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High-resolution quantitative record of planktonic foraminifera at low latitudes (ODP Leg 154 Site 926): biostratigraphy and paleoecology of the Aquitanian-Burdigalian interval

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ABSTRACT

Very few high-resolution quantitative records of planktonic foraminifera have been established for the Aquitanian to Burdigalian interval, particularly at low latitudes. In addition, the Burdigalian GSSP has not yet been defined, and there is still a debate about which bioevents provide the best approximation of the boundary.

Provisionally, the Base of the calcareous nannofossil *Helicosphaera ampliaperta* (calibrated at Ceara Rise at 20.43 Ma) has been chosen for the recognition of the base of Burdigalian Stage (e.g., Raffi et al., 2020). However, other events were proposed to define the boundary, such as Top *Paragloborotalia kugleri* (21.12 Ma), Base *Globigerinoides altiapturus* (19.97 Ma), Top of Chron C6An (19.97 Ma), Base of calcareous nannofossil *Sphenolithus belemnoides* (19.01 Ma) (e.g., Raffi et al., 2020). The aim of this work was to improve the resolution of planktonic foraminiferal record of the Aquitanian – Burdigalian interval, refine the stratigraphic position of bioevents and their age calibration, possibly identifying additional events, and obtain a paleoecological interpretation of the studied assemblages.

The first part of this work deals with a high-resolution quantitative analysis of the planktonic foraminiferal assemblages of Site 926 (ODP Leg 154, Ceara Rise, Equatorial Atlantic Ocean), in the interval from 21.5 to 17.6 Ma (Aquitanian-Burdigalian). Following the composite section of Site 926, astronomically calibrated by Shackleton et al. (1999) and Pälike et al. (2006a), 137 samples were selected from pale levels of nannofossil-foraminiferal chalk with a time resolution of ~30 kyr. The high-resolution quantitative analysis provided the quantitative distribution patterns of the 55 taxonomic categories identified in the assemblages. Particular focus was given to biostratigraphic marker species of this interval, typical of the low-latitude zonation (Wade et al., 2011; King et al., 2020), such as Top (T) *Paragloborotalia pseudokugleri*, Top *P. kugleri*, Top *Tenuitella munda*, Base (B) *Globigerinoides altiapturus*, Base *Globigerinatella* sp. and Base *Globorotalia praescitula*.

In the second part of this study, the high-resolution quantitative analysis was extended downwards in Hole 926B, selecting 44 samples after a qualitative survey and focusing on the *Paragloborotalia pseudokugleri*/*P. kugleri* group. This choice was made to obtain the quantitative distribution pattern of the group from the first occurrence of *P. kugleri*, close to the Oligo-Miocene boundary, to its last occurrence in the Aquitanian - Burdigalian interval, to observe the gradual morphological transition between the end members of this plexus and to better understand the evolution of *P. kugleri*.

The last part of this study deals with paleoecological evaluations on the planktonic foraminifera of the Aquitanian – Burdigalian interval, considering specific diversity, preservation state, depth habitat, temperature preference and productivity.

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1. Introduction

1.1. Planktonic foraminifera and Biostratigraphy

Planktonic foraminifera are marine protozoans with calcareous shells and chambered tests living in the upper part of the water column of modern oceans and seas. They first appeared in the mid-Jurassic, around 170 Ma and since the Early Cretaceous showed a progressive diversification with the appearance of new taxa (Frerichs et al., 1972; Caron & Homewood, 1983; Schiebel & Hemleben, 2017). Furthermore, they had two important mass extinctions at the Aptian/Albian (113 Ma) and Cretaceous/Paleogene (66 Ma) boundaries (Patterson et al., 2004) (Fig. 1.1).

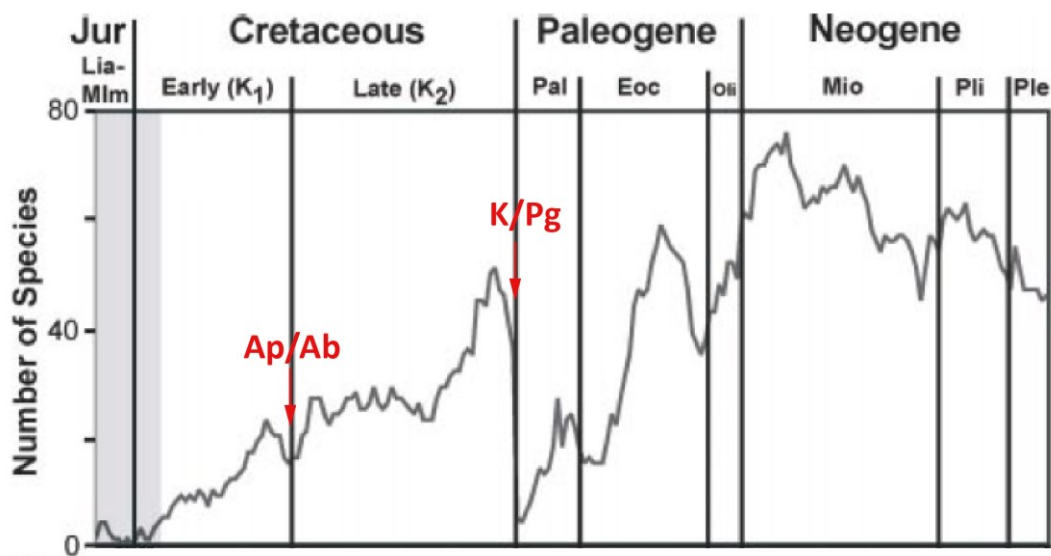


Fig. 1.1 - The number of planktonic foraminiferal species from the Jurassic through Recent as defined by speciation and extinction events. (modified from Patterson et al., 2004)

Due to their calcareous shell's high preservation potential within marine sedimentary rocks, they are commonly used in various geoscience fields, such as biostratigraphy, paleoecology, paleoceanography and paleoclimatology.

Planktonic foraminifera are valuable indicators of a rock's formation age and are extensively used in biostratigraphy. Indeed, although they do not live on the seabed (rock-forming environment), they rapidly sink to the bottom with sediment particles (future rocks), so they can be used for dating and correlations. They are particularly reliable for the oceanic province and the outer portion of the neritic zone, as their living environment generally excludes the inner neritic areas. They are excellent index fossils because they are morphologically distinct, diverse, rapidly evolving (short vertical distribution), highly abundant, often globally distributed, and have high preservation potential. As such, they are widely used for the biostratigraphy of Cretaceous and Cenozoic marine sediments and are fundamental components of chronostratigraphy (Schiebel & Hemleben, 2017).

Starting from the mid-nineteenth century, a standard biostratigraphic practice has been to divide stratigraphic sections into zones and subzones (Hedberg, 1976), known as biozones (Fig. 1.2). These are non-overlapping portions of a stratigraphic succession that are characterized by a

particular fossil content and are located between distinct biohorizons (McGowran, 2005). Biohorizons are levels, in a stratigraphic succession, where changes in the fossil record occur (e.g., appearances, disappearances, abundance variations, evolutionary changes, and also changes in coiling direction), that can be thought of as correlatable levels between stratigraphic sections. Hence, zones and subzones enable the identification of broad and easily recognizable intervals of stratigraphy, which can be confidently correlated regionally and/or globally (Wade et al., 2011). Following the more recent biozonal schemes (e.g., Wade et al., 2011; King et al., 2020), five types of biozones are currently used that are based on stratigraphic lowest and highest occurrences of fossil species (LO and HO or Base and Top) (Fig. 1.3).

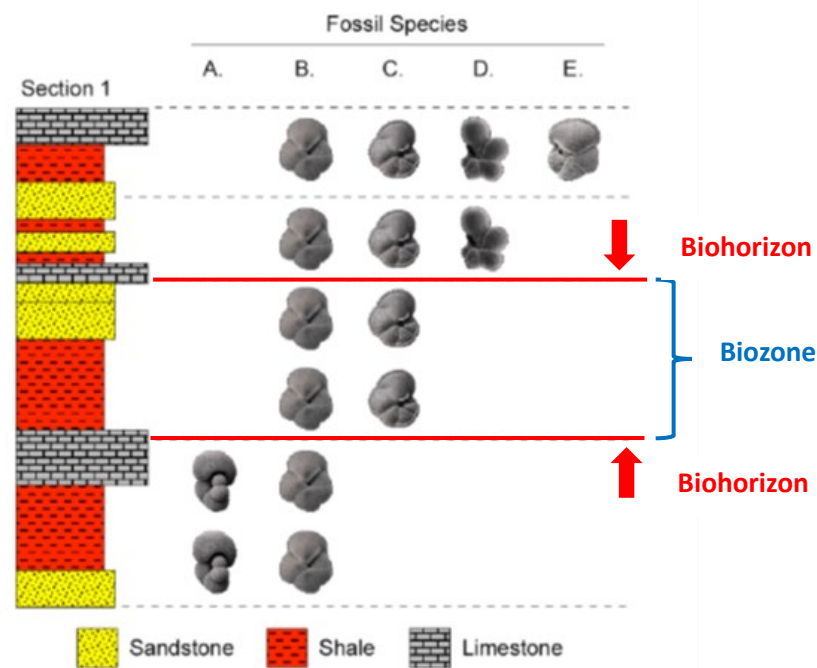


Fig. 1.2 – Example of biohorizons and biozones. (modified from MacLeod, 2005)

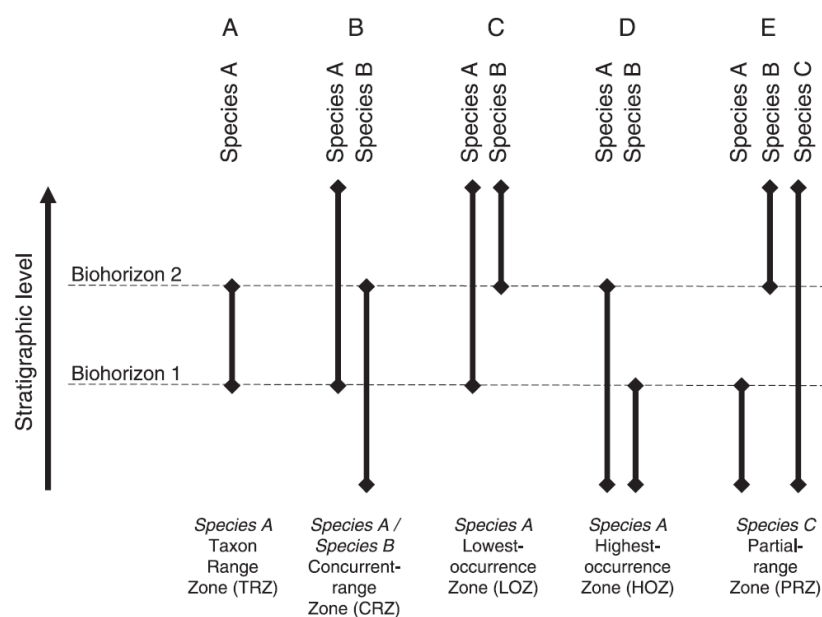


Fig. 1.3 - Nomenclature of biozones by Wade et al. (2011). (modified from Hedberg, 1976 and Pearson, 1998)

Given the importance of planktonic foraminifera for biostratigraphy, the first biostratigraphic schemes were developed in conjunction with taxonomic and stratigraphic research starting in the 1940s, particularly in the oil-producing regions of the USA (e.g., Cushman & Stainforth, 1945) and became highly advanced by the mid-20th century in important economic areas as in the West and the Former Soviet Union. Since the 1960s, the local schemes (e.g., Bandy, 1964; Banner & Blow, 1965) began to develop with the oceanographic campaigns of the Deep-Sea Drilling Project (DSDP), followed by the Ocean Drilling Programme (ODP), the Integrated Ocean Drilling Programme (IODP) and more recently Integrated Ocean Discovery Program (IODP). The findings from these expeditions revealed the existence of similar species assemblages and faunal succession across different ocean areas, including the deep Pacific Ocean (Krasheninikov, 1971). As a result, biostratigraphic schemes began to be considered global within broad latitudinal belts (see below), while also acknowledging some regional differences in various ocean basins, the Mediterranean Sea (e.g., Cita, 1973; Iaccarino & Salvatorini, 1982; Iaccarino, 1985; Di Stefano et al., 2008; Lirer et al., 2019) and highly productive areas.

Planktonic foraminifera have been most abundant and diverse in the tropics and subtropics throughout the Cenozoic. Therefore, the zonal schemes are the most detailed and easy to apply to these latitudes (e.g., Cushman & Stainforth, 1945; Bolli, 1957; Blow, 1959, 1969; Berggren et al., 1983, 1995; Bolli & Saunders, 1985; Wade et al., 2011; King et al., 2020). However, in the temperate mid-latitudes and sub-polar oceans, especially in the Neogene when climatic gradients were more pronounced than in the Paleogene, the use of secondary markers and the amalgamation of zones, when key species are absent, or the development of entirely separate zonal schemes are required (e.g., Jenkins, 1966, 1967, 1971; Kaneps, 1975; Poore & Berggren, 1975; Berggren et al., 1983; Kennett & Srinivasan, 1983; Stott & Kennett, 1990; Berggren et al., 1995). Nevertheless, the tropical/subtropical schemes have always provided the standard zonation incorporated in the Geological Time Scale (GTS), where an increasing number of key datum levels have been accurately calibrated against magneto- and/or astronomical time scales (e.g., Berggren et al., 1985, 1995; Lourens et al., 2004; Wade et al., 2011; Hilgen et al., 2012; Raffi et al., 2020).

The most recent Neogene GTS (Raffi et al., 2020) includes an amended version of the biostratigraphic scheme of Wade et al. (2011). Moreover, King et al. (2020) suggest further amendments to the zonation of Wade et al. (2011).

The next paragraph will focus on the planktonic foraminifera biostratigraphic scheme and biochronology of the Aquitanian- Burdigalian interval for the (sub)tropical regions.

1.2. Aquitanian - Burdigalian biostratigraphy, biochronology and chronostratigraphy (State-of-the-art)

According to the most recent (sub)tropical planktonic foraminiferal biozonation (Wade et al., 2011; King et al., 2020), the Aquitanian to Burdigalian interval spans from Zone M1 to Zone M4 (Fig. 1.4).

In the amended version of the biostratigraphic scheme of Wade et al. (2011), incorporated in the most recent Neogene GTS (Raffi et al., 2020), generic and species names have been updated according to the taxonomic revisions of Spezzaferri et al. (2018a, 2018b, 2018c) and Wade et al.

(2018), and the subdivision of Zone M4 into two subzones (M4a and M4b) has been removed (Berggren et al., 2018; Leckie et al., 2018). The most notable amendment to Wade et al. (2011) zonation proposed by King et al. (2020) is the reintroduction of the subdivision of Zone M3 into two subzones (M3a and M3b) (Fig. 1.4). Following Wade et al. (2011, amended) and King et al. (2020), here is a brief description of the planktonic foraminiferal zones characterizing the Aquitanian to Burdigalian interval at low latitudes:

- Zone M1 is defined by the total range of *Paragloborotalia kugleri*, from the Base (B) to the Top (T) of the nominal taxon, both calibrated at Ceara Rise in Hole 926B at 22.96 Ma and at 21.12 Ma, respectively (Pearson & Chaisson, 1997; Shackleton et al., 1999). This zone is divided into subzones M1a and M1b by the Base of *Globoquadrina dehiscens* (recorded in South Atlantic Hole 516 F by Berggren et al., 1983 and Pujol, 1983), dated at 22.50 Ma. The B of *P. kugleri*, which represents the lower boundary of Subzone M1a, is used to approximate the Oligocene/Miocene boundary (23.03 Ma) because it occurs two meters above the ‘golden spike’ for the base of Neogene System, Miocene Series, and Aquitanian Stage, at Lemme-Carrosio section, Italy (Berggren et al., 1983, 1985, 1995; Steininger et al., 1997; Gennari et al., 2018; Leckie et al., 2018).
- Zone M2 ranges from the T of *Paragloborotalia kugleri* (21.12 Ma) to the B of *Globigerinatella* sp. (19.30 Ma). The T of *P. kugleri* marks the boundary between Subzone M1b and Zone M2 and is considered one of the events used to approximate the Aquitanian-Burdigalian boundary (Raffi et al., 2020) that still lacks a formal definition.
- Zone M3 includes the interval from the B of *Globigerinatella* sp. (19.30 Ma) and the T of *Catapsydrax dissimilis* (17.54 Ma), both calibrated at Ceara Rise in Hole 926B by Pearson & Chaisson (1997). Initially, the base of Zone M3 was defined by the B of *Globigerinatella insueta* s.s. (Berggren et al., 1995). Wade et al. (2011), however, reconsidered this event and opted to use the first occurrence of *Globigerinatella* sp. as the lower boundary of Zone M3, based on the evolutionary trend of this species described by Pearson (1995) and Pearson & Chaisson (1997). Nowadays, according to King et al. (2020), the B of *G. insueta* s.s., calibrated at 17.59 Ma at Ceara Rise, is the event used to subdivide the Zone M3 into subzones M3a and M3b, leading to a highly condensed Subzone M3b of ~50 kyr (Fig. 1.4).
- Zone M4 spans from the T of *Catapsydrax dissimilis* (17.54 Ma) and the B of *Praeorbulina sicana* (16.39 Ma), both calibrated at Ceara Rise in Hole 926B (Pearson & Chaisson, 1997). This zone was previously subdivided into two Subzones (M4a and M4b) by the B of *Paragloborotalia birnageae* (Berggren et al., 1995; Wade et al., 2011). However, thanks to investigations by Spezzaferri (1994), Berggren et al. (2018) and Leckie et al. (2018) that found the B of *P. birnageae* in the uppermost Oligocene (Zone O7), this subdivision was removed (see also King et al. 2020).

Other bioevents occurring in this interval, although non-defining zonal boundaries, are the T of *Paragloborotalia pseudokugleri* (21.31 Ma), the T of *Tenuitella munda* (20.83 Ma), the B of *Globigerinoides altiapertura* (19.97 Ma), the T of *Dentoglobigerina binaiensis* (19.09 Ma) and the B of *Globorotalia praescitula* (18.22 Ma) (Raffi et al., 2020) (Fig. 1.4). Only two of these bioevents

(*Paragloborotalia pseudokugleri* T and *Dentoglobigerina binaiensis* T) were calibrated in the Ceara Rise based on the record of Pearson & Chaisson (1997), while the others were calibrated in Hole 516 F, South Atlantic (*G. praescitula* B and *G. altiapturus* B; Berggren et al., 1983, 1995; Pujol, 1983), and in Hole 747, Kerguelan Plateau (*T. munda* T; Li et al., 1992; Wright & Miller, 1992; Berggren et al., 1995).

In Figure 1.4, planktonic foraminiferal (sub)zones and bioevents are shown beside calcareous nannofossil zones and events following Backman et al. (2012) and Agnini et al. (2014).

PLANKTONIC FORAMINIFERA		CALCAREOUS NANNOFOSSILS		POLARITY CHRON		STAGE/AGE	SERIES/EPOCH	AGE (Ma)	
ZONES ¹⁾	BIOHORIZONS	ZONES ²⁾	BIOHORIZONS						
M4		CNM6			C5Cr	BURDIGALIAN	MIOCENE	17	
M3b	<i>C. dissimilis</i> T <i>G. insueta</i> B		<i>S. heteromorphus</i> Bc		C5Dn				
			<i>S. belemnus</i> T		C5Dr				
M3a	<i>G. prescitula</i> B	CNM5			C5En				
					C5Rr				
	<i>D. binaiensis</i> T <i>Globigerinatella</i> sp. B		<i>S. belemnus</i> B <i>T. carinatus</i> T		C6n			19	
		CNM4			C6r			20	
M2	<i>G. altiapturus</i> B		<i>H. ampliaptura</i> B		C6An	20.44			
	<i>T. munda</i> T		<i>H. euphratis/H. carteri</i> X		C6Ar			21	
	<i>P. kugleri</i> T <i>P. pseudokugleri</i> T	CNM3			C6AAn				
			<i>T. carinatus</i> Tc		C6AAr			22	
	<i>G. dehiscens</i> B	CNM2	<i>D. druggi</i> s.s. B		C6Bn				
M1a	<i>C. ciperoensis</i> T <i>P. kugleri</i> B	CNM1	<i>S. disbelemnus</i> B <i>S. delphix</i> T		C6Br				
					C6Cn			23	
	<i>T. gemma</i> T	CNO6	<i>S. delphix</i> B		C6Cr	CHATTIAN	OLIGOCENE		
O7			<i>S. ciperoensis</i> T		C7n				24
		CNO5	<i>T. longus/T. carinatus/X</i>		C7r				
					C7An				25
	<i>P. pseudokugleri</i> B				C7Ar				
O6					C8n				

Fig. 1.4 - Planktonic foraminifera and calcareous nannofossils biostratigraphy and biochronology. Zonations: 1) Wade et al., 2011; King et al., 2020; 2) Backman et al., 2012; Agnini et al., 2014.

As mentioned above, low-latitude planktonic foraminiferal events for the Aquitanian to Burdigalian interval are mainly based on Ceara Rise records (ODP Leg 154, Equatorial Atlantic Ocean; Pearson & Chaisson, 1997) and, to less extent, on Site 516 (Berggren et al., 1983; Pujol, 1983) and have been directly calibrated to magnetostratigraphy (Wright & Miller, 1992; Berggren et al., 1983, 1995) or to astrochronology (Shackleton et al., 1999). However, these bioevents have been defined through low-resolution and qualitative/semi-quantitative studies (e.g., Curry et al., 1995; Pearson & Chaisson, 1997). For this time interval, a few high-resolution quantitative records of planktonic foraminifera are available only for mid-latitudes (e.g., Fabbrini et al., 2019a, 2019b). In addition, the best biohorizon approximating the Aquitanian/Burdigalian boundary is still under discussion (Raffi et al., 2020).

Currently, there is no consensus on the criterion, and age, for determining the Aquitanian-Burdigalian boundary, and the GSSP (*Global Stratigraphic Section and Point*) of Burdigalian stage has still to be formally defined (Fig. 1.4) (Raffi et al., 2020). The criteria that have been proposed until now to define the boundary are:

- the Top of *Paragloborotalia kugleri* (M1/M2 zonal boundary) (Berggren et al., 1995) dated at 21.12 Ma (Lourens et al., 2004; Wade et al., 2011; King et al., 2020);
- the Base of the calcareous nannofossil *Helicosphaera ampliaperta* (associated with the base of magnetic polarity Subchron C6An.2n) (Fornaciari & Rio, 1996), dated at 20.43 Ma (Backman et al., 2012);
- the Base of *Globigerinoides altiaperturus* (approximating the magnetic polarity C6An/C6r transition) (Iaccarino & Salvatorini, 1982; Montanari et al., 1991), dated at 19.97 Ma (Wade et al., 2011; Raffi et al., 2020);
- the Top of the magnetic polarity Chron C6An (Berggren et al., 1995), dated at 19.97 Ma (Lourens et al., 2004);
- the Base of calcareous nannofossil *Sphenolithus belemnoides* (Haq et al., 1987), which defines the CNM4/CNM5 zonal boundary and is dated at 19.01 Ma (Backman et al., 2012) (Fig. 1.4).

Provisionally, the Base of *H. ampliaperta*, calibrated at 20.43 Ma at Ceara Rise, has been chosen for the recognition of the base of the Burdigalian Stage (Lourens et al., 2004; Backman et al., 2012; Hilgen et al., 2012; Raffi et al., 2020), because it is the best bioevent approximating the radiometric age $^{87}\text{Sr}/^{86}\text{Sr}$ of 20.10 Ma, measured in the historical stratotype section of the Burdigalian in Saucats (Bordeaux, France) (Cahuzac et al., 1997; Poignant et al., 1995; Raffi et al., 2020). However, although this biohorizon is well-recognized and reliable in the outcropping sections of the Mediterranean (e.g., Fornaciari & Rio, 1996; Fabbrini et al., 2019b), it has a low degree of reliability in the open ocean (Raffi et al., 2020).

Contrary to the other defined Miocene GSSPs, land-based deep marine succession in the Mediterranean region, suitable to establish the Burdigalian GSSP, has not been identified yet. Fabbrini et al. (2019b) recently proposed the Contessa section (Italy) as a potential candidate, despite the presence of hiatuses, since they identified the Base of *H. ampliaperta* within Chron C6An.2n. However, Kasbohm et al. (2021) modified geochronology by Fabbrini et al. (2019b), using high-precision U-Pb zircon dating to obtain new ages for the volcanoclastic horizons of the Bisciaro Formation (Contessa section). This led Kasbohm et al. (2021) to rejecting the proposal of Fabbrini et al. (2019b) to consider the Contessa section as a potential candidate of the GSSP for the Burdigalian

Stage, due to inconsistencies in the biostratigraphic and paleomagnetic data and the presence of hiatuses in the succession.

Other authors (Foresi et al., 2014; Di Stefano et al., 2024) suggest the St. Thomas section (Malta Island) as another option for formally defining the Aquitanian/Burdigalian boundary in the Mediterranean area. Here, *H. ampliaperta* is absent at the base of the section, despite its presence being reported in older levels (Fornaciari & Rio, 1996). However, in this section, the Base and the Base common (Bc) of *S. belemnoides* were recorded, dated respectively 19.09 Ma and 19.02 Ma. According to Foresi et al. (2014), the Bc of this taxon is a better-defined and more reliable event than the Base, and both these events fall in the upper part of magnetic polarity Chron C6n and denote the youngest possible option in literature to define the Aquitanian/Burdigalian boundary.

Currently, there is an ongoing evaluation of the possibility of defining the Burdigalian GSSP in an astronomically calibrated oceanic succession ((I)ODP core) as an alternative (Raffi et al., 2020). According to the latter authors, some potential candidates for establishing the Burdigalian GSSP are:

- ODP Sites 925/926/929 (Ceara Rise, Leg 154; Curry et al., 1995) that present high-resolution benthic foraminiferal stable isotope records based on a tuned cyclostratigraphy, but are lacking magnetostratigraphy because of magnetic overprint (Curry et al., 1995; Shackleton & Hall, 1997; Pälike et al., 2006a; N. Shackleton, unpublished);
- ODP Site 1264 (Walvis Ridge, Leg 208; Zachos et al., 2004) characterized by excellent records of carbonate (% CaCO₃) and benthic isotope ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$) tuned to 100-kyr short eccentricity (Liebrand et al., 2016);
- ODP Site 1090 (Billups et al., 2004) that presents a very good magnetostratigraphy and high-resolution stable isotope records tuned to obliquity, but at its high-latitude location the applicability of standard low-latitude calcareous plankton biostratigraphy is prevented;
- IODP Site U1337 (eastern equatorial Pacific, Exp. 320/321; Pälike et al., 2010b) with a high-resolution benthic foraminiferal and bulk carbonate stable isotope record (Holbourn et al., 2015).

All these records compose an almost complete astrochronology framework for the Miocene, but the stratigraphic community still has objections to defining the Burdigalian's GSSP in the deep-sea (IODP/ODP) core archives (Raffi et al., 2020).

This work presents the results of a high-resolution quantitative biostratigraphic analysis of planktonic foraminiferal assemblages performed on Site 926 (ODP Leg 154, Ceara Rise, Equatorial Atlantic Ocean), where the succession is continuous in the Aquitanian - Burdigalian interval and astronomically calibrated (Shackleton et al., 1999; Pälike et al., 2006a), generally has good preservation of planktonic foraminifera and underlies the Lower Miocene astronomical timescale (Raffi et al., 2020).

The aims of the first part of this work are the improvement of resolution of the planktonic foraminiferal distribution patterns in the Aquitanian - Burdigalian interval (from 21.5 to 17.6 Ma), the refinement of the bioevents stratigraphic position and their age calibration and, possibly, the identification of additional events useful to increase the biostratigraphic resolution. All these data give new insights into the issue of the formal definition of the base of the Burdigalian Stage.

1.3. The *Paragloborotalia pseudokugleri* - *Paragloborotalia kugleri* lineage

The *P. pseudokugleri*-*P. kugleri* plexus, with *P. kugleri* evolving from *P. pseudokugleri*, represents an important taxonomic group at the Oligo-Miocene Transition (OMT) and the Aquitanian/Burdigalian boundary.

Concerning *P. pseudokugleri*, its Base defines the zonal boundary O6/O7 (Fig. 1.4) that, according to Wade et al. (2011) and King et al. (2020), is dated at 25.4 Ma. This bioevent is calibrated at Site 1218 (Pälike et al., 2006b), in the Equatorial Pacific (Lyle et al., 2002), using benthic foraminiferal stable isotope records (Lear et al., 2004; Coxall et al., 2005; Tripathi et al., 2006; Wade et al., 2007). The Top of *P. pseudokugleri* is reported to be approximately halfway within the range of *P. kugleri*, falling within Zone M1 (Wade et al., 2011; Leckie et al., 2018) and calibrated at 21.31 Ma at ODP Site 926 (Pearson & Chaisson, 1997; Shackleton et al., 1999). However, some authors have found it extending to near the top of the range of *P. kugleri* (e.g., at Rio Grande Rise by Pujol, 1983; Ontong Java Plateau by Chaisson & Leckie, 1993; and at Ceara Rise by Pearson & Chaisson, 1997). Recent observations from IODP Site U1337 suggest a ~400 kyr offset between the extinction of *P. pseudokugleri* and *P. kugleri* (Pälike et al., 2010c; Leckie et al., 2018).

As mentioned in the previous paragraph, the entire range of the species *P. kugleri* defines Zone M1. The Base (22.96 Ma) approximates the Oligocene/Miocene boundary (23.03 Ma) (Base of *P. kugleri* for Berggren et al., 1983, 1985, 1995; Steininger et al., 1997; Leckie et al., 2018; Base common of *P. kugleri* for Gennari et al., 2018) and the Top is one of the candidate events to identify the Aquitanian/Burdigalian boundary (Raffi et al., 2020) (Fig. 1.4). Both these events were calibrated at Ceara Rise at ODP Site 926 and are considered in the most recent biochronology for (sub)tropical regions (Raffi et al., 2020).

The distinction between the two taxa is somewhat arbitrary because the morphological transition from *P. pseudokugleri* to *P. kugleri* is gradual. In a given succession, the lowermost specimens of *P. kugleri* are typically rare and are found within a population that is mostly classified as *P. pseudokugleri* due to their intergrading nature between the two end members of the plexus. The relative abundance of *P. kugleri* compared to *P. pseudokugleri* typically increases in the higher part of the succession, with the *P. pseudokugleri* morphospecies often persisting throughout most of the *P. kugleri* range (Leckie et al., 2018).

Another issue of this work is to quantitatively characterize the distribution pattern of the *Paragloborotalia pseudokugleri*-*P. kugleri* plexus, focusing on 1) the stratigraphic position of the Base and Top of *P. pseudokugleri* and *P. kugleri*; 2) the morphological transition between the end members of the plexus (*P. pseudokugleri* and *P. kugleri*, with their transitional forms).

1.4. Ecology of planktonic foraminifera

Planktonic foraminifera provide information on the past environment and climate. The physical conditions and chemical composition of the surficial seawater environment can be inferred by studying the taxonomic composition of the planktonic foraminiferal assemblages and analyzing the chemical composition of their calcite shells (Kucera, 2007). Changes of oxygen and carbon stable isotope and element ratios of planktonic foraminiferal shells are used as indicators of paleotemperature (e.g., $\delta^{18}\text{O}$, Mg/Ca), paleoproductivity (e.g., $\delta^{13}\text{C}$, Ba/Ca) and pH seawater changes (B/Ca).

1.4.1. Latitudinal and vertical distribution of planktonic foraminifera

Planktonic foraminifera are widely distributed in modern oceans, with clearly defined faunal provinces for many species (e.g., Hemleben et al., 1989).

The taxonomic composition of planktonic foraminiferal assemblages generally varies with latitude. Currently, the assemblages are divided into five main bioprovinces at global scale that present a bipolar trend compared to the tropical belt (Fig. 1.5): tropical, sub-tropical, temperate, subpolar and polar (e.g., Bradshaw, 1959; Bé, 1959, 1977; Hemleben et al., 1989; Kucera, 2007). Additionally, a sixth province is primarily determined by major upwelling regions and is almost exclusively characterized by eutrophic conditions, the abundance of prey and turbidity (Schiebel & Hemleben, 2017).

The distribution patterns in these provinces are influenced by factors such as water temperature, salinity (Phleger, 1960; Bé & Tolderlund, 1971; Tolderlund & Bé, 1971; Caron et al., 1987; Bijma et al., 1990), radiation (Erez, 1983; Erez & Luz, 1983), turbidity (Ortiz et al., 1995), stratification of water masses (Field, 2004), chemistry, seasonality, the presence of symbionts (Hemleben et al., 1989), abundance of prey, and trophic demands of planktonic foraminifera at a species level (e.g., Spindler et al., 1984; Schiebel et al., 2001).

Particularly, sea surface temperature (SST, surface mixed layer temperature) seems to be the primary factor influencing the latitudinal distribution, but also the abundance and diversity of planktonic foraminifera (Rutherford et al., 1999; Morey et al., 2005; Kucera, 2005), as evidenced by the $\delta^{18}\text{O}$ values recorded on their calcitic shells. Most planktonic foraminiferal species are largely eurythermal (Fig. 1.6) and occur over a wide temperature range of 15–20 °C, reaching up to 25 °C (Bé & Tolderlund, 1971), with an optimum temperature range of 10 °C (Lombard et al., 2011).

Figure 1.6 shows the temperature-related distribution of planktonic foraminiferal species in surface sediment data from the Atlantic Ocean. The colored bars display the proportions of the major species in the respective assemblages (Kucera et al., 2005; Schiebel & Hemleben, 2017).

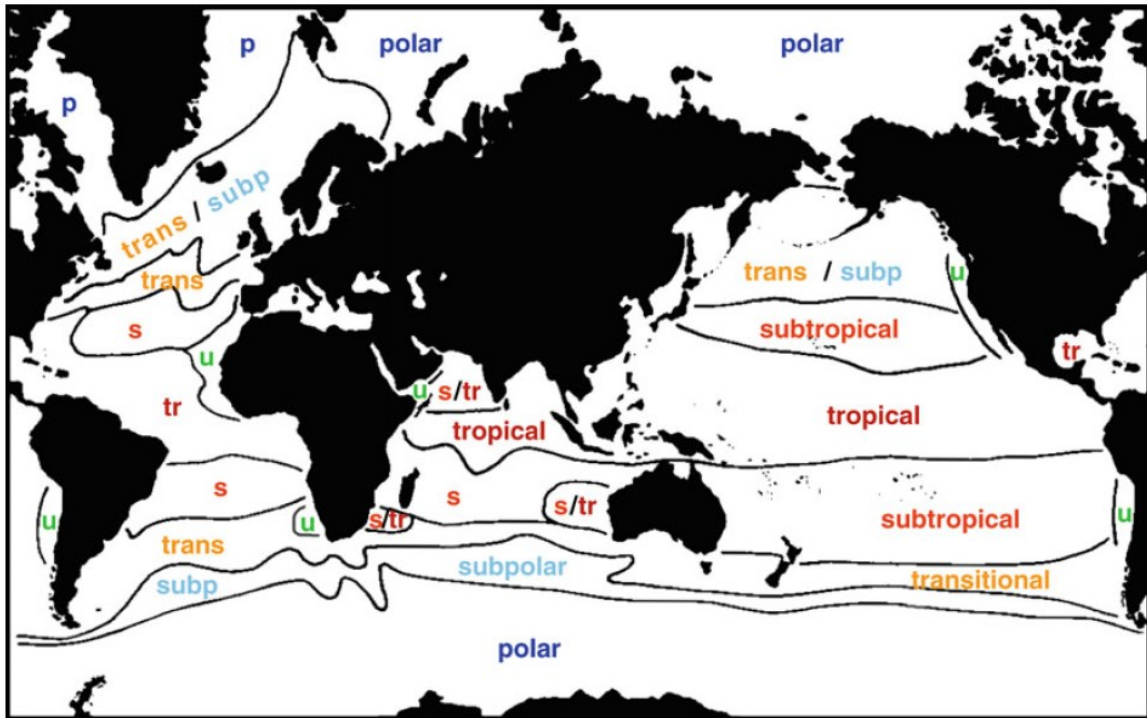


Fig. 1.5 – Planktonic foraminiferal provinces according to data from plankton tows and sediment samples. (Hemleben et al., 1989) (from Schiebel & Hemleben, 2017)

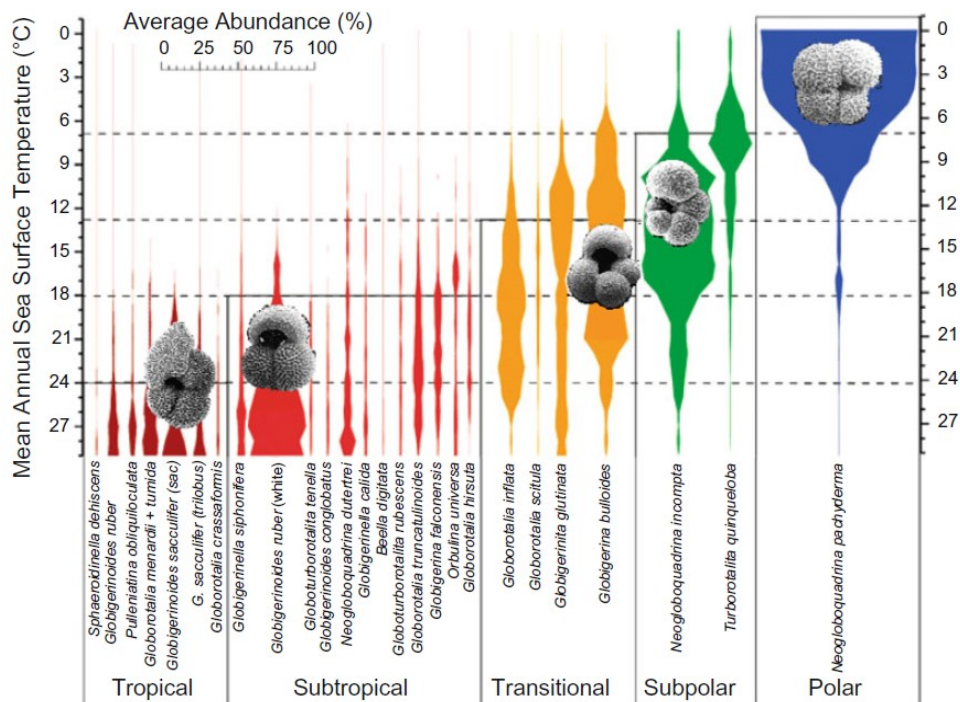


Fig. 1.6 - Surface-sediment data from the Atlantic Ocean (Kucera et al., 2005) were used to analyze the distribution of planktonic foraminiferal species at one-degree centigrade intervals, revealing a temperature-related pattern. (from Schiebel & Hemleben, 2017)

The various environmental factors also affect the vertical distribution of species that move within their specific depth range (Schiebel & Hemleben, 2005; Rebotim et al., 2017). As a result, these species develop shell morphologies that reflect their depth habitat. Generally, species living

in the superficial part of the water column have large and rounded shells, subspherical chambers and a very perforated wall. On the other hand, species from deeper habitats usually have thicker shells and often show thick and imperforate keels and ornamentations (Cita & Premoli Silva, 1978).

Living planktonic foraminifera are most abundant in euphotic near-surface waters between 10 and 50 meters (Fig. 1.7, Sen Gupta, 1999; Fig. 1.8A). Below this depth, their abundance decreases exponentially (Bé, 1977) and this pattern is related to the availability of nutrients, prey and sunlight (especially for those with photosymbionts such as *Globigerinoides sacculifer*) (Bijma & Hemleben, 1994; Sen Gupta, 1999).

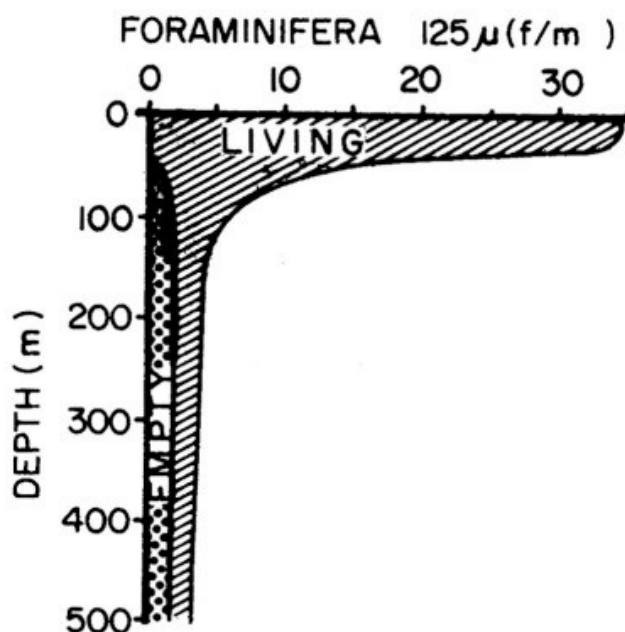


Fig. 1.7 – Abundance profile of planktonic foraminifera in Santa Barbara Basin. (from Sen Gupta, 1999)

Most planktonic foraminifera live in the mixed layer at the top of the water column, and only a few forms live in a deeper habitat (thermocline and sub-thermocline) (Fig. 1.8).

According to Bé (1977), as reported in Sen Gupta (1999), three broad groups exist based on their depth distribution:

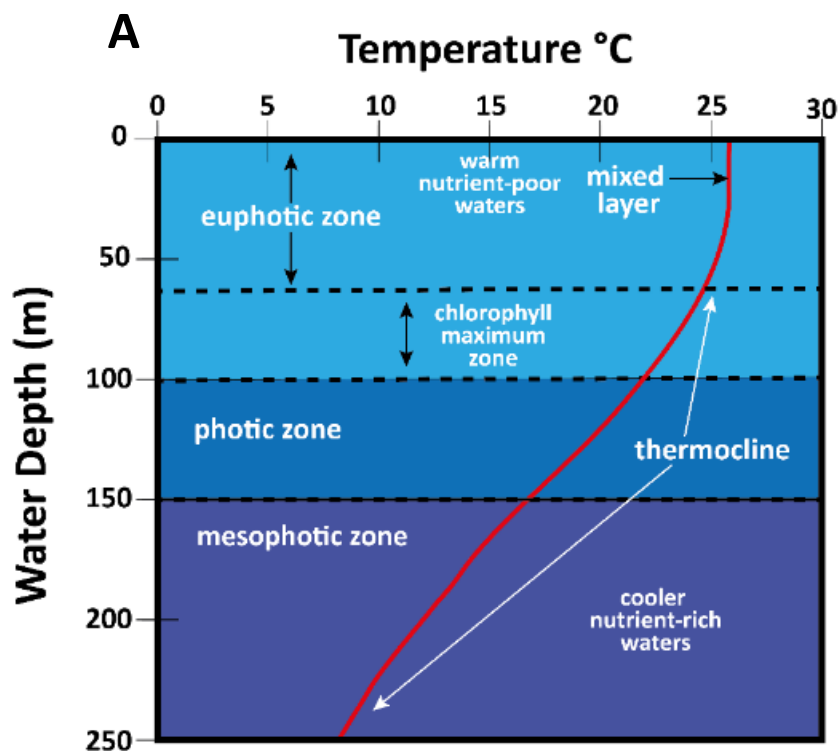
- Shallow-dwellers, that live at a depth < 50 m (Fig. 1.8). This group consists of spinose forms, including all species of *Globigerinoides* and several of *Globigerina*. These species tend to be thinner-walled and smaller than deeper-dwelling forms.
- Intermediate-dwellers (50-100 m deep) (Fig.1.8), that live at a depth of 50-100 m. In this group are considered both spinose (e.g., *Globigerina bulloides*, *Hastigerina pelagica*, *Orbulina universa*, *Globigerinella aequilateralis*, and *Globigerina calida*) and non-spinose forms (e.g., *Pulleniatina obliquiloculata*, *Neogloboquadrina dutertrei*, *Candeina nitida*, and *Globigerinita glutinata*).
- Deep-dwellers, that live at a depth > 100 m (Fig. 1.8). This assemblage includes spinose (e.g., *Hastigerinella digitata*, *Globigerinella adamsi* and *Sphaeroidinella dehiscens*) and non-spinose forms (e.g., *Neogloboquadrina pachyderma*, *Globoquadrina conglomerata* and all the species of *Globorotalia*).

The depth habitats of individual species are difficult to define within narrow limits due to diurnal, ontogenetic, seasonal, and long-term variation (Sen Gupta, 1999).

The vertical distribution of planktonic foraminifera in the water column (Fig. 1.9) is influenced by various biogenic and abiogenic environmental factors. Biogenic factors include: (1) the need for sunlight by species with symbionts, while symbiont-barren species can thrive independently from light (e.g., Weiner et al., 2012), (2) ontogenetic vertical migration and reproduction at specific water depths (e.g., Hemleben et al., 1989; Bijma et al., 1990; Schiebel et al., 1997) and (3) the availability of prey (e.g., Schiebel et al., 2001). Abiotic environmental factor, such as surface water mixing, transport of specimens by gales, and freshwater lenses hindering the ascent of individuals to surface waters also play a role in the depth distribution of foraminifera (Schiebel & Hemleben, 2017).

The depth preferences of planktonic foraminifera have been determined using stable oxygen ($\delta^{18}\text{O}$) and carbon isotope ($\delta^{13}\text{C}$) values measured on the shells of the specimens. At (sub)tropical oceanic latitudes, relatively low $\delta^{18}\text{O}$ values indicate shell growth in the mixed layer and, depending on the presence or absence of symbionts, there will record high or low $\delta^{13}\text{C}$ values, respectively. On the other hand, low $\delta^{13}\text{C}$ and relatively high $\delta^{18}\text{O}$ values indicate a shell growth in the thermocline and the subthermocline (intermediate and deep-dwellers), respectively (e.g., Pearson et al., 1997; Pearson & Wade, 2009; Aze et al., 2011).

Currently, for many species values of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ are available to define their depth preferences (Aze et al., 2011; Coxall & Spezzaferri, 2018; Leckie et al., 2018; Pearson et al., 2018a, 2018b; Spezzaferri et al., 2018a, 2018b, 2018c; Olsson et al., 2018; Wade et al., 2018).



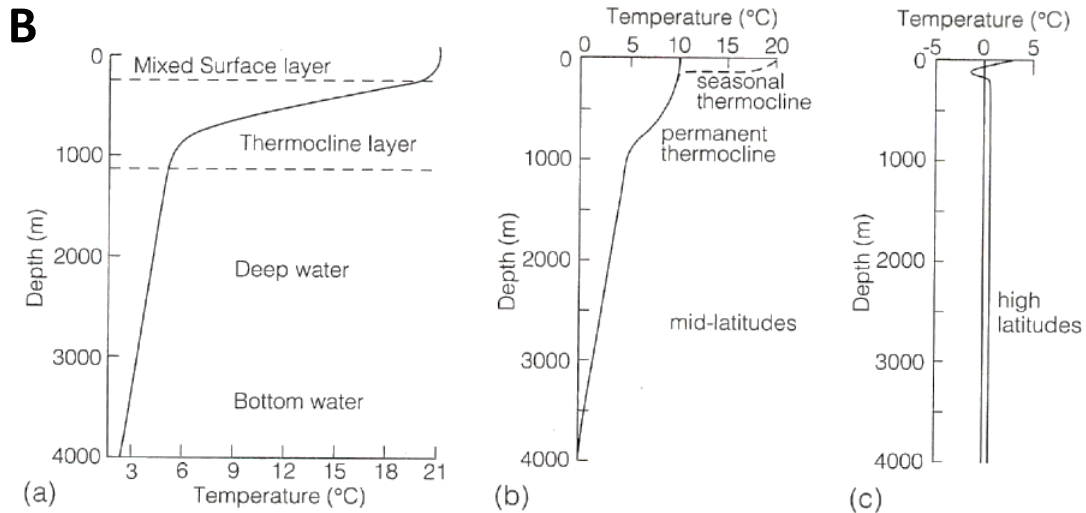


Fig. 1.8 - A) Temperature/depth profile divided into euphotic, photic, and mesophotic zones with different nutrient richness; B) Temperature/depth profiles for the open ocean at different latitudes (Brenchley & Harper, 1998).

Mixed layer: a layer of active turbulence generated by winds, surface heat fluxes, or processes such as evaporation or sea ice formation.

Thermocline: distinct layer characterized by a high-temperature gradient associated with depth. Its depth and thickness depend on seasonal weather variations, latitude, and local environmental conditions, such as tides and currents.

