene (West well: large form; North and East wells: both forms), Oligocene–early Miocene (West well: small form).

Reticulofenestra circus de Kaenel & Villa, 1996
Figure 5.5

1996 *Reticulofenestra circus* de Kaenel & Villa, p. 127, pl. 7, figs. 3–4.
2019 *Reticulofenestra circus* de Kaenel & Villa – Bedoya Agudelo, p. 152–153, pl. 4.11, fig. w, pl. 4.13, fig. j, pl. 4.14, fig. h.

Remarks. This species is well represented in the Magallanes Basin. Bedoya Agudelo (2019) found it in the surface formations Cerro Colorado, Estancia María Cristina and Puesto Herminita, Chile. According to de Kaenel & Villa (1996) its geologic range is restricted to the early Oligocene (NP22–NP23). However, in the East well, we found it associated with *Reticulofenestra reticulata,* so in the Magallanes Basin it possibly first appears in the late Eocene. However, its LO could be a good local event for correlation in the early Oligocene.

Occurrence. Early Oligocene (West and North wells), late Eocene (East well).

Reticulofenestra daviesii (Haq, 1968) Haq, 1971
Figure 5.6

1968 *Stradnerius daviesii* Haq, 32, pl. 4, figs. 4–5.
1971 *Reticulofenestra daviesii* (Haq, 1968) Haq, p. 154.
1971a *Dictyococcites callidus* Perch-Nielsen, p. 28, pl. 22, figs. 1–4, pl. 23, fig. 3, pl. 61, figs. 30–31.
2009 *Reticulofenestra daviesii* (Haq, 1968) Haq – Pérez Panera, pl. 3, fig. 4.
2013 *Reticulofenestra daviesii* (Haq, 1968) Haq – Pérez Panera, pl. 4, fig. 1.
2019 *Reticulofenestra daviesii* (Haq, 1968) Haq – Bedoya Agudelo, p. 153–154, pl. 4.5, fig. s, pl. 4.6, fig. l, pl. 4.10, fig. a, pl. 4.12, fig. a, pl. 4.13, fig. k, pl. 4.14, fig. i.

Remarks. *Reticulofenestra daviesii* is a dominant species throughout the Eocene–Oligocene in the Magallanes Basin. According to Villa *et al.* (2014) this taxon had an affinity to cool waters and high-nutrient conditions in the Southern Ocean. In some mid to low latitude biozonations, the lower common occurrence of *R. daviesii* is used to determine the Eocene/Oligocene boundary (Agnini *et al.*, 2014; see Bordiga *et al.*, 2017). This could be explained due to the opening of the Drake Passage at that moment, which would lead to a decrease in the sea surface temperature and enhance of upwelling conditions at mid and low latitudes, allowing *R. daviesii* to trigger. However, this event is not useful for correlation with southern high-latitude sites like Magallanes Basin, the Malvinas Plateau (Wise, 1983) or Canterbury Basin in New Zealand (Shepherd & Kulhanek, 2016) where *R. daviesii* first common occurrence is in the early Eocene.
Occurrence. Early Eocene–early Miocene (West, North, and East wells).

Reticulofenestra dictyoda
(Deflandre in Deflandre & Fert, 1954)
Stradner in Stradner & Edwards, 1968

1954 *Discolithus dictyodus* Deflandre in Deflandre & Fert, p. 140, textfigs. 15–16.
1966 *Apertapetra samodurovi* Hay *et al.*, p. 388, pl. 6, figs. 1–7.
1968 *Reticulofenestra dictyoda* (Deflandre in Deflandre & Fert) Stradner in Stradner & Edwards, p. 19, pl. 12–14, pl. 22, fig. 4, text-fig. 2c.
1970 *Reticulofenestra clatrata* Müller, p. 115, pl. 7, figs. 1–3, pl. 8, figs. 1–2.
1991 *Reticulofenestra dictyoda* (Deflandre) Stradner & Edwards – Concheyro, p. 395, pl. 1, fig. 3.
2013 *Reticulofenestra dictyoda* (Deflandre in Deflandre & Fert) Stradner in Stradner & Edwards – Pérez Panera, pl. 4, figs. 5–6.
2019 *Reticulofenestra dictyoda* (Deflandre in Deflandre & Fert) Stradner in Stradner & Edwards – Bedoya Agudelo, p. 154, pl. 4.2, fig. l, pl. 4.5, fig. t, pl. 4.6, fig. m, pl. 4.9, fig. f, pl. 4.10, fig. t, pl. 4.13, fig. l, pl. 4.15, fig. n.

Remarks. This taxon is abundant in the Eocene–Oligocene of the Magallanes Basin (Pérez Panera, 2009, 2013; Bedoya Agudelo, 2019). In the well West, small specimens (< 5 μm) were recorded in the early Oligocene which might be reflecting high nutrient conditions (Okada & Honjo, 1973; Young, 1994; Flores *et al.*, 2000).

Occurrence. Early Eocene–early Oligocene (West and North wells), early Eocene–early Miocene (East well), early Oligocene (West well: small form).

Reticulofenestra filewiczii (Wise & Wiegand in Wise, 1983)
Dunkley Jones *et al.*, 2009
Figure 5.7

1983 *Reticulofenestra bisecta filewiczii* Wise & Wiegand in Wise, p. 505, pl. 5, fig. 3, pl. 6, figs. 1–2.
2009 *Reticulofenestra bisecta filewiczii* Wise & Wiegand in Wise – Pérez Panera, pl. 3 fig. 9
2009 *Reticulofenestra filewiczii* (Wise & Wiegand in Wise) Dunkley Jones *et al.*, p. 373, pl. 1, figs. 10–12.
2019 *Reticulofenestra filewiczii* (Wise & Wiegand in Wise) Dunkley Jones *et al.* – Bedoya Agudelo, p. 154–155, pl. 4.6, fig. n, pl. 4.14, fig. j, pl. 4.15, fig. ñ.

Occurrence. Early Eocene–early Oligocene (West and North wells), late Eocene–early Oligocene (East well).

Reticulofenestra hampdenensis Edwards, 1973
Figure 5.8

1973 *Reticulofenestra hampdenensis* Edwards, p. 80, figs. 38–69.

Occurrence. Middle Eocene–late Eocene (West well).

Reticulofenestra hillae Bukry & Percival, 1971

1971 *Reticulofenestra hillae* Bukry & Percival, p. 136, pl. 6, figs. 1–3.
2019 *Reticulofenestra hillae* (Bukry & Percival) – Bedoya Agudelo, p. 155–156, pl. 4.12, fig. b, pl. 4.13, fig. m.

Remarks. *Reticulofenestra hillae* has its LO in the early Oligocene, around the LO of the marker *Reticulofenestra umbilicus* (Bown & Dunkley Jones, 2012). It was continuously recorded in the late Eocene–early Oligocene, and its LO is useful for correlation of the NP22 Biozone in the Magallanes Basin.
Occurrence. Late Eocene–early Oligocene (West well), middle Eocene–early Oligocene (North and East wells).

Reticulofenestra lockeri Müller, 1970

1970 *Reticulofenestra lockeri* Müller, p. 116, pl. 6, figs. 3–5, pl. 7, fig. 4

Occurrence. Early Eocene–early Miocene (West well), late

Eocene–early Miocene (North well), early Oligocene (East well).

Reticulofenestra minuta Roth, 1970
Figure 5.9

1970 *Reticulofenestra minuta* Roth, p. 850, pl. 5, figs. 3–4.

Remarks. *Reticulofenestra minutula* shows very high abundances in the Eocene–Oligocene transition, which might be reflecting high nutrient concentration at that moment in the Magallanes Basin.

Occurrence. Early Eocene–early Miocene (West, North, and East wells).

Reticulofenestra oamaruensis (Deflandre in Deflandre & Fert, 1954) Stradner in Haq, 1968
Figure 5.10–11

1954 *Discolithus oamaruensis* Deflandre in Deflandre & Fert, 139, pl. 12, figs. 1–2.
1968 *Reticulofenestra oamaruensis* (Deflandre in Deflandre & Fert) Stradner in Haq, p. 30, pl. 5, figs. 6–8.
2019 *Reticulofenestra oamaruensis* (Deflandre in Deflandre & Fert) Stradner in Haq – Bedoya Agudelo, p. 157–158, pl. 4.5, fig. v, pl. 4.12, fig. d.

Remarks. This species has a short geologic range, restricted to the Eocene–Oligocene transition and its FO and LO are useful events for local correlation in the southern oceans (Persico *et al.,* 2012).

Occurrence. Late Eocene–early Oligocene (West well), early Oligocene (North and East wells).

Reticulofenestra onusta (Perch-Nielsen, 1971a) Wise, 1983

1971a *Dictyococcites onustus* Perch-Nielsen, p. 29, pl. 20, figs. 3–4, pl. 61, figs. 28–29.
1983 *Reticulofenestra onusta* (Perch-Nielsen, 1971) Wise, 505, pl. 5, figs. 8–9.

Occurrence. Middle Eocene (West well).

Reticulofenestra reticulata (Gartner & Smith, 1967) Roth & Thierstein, 1972
Figure 5.12

1967 *Cyclococcolithus reticulatus* Gartner & Smith, p. 4, pl. 5, figs. 1–3, 4 a–d.
1972 *Reticulofenestra reticulata* (Gartner & Smith) Roth & Thierstein, p. 425.
2013 *Reticulofenestra reticulata* (Gartner & Smith) Roth & Thierstein – Pérez Panera, pl. 4, fig. 2.
2019 *Cribocentrum reticulatum* (Gartner & Smith) Perch-Nielsen, 1971 – Bedoya Agudelo, p. 146–147, pl. 4.5, fig. g, pl. 4.11, figs. l–m.

Remarks. The FO of *Reticulofenestra reticulata* is a reliable event for the NP16 biozone in the middle Eocene (Persico *et al.*, 2012; Fioroni *et al.*, 2012). The LO of this taxon is quite uncertain, although used in many biostratigraphic schemes (Fioroni *et al.,* 2012). According to our data, in the Magallanes Basin its LO is at the end of the Eocene, and we emphasize the value of *R. reticulata* for local correlation and approximation of the Eocene/Oligocene boundary (Thissen & Pérez Panera, 2020b).

Occurrence. Middle Eocene–late Eocene (West, North, and East wells).