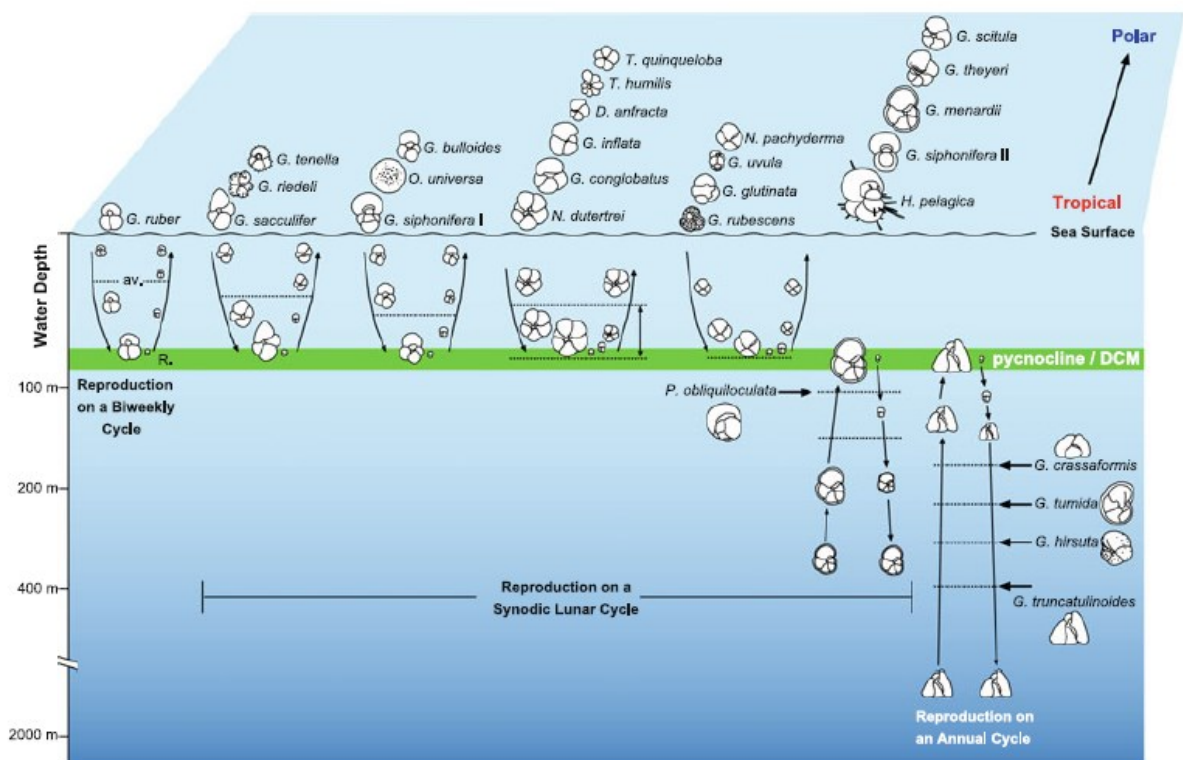


Fig. 1.9 - Idealized scheme of planktonic foraminiferal depths habitats and life cycle in the pelagic ocean. The average water depth inhabited by planktonic foraminifera varies at species level. (from Schiebel & Hemleben, 2017)

1.4.2. Productivity

Primary productivity and prey availability are other essential factors that can influence the distribution (regional and vertical) of planktonic foraminifera species. They have preferences on depth habitat (e.g., Weiner et al., 2012), according to specific ecological demands, and may ascend and descend in the water column during ontogeny (Hemleben et al., 1989). In tropical regions, there is a more noticeable vertical separation of species compared to polar waters. This is because there is a wider variety of environmental and biological factors at different depths in tropical waters, while the water column in polar regions tends to be more uniform (Schmidt et al., 2004a, b).

In addition, planktonic foraminifera show distinct seasonal distribution patterns, which are most noticeable at mid to high latitudes (e.g., Bé 1960, 1977; Schiebel & Hemleben, 2005; Fraile et al. 2009), where the interaction of increased mixing depth of surface waters, nutrient recycling, and light intensity leads to two main production seasons in spring and fall. At low latitudes, instead, where light intensity and temperature remain high year-round, seasonal variations are minimal, and productivity is influenced by regional conditions such as monsoonal activity and upwelling intensity (e.g., Kroon & Ganssen 1989; Ivanova et al., 1999; Conan & Brummer, 2000; Schiebel et al., 2004).

The highest concentrations of planktonic foraminifera on the vertical scale are found near the deep chlorophyll maximum (DCM), typically located around the seasonal thermocline and pycnocline in the upper 100 meters of the water column (e.g., Fairbanks & Wiebe 1980; Schiebel et al., 2001; Field, 2004). When surface water mixing increases (e.g., in upwelling zones) and the thermocline shifts to a greater depth, for example due to increased wind stress (e.g., Schiebel et al., 1995), chlorophyll may be redistributed from DCM, and nutrients may be drawn into surface waters (Fig. 1.10). The first consequence of this is the increase in opportunistic species, such as *Globigerina bulloides*, which is the most common morphospecies in the temperate ocean and was identified as an indicator of eutrophic conditions (Thiede, 1975), living in upwelling zones. Following this, planktonic foraminiferal species that prefer 'fresh' prey, like *Globigerinita glutinata*, proliferate due to the entrainment of nutrients into the mixed layer (Schiebel et al., 2001, 2004; Schiebel & Hemleben, 2017).

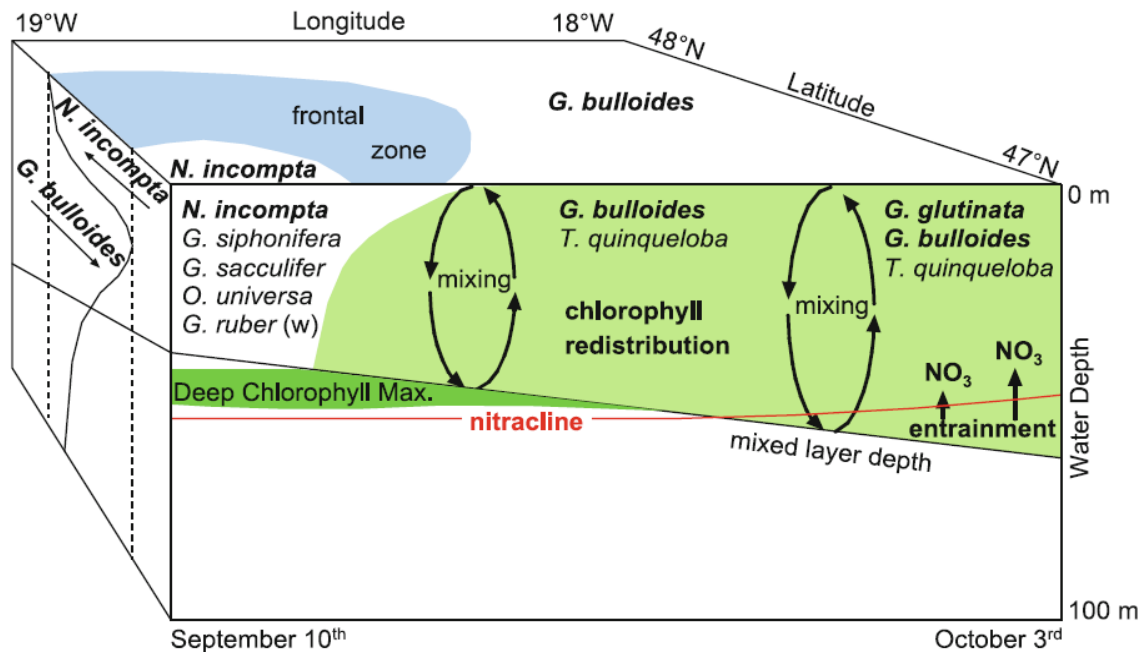


Fig. 1.10 - Schematic view of hydrographic, trophic, and faunal development in the eastern North Atlantic around 47 °N, 20 °W (BIOTRANS), between 10 September and 3 October 1996. (from Schiebel & Hemleben, 2017, modified from Schiebel et al., 2001)

1.4.3. Preservation of planktonic foraminifera in surface sediments

The chance of planktonic foraminifera being preserved in oceanic deep-water sediments and then in sedimentary rocks depends on the occurrence of carbonate dissolution.

The deep waters of the oceans are undersaturated with calcium carbonate (Berger, 1970), and the decomposition of organic matter during settling creates corrosive microenvironments conducive to calcite dissolution throughout the water column (Schiebel, 2002). This leads to the immediate dissolution of planktonic foraminiferal shells when they settle onto the sea floor after death (Berger, 1971). The dissolution intensity depends upon the final settling depth and the time the foraminiferal shells spend in the water column and on the sea floor. Recent estimates indicate that only about 25% of planktonic foraminiferal shells reach the sea floor (Schiebel, 2002).

The dissolution rate starts to increase rapidly from several hundred meters above the Calcite Compensation Depth (CCD), at a depth called lysocline (Fig. 1.11) (Berger, 1970; Kucera, 2007). This impacts the overall composition of the sediment by favoring insoluble components such as clay and opal (Kucera, 2007). Sometimes, carbonate dissolution can also occur above the lysocline when, in cases of high primary productivity, excess organic carbon reaching the sea floor can lead to increased CO₂ concentration in pore waters (Peterson & Prell, 1985; Adler et al., 2001).

The depth of the lysocline and the CCD reflects the concentration of CO₂ in the bottom waters, which changes in response to shifts in oceanic circulation and carbon redistribution among the major global reservoirs. The proximity of the lysocline and the rate of dissolution are evident in the preservation of planktonic foraminiferal shells, which can be utilized as an indicator of bottom water chemistry, as well as deep circulation and carbon cycling (Kucera, 2007).

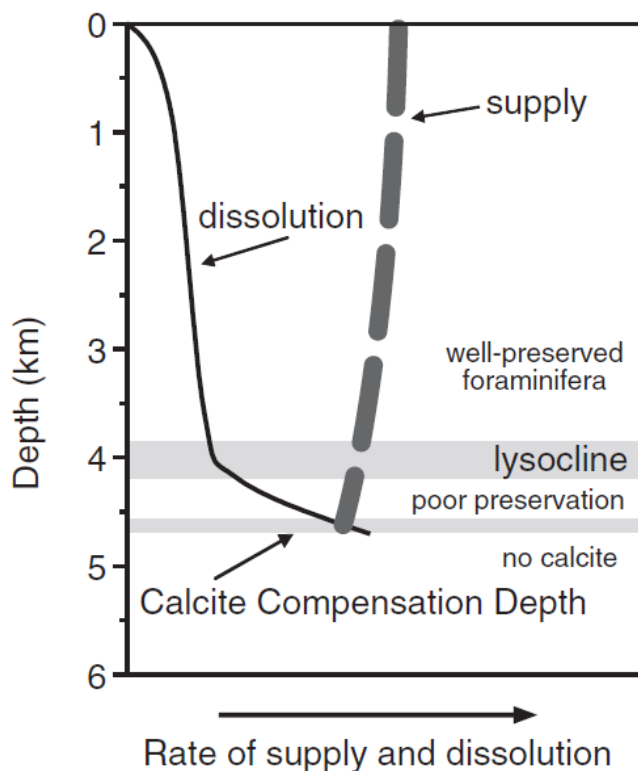


Fig. 1.11 - The relationship between calcite supply, dissolution, and preservation on the sea floor. (from Kucera, 2007, mod. from Berger, 1970)

Lysocline: depth at which a rapid dissolution of carbonates begins. It separates well preserved from poorly preserved foraminiferal assemblages.

CCD: depth at which dissolution exceeds the supply of calcium carbonate and below which sediments are devoid of calcium carbonate.

Studies by & Heezen (1967), Berger (1968, 1970), and Bé et al. (1975) highlighted that the thickness of the shells decreases with increasing dissolution (Fig. 1.12), and this corresponds to the mass of calcite lost to dissolution. This process gradually reduces the sand content of sediment in pelagic oozes, where the main component of the coarse fraction is planktonic foraminiferal shells (Kucera, 2007).

Because of the varying shell morphology, certain species of planktonic foraminifera are more susceptible to dissolution (Ruddiman & Heezen, 1967; Berger, 1968), and assemblages affected by dissolution are therefore enriched in species resistant to dissolution (e.g., *Neogloboquadrina pachyderma*, *N. dutertrei*, *Pulleniatina obliquiloculata*, *Globorotalia inflata*, *G. menardii*, *G. tumida*). This effect can be used to quantify dissolution intensity by determining the excess abundance of resistant species (Fig. 1.14, Kucera, 2007).

In addition, since deep-sea benthic foraminifera have generally thick and smooth shells, they are more resistant to dissolution than those of planktonic foraminifera. For this reason, the ratio between whole shells of the two groups (the P/B ratio) decreases with increasing dissolution (Fig. 1.12) and it can be used as an index to evaluate the intensity of dissolution (Fig. 1.13).

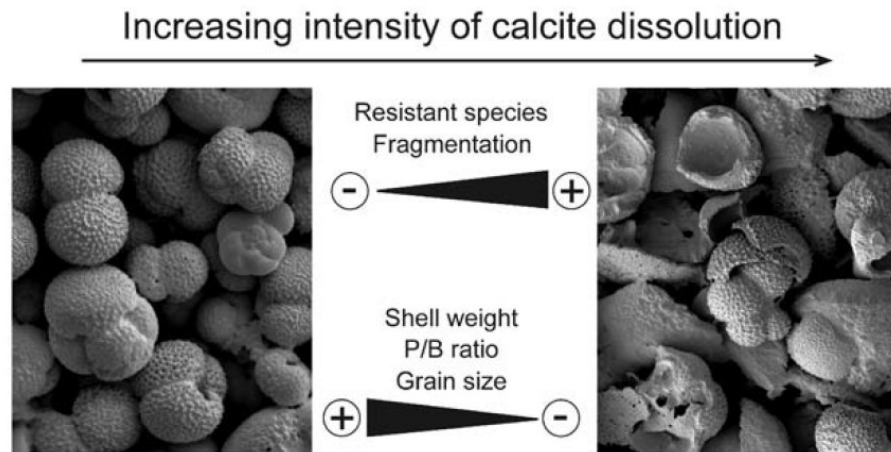


Fig. 1.12 – A well-preserved assemblage of planktonic foraminifera compared to an assemblage affected by calcite dissolution. (from Kucera, 2007)

In addition, calcite dissolution has the potential to alter the chemical composition of foraminiferal shells and influence geochemical proxies. The most notable impact is observed in the Mg/Ca ratio because, being the Mg-rich carbonate phase more soluble than pure calcite, foraminiferal shells undergoing dissolution will appear depleted in Mg (Brown & Elderfield, 1996; Barker et al., 2005). Instead, Berger & Killingley (1977) noted that calcite dissolution could affect the carbon and oxygen stable isotopic ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$) composition in foraminiferal shells. This may be due to the selective removal of outer shell layers that contain the geochemical and isotopic characteristics of the adult habitat of each species. The impact of calcite dissolution on geochemical proxies becomes more evident as the depth approaches the lysocline (Kucera, 2007).

Finally, calcite dissolution leads to increased fragmentation (Figs. 1.12, 1.13) and changes the mean size of the assemblage, gradually decreasing the number of dissolution-prone species. In this way, the remaining assemblages seem to indicate colder conditions (Berger, 1968; Vincent & Berger, 1981; Thunell & Honjo, 1981). This phenomenon reflects the tendency of dissolution-prone species to be more common in tropical faunas. For these reasons, it would be better to refrain from basing environmental reconstructions on samples that present signs of moderate to severe dissolution and limit studies to appropriately preserved fossil material (Kucera, 2007).

In Figure 1.13, Kucera (2007) summarized all the indices for estimating calcite dissolution intensity from planktonic foraminifera. The most commonly used index is the “Degree of fragmentation”, which represents the proportion between fragments and whole shells of planktonic foraminifera. It was used in numerous studies (Thunell, 1976; Le & Shackleton, 1992) thanks to its rapid and simple determinability and its applicability to pelagic sediments containing planktonic foraminifera of any age (Kucera, 2007).

Index	Remarks
Degree of fragmentation $F(\%) = 100 \times F/(C+F)$; F = number of fragments; C = number of complete shells; Berger (1970a)	The most commonly used dissolution index, considered to be reliable and robust. Its determination is subjective and it is therefore not suitable for quantitative calibrated reconstructions.
$F_{LS}(\%) = 100 \times (F/8)/((F/8)+C)$; Le and Shackleton (1992)	A modification used to improve the linearity of the relationship of the index with dissolution intensity.
Shell weight $\Delta CO_3^{2-} = [G. \text{ sacculifer (355–425 } \mu\text{m) shell weight (}\mu\text{g)} - 20.27]/0.70$; Broecker and Clark (2001a) $\Delta CO_3^{2-} = [G. \text{ nuber (300–355 } \mu\text{m) shell weight (}\mu\text{g)} - 12.6]/0.22$; de Villiers (2005) ΔCO_3^{2-} = Calcite saturation state at the sediment–water interface	Both calibrations are based on data from Indian and Pacific Ocean coretops and assume that all of the shell weight variation is due to calcite dissolution. Unlike fragmentation, this index is objective and thus better suited for quantitative calibration.
Percentage of resistant species $res(\%) = 100 \times r/(r+s)$; r = number of shells of resistant species; s = number of shells of susceptible species; Ruddiman and Heezen (1967)	Requires regional calibration and an <i>a priori</i> knowledge of species dissolution susceptibility. It is only sensitive at low dissolution intensity.
Assemblage dissolution index $FDX = \sum(p_i R_i)/\sum p_i$; R_i = rank of species i ; p_i = percentage of species i ; Berger (1968)	Requires regional calibration and an <i>a priori</i> knowledge of species dissolution susceptibility. It has a wider sensitivity range than the previous index.
Loss of susceptible species $L(\%) = 100 \times (1-r_o/r)$; r_o = percentage of resistant species in an unaltered sample; r = percentage of resistant species in a sediment sample; Berger, 1971	Requires one unaltered sample from the investigated region and an <i>a priori</i> knowledge of species dissolution susceptibility. It is only sensitive at low dissolution intensity.
P/B — plankton to benthos ratio $B(\%) = 100 \times B/(B+P)$; B = number of benthic foraminiferal shells; P = number of planktic foraminiferal shells (Arrhenius, 1952)	Shells of benthic foraminifera are more resistant to dissolution than those of planktic foraminifera, but there are many other factors influencing the abundance of both groups. This index is robust and sensitive even at high dissolution intensity, but it can be difficult to interpret unambiguously.

Fig. 1.13 – Dissolution indices. (from Kucera, 2007)

2. ODP Leg 154 - Site 926

2.1. Study area – Ceara Rise and ODP Leg 154

The study material comes from ODP Site 926 (Leg 154), which was drilled at Ceara Rise, located off the northern coast of Brazil (Western Equatorial Atlantic Ocean) (Fig. 2.1). The Ceara Rise is a bathymetric high formed around 80 Ma at the Mid-Atlantic Ridge, along with the Sierra Leone Rise located in the eastern equatorial Atlantic. Its depth ranges from 2600 to 4500 mbsl (Fig. 2.2), and it is covered by a succession of more than 1000 m thick, characterized by relatively undisturbed lithogenic and biogenic sediments (Curry et al., 1995). In addition, Ceara Rise is characterized by flat shoals oriented northwest-southeast, bordered by the Ceara Abyssal Plain to the northeast and east and by the Amazon Fan to the west and southwest (see Figs. 2.1 and 2.3) (Curry et al., 1995).

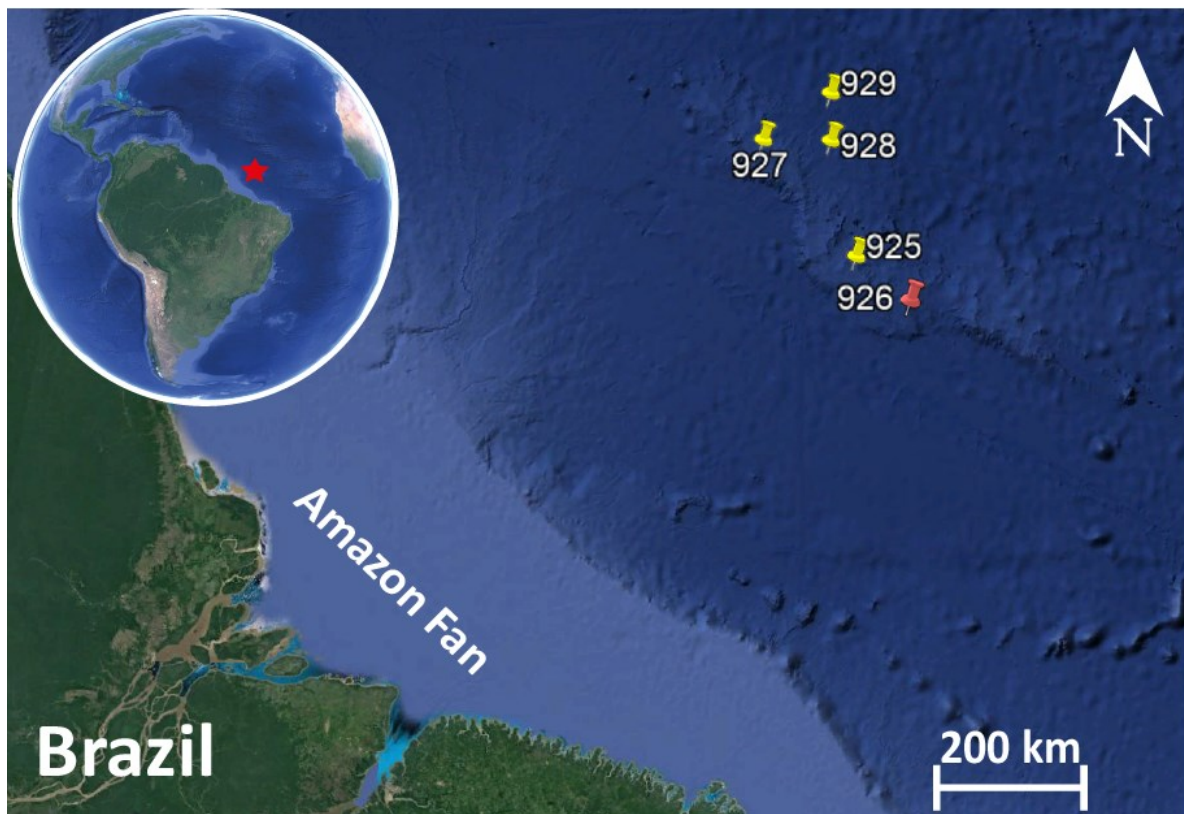


Fig. 2.1 - Location of study area on the Ceara Rise in the western Equatorial Atlantic Ocean and the five sites of the Ocean Drilling Program (ODP) Leg 154 (see the next paragraph).

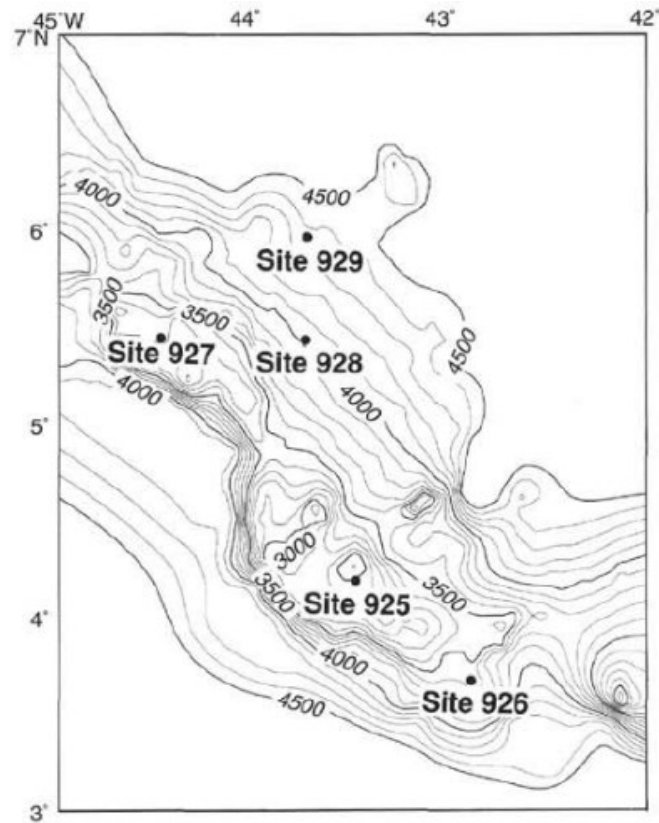


Fig. 2.2 – Ceara Rise bathymetry with locations of the five sites of the ODP Leg 154. (from Curry et al., 1995)

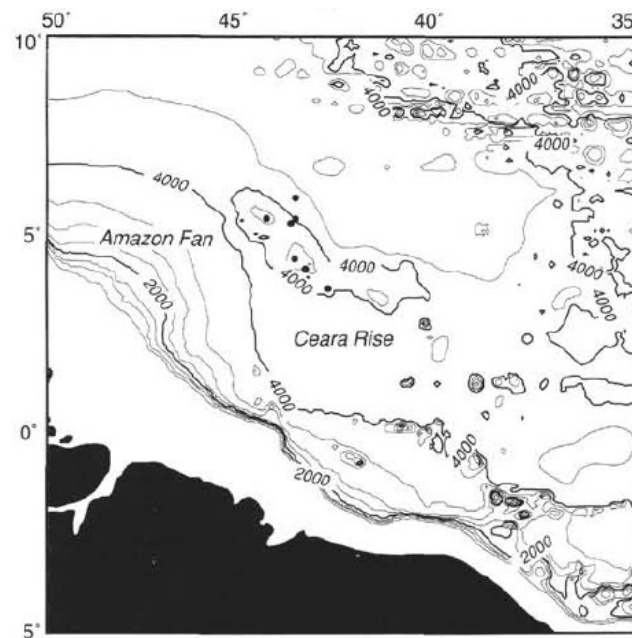


Fig. 2.3 – Location of Ceara Rise in relation to the Ceara Abyssal Plain and the Amazon Fan. (from Curry et al., 1995)

The goal of Leg 154 was to recover sedimentary successions along a bathymetric transect in the western equatorial Atlantic. This would have added to the previously collected global data on depth transects and helped the understanding of the Cenozoic history of deep-water chemistry. Since Ceara Rise is situated under the warm surface waters of the western tropical Atlantic, it was

considered an ideal area for studying the history of tropical sea-surface temperatures, the development of tropical calcareous microfossils (foraminifera and nannofossils), and the chemistry of nutrient-depleted surface waters (Curry et al., 1995).

Leg 154 is characterized by five sites (925, 926, 927, 928, and 929) drilled on the slopes of the northeast face of the rise at approximately 300-m depth intervals (Fig. 2.2). Sites 925, 926, and 927 are shallower (3041, 3598 and 3315 mbsl), while Sites 928 and 929 are deeper (4012 and 4356 mbsl).

At each site, APC/XCB cores (APC = Advanced hydraulic Piston Core; XCB = Extended Core Barrel) were collected into the Miocene interval, but deeper penetration was planned at three of the sites (925, 926, and 929) to provide a depth transect that would span since the lower Oligocene. However, drilling at Site 929 was extended downward into the Paleocene (Curry et al., 1995).

Since the aim of drilling during Leg 154 was to obtain the most complete successions possible for the drilled intervals, all five sites included triple, overlapping APC coring in order to reconstruct a composite section and obtain a continuous stratigraphic succession for each site (Curry et al., 1995).

Drilling multiple APC holes at each site, with an offset in depth, has typically been a method to have a continuous stratigraphic succession, overcoming the problems related to no sediment recovery and core breaks (Curry et al., 1995). For instance, the stratigraphic interval missing in sections with no recovery in one hole can be recovered in an adjacent hole. On Leg 154, the continuity of recovery was confirmed by creating combined depth sections at the sites where multiple coring took place. The methodology used for the composite section of Leg 154 is similar to that used by Hagelberg et al. (1992) during Leg 138 (Curry et al., 1995).

Firstly, for each site, high-resolution measurements of magnetic susceptibility, GRAPE (gamma-ray attenuation porosity evaluator) wet bulk density, natural gamma emissions, P-wave velocity and color reflectance percentages were obtained. Magnetic susceptibility and color reflectance were used as the primary lithologic parameters. Integration of at least two different physical properties allowed more confident hole-to-hole correlations than using only a single parameter. The correlative features were aligned by adjusting the ODP coring depths in meters below the seafloor (mbsf), core-by-core. Then, integrating several lithologic parameters, the resulting adjusted depth scale was in meters composite depth (mcd). So, for each core at each site, the depth adjustment required to convert from mbsf to mcd was provided. Finally, to establish correlations between the two holes, a single physical parameter was measured and shifted along a depth scale from one core to the next (for an example, see Fig. 2.4 by Curry et al., 1995).

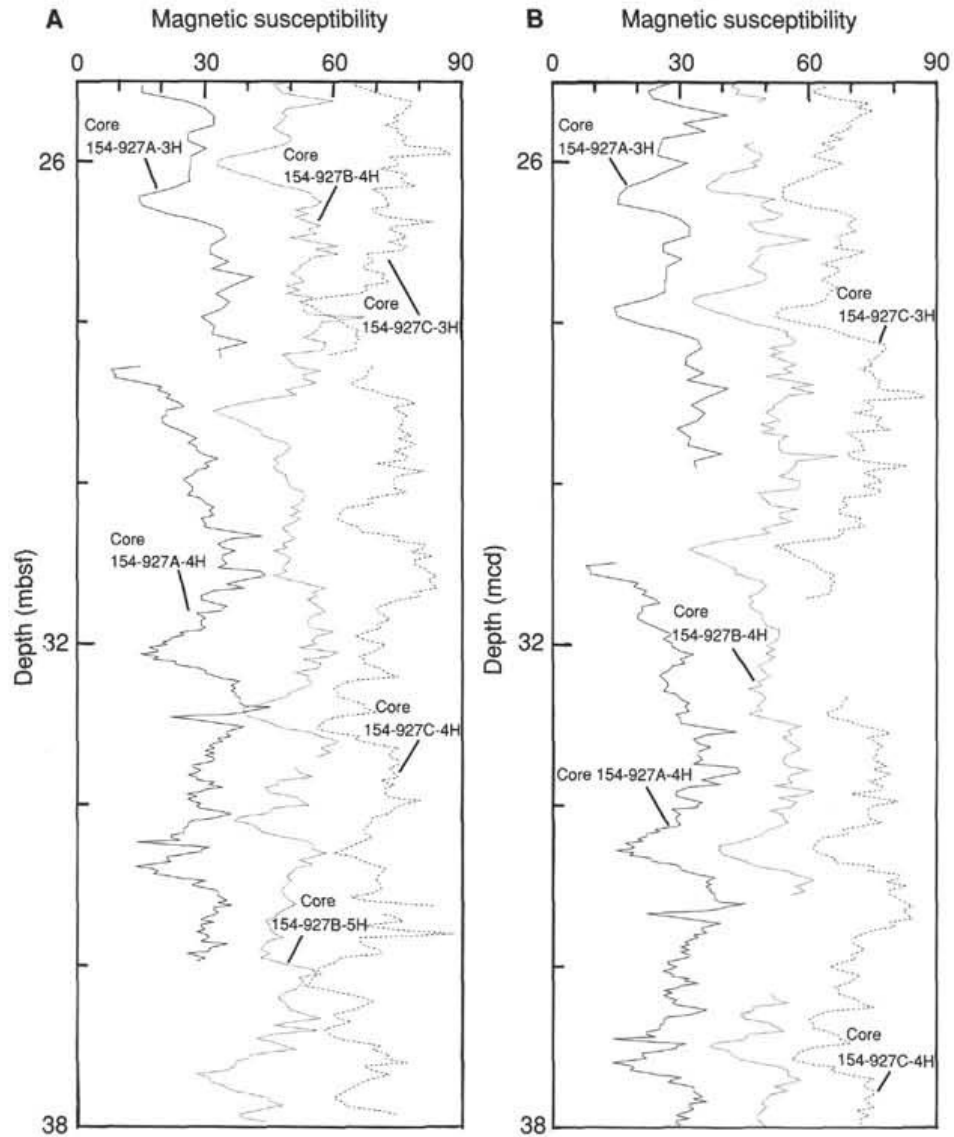


Fig. 2.4 - Magnetic susceptibility records from Site 927. A) Cores on mbsf depth scale where data from each hole are offset for clarity. B) Cores after adjusting the depth scale in meters composite depth (mcd), integrating lithologic parameters, where features common to all holes are relatively aligned. (from Curry et al., 1995)

Following the construction of composite depth, a single spliced record was created to represent the sedimentary succession from multiple cores. Identifying missing intervals between successive cores allowed data integration from adjacent holes, resulting in a complete record. The spliced record offers the advantage of providing a single representative dataset for a specific site about lithologic parameters such as magnetic susceptibility, color reflectance, or natural gamma (Curry et al., 1995).

2.2. Site 926

The present study focuses on Site 926, particularly on the Aquitanian—Burdigalian interval. So, this paragraph will show the general characteristics of this site and its recovered stratigraphic succession.

Site 926 is located at the midpoint of the Ceara Rise depth transect, where the seafloor is 3598 m deep and bathed by North Atlantic Deep Water (NADW) above the current lysocline. At Site 926, three holes were drilled: 926A, 926B, and 926C. Hole 926A drilled to a depth of 327 mbsf using the APC. Hole 926B was cored to 254 mbsf with the APC and then drilled further using the XCB to reach a depth of 605.7 mbsf. Hole 926C was cored to 247.5 mbsf with the APC and extended with the XCB to a depth of 398.3 mbsf. By comparing the magnetic susceptibility and high-resolution color reflectance records in detail, it was demonstrated that the sedimentary succession had been wholly recovered (Curry et al., 1995).

2.2.1. Lithology

The recovered sedimentary succession at Site 926 covers the interval from the late Oligocene to the Holocene without any significant stratigraphic break. It is characterized by rhythmic sedimentary cycles that show an alternation of light-colored nannofossil and foraminiferal chalk and ooze, and dark-colored siliciclastic sediments (see the example in Figure 2.5). Changes in sediment color are linked to variations in the amounts of carbonate, clay minerals, and to a lesser extent, iron oxides and sulfides (Fig. 2.6). In most of the succession, calcium carbonate is the dominant component of sediments (50% to 80%), while terrigenous material, most of which comes from the Amazon River outflow, constitutes the bulk of the noncarbonate portion of the sediments (Fig. 2.6). Between 10 and 12 Ma there was identified an interval of lower mean carbonate that corresponds to an interval of more dissolved calcareous microfossils (Fig. 2.7). Other low carbonate values are present near 375 mbsf (~20 Ma) and are characterized by consistently low color reflectance and high concentrations of sulfur and organic carbon (Fig. 2.6). These values correspond to the interval where pore-water silica values are near 1000 μM (Fig. 2.7) and are associated with the presence of diatoms and radiolarians, which are generally absent throughout much of the cored section. The more significant amount of solid phase silica and silica in the pore waters near 400 mbsf may be related to increased sedimentation rates during the early Miocene but also to silica concentration in the bottom waters. At Site 926, indeed, it is possible that there was more Antarctic Bottom Water than Northern Component Water, which is relatively depleted in silica (Curry et al., 1995).

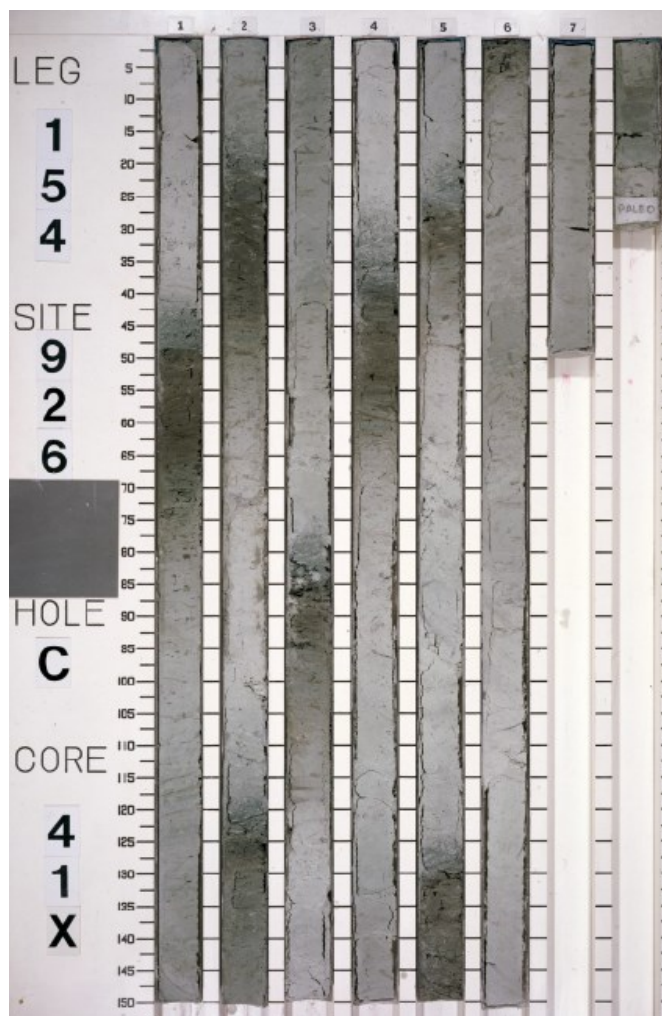


Fig. 2.5 – Original photos from core 41X by hole 926C to show an example of cyclicity in the sediments. (from Curry et al., 1995)

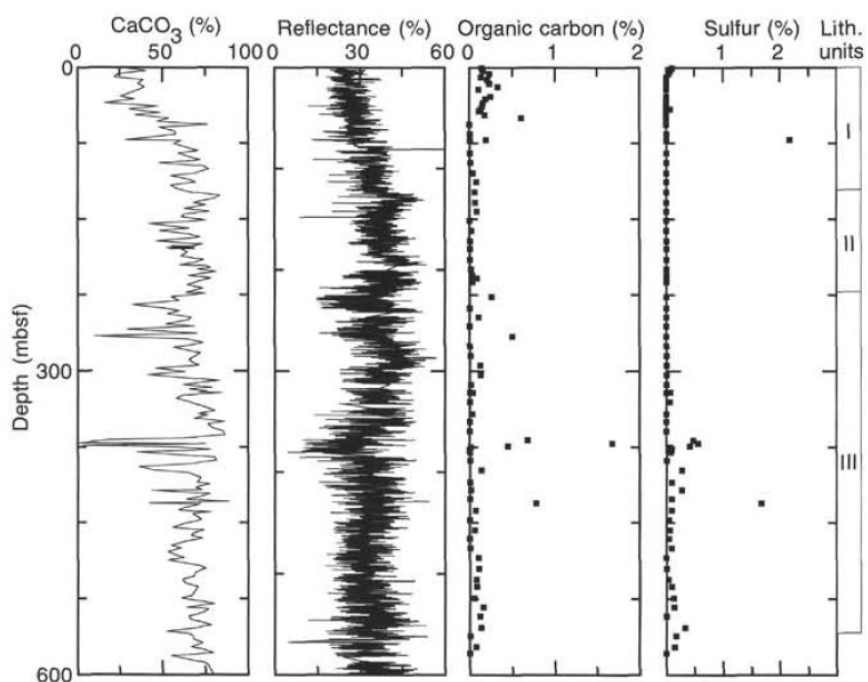


Fig. 2.6 – Calcium carbonate, color reflectance in the green (550 nm) wavelength, organic carbon, and sulfur vs. depth at Site 926. Lithologic unit boundaries are shown on the right side of the diagram. (from Curry et al., 1995)

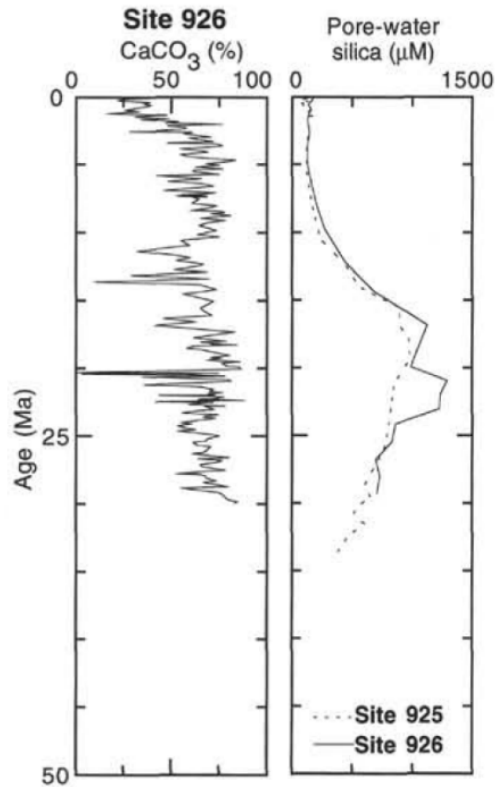


Fig. 2.7 – Calcium carbonate and pore-water silica profiles at Sites 926. (from Curry et al., 1995)

The rhythmic sedimentary cycles that characterize this succession are astronomically calibrated and related to the Milankovitch orbital cycles, particularly obliquity and precession, with amplitude modulated by eccentricity (details in paragraphs 2.3, Shackleton et al., 1999; Pälike et al., 2006a). Furthermore, the Neogene astronomical timescale (Astronomically Tuned Neogene Time Scale [ATNTS]) for the Early to Middle Miocene is based on the astronomically calibrated succession of Ceara Rise (Lourens et al., 2004; Hilgen et al., 2012; Raffi et al., 2020).

Sedimentary cyclicity was well recorded by magnetic susceptibility, color reflectance, and natural gamma-ray emission that show variations in the ratio of terrigenous material to biogenic carbonate in the sediments (Fig. 2.8) (Curry et al., 1995), and also by the $\delta^{18}\text{O}$ record based on analyses of a mixture of *Cibicidoides* (benthic foraminifera) species (Pälike et al., 2006a). Unfortunately, due to a pervasive magnetic overprint, it has been impossible to obtain magnetostratigraphic data at Site 926 and also at the other sites of Leg 154 (Curry et al., 1995).

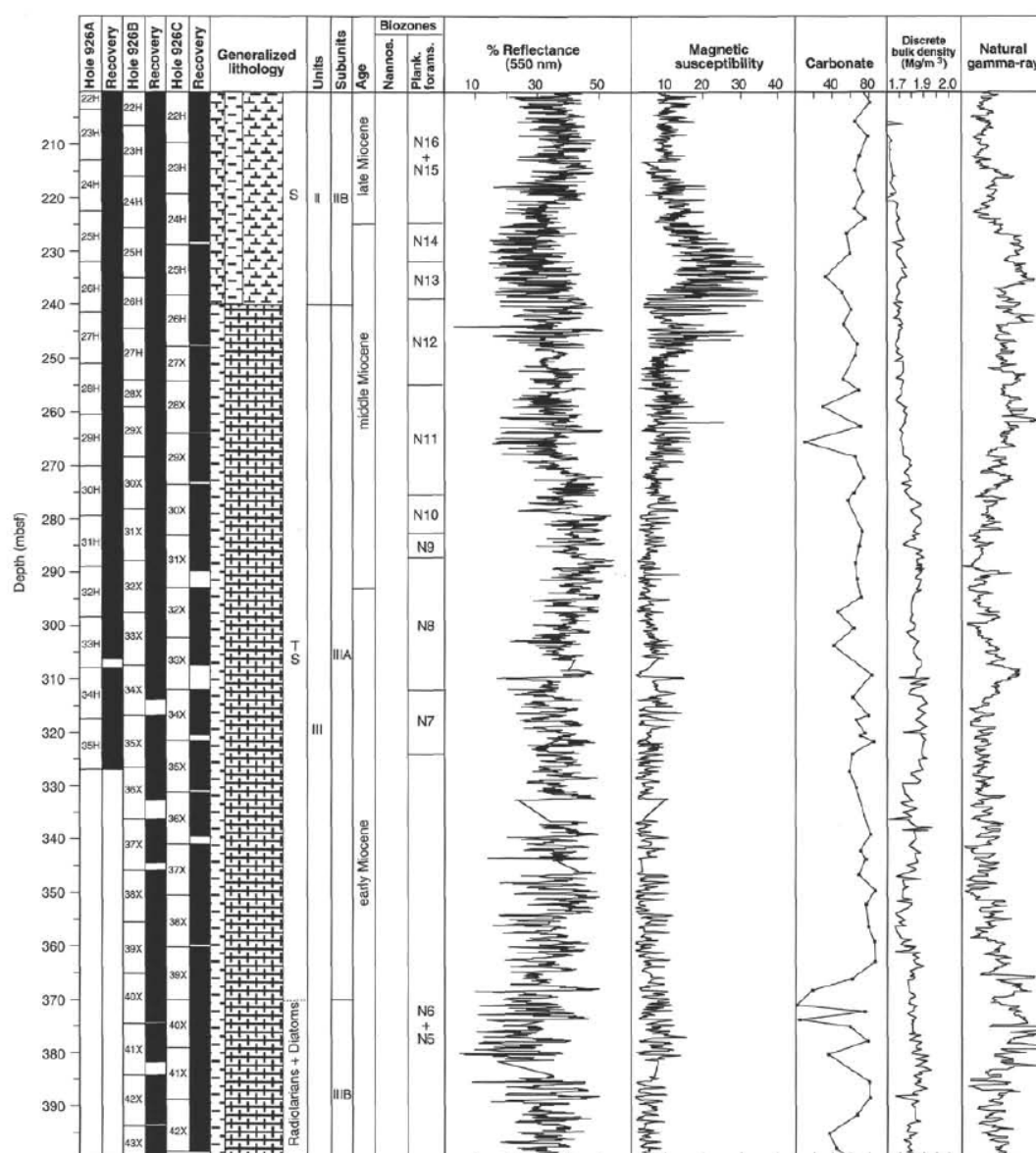


Fig. 2.8 – Core recovery, lithostratigraphy, age, biozones, percentage of reflectance (550 nm), magnetic susceptibility, carbonate content, bulk density, and natural gamma of sediments recovered at Holes 926A through 926C. (from Curry et al., 1995)

2.2.2. Initial age model of Site 926 (Curry et al., 1995)

According to Curry et al. (1995), age assignments at Site 926 were initially based on biostratigraphic analyses of calcareous nannofossils and planktonic foraminifera.

The assemblages of both fossil groups are rich and generally well-preserved, providing an exceptional biostratigraphic succession and excellent opportunities for studying evolutionary processes and ecological patterns, especially because there is no break in their stratigraphic records (Curry et al., 1995). Their preservation is excellent in the Pleistocene-Pliocene part of the succession but is affected by carbonate dissolution in some stratigraphic intervals, i.e. in the Middle Miocene and in the upper Lower Miocene.

The shipboard biostratigraphic analysis to establish stratigraphic constraints for calcareous nannofossil events was based on one to six samples per core section, with a sample spacing ranging from 1.5 to 0.25 m (example in Figure 2.9; Curry et al., 1995).

This resolution was later implemented by Raffi et al. (2006) and Backman et al. (2012).

Constraints on planktonic foraminifera events were established by examining three to six samples per core, with a sample spacing of 1.5 to 3 meters, in stratigraphic intervals with multiple cores. One to six samples were studied per 9 meters of core in stratigraphic intervals recovered in a single hole (example in Figure 2.10; Curry et al., 1995). Later, Pearson & Chaisson (1997) increased the resolution of the shipboard biostratigraphic data published by Curry et al. (1995), using a sampling distance of 1.5 meters (example in Fig. 2.11; Pearson & Chaisson, 1997), which corresponds to a time resolution of 100 kyr.