Reticulofenestra stavensis
(Levin & Joerger, 1967) Varol, 1989
Figure 5.13

1967 *Coccolithus stavensis* Levin & Joerger, p. 165, pl. 1, figs. 7 a–d.
1989 *Reticulofenestra stavensis* (Levin & Joerger) Varol, p. 261.
1998 *Dictyococcites stavensis* (Levin & Joerger) Varol, p. 218, pl. 7.2, fig. 5.

Occurrence. Middle Eocene–early Oligocene (West and North wells), early Oligocene (East well).

Reticulofenestra umbilicus
(Levin, 1965) Martini & Ritzowski, 1968
Figure 5.14–16

1965 *Coccolithus umbilicus* Levin, p. 265, pl. 41, fig. 2.
1968 *Reticulofenestra umbilicus* (Levin) Martini & Ritzowski, p. 137.
1991 *Reticulofenestra umbilica* (Levin) Martini & Ritzowski – Pérez Panera, p. 395, pl. 2, fig. 1 a–b.
2013 *Reticulofenestra umbilica* (Levin) Martini & Ritzowski – Pérez Panera, pl. 4, figs. 3–4.
2019 *Reticulofenestra umbilicus* (Levin) Martini & Ritzowski – Bedoya Agudelo, p. 159, pl. 4.5, fig. w, pl. 4.12, fig. f.

Remarks. The LO of *R. umbilicus* is a reliable marker for the early Oligocene and is useful for local correlation in the Magallanes Basin.

Occurrence. Middle Eocene–early Oligocene (West and North wells), early Oligocene (East well).

Order COCCOSPHAERALES Haeckel, 1894 *emend*. Young & Bown, 1997a

Family COCCOLITHACEAE Poche, 1913 *emend*. Young & Bown, 1997b

Genus ***Bramletteius*** Gartner, 1969

Type species. *Bramletteius serraculoides* Gartner, 1969. Middle Eocene–early Oligocene; cosmopolitan.

Bramletteius serraculoides Gartner, 1969

1969 *Bramletteius serraculoides* Gartner, p. 31, pl. 1, figs. 1–3.

Occurrence. Early Eocene (West well).

Genus ***Chiasmolithus*** Hay *et al*., 1966

Type species. *Chiasmolithus oamaruensis* (Deflandre, 1954) Hay *et al*., 1966. Late Eocene–early Oligocene; cosmopolitan.

Chiasmolithus altus Bukry & Percival, 1971

Figure 5.17–18

1971 *Chiasmolithus altus* Bukry & Percival, p. 126, pl. 2, figs. 1–2.

2019 *Chiasmolithus altus* Bukry & Percival – Bedoya Agudelo, p. 169, pl. 4.6, fig. c, pl. 4.11, fig. d, pl. 4.14, fig. b.

Remarks. This species is useful for the differentiation between Oligocene and early Miocene assemblages, as they can be quite similar in species composition in the Magallanes Basin.

Occurrence. Late Eocene–Oligocene (West well), middle Eocene–early Oligocene (North well), early Oligocene (East well).

Chiasmolithus bidens (Bramlette & Sullivan, 1961) Hay & Mohler, 1967

Figure 5.19

1961 *Coccolithus bidens* Bramlette & Sullivan, p. 139, pl. 1, fig. 1.

1967 *Chiasmolithus bidens* (Bramlette & Sullivan) Hay & Mohler, p. 1526, pl. 196, figs. 14–15, 17, pl. 197, figs. 4, 9, 14.

2009 *Chiasmolithus bidens* (Bramlette & Sullivan) Hay & Mohler – Pérez Panera, pl. 3, fig. 20.

2013 *Chiasmolithus bidens* (Bramlette & Sullivan) Hay & Mohler – Pérez Panera, pl. 4, fig. 18.

2018 *Chiasmolithus bidens* (Bramlette & Sullivan) Hay & Mohler – Bedoya Agudelo *et al*., pl. 3, fig. 1.

2019 *Chiasmolithus bidens* (Bramlette & Sullivan) Hay & Mohler – Bedoya Agudelo, p. 169–170, pl. 4.1., fig. a, pl. 4.3., fig. b, pl. 4.4, fig. b, pl. 4.8, fig. e.

Remarks. This taxon is well represented in the Magallanes Basin and its LO is a useful event for correlation of the early Eocene.

Occurrence. Middle Paleocene–early Eocene (West and North wells), early Eocene (East well).

Chiasmolithus danicus (Brotzen, 1959) Hay & Mohler, 1967

Figure 5. 20

1959 *Cribrosphaerella danica* Brotzen, p. 25, fig. 9.

1967 *Chiasmolithus danicus* (Brotzen) Hay & Mohler, p. 1526–1527, pl. 196, figs. 16, 21–22, pl. 198, figs. 8, 12–13.

1987 *Chiasmolithus danicus* (Brotzen) *ex* van Heck & Perch-Nielsen, p. 287–288, pl. 1, figs. 9–10, text-figs. 4 a–d.

1992 *Sullivania danica* (Brotzen) Varol, p. 148, pl. 2, figs. 12–14.

2013 *Sullivania danica* (Brotzen) Varol – Pérez Panera, pl. 4, fig. 21.

Remarks. This species is always present in the early–middle Paleocene assemblages of Magallanes and all other Argentinian offshore basins, making it an important taxon for regional correlation (Pérez Panera & Angelozzi, 2006; Pérez Panera, 2009, 2013; Pérez Panera *et al*., 2015; Guler *et al*., 2019; Bedoya Agudelo, 2019).

Occurrence. Early–middle Paleocene (West, North, and East wells).

Chiasmolithus grandis (Bramlette & Riedel, 1954) Radomski, 1968

Figure 6.1

1954 *Coccolithus grandis* Bramlette & Riedel, p. 391, pl. 38, figs. 1 a–b.

1968 *Chiasmolithus grandis* (Bramlette & Riedel) Radomski, p. 560, pl. 44, figs. 3–4.

1991 *Chiasmolithus grandis* (Bramlette & Riedel) Radomski – Concheyro, p. 389–390, pl. 2, figs. 3–4.

2009 *Chiasmolithus grandis* (Bramlette & Riedel) Radomski – Pérez Panera, pl. 3, fig. 5.

2013 *Chiasmolithus grandis* (Bramlette & Riedel) Radomski –

Pérez Panera, pl. 4, fig. 17.
2019 *Chiasmolithus grandis* (Bramlette & Riedel) Radomski – Bedoya Agudelo, p. 171–172.

Occurrence. Early Eocene (West well), early–middle Eocene (North and East wells).

Chiasmolithus modestus Perch-Nielsen, 1971a
Figure 6.2

1971a *Chiasmolithus modestus* Perch-Nielsen, p. 20, pl. 8, figs. 1–2, pl. 11, figs. 2–3, pl. 12, fig. 6, pl. 60, figs. 21–22.
2009 *Chiasmolithus modestus* Perch-Nielsen – Pérez Panera, pl. 3, figs. 7–8.
2013 *Chiasmolithus modestus* Perch-Nielsen – Pérez Panera, pl. 4, fig. 16.
2019 *Chiasmolithus modestus* Perch-Nielsen – Bedoya Agudelo, p. 172, pl. 4.2, fig. c, pl. 4.8, fig. h.

Occurrence. Middle Eocene (West and North wells).

Chiasmolithus nitidus Perch-Nielsen, 1971a
Figure 6.3

1971a *Chiasmolithus nitidus* Perch-Nielsen, p. 20, pl. 13, figs. 5–6, pl. 60, figs. 13–14.
2019 *Chiasmolithus nitidus* Perch-Nielsen – Bedoya Agudelo, p. 172–173, pl. 41. Fig. b, pl. 4.4 fig. c, pl. 4.8, fig. i.

Occurrence. Early–middle Eocene (North well).

Chiasmolithus oamaruensis
(Deflandre in Deflandre & Fert, 1954) Hay *et al.*, 1966
Figure 6.4–5

1954 *Tremalithus oamaruensis* Deflandre in Deflandre & Fert, p. 154, pl. 11, fig. 22, text-figs. 72–74.
1966 *Chiasmolithus oamaruensis* (Deflandre) Hay *et al.*, p. 388–389, pl. 7, fig. 1.
1991 *Chiasmolithus oamaruensis* (Deflandre) Hay *et al.* – Concheyro, p. 390, pl. 2, fig. 5.
2019 *Chiasmolithus oamaruensis* (Deflandre) Hay *et al.* – Bedoya Agudelo, 173, pl. 4.5, figs. b–c, pl. 4.11, fig. h, pl. 4.13, figs. a–b.

Remarks. According to Persico *et al.* (2012) and Fioroni *et al.* (2012) the FO of *Chiasmolithus oamaruensis* is in the middle Eocene and constitutes a reliable biostratigraphic event. Wei & Wise (1990) use this event to define the base of the *Chiasmolithus oamaruensis* Interval Biozone in high latitudes. Its LO in the early Oligocene (Wise & Mostajo, 1983) appears to be useful to approximate the Eocene/Oligocene boundary in the Magallanes Basin (Pérez Panera, 2013). However, in this basin, it is not consistently recorded, and its FO has been registered in the middle Eocene Man Aike Formation (Concheyro, 1991) and the late Eocene (Pérez Panera, 2013; Bedoya Agudelo, 2019).

Occurrence. Late Eocene (West well), early Oligocene (North well).

Chiasmolithus solitus
(Bramlette & Sullivan, 1961) Locker, 1968
Figure 6.6

1961 *Coccolithus solitus* Bramlette & Sullivan, p. 140, pl. 2, figs. 4 a–c.
1968 *Chiasmolithus solitus* (Bramlette & Sullivan) Locker, p. 221, pl. 1, figs. 5–6.
2009 *Chiasmolithus solitus* (Bramlette & Sullivan) Locker – Pérez Panera, pl. 4, figs. 19–20.
2019 *Chiasmolithus solitus* (Bramlette & Sullivan) Locker – Bedoya Agudelo, p. 173–174, pl. 4.2, fig. b, pl. 4.8, fig. j, pl. 4.10, fig. f, pl. 4.11, fig. e, pl. 4.18, fig. e.

Remarks. *Chiasmolithus solitus* is abundant and consistently recorded in the Magallanes Basin (Pérez Panera, 2013; Bedoya Agudelo, 2019), and its LO is useful to identify the top of NP16 Biozone in the earliest Bartonian.

Occurrence. Early Eocene–late Eocene (West and North wells), middle–late Eocene (East well).

Chiasmolithus sp.

Remarks. Complete hollow or fragmented rings of *Chiasmolithus* are very abundant along the Paleogene in the Magallanes Basin. We include all unidentified specimens in this category. The identification of these elements records information on the relative abundance of the genus *Chiasmolithus* along the investigated sections, which can be applied for interpreting variations in the nutrient availability.