Events	Age (Ma)	Sample ID (top to bottom)	Depth (mbsf)	Mean depth (mbsf)	Depth (mcd)	Mean depth (mcd)
B <i>Sphenolithus heteromorphus</i>	18.1	34X-CC to 35X-1, 40	312.64–317.30	314.97	342.45–347.11	344.78
T <i>Sphenolithus belemnos</i>	18.4	35X-4, 120 to 35X-5, 40	322.60–323.30	322.95	352.41–353.11	352.76
B <i>Sphenolithus belemnos</i>	19.7	38X-5, 120 to 38X-6, 80	353.00–354.10	353.55	382.81–383.91	383.36
T <i>Sphenolithus delphix</i>	23.7	50X-6, 80 to 50X-6, 110	469.70–470.00	469.85	499.51–499.81	499.66
B <i>Sphenolithus delphix</i>	24.4	51X-1, 120 to 51X-2, 40	472.20–472.90	472.55	502.01–502.71	502.36

Fig. 2.9 – Calcareous nannofossil biohorizons identified in Hole 926B (T = top, B = base) of Late Oligocene- Early Miocene interval. (modified from Curry et al., 1995)

Events	Age (Ma)	Sample range	Depth (mbsf)	Mean depth (mbsf)	Composite depth (m)	Mean composite depth (m)
T <i>Catapsydrax dissimilis</i>	17.3	33X-6, 70–71 cm, to 34X-2, 70–72 cm	305.81–309.51	307.66	335.62–339.32	337.47
T <i>Globorotalia binaensis</i>	19.1	39X-4, 70–72 cm, to 39X-5, 70–72 cm	360.70–362.20	361.45	390.52–392.02	391.27
T <i>Paragloborotalia kugleri</i>	21.6	44X-6, 70–72 cm, to 45X-1, 70–72 cm	411.60–413.80	412.70	441.41–443.61	442.51
B <i>Paragloborotalia kugleri</i>	23.7	50X-3, 70–72 cm, to 50X-4, 70–72 cm	465.08–466.60	465.84	494.92–496.42	495.67
B <i>Paragloborotalia pseudokugleri</i>	26.3	54X-4, 72–74 cm, to 54X-5, 68–70 cm	505.13–506.54	505.86	534.92–536.42	535.67

Fig. 2.10 – Planktonic foraminifera events identified in Hole 926B (T = top, B = base) of Late Oligocene- Early Miocene interval. (modified from Curry et al., 1995)

Datum	Category	Stratigraphic position	Age (Ma)	Core section interval (cm)		Depth (mbsf)		Interpolated depth (mbsf)	Depth (mcd)		Interpolated depth (mcd)
				Top	Bottom	Top	Bottom		Top	Bottom	
T <i>Catapsydrax dissimilis</i>	Extinction	Base N7/Top N5/6	17.3	34X-3, 70–72	34X-4, 20–22	311.01	312.01	311.51	340.32	341.82	341.06
B <i>Globigerinatella insueta s.str.</i>	Pseudospeciation		?	34X-3, 70–72	34X-4, 20–22	311.01	312.01	311.51	340.32	341.82	341.06
T <i>Globobuccina binaensis</i>	Extinction		19.1	39X-4, 70–72	39X-5, 70–72	360.70	362.20	361.45	390.52	392.02	391.27
B <i>Globigerinatella sp.</i>	Pseudospeciation		?	39X-4, 70–72	39X-5, 70–72	360.70	362.20	361.45	390.52	392.02	391.27
T <i>Paragloborotalia kugleri</i>	Extinction	Base N5–6/Top N4	21.6	44X-6, 70–72	45X-1, 70–72	411.60	413.80	412.70	441.41	443.61	442.51
T <i>Paragloborotalia pseudokugleri</i>	Pseudospeciation		23.3	45X-2, 70–72	45X-6, 68–70	415.30	421.30	418.30	445.09	451.29	448.19
B <i>Globigerinoides trilobus</i>	Pseudospeciation		?	50X-3, 70–72	50X-4, 70–72	465.08	466.60	465.84	494.92	496.42	495.67
B <i>Paragloborotalia kugleri</i>	Pseudospeciation	Base N4/Top P22	23.7	50X-3, 70–72	50X-4, 70–72	465.08	466.60	465.84	494.92	496.42	495.67
T <i>Globigerina ciperensis</i>	Extinction		?	53X-2, 70–72	53X-3, 68–70	463.60	465.08	464.34	493.41	494.92	494.16
T <i>Globigerina angulatus</i>	Extinction		23.3	52X-6, 65–67	53X-2, 53–55	468.65	492.33	490.49	518.44	522.04	520.24
B <i>Paragloborotalia pseudokugleri</i>	Pseudospeciation		26.3	54X-6, 68–70	55X-2, 70–72	508.08	511.70	509.89	537.89	541.51	539.70

Fig. 2.11 – Planktonic foraminifera events in Hole 926B (T = top, B = base) of Late Oligocene- Early Miocene interval. (modified from Pearson & Chaisson, 1997)

The initial age model of Site 926, published by Curry et al. (1995), was based on the calibration of calcareous nannofossil and planktonic foraminiferal events, derived from the age estimates provided in the time scale of Berggren et al. (1995).

Currently, the age calibration of these events is based on the age model developed by Shackleton et al. (1999) through astronomical tuning, which was later improved and corrected by Pälike et al. (2006a) (see paragraph 2.3 for details).

The sedimentation rates were calculated starting from the age calibration of calcareous nannofossils and planktonic foraminifera (Fig. 2.12) (Curry et al., 1995). They were highest in the Pleistocene (33 m/myr), lowest in the middle Miocene (11 m/myr), and intermediate in the lower

Miocene and late Oligocene (20-25 m/myr). They gradually increased from the middle Miocene to the Pleistocene (Fig. 2.13), and this increase was mainly due to a growing amount of terrigenous material from the Amazon River. On the other hand, during the Pleistocene, a biogenic carbonate flux decrease was recorded. However, the change in sedimentation rates is not just because of variations in terrigenous supply but also due to a dissolution problem. In fact, during the Middle Miocene, episodes of severe dissolution caused the lysocline to move up to depths shallower than 3600 m, which reduced sedimentation rates at Site 926 (Curry et al., 1995).

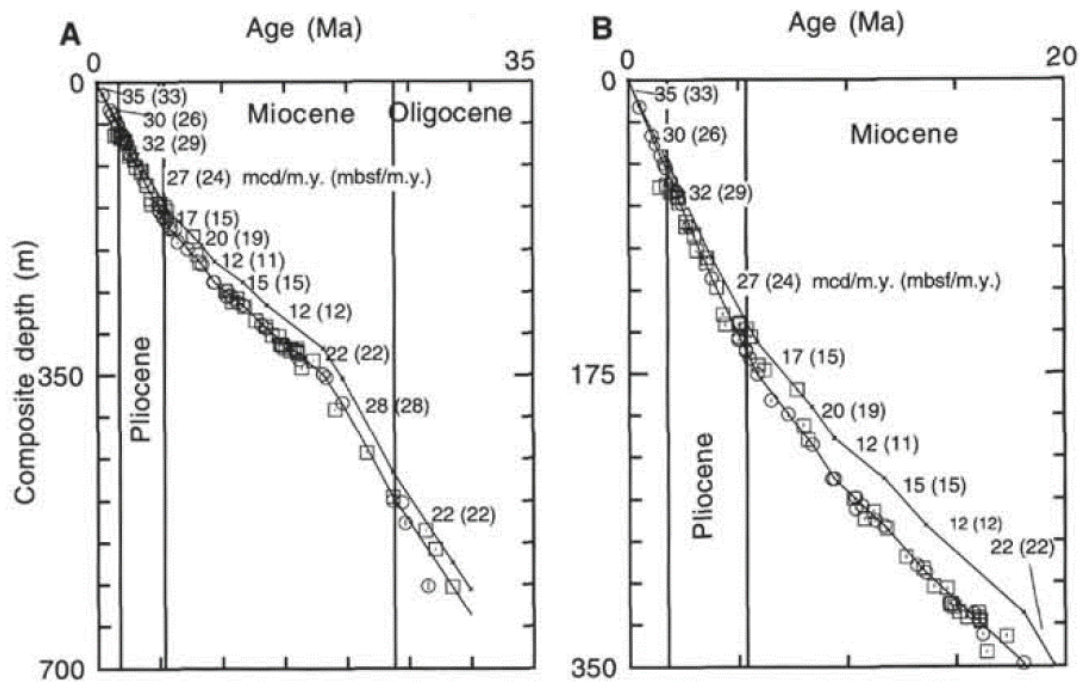


Fig. 2.12 - Age-depth plots of calcareous nannofossil (circles) and planktonic foraminiferal (squares) events at Site 926, using data from Holes 926A and 926B. The events are plotted on the mcd depth scale. The sedimentation rates are expressed in meters per million years both on the mcd and mbst (in parentheses) scales. (from Curry et al., 1995)

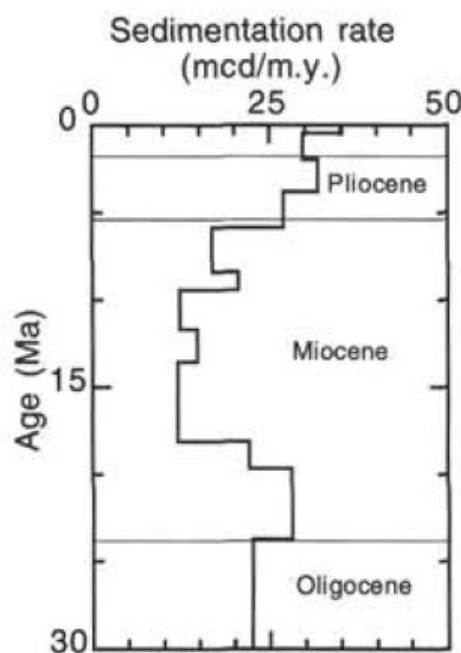


Fig. 2.13 - Sedimentation rates at Site 926 on the age. (from Curry et al., 1995)

2.3. Age model and astronomical tuning of Site 926

The age model adopted in this study is based on the astronomical tuning of the composite section of Site 926 by Shackleton et al. (1999), with the most recent recalibration by Pälike et al. (2006a).

2.3.1. Age model and astronomical tuning by Shackleton et al. (1999)

Shackleton et al. (1999) created their timescale, adopting the astronomical solution of Laskar et al. (1993), which provided the basis for their tuning.

The starting point of their work were the shipboard data of Site 926 (magnetic susceptibility, color reflectance, and natural gamma-ray emission, Fig. 2.14), which recorded the cyclicity of sediments (see paragraph 2.2) and the age model based on calcareous nannofossil and foraminiferal bioevents (Curry et al., 1995; Pearson & Chaisson, 1997).

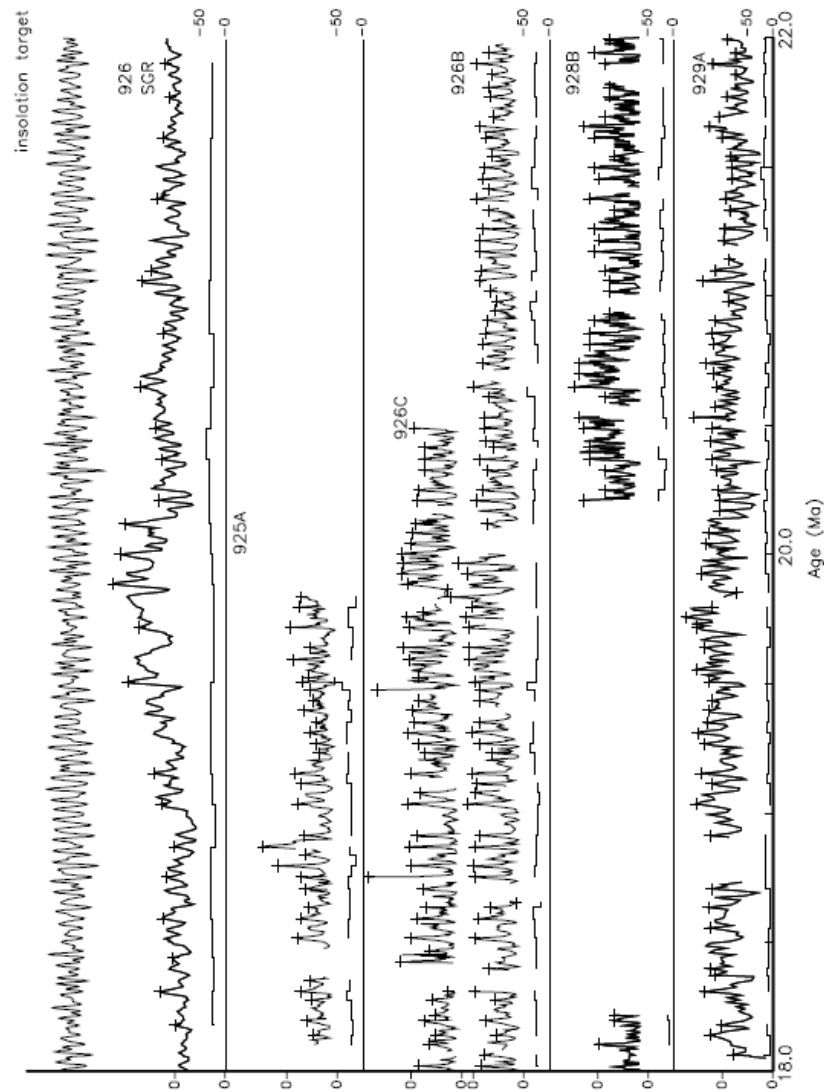


Fig. 2.14 - From left to right, data of insolation target, downhole spectral gamma ray (SGR) log for ODP Hole 926B, and magnetic susceptibility (volume-normalized SI units) for Holes 925A, 926C, 926B, 928B and 929A in the interval 18-22 Ma. (from Shackleton et al., 1999)

First of all, as mentioned in the previous paragraph, the measurements of magnetic susceptibility, color reflectance and natural gamma-ray emission can help estimate the amount of terrigenous material compared to biogenic calcium carbonate. Terrigenous material is dark-colored and contains uranium, potassium, and iron minerals, while biogenic calcium carbonate is white, non-radioactive, and non-magnetizable (Curry et al., 1995; Harris et al., 1997). Shackleton et al. (1999) noted that using the three data sets in parallel was convenient for scaling the shipboard measurements, which have incompatible units, approximately in terms of percent CaCO_3 . In fact, very high percent carbonate values are characterized by very high reflectance that is sensitive to small changes, while the values of the other two parameters are low. On the other hand, very low percent carbonate values are better recognized by the exceptionally high magnetic susceptibility since reflectance is a less sensitive parameter in dark-colored sediment.

Regarding bioevents, the time-scale work was mainly based on age assignments by Berggren et al. (1995), but, unfortunately, due to a pervasive magnetic overprint, magnetostratigraphic information was lacking (see paragraph 2.2), and it was impossible to carry out a direct correlation between bioevents and magnetostratigraphy to obtain the absolute ages at Site 926.

About astronomical tuning, Shackleton et al. (1999) extended the work started by Weedon et al. (1997), who studied the lithological cyclicity in the sedimentary record in Ceara Rise. They confirmed that the Oligocene was characterized by $\sim 41\text{kyr}$ cycles and established a provisional time scale for the Oligocene by assuming that the cyclicity is a response to orbital obliquity variation. Furthermore, they used spectral analysis to estimate the mean wavelength and the sedimentation rate of successive core intervals.

Shackleton et al. (1999) performed a high-resolution correlation between stratigraphic successions of Leg 154 Sites that allowed for the determination of changing vertical gradients with respect to water depth in parameters such as CaCO_3 (%) or $\delta^{18}\text{O}$, permitting reconstructions of the Oligocene water masses to be attempted. Subsequently, they tried to identify the imprint of a particular component of the orbital forcing in the successions, determining the dominance of the obliquity cycle in the variability of Oligocene sediments. Then, they conducted a depth-to-time conversion that correlated the sedimentary cycles above and below the Miocene base to a series of obliquity cycles (Shackleton et al., 1999). The high-resolution site-to-site correlations were completed only after displaying all the sites on a common time scale. This was probably achieved correctly for most of the material recovered from the time interval 18-28 Ma.

Weedon et al. (1997) arranged their time scale, assuming the Oligocene-Miocene boundary was identified with the Top of *Sphenolithus delphix* calibrated at 23.8 Ma. However, Shackleton et al. (1999) discovered that during this interval the obliquity signal showed long-period variation in amplitude, with reduced amplitude cycles very close to the boundary and higher-amplitude cycles above and below. This pattern does not align with the calculated obliquity at the accepted age for the boundary; hence, the most probable position was at the amplitude minimum, younger than previously calibrated ones.

After the entire sequence had been placed on the age model using obliquity cycles, it became possible to utilize amplitude modulation of the precession signal, which is influenced by the long-period component of eccentricity (406 kyr), and then progress through the $\sim 100\text{kyr}$ cycle, while still keeping obliquity as the primary basis for tuning. The most reliable method for determining the correct age of a tuned succession is to analyze the long-period amplitude modulations (eccentricity). It is important to note that the actual tuning is usually based on the most evident cyclical patterns

found in the geological records, typically related to obliquity or precession cycles (Shackleton et al., 1999).

As said previously, the Oligocene and Lower Miocene sediments display a strong 41 krs cyclicity, but some variations occur at about twice that frequency, likely due to precession, in certain intervals. Because of this, it was used a curve dominated by obliquity but also including a noticeable precession component as a tuning target. Traditionally, the insolation curve June 65 N was used as a tuning target because the precession component heavily influences it, but was unsuitable for use here. To prevent variability from being forced into the precession band, control point insertion was limited to once per 41 kyr cycle. However, it is essential to note that any method that links data extremes to insolation extremes does improve consistency with precession (Shackleton et al., 1999).

As a result of this astronomical tuning, a time scale was developed for each recovered core by either matching it to the astronomical target curves by Laskar et al. (1993) or identifying the most suitable match in another site that could be more easily linked to the orbital template (Shackleton et al., 1999). This method, which had already been successfully used by Shackleton & Crowhurst (1997) for the interval younger than ca. 14 Ma, was extended by Shackleton et al. (1999) to the interval from ca. 18 to 28 Ma (Fig. 2.15).

Regarding the absolute age of the tuned section, it was evaluated by statistical comparisons with the orbital target. To perform statistical analyses of the entire interval, a spliced record based chiefly on data from Site 926 was created with a percentage of data from Sites 928 and 925 inserted in gaps in the record of Site 926 (Shackleton et al., 1999).

Thanks to the evaluation of absolute age, it was possible to recalibrate the age of Site 926 bioevents by Curry et al. (1995), for calcareous nannofossils, and Pearson & Chaisson (1997), for planktonic foraminifera.

The calculated absolute age was assigned to the Top and Base of each bioevent (both nannofossils and foraminifera) in each Leg 154 site considered (see Tab. 2 in Shackleton et al., 1999). The mean of the two ages (top and base) corresponded to the tuned age of each bioevent in each site. The best age estimates are usually derived from the most reliable site and were given to 0.1 Ma, except for a few nannofossil data determined with exceptional precision.

In the end, comparing the ages by Shackleton et al. (1999) with the literature ages of previously published CK95 time scale by Cande & Kent (1995), it is noticed that the age calibration of the Oligocene-Miocene boundary, previously dated at 23.8 Ma, and events close the boundary, are ~0.9 Ma younger (Shackleton et al., 1999). In this way, the O/M boundary was shifted from 23.8 Ma (Cande & Kent, 1995) to 22.9 Ma (Shackleton et al., 2000).

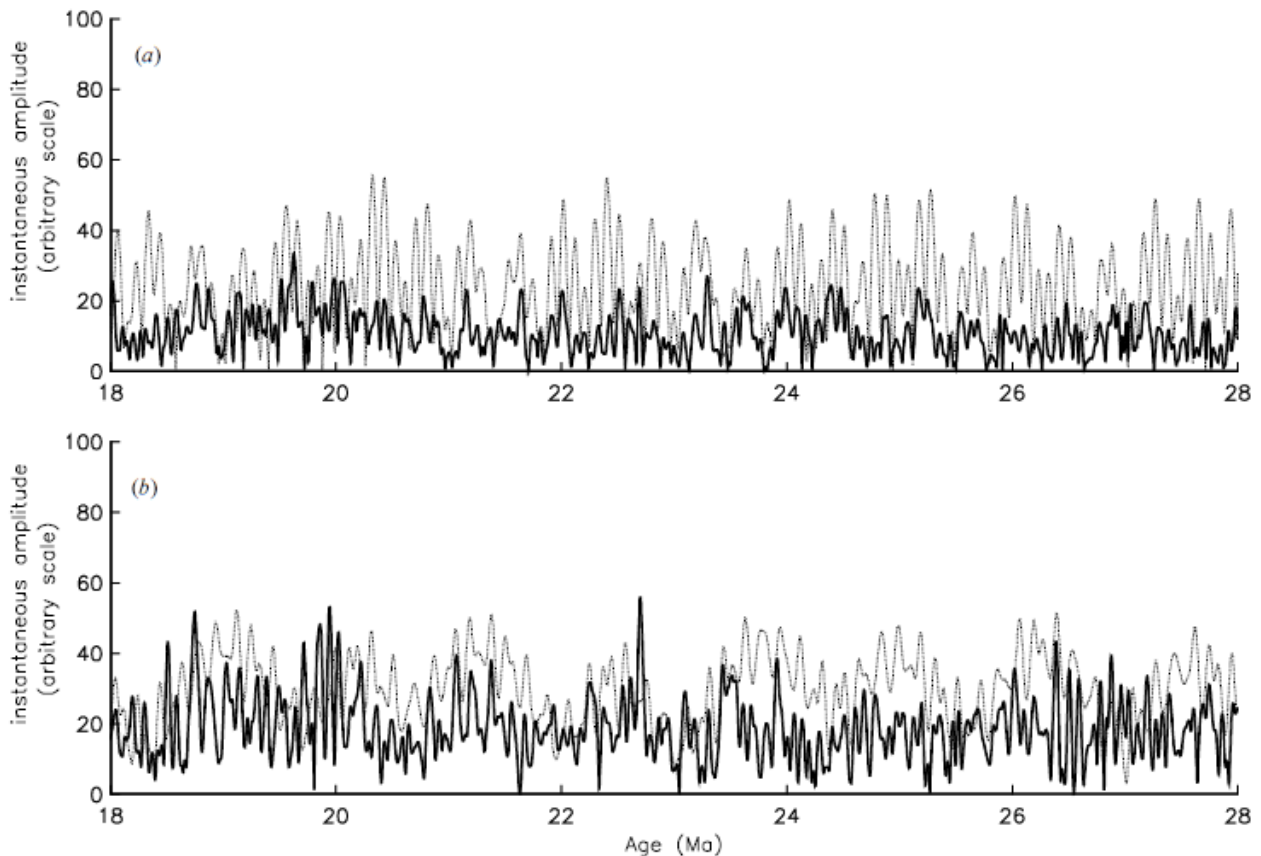


Fig. 2.15 - (a) Amplitude of the 21 ka variability (obtained by complex demodulation) of a spliced magnetic susceptibility record for the interval 18-28 Ma (solid) compared with orbital eccentricity (dotted) over the same time-interval (Laskar et al., 1993). (b) Amplitude of the 41 ka variability (obtained by complex demodulation) of the spliced record (solid), compared with amplitude of the obliquity variability (dotted) from Laskar et al., (1993). (from Shackleton et al., 1999)

2.3.2. Recalibration by Pälike et al. (2006a)

Pälike et al. (2006a) revised Shackleton et al. (1999)'s age model at Site 926. They improved the astronomical tuning for the interval from ~17.86 to ~26.5 Ma, by adding to previous datasets (e.g., magnetic susceptibility and color reflectance) stable isotope ($\delta^{18}\text{O}$ and $\delta^{13}\text{C}$) records across the Oligocene/Miocene boundary (extended by Paul et al., 2000, and Zachos et al., 2001) and the percentage of > 65 μm coarse sand fraction.

The new records of benthic stable isotope ($\delta^{18}\text{O}$ and $\delta^{13}\text{C}$) and percent sand fraction > 65 μm by Pälike et al. (2006a) follow the methods described by Paul et al. (2000). The benthic stable isotope records were extended downward analyzing a mix of *Cibicidoides* species (e.g., *C. mundulus* and *C. crebbsi*) and upward analyzing only *C. mundulus* record (Pälike et al., 2006a). The coarse fraction data by Pälike et al. (2006a) were added to those published previously from ODP Site 929 (Zachos et al., 1997; Paul et al., 2000). The percentage of the coarse fraction was transformed into “ $\arcsin(\sqrt{\text{\%coarse fraction}/100})$ ” to obtain more normally distributed values from data cutted at zero percent (Weedon, 2003).

The re-adjustment of the ODP Leg 154 data set by Pälike et al. (2006a) started from the astronomical solution by Laskar et al. (2004), who improved the calculation of Earth's orbital variations to fit better with the geological data (Pälike et al., 2004).

In Fig. 2.16, all available datasets ($\delta^{18}\text{O}$, $\delta^{13}\text{C}$, coarse fraction, susceptibility and lightness combined data, obliquity and ETP) by Pälike et al. (2006a) are plotted against their new time scale together with the astronomical target curves from Laskar et al. (2004), where the ETP is an artificial combination of eccentricity, obliquity (tilt) and climatic precession that normalizes these three orbital components. Here, the stable isotope data show a significant eccentricity imprint, making the eccentricity component very prominent.

The new ages by Pälike et al. (2006a) were found to be approximately 20 kyr older in the interval preceding ~19.71 Ma (Shackleton et al., 1999). This age shift then gradually increases from 19.71 to 20.15 Ma and reaches an average offset of approximately 90 kyr for the remainder of the data, except for the interval from 23.35 to 24.21 Ma.

Both stable isotope time series contain ~110 and ~405 kyr eccentricity cycles. The oxygen isotope record shows obliquity cycle amplitude variations that co-vary with the astronomical target curve, and this pattern also fits the benthic carbon isotope record. These results are similar to those of Zachos et al. (2001).

The $\delta^{18}\text{O}$ curve in detail (Fig. 2.16) shows a significant positive excursion correlated to the glacial event Mi-1 (Miller et al., 1991; Zachos et al., 2001). According to Zachos et al. (2001), the Mi-1 event coincides with a period of low eccentricity associated with the 400-kyr cycle. During this event, a series of obliquity period cycles started at 23.3 Ma, over which $\delta^{18}\text{O}$ increased to a peak at 23.0 Ma. In the new time scale by Pälike et al. (2006a), the position of the Mi-1 event coincides with an obliquity minimum near the position of the Oligocene/Miocene boundary (Shackleton et al., 2000; Zachos et al., 2001).

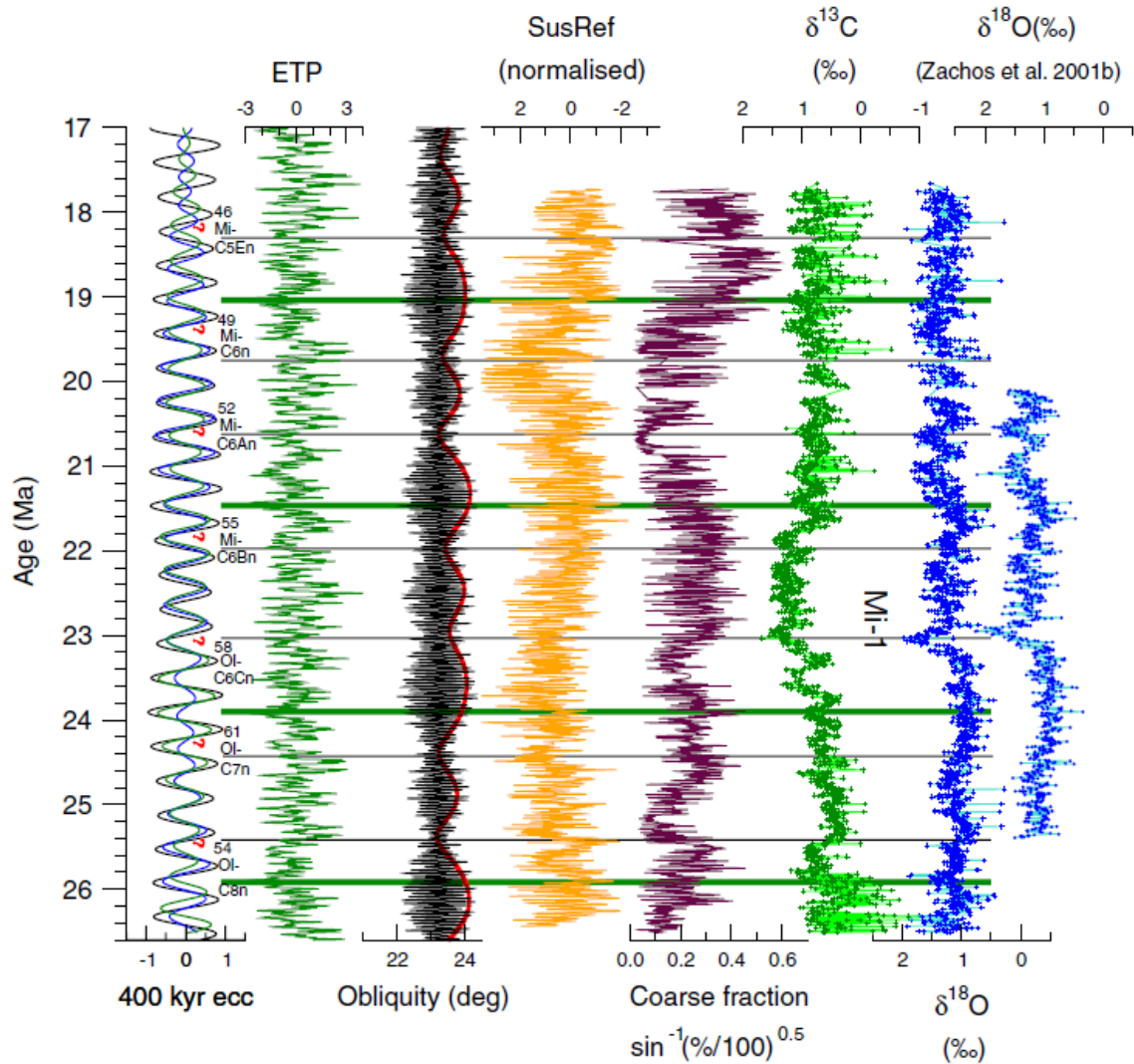


Fig. 2.16 - ODP Leg 154 data plotted versus age (Ma) according to the revised astronomical time scale of Site 926 of Pälike et al. (2006a). Astronomical solutions of Laskar et al., (2004) were applied. Red tick and codes mark the position of the absolute number of ~400 kyr cycles as first proposed by Wade & Pälike (2004). Thin cross-lines mark the position of obliquity amplitude minima, thick green cross-lines mark the position of long-term eccentricity amplitude minima. (from Pälike et al., 2006a)

Starting from Pälike et al. (2006a) new calibration, the definitive position of the O/M boundary at Site 926 was determined by correlating the isotope stratigraphy and nannofossil biostratigraphy of ODP Sites 926 and 1090 (Billups et al., 2004). The latter is located in the Southern Atlantic Ocean and it was chosen because used the astronomical solution of Laskar et al. (2004), as a tuning target, and presented a well-defined magnetic polarity data set (Channell et al., 2003). The correlation between the two sites was used to refine the geomagnetic polarity time scale by Cande & Kent (1995) and to define the O/M boundary in Site 926. In Site 1090, the O/M boundary was defined at the Base of Chron C6Cn.2n, dated at 23.03 Ma, corresponding to the positive oxygen isotope excursion of Mi-1 “Event” (Zachos et al., 2001), and was approximated by the Top of calcareous nannofossil *Sphenolithus delphix* (dated at 23.06 Ma), located just below the chron base (Pälike et al., 2006a; Wade et al., 2011; Agnini et al., 2014) (see Fig. 2.17).

Correlating the oxygen isotope records of two sites (see Fig. 2.17) made it possible to match the positive excursions referred to the Mi-1 event and correlate the Top of *S. delphix*. In this way, the O/M boundary in Site 926 was dated at 23.03 Ma (Lourens et al., 2005), approximated by glacial event Mi-1 (~23.0 Ma) and the last occurrence of *S. delphix*, dated at 23.06 by Raffi et al. (2006).

This revision led to a shift of ~100 kyr in the age calibration of the Oligocene/Miocene by Shackleton et al. (2000), controlled by the difference in amplitudes of the 100 kyr eccentricity cycle (Pälike et al., 2006a).

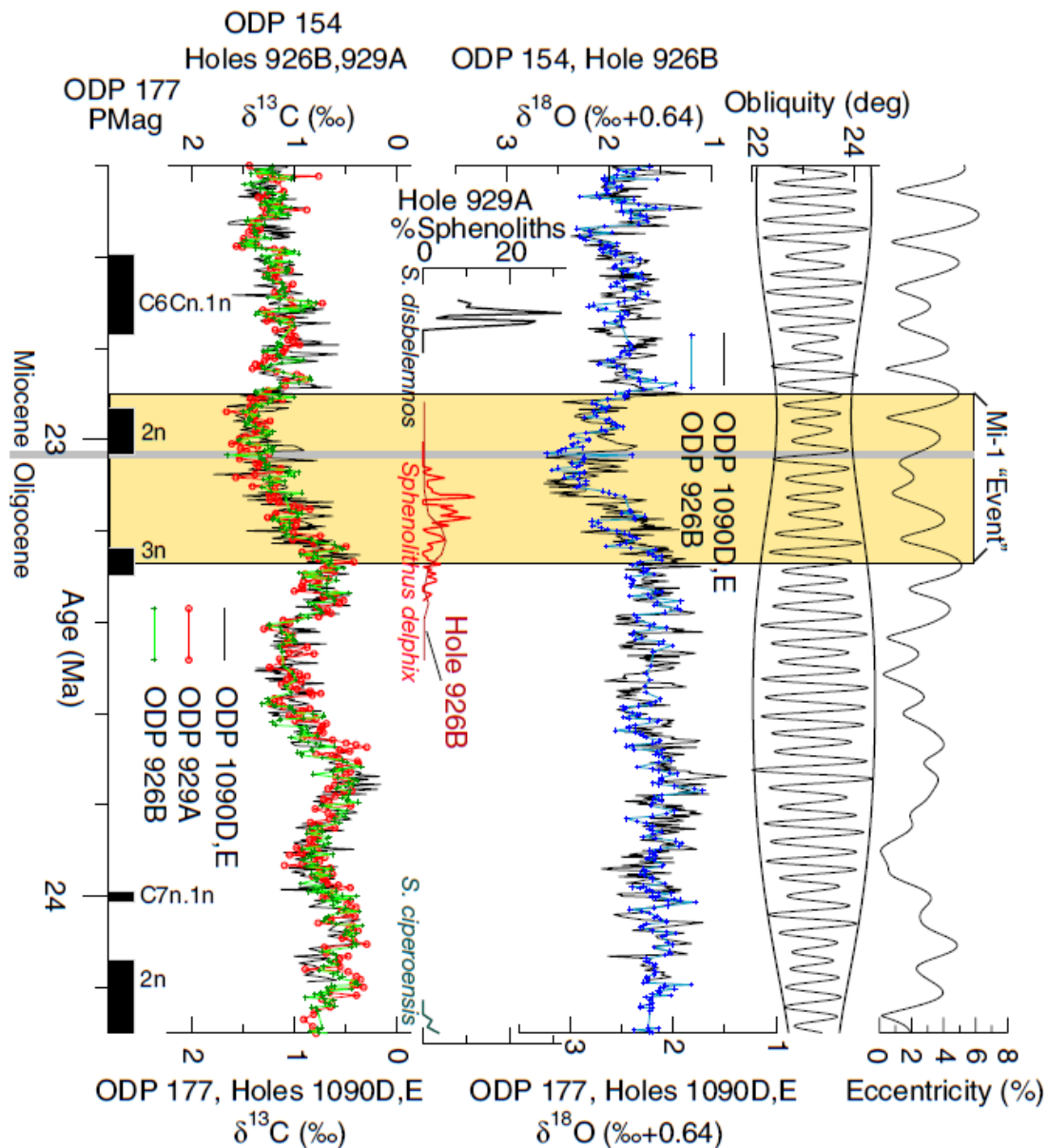


Fig. 2.17 – Focus on data around Oligocene/Miocene boundary between 22.4 and 24.3 Ma on Pälike revised time scale and comparison between ODP Site 1090 and ODP Hole 926B and Hole 929A to define the O/M boundary. (from Pälike et al., 2006a)

3. Material and Methods

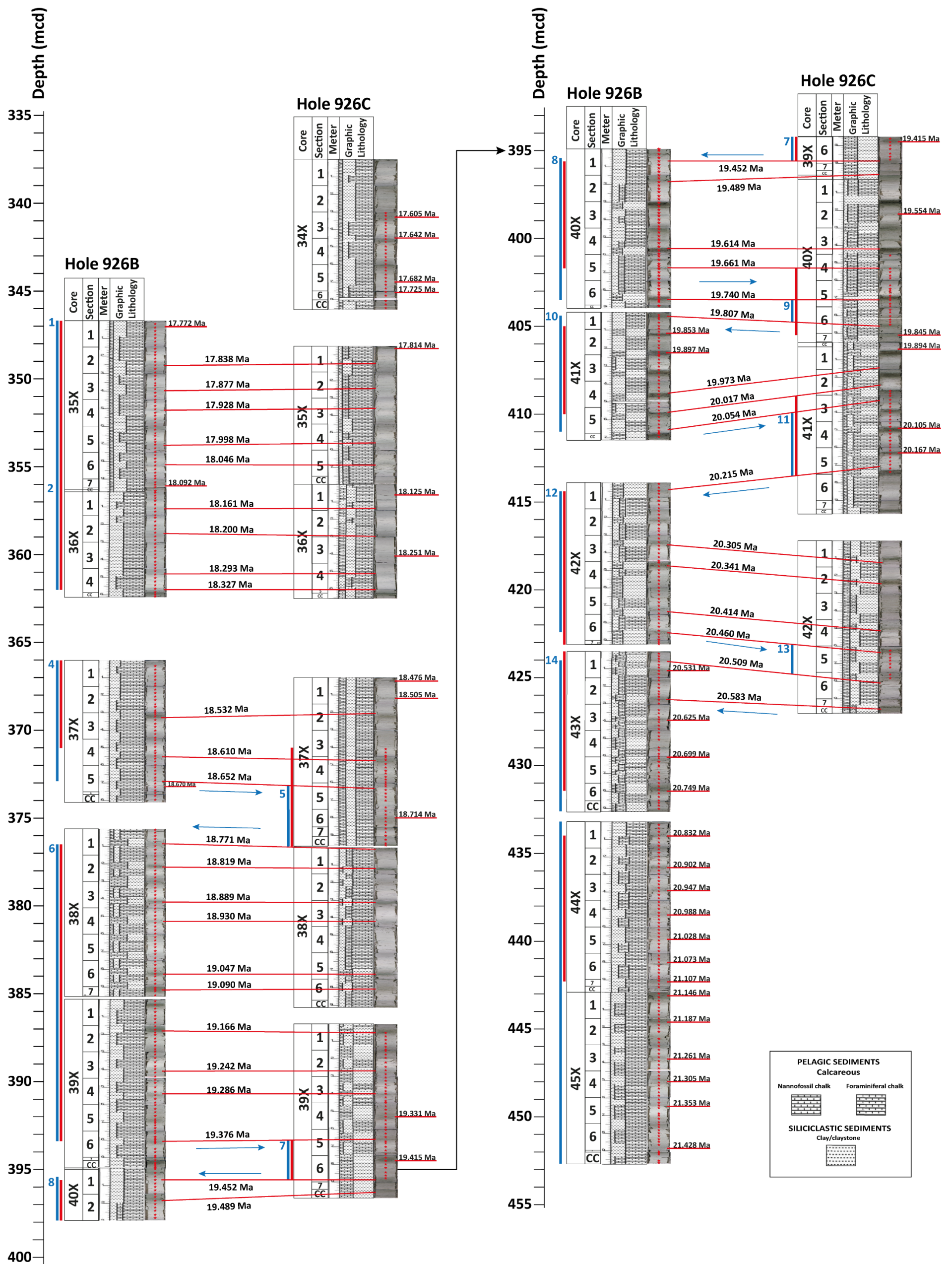
3.1. Site 926 Composite section and sample choice

3.1.1. Aquitanian – Burdigalian interval

Referring to the previous chapter, which gave an overview of ODP Site 926, a composite section of Site 926 for the Aquitanian - Burdigalian interval, from 21.5 Ma – 17.6 Ma (which is the main focus of this part of the work), was reconstructed by correlating Holes 926B and 926C starting from the calibrated tie points of the age model of Shackleton et al. (1999), with the new age calibration by Pälike et al. (2006a). As a result, a graphic reconstruction of the composite section was made, where lithological data from the cores by Curry et al. (1995) were added (Fig. 3.1). In Figure 3.1, the horizontal red bands indicate the calibrated tie points by Shackleton et al. (1999) and Pälike et al. (2006a), while the vertical bands, near the cores, mark the composite sections followed by Shackleton et al. (1999) (red) and in this work (blue). This study focused on samples collected from Holes 926B and 926C, previously requested from the ODP Repository in Bremen (Germany), chosen with a sampling interval of 20 cm (~5kyr resolution). Each sample was added to the graphic representation of the composite section (red stars in Figure 3.1).

Following the composite section, the studied interval precisely ranges from core 926B/45X (452.61 mcd) to core 926C/34X (340.56 mcd) (21.5 Ma – 17.6 Ma). The age of each sample was calculated by linear interpolation using the software PAST (Hammer et al., 2001), starting from the calibrated tie points (Shackleton et al., 1999; Pälike et al., 2006a). From the initial collected samples, 137 samples were selected to conduct a quantitative analysis of planktonic foraminifera. The samples were chosen from the same lithology (light-colored nannofossil and foraminiferal chalk levels), with a time resolution of ~30 kyr, in order to evaluate planktonic foraminifera assemblages always in the same phase of the sedimentary cycle (obliquity minima) (Pälike et al., 2006a).

Following the samples chosen for this part of the work, the last version of the composite section, visible in Figure 3.2, was reconstructed, with a particular focus on a portion of the section to show the cyclicity in sediments (with light-dark alternation) and the chosen samples. The bioevents of this interval were also added: planktonic foraminifera events by Pearson & Chaisson (1997) (red) and calcareous nannofossil events by Backman et al. (2012) (blue).



Bioevents

PF Pearson & Chaisson, 1997

CN Backman et al., 2012

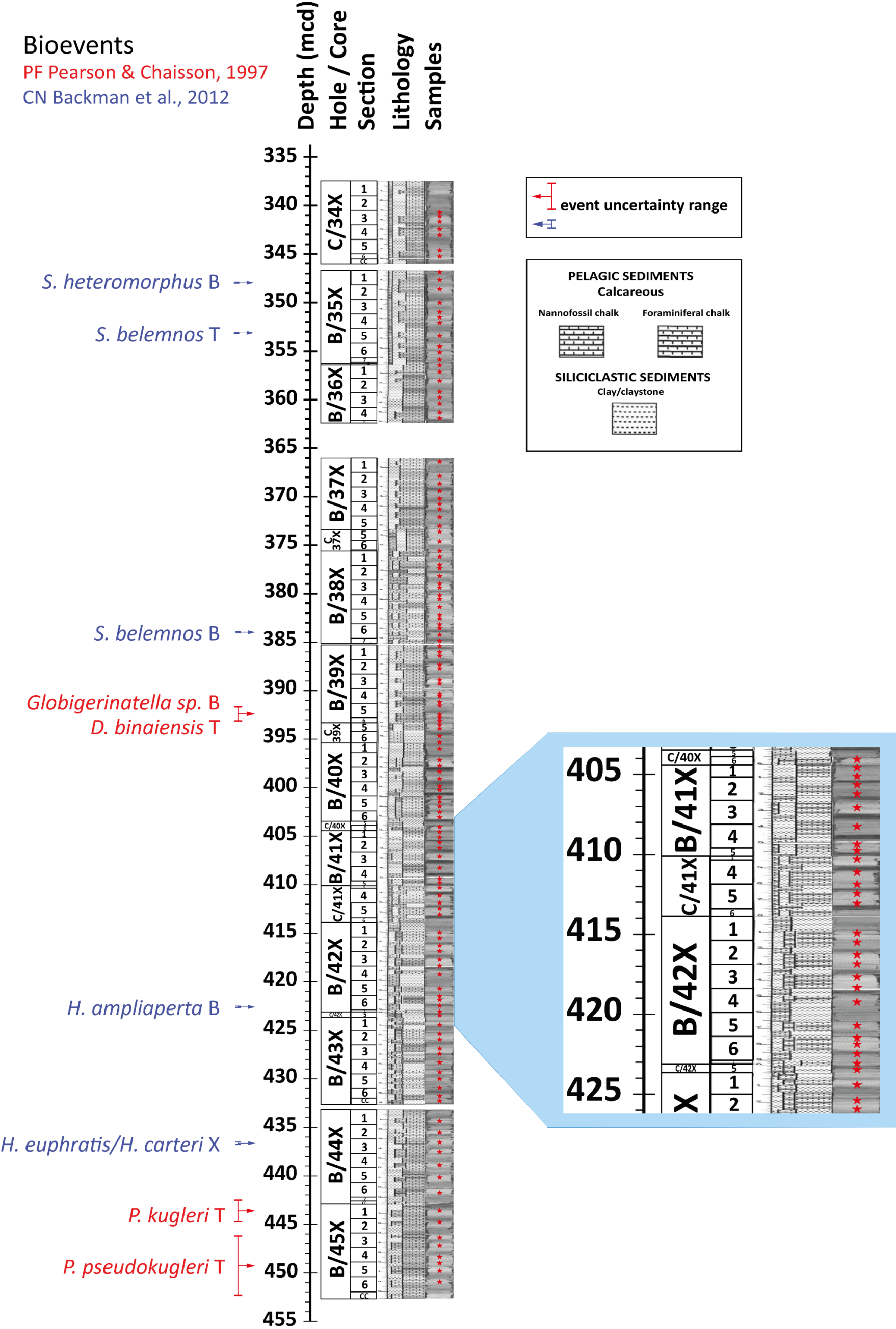


Fig.3.2 – Composite section of the Aquitanian-Burdigalian interval and bioevents by Pearson & Chaisson (1997) (planktonic foraminifera) and Backman et al. (2012) (calcareous nannofossils).

3.1.2. Upper Chattian – Aquitanian interval

For the second part of the work aimed to obtain the entire distribution pattern of *Paragloborotalia pseudokugleri*/*Paragloborotalia kugleri* group, the analysis conducted on the Aquitanian – Burdigalian interval was extended downwards to the upper Chattian. This stratigraphic interval was recovered only in Hole 926B, but the depths were reported in mcd, like the interval above, following the meters composite depth scale of Shackleton et al. (1999) and Pälike et al. (2006a).

The studied interval for this part of the work ranges from the Top of the Core 926B/55X (541,68 mcd) to the top of Core 926B/46X (453.47 mcd), covering the time interval from 24.7 Ma to 21.5 Ma. Also for this interval, a graphic reconstruction of the section was made, with the addition of lithological data from the cores by Curry et al. (1995) and the bioevents by Pearson & Chaisson (1997) (planktonic foraminifera) and Raffi et al. (2006) (calcareous nannofossils) (Fig. 3.3). Here, the samples requested to the ODP Repository in Bremen (Germany) have a sampling distance of ~50 cm (~12.5 kyr resolution), and their ages were calculated by linear interpolation using the software PAST (Hammer et al., 2001), starting from the calibrated tie points by Shackleton et al. (1999) and Pälike et al. (2006a).

The first step of this part of the work was a qualitative analysis of this interval in order to have an overview of the distribution of the entire group and identify, preliminarily, the Bases of *P. pseudokugleri* and *P. kugleri*. Then, 44 samples were selected from nannofossil and foraminiferal chalk levels (as in the previous interval), with a time resolution of ~35 kyr, for a quantitative analysis of planktonic foraminifera. These samples belong to the interval from the top of Core 926B/46X (453.47 mcd) to the top of the Core 926B/51X (503.27 mcd), covering the time span from 21.5 to 23.2 Ma.

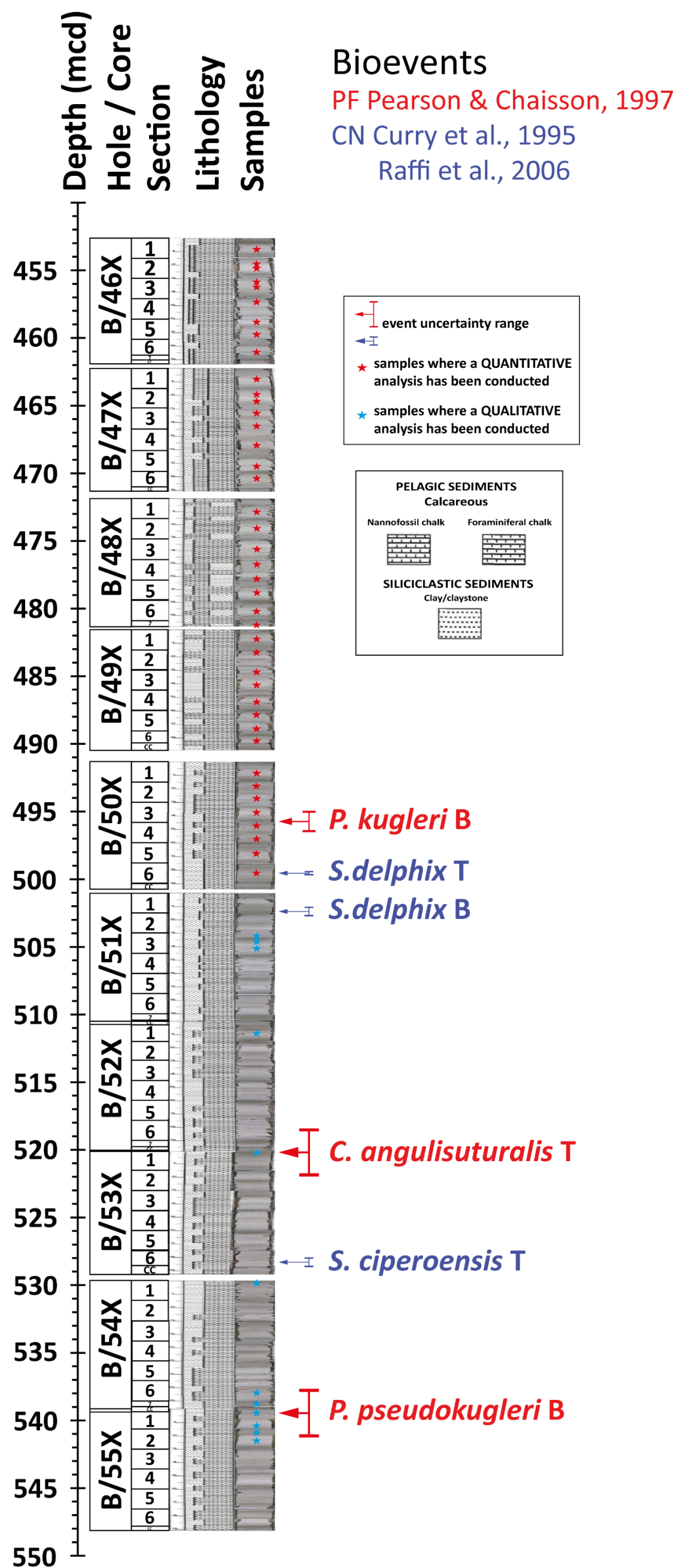


Fig.3.3 – Upper Chattian - Aquitanian interval of Hole 926B in mcd scale and bioevents by Pearson & Chaisson (1997) (planktonic foraminifera), and Curry et al. (1995) and Raffi et al. (2006) (calcareous nannofossils).

3.2. Sample preparation

Each sample was subjected to laboratory treatment by dedicated laboratory staff to obtain washed residues.

Firstly, the samples were weighed using an electronic scale and then heated in an oven at a constant temperature of 40°C for 4-5 days. Once the residual moisture was removed, the samples were taken out of the oven and weighed again (sample dry weight). Distilled water was then slowly added to the glass beakers containing the samples and stirred with a glass rod to break up the samples. After the reaction with the distilled water was complete and each sample had been fully disaggregated, it was gently washed with running water by pouring it into a 63 µm mesh sieve, which was previously cleaned with a methylene blue solution to highlight the presence of any contaminating particles. The remaining fraction > 63 µm was poured onto a filter paper and placed in a flask to create a vacuum, eliminating the residual water. Finally, each sample was placed in an oven at a temperature of 40°C for 2-3 days. Once completely dry, the washed residues were sieved using a 125 µm mesh sieve, obtaining two fractions (> 125 and < 125 µm) that were weighed. The fractions of the washed residues were placed in plastic boxes and appropriately labeled.

3.3. Micropaleontological analysis

At this phase, the samples were ready for micropaleontological analyses using a reflected light stereomicroscope. This type of analysis was performed on each sample by splitting the > 125 µm fraction of the washed residue obtained using a microsplitter that divided sediment fractions into equal parts.

For each sample, 200-300 specimens of planktonic foraminifera were counted in splits of >125 µm fraction of the washed residue. The number of benthic foraminifera, planktonic foraminifera fragments, and radiolarians were also counted. The faunal density was calculated using planktonic foraminifera countings and the weight (in grams) of each sample. It indicates the concentration of planktonic foraminifera in the entire > 125 µm fraction for each sample, expressed as the number of specimens of planktonic foraminifera per gram of residue > 125 µm.

Each taxa were classified at specific and supra-specific level by using taxonomic manuals (e.g., Blow, 1969; Bolli & Saunders, 1985; Kennett & Srinivasan, 1983; Spezzaferri, 1994; Pearson & Chaisson, 1997; Iaccarino et al., 2005; Iaccarino et al., 2007; Coxall & Spezzaferri, 2018; Leckie et al., 2018; Olsson et al., 2018; Pearson et al., 2018a, 2018b; Spezzaferri et al., 2018a, 2018b, 2018c; Wade et al., 2018).

The supra-specific taxonomic categories identified in this work are:

- *Dentoglobigerina altispira* group: *Dentoglobigerina altispira* and *Dentoglobigerina globosa*.
- *Dentoglobigerina baroemoenensis* group: *Dentoglobigerina baroemoenensis* and *Dentoglobigerina larmei*.
- *Globigerinella obesa* group: *Globigerinella obesa* and *Globigerinella pseudobesa*.
- *Globigerinoides parawoodi* group: *Globigerinoides italicus*, *Globigerinoides joli* and *Globigerinoides neoparawoodi*.

- Paragloborotalia continuosa group: *Paragloborotalia continuosa* and *Paragloborotalia pseudocontinuosa*.
- Paragloborotalia pseudokugleri/P. kugleri group: *Paragloborotalia pseudokugleri*, *Paragloborotalia kugleri* and *Paragloborotalia pseudokugleri/P. kugleri* transition forms.
- Tenuitella clemenciae group: *Tenuitella clemenciae* and *Tenuitella minutissima*.
- Trilobatus trilobus group: *Trilobatus immaturus*, *Trilobatus quadrilobatus* and *Trilobatus trilobus*.

(Additional information is in the “Taxonomic Appendix” at the end of this volume).

In addition, sinistral and dextral-coiled specimens of *Paragloborotalia siakensis* and *Paragloborotalia* cf. *P. bella* were counted separately to represent the prevailing coiling direction of the species.

The quantitative analysis of the samples from the stratigraphic interval from the top of Core 926B/46X (453.47 mcd) to the top of the Core 926B/51X (503.27 mcd) was focused on the *P. pseudokugleri/P. kugleri* group.

The relative abundance of each taxon was calculated by dividing the number of specimens of that taxon by the total number of planktonic foraminifera specimens in the sample and then multiplying by 100 to express it as a percentage. However, a variable number of specimens (on average about 12%) cannot be identified being juvenile forms or poorly preserved.

The main biostratigraphic events characterizing this interval have been identified. The lowest and highest occurrences of a taxon are indicated with the terms Base (B) and Top (T), respectively. The term Top Common (Tc) indicates the stratigraphically highest common presence.

In addition, a qualitative analysis of planktonic foraminifera was conducted for some samples to identify the exact position of some bioevents, increasing the resolution of the analysis. (i.e., *Paragloborotalia kugleri* Base and Top, *Paragloborotalia pseudokugleri* Base and Top, *Globigerinatella* sp. Base, *Globigerinoides altiaperturus* Base, *Globorotalia praescitula* Base).

The diversity indices were calculated using the software PAST (Hammer et al., 2001) to evaluate the biodiversity (number of species) of assemblages along the succession. The considered indices are:

- Shannon–Wiener Index (H): It provides an estimate of the diversity of the assemblage. It is a function of the number of species, and for a given number of species, it reaches the greatest number if all species have the same relative abundance. It considers both the number of species and their relative proportion (Spellerberg & Fedor, 2003).

$$H = - \sum_{i=1}^S p_i \ln p_i$$

p_i = relative abundance for each species

S = number of species

- Equitability (E): it expresses the degree of uniformity in which individuals are distributed among the various species that comprise a community (Buzas & Gibson, 1969; Pielou, 1975).

$$E = e^H / S$$

H = Shannon–Wiener Index

S = number of species

- Dominance (D): it indicates how evenly or unevenly individuals are spread across different species in a particular sample. If there is high dominance, it means that one or a few species dominate and have a monopoly on the available resources in the system. On the other hand, low dominance indicates a more balanced distribution of species, which is a sign of a healthier ecosystem (Simpson, 1949).

$$D = \sum_i \left(\frac{n_i}{N} \right)^2$$

n_i = number of individuals of the i-th species

N = total number of individuals

The percentages of planktonic foraminiferal fragments, the Plankton/Benthic ratio, and the percentages of radiolarians were calculated. These are considered dissolution indices and provide an estimate of the assemblage's preservation state (Parker & Berger, 1971; Berger, 1973; Thunell, 1976; Cullen & Prell, 1984; Peterson & Prell, 1985; Cullen & Droxler, 1990; Naidu et al., 1992; Le & Thunell, 1996; Conan et al., 2002; Kucera, 2007, see paragraph 1.4.2).

The plankton/benthic ratio (%) and the percentage of radiolarians can also be considered as productivity indices (Berger & Diester-Haass, 1988; Weinheimer, 2001; Lazarus, 2005, 2008), together with the faunal density.

The taxa recognized were divided into dissolution-resistant and dissolution-susceptible to evaluate the preservation status of the assemblages along the succession (Tab. 3.1). To carry out this division, some papers and manuals were consulted (Kennet & Srinivasan, 1983; Spezzaferri, 1994; Kucera, 2007; Fox & Wade, 2013)

Taxa were also divided into three groups according to their depth habitat (Tab. 3.2): mixed layer (surface + mixed layer dwellers), thermocline and sub-thermocline. The abundances (%) for each group were calculated to identify the preferred depth range of the assemblages' taxa. The species marked with an asterisk (*) prefer a surface habitat. The species whose depth habitat is unknown were not counted in the groups. In addition, *Dentoglobigerina tripartita*, *D. venezuelana* and *Tenuitella munda* were not considered because they can inhabit different depth habitats. The groupings were made possible by consulting various papers and taxonomic manuals (Wade et al., 2007; Pearson & Wade, 2009; Aze et al., 2011; Coxall & Spezzaferri, 2018; Leckie et al., 2018; Pearson et al., 2018a, 2018b; Spezzaferri et al., 2018a, 2018b, 2018c; Olsson et al., 2018; Wade et al., 2018).

In addition, the taxa were divided into four groups according to their temperature preferences (warm, warm-temperate, cold-temperate and cold) to evaluate the variations of surface paleotemperature of water masses (SST) (Tab. 3.3). Some taxonomic manuals and papers were considered for these groupings (Bé & Tolderlund, 1971; Sanvoisin et al., 1993; Spezzaferri, 1994;

Pearson et al., 1997; Pearson & Shackleton, 1995; Pearson & Wade, 2009; Aze et al., 2011; Stewart et al., 2012; Spezzaferri et al., 2018c). This subdivision partly reflects the latitudinal distribution and the depth of habitat (Tab. 3.2).

The ratio between the warm/temperate-warm taxa and temperate-cold/cold taxa was calculated. Species with poorly known temperature preferences or wide tolerance ranges were excluded (*Dentoglobigerina venezuelana*, *Globoturborotalita woodi*, *Paragloborotalia bella*, *Paragloborotalia siakensis*, marked in yellow in Tab. 3.3).

Finally, eutrophic taxa and/or upwelling zone taxa are grouped to evaluate, together the faunal density, the paleoproductivity (Tab. 3.4). To identify these specific taxa, several papers were consulted such as Spezzaferri (1994, 1995), Wade et al. (2007); Kucera (2007); Pearson & Wade (2009) and Coxall & Spezzaferri (2018).

Dissolution resistant taxa	Dissolution susceptible taxa
<i>Catapsydrax</i>	<i>Globigerinatella</i>
<i>Dentoglobigerina</i>	<i>Globigerinella</i>
<i>Globorotalia</i>	<i>Globigerinoides</i>
<i>Globorotaloides</i>	<i>Globoturborotalita</i>
	<i>Trilobatus</i>

Tab. 3.1 – Dissolution resistant and susceptible taxa.

mixed-layer (surface dwellers*)	thermocline	sub-thermocline
<i>Cassigerinella chipolensis</i> *	<i>Dentoglobigerina binaiensis</i>	<i>Catapsydrax dissimilis</i>
<i>Ciperoella anguliofficialis</i>	<i>Dentoglobigerina larmei</i>	<i>Catapsydrax unicavus</i>
<i>Dentoglobigerina altispira</i>	<i>Globoquadrina dehiscens</i>	<i>Globorotalia praescitula</i>
<i>Dentoglobigerina baroemoenensis</i>	<i>Globoturborotalita euapertura</i>	<i>Globorotaloides stainforthi</i>
<i>Dentoglobigerina globularis</i>	<i>Paragloborotalia bella</i>	<i>Globorotaloides suteri</i>
<i>Globigerina bulloides</i>	<i>Paragloborotalia nana</i>	
<i>Globigerinita glutinata</i>	<i>Paragloborotalia siakensis</i>	
<i>Globigerinoides altiapertura</i> *		
<i>Globigerinoides obliquus</i> *		
<i>Globigerinoides subquadratus</i> *		
<i>Globoturborotalita brazieri</i>		
<i>Globoturborotalita connecta</i>		
<i>Globoturborotalita drury</i>		
<i>Globoturborotalita martini</i>		
<i>Globoturborotalita occlusa</i>		
<i>Globoturborotalita pseudopraebulloides</i>		
<i>Globoturborotalita woodi</i>		
<i>Paragloborotalia continuosa</i> *		
<i>Paragloborotalia kugleri</i>		
<i>Paragloborotalia pseudokugleri</i>		
<i>Tenuitella angustiumbilicata</i>		
<i>Trilobatus immaturus</i> *		
<i>Trilobatus primordius</i>		
<i>Trilobatus quadrilobatus</i>		
<i>Trilobatus sicanus</i>		
<i>Trilobatus subsacculifer</i>		
<i>Trilobatus trilobus</i>		

Tab. 3.2 – Depth habitat preference of the species of studied interval (surface dwellers are indicated with *).

warm taxa	warm temperate taxa	cold temperate taxa	cold taxa
<i>Cassigerinella chipolensis</i>			
			<i>Catapsydrax dissimilis</i>
			<i>Catapsydrax unicavus</i>
<i>Dentoglobigerina altispira</i> gr.			
<i>Dentoglobigerina globularis</i>			
	<i>Dentoglobigerina larmei</i> gr.		
	<i>Dentoglobigerina tripartita</i>		
<i>Dentoglobigerina venezuelana</i>	<i>Dentoglobigerina venezuelana</i>	<i>Dentoglobigerina venezuelana</i>	<i>Dentoglobigerina venezuelana</i>
			<i>Globigerina bulloides</i>
			<i>Globigerinita glutinata</i>
<i>Globigerinoides altiapertura</i>			
<i>Globigerinoides bolli</i>			
<i>Globigerinoides obliquus</i>			
<i>Globigerinoides parawoodi</i> gr.			
<i>Globigerinoides subquadratus</i>			
<i>Globoquadrina dehiscens</i>	<i>Globoquadrina dehiscens</i>	<i>Globoquadrina dehiscens</i>	<i>Globoquadrina dehiscens</i>
			<i>Globorotalia praescitula</i>
			<i>Globorotaloides</i>
<i>Globoturborotalita brazieri</i>			
<i>Globoturborotalita druryi</i>			
<i>Globoturborotalita connecta</i>			
<i>Globoturborotalita martini</i>			
<i>Globoturborotalita occlusa</i>			
<i>Globoturborotalita pseudopraebuloides</i>			
	<i>Globoturborotalita woodi</i>	<i>Globoturborotalita woodi</i>	
	<i>Paragloborotalia bella</i>	<i>Paragloborotalia bella</i>	
	<i>Paragloborotalia nana</i>		
<i>Paragloborotalia pseudokugleri</i> / <i>P. kugleri</i> gr.			
	<i>Paragloborotalia siakensis</i>	<i>Paragloborotalia siakensis</i>	
	<i>Tenuitella angustumbilicata</i>		
			<i>Tenuitella munda</i>
<i>Trilobatus sicanus</i> gr.			
<i>Trilobatus subsacculifer</i>			
<i>Trilobatus trilobus</i> gr.			

Tab. 3.3 – Temperature preferences of the species of studied interval.

eutrophic taxa (upwelling zone)
<i>Cassigerinella chipolensis</i>
<i>Catapsydrax dissimilis</i>
<i>Catapsydrax unicavus</i>
<i>Globigerina bulloides</i>
<i>Globigerinita glutinata</i>
<i>Globigerinita uvula</i>
<i>Globorotaloides</i>
<i>Paragloborotalia pseudokugleri</i> / <i>P. kugleri</i> gr.

Tab. 3.4 – Eutrophic species of studied interval.

4. High resolution biostratigraphy of the Aquitanian – Burdigalian interval at Site 926

The foraminiferal assemblages from the interval between 21.5 Ma and 17.6 Ma at Site 926 are mainly characterized by planktonic foraminifera, as shown by the high Plankton/Benthos ratio with values varying from 98 to 100% (details in paragraph 7.3, Fig. 7.4.). The state of preservation of planktonic foraminifera is generally rather good, although a notable percentage of fragments (from 15.1 to 49.9 %) might suggest varying levels of dissolution throughout the succession (details in paragraph 7.3, Fig. 7.4.). However, the effect of dissolution does not seem so strong to modify the taxonomic composition of the planktonic foraminiferal assemblages as indicated by the high values of Plankton/Benthos ratio and diversity indexes (Shannon Wiener and Equitability) (see paragraph 7.2, Fig. 7.3).

In this chapter, the results of the high resolution quantitative biostratigraphic analysis carried out in this study are described, the bioevents identified in this study and their age calibration are discussed and compared with previous studies at Site 926, and the biostratigraphic interpretation of the studied interval encompassing the Aquitanian-Burdigalian boundary is presented.

4.1. Biostratigraphic results

The quantitative distribution patterns of selected biostratigraphic marker species (zonal markers and secondary markers), plotted against mcd depth and the bioevents identified in the studied interval are presented in Figure 4.1. The age calibration of these bioevents, derived from the age model of Pälike et al. (2006a), are shown in Table 4.1.

Taxonomy and distribution patterns of the main biostratigraphic marker species are discussed in detail in the following paragraphs.

4.1.1. *Paragloborotalia pseudokugleri* / *P. kugleri* group

As mentioned in paragraph 1.3, the species *Paragloborotalia pseudokugleri* and *Paragloborotalia kugleri* are two important markers for the Oligocene-Miocene Transition and the Early Miocene zonation (e.g., Wade et al., 2011). According to Wade et al. (2018), *P. kugleri* is distinguished from *P. pseudokugleri* by the following main morphological features: curved sutures on the spiral side (on both sides in more advanced forms), 6–8 chambers in the final whorl and pinched profile.

In this quantitative study, *P. pseudokugleri* and *P. kugleri* were lumped together in a group to maintain the classification consistent along the succession because of the presence of transitional forms between the two species as those described by Spezzaferri (1994; see Plate 23, Figs. 2-4). In the present study, forms with a lobate profile, radial sutures and a rounded final chamber were considered as specimens of *P. pseudokugleri*, while forms with a continuous outline, curve sutures on spiral side and a pinched final chamber were classified as *P. kugleri*. Finally, forms with a lobate outline and sutures that start to curve were considered transitional forms (see Spezzaferri, 1994). The latter are the most abundant in the group.

Observing the distribution pattern of this group (Fig. 4.1), it can be noticed that it is fairly abundant (from 13 to 40%) in the lower part of the studied interval up to the depth of 444 mcd, and then it shows a marked decrease in abundance, becoming rare up to 410.18 mcd (except for two abundance peaks at depths of 417.50 and 430 mcd).

Considering this distribution pattern, obtained through quantitative analysis, and increasing the sample resolution with qualitative analysis, it was possible to define the stratigraphic position of the T of *P. pseudokugleri*, and the Tc and the T of *P. kugleri* (respectively, bioevents 1, 2 and 4 in Fig. 4.1 and Tab. 4.1):

- the T of *P. pseudokugleri* is recorded at 448.72 mcd, between the samples 154/926B/45X/5/10-12 and 154/926B/45X/4/100-102, and is dated at 21.33 Ma;
- the Tc of *P. kugleri* corresponds to the remarkable abundance decrease at about 443 mcd, between samples 154/926B/45X/1/85-87 and 154/926B/44X/6/110-112, with an age of 21.13 Ma;
- T of *P. kugleri* is placed at a higher stratigraphic level at 410.18 mcd, between the samples 154/926C/41X/3/140-142 and 154/926C/41X/3/120-122, and is calibrated at 20.05 Ma.

Figure 4.2 shows a focus on the distribution pattern of this group with the recognized events and photos of *P. pseudokugleri* and *P. kugleri* specimens taken with a reflected-light stereomicroscope camera.

4.1.2. *Tenuitella munda*

Tenuitella munda is considered in this work as a marker species of this interval because Wade et al. (2011) and Raffi et al. (2020) took it into account as a secondary event of Zone M2 in the standard zonation of the (sub)tropical region.

The distribution pattern of this species (Fig. 4.1) shows abundances relatively higher (0.5 - 3.5 %) in the lower part of the interval and a slight decrease starting from 424.05 mcd, between samples 154/926B/43X/1/90-92 and 154/926C/42X/5/45-47. The Tc of *T. munda* (bioevent 3 in Fig. 4.1 and Tab. 4.1), is placed in correspondence with this decrease in abundance and calibrated at 20.50 Ma. Above this level, the species is discontinuously present with rare specimens up to the top of the studied interval. Specimens of *T. munda* are shown in Plate 4.1.

4.1.3. *Globigerinoides altiaperturus*

Globigerinoides altiaperturus is a helpful marker species for the Early Miocene (e.g., Kennett & Srinivasan, 1983; Bolli & Saunders, 1985) and has been documented in various locations and time intervals. Its distinctive features include an umbilical primary aperture with a distinct and generally very rounded high arch, as well as one very high-arched supplementary sutural aperture on the spiral side opposite the primary aperture (Spezzaferri et al., 2018a). In their Plate 9.1, these authors figured forms very similar to the holotype *Globigerinoides altiaperturus*, originally described by Bolli (1957) (pictures 1-8), together with specimens less typical having a small and low arched supplementary aperture (pictures 9-17).

In the present study, the typical forms were labeled as *Globigerinoides altiaperturus* s.s. (*sensu stricto*), whereas the less typical forms were indicated as *Globigerinoides* cf. *G. altiaperturus*.

At Site 926, the Base of *G. altiaperturus* s.l. (sensu latu, which includes less typical forms) (bioevent 5 in Fig. 4.1 and Tab. 4.1) was found at a depth of 409.52 mcd, between samples 154/926B/41X/5/15-17 and 154/926B/41X/4/125-127, (Fig. 4.1) and dated at 20.00 Ma (Tab. 4.1). Specimens of *G. cf. G. altiaperturus* are present in the lower portion of the distribution range, whereas *G. altiaperturus* s.s. (Pl. 4.1) are recorded from 386.87 mcd, dated at 19.16 Ma, up to the top of the studied interval.

4.1.4. *Globigerinatella* sp.

The species *Globigerinatella* sp. was described for the first time by Pearson (1995) as a transitional form between *Globigerinita glutinata* and *Globigerinatella insueta*. *Globigerinatella* sp. can be distinguished from *G. glutinata* by having a more spherical morphology and the presence of a second generation of bullae, which are usually around the final chamber/swollen bulla typical of the species; instead, it is distinguished from *G. insueta* because it is lacking one or more areal apertures or areal bullae (see Plate 2 by Pearson, 1995). In addition, the author showed the presence of transitional forms between *G. glutinata* and *Globigerinatella* sp. These transitional forms exhibit a swollen chamber-like bulla with one or more sutural apertures but do not have secondary bullae (see pictures 5-6 in Plate 2 in Pearson, 1995). Pearson & Chaisson (1997) also observed an intergradation in Leg 154 material between these species. They showed how some individuals attributed to *Globigerinatella* sp. occur among populations of *G. glutinata* in the lower part of Zone N5/6 (= Zone M2/M3 by Wade et al., 2011), below the Base of the calcareous nannofossil *Sphenolithus belemnos*.

In Figure 4.3 the distribution patterns of *G. glutinata*, *G. glutinata/Globigerinatella* sp. transition and *Globigerinatella* sp. obtained in this work together with SEM photos are shown to document the variability of this group of species along the stratigraphic succession:

- *G. glutinata* is always present and abundant (0.3-25%) throughout the studied interval.
- The transitional forms were found from the base of the interval until the first appearance of *Globigerinatella* sp. with an abundance of 0.3-3.8 %.
- *Globigerinatella* sp. presents a continuous distribution with an abundance of 0.3-2.1% from its Base (bioevent 6 in Fig. 4.1 and Tab. 4.1) identified at a depth of 391.35 mcd between samples 154/926B/39X/5/20-22 and 154/926B/39X/4/135-137 and dated at 19.30 Ma. *Globigerinatella* sp. specimens found at the top of the studied interval are much more evolved than those of the lower levels and they closely resemble *G. insueta* s.s., but they do not show the areal apertures yet.

Some specimens of *Globigerinatella* sp. are also shown in Plate 4.1.

4.1.5. *Globorotalia praescitula*

Globorotalia praescitula is considered as the initial taxon of the *Globorotalia* radiation during the Miocene (Cifelli & Scott, 1986), and Wade et al. (2011) and King et al. (2020) considered its first occurrence as an additional event occurring within Zone M3a in the standard zonation of (sub)tropical areas. For this reason, this species is taken into account as a marker of the studied interval.

At Site 926, *G. praescitula* is very rare (0.3-0.7%) and presents a very discontinuous distribution pattern (Fig. 4.1). Its Base (bioevent 7 in Fig. 4.1 and Tab. 4.1) is recorded between samples 154/926B/36X/1/100-102 and 154/926B/36X/1/80-82 at a depth of 357.22 mcd and dated at 18.15 Ma.

In Plate 4.1, some specimens from the Base level of *G. praescitula* are shown.

4.1.6. *Catapsydrax dissimilis*

Catapsydrax dissimilis is a long-ranging taxon (upper Middle Eocene - Lower Miocene) characterized by large tests with globular to subglobular chambers with a cancellate wall texture, and a distinct bulla covering the umbilicus, with a countable number (2-4) of infralaminar apertures. It is an important marker species in standard biozonal schemes from different climatic regions (Blow, 1969; Bolli, 1957; Wade et al., 2011; Raffi et al., 2020).

Observing its distribution pattern in this study (Fig. 4.1), *C. dissimilis* is discontinuously present throughout the interval, with abundances ranging from 0.2 to 3.4 %.

Some photos of this species are shown in Plate 4.2.

4.1.7. *Paragloborotalia birnageae*

Paragloborotalia birnageae is characterized by a coarsely cancellate wall, a circular, weakly lobulate equatorial outline and a kummerform final chamber with low aperture and flap-like lip (Leckie et al., 2018). This species was considered an upper Burdigalian marker, as previously mentioned in paragraph 1.2, because its first occurrence was originally thought to identify the zonal boundary M4a/M4b by Berggren et al. (1995), until when several authors reported this taxon in the lower Miocene and upper Oligocene (e.g., Blow, 1979; Chaisson & Leckie, 1993; Spezzaferri, 1994).

In this study, *P. birnageae* is present throughout the interval but more abundant and continuous in the lower part (0.3-5.3%), then occurs sporadically from 405 mcd depth up to the top (Fig. 4.1).

In Plate 4.2, some SEM photos of this species are present.

4.1.8. *Paragloborotalia nana*

Paragloborotalia nana is indicated as the ancestral species of all *Paragloborotalia* lineages (Kennett & Srinivasan, 1983; Leckie et al., 2018). It is taken into account as a marker of this interval because it ranges up to the top of Zone M1a in (sub)tropical oceans, according to Iaccarino & Premoli Silva (2007) and up to Zone M2 as noted by Leckie et al. (2018).

In the present study, the distribution pattern of *P. nana* is discontinuous but spans the entire interval up to the top, with a higher abundance (0.3-3.4%) in the lower part of the section (see Fig. 4.1).

Some photos of this species, made with a reflected-light stereomicroscope camera, are shown in Plate 4.2.

4.1.9. *Paragloborotalia siakensis*

Paragloborotalia siakensis is a long-ranging species which extends from the Oligocene (Zone O3) up to Upper Miocene (Zone M11) (e.g., Wade et al., 2011). In this work, it is considered as a marker for the studied interval due to the potential biostratigraphic value of its changes in coiling direction, as highlighted for the Langhian in oceanic marine successions (King et al., 2023) and in the Mediterranean (Lirer et al., 2019 and references therein).

In this work, *P. siakensis* is abundant (2.7-39.7%) and exhibits a random coiling direction throughout the entire studied interval; however, it is characterized by a decrease in abundance close to the B of *H. ampliaperta* (421 mcd) and at 362 mcd in the upper part of the studied interval (Fig. 4.1).

Specimens of *P. siakensis* are shown in Plate 4.2.

4.1.10. *Globoquadrina dehiscens* and *Dentoglobigerina binaiensis*

Other two important markers of this interval are *Globoquadrina dehiscens* and *Dentoglobigerina binaiensis*. The Base of *G. dehiscens* (22.50 Ma) marks an important zonal boundary (M1a/M1b) (see paragraph 1.2), while the Top of *D. binaiensis* (19.09 Ma) is a secondary bioevent of Early Miocene, occurring after the Base of *Globigerinatella* sp. (19.30 Ma) and preceding the Base of the nannofossil *Sphenolithus belemnoides* (19.01 Ma). Both these events were identified at Sites 925 and 926 by Pearson & Chaisson (1997) and calibrated by Shackleton et al. (1999).

Unfortunately, these species are almost absent in the studied interval. They are present only in a few samples (*D. binaiensis* with an abundance of < 1 % and *G. dehiscens* with an abundance of ~1%) and, for this reason, the distribution patterns of these species are not shown. Some well-preserved specimens of *D. binaiensis* were found in samples 154/926C/41X/4/70-72 and 154/926C/41X/3/140-142 (see Plate 4.2).

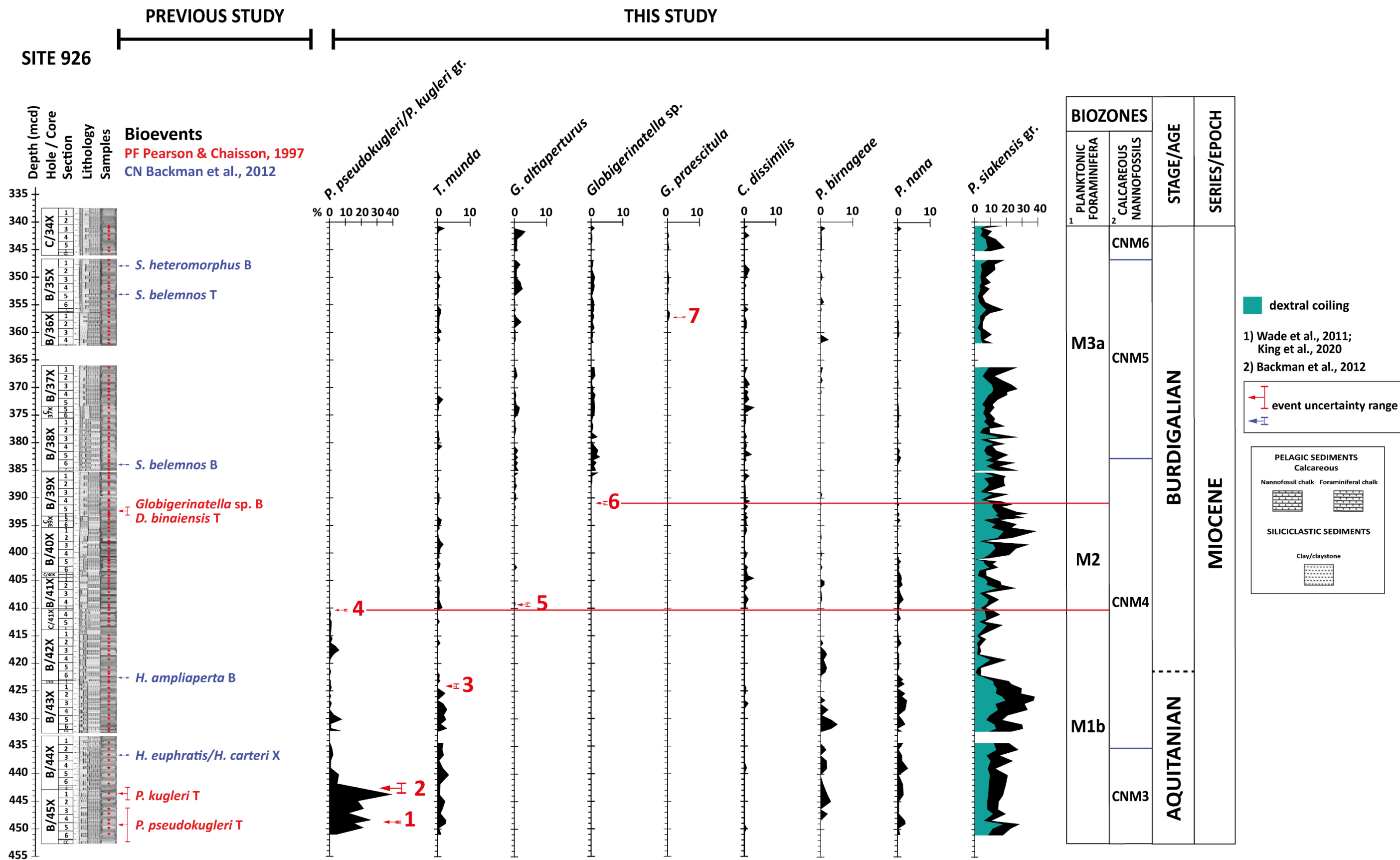


Fig. 4.1 – Quantitative distribution patterns of planktonic foraminiferal markers from Site 926 in the Aquitanian – Burdigalian interval. Bioevents are indicated with numbers from 1 to 7: 1) T *P. pseudokugleri*; 2) Tc *P. kugleri*; 3) Tc *T. munda*; 4) T *P. kugleri*; 5) B *G. altiapertura*; 6) B *Globigerinatella* sp.; 7) B *G. praescitula*. The biostratigraphic results of this study are compared with those previously published from Site 926 (Pearson & Chaisson, 1997). Calcareous nannofossil events are also indicated in blue (Curry et al., 1995; Backman et al., 2012).

Tab. 4.1 - Planktonic foraminiferal datums at Site 926, their stratigraphic positions and age calibrations. Bioevents are indicated with the same coding number shown in Figure 4.1. Age calibrations of bioevents derived from this study are compared with the published biochronology (Raffi et al., 2020).

	Bioevents	Core, section, interval (cm)		Depth (mcd)		Mean depth (mcd)	Age (Ma) [This study]	Age (Ma) Raffi et al., 2020	Δ Age (Ma)
		Top	Bottom	Top	Bottom				
7	B <i>Globorotalia praescitula</i>	154/926B/36X/1/80-82	154/926B/36X/1/100-102	357.12	357.32	357.22	18.15 $\pm$ 0.005	18.22	0.07
6	B <i>Globigerinatella</i> sp.	154/926B/39X/4/135-137	154/926B/39X/5/20-22	391.17	391.52	391.35	19.30 $\pm$ 0.005	19.30	0
5	B <i>Globigerinoides altiaperturus</i>	154/926B/41X/4/125-127	154/926B/41X/5/15-17	409.17	409.87	409.52	20.00 $\pm$ 0.007	19.97	0.03
4	T <i>Paragloborotalia kugleri</i>	154/926C/41X/3/120-122	154/926C/41X/3/140-142	410.08	410.28	410.18	20.08 $\pm$ 0.005	21.12	1.04
3	Tc <i>Tenuitella munda</i>	154/926C/42X/5/45-47	154/926B/43X/1/90-92	423.67	424.42	424.05	20.50 $\pm$ 0.028	20.83	0.33
2	Tc <i>Paragloborotalia kugleri</i>	154/926B/44X/6/110-112	154/926B/45X/1/85-87	441.82	443.77	442.80	21.13 $\pm$ 0.037		
1	T <i>Paragloborotalia pseudokugleri</i>	154/926B/45X/4/100-102	154/926B/45X/5/10-12	448.42	449.02	448.72	21.33 $\pm$ 0.010	21.31	0.02

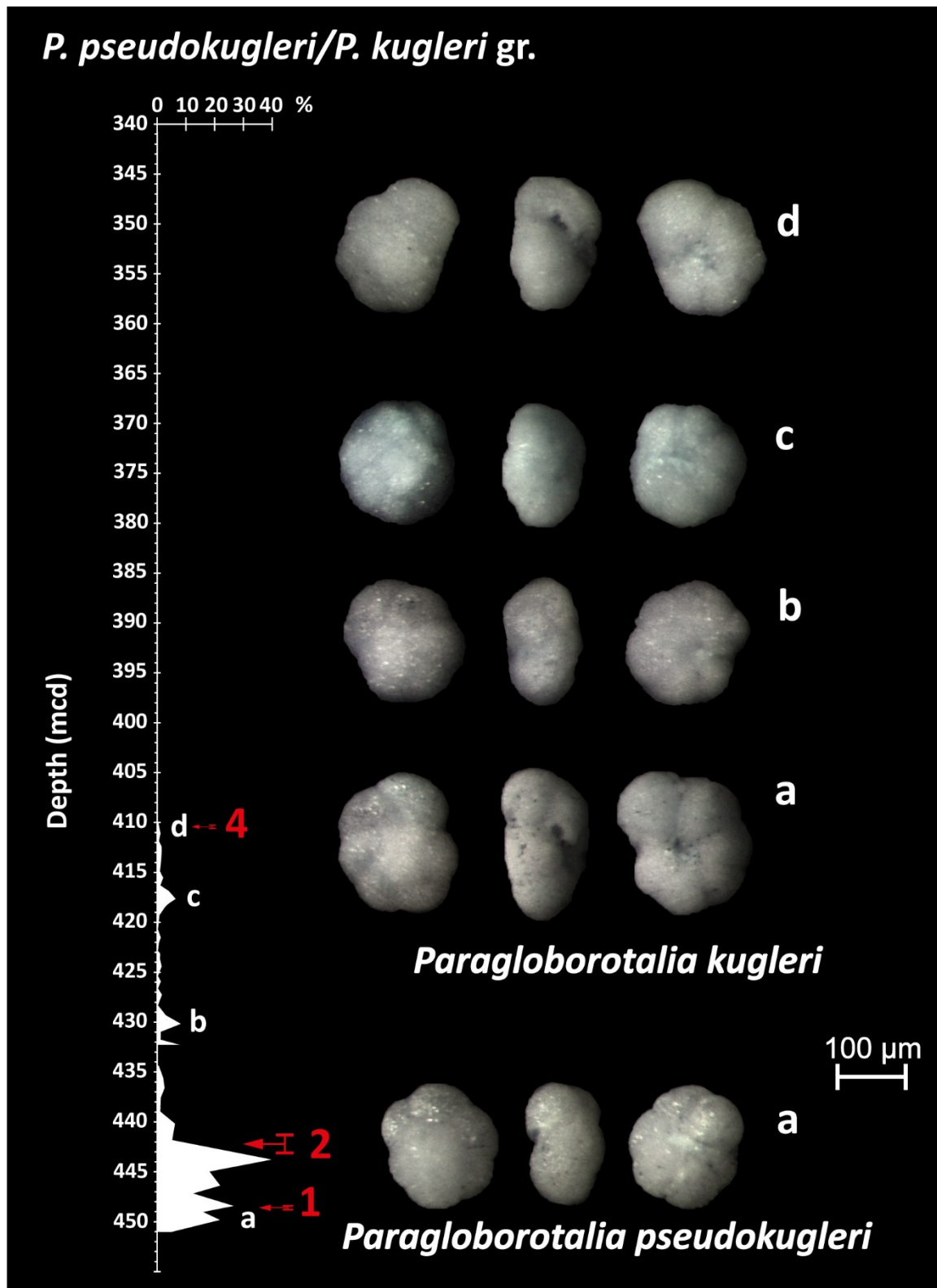


Fig. 4.2 – Distribution pattern of *Paragloborotalia pseudokugleri/P. kugleri* group with the recognized events (1, 2 and 4, see caption Figure 4.1) and photos of *P. pseudokugleri* and *P. kugleri* taken with a reflected-light stereomicroscope camera. a) *Paragloborotalia pseudokugleri* and *Paragloborotalia kugleri*, sample 154/926B/45X/5/90-92; b) *Paragloborotalia kugleri*, sample 154/926B/43X/5/65-67; c) *Paragloborotalia kugleri*, sample 154/926B/42X/3/73-75; d) *Paragloborotalia kugleri*, sample 154/926C/41X/4/70-72.

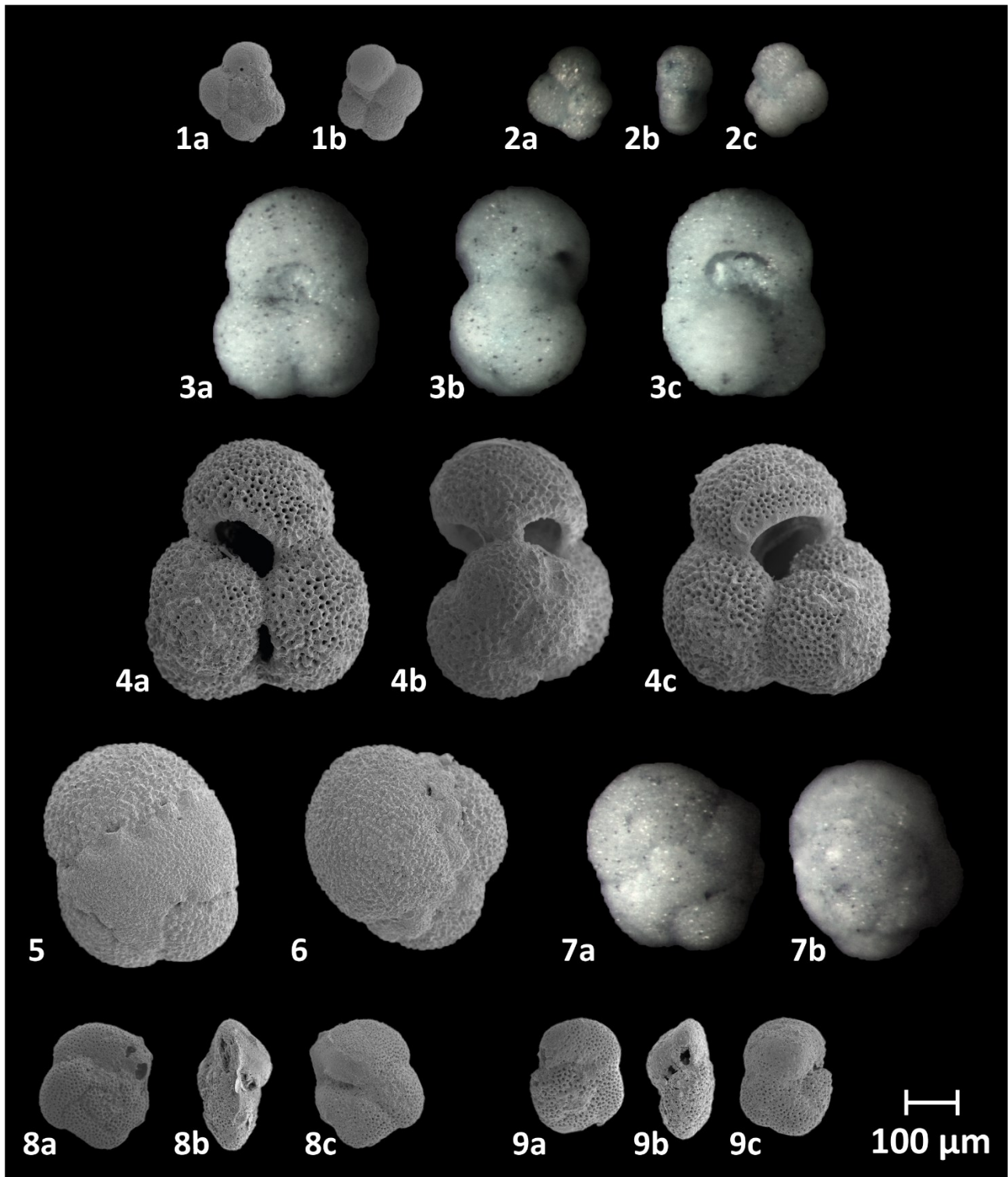


Plate 4.1 – Marker species photos taken with a reflected-light stereomicroscope camera and SEM (scanning electron microscope). 1a-1b) *Tenuitella munda*, sample 154/926B/36X/1/80-82; 2a-2c) *Tenuitella munda*, sample 154/926B/45X/4/100-102. (a) spiral view; (b) side view; (c) umbilical view. 3a-3c) *Globigerinoides altiaperturus*, sample 154/926B/39X/1/71-73; 4a-4c) *Globigerinoides altiaperturus*, sample 154/926B/40X/6/69-71; 5) *Globigerinatella* sp., sample 154/926C/34X/4/65-67; 6) *Globigerinatella* sp. sample 154/926C/34X/4/65-67; 7a-7b) *Globigerinatella* sp., sample 154/926C/34X/3/20-22; 8a-8c) *Globorotalia praescitula*, sample 154/926B/36X/1/80-82; 9a-9c) *Globorotalia praescitula*, sample 154/926B/36X/1/80-82; Scale bar: 1-9 = 100 μ m.

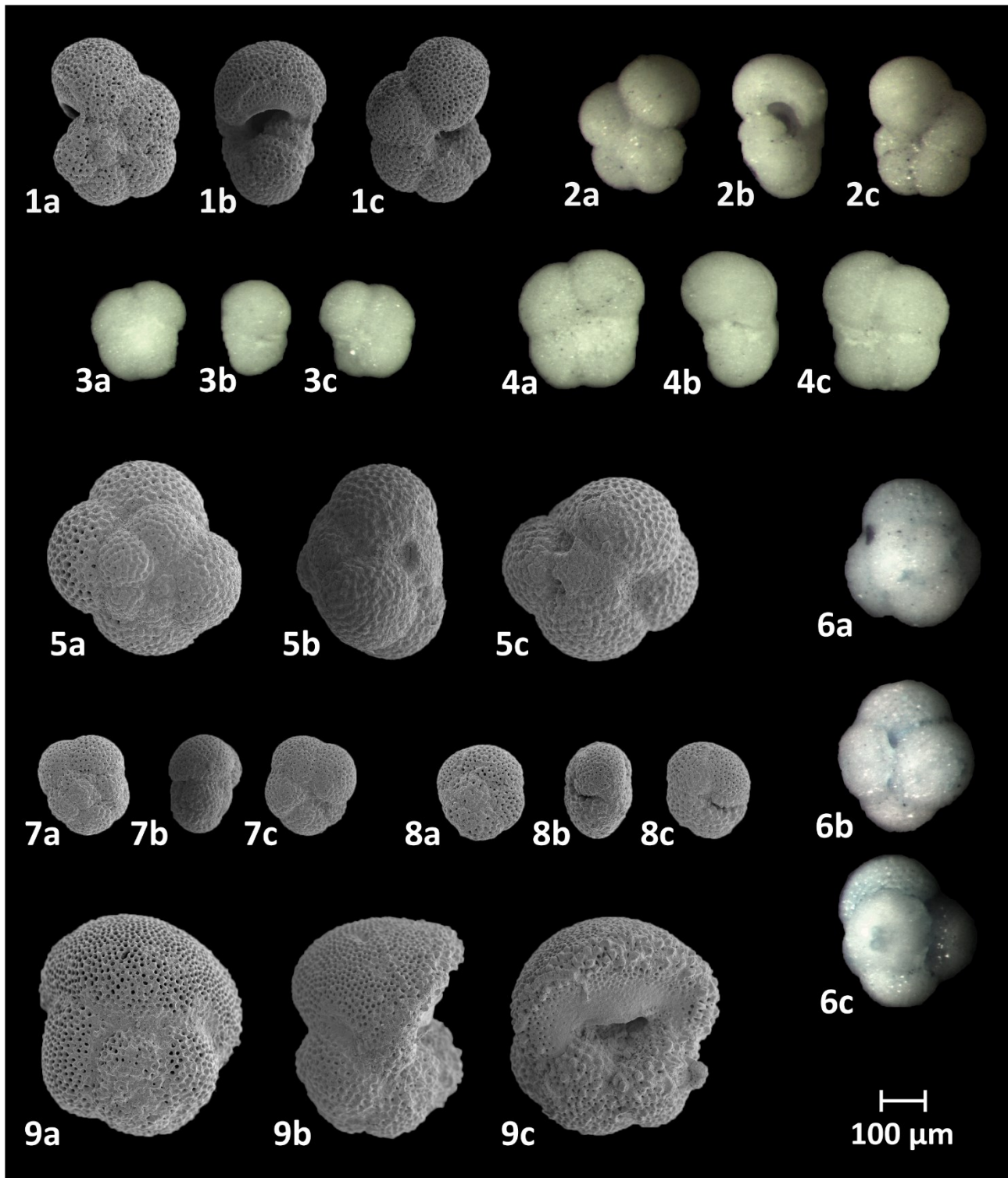


Plate 4.2 – Marker species photos taken with a reflected-light stereomicroscope camera and scanning electron microscope (SEM) microscope). 1a-1c) *Paragloborotalia siakensis*, sample 154/926B/45X/1/85-87; 2a-2c) *Paragloborotalia siakensis*, sample 154/926B/45X/5/90-92; 3a-3c) *Paragloborotalia nana*, sample 154/926B/42X/3/135-137; 4a-4c) *Paragloborotalia nana*, sample 154/926B/36X/3/105-107; 5a-5c) *Catapsydrax dissimilis*, sample 154/926C/34X/3/20-22; 6a-6c) *Catapsydrax dissimilis*, sample 154/926B/45X/1/85-87; 7a-7c) *Paragloborotalia birnageae*, sample 154/926B/43X/5/65-67; 8a-8c) *Paragloborotalia birnageae*, sample 154/926C/41X/4/70-72; 9a-9c) *Dentoglobigerina binaiensis*, sample 154/926C/41X/4/70-72; 2). (a) spiral view; (b) side view; (c) umbilical view. Scale bar: 1-9 = 100 μm .