Occurrence. Early Paleocene–early Oligocene (West, North, and East wells).

Genus ***Clausicoccus*** Prins, 1979

Type species. *Clausicoccus fenestratus* (Deflandre & Fert, 1955) Prins, 1979. Early Eocene–earliest Miocene, cosmopolitan.

Clausicoccus fenestratus
(Deflandre & Fert, 1954) Prins, 1979.
Figure 6.7

1954 *Discolithus fenestratus* Deflandre & Fert, p. 139, pl. 11, fig. 25, text-fig. 52.
1979 *Clausicoccus fenestratus* (Deflandre & Fert) Prins, p. N-3, text-fig. 3.
2019 *Clausicoccus fenestratus* (Deflandre & Fert) Prins – Bedoya Agudelo, p. 174–175, pl. 4.6, fig. e, pl. 4.14, fig. c.

Remarks*.* In the Magallanes Basin, this taxon is most abundant in the latest Eocene–earliest Oligocene.

Occurrence*.* Middle Eocene (West well), early Eocene–early Oligocene (North well), early Oligocene (East well).

Clausicoccus subdistichus
(Roth & Hay in Hay *et al.*, 1967) Prins, 1979
Figure 6.8

1967 *Ellipsolithus subdistichus* Roth & Hay in Hay *et al.*, p. 446, pl. 6, fig. 7.
1979 *Clausicoccus subdistichus* (Roth & Hay in Hay *et al.*) Prins, p. N-3, text-figs. 1–2.
2019 *Clausicoccus subdistichus* (Roth & Hay in Hay *et al.*) Prins – Bedoya Agudelo, p. 175, pl. 4.6, fig. f, pl. 4.11, fig. l, pl. 4.13, fig. c.

Occurrence*.* Middle Eocene–early Oligocene (West well).

Genus ***Coccolithus*** Schwarz, 1894

Type species*. Coccolithus pelagicus* (Wallich, 1877) Schiller, 1930*.* Paleocene–Holocene; cosmopolitan.

Coccolithus cachaoi Bown, 2005

2005 *Coccolithus cachaoi* Bown, p. 26, pl. 3, figs. 8–10.

Occurrence*.* Early Eocene (West well).

Coccolithus eopelagicus
(Bramlette & Riedel, 1954) Hay *et al.*, 1966.
Figure 6.9

1954 *Tremalithus eopelagicus* Bramlette & Riedel, p. 392, pl. 38, figs. 2 a–b.
1961 *Coccolithus eopelagicus* (Bramlette & Riedel) Bramlette & Sullivan, p. 141. Invalid - ICBN Art 33.4.
1966 *Coccolithus eopelagicus* (Bramlette & Riedel) Hay *et al.*, p. 385, pl. 1, fig. 1.
1991 *Coccolithus eopelagicus* (Bramlette & Riedel) Bramlette & Sullivan – Concheyro, p. 390, pl. 2, figs. 2 a–b.
2019 *Coccolithus eopelagicus* (Bramlette & Riedel) Bramlette & Sullivan – Bedoya Agudelo, p. 176, pl. 4.5, fig. d, pl. 4.11, fig. j, pl. 4.13, fig. d.

Occurrence*.* Early Eocene–late Eocene (West well), early Eocene–early Oligocene (North well).

Coccolithus formosus (Kamptner, 1963) Wise, 1973
Figure 6.10

1963 *Cyclococcolithus formosus* Kamptner, p. 163, pl. 2, fig. 8, text-figs. 20 a–b.
1973 *Coccolithus formosus* (Kamptner) Wise, p. 593, pl. 4, figs. 1–6.
1991 *Ericsonia formosa* (Kamptner) Haq – Concheyro, p. 390, 392, pl. 2, fig. 12
2019 *Ericsonia formosa* (Kamptner) Haq – Bedoya Agudelo, p. 180–181, pl. 4.2, fig. d, pl. 4.8, fig. r, pl. 4.10, fig. j, pl. 4.11, fig. o.

Remarks*.* Fioroni *et al.* (2012) and Persico *et al.* (2012) use the common LO of this taxon (= *Ericsonia formosa*) to define a Biozone in the late middle Eocene for the southern oceans. In the Magallanes Basin, *C. formosus* is a characteristic component of the middle–late Eocene assemblages and is more abundant in the late Eocene (Pérez Panera, 2013). Its LO is useful to approximate the Eocene/Oligocene boundary.

Occurrence*.* Middle Eocene–late Eocene (West well), middle Eocene (North and East wells).

Coccolithus pelagicus (Wallich, 1877) Schiller, 1930
Figure 6.11

1877 *Coccosphaera pelagica* Wallich, p. 348.
1930 *Coccolithus pelagicus* (Wallich) Schiller, p. 92.

Occurrence*.* Paleocene–Miocene (West, North, and East wells).

Coccolithus staurion Bramlette & Sullivan, 1961

1961 *Coccolithus staurion* Bramlette & Sullivan, p. 141, pl. 2, figs. 5 a–b, 6 a–c.
2009 *Birkelundia staurion* (Bramlette & Sullivan) Perch-Nielsen – Pérez Panera, pl. 3, fig. 11.
2013 *Cruciplacolithus staurion* (Bramlette & Sullivan) Gartner

– Pérez Panera, pl. 4, fig. 22.

Remarks. In the Magallanes Basin, the LO of this taxon is a good marker for the top of NP17 Biozone (Pérez Panera, 2013).

Occurrence. Early Eocene–late Eocene (West well).

Genus ***Cruciplacolithus***
Hay & Mohler in Hay *et al.*, 1967

Type species. *Cruciplacolithus tenuis* (Stradner, 1961) Hay & Mohler in Hay *et al.,* 1967. Paleocene; cosmopolitan.

Cruciplacolithus frequens
(Perch-Nielsen, 1977) Romein, 1979
Figure 6.12

1977 *Chiasmolithus frequens* Perch-Nielsen, p. 746, pl. 18, figs. 2, 4, pl. 19, figs. 1, 3, 5, pl. 50, figs. 5–6.
1979 *Cruciplacolithus frequens* (Perch-Nielsen, 1977) Romein, p. 103, pl. 9, fig. 6.

Occurrence. Early–middle Paleocene (West well).

Cruciplacolithus latipons Romein, 1979

1979 *Cruciplacolithus latipons* Romein, p. 102, pl. 9, figs. 7–8.
2019 *Cruciplacolithus latipons* Romein – Bedoya Agudelo, p. 179.

Occurrence. Early Eocene (West well).

Cruciplacolithus primus Perch-Nielsen, 1977
Figure 6.13

1977 *Cruciplacolithus primus* Perch-Nielsen, p. 746, pl. 17, figs. 7–8, pl. 50, figs. 11–12.
2009 *Cruciplacolithus primus* Perch-Nielsen – Pérez Panera, pl. 3, fig. 23.
2013 *Cruciplacolithus primus* Perch-Nielsen – Pérez Panera, pl. 4, fig. 23.

Remarks. This taxon is a good marker for the early Paleocene. Its FO in NP1 Biozone is consistently recorded from the Danian–Selandian in the Magallanes Basin (Pérez Panera, 2009, 2013).

Occurrence. Early–middle Paleocene (West and North wells).

Cruciplacolithus tenuis
(Stradner, 1961) Hay & Mohler in Hay *et al.*, 1967

1961 *Heliorthus tenuis* Stradner, p. 84, text-figs. 64–65.
1967 *Cruciplacolithus tenuis* (Stradner) Hay & Mohler in Hay *et al.*, p. 1527, pl. 196, figs. 29–31, pl. 198, figs. 1, 17.

Occurrence. Middle Eocene (West well).

Genus ***Ericsonia*** Black, 1964

Type species. *Ericsonia occidentalis* Black, 1964. (= *Coccolithus pelagicus* (Wallich, 1877) Schiller, 1930). Paleocene–Holocene; cosmopolitan.

Ericsonia orbis Bown, 2016

2016 *Ericsonia orbis* Bown, p. 6, pl. 1, figs. 44–45, pl. 11, figs. 4–6.

Occurrence. Early Eocene–late Eocene (West well).

Family CALCIDISCACEAE Young & Bown, 1997b

Genus ***Calcidiscus*** Kamptner, 1950

Type species. *Calcidiscus leptoporus* (Murray & Blackman, 1898) Loeblich & Tappan, 1978. Miocene–Holocene; cosmopolitan.

Calcidiscus bicircus Bown, 2005

2005 *Calcidiscus bicircus* Bown, p. 29, pl. 9, figs. 11–23.

Occurrence. Middle Eocene (East well).

Genus ***Hayella*** Gartner, 1969

Type species. *Hayella situliformis* Gartner, 1969. Late Eocene–early Oligocene; cosmopolitan.

Hayella cf. ***gauliformis*** Troelsen & Quadros, 1971

1971 *Hayella gauliformis* Troelsen & Quadros, p. 602, pl. 7, figs. 115–118.

Remarks. One poorly preserved specimen and comparable to *Hayella gauliformis* was recorded in the well West.

Occurrence. Early Eocene (West well).

Genus ***Umbilicosphaera*** Lohmann, 1902

Type species. *Umbilicosphaera mirabilis* Lohmann, 1902. Paleocene–Holocene; cosmopolitan.

Umbilicosphaera edgariae (Bown & Dunkley Jones, 2012)
Young & Bown, 2014
Figure 6.14

2012 *Calcidiscus*? *edgariae* Bown & Dunkley Jones, p. 25, pl. 2, figs. 36–49.
2014 *Umbilicosphaera edgariae* (Bown & Dunkley Jones) Young & Bown, p. 42.

Occurrence. Early Eocene (West well), early Eocene–early Oligocene (North well).

Order EIFFELLITHALES Rood *et al.*, 1971

Family CHIASTOZYGACEAE Rood *et al.*, 1973

Genus ***Neocrepidolithus*** Romein, 1979

Type species. *Crepidolithus neocrassus* Perch-Nielsen, 1968. Late Cretaceous–early Paleocene; cosmopolitan.

Neocrepidolithus sp.

Remarks. Undiferentiated *Neocrepidolithus.*

Occurrence. Early–middle Paleocene (West well).

“HETEROCOCOLITH genera *incertae sedis*”

Genus ***Ellipsolithus*** Sullivan, 1964

Type species. *Ellipsolithus macellus* (Bramlette & Sullivan, 1961) Sullivan, 1964. Early Paleocene–early Eocene; cosmopolitan.

Ellipsolithus macellus (Bramlette & Sullivan, 1961) Sullivan, 1964

1961 *Coccolithites macellus* Bramlette & Sullivan, p. 152, pl. 7, figs. 11–12, 13 a–d.
1964 *Ellipsolithus macellus* (Bramlette & Sullivan) Sullivan, p. 184, pl. 5, fig. 3.

Occurrence. Early Eocene (West well).

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

Type species. *Cyclococcolithus leptoporus inversus* Deflandre in Deflandre & Fert, 1954. Late Cretaceous–early Oligocene; cosmopolitan.

Markalius inversus (Deflandre in Deflandre & Fert, 1954) Bramlette & Martini, 1964

1954 *Coccolithus leptoporus inversus* Deflandre in Deflandre & Fert, p. 150, pl. 9, figs. 4–7.
1964 *Markalius inversus* (Deflandre in Deflandre & Fert) Bramlette & Martini, p. 302, pl. 2, figs. 4–9, non pl. 7, figs. 2 a–b.
2009 *Markalius inversus* (Deflandre in Deflandre & Fert) Bramlette & Martini – Pérez Panera, pl. 3, fig. 22.
2019 *Markalius inversus* (Deflandre in Deflandre & Fert) Bramlette & Martini – Bedoya Agudelo, p. 202–203, pl. 4.8, fig. u.

Occurrence. Early Eocene–early Oligocene (West well), early Eocene–late Eocene (North well).

“HOLOCOCCOLITHS”

Family CALYPTROSPHAERACEAE Boudreaux & Hay, 1969

Genus ***Clathrolithus*** Deflandre in Deflandre & Fert, 1954

Type species. *Clathrolithus ellipticus* Deflandre in Deflandre & Fert, 1954. Late Paleocene–Early Oligocene; cosmopolitan.

Clathrolithus ellipticus Deflandre in Deflandre & Fert, 1954

1954 *Clathrolithus ellipticus* Deflandre in Deflandre & Fert, p. 169, pl. 12, fig. 19, pl. 14, fig. 7, text-figs. 123–124.

Occurrence. Early–middle Eocene (West well).

Genus ***Holodiscolithus*** Roth, 1970

Type species. *Discolithus macroporus* Deflandre in Deflandre & Fert, 1954. Early Paleocene–Quaternary; cosmopolitan.

Holodiscolithus solidus (Deflandre in Deflandre & Fert, 1954) Roth, 1970

1954 *Discolithus solidus* Deflandre in Deflandre & Fert, p. 141, pl. 12, figs. 14–16.
1970 *Holodiscolithus solidus* (Deflandre in Deflandre & Fert) Roth, p. 867, pl. 11, fig. 5.

Occurrence. Early Paleocene–early Eocene (North well).

Holodiscolithus sp.

Occurrence. Early Eocene (West well).

Genus ***Lanternithus*** Stradner, 19620

Type species. *Lanternithus minutus* Stradner, 1962. Middle Eocene–early Oligocene; cosmopolitan.

Lanternithus minutus Stradner, 1962

Figure 6.15

1962 *Lanternithus minutus* Stradner, p. 375, pl. 2, figs. 12–15.
2013 *Lanternithus minutus* Stradner – Pérez Panera, pl. 4. Fig. 27.
2019 *Lanternithus minutus* Stradner – Bedoya Agudelo, p. 204, pl. 4.5, fig. p, pl. 4.11, fig. q.

Occurrence. Late Eocene–early Oligocene (West well), middle Eocene–late Eocene (North well), early Eocene–middle Eocene (East well).

Lanternithus simplex Bown, 2005

2005 *Lanternithus simplex* Bown, p. 39, pl. 29, figs. 26-29, pl. 30, figs. 1–5.
2019 *Lanternithus simplex* Bown – Bedoya Agudelo, p. 204–205.

Occurrence. Early Eocene–middle Eocene (West, North, and East wells).

Lanternithus sp.

Remarks. All unidentified morphotypes of *Lanternithus* are included in this category.

Occurrence. Early Eocene–early Oligocene (West well), middle Eocene–early Oligocene (East well).

Genus ***Semihololithus*** Perch-Nielsen, 1971c

Type species. *Semihololithus biskayae* Perch-Nielsen, 1971c. Middle Paleocene–Late Eocene; cosmopolitan.

Semihololithus cf. ***kanungoi*** Bown, 2005

cf. 2005 *Semihololithus kanungoi* Bown, p. 41, pl. 31, figs. 21–25.

Occurrence. Early Eocene (West well).

Genus ***Zygrhablithus*** Deflandre, 1959

Type species. *Zygolithus bijugatus* Deflandre in Deflandre & Fert, 1954. Late Paleocene–early Miocene; cosmopolitan.

Zygrhablithus bijugatus bijugatus

(Deflandre in Deflandre & Fert, 1954) Deflandre, 1959

Figure 6.16

1954 *Zygolithus bijugatus* Deflandre in Deflandre & Fert, p. 148, pl. 11, figs. 20–21, text-fig. 59.
1959 *Zygrhablithus bijugatus* (Deflandre in Deflandre & Fert) Deflandre, p. 135.
1991 *Zygrhablithus bijugatus* (Deflandre in Deflandre & Fert) Deflandre – Concheyro, p. 396, pl. 2, fig. 22.
2009 *Zygrhablithus bijugatus* (Deflandre in Deflandre & Fert) Deflandre – Pérez Panera, pl. 3, fig. 3.
2013 *Zygrhablithus bijugatus* (Deflandre in Deflandre & Fert) Deflandre – Pérez Panera, pl. 4, fig. 28.
2019 *Zygrhablithus bijugatus* (Deflandre in Deflandre & Fert) Deflandre – Bedoya Agudelo, p. 205, pl. 4.6, fig. o, pl. 4.9, figs. r–s, pl. 4.12, fig. h, pl. 4.18, fig. a.

Occurrence. Early Eocene–early Oligocene (West and North wells), early Eocene–middle Eocene (East well).

Zygrhablithus bijugatus cornutus Bown, 2005

2005 *Zygrhablithus bijugatus cornutus* Bown, p. 41, pl. 32, figs. 11–15.

Occurrence. Early Oligocene (West well).

"NANNOLITHS"

Family BRAARUDOSPHAERACEAE Deflandre, 1947

Genus ***Braarudosphaera*** Deflandre, 1947

Type species. *Pontosphaera bigelowi* Gran & Braarud, 1935. Late Cretaceous–Holocene; cosmopolitan.

Braarudosphaera bigelowii

(Gran & Braarud, 1935) Deflandre, 1947

1935 *Pontosphaera bigelowi* Gran & Braarud, p. 388, fig. 67.
1947 *Braarudosphaera bigelowii* (Gran & Braarud, 1935) Deflandre, p. 439, figs. 1–5.

Occurrence. Early Paleocene–early Oligocene (West well), early Eocene–early Miocene (North and East wells).

Genus ***Micrantholithus*** Deflandre in Deflandre & Fert, 1954

Type species. *Micrantholithus flos* Deflandre, 1950 *ex* Deflandre in Deflandre & Fert, 1954. Middle Paleocene–early Oligocene; cosmopolitan.

Micrantholithus attenuatus Bramlette & Sullivan, 1961

1961 *Micrantholithus attenuatus* Bramlette & Sullivan, p. 154, pl. 8, figs. 8 a–b, 9–11.
non 1991 *Micrantholithus attenuatus* Bramlette & Sullivan – Concheyro, p. 389, pl. 2, fig. 17.

Occurrence. Early Eocene (North well).

Micrantholithus disculus

(Bramlette & Riedel, 1954) Bown, 2005 Figure 6.17

1954 *Braarudosphaera discula* Bramelette & Riedel, p. 394, pl. 38, fig. 7.
1991 *Braarudosphaera discula* Bramelette & Riedel – Concheyro, p. 389, pl. 2, fig. 15.
2005 *Micrantholithus discula* (Bramelette & Riedel) Bown, p. 42, pl. 34, figs. 23–27.
2016 *Micrantholithus disculus* (Bramelette & Riedel) Bown – Bown, p. 12.

Occurrence. Early–middle Eocene (West, North, and East wells).

***Micrantholithus flo*s**

Deflandre, 1950 *ex* Deflandre in Deflandre & Fert, 1954

1950 *Micrantholithus flos* Deflandre, p. 1158, figs. 8–11.
1954 *Micrantholithus flos* (Deflandre) Deflandre in Deflandre & Fert, p. 166, pl. 13, figs. 10–11. (Description and designation of holotype by the Author).
1991 *Micrantholithus attenuatus* Bramlette & Sullivan – Concheyro, p. 389, pl. 2, fig. 17.
2019 *Micrantholithus flos* Deflandre in Deflandre & Fert – Bedoya Agudelo, p. 206–207, pl. 4.10, figs. k–m.

Occurrence. Early Eocene (West well).

Order DISCOASTERALES Hay, 1977

Family DISCOASTERACEAE Tan, 1927

Genus ***Discoaster*** Tan, 1927

Type species. *Discoaster pentaradiatus* Tan, 1927. Late Miocene–Quaternary; cosmopolitan.

Discoaster deflandrei Bramlette & Riedel, 1954

1954 *Discoaster deflandrei* Bramlette & Riedel, p. 399, pl. 39, fig. 6, text-figs. 1 a–c.
2013 *Discoaster deflandrei* Bramlette & Riedel – Pérez Panera, pl. 4, fig. 29.
2019 *Discoaster deflandrei* Bramlette & Riedel – Bedoya Agudelo, p. 209.

Occurrence. Late Eocene (West well).

Discoaster saipanensis Bramlette & Riedel, 1954

Figure 6.18

1954 *Discoaster saipanensis* Bramlette & Riedel, p. 398, pl. 39, fig. 4
1991 *Discoaster saipanensis* Bramlette & Riedel – Concheyro, p. 396, pl. 2, fig. 18.
2019 *Discoaster saipanensis* Bramlette & Riedel – Bedoya Agudelo, p. 210.

Remarks. The LO of *Discoaster saipanensis* is a widely used marker for the top of the Eocene (Perch-Nielsen, 1985), but is not useful in the Magallanes Basin since all its occurrences are from the middle Eocene (Concheyro, 1991; Bedoya Agudelo, 2019; this work). As the Magallanes Basin is in high latitude and discoasters are typically warm-water and oligotrophic species (Aubry, 1992; Bralower, 2002; Villa *et al.*, 2014), the presence of *D. saipanensis* seems to be related to the Middle Eocene Climatic Optimum (MECO). Eventually, its presence could be useful for the identification of this global climatic event and thereby for local biostratigraphic correlation.