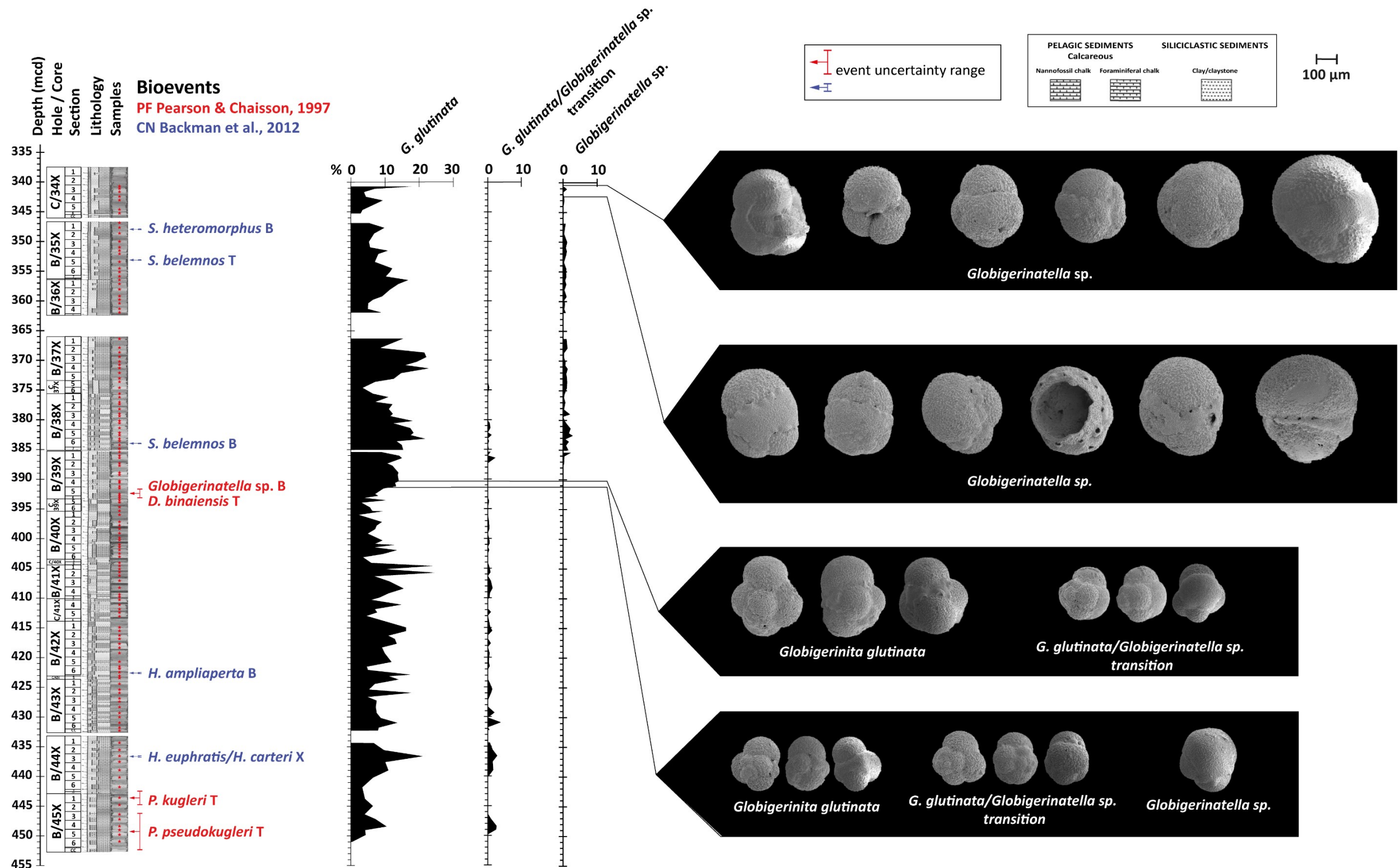


Fig. 4.3 – Quantitative distribution patterns of *Globigerinita glutinata*, *Globigerinatella* sp. and transition forms between two species.

4.2. Discussions on planktonic foraminiferal bioevents at Site 926

In this section, the bioevents identified in the studied interval (indicated by numbers 1 to 7 from bottom to top in Fig. 4.1 and Tab. 4.1) are discussed and compared with previously published data at Site 926 by Pearson & Chaisson (1997) and other literature data. Three out of the seven bioevents identified had been previously defined at this site: T *Paragloborotalia pseudokugleri*, T *Paragloborotalia kugleri*, and B *Globigerinatella* sp. In Figure 4.1 the stratigraphic position and the uncertainty range of these bioevents, as defined in this work, can be compared with those published by Pearson & Chaisson (1997) based on lower resolution analysis. Bioevents not previously recorded at Site 926 are Tc *Paragloborotalia kugleri*, B *Globigerinoides altiaperturus*, Tc *Tenuitella munda* and B *Globorotalia praescitula*. In addition, the relative position of the planktonic foraminiferal events with respect to the main and most reliable calcareous nannofossil bio-horizons has been considered (Fig. 4.1) (Curry et al., 1995; Backman et al., 2012; Raffi et al., 2020).

Finally, age calibration of the identified bioevents, reported in Table 4.1, is compared with the most recent biochronology by Raffi et al. (2020) and the age difference (Δ) is calculated to show the discrepancy between the calibration obtained in this work and literature data (Raffi et al. 2020).

In the following paragraphs, each recognized bioevent was discussed.

4.2.1. Top *Paragloborotalia pseudokugleri*

Following the (sub)tropical standard zonation and biochronology (Raffi et al., 2020), this bioevent falls in the upper part of Subzone M1b and is dated at 21.31 Ma.

The stratigraphic position of Top *P. pseudokugleri*, as defined in this work, is in very good agreement with that recorded by Pearson & Chaisson (1997) (Fig.4.1) and its age of 21.33 Ma is 20 kyr older than the calibration reported by Raffi et al. (2020) (Tab. 4.1).

4.2.2. Top common and Top *Paragloborotalia kugleri*

The Top of *P. kugleri* identifies the boundary between Subzone M1b and Zone M2 (Wade et al., 2011) and is dated at 21.12 Ma (Raffi et al., 2020). This bioevent, as defined at Site 926 by Pearson & Chaisson (1997) and adopted in the standard zonation and biochronology (see Raffi et al., 2020), predates by about 230 kyr the calcareous nannofossil *Helicosphaera euphratis* / *H. carteri* crossover (X), which is recorded at 435.51 mcd (Fig. 4.1) with an age of 20.89 Ma and defines the base of the CNM4 zone (Backman et al., 2012). The Top of *P. kugleri* at Site 926 also predates by about 680 kyr the B of the calcareous nannofossil *Helicosphaera ampliapertura* (recorded at 421.46 mcd and dated at 20.44 Ma) (Fig.4.1), chosen as a provisional event to define the Aquitanian/ Burdigalian boundary (Pearson & Chaisson, 1997; Backman et al., 2012; Raffi et al., 2020).

In this research, the quantitative distribution pattern of the group *P. pseudokugleri*/*P. kugleri* allowed the recognition of the Tc of *P. kugleri*, associated with a significant abundance decrease at 442.80 mcd and dated at 21.13 Ma, and the T of *P. kugleri* at 410.18 mcd and dated at 20.08 Ma. As defined in this study, the Tc of *P. kugleri* nearly coincides with the extinction level of *P. kugleri*, as recorded by Pearson & Chaisson (1997), and the T of *P. kugleri* results younger by

about 1 Myr than the calibration known in literature and postdates B *Helicosphaera ampliaperta* by about 360 kyr (Fig. 4.1).

These discrepancies between the results of the present study and the data by Pearson & Chaisson (1997) could be a consequence of the different sampling resolution (1.5 m instead of ~ 50 cm on average), different method of biostratigraphic analysis (semiquantitative instead of quantitative) and the different size fractions of the residue analyzed (> 150 µm instead of > 125 µm).

4.2.3. Top common *Tenuitella munda*

The occurrence of *Tenuitella munda* has been reported starting from the upper Eocene (Pearson et al., 2018b), but its extinction level is not well defined yet. Blow (1979) recorded the Top of this species in the Upper Miocene. Li (1987) noted that it persists into the upper part of Lower Miocene Zone M3. Pearson & Chaisson (1997) recorded its occurrence up to the top of Zone N4 (= M1) in Site 925 but not at Site 926, and more recently Pälike et al. (2010c) up to Subzone M5a at Site U1338 in the equatorial Pacific Ocean. Following the current biochronology (Raffi et al., 2020), the T of *T. munda* is recorded at Site 747 (Kerguelen Plateau) in the Southern Ocean (Li et al., 1992) with the magnetostratigraphy reinterpreted in Wright & Miller (1992) and dated at 20.83 Ma.

According to the data of this study, the occurrence of *T. munda* throughout the studied interval indicates that this species persists longer at low latitudes than at mid-latitude Southern Ocean. The Tc of *T. munda* at Site 926, recorded in correspondence with a slight decrease in abundance at 424.05 mcd and dated at 20.50 Ma, slightly predates the Base of *H. ampliaperta* (Fig. 4.1). The calibration of Tc of *T. munda* at Site 926 is about 330 kyr younger than the Top of *T. munda* in the Southern Ocean presented in the current biochronology by Raffi et al. (2020) (Tab. 4.1).

4.2.4. Base *Globigerinoides altiapturus*

The Base of *G. altiapturus* was found in the upper part of Subzone M1b, just below the zonal boundary M1/M2, in the Lemme-Carrosio Section (Italy), Global Stratotype section and Point (GSSP) for the base of Aquitanian Stage. This bioevent is associated with the magnetic polarity Subchron C6Aa.2r (Spezzaferri, 1996; Iaccarino et al., 1996; Spezzaferri et al., 2018a). According to the most recent biochronology by Raffi et al. (2020), however, the Base of *G. altiapturus* set at the base of Chron C6r, dated at 19.97 Ma, based on the record at Hole 516F in South Atlantic Ocean (Pujol, 1983; Berggren et al., 1995) and in the Contessa Highway section (Montanari et al., 1991; Berggren et al., 1995; Fabbrini et al., 2019b). This event has never been calibrated in Site 926, but Pearson & Chaisson (1997) documented the occurrence of *G. altiapturus* in the Early Miocene, from Zone N4 to Zone N7 (= Zones M1 to M4) at Site 925.

In this work, the age calibration of B *G. altiapturus* s.l. (recorded at 409.52 mcd and dated at 20.00 Ma) is consistent with the current biochronology by Raffi et al. (2020) (see Tab. 4.1). On the other hand, if only typical forms (*G. altiapturus* s.s.) are considered, the Base of this species would be defined at a depth of 386.87 mcd and dated at 19.16 Ma, resulting ~800 kyr younger.

4.2.5. Base *Globigerinatella* sp.

The Base of *Globigerinatella* sp. defines the lower boundary of Zone M3 of Wade et al. (2011), calibrated at 19.30 Ma at Ceara Rise (Pearson & Chaisson, 1997) postdating the B of *Helicosphaera ampliapertura* and predating the B of *Sphenolithus belemnus*.

According to this work, B *Globigerinatella* sp. is almost coincident with previously published data at Site 926 by Pearson & Chaisson (1997) (Fig. 4.1 and Tab. 4.1). The B of *Globigerinatella insueta* s.s., which evolves from *Globigerinatella* sp. and is dated at 17.59 Ma (Raffi et al., 2020), was not found despite the occurrence, in the topmost part of the studied interval, of more evolved specimens that do not show yet the areal apertures typical of *G. insueta* s.s..

4.2.6. Base *Globorotalia praescitula*

According to Berggren et al. (1995), *Globorotalia praescitula* appeared in Chron C5En and its Base was considered as Early Miocene zonal marker for Transitional and Sub-Antarctic areas. Berggren et al. (1995) also used this event to define the base of Zone Mt3 of transitional planktonic foraminiferal zonation. According to Wade et al. (2011) and King et al. (2020), the Base of *G. praescitula* is a secondary event falling within Zone M3a, and it is dated at 18.22 Ma (Berggren et al., 1983; King et al., 2020). This event was recorded in Indian Ocean Holes 747A, 748B, 751, in North Atlantic Hole 608, and in South Atlantic Hole 516F in the lowest part of polarity zone C5En (precisely at Chron C5En.5) (Berggren et al., 1983; Raffi et al., 2020). Pearson & Chaisson (1997) found this species at Site 925, from the zone N5/N6 (= M2/M3).

The Base of *G. praescitula*, recorded at 357.22 mcd at Site 926 is calibrated at 18.15 Ma, and this age estimate is rather consistent with the existing biochronology of King et al. (2020) and Raffi et al. (2020) (Tab. 4.1).

4.2.7. Top *Catapsydrax dissimilis*

As mentioned in paragraph 1.2, *Catapsydrax dissimilis* is an important marker species of Lower Miocene because its Top marks the lower boundary of Zone M4 and is calibrated at 17.54 Ma at Sites 925 and 926 (Pearson & Chaisson, 1997; Shackleton et al., 1999; Lourens et al., 2004; Wade et al., 2011).

In this study, *C. dissimilis* occurs until the top of the studied interval, so it was not possible to define the Base of Zone M4.

4.2.8. Base *Paraglobotalia birnageae*

The distribution pattern of *Paraglobotalia birnageae* in this work confirms its presence already in the Aquitanian—Burdigalian interval. This record is in agreement with the findings of the other authors (Blow, 1979; Chaisson & Leckie, 1993; Spezzaferri, 1994; Leckie et al., 2018) who recorded this species from the Upper Oligocene and not from the upper part of Lower Miocene (zonal boundary M4a/M4b) (Berggren et al., 1995).

4.2.9. Top *Paraglobotalia nana*

Paraglobotalia nana is a long-ranging species that first appeared in upper Eocene Zone E13 (Olsson et al., 2006) and disappeared in the Lower Miocene. According to Iaccarino et al. (2007), the Top of this species is recorded close to the top of Zone M1a in (sub)tropical oceans. Some other authors, however, reported the Top of *P. nana* at higher stratigraphic levels in several

oceanic sites, namely within Zone M3 (e.g., Chaisson & Leckie, 1993; Spezzaferri, 1994; Pearson & Chaisson, 1997; Leckie et al., 2018; Fabbrini et al., 2019a).

The results of this study agree with these findings because *P. nana* was recorded up to the top of the studied interval corresponding to Zone M3a.

4.2.10. Coiling change of *Paraglobotalia siakensis*

In this work, this species appears to be randomly coiled throughout the entire interval, indicating that no coiling direction change of biostratigraphic significance occurred.

4.3. Biostratigraphic interpretation

The planktonic foraminiferal (sub)tropical zonation of Wade et al. (2011) and King et al. (2020) were applied for the biostratigraphic interpretation of the studied interval at Site 926. The following considerations can be made, based on the results of this study:

- The studied interval ranges from Subzone M1b (*pars*), for the presence of *Paragloborotalia pseudokugleri*, *Paragloborotalia kugleri* and *Globoquadrina dehiscens* from the base to Subzone M3a (*pars*), due to the absence of *Globigerinatella insueta* s.s. and the presence of *Catapsydrax dissimilis* up to the top of the interval. The Base of *G. insueta* s.s. and the Top of *C. dissimilis* define the lower boundary of Subzone M3b and the lower boundary of Zone M4, respectively (Fig. 4.4).
- The boundary between Subzone M1b and Zone M2, defined by the Top of *P. kugleri* dated at 20.08 Ma, results younger by about 1 Myr than what is reported in Wade et al. (2011) and Raffi et al. (2020). According to the present study, the boundary M1b/M2 postdates the Base of the calcareous nannofossil *Helicosphaera ampliaperta* (20.43 Ma) and then the provisional base of the Burdigalian Stage by about 360 kyr (Fig. 4.4). Note, however, that Tc of *P. kugleri*, identified in this work, is nearly coinciding with the T of this species as identified by Pearson & Chaisson (1997).
- The zonal boundary M2/M3a, defined by the Base of *Globigerinatella* sp. (19.30 Ma), is in very good agreement with literature data.
- Additional events were identified for the first time at Site 926: Tc *Paragloborotalia kugleri* and Tc *Tenuitella munda*, which fall within Subzone M1b, B *Globigerinoides altiapturus*, which falls in the lowermost part of Zone M2, and B *Globorotalia praescitula* occurring within Subzone M3a (Fig. 4.4). They can help to improve the biostratigraphic resolution of the studied interval.
- Tc of *T. munda* (dated at 20.50 Ma) closely approximates the Aquitanian/Burdigalian boundary, provisionally identified by the B of *H. ampliaperta* (dated at 20.44 Ma), although the reliability of this bioevent should be confirmed in other successions. A marked abundance decrease of *P. siakensis* is observed close to the boundary.
- B of *G. altiapturus* (dated at 20.00 Ma) postdates the Aquitanian/ Burdigalian boundary by 440 kyr.
- Based on the age estimates of this study, T *P. kugleri* and B *G. altiapturus* seem to align with the top of magnetic polarity Chron C6An, dated at 19.97 Ma. Thus, three of the five potential criteria for the definition of the Aquitanian/Burdigalian boundary (as discussed in paragraph 1.2) may be very close to one another.

In conclusion, the high-resolution quantitative biostratigraphic record of planktonic foraminifera presented in this study contributes to increasing knowledge of the distribution patterns of biostratigraphic markers, identifying more precisely biostratigraphic events and, therefore, improving the standard zonation of (sub)tropical regions across the Aquitanian-Burdigalian interval.

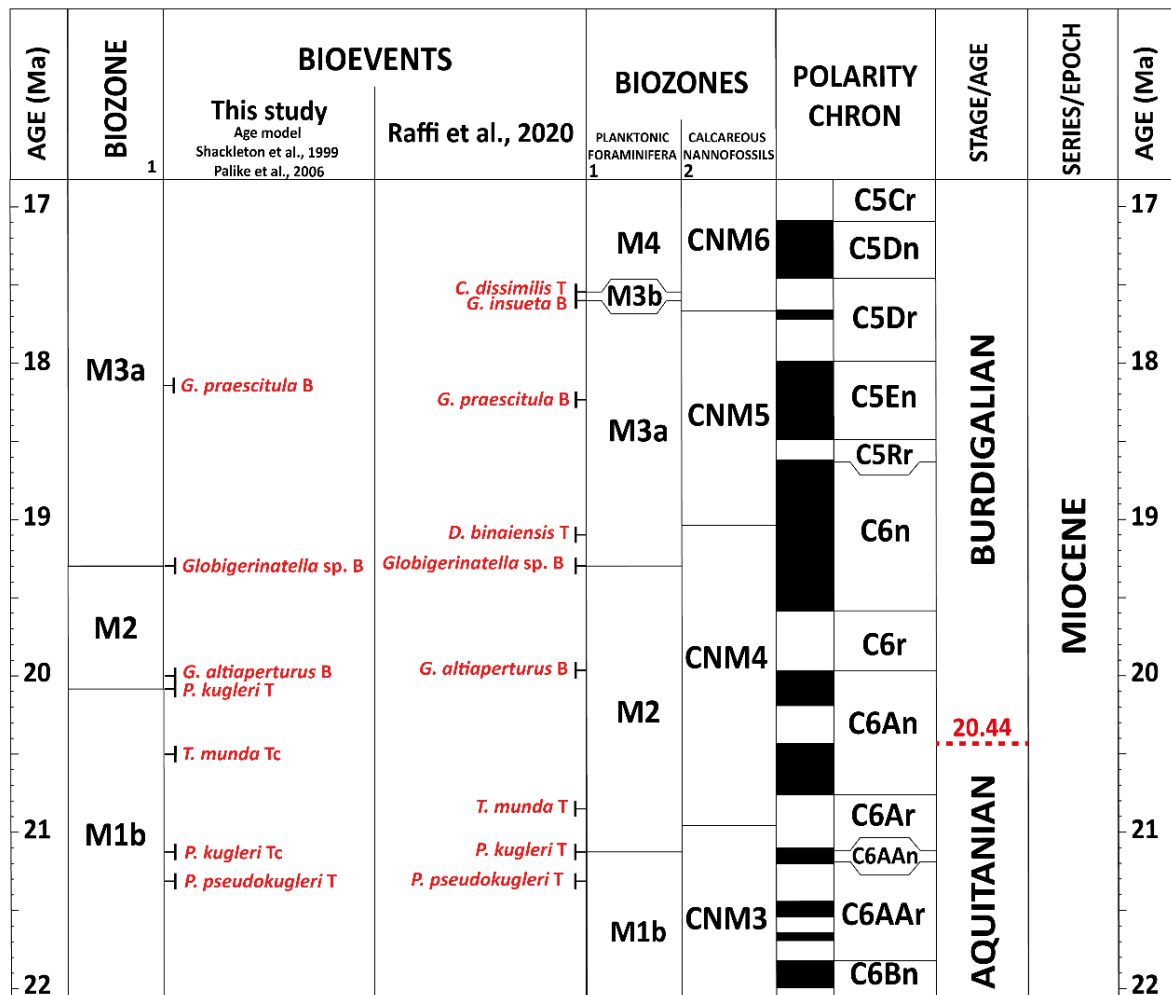


Fig. 4.4 - Planktonic foraminifera biochronology of this study compared with biochronology by Raffi et al. (2020). Zonations: 1) Wade et al., 2011; King et al., 2020; 2) Backman et al., 2012.

5. The *Paragloborotalia pseudokugleri*-*P. kugleri* group

As mentioned in paragraph 3.1.2, the quantitative analysis of planktonic foraminifera carried out for the Aquitanian — Burdigalian interval was extended downwards to the upper Chattian in Hole 926B, focusing on the *Paragloborotalia pseudokugleri*/*P. kugleri* group. The aim of this part of the work was to obtain a high-resolution quantitative distribution pattern of the group, and to observe the morphological variation from *P. pseudokugleri* to *P. kugleri* through transitional forms along the stratigraphic succession, starting from the levels of the Bases of *Paragloborotalia pseudokugleri* and *Paragloborotalia kugleri*. The latter bioevent approximates the Oligocene/Miocene boundary (see paragraphs 1.3 and 2.3.2; Berggren et al., 1983, 1985, 1995; Steininger et al., 1997; Gennari et al., 2018; Leckie et al., 2018).

Additionally, this analysis aimed to compare the morphotypes of *P. kugleri* identified at the beginning of its distribution range, which are more typical forms, with those found near its last occurrence in this study.

5.1. Results

A preliminary qualitative analysis of this interval allowed the identification of the stratigraphic position of the Base of *P. pseudokugleri* and the Base of *P. kugleri*.

The B of *P. pseudokugleri* is defined at a depth of 541.37 mcd, between samples 154/926B/55X/2/85.5-87.5 and 154/926B/55X/2/25-27, and dated at 24.72 Ma. The B of *P. kugleri*, instead, is placed at 498.28 mcd, between samples 154/926B/50X/5/132.5-134.5 and 154/926B/50X/5/80-82, and calibrated at 23.05 Ma. The transitional forms between *P. pseudokugleri* and *P. kugleri* start to appear shortly before the first appearance of *P. kugleri*, at 500.44 mcd between the top of Core 926B/51X and the base of Core 926B/50X.

In addition, the quantitative analysis conducted from the top of Core 926B/51X (503.27 mcd - 23.2 Ma) to the Top of Core 926B/46X (453.47 mcd - 21.5 Ma) allowed to complete the distribution pattern of the group starting from the levels preceding the occurrence of the transitional forms to *P. kugleri*.

The results of these analyses are shown in Figure 5.1, and a summary of all bioevents related to this group, with their age calibration, is presented in Table 5.1.

In the interval from cores B/55X to B/51X only *P. pseudokugleri* is present. The quantitative distribution pattern of *P. pseudokugleri*/*P. kugleri* group indicates that its abundance ranges from 5 to 42 % from the B up to the Tc of *P. kugleri*, with some oscillations along the studied interval, while it is always < 10 % above the Tc of *P. kugleri* up to its Top.

In Figure 5.1, photos of *P. pseudokugleri*, *P. pseudokugleri*-*P. kugleri* transition and *P. kugleri* from selected stratigraphic levels are also included to document the morphological variability of this group both in the same stratigraphic level and along with its distribution range. Starting from the B *P. pseudokugleri* level, typical forms of this species are shown, having a lobulate outline, with inflated, subglobular chambers and radial depressed dorsal intercameral sutures. Then, from the Base of *P. kugleri* to the Top of *P. pseudokugleri*, a gradual transition between *P. pseudokugleri* and *P. kugleri* forms can be noticed. *P. kugleri* specimens present a more continuous outline, less inflated and more appressed chambers, with a pinched final chamber, and more curved and less depressed sutures. *P. pseudokugleri*-*P. kugleri* transitional forms exhibit intermediate characteristics between the two end members of the group. They have a less lobulate outline, still inflated chambers and no pinched final chamber with respect to *P. pseudokugleri*, but present

sutures starting to curve from the first chambers on the spiral side more similar to *P. kugleri*. Above the Top of *P. pseudokugleri*, these transitional forms persist and disappear together with *P. kugleri*. At the Top of its range, however, specimens of *P. kugleri* are very rare and not well preserved.

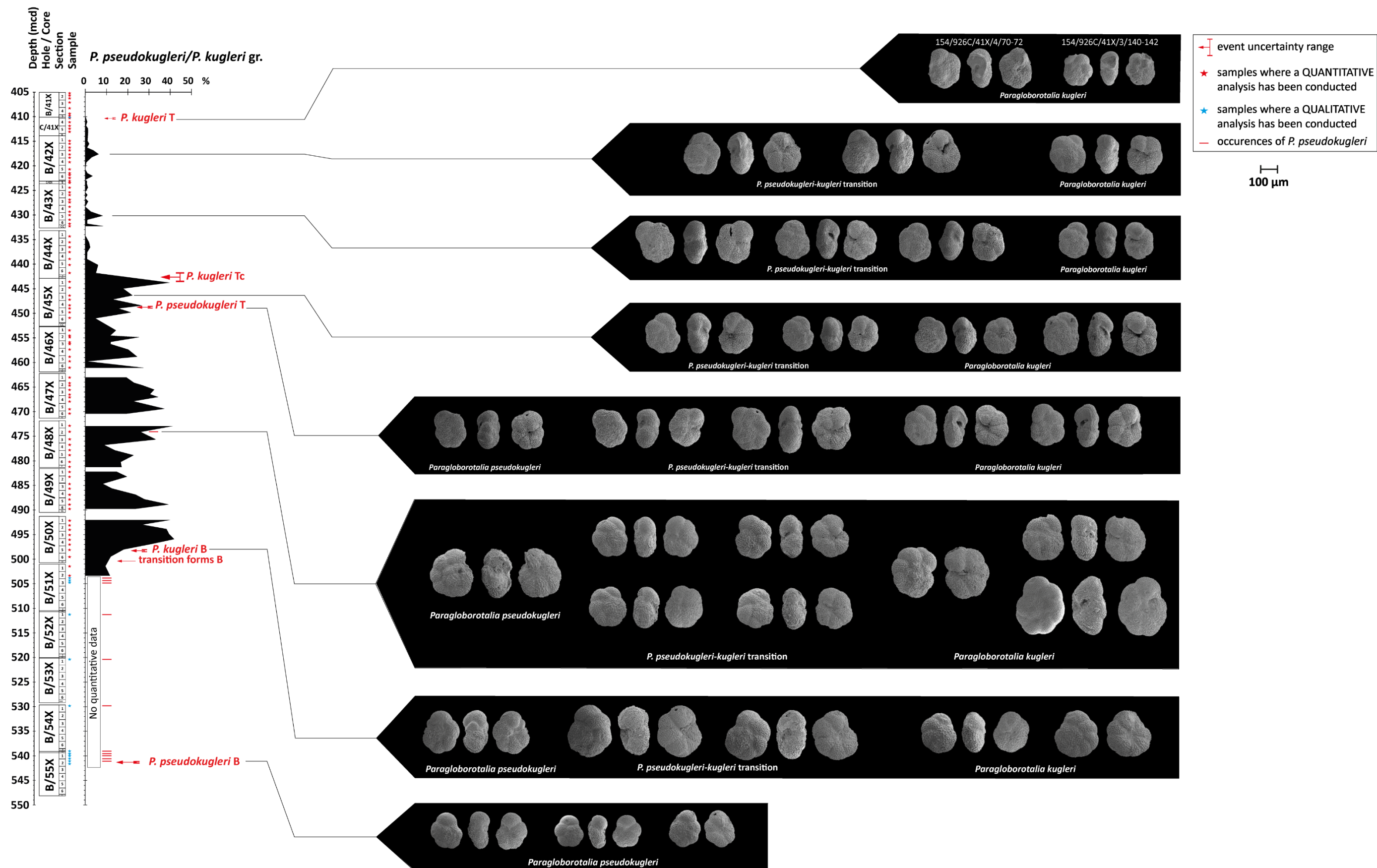


Fig. 5.1 – Distribution pattern of the *Paragloborotalia pseudokugleri/P. kugleri* group, the identified bioevents and the morphological evolution of the group along the stratigraphic succession.

Tab. 5.1 – Bioevents related to *Paragloborotalia pseudokugleri*/*P. kugleri* group at Site 926, along with their stratigraphic positions, their age calibrations derived from this study, and comparison with the standard biochronology.

Bioevent	Core, section, interval (cm)		Depth (mcd)		Mean depth (mcd)	Age (Ma) [This study]	Age (Ma) Raffi et al., 2020 Wade et al., 2011 Shackleton et al., 1999 and Pälike et al., 2006a	Δ Age (Ma)
	Top	Bottom	Top	Bottom				
T <i>Paragloborotalia kugleri</i>	154/926C/41X/3/120-122	154/926C/41X/3/140-142	410.08	410.28	410.18	20.08 ± 0.005	21.12	1.04
Tc <i>Paragloborotalia kugleri</i>	154/926B/44X/6/110-112	154/926B/45X/1/85-87	441.82	443.77	442.80	21.13 ± 0.037		
T <i>Paragloborotalia pseudokugleri</i>	154/926B/45X/4/100-102	154/926B/45X/5/10-12	448.42	449.02	448.72	21.33 ± 0.010	21.31	0.02
B <i>Paragloborotalia kugleri</i>	154/926B/50X/5/80-82	154/926B/50X/5/132.5-134.5	489.02	489.55	498.28	23.05 ± 0.01	22.96	0.09
B <i>Paragloborotalia pseudokugleri</i>	154/926B/55X/2/25-27	154/926B/55X/2/85.5-87.5	541.07	541.68	541.37	24.72 ± 0.30	25.4 /24.67	0.68/0.05

5.2. Discussions

The morphological variations of the *Paragloborotalia pseudokugleri*/*P. kugleri* group shown in Figure 5.1 confirm the gradual transition from *P. pseudokugleri* and *P. kugleri* and the consistency of morphological features of *P. kugleri* from its Base to its Top. This consistency is particularly evident even after the Top common *P. kugleri* level, where *P. kugleri* forms were identified for the first time at Site 926 in this study. These observations confirm the persistent presence of *P. kugleri* until ~1 Myr after the T *P. kugleri* identified by Pearson & Chaisson (1997), despite specimens at the Top level of *P. kugleri* are poorly preserved (Fig. 5.1).

The Top of *P. pseudokugleri*, and the Top and Top common of *P. kugleri* were discussed in paragraphs 4.2.1 and 4.3, while the Bases of *P. pseudokugleri* and *P. kugleri* are discussed in the following paragraphs.

5.2.1. Base *Paragloborotalia pseudokugleri*

The Base of *P. pseudokugleri* defines the boundary between Zones O6 and O7 that, according to Wade et al. (2011) and King et al. (2020), is dated at 25.4 Ma. This age was calibrated by Pälike et al. (2006b) at Site 1218, Equatorial Pacific (Lyle et al., 2002), using new benthic foraminiferal stable isotope records (Lear et al., 2004; Coxall et al., 2005; Tripathi et al., 2006; Wade et al., 2007). This is because Wade et al. (2011) did not include tuned ages from Ceara Rise for the Oligocene (Pearson & Chaisson, 1997; Shackleton et al., 1999) due to the significant differences in the age estimates between Site 925 (24.6 Ma) and 929 (24.9 Ma) (Shackleton et al., 1999, p. 1926). However, even though *P. pseudokugleri* is rare at Site 1218, its Base falls within Subchron C8n.1n (Shipboard Scientific Party, 2002), and this is consistent with the age estimate in BKSA95 (Berggren et al., 1995). The age of this event in BKSA95 is derived from Hole 803D and Hole 628A (Leckie et al., 1993), where this bioevent was recorded within Chrons C8n and C7n, respectively.

However, based on the calibration by Shackleton et al. (1999) and Pälike et al. (2006a), this event was dated at 24.67 Ma at Site 926, resulting in 800 kyr younger than the age by Wade et al. (2011).

In this study, the Base of *P. pseudokugleri* is found at a slightly lower stratigraphic position than that reported by Pearson & Chaisson (1997). It is dated at 24.72 Ma, appearing older 50 kyr than the calibration of Shackleton et al. (1999) and Pälike et al. (2006a), but younger 680 kyr than the calibration used by Wade et al. (2011) and King et al. (2020).

5.2.2. Base *Paragloborotalia kugleri*

The Base of *P. kugleri* defines the boundary between Zones O7 and M1a, dated at 22.96 Ma (calibrated at Ceara Rise by Pearson & Chaisson, 1997; Shackleton et al., 1999 and Pälike et al., 2006a), approximates the Oligo-Miocene boundary (23.03 Ma, Pälike et al., 2006a) and postdates the Top of calcareous nannofossil *Sphenolithus delphix*, located at 499.66 mcd depth (Curry et al., 1995) and dated at 23.06 Ma (Raffi et al., 2006) at Site 926. Berggren et al. (1995a) also recorded this event in Holes 558, 563 (North Atlantic) and 516 F (South Atlantic). In the latter hole, it corresponds to the base of Subchron C6Cn.2n.

The Base of *P. kugleri* of this work is identified in a slightly lower stratigraphic position (498.28 mcd) compared to that of Pearson & Chaisson (1997) and dated at 23.05 Ma, resulting 90 kyr older than the previous calibration.

5.3. Conclusions

Following the planktonic foraminiferal (sub)tropical zonation by Wade et al. (2011) and King et al. (2020), the interval studied in this part of the work spans from the Base of Zone O7 to the Top of Subzone M1b defined by the Top of *Paragloborotalia kugleri* (see Fig. 5.2).

The Base of *P. pseudokugleri* (25.4 Ma), which defines the zonal boundary O6/O7, results 680 kyr younger than the age calibration for this bioevent used by Wade et al. (2011) and King et al. (2020).

The Base of *P. kugleri* (22.96 Ma), which identifies the zonal boundary O7/M1a, is calibrated at 23.05 Ma in this work, and, therefore, the zonal boundary should be shifted downward than 90 kyr, getting closer to *T. Sphenolithus delphix*, dated at 23.06 Ma (Raffi et al., 2006; Backman et al., 2012) and slightly predating the O/M boundary (23.03 Ma) (see Fig. 5.2).

In conclusion, the high-resolution quantitative analysis was useful to refine the stratigraphic position of the bioevents related *Paragloborotalia pseudokugleri*/*P. kugleri* group and to improve the knowledge of its morphologic variability along the entire distribution range of *P. kugleri*.

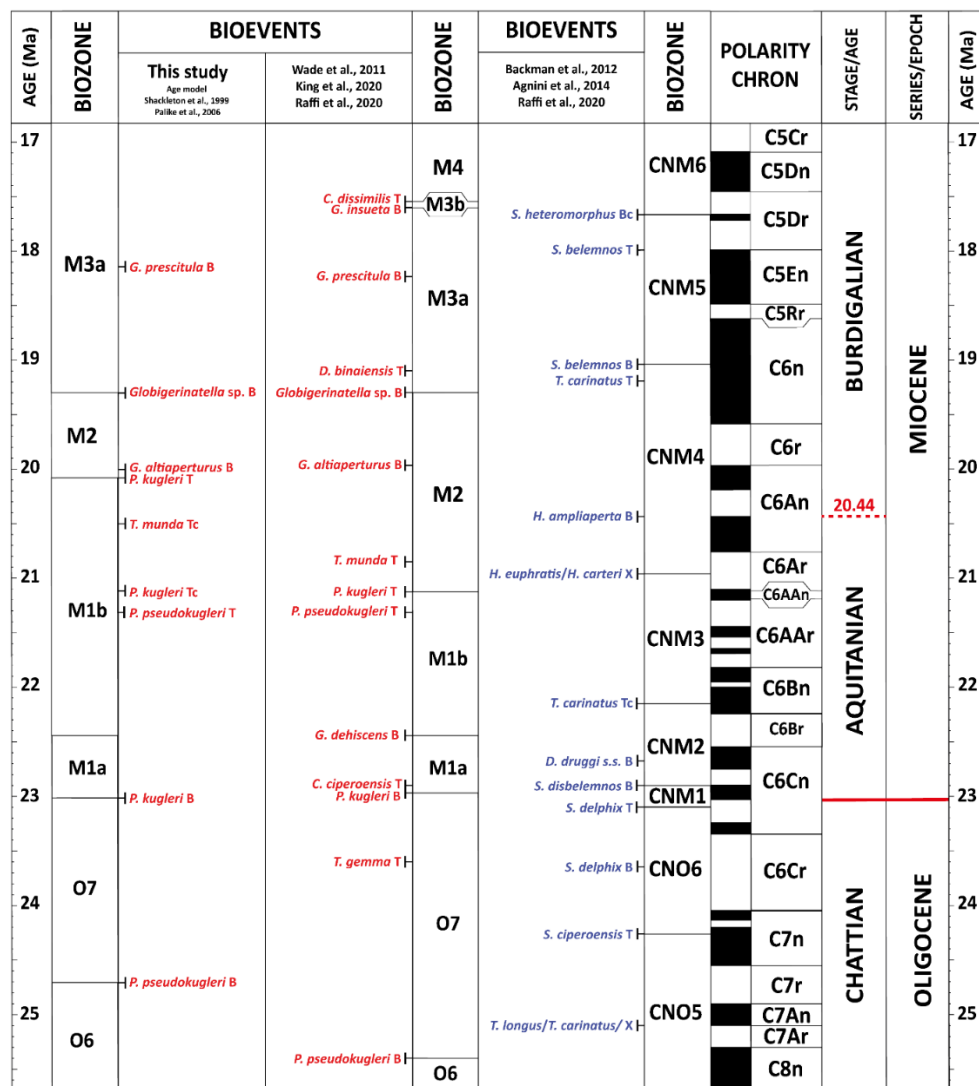


Fig. 5.2 - Planktonic foraminifera biochronology of this study compared with Raffi et al. (2020) biochronology of planktonic foraminifera (bioevents by (1) Wade et al., 2011 and King et al., 2020) and calcareous nannofossil (bioevents by (2) Backman et al., 2012 and Agnini et al., 2014).

6. Biostratigraphic correlation between Site 926 (this study) and (I)ODP sites (and sections) at low and middle latitudes

In this chapter the biostratigraphic record from Site 926, obtained in this study (see Chapters 4 and 5), is correlated with those from selected (I)ODP successions and/or outcropping section following an equatorial transect and a low-to middle-latitude transect. The two transects were correlated with the magnetostratigraphic scale whenever possible to establish a reliable time constraint. These correlations were attempted to verify the reliability of the biovents identified in this study.

6.1. Equatorial transect

For this correlation, Holes U1336A, U1336B, and U1337A (IODP Expedition 320/321), and Site 1218 (Leg 199) (Pälike et al., 2010a, 2010b, 2010c; Lyle et al., 2002) were chosen. They are located within the equatorial region on the Pacific plate (Fig. 6.1).

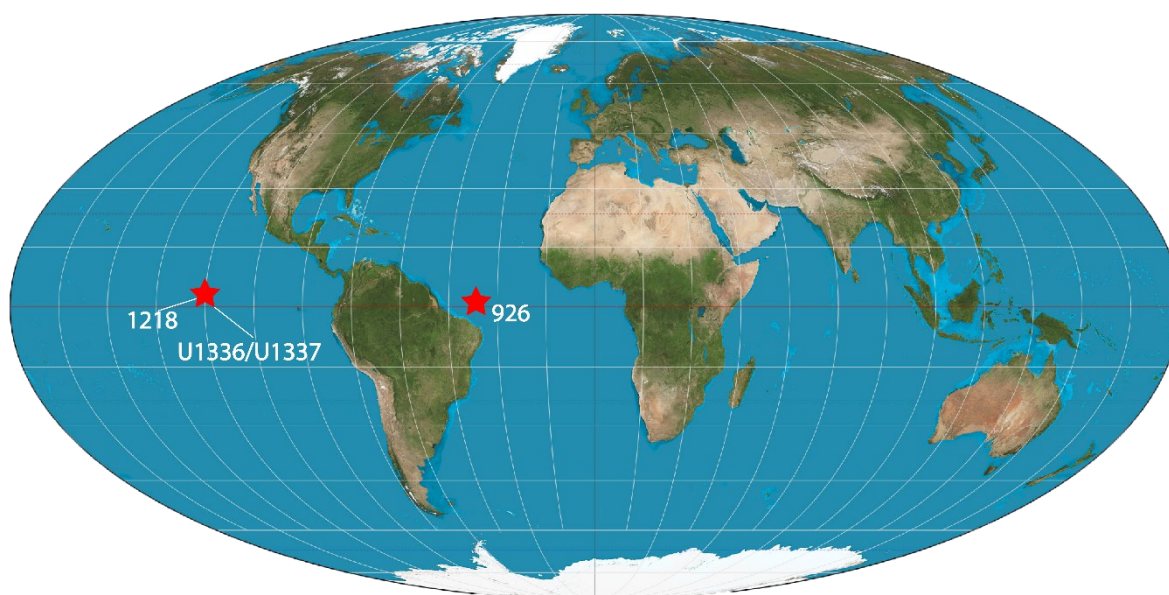


Fig. 6.1 - Location map of the Sites 1218, U1336, U1337 and 926 in Mollweide projection.

Each Hole/Site presents a stratigraphic succession continuous in the Aquitanian-Burdigalian interval and also in the interval across the Oligocene/Miocene boundary (Lyle et al., 2002; Pälike et al., 2010b, 2010c), and astronomically calibrated (Site 1218, Pälike et al., 2006b; Site U1336, Kochhann et al., 2016; Site U1337, Holbourn et al., 2015 and Hilgen, 2025). Only Site 1218 provides a complete magnetostratigraphy for the entire interval, whereas Holes U1336A and U1336B only present partial data. Planktonic foraminifera events identified in these wells are comparable to those in this study. Calcareous nannofossil events, defined by a high-resolution analysis were also considered in order to better constrain the correlation of planktonic foraminiferal bioevents.

The correlation, shown in Figure 6.2, resulted rather complex due to the following factors:

- the lower resolution of biostratigraphic data, since the sampling step of the equatorial Pacific successions was up to 9 m for some events, while it is about 50 cm at Site 926 in this study.
- the different size fraction of the analyzed residue, because the size fractions used for micropaleontological analysis in the equatorial Pacific sites were > 250 μm and > 150 μm , compared to > 125 μm fraction of this work.
- some critical events for the studied interval, as the Base of *Globigerinatella* sp. (Base of Zone M3a) and the Base of *Helicosphaera ampliaperta* (approximation of the Aquitanian/Burdigalian boundary), were not identified in all the successions.
- the discordance of the relative positions of the Base of *P. pseudokugleri* and the Top of *Sphenolithus ciperoensis*. The T of *S. ciperoensis* postdates B *P. pseudokugleri* in Site 926 and in Site 1218, but the relative position of these two bioevents is inverted in Hole U1336A, and this stratigraphic interval is not recovered in Holes U1336B and U1337.
- the discordance of the relative positions of the Base of *P. kugleri* and the Top of *Sphenolithus delphix* that approximate the O/M boundary. At Site 926 (this work) and in Hole 1336A B *P. kugleri* postdates T *S. delphix*, but at Site 1218 and in Holes U1336B and U1337A, the relative positions of these bioevents are inverted. In addition, at Site 1218, B *P. kugleri* falls in Chron C6Cn.2r (Upper Oligocene), while according to Wade et al. (2011) and Lirer et al. (2019) it is placed in Chron C6Cn.2n (Lower Miocene).
- the discrepancy of the relative positions of the Top of *Paragloborotalia kugleri* and the Top of *Paragloborotalia pseudokugleri*. At Site 926 and in Hole 1336B T *P. kugleri* postdates T *P. pseudokugleri* in agreement with literature, but they coincide in Hole U1336A and are inverted in Hole U1337A.
- the discrepancy of the magnetostratigraphic constrain of the Top of *P. kugleri*. At Site 1218 this bioevent is associated with magnetic polarity Chron C6Ar (Lyle et al., 2002), whereas according to the existing biochronology (Raffi et al., 2020) is associated with C6AAn. All this indicates a younger Top for *P. kugleri* at Site 1218, which is in better agreement with the data of the present work.
- the presence of specimens classified as *P. cf. P. kugleri* and *P. cf. P. pseudokugleri* recorded in an anomalous stratigraphic position in Hole U1337A, close to the Top of *Catapsydrax dissimilis* (17.54 Ma), which corresponds to the base of the M4 zone (Burdigalian) (Pälike et al., 2010a, 2010b).

As can be noticed, the correlation was inconclusive due to the lack of high-resolution records of planktonic foraminifera, since the only biostratigraphic data available of Sites 1218, U1336 and U1337 are those with the resolution of the Shipboard Scientific Party (Lyle et al., 2002; Pälike et al., 2010b, 2010c).

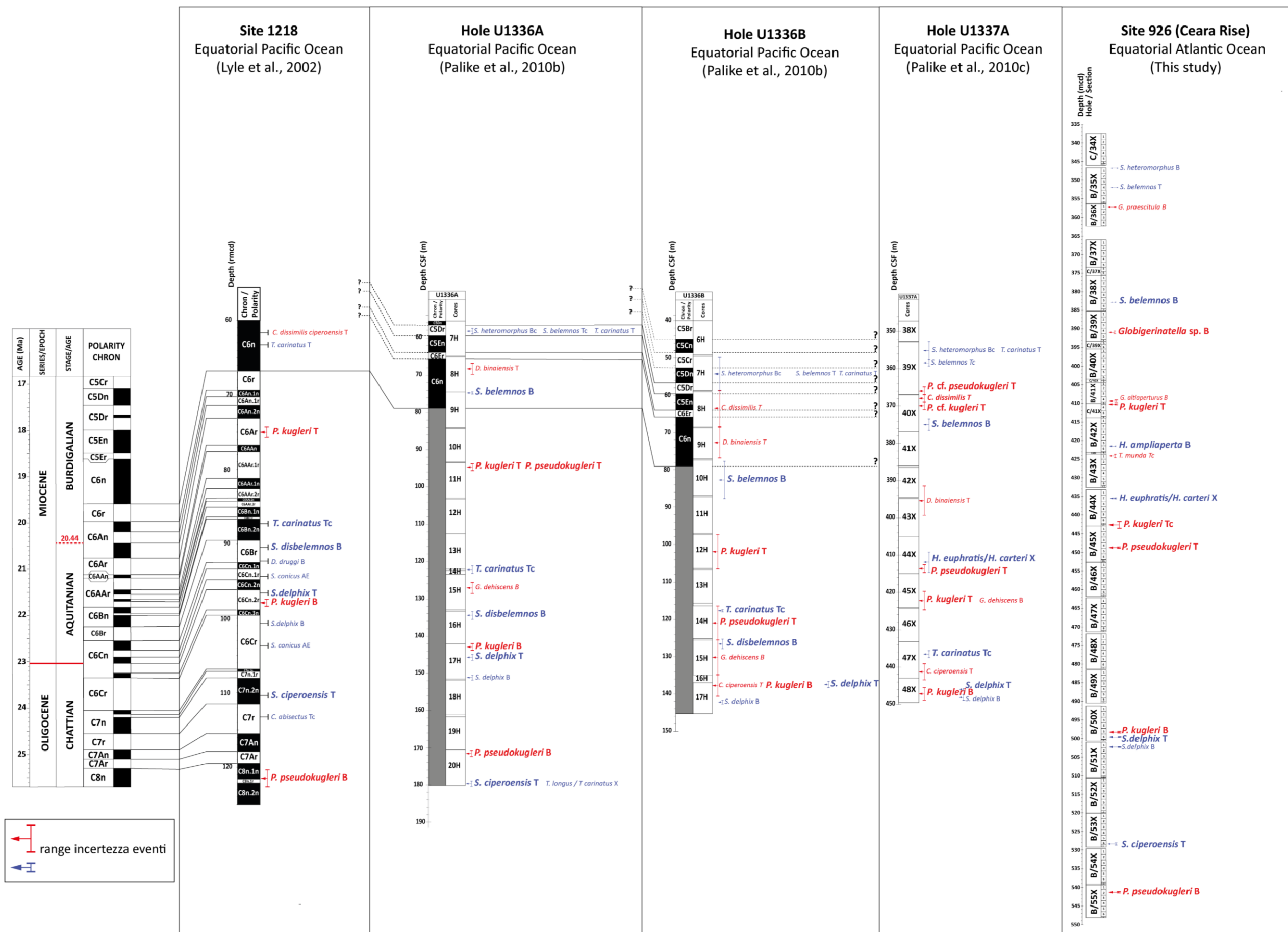


Fig. 6.2 – Bio-magnetostratigraphic correlation of Site 926 (this study) with Equatorial Pacific Ocean Site 1218 (Lyle et al., 2002) and Holes U1336A, U1336B and U13367A (Expedition 320/321; Pälke et al., 2010b, 2010c).

6.1. Low to mid-latitude (South to North Atlantic) transect

For the second correlation with Site 926, Hole 516F (located in SW Atlantic Ocean at 30°S), Hole U1406A (located in NW Atlantic Ocean at 40°N) and the Contessa section (an outcropping section located in the Mediterranean Sea at 43°N) were chosen, proceeding from south to north (Fig. 6.3).