Occurrence. Middle Eocene (West well).

Family FASCICULITHACEAE Hay & Mohler, 1967

Genus ***Fasciculithus*** Bramlette & Sullivan, 1961

Type species. *Fasciculithus involutus* Bramlette & Sullivan, 1961. Middle Paleocene–early Eocene; cosmopolitan.

Fasciculithus tympaniformis Hay & Mohler in Hay *et al.*, 1967

Figure 6.19–20

1967 *Fasciculithus tympaniformis* Hay & Mohler in Hay *et al.*, p. 447, pls. 8–9, figs. 1–5.
2019 *Fasciculithus tympaniformis* Hay & Mohler in Hay *et al.* – Bedoya Agudelo, p. 213–214, pl. 4.1, fig. f, pl. 4.4, fig. ñ.

Remarks. In the Magallanes Basin, this taxon is rare and not consistently present but useful for the identification of the earliest Eocene, when present.

Occurrence. Middle Paleocene (West well), early Eocene (North well).

Family SPHENOLITHACEAE Deflandre, 1952

Genus ***Sphenolithus*** Deflandre in Grassé, 1952

Type species. *Sphenolithus radians* Deflandre in Grassé, 1952. Early Eocene–early Oligocene; cosmopolitan.

Sphenolithus moriformis (Brönnimann & Stradner, 1960) Bramlette & Wilcoxon, 1967

1960 *Nannoturbella moriformis* Brönnimann & Stradner, p. 368, figs. 11–16.
1967 *Sphenolithus moriformis* (Brönnimann & Stradner) Bramlette & Wilcoxon, p. 124, 126, pl. 3, figs. 1–6.
2019 *Sphenolithus moriformis* (Brönnimann & Stradner) Bramlette & Wilcoxon – Bedoya Agudelo, p. 217, pl. 4.8, figs. p–q.

Occurrence. Late Eocene (West well), middle Eocene–early Oligocene (North well), early Miocene (East well).

Sphenolithus orphanknollensis Perch-Nielsen, 1971c

1971c *Sphenolithus orphanknolli* Perch-Nielsen, p. 56-57, pl. 3, figs. 1–3, pl. 7, figs. 30–32.

Occurrence. Early–middle Eocene (North well).

Division PYRROPHYTA Pascher, 1914
Class DINOPHYCEAE Fritsch, 1929
Subclass PRYMNESIOPHYCIDAE Cavalier-Smith, 1986
Order THORACOSPHAERALES Tangen in Tangen *et al.*, 1982
Family THORACOSPHAERACEAE Schiller, 1930 *emend.* Tangen in Tangen *et al.*, 1982

Genus ***Cervisiella*** Hildebrand-Habel *et al.*, 1999

Type species. *Cervisiella saxea* (Stradner, 1961) Hildebrand-Habel *et al.*, 1999. Maastrichtian–Miocene; cosmopolitan.

Cervisiella sp.

Occurrence. Paleocene–early Miocene (West and North wells), early Eocene–early Miocene (East well).

Genus ***Thoracosphaera*** Kamptner, 1927

Type species. *Thoracosphaera pelagica* Kamptner, 1927. Late Cretaceous–Holocene; cosmopolitan.

Thoracosphaera heimii (Lohmann, 1920) Kamptner, 1944

1920 *Syracosphaera heimii* Lohmann, p. 117, fig. 29.
1944 *Thoracosphaera heimii* (Lohmann, 1920) Kamptner, p. 118.

Occurrence. Late Eocene–early Miocene (North well), middle Eocene (East well).

DISCUSSION

The succession of Cenozoic sediments penetrated by the three wells represents marine facies from the uppermost early Miocene down to the early Paleocene. Table 1 summarizes the assemblages, correlatable surface and subsurface formations (after Malumián & Jannou, 2010; Malumián *et al.*, 2013; Pérez Panera, 2013), and main biomarkers of the three wells, obtained by the two studied disciplines.

The early–middle Paleocene is only indicated by a few calcareous nannofossil specimens of *Prinsius tenuiculus* and *Hornibrookina edwardsii*, similar to findings in other areas of the basin from the Campo Bola Formation (Pérez Panera, 2013; González Estebenet *et al.*, 2021) (Tab. 1). The classic cosmopolitan Midway-fauna (Berggren & Aubert, 1975), which has been described from other parts of the basin (Caramés & Malumián, 1999; Malumián & Jannou, 2010; Malumián *et al.*, 2013), is completely missing in these wells. Instead, the microfossils are only represented by agglutinated foraminifera, with most of them remaining undetermined due to their poor preservation. An indistinguishably similar fauna was recorded from the Maastrichtian of the same wells (Thissen & Pérez Panera, 2020a). Between the Paleocene and the overlying early Eocene an important unconformity exists, evidenced by the absence of Thanetian strata.

The early Eocene is marked by the planktic foraminiferal species *Subbotina triloculinoides* (*sensu* Jenkins, 1971) and *Globanomalina australiformis* (Malumián *et al.*, 2013). This assemblage bears similarities with the lower Agua Fresca shale and the Punta Noguera and Punta Torcida formations (Todd & Kniker, 1952; Malumián, 1990a; Malumián *et al.*, 2013) (Tab. 1). Abundances and preservation are strongly reduced in these layers due to the deposition within a glauconite-rich sandstone (Olivero *et al.*, 2002; Olivero &

Malumián, 2008). High abundances of radiolarians are evidence of a deepening of the basin and unfavourable conditions for the fossilization of calcareous tests (Jannou & Olivero, 2001; Jannou, 2007; Malumián & Jannou, 2010). *Chiasmolithus bidens*, *Fasciculithus tympaniformis*, *Prinsius martini*, *Toweius rotundus*, and *T. occultatus* are the most distinctive calcareous nannofossil species in this part of the succession. They can be correlated to the nannofossil assemblages and events recorded at Punta Torcida Formation (Pérez Panera *et al.*, 2017). The most characteristic event is the *Toweius/Reticulofenestra* turnover which has been recorded in high to low latitudes worldwide and occurs in the Ypresian, around NP13 Biozone (*i.e.*, Agnini *et al.*, 2006, 2014; Shamrock & Watkins, 2012; Shepherd & Kulhanek, 2016).

The middle–late Eocene assemblage contains a foraminiferal assemblage that includes the representative planktic species *Globigerinatheka index* and *Acarinina primitiva*, which are global markers for this time. The benthic microfauna, that consists of typical Eocene species like *Virgulinella severini*, *Lenticulina alatolimbata*, *Bathysiphon eocenicus*, *Heterolepa perlucida* and *Elphidium saginatum* allows the correlation of this section with the La Despedida group from the Argentinian sector of the Isla Grande de Tierra del Fuego (Malumián, 1989, 1990a) as well as to the Agua Fresca shale from the Brunswick Peninsula in southernmost Chile (Todd & Kniker, 1952) (Tab. 1). *Boltovskoyella*, a classic marker of the late Eocene from the province of Santa Cruz (Malumián & Masiuk, 1972; Ronchi & Angelozzi, 1994), is not represented in the wells from

TABLE 1 - Formations, foraminiferal and nannofossil assemblages and markers.

Formation	Age	Micro markers	Nanno markers
Carmen Silva		*Trilobatus sicanus*	Low diversity of Cz taxa *Helicosphaera carteri* *Reticulofenestra minuta*
Monte León	early Miocene – late Oligocene	Nonionids *Globoturborotalita euapertura* Agglutinated foraminifera	*Reticulofenestra dictyoda* *Reticulofenestra daviesii*
San Julián			*Chiasmolithus altus* *Helicosphaera ethologa* *Reticulofenestra circus* *Reticulofenestra hillae* *Reticulofenestra umbilicus*
Cabo Peña	early Oligocene	*Globoturborotalita labiacrassata* *Subbotina angiporoides*	*Chiasmolithus oamaruensis* *Isthmolithus recurvus*
La Despedida	late Eocene	*Virgulinella severini* *Globigerinatheka index*	*Pontosphaera pulchra* *Reticulofenestra reticulata* *Isthmolithus recurvus* *Chiasmolithus oamaruensis*
Man Aike	–		*Coccolithus staurion*
Agua Fresca	middle Eocene	*Acarinina primitiva*	*Chiasmolithus modestus* *Discoaster saipanensis* *Chiasmolithus solitus* *Neococcolithes protenus*
Punta Noguera Punta Torcida	early Eocene	*Globanomalina australiformis* *Subbotina triloculinoides* Radiolarians	*Toweius callosus* Tow./ Ret. turnover *Toweius pertusus* *Chiasmolithus bidens* *Prinsius martini* *Fasciculithus tympaniformis*
Campo Bola	Paleocene	Agglutinated foraminifera	*Chiasmolithus danicus* *Prinsius dimorphosus* *Hornibrookina edwardsii* *Prinsius tenuiculus*

Tierra del Fuego studied in this contribution. In terms of calcareous nannofossils, the section includes two well differentiated assemblages. In the lower part, *Chiasmolithus modestus*, *C. grandis*, *C. solitus*, *Neococcolithes protenus*, the FO of *Reticulofenestra reticulata*, and the presence of *Discoaster saipanensis* allow a correlation to the middle Eocene Man Aike Formation from the province of Santa Cruz (Concheyro, 1991; Pérez Panera, 2009, 2013). In the upper part, FOs of *Isthmolithus recurvus*, *Chiasmolithus oamaruensis*, *Reticulofenestra oamaruensis* at the bottom, and LOs of *Reticulofenestra reticulata* and *Pontosphaera pulchra*, define a late Eocene succession.

During the early Oligocene, the faunal composition shifts to a predominance of agglutinated foraminifera, comparable to the stratigraphically important *Martinottiella-Spirosigmoilinella* assemblage (Malumián, 1968; Malumián & Náñez, 1988; Náñez *et al.*, 2009). This microfauna correlates to a fauna previously described by Malumián & Náñez (1988) from the Cabo Peña Formation (Tab. 1). Increasing numbers of planktic foraminifera like *Globoturborotalita euapertura*, *G. labiacrassata* and *Subbotina angiporoides*, as well as indicative calcareous nannofossils like *Chiasmolithus altus*, *C. oamaruensis*, *Reticulofenestra oamaruensis*, *R. hillae*, *R. circus*, *R. umbilicus*, *Isthmolithus recurvus*, and *Helicosphaera ethologa* are characteristic of early Oligocene strata in the Magallanes Basin (Scarpa & Malumián, 2008; Malumián & Jannou, 2010; Pérez Panera, 2013; Thissen & Pérez Panera, 2019).