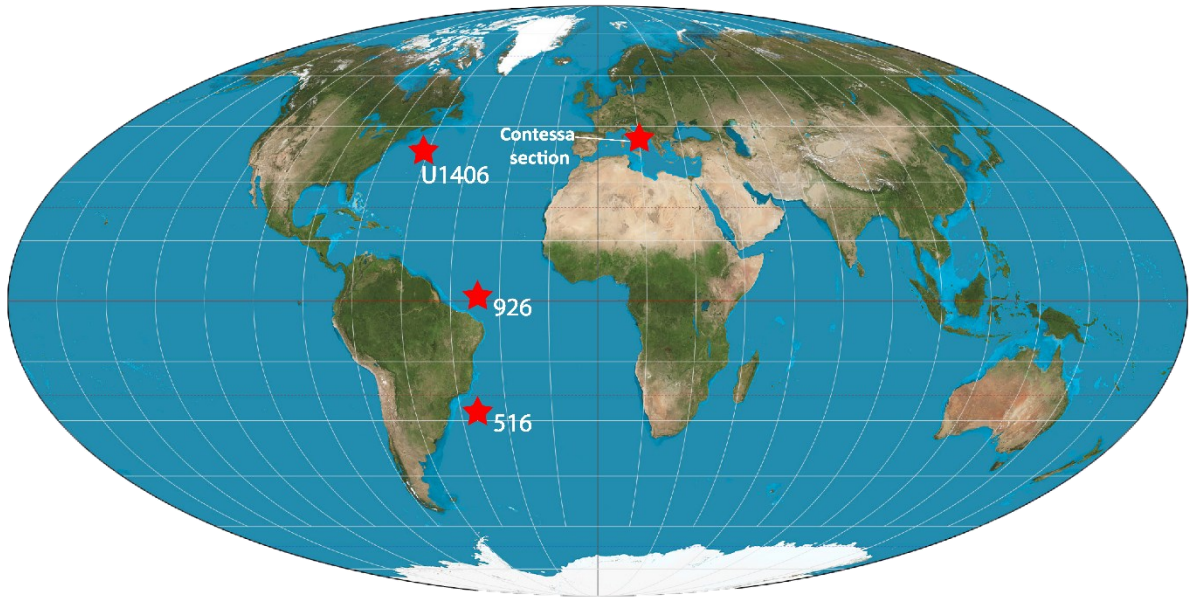


Fig. 6.3 - Location map of the Contessa section and Sites U1406, 926 and 516 in Mollweide projection.

Except for Site 926, each succession provides almost complete magnetostratigraphy of the interval (some levels of uncertainty are marked with gray bands in Figure 6.4). In Hole U1406A and in the Contessa section, however, the stratigraphic succession is not complete due to the presence of hiatuses. Despite this, a correlation with Hole 516F and Site 926 was attempted. Planktonic foraminifera and calcareous nannofossil events are considered as in the previous correlation. However, in this case, bioevents were defined with a high-resolution quantitative analysis (Gennari et al., 2018; Fabbrini et al., 2019a, 2019b) and are comparable to those of Site 926 (this study).

In the correlation shown in Fig. 6.4, it is possible to note that:

- It was impossible to correlate some critical events, such as B *Globigerinatella* sp. and B *Helicosphaera ampliaperta*, because they were not identified in the holes. B *H. ampliaperta* was defined only in the Contessa section (Fabbrini et al., 2019b) and, according to the existing biochronology (Raffi et al., 2020), postdates T *P. kugleri* and occurs in Chron C6An.2n. According to the most recent work by Kasbohm et al. (2021), who reinterpreted the magnetostratigraphy of the Contessa section and modified the age model of Fabbrini et al. (2019b), B *H. ampliaperta*, estimated at 20.43 Ma (Raffi et al., 2020), should fall between the volcanoclastic horizons dated at 20.86 Ma and 20.57 Ma. This suggests a potentially earlier first occurrence at the Contessa section.
- The relative positions of T *Paragloborotalia kugleri* and T *Paragloborotalia pseudokugleri* are consistent. In the Contessa section, T *P. pseudokugleri* was not indicated (Fabbrini et al., 2019b) and T *P. kugleri* is located below Raffaello Level (RL in Fig. 6.4) dated by Kasbohm et

al. (2021) at 22.30 Ma. This should indicate an early last occurrence of *P. kugleri*, possibly due to underestimating its stratigraphic range (Kasbohm et al., 2021).

- The relative positions of B *P. kugleri* and T *S. delphix* also align with biochronology (Raffi et al., 2020) because B *P. kugleri* always postdates T *S. delphix*. In Hole 516F, the Base common (Bc) of *P. kugleri* was considered by Gennari et al. (2018) to be time-equivalent to the Base of *P. kugleri* recorded in the Lemme-Carrosio section (Steininger et al., 1997) and at low latitude (Pearson & Chaisson, 1997), falling in Chron C6Cn.2n. Instead, in the Contessa Section (Fabbrini et al., 2019b), B *P. kugleri* falls in Chron C6Cn.2r as in Site 1218, while in Hole 1406A it falls into an uncertainty interval.

In conclusion, these correlations highlight the importance of high-resolution quantitative analysis of planktonic foraminiferal assemblages in biostratigraphy. This is essential for enhancing the understanding of the distribution patterns of biostratigraphic markers within specific time intervals on a global scale, and for improving the resolution and accuracy of standard zonations.

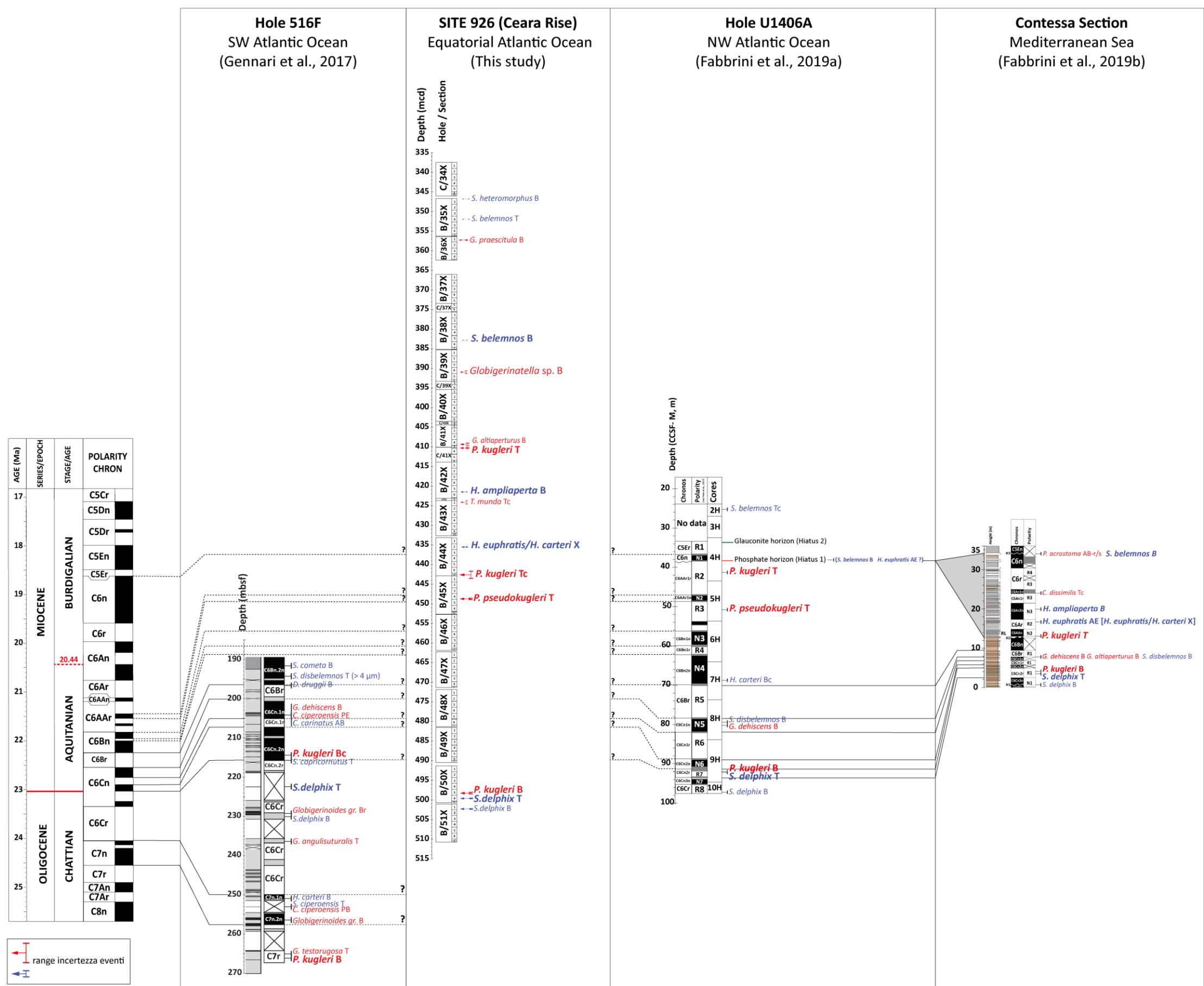


Fig. 6.4 – Bio-magnetostratigraphic correlation of Site 926 (this study) with Hole 516F (SW Atlantic Ocean; Gennari et al., 2017), Hole U1406A (NW Atlantic Ocean; Fabbrini et al., 2019a) and the Contessa Section (Mediterranean Sea; Fabbrini et al., 2019b).

7. Paleoecology of planktonic foraminiferal assemblages of Site 926 in the Aquitanian-Burdigalian interval

7.1. General features of the assemblage

The planktonic foraminifera assemblage of the studied interval comprises 16 genera and 55 taxonomic categories classified at specific and supra-specific levels (see paragraph 3.3. and Appendix 1). In addition, a variable portion of specimens (from 2 to 35 %) cannot be determined as they are juvenile or poorly preserved forms (undetermined).

The abundance patterns of genera recognized (%) and undetermined specimens (%) are shown in Figure 7.1 (the percentage values are reported in Appendix 2). Genera *Globoquadrina* and *Globigerinatella* are omitted, the first one because its abundance is always < 2 %, and the second one because *Globigerinatella* sp. is the only species of this genus and its distribution curve is shown together with other species in Figure 7.2c.

As shown in Figure 7.1, genera *Paragloborotalia*, *Globigerinita*, *Dentoglobigerina*, *Globorotaloides* and *Ciperoella* dominate in the assemblage. They are always present throughout the succession, showing a mean abundance > 5%. *Paragloborotalia* is the most representative genus and shows an abundance spanning from 5.7 to 70.4 %, with a decrease at a depth of ~421 mcd (near the Base of *H. ampliapertura*) and in the upper part of the studied interval at 362 mcd. *Globigerinita* is the second most abundant genus of the assemblage, it is always present in the assemblage and shows an abundance that ranges from 1.9 to 39.5 %. Genus *Dentoglobigerina* has an abundance spanning from 1 to 23.3 %, with higher values from 425 mcd up to the top of the interval. Genus *Globorotaloides* is characterized by an abundance ranging from 0.6 to 26.5 % and shows a gradual decrease in abundance moving towards the top of the interval. Genus *Ciperoella* is continuously present in the entire succession, presenting an abundance from 1 to 20.8 %.

Genera *Catapsydrax*, *Tenuitella* and *Globigerinella* are present throughout the interval exhibiting discontinuous abundance patterns in some intervals. Genus *Tenuitella* is characterized by an abundance ranging from 0.3 to 12.2%, with a higher abundance in the lower part of the interval up to the depth of 425 mcd, above which it always remains below 10%. Genera *Catapsydrax* and *Globigerinella* present values of abundance always <10%.

Genera *Globoturborotalita*, *Trilobatus*, and *Globigerinoides* have a similar abundance pattern. They are discontinuously present in the lower part of the interval and gradually increase in abundance starting from ~423 mcd depth, occurring more continuously.

Genera *Globorotalia*, *Globigerina* and *Cassigerinella* show very discontinuous or spotted abundance patterns. *Globorotalia* shows higher abundances in the interval from 425 to 410 mcd. *Cassigerinella* is very scattered in the upper part of the interval from 380 mcd.

The last abundance curve in Figure 7.1 shows the percentage of undetermined specimens in the assemblages, with a mean value of 15% (2 – 35%).

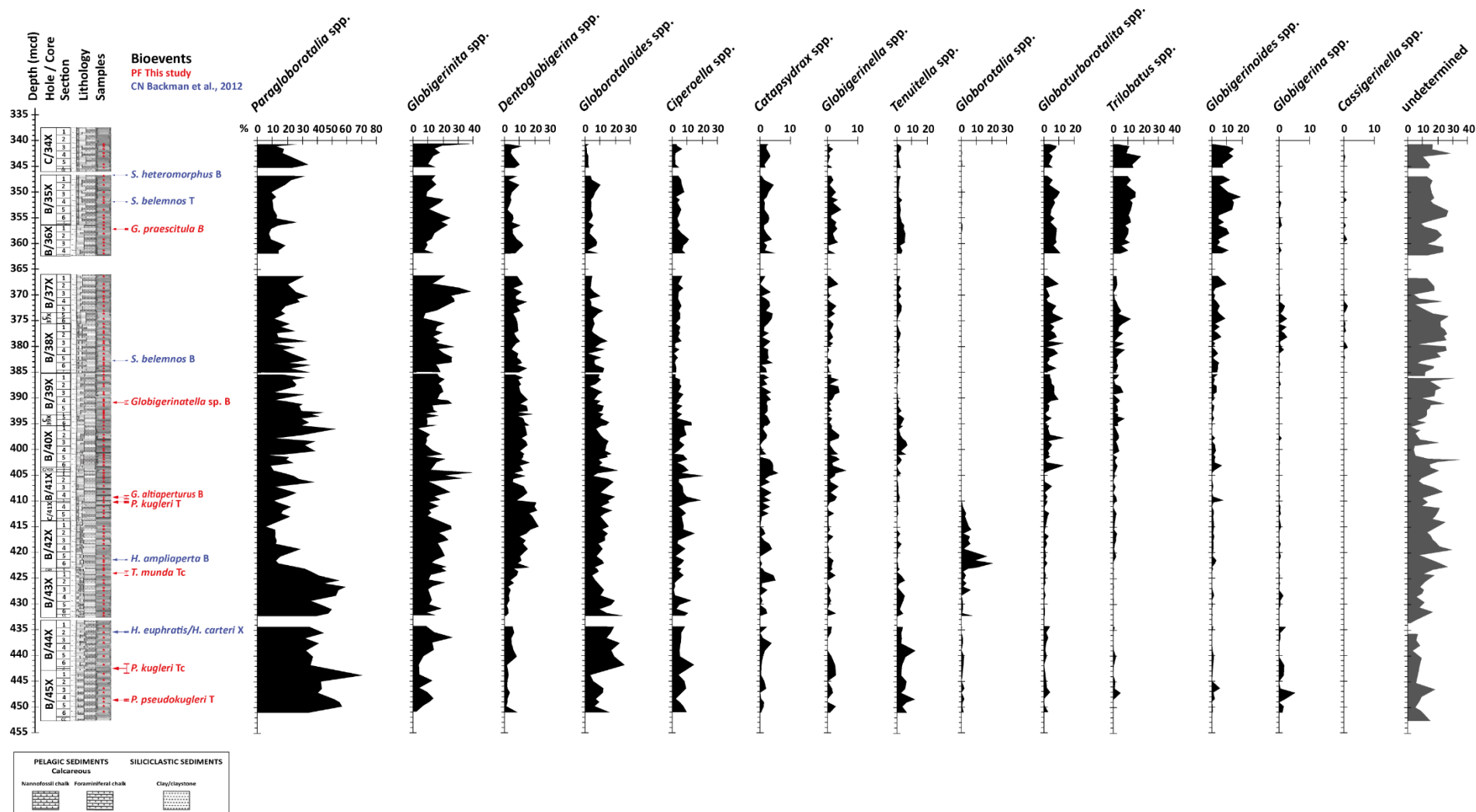


Fig. 7.1 – Genera and undetermined specimens' abundance patterns vs. depth (mcd).

Figures 7.2a-d present the species characterizing the main genera, starting with the most abundant ones that have a continuous distribution throughout the succession, and ending with those that exhibit a discontinuous or scattered pattern.

In Figure 7.2a, species with a continuous distribution pattern throughout the studied interval are shown: *Paragloborotalia siakensis*, *Paragloborotalia* sp.1, *Globigerinita glutinata*, *Globigerinita uvula*, *Globorotaloides suteri*, *Ciperoella anguliofficialis* and *Catapsydrax unicavus*. *P. siakensis* (randomly coiled) and *G. glutinata* are the most abundant species with an abundance spanning from 2.7 to 39.7 % and 2.2 to 24.4 %, respectively.

Figure 7.2b shows species with a decreasing distribution pattern from bottom to top in the studied interval. These are the entire group of *Paragloborotalia* (except for *P. siakensis*), all *Globorotaloides* (except *G. suteri*), *Ciperoella fariasi*, *Tenuitella praestainforthi*, *T. munda* and *Globigerinita* sp. (*G. glutinata* - *Globigerinatella* sp. transition forms, see Chapter 4). *Paragloborotalia pseudokugleri*/*P. kugleri* group is the most abundant, with values spanning from 13 to 40 %. Additionally, also for *Paragloborotalia* cf. *P. bella*, which shows values between 0.3 and 13 %, as for *P. siakensis*, the two different coiling directions of species show random distribution throughout the succession.

Figure 7.2c presents species with an increasing distribution pattern in the central part of the studied interval and those with an increasing distribution pattern from bottom to top. The first group is characterized by *Globorotalia* sp. (0.3 - 21%), *Dentoglobigerina venezuelana* (0.3 - 5.5%), *D. globularis* (0.2 - 15.3%) and *D. larmei* gr. (0.3 - 11.7%). The second group is represented by species of genera *Globoturborotalita*, *Globigerinoides* and *Trilobatus*, as mentioned at the beginning of the paragraph, and by other species such as *Globigerinatella* sp. (0.3 - 3.8%), *Dentoglobigerina altispira* gr. (0.3 - 13%), *Catapsydrax dissimilis* (0.2 - 3.4%), *Globigerinella* sp. (0.3 - 3.7%) and *Tenuitella clemenciae* gr. (0.3 - 2.4%).

The last group of species is shown in Figure 7.2d. It is characterized by species that present a discontinuous distribution pattern. The most abundant are *Tenuitella angustiumbilitata* (0.3 - 6.1%), *Globigerinella obesa* gr. (0.3 - 3.7%) and *Globigerina bulloides* (0.2 - 5.4%). The other species occur scattered throughout the interval with an abundance always < 2%.

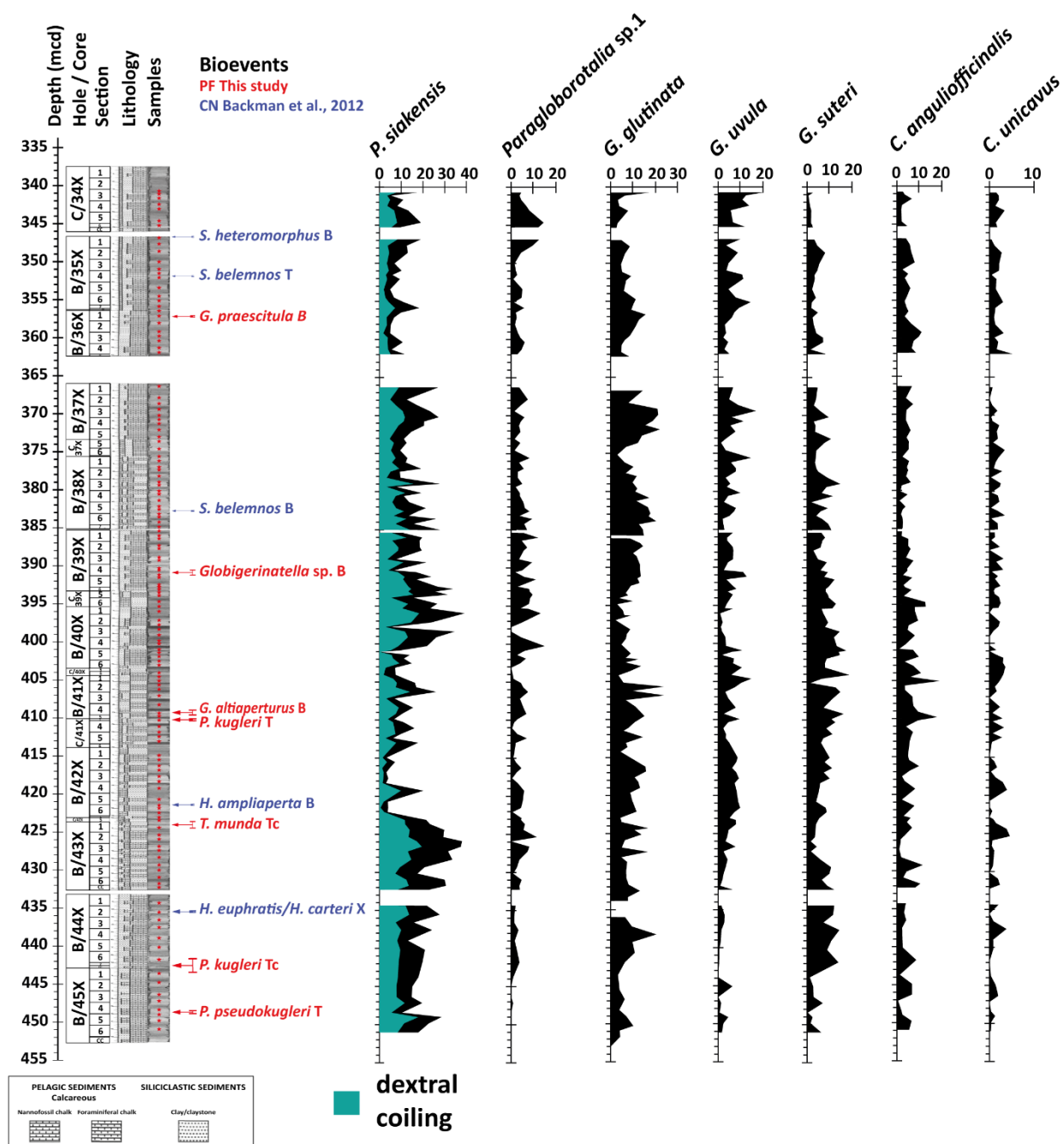


Fig. 7.2a – Relative abundance of species (%) vs. depth (mcd). Species with continuous distribution pattern throughout the studied interval.

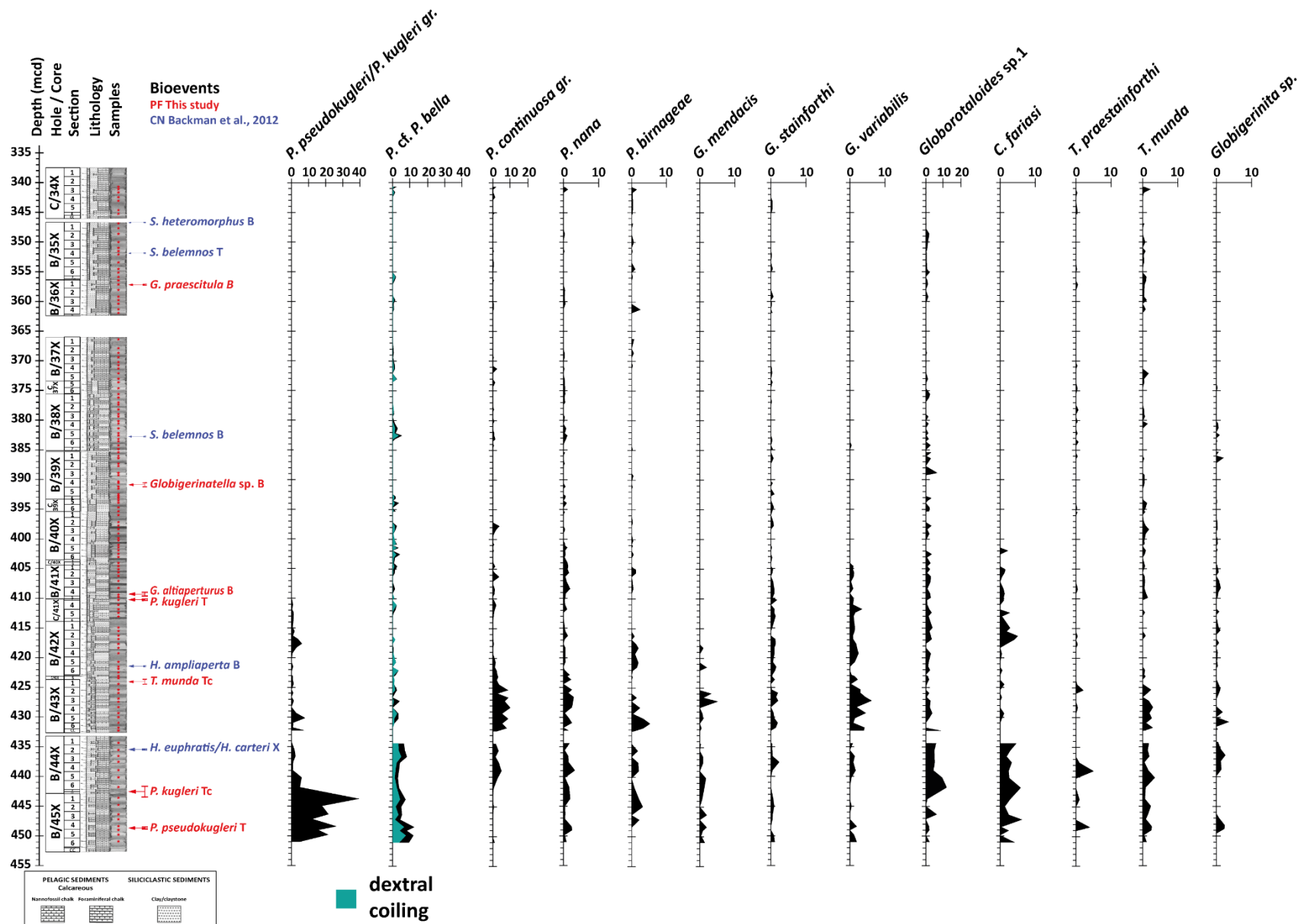


Fig. 7.2b – Relative abundance of species (%) vs. depth (mcd). Species with decreasing distribution pattern from bottom to top in the studied interval.

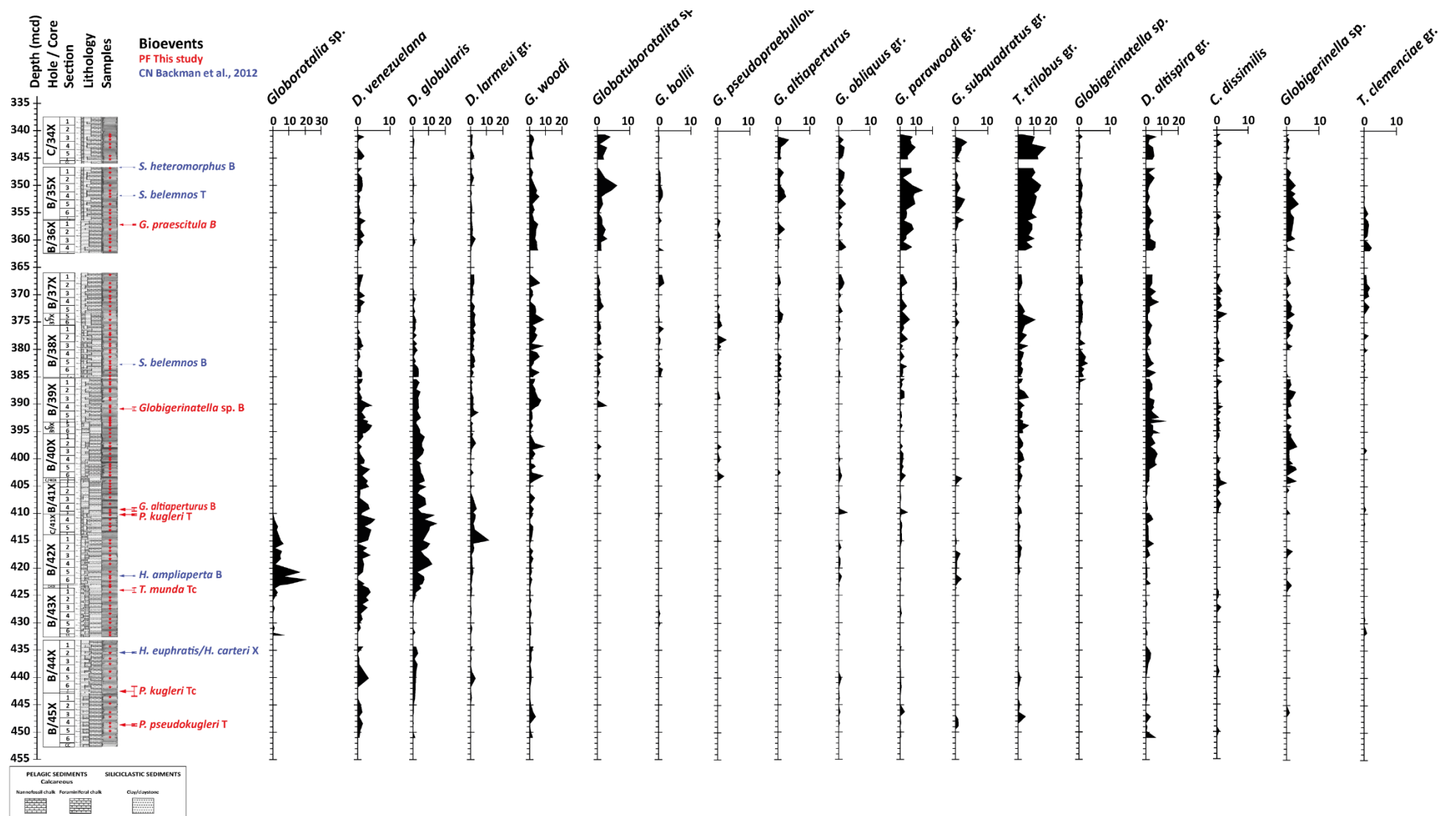


Fig. 7.2c – Relative abundance of species (%) vs. depth (mcd). Species with increasing distribution pattern in the central part of the range and species with increasing distribution from bottom to top in the studied range.

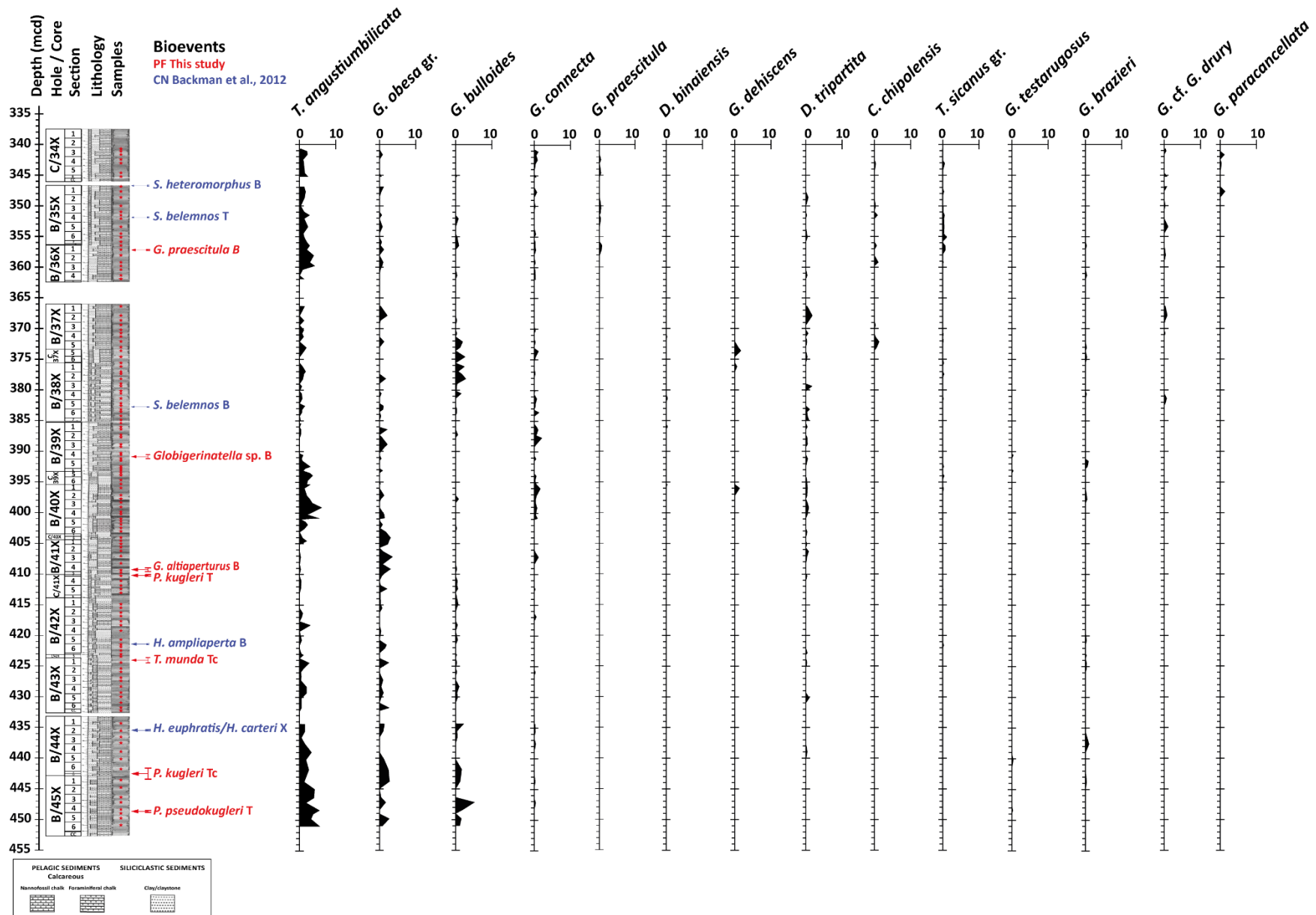


Fig. 7.2d – Relative abundance of species (%) vs. depth (mcd). Species with discontinuous distribution pattern or rare occurrences.

7.2. Diversity indices

In Figure 7.3 the distribution patterns of diversity indices (Shannon-Wiener Index, Equitability, and Dominance) are presented (numeric values in Appendix 2).

Shannon-Wiener Index consistently shows high values in the entire interval, ranging from 2.1 to 3.2. It is the same for Equitability, which varies between 0.7 and 0.9, with values close to the maximum. In contrast, Dominance always remains low, ranging from 0.1 to 0.2. The curves of Equitability and Dominance are nearly mirrored images.

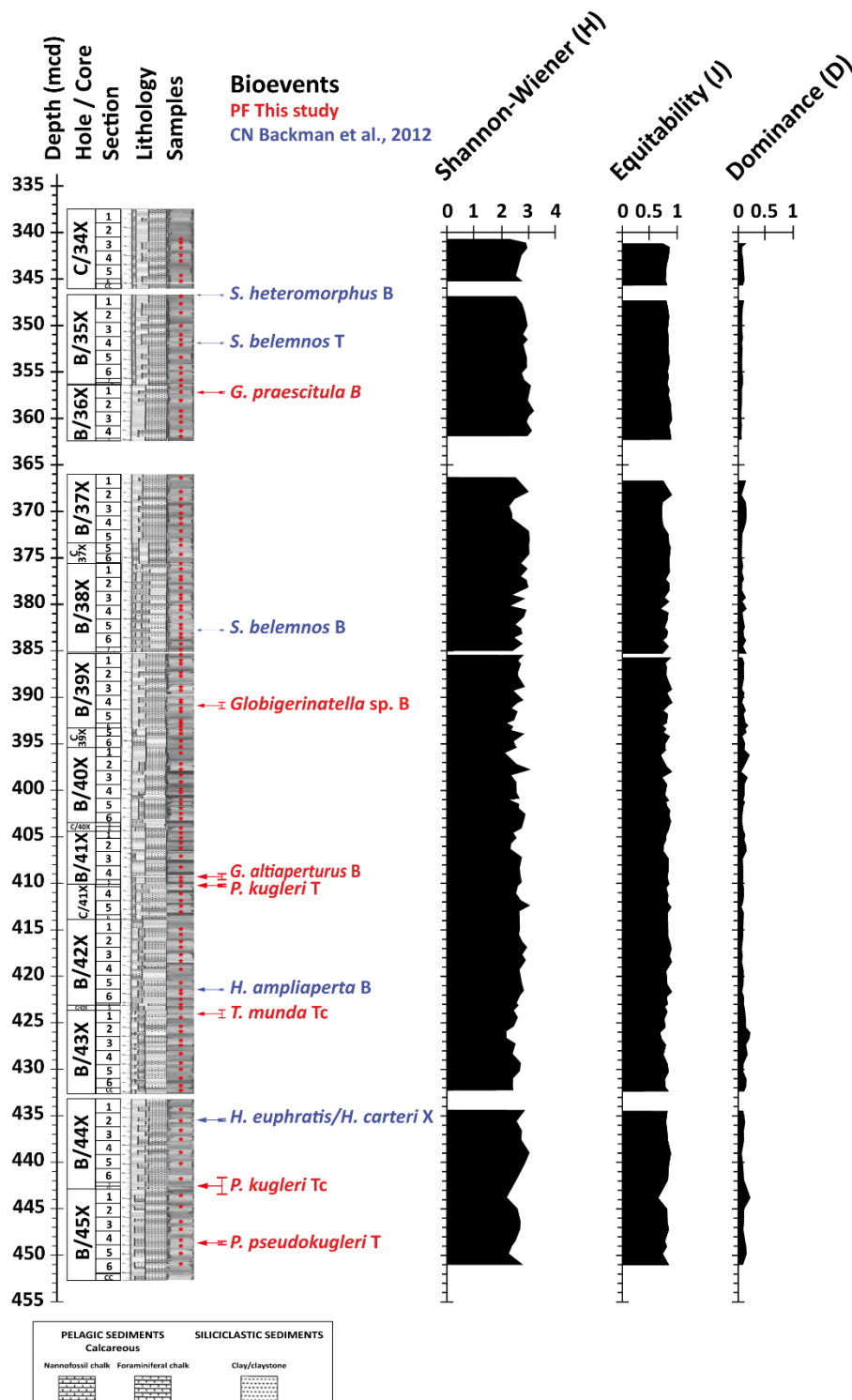


Fig. 7.3 – Diversity indices vs depth (mcd).

7.3. Dissolution and preservation

Figure 7.4 shows the distribution patterns of dissolution/preservation indices of the assemblage (numeric values in Appendix 2).

The Plankton/Benthos ratio is always very high, with values ranging from 98 to 100 %. The curve of fragments' percentage presents a notable range of values, averaging 34.7% with peaks reaching 49.9%, and the curve of dissolution-resistant / dissolution-susceptible taxa (Tab. 3.1) has values ranging from 17.4 to 100%, showing a gradual decrease in abundance, starting from ~405 mcd depth, until the top of the succession, with a slightly increase between 373 and 369 mcd (core 926B/37X). Radiolarians show an abundance spanning 1 to 17 %, with higher values in the first part of succession (from the base to ~405 mcd depth). Their abundance pattern is continuous from the lower part of the succession until ~405 mcd depth (core B/41X mcd), and then discontinuous until the top.

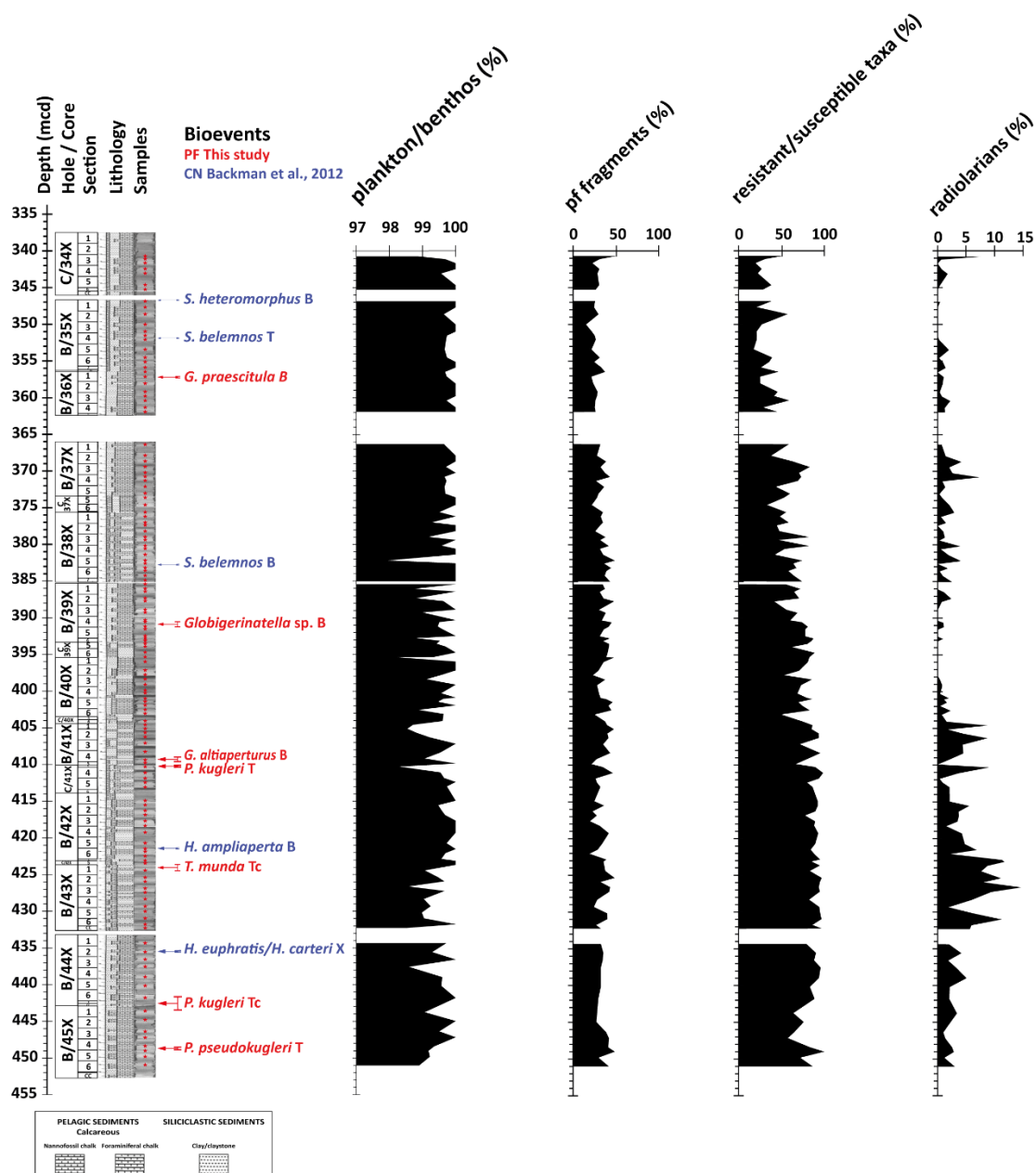


Fig. 7.4 – Dissolution/preservation indices vs depth (mcd).

7.4. Productivity indices

In Figure 7.5, the indices used to evaluate the productivity of the planktonic foraminiferal assemblage are illustrated (numeric values in Appendix 2).

Faunal density (number of specimens per gram of residue >125 µm) presents values that span from 53091 to 697958 and exhibits two significant peaks at depths of 436.6 mcd (697958) and 370.8 mcd (633600).

Paleoproductivity (sum of eutrophic taxa, Tab. 3.4) varies from 11.1 to 53.8 % and presents a continuous distribution pattern throughout the interval, with a slight decrease in abundance in the last three cores of the succession (B/36X – C/34X), in correspondence with the interval of less radiolarian abundance.

Radiolarians are both a dissolution index and a productivity index (details in the previous paragraph).

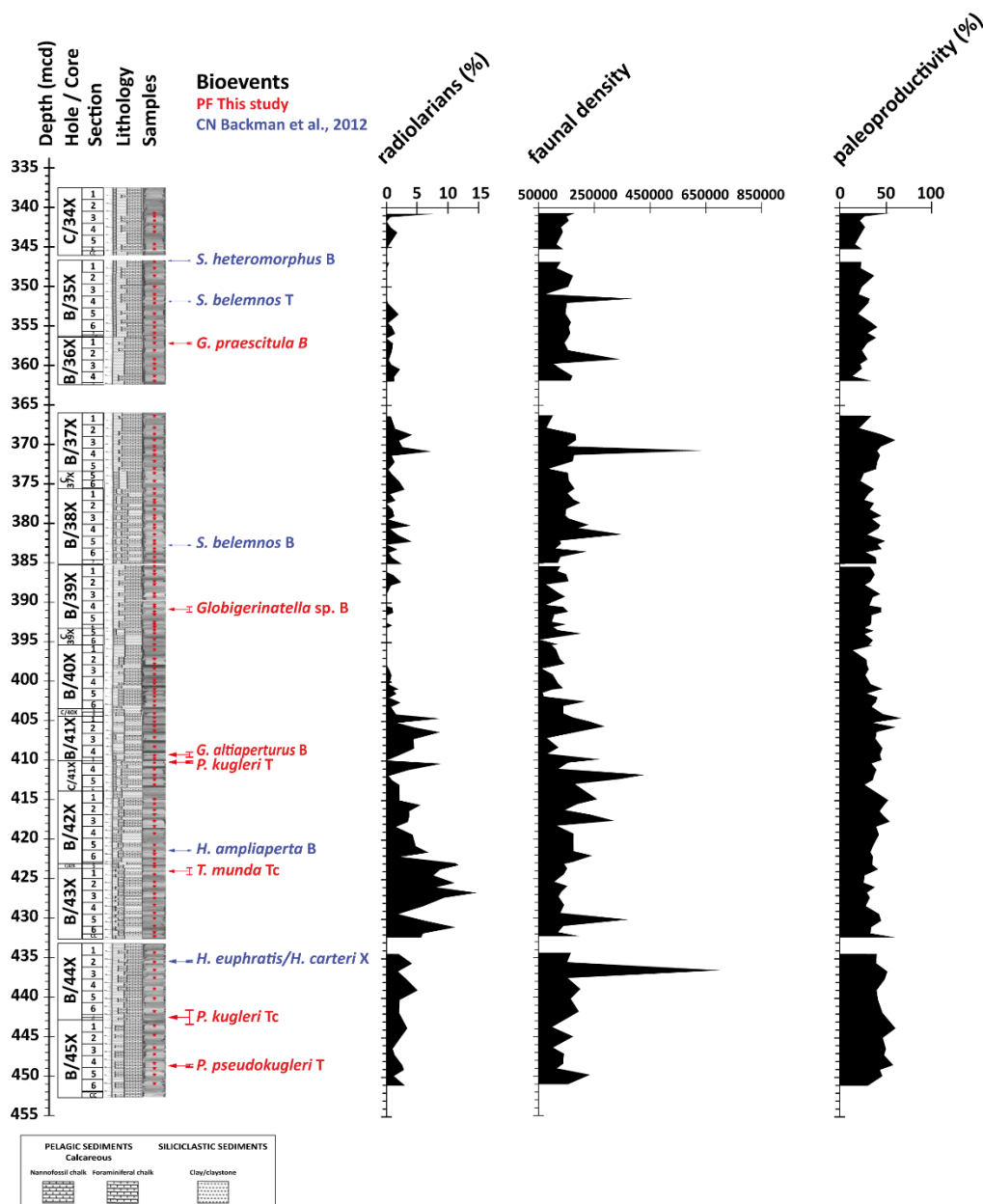


Fig. 7.5 – Faunal density (number of specimens per gram of residue >125 µm) and Paleoproductivity (sum of eutrophic taxa %) vs depth (mcd).

7.5. Depth habitat and sea surface temperature (SST)

In Figure 7.6, the depth habitat preference of taxa and the warm/cold taxa ratio (variation of SST) are shown (numeric values in Appendix 2).

Mixed layer and thermocline taxa dominate the assemblages. Mixed layer taxa, which are also comprised of surface dwellers (see Tab. 3.2), have an abundance that ranges from 17.5 to 51.9 %. Thermocline taxa show an abundance spanning from 0.4 to 40.6 %, and their distribution is dominated by *Paragloborotalia siakensis* (see Fig. 7.2a), with higher values concentrated from the base of the interval until the depth of ~422 mcd (close to *B. H. ampliaperta*). Sub-thermocline taxa are poorly represented in this assemblage, mostly dominated by *Catapsydrax* and *Globorotaloides* genera, with an abundance ranging from 0.6 to 23.4 %.

The warm/cold taxa (Tab. 3.3) ratio presents values ranging from 12.5 to 82.8 %, showing some fluctuations along the succession, with lower values occurring between 442 and 425 mcd, 406 and 404 mcd, and 371 and 369 mcd.

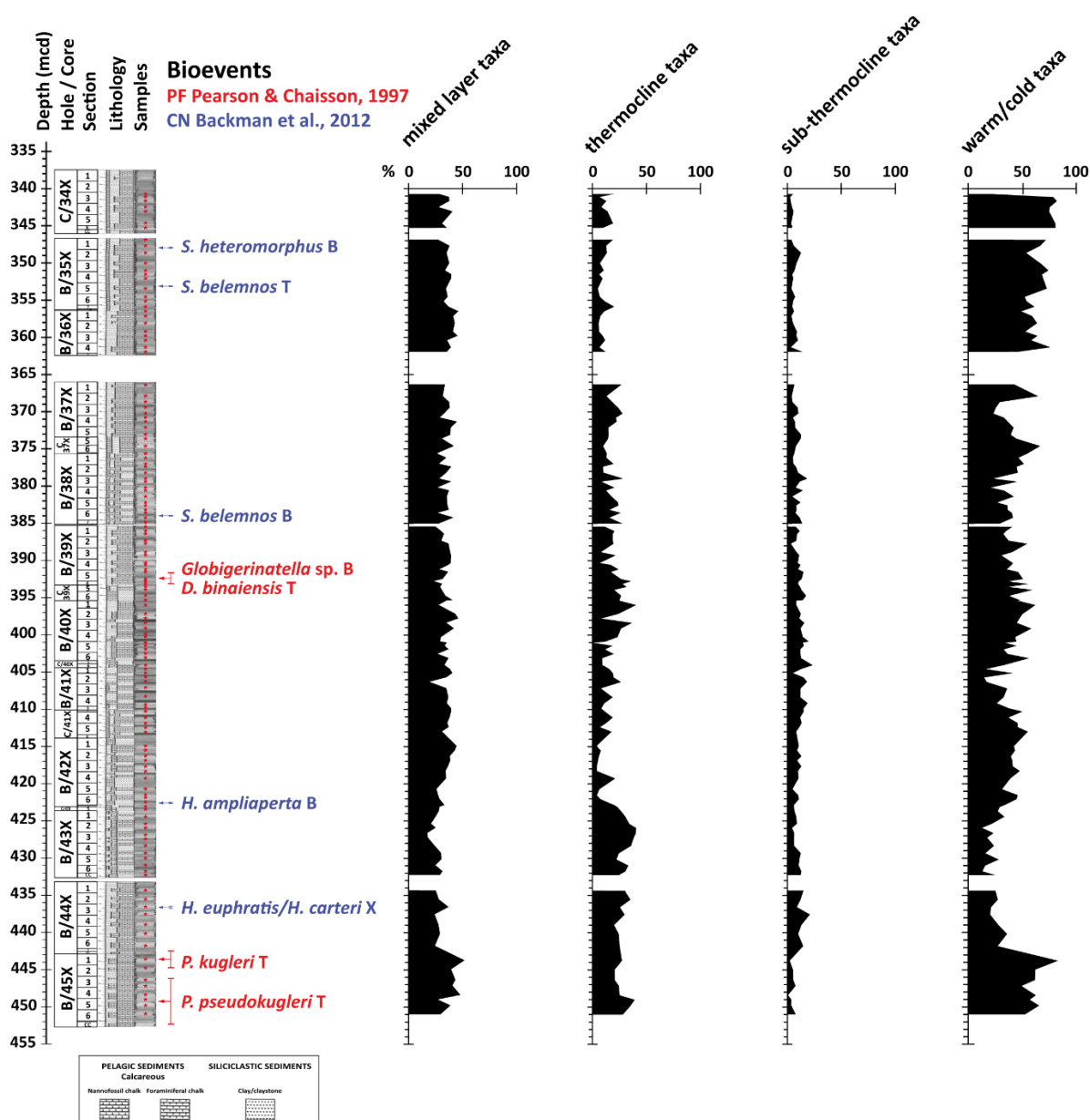


Fig. 7.6 – Depth habitat preferences (%) and warm/cold taxa ratio vs depth (mcd).

7.6. Discussion

7.6.1. Diversity

Observing the distribution curves of different indices, summarized in Figures 7.7a-b, it was possible to note that assemblage at Site 926, in the Aquitanian – Burdigalian interval (from 21.5 to 17.6 Ma), is mainly characterized by planktonic foraminifera, as shown by the high values of Plankton/Benthos ratio. It also appears well diversified, as demonstrated by dominant high values of Shannon-Wiener Index and Equitability and by low values of Dominance, which provide an estimate of the diversity (species richness and their relative abundance) variation of the assemblage along the succession (Simpson, 1949; Buzas & Gibson, 1969; Pielou, 1975; Spellerberg & Fedor, 2003). This could mean a balanced species distribution in the assemblage, indicating stable environmental conditions.

7.6.2. Preservation and dissolution

The preservation state of the assemblage is generally quite good due to high values of the Plankton/Benthos ratio throughout the studied interval. Generally, shells of planktonic foraminifera are considered to be less resistant to dissolution than those of benthic foraminifera (Conan et al., 2002; Kucera, 2007), so high values of this ratio should indicate that dissolution did not severely affect the assemblage. However, there are a significant percentage of fragments in some levels of the succession and very high values of dissolution resistant/susceptible taxa ratio (dissolution index by Conan et al., 2002; Kucera, 2007) in the interval from ~442 to ~405 mcd (~21.09 -19.81 Ma). Above ~405 mcd the dissolution resistant/susceptible taxa ratio shows a gradual decrease up to the top of the studied interval. In addition, the percentage of radiolarians (dissolution index by Conan et al., 2002) is high in the lower and middle parts of the studied interval and also shows a decline from ~405 mcd depth upward. The high values of radiolarians and dissolution resistant/susceptible taxa ratio appear to be unrelated to the Plankton/Benthos ratio and the percentage of fragments.

According to Curry et al. (1995), the interval of high percentage of radiolarians could correspond to the interval of high values of pore-water silica values (near 1000 μM), which might be related to increased sedimentation rates within the Early Miocene at Site 926 and to greater silica concentration in the bottom waters, due to a more significant proportion of Antarctic Bottom Water compared to Northern Component Water, which is relatively depleted in silica (see paragraph 2.2.1).

7.6.3. Productivity

Productivity appears to remain relatively constant, as there are no significant fluctuations in the curve of eutrophic taxa (paleoproductivity curve in Figs. 7.7a-b) throughout the succession (always below 50%, except for some sporadic levels), with the lowest values at the top of studied interval, between core 926B/36X and core 926C/34X (from 18.32 to 17.60 Ma).

Furthermore, there is no evident correlation between the paleoproductivity curve, the faunal density curve (especially with its prominent peaks), and the drastic decline of radiolarians, which also serve as a productivity index (Lazarus, 2005, 2008).

According to literature about Site 926 (Curry et al., 1995), nutrient concentrations in the Ceara Rise zone remain low because the productivity of surface waters exceeds the upwelling of nutrients in the mixed layer. This happens because Ceara Rise is located on the western side of the Atlantic Ocean, making it less susceptible to annual and glacial-interglacial fluctuations in upwelling. As a

result, the concentration of nutrients in the surface-water mixed layer tends to remain consistently low (Curry & Crowley, 1987; Curry et al., 1995).

7.6.4. Depth habitat and Temperature

Regarding the depth habitat, the assemblage is mainly characterized by mixed-layer taxa, which are always abundant, particularly in the interval between the base of succession and Tc *P. kugleri*. However, there is a slight decline in abundance between Tc *P. kugleri* (21.13 Ma) and B *H. ampliaperta* (20.43 Ma), where thermocline taxa show higher values.

The warm/cold taxa ratio (Figs. 7.7a-b) indicates the variation in sea surface temperature (SST) and was compared with other indices and the isotopic record ($\delta^{18}\text{O}$) by Pälike et al. (2006a). It is important to note that the isotopic record at Site 926 was conducted only for Hole 926B and with a higher resolution than that of this study. As a result, there is no direct correlation between the isotopic record and the indices values calculated in the composite section used in this study.

Observing the warm/cold taxa ratio, it was possible to note that higher values (> 50%) are concentrated at the base and the top of the interval, particularly between the base of the succession and Tc *P. kugleri* (from 21.5 to 21.13 Ma), and between cores 926B/36X and 926C/34X (from 18.32 to 17.60 Ma, highlighted by the orange bands in Fig. 7.7b). However, it must be specified that the interval at the base is mainly characterized by *Paragloborotalia* species of mixed layer (all except *P. siakensis* that is a thermocline taxa), while the interval at the top by species of *Globoturborotalita*, *Globigerinoides* and *Trilobatus* genera (see distribution patterns of species in Figs. 7.2b-c). These intervals also correspond to low $\delta^{18}\text{O}$ values (Fig. 7.7b), suggesting higher sea surface temperatures.

In contrast, the middle part of the interval, between Tc *P. kugleri* and the top of core 926B/37X (from 21.13 to 18.51 Ma, marked by the blue wide band in Fig. 7.7b), displays lower values of the warm/cold taxa ratio, reflecting a lower concentration of warm taxa, which consistently remains < 50 % (except for some levels), in favor of cold taxa. This could indicate a less warm interval than the previous ones.

Here, three particular intervals (darker blue bands in Fig. 7.7b) are marked by the lowest values of warm/cold taxa ratio.

The first level is located between Tc *P. kugleri* and Tc *T. munda* (from 21.13 to 20.50 Ma, a little below B *H. ampliaperta*), and it is characterized by a decrease in abundance of mixed-layer taxa, an increase in abundance of thermocline taxa and the highest values of radiolarians. In addition, this interval is in correspondence with two maxima of $\delta^{18}\text{O}$ values (dated at ~21.04 Ma and 20.65, close to Tc *P. kugleri*), whose the second one corresponds to a obliquity minimum indicated by Pälike et al. (2006a).

This interval could be associated with the minor glacial event Mi-1a by Miller et al. (1991), calibrated at 21.1 Ma to the ATS of Shackleton et al. (1999) and identified at the top of Zone N4b (= M1b, defined by T *P. kugleri* coincident with Tc *P. kugleri* of this work). Therefore, these results could indicate a level of colder sea surface temperatures.

The second level corresponds to a depth of ~405 mcd (above B *G. altiapertura*), where the beginning of the decline of radiolarians and the gradual decrease of dissolution-resistant taxa were recorded (see paragraph 7.6.2). This level also corresponds to a maximum of $\delta^{18}\text{O}$ that could indicate another level of colder sea surface temperatures.

In the end, the third level, located in core 926B/37X (between 373 and 369 mdc), is characterized by slightly increased radiolarian values, higher paleoproductivity values, a peak of

faunal density, an increase in abundance of dissolution resistant/susceptible taxa ratio, and lower values of diversity indices (Shannon-Wiener Index and Equitability). In this case, there is a correlation with higher values of $\delta^{18}\text{O}$, although not as elevated as in the levels previously mentioned. This may suggest a level characterized by colder surface temperatures, slightly increased productivity, and a resulting decrease in diversity.

7.7. Conclusions

The analysis of the planktonic foraminifera in the Aquitanian to Burdigalian interval (from 21.5 to 17.6 Ma) revealed a rich and well-diversified assemblage characterized by almost constant productivity and a predominance of warm taxa, particularly in the lower and upper intervals of the studied succession, which indicate warmer sea surface temperature levels. However, it was identified, in the middle part of the succession (from 21.13 Ma to 18.51 Ma), a colder interval where colder taxa seem more prevalent, particularly in three levels corresponding to high values of $\delta^{18}\text{O}$. The first interval could correspond to the Mi-1a event by Miller et al. (1991) (21.1 Ma), although this event was not indicated in the isotopic record ($\delta^{18}\text{O}$) at Site 926 by Pälike et al. (2006a).

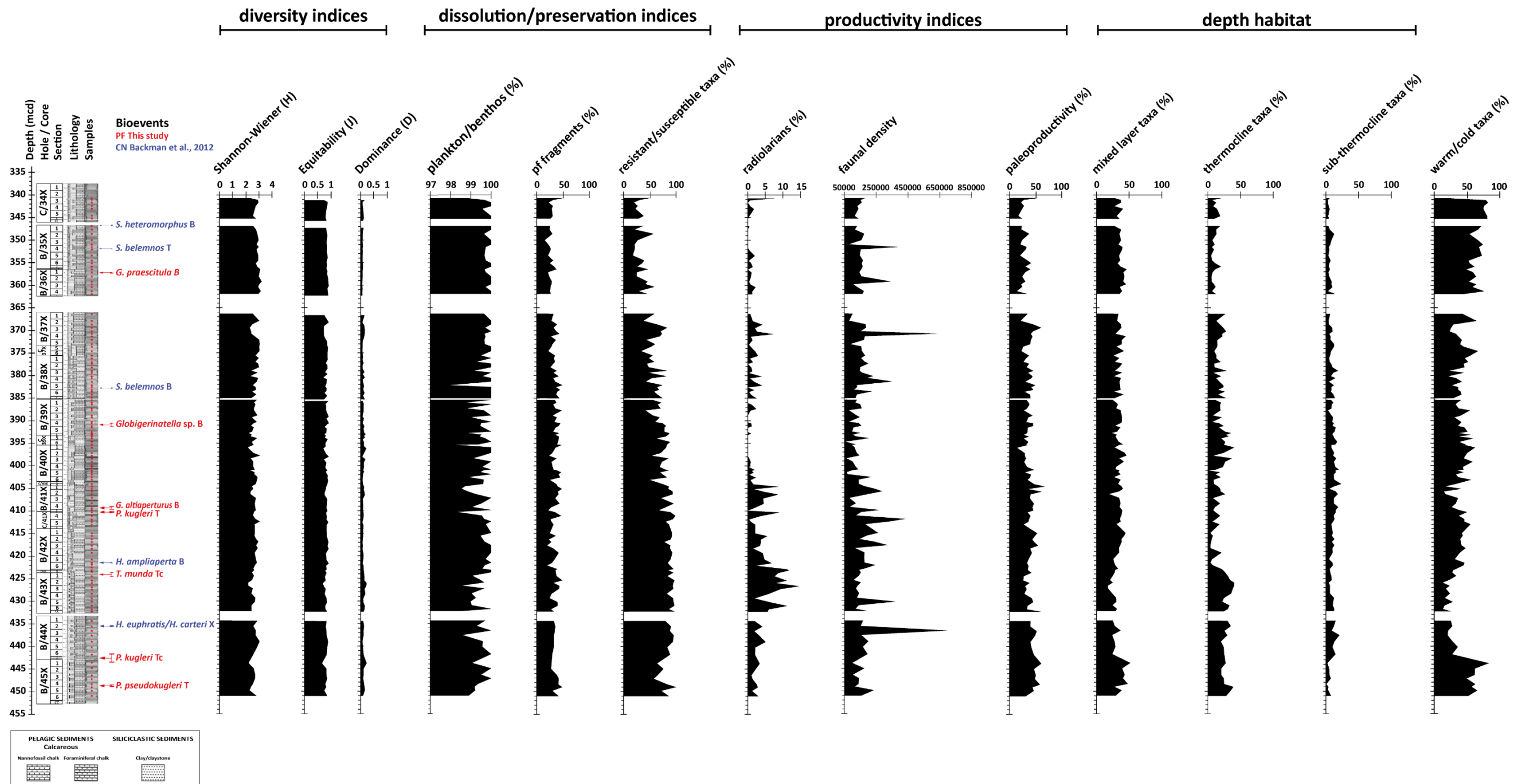


Fig. 7.7a – Summary of all indices for the assemblages.

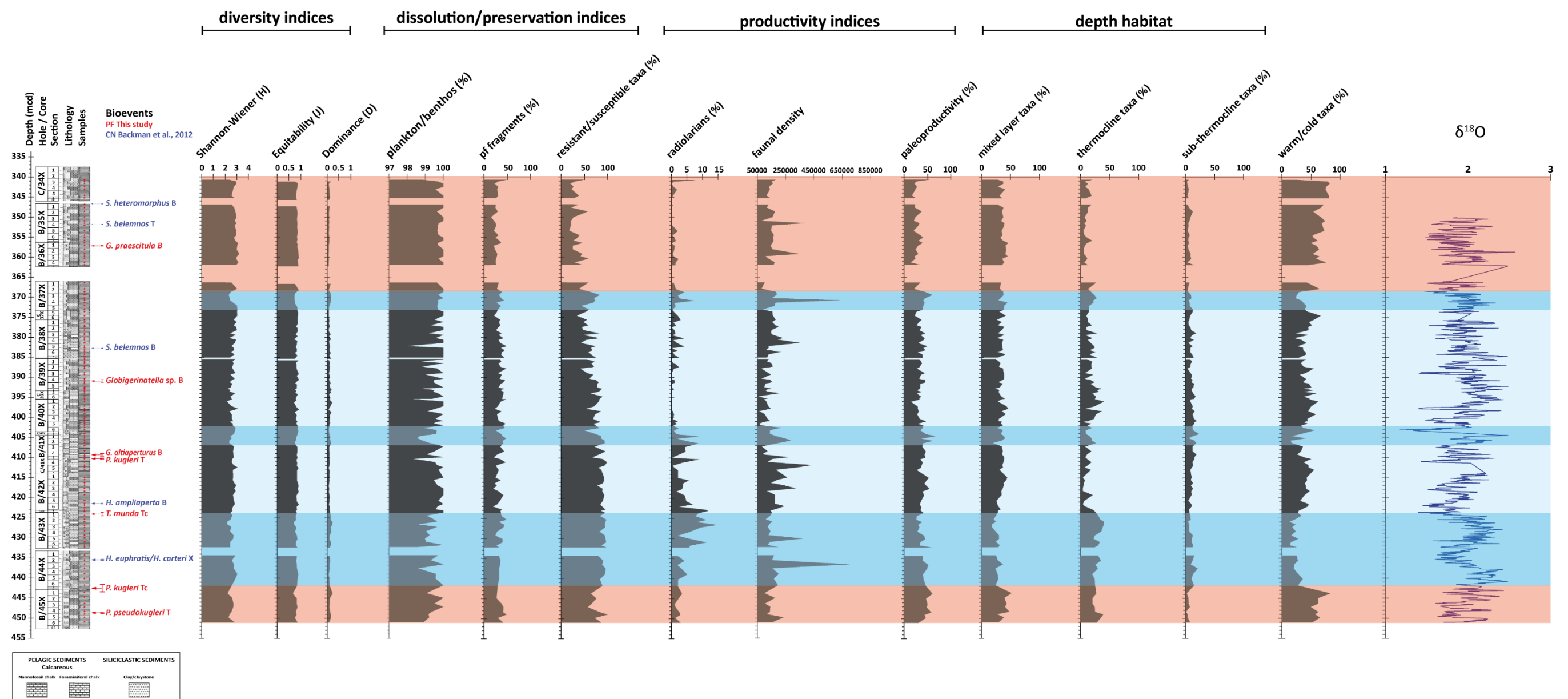


Fig. 7.7b – Summary of all assemblage indices with $\delta^{18}\text{O}$ curve.

8. General conclusions

The data obtained from this study allowed the identification of the planktonic foraminiferal events of the Aquitanian-Burdigalian interval detailing with high resolution their stratigraphic position and their age calibration.

Particularly, the most significant events recognized in the studied interval were those related to *Paragloborotalia kugleri*. The Top common of *P. kugleri* (dated at 21.13 Ma) was identified for the first time at Site 926 in this study. It coincides with the Top of *P. kugleri* by Pearson & Chaisson (1997), which was identified at the same site. On the other hand, the Top of *P. kugleri* in this study was dated at 20.08 Ma, resulting more recent, by about 1 Myr, than reported in the standard biochronology (e.g., Wade et al., 2011; King et al., 2020; Raffi et al., 2020). This implies that the Top of the Subzone M1b (Wade et al., 2011; King et al., 2020) should be ~1 Myr younger and the Top of *P. kugleri* postdates the Base of *Helicosphaera ampliaperta* (20.43 Ma) falling in the Burdigalian.

Additionally, it was possible to observe that the age estimates of Top of *P. kugleri* (20.08 Ma) and the Base of *Globigerinoides altiapertura* (20.00 Ma), recorded for the first time at Site 926, approximate the age of Top of Chron C6An (19.97 Ma). These events represent three of the five optional criteria suggested to approximate the Aquitanian/Burdigalian boundary (Raffi et al., 2020; see paragraph 1.2 for details). Their close proximity, at Site 926, could give new insight into the selection of criterium to identify the base of Burdigalian Stage.

The focus on the *Paragloborotalia pseudokugleri*/*P. kugleri* group allowed for better documentation of the morphological variability of these two species throughout the entire distribution range of *P. kugleri*, from 23.05 to 20.08 Ma. This confirmed the presence of transitional forms between two end members of the group, starting from levels closely preceding the Base of *P. kugleri* up to its last occurrence level.

Biostratigraphic correlations of Site 926 with other (I)ODP sites and the Contessa section were complex or unclear due to the different resolution of the analysis, the different fraction of washed residue considered for the analysis, the presence of several hiatuses in sedimentation (both in Hole U1406 and Contessa Section), the absence of significant events in some successions (B *Globigerinatella* sp. and B *H. ampliaperta*) and the discrepancy of relative positions of important planktonic foraminiferal and calcareous nannofossil events (T *P. pseudokugleri* and T *P. kugleri*, B *P. kugleri* and T *S. delphix*, B *P. pseudokugleri* and T *S. ciperoensis*) in the various sites.

These results emphasize the importance of high-resolution quantitative studies to improve the understanding of the distribution patterns of biostratigraphic markers, identify biostratigraphic events more accurately across specific time intervals on a global scale, and improve the resolution and accuracy of standard zonations.

From the paleoecological evaluation of Aquitanian - Burdigalian interval (from 21.5 Ma to 17.6 Ma), it was possible to note that the assemblage is: mainly composed by planktonic foraminifera, as testified by high values of the Plankton/Benthos ratio; well-diversified, as indicated by high values of the diversity indices, Shannon-Wiener and Equitability, and low values of Dominance; well-preserved (not very severely affected by dissolution) because of high values Plankton/Benthos ratio and specific diversity indices, despite a significant percentage of fragments and dissolution resistant taxa. The productivity seems apparently constant throughout the succession, with no notable oscillations, since there are no significant variations in the curve of the group of eutrophic taxa and no clear relationship with the faunal density and the variations in

abundance of radiolarians. Additionally, the assemblage is mainly composed by mixed layer and thermocline taxa (especially at the base of succession) and, in general, by warm taxa.

Finally, higher values of the warm/cold taxa *ratio* indicate higher sea surface temperatures in the basal interval up to Tc *P. kugleri* (21.13 Ma) and at the top of the interval (cores 926B/36X - 926C/34X, 18.32 - 17.60 Ma). Instead, lower values of the warm/cold taxa ratio in the middle part of the succession (from Tc *P. kugleri* to top core 926B/37X, from 21.13 to 18.51 Ma) suggest a higher concentration of cold taxa and a decrease in sea surface temperature, particularly in three intervals corresponding to high values of $\delta^{18}\text{O}$ (Pälike et al., 2006a), where the first interval could be associated with the Mi-1a event by Miller et al. (1991).

References

- Adler, M., Hensen, C., Wenzhöfer, F., Pfeifer, K., & Schulz, H.D., 2001. Modeling of calcite dissolution by oxic respiration in supralysoclineal deep-sea sediments. *Marine Geology*, 177(1-2), 167-189.
- Agnini, C., Fornaciari, E., Raffi, I., Catanzariti, R., Pälike, H., Backman, J., & Rio, D., 2014. Biozonation and biochronology of Paleogene calcareous nannofossils from low and middle latitudes. *Newsletters on Stratigraphy*, 47(2), 131–181.
- Akers, W.H., 1955. Some planktonic foraminifera of the American Gulf Coast and suggested correlations with the Caribbean Tertiary. *Journal of Paleontology*, 29, 647–664.
- Aze, T., Ezard, T.H.G., Purvis, A., Coxall, H.K., Stewart, D.R.M., Wade, B.S., & Pearson, P.N., 2011. A phylogeny of Cenozoic macroperforate planktonic foraminifera from fossil data. *Biological Reviews*, 86, 900–927.
- Backman, J., Raffi, I., Rio, D., Fornaciari, E., & Pälike, H., 2012. Biozonation and biochronology of Miocene through Pleistocene calcareous nannofossils from low and middle latitudes. *Newsletters on Stratigraphy*, 45(3), 221–244.
- Bandy, O.L., 1964. Cenozoic planktonic foraminiferal zonation. *Micropaleontology* 10, 1–17.
- Banner, F.T., & Blow, W.H., 1965. Progress in the planktonic foraminiferal biostratigraphy of the Neogene. *Nature*, 208, 1164–1166.
- Barker, S., Cacho, I., Benway, H., & Tachikawa, K., 2005. Planktonic foraminiferal Mg/Ca as a proxy for past oceanic temperatures: A methodological overview and data compilation for the Last Glacial Maximum. *Quaternary Science Reviews*, 24, 821–834.
- Bé, A.W.H., 1959. A method for rapid sorting of foraminifera from marine plankton samples. *Journal of Paleontology*, 846–848.
- Bé, A.W.H., 1977. An ecological, zoogeographic and taxonomic review of recent planktonic Foraminifera. In: Ramsay A.T.S. (ed.). *Oceanic micropaleontology*. Academic Press, London, 1–100.
- Bé, A.W.H., & Tolderlund, D.S., 1971. Distribution and ecology of living planktonic Foraminifera in surface waters of the Atlantic and Indian Oceans. In: Funell B.M., Riedel W.R. (eds.). *The micropalaeontology of oceans*. University Press, Cambridge, 105–149.
- Berger, W.H., 1968. Planktonic foraminifera: Selective solution and paleoclimatic interpretation. *Deep-Sea Research*, 15, 31–43.
- Berger, W.H., 1970. Planktonic foraminifera: Selective solution and the lysocline. *Marine Geology*, 8, 111–138.
- Berger, W.H., 1971. Sedimentation of planktic foraminifera. *Marine Geology*, 11, 325–358.
- Berger, W.H., 1973. Deep-sea carbonates: Pleistocene dissolution cycles. *The Journal of Foraminiferal Research*, 3(4), 187–195.
- Berger, W.H., & Diester-Haass, L., 1988. Paleoproductivity: the benthic/planktonic ratio in foraminifera as a productivity index. *Marine Geology*, 81, 15–25.
- Berger, W.H., & Killingley, J.S., 1977. Glacial-Holocene transition in deep-sea carbonates: Selective dissolution and the stable isotope signal. *Science*, 197, 563–566.
- Berggren, W.A., Aubry, M.P., & Hamilton, N., 1983. Neogene magnetobiostratigraphy of Deep Sea Drilling Project Site 516 (Rio Grande Rise, South Atlantic). In: Barker, P., et al., (eds.). *Initial Reports of the Deep Sea Drilling Project*, 72, 675–713.

- Berggren, W.A., Kent, D.V., Flynn, J.J., & Van Couvering, J.A., 1985. Cenozoic geochronology. Geological Society of America Bulletin, 96(11), 1407–1418.
- Berggren, W.A., Kent, D.V., Swisher III, C.C., & Aubry, M.-P., 1995. A revised Cenozoic geochronology and chronostratigraphy. In: Berggren, W.A., Kent, D.V., Aubry, M.-P., and Hardenbol, J. (eds). Geochronology, Time Scales and Global Stratigraphic Correlation. SEPM Special Publication, 54, 129–212.
- Berggren, W. A., Wade, B. S., & Pearson, P. N., 2018. Oligocene chronostratigraphy and planktonic foraminiferal biostratigraphy: Historical review and current state-of-the-art.
- Berggren, W. A., Wade, B. S., & Pearson, P. N., 2018. Oligocene chronostratigraphy and planktonic foraminiferal biostratigraphy: Historical review and current state-of-the-art. In: Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T. & Berggren, W.A. (eds.). Atlas of Oligocene Planktonic Foraminifera, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 29–54.
- Bermúdez, P.J., 1961. Contribucion al estudio de las Globigerindea de la region Caribe-Antillana (Paleocene-Reciente): Boletino Geologia (Venezuela), Special Publicacion, v. 3 (Congres Geologia Venezolano, 3d, Caracas, 1959, Mem. 3): 1119–1393.
- Billups, K., Pälike, H., Channell, J.E.T., Zachos, J.C., & Shackleton, N.J., 2004. Astronomical calibration of the Late Oligocene through Early Miocene geomagnetic polarity time scale. Earth Planetary Science Letters, 224 (1–2), 33–44.
- Bijma, J., & Hemleben, C., 1994. Population dynamics of the planktonic foraminifer *Globigerinoides sacculifer* (Brady) from the central Red Sea. Deep-Sea Research, 41 (3), 485–510.
- Bijma, J., Faber, W.W., & Hemleben, C., 1990. Temperature and salinity limits for growth and survival of some planktonic foraminifers in laboratory cultures. Journal of foraminiferal research, 20, 95–116.
- Blow, W.H., 1959. Age, correlation and biostratigraphy of the upper Tocuyo (San Lorenzo) and Pozon Formations, eastern Falcon, Venezuela. Bulletins of American Paleontology, 39, 67–251.
- Blow, W.H., 1969. Late middle Eocene to Recent planktonic foraminiferal biostratigraphy. In: Bronniman, P., & Renz, H.H. (eds.). Proceedings of the First International Conference on Planktonic Microfossils, Geneva, 1967, 1, 199–422.
- Blow, W.H., 1979. The Cainozoic Globigerinida: Leiden: E.J. Brill, 1413 pp.
- Blow, W.H., & Banner, F.T., 1962. The Mid-Tertiary (Upper Eocene to Aquitanian) Globigerinaceae. Part 2. In: Eames, F.E., Banner, F.T., Blow, W.H., and Clarke, W.J., (eds.). Fundamentals of Mid-Tertiary Stratigraphical correlation, Cambridge University Press, Cambridge, England, 61-151.
- Bolli, H.M., 1954. Note on *Globigerina concinna* Reuss 1850 (Point-a-Pierre, Trinidad). Contributions from the Cushman Foundation for Foraminiferal Research, 5, 1–3.
- Bolli, H.M., 1957. Planktonic foraminifera from the Eocene Navet Formation and San Fernando Formations in Trinidad, B.W.I. In: Loeblich Jr., A.R., et al. (ed.), Studies in Foraminifera: Bulletin of the United States National Museum, 215, 155–172.
- Bolli, H.M., & Saunders, J.B., 1985. Oligocene to Holocene low latitude planktic foraminifera. In: Bolli, H.M., Saunders, J.B., Perch-Nielsen, K. (eds.). Plankton Stratigraphy, 1. Cambridge University Press, Cambridge, 155–262.
- Bolli, H.M., Loeblich, A.R., & Tappan, H., 1957, Planktonic Foraminiferal Families Hantkeninidae, Orbulinidae, Globorotaliidae and Globotruncanidae. United States National Museum Bulletin 215, 3–50.

- Bradshaw, J.S., 1959. Ecology of living planktonic foraminifera in the north and equatorial Pacific Ocean. Contributions from the Cushman Laboratory for Foraminiferal Research 10, 25–64
- Brenchley, P.J., & Harper, D.A.T., 1998. Palaeoecology: Ecosystems, Environments and Evolution. Routledge, Oxford. 402 pp.
- Brönnimann, P., 1951. *Globigerinita naparimaensis* n. gen., n. sp., from the Miocene of Trinidad, BWI Contributions from the Cushman Foundation for Foraminiferal Research, 2, 16–18.
- Brönnimann, P., & Todd, R., 1954. Appendix Descriptions of new species. In: Todd, R., Cloud, P.E., Low, D., Schmidt, R.G. (eds.). Probable occurrence of Oligocene on Saipan, American Journal of Science, 252, 673–682.
- Brown, S.J., & Elderfield, H., 1996. Variations in Mg/Ca and Sr/Ca ratios of planktonic foraminifera caused by postdepositional dissolution: Evidence of shallow Mg-dependent dissolution. Paleoceanography, 11, 543–551.
- Buzas, M.A., & Gibson, T. G., 1969. Species diversity: benthonic foraminifera in western North Atlantic. Science, 163(3862), 72–75.
- Cande, S.C., & Kent, D.V., 1995. Revised calibration of the geomagnetic polarity timescale for the Late Cretaceous and Cenozoic. Journal of Geophysical Research: Solid Earth, 100(B4), 6093–6095.
- Caron, M., & Homewood, P., 1983. Evolution of early planktic foraminifers. Marine Micropaleontology, 7(6), 453–462.
- Caron, D.A., Faber, W.W., & Bé, A.W.H., 1987. Effects of temperature and salinity on the growth and survival of the planktonic foraminifer *Globigerinoides sacculifer*. Journal of the marine biological association of the United Kingdom, 67(2), 323–341.
- Cahuzac, B., Turpin, L., & Bonhomme, P., 1997. Sr isotope record in the area of the lower Miocene historical stratotypes of the Aquitaine basin (France). In Developments in Palaeontology and Stratigraphy, Elsevier, 15, 33–56.
- Chaisson, W.P. & Leckie, R.M., 1993. High-resolution Neogene planktonic foraminifera biostratigraphy of Site 806, Ontong Java Plateau (western equatorial Pacific). In: Berger, W.H., Kroenke, L.W., Mayer, L.A., et al. (eds.). Proceedings of the Ocean Drilling Program, Scientific Results, Ocean Drilling Program, College Station, TX, 130, 137–178.
- Channell, J.E.T., Galeotti, S., Martin, E.E., Billups, K., Scher, H.D., & Stoner, J.S., 2003. Eocene to Miocene magnetostratigraphy, biostratigraphy and chemostratigraphy at ODP Site 1090 (sub-Antarctic South Atlantic). Geological Society American Bulletin 115, 607–623.
- Chapman, F., Parr, W.J., & Collins, A.C., 1934. Tertiary foraminifers of Victoria, Australia: the Balcombian deposits of Port Philip (Pt. III). Zoological Journal of the Linnean Society of London, 38, 553–577.
- Cifelli, R., 1982. Early occurrences and some phylogenetic implications of spiny, honeycomb textured planktonic foraminifera. Journal of Foraminiferal Research, 12, 105–115.
- Cifelli, R. & Scott, H.G., 1986. Stratigraphic record of the Neogene globorotalid radiation (Planktonic Foraminiferida). Smithsonian Contributions to Paleobiology. Smithsonian Institution Press, Washington D.C., 58, 101.
- Cita, M.B., 1973. Pliocene biostratigraphy and chronostratigraphy. In: Ryan, W.F.F., et al. (ed.), Initial Reports of the Deep Sea Drilling Project. Government Printing Office, Washington, D.C, 13, 1343–1379.

- Cita, M.B., & Premoli Silva, I., 1978. Planktonic foraminifers as ecologic indicators. Examples from the fossil record of the Mediterranean sea and of the Atlantic Ocean. *Bollettino di Zoologia*, 45, 115–131.
- Cita, M.B., Premoli Silva, I., & Rossi, R., 1965. Foraminiferi planctonici del Tortonian-tipo. *Rivista Italiana di Paleontologia e Stratigrafia*, 71, 217–309.
- Conan, S.H., & Brummer, G.J.A., 2000. Fluxes of planktic foraminifera in response to monsoonal upwelling on the Somalia Basin margin. *Deep Sea Research Part II: Topical Studies in Oceanography*, 47(9-11), 2207-2227.
- Conan, S.H., Ivanova, E.M., & Brummer, G. J., 2002. Quantifying carbonate dissolution and calibration of foraminiferal dissolution indices in the Somali Basin. *Marine Geology*, 182(3–4), 325–349.
- Coxall, H.K., Wilson, P.A., Pälike, H., Lear, C.H., & Backman, J., 2005. Rapid stepwise onset of Antarctic glaciation and deeper calcite compensation in the Pacific Ocean. *Nature*, 433 (7021), 53–57.
- Coxall, H.K., & Spezzaferri, S., 2018. Taxonomy, biostratigraphy, and, phylogeny of Oligocene *Catapsydrax*, *Globorotaloides* and *Protentelloides*. In Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T. & Berggren, W.A. (eds.). *Atlas of Oligocene Planktonic Foraminifera*, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 79–124.
- Cullen, J.L., & Prell, W.L., 1984. Planktic foraminifera of the northern Indian ocean: distribution and preservation in surface sediments. *Marine Micropaleontology*, 9(1), 1–52.
- Cullen, J.L., & Droxler, A.W., 1990. Late Quaternary variations in planktic foraminifer faunas and pteropod preservation in the equatorial Indian ocean. In: Duncan, R.A., Backman, J., Peterson, L.C. et al. (eds.). *Proceedings of the Ocean Drilling Program, Scientific Results*, 115, 579–588.
- Curry, W.B., & Crowley, T.J., 1987. The $\delta^{13}\text{C}$ of equatorial Atlantic surface waters: Implications for ice age pCO₂ levels. *Paleoceanography*, 2(5), 489–517.
- Curry, W.B., Shackleton, N.J., Richter, C., & Shipboard Scientific Party, 1995. *Proceedings of the Ocean Drilling Program, Initial Report*, 154, College Station, TX (Ocean Drilling Program).
- Cushman, J.A., 1927. Some new genera of the Foraminifera: Contributions of the Cushman Laboratory for Foraminiferal Research, 2, 77–81.
- Cushman, J.A. & Bermúdez, P.J., 1937. Further new species from the Eocene of Cuba. *Contributions from the Cushman Laboratory for Foraminiferal Research*, 13, 1–29.
- Cushman, J.A., & Jarvis, P.W., 1936. Three new Foraminifera from the Miocene Bowden Marl of Jamaica. *Contributions from the Cushman Laboratory for Foraminiferal Research*, 12, 3–5.
- Cushman, J.A., & Ponton, G.M., 1932. The foraminifera of the Upper, Middle and part of the Lower Miocene of Florida. *Bulletin of the Florida State Geological Survey*, 9, 1–147.
- Cushman, J.A., & Stainforth, R.M., 1945. The foraminifera of the Cipero marl formation of Trinidad, British West Indies. *Cushman Laboratory for Foraminiferal Research Special Publication*, 14, 1–75.
- d’Orbigny, A., 1826. Tableau méthodique de la classe des Céphalopodes. *Annales des Sciences Naturelles*, 7, 245–314.
- d’Orbigny, A., 1839. Foraminifères des Iles Canaries. In: Barker-Webb, P., & Berthelot, S., (eds.). *Histoire naturelle des Iles Canaries*, 2, 120–146.
- Di Stefano, A., Foresi, L.M., Lirer, F., Iaccarino, S.M., Turco, E., Amore, F.O., Mazzei, R., Morabito, S., Salvatorini, G., & Aziz, H.A., 2008. Calcareous plankton high resolution biomagnetostratigraphy for the Langhian of the Mediterranean area. *Rivista Italiana di Paleontologia e Stratigrafia*, 114(1), 51–76.

- Di Stefano, A., Foresi, L.M., Lirer, F., Barbagallo, V., Catania, G., Cacho Lascor, I., D'Andrea, N.M., Cornacchia, I., Sagnotti, L., Raffi, I., Turco, E., & Hilgen, F.J., 2024. A potential Mediterranean reference section for the GGSP of the Burdigalian Stage: St. Thomas section (Delimara Peninsula, Malta Island). Società Geologica Italiana ETS, Roma 2024 Congresso SGI-SIMP 2024.
- Egger, J.G., 1893. Foraminiferen aus Meeresgrundproben, gelothet von 1874 bis 1876 von S.M. Sch. Gazelle. Abhandlungen der Bayrischen Akademie der Wissenschaften, Mathematisch-Physikalische Classe, 18, 193–458.
- Ehrenberg, C.G., 1861. Elemente des tiefen Meeresgrundes in Mexikanischen Golfstrome bei Florida, in Über die Tiefgrund- Verhältnisse des Oceans am Eingange der Davisstrasse und bei Island. Monatsbericht der Koniglichen Preussischen Akademie der Wissenschaften zu Berlin, 275–315.
- Ellis, B.F., & Messina, A., 1949. Catalogue of Foraminifera (Supplements including 2009). Bulletin of the American Museum of Natural History.
- Erez, J., 1983. Calcification rates, photosynthesis and light in planktonic Foraminifera. In: Westbroek P., & de Jong E.W. (eds.). Biomineralization and biological metal accumulation. Reidel Publishing Company, Dordrecht, 307–312.
- Erez, J., & Luz, B., 1983. Experimental paleotemperature equation for planktonic Foraminifera. *Geochimica et Cosmochimica Acta*, 47(6), 1025–1031.
- Fabbrini, A., Baldassini, N., Caricchi, C., Di Stefano, A., Dinarès Turell, J., Foresi L., Lirer, F., Patricolo, S., Sagnotti, L. & Winkler, A., 2019a. Integrated quantitative calcareous plankton biomagnetostratigraphy of the Early Miocene from IODP Leg 342, Hole U1406A (Newfoundland Ridge, NW Atlantic Ocean). *Stratigraphy and Geological Correlation*, 27(2), 259–276.
- Fabbrini, A., Baldassini, N., Caricchi, C., Foresi, L.M., Sagnotti, L., Dinarès-Turell, J., Di Stefano, A., Lirer, F., Menichetti, M., Winkler, A., & Di Stefano, S., 2019b. In search of the Burdigalian GSSP: new evidence from the Contessa Section (Italy). *Italian Journal of Geosciences*, 138(2), 274–295.
- Fairbanks, R.G., & Wiebe, P.H., 1980. Foraminifera and chlorophyll maximum: vertical distribution, seasonal succession, and paleoceanographic significance. *Science*, 209(4464), 1524–1526.
- Field, D.B., 2004. Variability in vertical distributions of planktonic foraminifera in the California Current: Relationships to vertical ocean structure. *Paleoceanography*, 19(2).
- Finlay, H.J., 1947. New Zealand Foraminifera: Key species in stratigraphy - No. 5. *New Zealand Journal of Science and Technology*, 28, 259–292.
- Fleisher, R.L., 1974. Cenozoic planktonic foraminifera and biostratigraphy, Arabian Deep Sea Drilling Project, Leg 23A. In: Witmarsh, R. B., et al. (eds.). Initial Reports of the Deep Sea Drilling Project, U.S. Government Printing Office, Washington, D.C., 23, 1001–1072.
- Foresi, L.M., Iaccarino, S., Mazzei, R., Salvatorini, G., & Bambini, A.M., 2001. Il plancton calcareo (foraminiferi e nannofossili) del Miocene delle Isole Tremiti. *Palaeontographia italica*, 88, 1–62.
- Foresi, L.M., Bonomo, S., Caruso, A., Di Stefano, E., Salvatorini, G., & Sprovieri, R., 2002. Calcareous plankton high resolution biostratigraphy (foraminifera and nannofossils) of the uppermost Langhian–lower Serravallian Ras il-Pellegrin section (Malta). *Rivista Italiana di Paleontologia e Stratigrafia*, 108(2), 195–210.

- Foresi, L.M., Baldassini, N., Sagnotti, L., Lirer, F., Di Stefano, A., Caricchi, C., Verducci, M., Salvatorini, G. & Mazzei, R., 2014. Integrated stratigraphy of the St. Thomas section (Malta Island): a reference section for the lower Burdigalian of the Mediterranean Region. *Marine Micropaleontology*, 111, 66–89.
- Fraile, I., Schulz, M., Mulitza, S., Merkel, U., Prange, M., & Paul, A., 2009. Modeling the seasonal distribution of planktonic foraminifera during the Last Glacial Maximum. *Paleoceanography*, 24(2).
- Frerichs, W.E., Heiman, M.E., Borgman, L.E., & Bé, A.W.H., 1972. Latitudinal variations in planktonic foraminiferal test porosity, Part 1, Optical studies. *The Journal of Foraminiferal Research*, 2(1), 6–13.
- Fornaciari, E., & Rio, D., 1996. Latest Oligocene to early middle Miocene quantitative calcareous nannofossil biostratigraphy in the Mediterranean region. *Micropaleontology*, 42, 1–36.
- Foster, G.L., 2008. Seawater pH, pCO₂ and [CO₂⁻³] variations in the Caribbean Sea over the last 130 kyr: A boron isotope and B/Ca study of planktic foraminifera. *Earth and Planetary Science Letters*, 271(1-4), 254–266.
- Gennari, R., Persico, D., Turco, E., Villa, G., Iaccarino, S.M., Florindo, F., Lurcock P.C., & de Santana dos Anjos Zerfass, G., 2018. High-resolution integrated calcareous plankton biostratigraphy and magnetostratigraphy at the Oligocene–Miocene transition in Southwestern Atlantic Ocean. *Geological Journal*, 53(3), 1079–1101.
- Haq, B.U., Hardenbol, J., & Vail, P.R., 1987. Chronology of fluctuating sea levels since the Triassic. *Science*, 235, 1156–1167.
- Hammer, Ø., Harper, D.A.T., & Ryan, P.D., 2001. Past: paleontological statistics software package for education and data analysis. *Palaeontologia electronica*, 4, 1–9
- Harris, S. E., Mix, A. C. & King, T., 1997. Biogenic and terrigenous sedimentation at Ceara Rise, Western Tropical Atlantic supports Pliocene–Pleistocene deep-water linkage between hemispheres. In: *Proceedings of the Ocean Drilling Program, Scientific Results*, 154 (ed. N. J. Shackleton, W. B. Curry, C. Richter & T. J. Bralower), College Station, TX: Ocean Drilling Program, 331–345.
- Hedberg, H.D., 1937. Foraminifera of the Middle Tertiary Carapita Formation of northeastern Venezuela. *Journal of Paleontology*, 11, 681.
- Hedberg, H.D. (ed.), 1976. *International Stratigraphic Guide: A Guide to Stratigraphic Classification, Terminology and Procedure*. John Wiley and Sons, New York.
- Hemleben, C., Spindler, M., & Anderson, O.R., 1989. *Modern planktonic foraminifera*. Springer, Berlin.
- Hilgen, F., 2025. Revised astrochronology for the lower to middle Miocene of IODP site U1337. Implications for the Cenozoic megasplice (CENOGRID). *Paleogeography, Paleoclimatology, Paleoecology*, 662, 112748.
- Hilgen, F.J., Lourens, L.J., & Van Dam, J.A., 2012. The Neogene Period, Chapter 29. In: Gradstein, F.M., Ogg, J.G., Schmitz, M.D., Ogg, G.M. (eds.). *The Geologic Time Scale 2012*, volume 2. Elsevier, Amsterdam, 923–978.
- Hofker, J., 1956. Foraminifera Dentata; Foraminifera of Santa Cruz and Thatch-Island Virginia-Archipelago West-Indies. *Zoological Museum, Spolia (Skriter)*, Copenhagen, 234 pp.
- Hofker, J., 1976. La famille Turborotalitidae n. fam., *Revue de Micropaléontologie*, 19, 47-53.