The late Oligocene–early Miocene assemblage presents the greatest uncertainties among all the assemblages distinguished here. In the Magallanes Basin, the Oligocene/Miocene boundary is very difficult to determine, due to the absence of marker species, poor preservation, low species richness, and no evidence for a sudden turnover in the faunal composition (Thissen *et al.*, 2018). The assemblage is dominated by nonionid foraminifers in the middle part of this section, a fauna typical of early Miocene age in the basin, previously described by Bertels (1977, 1980) from the San Julián and Monte León formations (Tab. 1). The dominance of reticulofenestrid nannofossils supports this assessment (Náñez & Pérez Panera, 2017; Parras *et al.*, 2020). The age of the top of this section is difficult to determine due to barren samples, poor preservation of the few recovered microfossils, and the absence of marker species. At least, in the well West, the planktic foraminifer *Trilobatus sicanus* allows an estimation of the uppermost sediments penetrated by the well. This species has a short range across the Burdigalian/Langhian boundary (see Bown *et al.*, 2020), *i.e.*, its occurrence in the uppermost sample of the well restricts the sediments to an age not younger than the lowermost middle Miocene.

CONCLUSIONS

In summary, five assemblages were recorded in the succession of Paleogene and Neogene sediments from the wells West, North and East. These sediments are of early–middle Paleocene, early Eocene, middle–late Eocene, early Oligocene, and late Oligocene–early Miocene age. These assemblages allow correlation of the drilled sediments with formations previously studied in the Magallanes Basin, which include Campo Bola, Punta Torcida, Punta Noguera, Agua Fresca, La Despedida, Man Aike, Cabo Peña, San Julián, Monte León, and Carmen Silva (see Malumián & Jannou, 2010; Malumián *et al.*, 2013; Pérez Panera, 2013; Bedoya Agudelo, 2019) (Tab. 1).

There is a well determinable biostratigraphical hiatus of late Paleocene age, evidenced by a distinct faunal turnover between the early–middle Paleocene and the early Eocene assemblages. This unconformity is continuous across all three studied wells.

The presence of exclusively agglutinated foraminifera, the few nannofossils found in the Paleocene, and the affinities with the underlying Maastrichtian assemblage impede the determination of the exact position of the K/Pg boundary in these wells, which will be discussed in more detail in another contribution.

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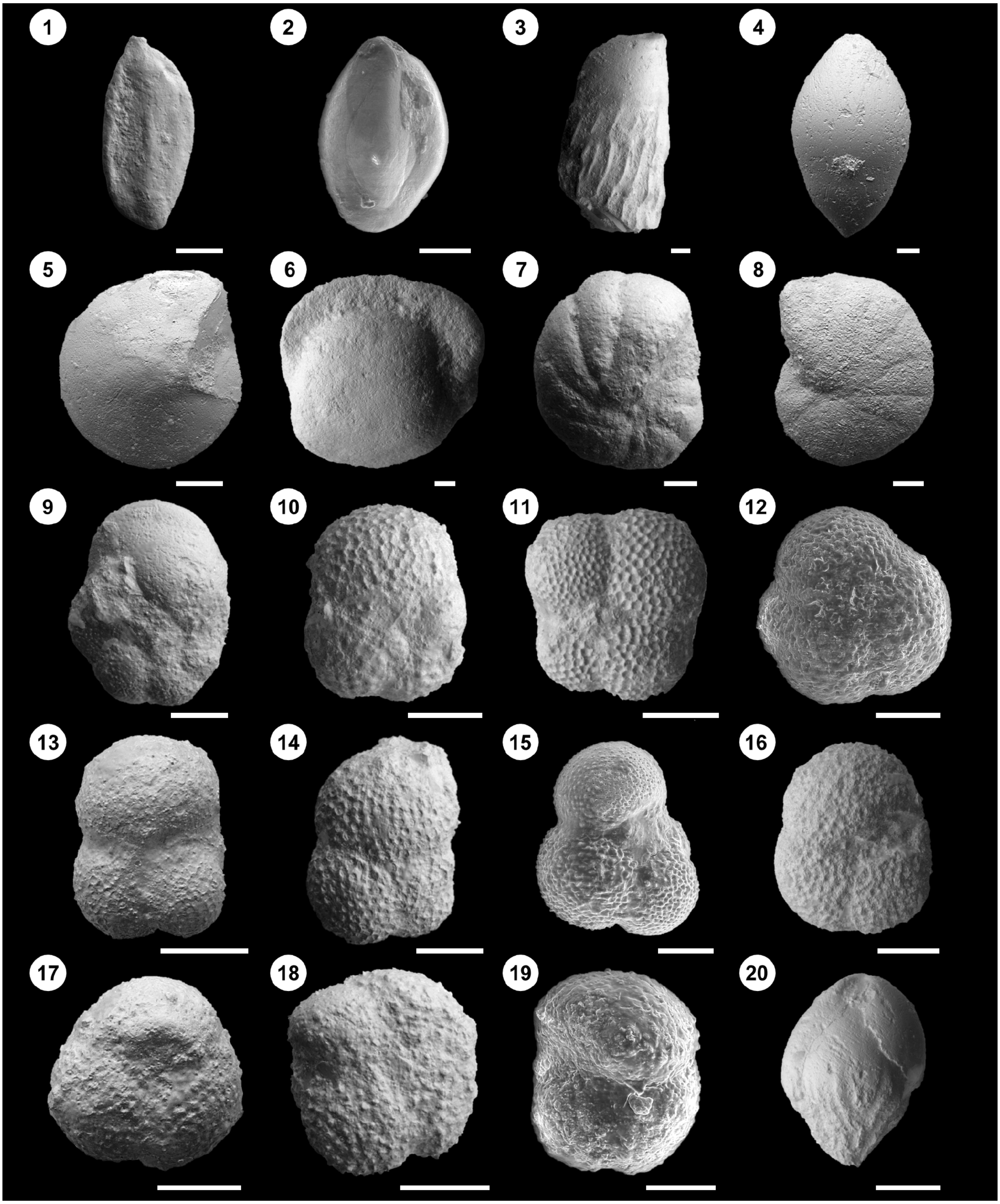

Figure 2. Cenozoic foraminifera recovered from the three studied wells, photographed with a scanning electron microscope. **1,** ***Spirosigmoilinella compressa***, West well, **YT.RMP_M.000011.17**; **2,** ***Quinqueloculina akneriana***, East well, **YT.RMP_M.000010.2**; **3,** ***Vaginulinopsis hochstetteri***, North well, **YT.RMP_M.000011.23**; **4,** ***Glandulina laevigata***, East well, **YT.RMP_M.000010.23**; **5,** ***Hoeglundina elegans***, East well, **YT.RMP_M.000010.9**; **6,** ***Cribrostomoides*** sp., North well, **YT.RMP_M.000008.21**; **7,** ***Alveolophragmium*** sp., West well, **YT.RMP_M.000011.24**; **8,** ***Cyclammina incisa***, East well, **YT.RMP_M.000010.15**; **9,** ***Globanomalina chapmani***, West well, **YT.RMP_M.000011.34**; **10,** ***Catapsydrax unicavus***, North well, **YT.RMP_M.000008.25**; **11,** ***Paragloborotalia nana***, West well, **YT.RMP_M.000011.17**; **12,** ***Subbotina angiporoides***, East well, **YT.RMP_M.000010.16**; **13,** ***Subbotina patagonica***, East well, **YT.RMP_M.000010.23**; **14,** ***Subbotina triloculinoides***, West well, **YT.RMP_M.000011.34**; **15,** ***Globigerina bulloides***, West well, **YT.RMP_M.000011.8**; **16,** ***Globoturborotalita euapertura***, West well, **YT.RMP_M.000011.17**; **17,** ***Globigerinatheka index***, East well, **YT.RMP_M.000010.19**; **18,** ***Acarinina collactea***, West well, **YT.RMP_M.000011.31**; **19,** ***Acarinina primitiva***, East well, **YT.RMP_M.000010.27**; **20,** ***Bulimina alsatica***, West well, **YT.RMP_M.000011.17**. Scale bar= 100 µm.

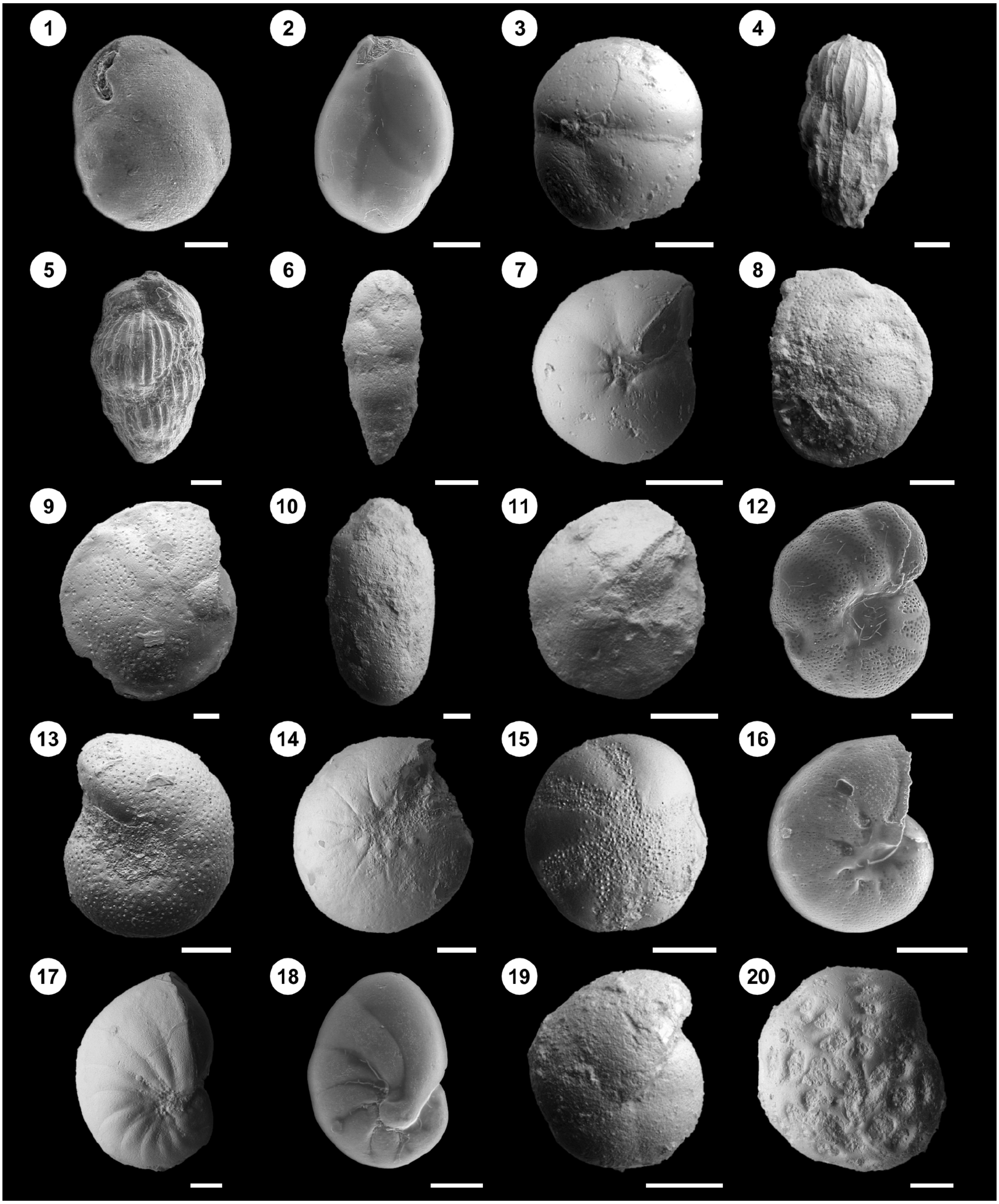

Figure 3. Cenozoic foraminifera recovered from the three studied wells, photographed with a scanning electron microscope. **1,** ***Globocassidulina subglobosa***, West well, **YT.RMP_M.000011.4**; **2,** ***Globobulimina*** **sp. A**, West well, **YT.RMP_M.000011.4**; **3,** ***Sphaeroidina bulloides***, West well, **YT.RMP_M.000011.17**; **4,** ***Uvigerina gallowayi***, West well, **YT.RMP_M.000011.17**; **5,** ***Uvigerina peregrina***, East well, **YT.RMP_M.000010.21**; **6,** ***Virgulinella severini***, East well, **YT.RMP_M.000010.20**; **7,** ***Gyroidinoides zelandica***, North well, **YT.RMP_M.000008.7**; **8,** ***Cibicidoides wuellerstorfi***, West well, **YT.RMP_M.000011.25**; **9,** ***Heterolepa perlucida***, East well, **YT.RMP_M.000010.20**; **10,** ***Chilostomella cylindroides***, West well, **YT.RMP_M.000011.36**; **11,** ***Oridorsalis umbonatus***, East well, **YT.RMP_M.000010.22**; **12,** ***Anomalinoides orbiculus***, West well, **YT.RMP_M.000011.4**; **13,** ***Anomalinoides pinguiglaber***, East well, **YT.RMP_M.000010.26**; **14,** ***Hansenisca soldanii***, North well, **YT.RMP_M.000008.2**; **15,** ***Buccella peruviana***, North well, **YT.RMP_M.000008.2**; **16,** ***Astrononion echolsi***, West well, **YT.RMP_M.000011.8**; **17,** ***Nonion deceptrix***, North well, **YT.RMP_M.000008.1**; **18,** ***Nonionella auris***, West well, **YT.RMP_M.000011.6**; **19,** ***Pullenia bulloides***, West well, **YT.RMP_M.000011.23**; **20,** ***Elphidium saginatum***, North well, **YT.RMP_M.000008.28**. Scale bar= 100 µm.

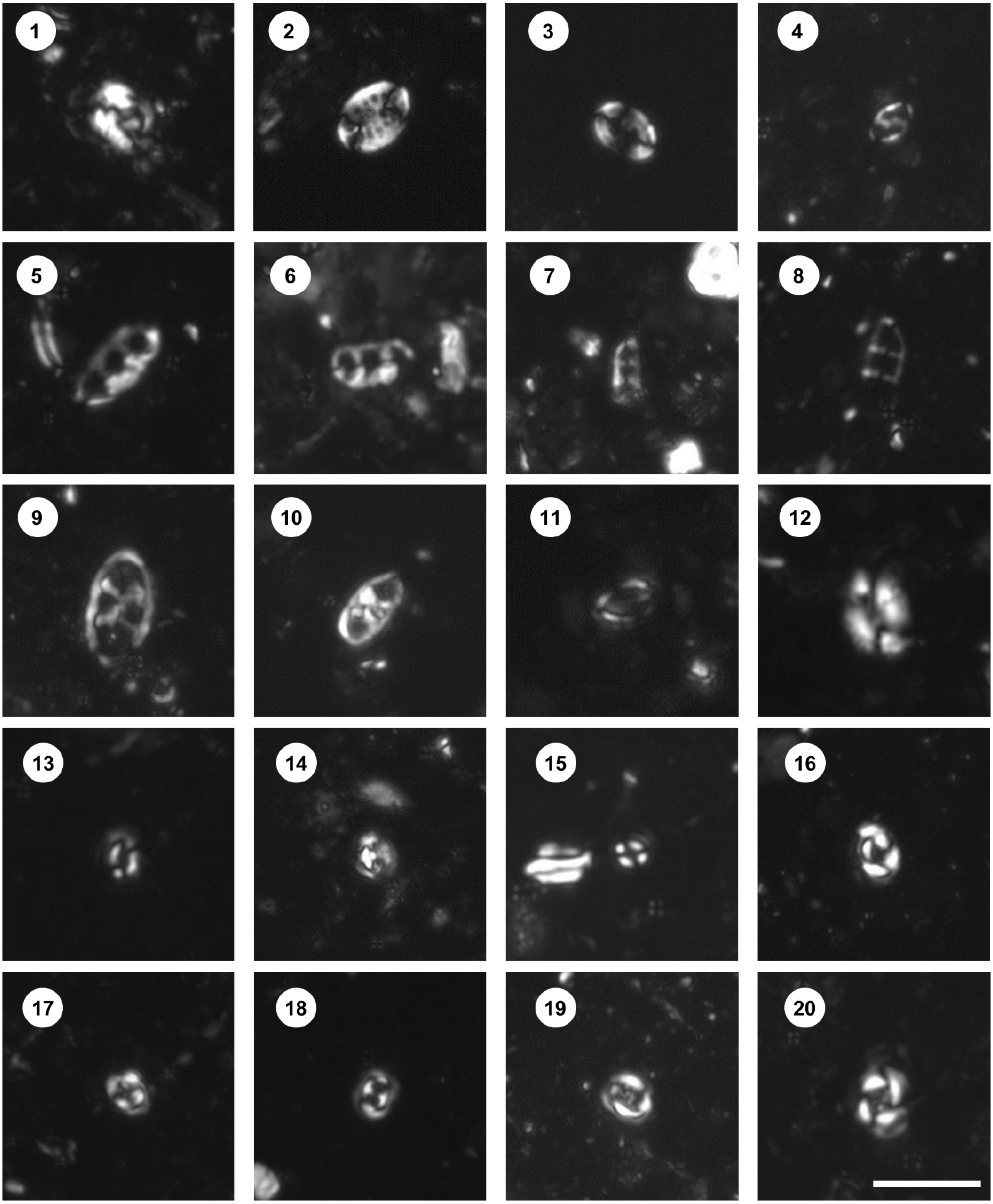

Figure 4. Cenozoic calcareous nannofossils recovered from the three studied wells, photographed with an optical microscope and polarized light. **1,** ***Helicosphaera lophota***, North well, **YT.RMP_N.000008.22**; **2,** ***Pontosphaera multipora***, West well, **YT.RMP_N.000011.20**; **3,** ***Pontosphaera pulchra***, West well, **YT.RMP_N.000011.23**; **4,** ***Pontosphaera pygmaea***, East well, **YT.RMP_N.000010.11**; **5,** ***Isthmolithus recurvus***, North well, **YT.RMP_N.000008.18**; **6,** ***Isthmolithus recurvus***, North well, **YT.RMP_N.000008.17**; **7,** ***Isthmolithus recurvus***, West well, **YT.RMP_N.000011.24**; **8,** ***Isthmolithus recurvus***, West well, **YT.RMP_N.000011.22**; **9,** ***Neococcolithes minutus***, West well, **YT.RMP_N.000011.35**; **10,** ***Neococcolithes protenus***, West well, **YT.RMP_N.000011.28**; **11,** ***Hornibrookina edwardsii***, West well, **YT.RMP_N.000011.39**; **12,** ***Hornibrookina nicolasii***, North well, **YT.RMP_N.000008.21**; **13,** ***Prinsius dimorphosus***, North well, **YT.RMP_N.000008.32**; **14,** ***Prinsius martinii***, West well, **YT.RMP_N.000011.34**; **15,** ***Prinsius tenuiculus***, North well, **YT.RMP_N.000008.32**; **16,** ***Toweius callosus***, West well, **YT.RMP_N.000011.36**; **17,** ***Toweius eminens***, East well, **YT.RMP_N.000010.24**; **18,** ***Toweius occultatus***, East well, **YT.RMP_N.000010.23**; **19,** ***Toweius pertusus***, West well, **YT.RMP_N.000011.35**; **20,** ***Toweius rotundus***, North well, **YT.RMP_N.000008.32**. Scale bar= 10 µm.

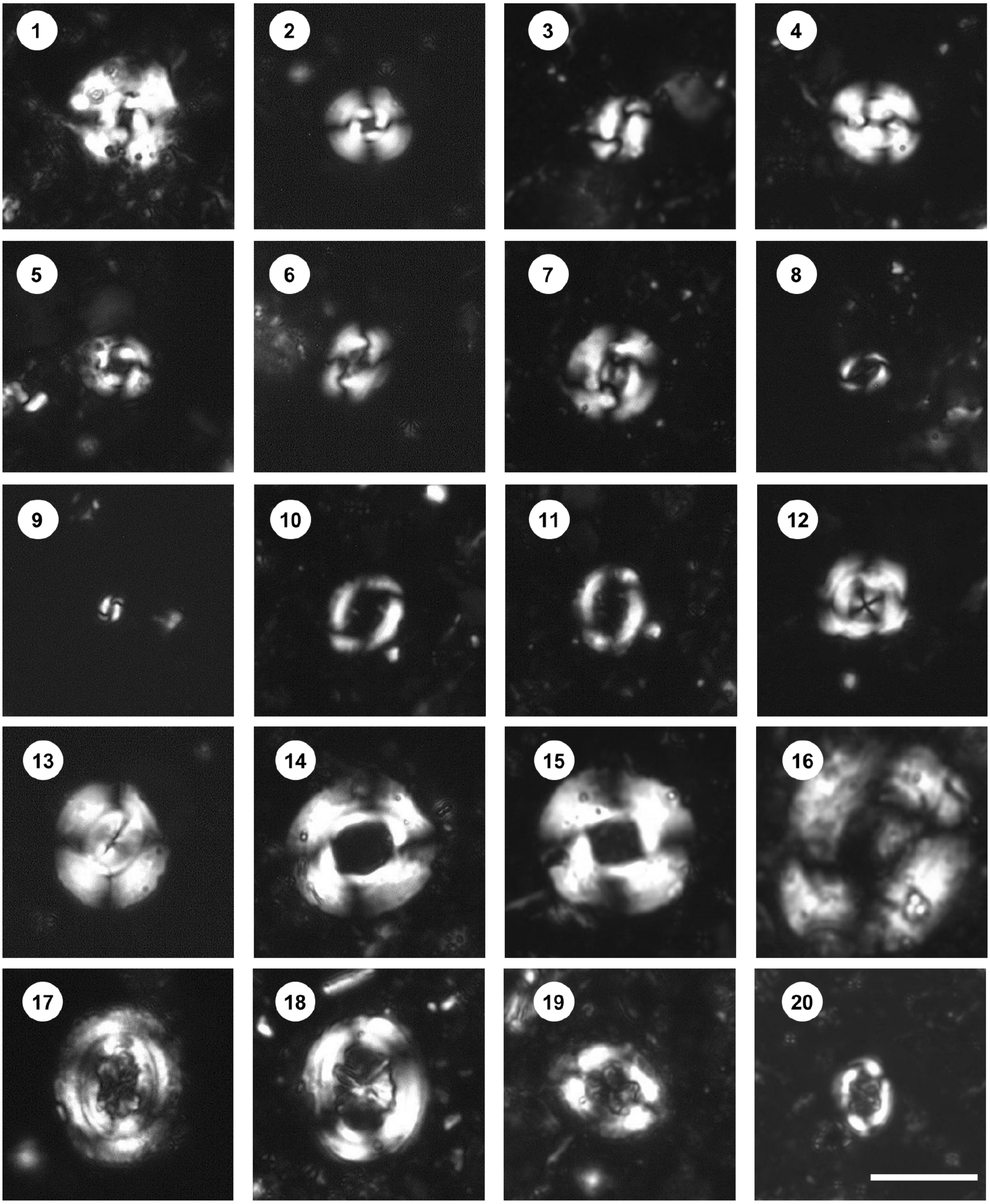

Figure 5. Cenozoic calcareous nannofossils recovered from the three studied wells, photographed with an optical microscope and polarized light. **1,** ***Cyclicargolithus abisectus,*** West well, **YT.RMP_N.000011.11**; **2,** ***Cyclicargolithus floridanus***, West well, **YT.RMP_N.000011.19**; **3,** ***Reticulofenestra bisecta,*** West well, **YT.RMP_N.000011.5**; **4,** ***Reticulofenestra daviesii,*** West well, **YT.RMP_N.000011.22**; **5,** ***Reticulofenestra circus***, West well, **YT.RMP_N.000011.18**; **6,** ***Reticulofenestra daviesii***, West well, **YT.RMP_N.000011.19**; **7,** ***Reticulofenestra filewiczii***, West well, **YT.RMP_N.000011.18**; **8,** ***Reticulofenestra hampdenensis***, West well, **YT.RMP_N.000011.18**; **9,** ***Reticulofenestra minuta***, West well, **YT.RMP_N.000011.1**; **10–11,** ***Reticulofenestra oamaruensis***, West well, **YT.RMP_N.000011.21**; **12,** ***Reticulofenestra reticulata***, West well, **YT.RMP_N.000011.23**; **13,** ***Reticulofenestra stavensis***, West well, **YT.RMP_N.000011.19**; **14,** ***Reticulofenestra umbilicus***, West well, **YT.RMP_N.000011.21**; **15,** ***Reticulofenestra umbilicus***, North well, **YT.RMP_N.000008.18**; **16,** ***Reticulofenestra umbilicus***, North well, **YT.RMP_N.000008.16**; **17,** ***Chiasmolithus altus***, West well, **YT.RMP_N.000011.11**; **18,** ***Chiasmolithus altus***, West well, **YT.RMP_N.000011.21**; **19,** ***Chiasmolithus bidens***, West well, **YT.RMP_N.000011.32**; **20,** ***Chiasmolithus danicus***, East well, **YT.RMP_N.000010.26**. Scale bar= 10 µm.

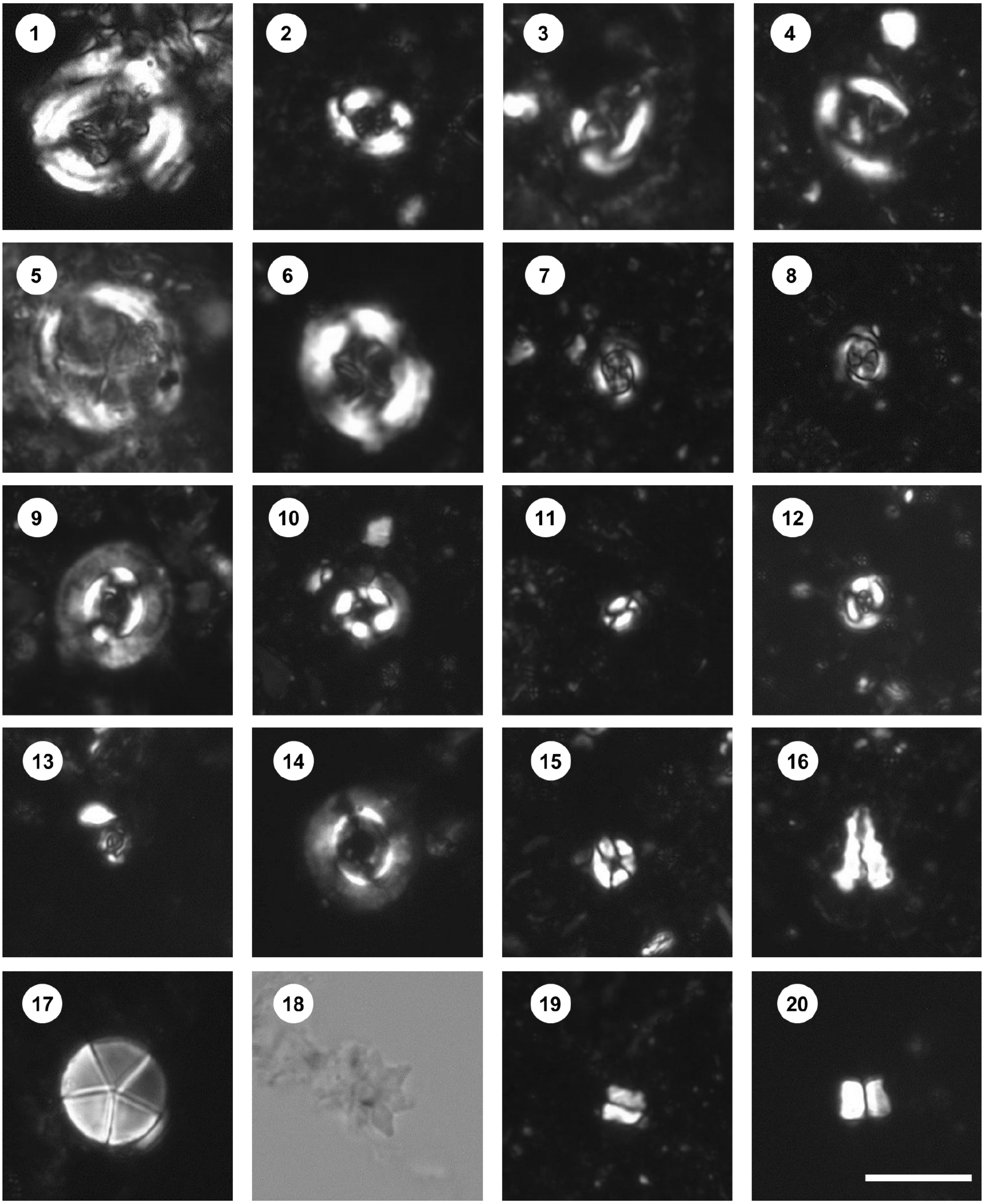

Figure 6. Cenozoic calcareous nannofossils recovered from the three studied wells, photographed with an optical microscope and polarized light. **1,** ***Chiasmolithus grandis***, West well, **YT.RMP_N.000011.27**; **2,** ***Chiasmolithus modestus***, North well, **YT.RMP_N.000008.24**; **3,** ***Chiasmolithus nitidus***, North well, **YT.RMP_N.000008.25**; **4,** ***Chiasmolithus oamaruensis***, West well, **YT.RMP_N.000011.24**; **5,** ***Chiasmolithus oamaruensis***, North well, **YT.RMP_N.000008.18**; **6,** ***Chiasmolithus solitus***, North well, **YT.RMP_N.000008.24**; **7,** ***Clausicoccus fenestratus***, North well, **YT.RMP_N.000008.16**; **8,** ***Clausicoccus subdistichus***, West well, **YT.RMP_N.000011.21**; **9,** ***Coccolithus eopelagicus***, North well, **YT.RMP_N.000008.25**; **10,** ***Coccolithus formosus***, West well, **YT.RMP_N.000011.24**; **11,** ***Coccolithus pelagicus***, West well, **YT.RMP_N.000011.24**; **12,** ***Cruciplacolithus frequens***, West well, **YT.RMP_N.000011.40**; **13,** ***Cruciplacolithus primus***, West well, **YT.RMP_N.000011.45**; **14,** ***Umbilicosphaera edgariae***, West well, **YT.RMP_N.000011.28**; **15,** ***Lanternithus minutus***, West well, **YT.RMP_N.000011.23**; **16,** ***Zygrhablithus bijugatus bijugatus***, West well, **YT.RMP_N.000011.25**; **17,** ***Micrantholithus disculus***, West well, **YT.RMP_N.000011.26**; **18,** ***Discoaster saipanensis***, West well, **YT.RMP_N.000011.28**; **19,** ***Fasciculithus tympaniformis***, North well, **YT.RMP_N.000008.29**; **20,** ***Fasciculithus tympaniformis***, West well, **YT.RMP_N.000011.44**. Scale bar= 10 µm

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