- Holbourn, A., Kuhnt, W., Kochhann, K.G., Andersen, N., & Sebastian Meier, K.J., 2015. Global perturbation of the carbon cycle at the onset of the Miocene Climatic Optimum. *Geology*, 43(2), 123–126.
- Huber, B.T., Olsson, R.K., & Pearson, P.N., 2006. Taxonomy, biostratigraphy, and phylogeny of Eocene microperforate planktonic foraminifera (*Jenkinsina*, *Cassigerinelloita*, *Chiloguembelina*, *Streptochilus*, *Zeauvigerina*, *Tenuitella*, and *Cassigerinella*) and Problematica (*Dipsidripella*). In: Pearson, P. N., Olsson, R.K., Huber, B.T., Hemleben, C., & Berggren, W.A. (eds.). *Atlas of Eocene Planktonic Foraminifera*, Cushman Foundation Special Publication, 41, 461–508.
- Iaccarino, S., & Salvatorini, G., 1982. A framework of planktonic foraminiferal biostratigraphy for Early Miocene to Late Pliocene Mediterranean area. *Paleontologia Stratigrafica e Evoluzione*, 2, 115–125.
- Iaccarino, S., 1985. Mediterranean Miocene and Pliocene planktic foraminifera. In: Bolli, H.M., Saunders, J.B., & Perch-Nielsen, K., (eds.). *Plankton Stratigraphy*, Cambridge University Press, 283–314.
- Iaccarino, S., Borsetti, A.M., & Rögl, F., 1996. Planktonic foraminifera of the Neogene Lemme-Carrosio GSSP Section (Piedmont, Northern Italy). *Giornale di Geologia*, 58, 35–49.
- Iaccarino, S., Premoli Silva, I., Biolzi, M., Foresi, L. M., Lirer, F., & Petrizzo, M. R., 2005. Practical manual of Oligocene to Middle Miocene planktonic foraminifera. International School on Planktonic Foraminifera, IV Course: Oligocene to Middle Miocene Planktonic Foraminifera, Perugia (Italy) February 14–18, 2005.
- Iaccarino, S., Premoli Silva, I., Biolzi, M., Foresi, L. M., Lirer, F., Turco, E., & Petrizzo, M. R., 2007. Practical manual of Neogene planktonic foraminifera. International School on Planktonic Foraminifera, VI Course: Neogene, Perugia (Italy) February 19–23, 2007 (p. 180). Perugia: Università di Perugia Press.
- Ivanova, E.M., Conan, S.M. H., Peeters, F.J., & Troelstra, S.R., 1999. Living *Neoglobobulimina pachyderma* sin and its distribution in the sediments from Oman and Somalia upwelling areas. *Marine Micropaleontology*, 36(2-3), 91-107.
- Jenkins, D.G., 1960. Planktonic foraminifera from the Lakes Entrance oil shaft, Victoria, Australia. *Micropaleontology*, 6, 345–371.
- Jenkins, D.G., 1964. A new planktonic foraminiferal subspecies from the Australasian Lower Miocene. *Micropaleontology*, 10, 72.
- Jenkins, D.G., 1965. Planktonic foraminiferal zones and new taxa from Danian to Lower Miocene of New Zealand. *New Zealand Journal of Geology and Geophysics*, 8, 1088–1126.
- Jenkins, D.G., 1966. Planktonic foraminiferal zones and new taxa from the Danian to Lower Miocene of New Zealand. *New Zealand Journal of Geology and Geophysics*, 8, 1088–1126.
- Jenkins, D.G., 1967. Planktonic foraminiferal zones and new taxa from the lower Miocene to the Pleistocene of New Zealand. *New Zealand Journal of Geology and Geophysics* 10, 1064–1078.
- Jenkins, D.G., 1971. New Zealand Cenozoic planktonic foraminifera. *New Zealand Geological Survey Paleontological Bulletin*, 42, 1–278.
- Kaneps, A.G., 1975. Cenozoic planktonic foraminifera from Antarctic Deep Sea sediments, Leg 28, DSDP. In: Hays, D.E., et al. (eds.). *Initial Reports of the Deep Sea Drilling Project*. Government Printing Office, Washington, D.C., US, 28, 573–583.
- Kasbohm, J., Schoene, B., Montanari, A., & Coccioni, R., 2021. High-precision U-Pb zircon geochronology of the Miocene Bisciaro Formation, Contessa Section, Italy: A case study for

- requisite radioisotopic calibration of bio-and magnetostratigraphy. *Paleogeography, Paleoclimatology, Paleoecology*, 576, 110487.
- Keller, G., 1981. Origin and evolution of the genus *Globigerinoides* in the Early Miocene of the northwestern Pacific, DSDP Site 292. *Micropaleontology*, 6, 269–295.
- Kennett, J.P., & Srinivasan, M.S., 1983. Neogene Planktonic Foraminifera, A Phylogenetic Atlas. Hutchinson Ross, Stroudsburg, Pennsylvania, 265 pp.
- King, D.J., Wade, B.S., Liska, R.D., & Miller, C.G., 2020. A review of the importance of the Caribbean region in Oligo-Miocene low latitude planktonic foraminiferal biostratigraphy and the implications for modern biogeochronological schemes. *Earth-Science Reviews*, 202, 102968.
- King, D.J., Wade, B.S., & Miller, C.G., 2023. Biostratigraphic utility of coiling direction in Miocene planktonic foraminiferal genus *Paragloborotalia*. *Newsletters on Stratigraphy*, 56(3), 331–355.
- Koch, R., 1926. Mitteltertiäre Foraminiferen aus Bulongan, Ost-Borneo. *Eclogae Geologicae Helvetiae*, 19, 722–751.
- Koch, R., 1935. Namensänderung einiger Tertiär-Foraminiferen aus Neiderlandisch Ost-Indien. *Eclogae Geologicae Helvetiae*, 28, 558.
- Kochhann, K.G., Holbourn, A., Kuhnt, W., Channell, J.E., Lyle, M., Shackford, J.K., Wilkens, R.H., & Andersen, N., 2016. Eccentricity pacing of eastern equatorial Pacific carbonate dissolution cycles during the Miocene Climatic Optimum. *Paleoceanography*, 31(9), 1176–1192.
- Krasheninnikov, V.A., 1971. Cenozoic foraminifera. In: Fischer, A.G., et al. (ed.), Initial Reports of the Deep Sea Drilling Project VI, 1055–1068.
- Kroon, D., & Ganssen, G., 1989. Northern Indian Ocean upwelling cells and the stable isotope composition of living planktonic foraminifers. *Deep Sea Research Part A. Oceanographic Research Papers*, 36(8), 1219–1236.
- Kucera, M., Weinelt, M., Kiefer, T., Pflaumann, U., Hayes, A., Weinelt, M., Chen, M.-T., Mix, A. C., Barrows, T. T., Cortijo, E., Duprat, J., Juggins, S., & Waelbroeck, C., 2005. Reconstruction of sea-surface temperatures from assemblages of planktonic foraminifera: Multi-technique approach based on geographically constrained calibration datasets and its application to glacial Atlantic and Pacific Oceans. *Quaternary Science Reviews*, 24, 951–998.
- Kucera, M., 2007. Planktonic Foraminifera as tracers of past oceanic environments. In: Hillaire-Marce C., de Vernal A. (eds.). *Developments in marine geology*, Elsevier, 213–262.
- Laskar, J., Joutel, F. & Boudin, F., 1993. Orbital, precessional, and insolation quantities for the Earth from –20 Myr to +10 Myr. *Astronomy and Astrophysics (ISSN 0004-6361)*, 270, 522–533.
- Laskar, J., Robutel, P., Joutel, F., Gastineau, M., Correia, A., & Levrard, B., 2004. A long term numerical solution for the insolation quantities of the Earth. *Astronomy and Astrophysics*, 428, 261–285.
- Lazarus, D.B., 2005. A brief review of radiolarian research. *Paläontologische Zeitschrift* 79 (1), 183–200.
- Le, J., Thunell, R.C., 1996. Modelling planktic foraminiferal assemblage changes and application to sea surface temperature estimation in the western Equatorial Pacific Ocean. *Marine Micropaleontology*, 28, 211–229.
- Lazarus, D., Bittniok, B., Diester-Haass, L., Billups, K., Ogawa, Y., Takahashi, K., & Meyers, P., 2008. Radiolarian and sedimentologic paleoproductivity proxies in late Pleistocene sediments of the Benguela Upwelling System, ODP Site 1084. *Marine Micropaleontology*, 68(3-4), 223–235.
- Le, J., & Shackleton, N.J., 1992. Carbonate dissolution fluctuations in the western Equatorial Pacific during the late Quaternary. *Paleoceanography*, 7, 21–42.

- Lear, C.H., Rosenthal, Y., Coxall, H.K., & Wilson, P.A., 2004. Late Eocene to early Miocene ice sheet dynamics and the global carbon cycle. *Paleoceanography*, 19(4).
- Leckie, R.M., Farnham, C., & Schmidt, M.G., 1993. Oligocene planktonic foraminifer biostratigraphy of Hole 803D (Ontong Java Plateau) and Hole 628A (Little Bahama Bank), and comparison with the southern high latitudes. In: Berger, W.H., Kroenke, L.W., Mayer, L.A (eds.). *Proceedings of the Ocean Drilling Program: Scientific Results: Scientific Results*, 130, 113–127.
- Leckie, R.M., Wade, B.S., Pearson, P.N., Fraass, A.J., King, D.J., Olsson, R.K., Premoli Silva, I., Spezzaferri, S., & Berggren, W.A., 2018. Taxonomy, biostratigraphy, and phylogeny of Oligocene and early Miocene *Paragloborotalia* and *Parasubbotina*. In: Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T. & Berggren, W.A. (eds.). *Atlas of Oligocene Planktonic Foraminifera*, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 125–178.
- LeRoy, L.W., 1939. Some small foraminifera ostracoda and otoliths from the Neogene (Miocene) of the Rokan-Tapanoeli area, Central Sumatra, *Natuurkundig Tijdschrift voor Nederlandsch-Indië*, 99, 215–296.
- Li, Q., 1986. Ultrastructure, morphology, affinities and reclassification of *Cassigerinella* Pokorný (Foraminiferida: Globigerinina). *Journal of Micropaleontology*, 5, 49–64.
- Li, Q., 1987. Origin, phylogenetic development and systematic taxonomy of the *Tenuitella* plexus (Globigerinitidae, Globigerinina): *Journal of Foraminiferal Research*, 17, 295–300.
- Li, Q., Radford, S.S., & Banner, F.T., 1992. Distribution of microperforate tenuitellid planktonic foraminifers in holes 747A and 749B, Kerguelen Plateau. In: Wise Jr., S.W., Schlich, R., et al., (eds.). *Proceedings of the Ocean Drilling Program, Scientific Results*, 120, 569–594.
- Lirer, F., Foresi, L.M., Iaccarino, S.M., Salvatorini, G., Turco, E., Cosentino, C., Sierro, F.J., & Caruso, A., 2019. Mediterranean Neogene planktonic foraminifer biozonation and biochronology. *Earth-Science Reviews* 196, 102869.
- Lombard, F., Labeyrie, L., Michel, E., Bopp, L., Cortijo, E., Retailleau, S., Howa, H., & Jorissen, F., 2011. Modelling planktic foraminifer growth and distribution using an ecophysiological multi-species approach. *Biogeosciences*, 8(4), 853–873.
- Lourens, L.J., Hilgen, F.J., Laskar, J., Shackleton, N.J., & Wilson, D., 2004. The Neogene Period. In: Gradstein, F.M., Ogg, J.G., & Smith, A.G. (eds.). *A Geologic Time Scale 2004*. Cambridge: Cambridge University Press, 409–440.
- Lyle, M., Wilson, P. A., Janecek, T. R., et al. (2002). Site 1218. In *Proceedings of the Ocean Drilling Program, Initial Reports, Volume 199*. Ocean Drilling Program.
- MacLeod, N., 2005. Principles of stratigraphy. *Encyclopedia of Geology*. Academic Press, London, 295–307.
- McGowran, B., 2005. *Biostratigraphy: Microfossils and Geological Time*. Cambridge University Press, Cambridge, 459 pp.
- Miller, K.G., Wright, J.D., & Fairbanks, R.G., 1991. Unlocking the Ice House—Oligocene–Miocene oxygen isotopes, eustasy, and margin erosion. *Journal of Geophysical Research Sol. Earth & Planets*, 96 (B4), 6829–6848.
- Montanari, A., Deino, A., Coccioni, R., Langenheim, V.E., Capo, R., & Monechi, S., 1991. Geochronology, Sr isotope analysis, magnetostratigraphy, and plankton stratigraphy across the Oligocene-Miocene boundary in the Contessa section (Gubbio, Italy). *Newsletters Stratigraphy*, 23, 151–180.

- Morey, A.E., Mix, A.C., & Pisias, N.G., 2005. Planktonic foraminiferal assemblages preserved in surface sediments correspond to multiple environmental variables. *Quaternary Science Reviews*, 24, 925–950.
- Mosna, S., & Vercesi, P.L., 1975. *Globigerinoides italicus* nuova specie del Pliocene inferiore ligure: Atti dell' Istituto geologico dell'Universita di Pavia, Pavia, 25, 14–15.
- Naidu, P.D., Babu, C.P., & Rao, C.M., 1992. The upwelling record in the sediments of the western continental margin of India. *Deep Sea Research Part A. Oceanographic Research Papers*, 39, 715–723.
- Olsson, R.K., Hemleben, C., Coxall, H.K., & Wade, B.S., 2018. Taxonomy, biostratigraphy, and phylogeny of Oligocene *Ciperoella* n. gen. In: Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T. & Berggren, W.A. (eds.). *Atlas of Oligocene Planktonic Foraminifera*, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 215–230.
- Ortiz, J.D., Mix, A.C., Collier, R.W., 1995. Environmental control of living symbiotic and asymbiotic Foraminifera of the California Current. *Paleoceanography*, 10:987–1009.
- Pälike, H., Laskar, J., & Shackleton, N.J., 2004. Geologic constraints on the chaotic diffusion of the solar system. *Geology*, 32 (11), 929–932.
- Pälike, H., Frazier, J., & Zachos, J. C., 2006a. Extended orbitally forced palaeoclimatic records from the equatorial Atlantic Ceara Rise. *Quaternary Science Reviews*, 25(23–24), 3138–3149.
- Pälike, H., Norris, R.D., Herrle, J.O., Wilson, P.A., Coxall, H.K., Lear, C.H., Shackleton, N.J. Tripathi, A.K., & Wade, B.S., 2006b. The heartbeat of the Oligocene climate system. *Science*, 314 (5807), 1894–1898.
- Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., & the Expedition 320/321 scientists, 2010a. Expedition 320/321 summary. In: *Proceedings of the IODP, 320/321. Integrated Ocean Drilling Program*.
- Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., & the Expedition 320/321 scientists, 2010b. Site U1336. In: *Proceedings of the IODP, 320/321. Integrated Ocean Drilling Program*.
- Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., & the Expedition 320/321 Scientists, 2010c. Site U1337. In: *Proceedings of the IODP, 320/321. Integrated Ocean Drilling Program*.
- Pälike, H., Lyle, M., Nishi, H., Raffi, I., Gamage, K., Klaus, A., & the Expedition 320/321 Scientists, 2010d. Site U1338. In: *Proceedings of the IODP, 320/321. Integrated Ocean Drilling Program*.
- Parker, F.L., & Berger, W.H., 1971. Faunal and solution patterns of planktic foraminifera in surface sediments of the South Pacific. *Deep-Sea Res.* 18, 73–107.
- Patterson, R. T., Fowler, A. D., & Huber, B. T., 2004. Evidence of hierarchical organization in the planktic foraminiferal evolutionary record. *Journal of Foraminiferal Research*, 34(2), 85–95.
- Paul, H.A., Zachos, J.C., Flower, B.P., & Tripathi, A., 2000. Orbitally induced climate and geochemical variability across the Oligocene/Miocene boundary. *Paleoceanography* 15 (5), 471–485.
- Pearson, P.N., 1995. Planktonic foraminifer biostratigraphy and the development of pelagic caps on guyots in the Marshall Islands Group. In: Haggerty, J., Premoli Silva, I., Rack, F., & McNutt, M.K. (eds.). *Proceedings of the Ocean Drilling Program, Scientific Results*, 144, 21–59.
- Pearson, P.N., 1998. Evolutionary concepts in biostratigraphy. In: Doyle, P., Bennett, M.R. (eds.). *Unlocking the Stratigraphical Record*. John Wiley & Sons, New York, 123–144.
- Pearson, P.N., & Shackleton, N.J., 1995. Neogene multispecies planktonic foraminifer stable isotope record, Site 871, Limalok Guyot. *Proceedings of the Ocean Drilling Program, Scientific Results Ocean Drilling Program, College Station, TX*, 401–410.

- Pearson, P.N., & Chaisson, W.P., 1997. Late Paleocene to middle Miocene planktonic foraminifer biostratigraphy of the Ceara Rise. In: Shackleton, N. J., Curry, W. B., Richter, C., & Bralower, T. J. (eds.). Proceedings of the Ocean Drilling Program, Scientific Results, 154, 33–66.
- Pearson, P.N., & Wade, B.S., 2009. Taxonomy and stable isotope paleoecology of well-preserved planktonic foraminifera from the uppermost Oligocene of Trinidad. *Journal of Foraminiferal Research*, 39, 191–217.
- Pearson, P.N., Shackleton, N.J., Weedon, G.P. & Hall, M.A., 1997. Multispecies planktonic foraminifer stable isotope stratigraphy through Oligocene/Miocene boundary climatic cycles, Site 926. 154, 441–450. Proceedings of the Ocean Drilling Program, Scientific Results, 154, 441–450.
- Pearson, P.N., Spezzaferri, S., Huber, B.T., & Kucera, M., 2018a. Taxonomy, biostratigraphy, and phylogeny of Oligocene *Cassigerinella*. In: Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T. & Berggren, W.A. (eds.). Atlas of Oligocene Planktonic Foraminifera, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 481–494.
- Pearson, P.N., Wade, B.S., & Huber, B.T., 2018b. Taxonomy, biostratigraphy, and phylogeny of Oligocene Globigerinitidae (*Dipsidripella*, *Globigerinita*, and *Tenuitella*). In: Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T. & Berggren, W.A. (eds.). Atlas of Oligocene Planktonic Foraminifera, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 429–458.
- Pekar, S.F., & DeConto, R.M., 2006. High-resolution ice-volume estimates for the early Miocene: Evidence for a dynamic ice sheet in Antarctica. *Palaeogeography, Palaeoclimatology, Palaeoecology*, 231(1-2), 101–109.
- Peterson, L.C., Prell, W.L., 1985. Carbonate dissolution in recent sediments of the eastern equatorial Indian Ocean: preservation patterns and carbonate loss above the lysocline. *Marine Geology*, 64(3-4), 259–290.
- Petrizzo, M.R., King, D.J., Pearson, P.N., Huber, B.T., & Wade, B.S., 2024. Planktonic foraminifera in biostratigraphy and biochronology. *Newsletters on Stratigraphy*.
- Phleger, F.B., 1960. Ecology and distribution of recent Foraminifera. The Johns Hopkins Press, Baltimore.
- Pielou, E.C., 1975. Ecological models on an environmental gradient. *Applied Statistics* (Gupta, RP, ed.), 261–269.
- Poignant, A., Pujol, C., Ringeade, M., & Londeix, L., 1995. The Burdigalian historical stratotype. In: MONTANARI, A., ODIN, G.S. & COCCIONI, R. (eds.). Miocene Stratigraphy. Developments in Palaeontology and Stratigraphy, Elsevier, Amsterdam, 15, 17–24.
- Pokorný, V., 1955. *Cassigerinella boudecensis* n. gen., n. sp. (Foraminifera, Protozoa) z Oligocénu ždánického flyše. *Ústředního Sstavu Gelogického, Věstník*, 30, 136–140.
- Poole, C. R., & Wade, B. S., 2019. Systematic taxonomy of the *Trilobatus sacculifer* plexus and descendant *Globigerinoidesella fistulosa* (planktonic foraminifera). *Journal of Systematic Palaeontology*, 17(23), 1989–2030.
- Poore, R.Z., & Berggren, W.A., 1975. Late Cenozoic planktonic foraminiferal biostratigraphy and paleoclimatology of Hatton-Rockall Basin, DSDP Site 116. *Journal of Foraminiferal Research* 5, 270–293.
- Pujol, C., 1983. Cenozoic planktonic foraminiferal biostratigraphy of the southwestern Atlantic (Rio Grande Rise). In: Barker, P.F., Carlson, R.L., Johnson, D.A., et al., (eds.). Initial Reports of the Deep Sea Drilling Project, 72, 623–673.

- Raffi, I., Backman, J., Fornaciari, E., Pälike, H., Rio, D., Lourens, L., & Hilgen, F., 2006. A review of calcareous nannofossil astrobiochronology encompassing the past 25 million years. *Quaternary Science Reviews*, 25(23-24), 3113–3137.
- Raffi, I., Wade, B. S., Pälike, H., Beu, A. G., Cooper, R., Crundwell, M. P., Krijgsman, W., Moore, T., Raine, J. I., Sardella, R., & Vernyhorova, Y. V., 2020. The Neogene Period. In *Geologic Time Scale 2020*. Elsevier, 1141–1215.
- Rebotim, A., Voelker, A.H.L., Jonkers, L., Waniek, J.J., Meggers, H., Schiebel, R., Fraile, I., Schulz, M., & Kucera, M., 2017. Factors controlling the depth habitat of planktonic foraminifera in the subtropical eastern North Atlantic. *Biogeosciences*, 14(4), 827–859.
- Reuss, A.E., 1850. Die fossilen Entomostraceen des österreichischen Tertiärbeckens. *Naturwissenschaftliche Abhandlungen*, 3, 281–315.
- Rögl, F., 1996. *Paragloborotalia kugleri* (Bolli): An index fossil for the Paleogene/Neogene boundary. *Giornale di Geologia*, 58, 151–155.
- Ruddiman, W.F., & Heezen, B.C., 1967. Differential solution of planktic foraminifera. *Deep-Sea Research*, 14, 801–808.
- Rutherford, S., D'Hondt, S., & Prell, W., 1999. Environmental controls on the geographic distribution of zooplankton diversity. *Nature*, 400(6746), 749–753.
- Salvatorini, 1966. Alcuni nuova specie di foraminiferi del Miocene superiori della Toscana Marittima. *Atti della Societa Toscana di Scienze Naturali Residente in Pisa Memorie Serie A*, 73.
- Sanvoisin, R., d'Onofrio, S., Lucchi, R., Violanti, D., & Castradori, D., 1993. 1 Ma paleoclimatic record from the eastern Mediterranean-Marflux Project: first results of a micropaleontological and sedimentological investigation of a long piston core from the Calabrian Ridge. *Alpine and Mediterranean Quaternary*, 6(2), 169–188.
- Sen Gupta, B. K. (ed.). (1999). *Modern Foraminifera*. Kluwer Academic Publishers.
- Shackleton, N.J., & Hall, M.A., 1997. The late Miocene stable isotope record, Site 926. In: Shackleton, N.J., Curry, W.B., Richter, C., & Bralower, T.J. (eds.). *Proceedings of the Ocean Drilling Program, Scientific Results*, 154, 367–373.
- Shackleton, N. J. & Crowhurst, S., 1997 Sediment fluxes based on an orbitally tuned time scale 5 Ma to 14 Ma, Site 926. In: *Proceedings of the Ocean Drilling Program, Scientific Results*, 154 (ed. N. J. Shackleton, W. B. Curry, C. Richter & T. J. Bralower), College Station, TX: Ocean Drilling Program, 69–82.
- Shackleton, N. J., Crowhurst, S. J., Weedon, G. P., & Laskar, J., 1999. Astronomical calibration of Oligocene-Miocene time. *Philosophical Transactions of the Royal Society*, 357, 1907–1929.
- Shackleton, N.J., Hall, M.A., Raffi, I., Tauxe, L., & Zachos, J., 2000. Astronomical calibration age for the Oligocene/Miocene boundary, 28 (5), 447–450.
- Schiebel, R., 2002. Planktic foraminiferal sedimentation and the marine calcite budget. *Global Biogeochemical Cycles*, 16, 1065.
- Schiebel, R., & Hemleben, C., 2005. Modern planktic Foraminifera. *Paläontologische Zeitschrift*, 79, 135–148.
- Schiebel, R., & Hemleben, C., 2017. *Planktic foraminifers in the modern ocean*. Berlin: Springer, 358.
- Schiebel, R., Hiller, B., & Hemleben, C., 1995. Impacts of storms on recent planktic foraminiferal test production and CaCO₃ flux in the North Atlantic at 47° N, 20° W (JGOFS). *Marine Micropaleontology*, 26(1-4), 115–129.

- Schiebel, R., Bijma, J., & Hemleben, C., 1997. Population dynamics of the planktic foraminifer *Globigerina bulloides* from the eastern North Atlantic. *Deep Sea Research Part I: Oceanographic Research Papers*, 44(9-10), 1701-1713.
- Schiebel, R., Waniek, J., Bork, M., & Hemleben, C., 2001. Planktic foraminiferal production stimulated by chlorophyll redistribution and entrainment of nutrients. *Deep Sea Research Part I: Oceanographic Research Papers*, 48(3), 721-740.
- Schiebel, R., Zeltner, A., Treppke, U.F., Waniek, J. J., Bollmann, J., Rixen, T., & Hemleben, C., 2004. Distribution of diatoms, coccolithophores and planktic foraminifers along a trophic gradient during SW monsoon in the Arabian Sea. *Marine Micropaleontology*, 51(3-4), 345-371.
- Shipboard Scientific Party, 1983. 5. Site 516: Rio Grande Rise. In: Barker, P.F., Carlson, R.L., Johnson, D.A., et al. (eds.). *Initial Reports of the Deep Sea Drilling Project, Volume 72*. United States Government Printing Office, Washington, 155–338.
- Schmidt, D. N., Renaud, S., Bollmann, J., Schiebel, R., & Thierstein, H. R., 2004a. Size distribution of Holocene planktic foraminifer assemblages: biogeography, ecology and adaptation. *Marine Micropaleontology*, 50(3-4), 319-338.
- Schmidt, D. N., Thierstein, H. R., Bollmann, J., & Schiebel, R., 2004b. Abiotic forcing of plankton evolution in the Cenozoic. *Science*, 303(5655), 207-210.
- Simpson, E., 1949. Measurement of diversity. *Nature*, 163, 688.
- Spellerberg, I.F., & Fedor, P.J., 2003. A tribute to Claude Shannon (1916–2001) and a plea for more rigorous use of species richness, species diversity and the ‘Shannon–Wiener’ Index. *Global ecology and biogeography*, 12(3), 177–179.
- Spezzaferri, S., 1994. Planktonic foraminiferal biostratigraphy and taxonomy of the Oligocene and lower Miocene in the oceanic record. An overview: *Palaeontographia Italica*, 81, 187.
- Spezzaferri, S., 1996. The Oligocene/Miocene boundary in the Lemme Section (Piedmont Basin, Northern Italy): paleoclimatic evidence based on planktonic foraminifera: *Giornale di Geologia*, 58, 119–139.
- Spezzaferri, S., 1998. Planktonic foraminifer biostratigraphy and paleoenvironmental implications of Leg 152 Sites (East Greenland Margin). In: *Proceedings of the Ocean Drilling Program, Scientific Results*, 152, 161–190.
- Spezzaferri, S., Kucera, M., Pearson, P.N., Wade, B.S., Rappo, S., Poole, C.R., Morard, R., & Stalder, C., 2015. Fossil and genetic evidence for the polyphyletic nature of the planktonic foraminifera "Globigerinoides", and description of the new genus *Trilobatus*. *PloS one*, 10(5), e0128108.
- Spezzaferri, S., Constandache, M., & Olsson, R. K., 2018a. Taxonomy, biostratigraphy, and phylogeny of Oligocene to lower Miocene *Globigerinoides* and *Trilobatus*. In: Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T. & Berggren, W.A. (eds.). *Atlas of Oligocene Planktonic Foraminifera*, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 269–306.
- Spezzaferri, S., Coxall, H. K., Olsson, R. K., Hemleben, C., & Constandache, M., 2018b. Taxonomy, biostratigraphy, and phylogeny of Oligocene *Globigerina*, *Globigerinella*, and *Quiltyella* N. Gen. In: Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T. & Berggren, W.A. (eds.). *Atlas of Oligocene Planktonic Foraminifera*, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 179–214.
- Spezzaferri, S., Olsson, R. K., Hemleben, C., Wade, B. S., & Coxall, H. K., 2018c. Taxonomy, biostratigraphy, and phylogeny of Oligocene and lower Miocene *Globoturbotalita*. In: Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T. & Berggren, W.A. (eds.). *Atlas of Oligocene*

- Planktonic Foraminifera, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 231–258.
- Spindler, M., Hemleben, C., Salomons, J.B., & Smit, L.P., 1984. Feeding behavior of some planktonic foraminifers in laboratory cultures. *Journal of Foraminiferal Research*, 14, 237–249.
- Steininger, F.F., Aubry, M.P., Berggren, W.A., Beard, J.H., & Jeffords, R.M., 1997. The Global Stratotype Section and Point (GSSP) for the base of the Neogene. *Episodes*, 20, 23–28.
- Stewart, J.A., Wilson, P.A., Edgar, K.M., Anand, P., & James, R.H., 2012. Geochemical assessment of the palaeoecology, ontogeny, morphotypic variability and palaeoceanographic utility of “*Dentoglobigerina*” *venezuelana*. *Marine Micropaleontology*, 84, 74–86.
- Stott, L.D., & Kennett, J.P., 1990. Antarctic Paleogene planktonic foraminifer biostratigraphy: ODP Leg 113, Sites 689 and 690. In: Barker, P.F., Kennett, J.P., et al. (eds.). *Proceedings of the Ocean Drilling Program 113: Ocean Drilling Program*. College Station, Texas, 549–569.
- Thiede, J., 1975. Distribution of foraminifera in surface waters of a coastal upwelling area. *Nature*, 253(5494), 712–714.
- Thunell, R.C., 1976. Optimum index of calcium carbonate dissolution in deep-sea sediments. *Geology* 4, 525–528.
- Thunell, R.C., & Honjo, S., 1981. Calcite dissolution and the modification of planktic foraminiferal assemblages. *Marine Micropaleontology*, 6, 169–182.
- Tolderlund, D.S., & Bé, A.W.H., 1971. Seasonal distribution of planktonic Foraminifera in the western North Atlantic. *Micropaleontology* 17, 297–329.
- Tripathi, A., Elderfield, H., Booth, L., Zachos, J., & Ferretti, P., 2006. Data report: high-resolution benthic foraminiferal stable isotope stratigraphy across the Oligocene/Miocene boundary at Site 1218. In Wilson, P.A., Lyle, M., and Firth, J.V. (eds.). *Proc. ODP, Sci. Results*, 199: College Station, TX (Ocean Drilling Program), 1–13.
- Tripathi, A.K., Roberts, C.D., & Eagle, R.A., 2009. Coupling of CO₂ and ice sheet stability over major climate transitions of the last 20 million years. *Science*, 326(5958), 1394–1397.
- Vincent, E., & Berger, W.H., 1981. Planktonic foraminifera and their use in paleoceanography. *The sea*, 7, 1025–1119.
- Wade, B. S., Berggren, W. A., & Olsson, R. K., 2007. The biostratigraphy and paleobiology of Oligocene planktonic foraminifera from the equatorial Pacific Ocean (ODP Site 1218). *Marine Micropaleontology*, 62(3), 167–179.
- Wade, B. S., Pearson, P. N., Berggren, W. A., & Pälike, H., 2011. Review and revision of Cenozoic tropical planktonic foraminiferal biostratigraphy and calibration to the geomagnetic polarity and astronomical time scale. *Earth-Science Reviews*, 104, 111–142.
- Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T., & Berggren, W.A., 2018a. Atlas of Oligocene planktonic foraminifera. Cushman Foundation for Foraminiferal Research, Special Publication, 46.
- Wade, B.S., Pearson, P.N., Olsson, R.K., Fraass, A.J., Leckie, R.M., & Hemleben, C., 2018b. Taxonomy, biostratigraphy, and phylogeny of Oligocene and lower Miocene *Dentoglobigerina* and *Globoquadrina*. In: Wade, B.S., Olsson, R.K., Pearson, P.N., Huber, B.T., & Berggren, W.A. (eds.). *Atlas of Oligocene Planktonic Foraminifera*, Cushman Foundation of Foraminiferal Research, Special Publication, 46, 331–384.
- Weedon, G.P., 2003. *Time-Series Analysis and Cyclostratigraphy*. Cambridge University Press, Cambridge.

- Weedon, G.P., Shackleton, N.J. & Pearson, P.N. 1997 The Oligocene time scale and cyclostratigraphy on the Ceara Rise, Western Equatorial Atlantic. In: Proc. ODP, Sci. Results (ed. N. J. Shackleton, W. B. Curry, C. Richter & T. J. Bralower). College Station, TX: Ocean Drilling Program, 154, 101–114.
- Weiner, A., Aurahs, R., Kurasawa, A., Kitazato, H., & Kucera, M., 2012. Vertical niche partitioning between cryptic sibling species of a cosmopolitan marine planktonic protist. *Molecular Ecology*, 21(16), 4063–4073.
- Weinheimer, A., 2001. Radiolarians from the Northern Cape Basin, Site 1082. In: Wefer, G., Berger, W.H., Richter, C. (eds.). *Proceedings of the Ocean Drilling Program, Science Results*, 175. Ocean Drilling Program, College Station, TX, 1–16.
- Wright, J.D., & Miller, K.G., 1992, Miocene stable isotope stratigraphy, Site 747, Kerguelen Plateau. In: Wise Jr., S.W., Schlich, R., et al., (eds.). *Proceedings of the Ocean Drilling Program, Scientific Results*, 120, 855–866.
- Yu, J., Elderfield, H., & Hönisch, B., 2007. B/Ca in planktonic foraminifera as a proxy for surface seawater pH. *Paleoceanography*, 22(2).
- Yu, J., Thornalley, D.J., Rae, J.W., & McCave, N.I., 2013. Calibration and application of B/Ca, Cd/Ca, and $\delta^{11}\text{B}$ in *Neogloboquadrina pachyderma* (sinistral) to constrain CO₂ uptake in the subpolar North Atlantic during the last deglaciation. *Paleoceanography*, 28(2), 237–252.
- Zachariasse, W.J., & Sudijono, 2012. New data on the morphology and classification of the Oligocene – Miocene planktonic foraminifer *Paragloborotalia siakensis*. *Journal of Foraminiferal Research*, 42(2), 156–168.
- Zachos, J.C., Shackleton, N.J., Revenaugh, J.S., Pälike, H., & Flower, B.P., 2001. Climate response to orbital forcing across the Oligocene–Miocene boundary, *Science* 292 (5515), 274–278.
- Zachos, J.C., Kroon, D., Blum, P., et al., 2004, *Proceedings of the Ocean Drilling Program, Initial Reports*, 208.
- Zachos, J.C., Dickens, G.R., Zeebe, R.E., 2008. An early Cenozoic perspective on greenhouse warming and carbon-cycle dynamics. *Nature*, 451, 279–283.

Appendix 1 - Taxonomic notes

All the taxonomic categories recognized in the planktonic foraminiferal assemblages of Site 926 are alphabetically listed by genus. For each species the taxonomic references, used for classification, are indicated and some observations are added.

Genus ***Cassigerinella*** Pokorný, 1955, emended Li, 1986

TYPE SPECIES — *Cassigerinella boudecensis* Pokorný, 1955 (= junior subjective synonym of *Cassigerinella chipolensis* Cushman & Ponton, 1932)

Cassigerinella chipolensis (Cushman & Ponton, 1932)

Cassidulina chipolensis Cushman & Ponton, 1932: p. 98, pl. 15, figs. 2a-c.

Cassidulina chipolensis - Kennett & Srinivasan, 1983: p. 19, pl. 1, figs. 1,3-5.

Cassigerinella chipolensis - Spezzaferri, 1994: p. 155, pl. 29, figs. 5a-c.

Cassigerinella chipolensis - Pearson et al., 2018a: p. 484, pl. 18.1, figs. 1-16.

Observations: it is very rare and present from core 926B/37X to the top of the studied interval.

Cassigerinella sp.

Observations: specimens like *Cassigerinella globulosa* Egger, 1857 but with a few chambers (juvenile forms) occur sporadically in cores 926B/38X and 926C/37X.

Genus ***Catapsydrax*** Bolli, Loeblich, & Tappan, 1957

TYPE SPECIES — *Globigerina dissimilis* Cushman & Bermúdez, 1937.

Catapsydrax dissimilis (Cushman & Bermúdez, 1937)

Globigerina dissimilis Cushman & Bermúdez, 1937: p. 25, pl.3, figs. 4-6.

Catapsydrax dissimilis - Kennett & Srinivasan, 1983: p. 23, pl. 2, figs. 1, 3-8.

Catapsydrax dissimilis dissimilis - Spezzaferri, 1994: p. 163, pl. 33, figs. 1a-c.

Catapsydrax dissimilis - Coxall & Spezzaferri, 2018: p. 84, pl. 4.1, figs. 1-16.

Observations: *C. dissimilis* is characterized by the primary aperture covered by a slightly inflated or flattened bulla, with 2 or more (up to 4) rimmed infralaminar openings (Coxall & Spezzaferri, 2018). It is discontinuously present throughout the studied interval.

Catapsydrax unicavus Bolli, Loeblich, & Tappan, 1957

Catapsydrax unicavus Bolli, Loeblich, & Tappan 1957: p. 37, pl. 7: fig. 9a-c.

Catapsydrax unicavus - Kennett & Srinivasan, 1983: p. 27, pl. 3, figs. 1-3.

Catapsydrax unicavus - Spezzaferri, 1994: p. 163, pl. 33, figs. 5a-c.

Catapsydrax unicavus - Coxall & Spezzaferri, 2018: p. 90, pl. 4.3, figs. 1-16.

Observations: *C. unicavus* is distinguished from *C. dissimilis* by having a more compact test and a single infralaminar aperture always located at the umbilical end of the bulla (Coxall & Spezzaferri, 2018).

It is continuously present throughout the studied interval and is more abundant than *C. dissimilis*.

Genus ***Ciperoella*** Olsson & Hemleben, 2018
TYPE SPECIES — *Globigerina ciperoensis* Bolli, 1954.

Ciperoella anguliofficialis (Blow, 1969)

Globigerina anguliofficialis Blow, 1969: p. 379, pl. 11, figs. 1, 2, holotype, figs. 3-5 paratype.

"*Globigerina*" *anguliofficialis* - Spezzaferri, 1994: p. 103, pl. 3, figs. 4a-c.

Ciperoella anguliofficialis - Olsson et al., 2018: p. 219, pl. 7.1. figs. 1-18.

Observations: It occurs abundantly throughout the studied interval.

Ciperoella fariasi (Bermúdez, 1961)

Globigerina fariasi Bermúdez, 1961: p. 1181, pl. 3, figs. 5a-c.

"*Globigerina*" *ciperoensis fariasi* - Spezzaferri, 1994: p. 103, pl. 3, figs. 5a-c.

Ciperoella fariasi - Olsson et al., 2018: p. 225, pl. 7.4. figs. 1-18.

Observations: It occurs continuously from the base of the studied interval until ~434 mcd of depth (close to the *Helicosphaera euphratis*/ *H. carteri* crossover), then discontinuously occurs up to core 926B/40X (401.92 mcd, Zone M2). Its stratigraphic range is uncertain in literature because Spezzaferri (1994) recorded it from Zone O3 to M1 (?), and Pearson & Chaisson (1997) identified this species from Zone O3 at Ceara Rise, equatorial Atlantic Ocean.

Genus ***Dentoglobigerina*** Blow, 1979

TYPE SPECIES — *Globigerina galavisi* Bermúdez, 1961.

Dentoglobigerina altispira group

Dentoglobigerina altispira (Cushman and Jarvis, 1936)

Globigerina altispira Cushman and Jarvis, 1936: p. 5, pl. 1, fig. 13a-c.

Dentoglobigerina altispira altispira - Kennett & Srinivasan, 1983: p. 187, pl. 46, figs. 4-6.

Dentoglobigerina altispira altispira - Spezzaferri, 1994: p. 177, pl. 40, figs. 5a-c.

Dentoglobigerina globosa (Bolli, 1957)

Globoquadrina altispira globosa Bolli, 1957: p. 111, pl. 24, figs. 9a-10c.

Dentoglobigerina altispira globosa - Kennett & Srinivasan, 1983: p. 181, pl. 44, fig. 4; p. 187, pl. 46, figs. 7-9.

Dentoglobigerina altispira globosa - Spezzaferri, 1994: p. 177, pl. 40, figs. 3a-c.

Dentoglobigerina globosa - Wade et al., 2018b: p. 349, pl. 11.6, figs. 1-16.

Observations: *D. altispira* differs from its ancestor *D. globosa* by having a distinctly high trochospire and laterally compressed and umbilically prolonged fewer chambers in the final whorl (Wade et al., 2018b). As reported by Wade et al. (2018b) *D. altispira* first appeared in Lower Miocene Subzone M1b evolving from *D. globosa*. In the studied interval, first occurrences of this species are recorded scattered from the base of core 926B/40X (Zone M2).

Specimens of *D. altispira* and *D. globosa* were counted together due to morphological gradation between the two species. Specimens of *D. globosa* not showing clear teeth could be confused with *Ciperoella fariasi*.

Dentoglobigerina baroemoenensis group

Globigerina baroemoenensis (LeRoy, 1939)

Globigerina baroemoenensis LeRoy, 1939: p. 263, pl. 6, figs. 1, 2.

Globoquadrina baroemoenensis - Kennett & Srinivasan, 1983: p. 187, pl. 46, figs. 1-3.

Dentoglobigerina baroemoenensis - Spezzaferri, 1994: p. 177, pl. 40, figs. 1 a-c.

Dentoglobigerina baroemoenensis - Wade et al., 2018b: p. 336, pl. 11.1, figs. 1-16.

Dentoglobigerina larmeui (Akers, 1955)

Globoquadrina larmeui Akers, 1955: p. 661, pl. 65, figs. 4a-c.

Dentoglobigerina larmeui - Spezzaferri, 1994: p. 179, pl. 41, figs. 3a-c.

Dentoglobigerina larmeui - Wade et al., 2018b: p. 354, pl. 11.8, figs. 1-16.

Observations: As reported by Wade et al. (2018b), *D. baroemoenensis* is distinguished from *D. larmeui* by its more angular, disjunct and slightly reniform chambers and more trapezoidal outline, and by the broad, deep umbilicus. Specimens of these species were counted together to keep the classification consistent.

Dentoglobigerina binaiensis (Koch, 1935)

Globigerina binaiensis Koch, 1935: p. 558, nomen novum for *G. aspera* Koch, 1926.

Globoquadrina binaiensis - Kennett & Srinivasan, 1983: p. 181, pl. 44, figs. 1, 3; p. 183, pl. 45, figs. 1-3.

Globoquadrina binaiensis - Spezzaferri, 1994: p. 181, pl. 42, figs. 3a-c; 4a-c.

Dentoglobigerina binaiensis - Wade et al., 2018b: p. 339 pl. 11.2, figs. 1-16; p. 341 pl. 11.3, figs. 1-16.

Observations: it is very rare and scattered along the studied interval.

Dentoglobigerina globularis (Bermúdez, 1961)

Globoquadrina globularis Bermúdez, 1961: p. 1311, pl. 13, figs. 4-6.

Dentoglobigerina globularis - Spezzaferri, 1994: p. 177, pl. 40, figs. 2a-c.

Dentoglobigerina globularis - Wade et al., 2018b: p. 351, pl. 11.7, figs. 1-16.

Observations: *D. globularis* differs from *D. globosa* by having less chambers (3½-4 and 5-6, respectively) in the final whorl leading to a less lobulate outline (Wade et al., 2018b). It is discontinuous in the lower and higher parts of the studied interval, but more continuous and abundant between 425 and 370 mcd (from core 926B/43X to core 926B/37X).

Dentoglobigerina tripartita (Koch, 1926)

Globigerina bulloides var. *tripartita* Koch, 1926: p. 742, figs. 21 a, b.

Globoquadrina tripartita - Spezzaferri, 1994: p. 181, pl. 42, figs. 2a-c.

Dentoglobigerina tripartita - Wade et al., 2018b: p. 369, pl. 11.14, figs. 1-9; p. 371, pl. 11.15, figs. 1-16.

Observations: it occurs scattered in the entire interval.

Dentoglobigerina venezuelana (Hedberg, 1937)

Globigerina venezuelana Hedberg, 1937: p. 681, pl. 92, fig. 7 a, b.

Globoquadrina venezuelana - Kennett & Srinivasan, 1983: p. 181, pl. 44, figs. 5-7.

"Globigerina" venezuelana - Spezzaferri, 1994: p. 171, pl. 37, figs. 2a-c, 3a-d; p. 173, pl. 38, figs. 2a-c, 3a-c; p. 175, pl. 39; figs. 4a-c.

Dentoglobigerina venezuelana - Wade et al., 2018b: p. 374, pl. 11.16, figs. 1-16.

Observations: it is present in the entire interval.

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

TYPE SPECIES— *Globigerina bulloides* d'Orbigny, 1826.

Globigerina bulloides d'Orbigny, 1826

Globigerina bulloides d'Orbigny, 1826: Ann. Sci. Nat. 7, p. 277, no. 1.

Globigerina (Globigerina) bulloides - Kennett & Srinivasan, 1983: p. 37, pl. 6, figs. 4-6.

Globigerina bulloides - Spezzaferri et al., 2018b: p. 187, pl. 6.2, figs. 1-16.

Observations: it is discontinuous throughout the interval.

Globigerina sp.

Observations: very small specimens of *Globigerina* that are difficult to assign to a species.

Genus *Globigerinatella* Cushman & Stainforth, 1945

TYPE SPECIES — *Globigerinatella insueta* Cushman & Stainforth, 1945

Globigerinatella insueta Cushman & Stainforth, Chaisson & Leckie 1993 (partim), p. 157, pl. 10, figs. 3-5

Globigerinatella sp. Pearson, 1995: p. 56, pl. 2, figs. 7-12.

Globigerinatella sp. Pearson & Chaisson, 1997: p. 67, pl. 1, figs. 2-12.

Observations: *Globigerinatella* sp. was described for the first time by Pearson (1995) as a transitional form between *Globigerinita glutinata* and *Globigerinatella insueta*. It can be distinguished from *G. glutinata* by having a more spherical morphology and the presence of a second generation of bullae, which are usually around the final chamber/swollen bulla typical of the species; instead, it is distinguished from *G. insueta* because it is lacking of one or more areal apertures or areal bullae (Pearson, 1995).

Genus ***Globigerinella*** Cushman, 1927

TYPE SPECIES — *Globigerina aequilateralis* Brady, 1879 = junior subjective synonym of *Globigerinella siphonifera* (d'Orbigny, 1839).

Globigerinella obesa group

Globigerinella pseudobesa (Salvatorini, 1967)

Turborotalia pseudobesa Salvatorini, 1966: p. 10, pl. 2, figs. 6a-15.

Globigerinella pseudobesa - Kennett & Srinivasan, 1983: p. 235, pl. 59, figs. 6-8

Globigerinella obesa (Bolli, 1957)

Globorotalia obesa Bolli, 1957: p. 119, pl. 29, figs. 2-3.

Globigerinella obesa - Kennett & Srinivasan, 1983: p. 235, pl. 59, figs. 2-5.
Globigerinella obesa - Spezzaferri, 1994: p. 131, pl. 17, figs. 5a-c.
Globigerinella obesa - Spezzaferri et al., 2018b: p. 199, pl. 6.8, figs. 1-23.

Observations: specimens of these species were counted together to keep the classification consistent.

Globigerinella sp.

Observations: it includes very small specimens of *Globigerinella* difficult to classify at species level.

Genus ***Globigerinita*** Brönnimann, 1951

TYPE SPECIES — *Globigerinita naparimaensis* Brönnimann, 1951.

Globigerinita glutinata (Egger, 1893)

Globigerina glutinata Egger, 1893: p. 371, pl. 13 (on p. 356), figs. 19-21.
Globigerinita glutinata - Kennett & Srinivasan, 1983: p. 225, pl. 56, figs., 1,3-5.
Globigerinita glutinata - Spezzaferri, 1994: p. 151, pl. 27, figs. 6a-c; p. 153, pl. 28, figs. 1a-c.
Globigerinita glutinata - Pearson et al., 2018a: p. 438, pl. 16.2, figs. 1-16; p. 439, pl. 16.3, figs. 1-13.

Observations: *G. glutinata* differs from other globigeriniform species by its distinctive *glutinata*-type microperforate wall texture (Pearson et al., 2018a). It is very abundant in the entire interval.

Globigerinita uvula (Ehrenberg, 1861)

Globigerinita uvula (Ehrenberg) Parker, 1962: p. 252, pl. 8, figs. 14-20.
Globigerinita uvula - Kennett & Srinivasan, 1983: p. 225, pl. 56, figs. 6-8.
Globigerinita uvula - Spezzaferri, 1994: p. 151, pl. 27, figs. 5a-c.
Globigerinita uvula - Pearson et al., 2018a: p. 439, pl. 16.3, figs. 14-15.

Observations: *G. uvula* is distinguished from *G. glutinata* by its high to very high trochospiral coiling (Parker, 1962; Pearson et al., 2018a). It is abundant in the entire interval.

Globigerinita sp. (*G. glutinata* - *Globigerinatella* sp. transition)

Observations: transitional forms between *G. glutinata* and *Globigerinatella* sp., shown by Pearson (1995), were considered. They exhibit a swollen chamber-like bulla with one or more sutural apertures but do not have secondary bullae (see pictures 5-6 in Plate 2 in Pearson, 1995). Pearson & Chaisson (1997) already observed an intergradation between these species in Leg 154 material.

Genus ***Globigerinoides*** Cushman 1927, emended by Spezzaferri et al., 2015

TYPE SPECIES — *Globigerina rubra* d'Orbigny, 1839.

Globigerinoides altiapertura Bolli, 1957

Globigerinoides triloba altiapertura Bolli, 1957: p. 113, pl. 25, figs. 7a-c, 8.
Globigerinoides altiapertura - Kennett & Srinivasan, 1983: p. 55, pl. 10, figs. 1; p. 57, pl. 11, figs. 4-6.
"*Globigerinoides*" *altiapertura* - Spezzaferri, 1994: p. 119, pl. 11, figs. 3a-c, 4a-c, 5a-c.

Globigerinoides altiapertura - Spezzaferri et al., 2018a: p. 275, pl. 9.1, figs. 1-22.

Observations: the main distinguishing features of *G. altiapertura* are an umbilical primary aperture, which is a distinct and generally very rounded high arch, and one very high arched supplementary aperture on the spiral side opposite to the primary aperture (see figures 1-8 of Plate 9.1 in Spezzaferri et al., 2018a). Within the variability of the species, these authors considered also specimens, that in our opinion are less typical being characterized by somewhat lower arched primary and supplementary apertures (see figures 9-17 of Plate 9.1). In the studied assemblages at Site 926, less typical specimens (indicated as *G. cf. G. altiapertura*) are present in the lower portion of the distribution range, starting from core 926B/41X (409,17 mcd), whereas typical forms (indicated as *G. altiapertura* s.s., see also Pl. 4.1) are recorded from 386.42 mcd (cores 926B/39X), dated at 19.16 Ma (lower part of Zone M2), up to the top of the studied interval (Zone M3a).

In literature *G. altiapertura* was recorded from Subzone M1b, just below the boundary between Zone M1/M2 (Spezzaferri, 1996; Iaccarino et al., 1996) to Zone M4 (Kennett and Srinivasan, 1983; Spezzaferri, 1994). *G. altiapertura* is identified at the base of Zone M2 (= N5) in Hole 516F in the Atlantic Ocean (Spezzaferri, 1994; Spezzaferri and Pearson, 2009) dated at 21.8 Ma (Wade et al., 2011), but also at the Aquitanian GSSP at Lemme Carrosio section (Italy), documented at 13 m, in Subchron C6Ar2r, in the upper part of Subzone M1b, just below the Subzone M1/M2 boundary (Spezzaferri, 1996; Iaccarino et al., 1996).

Globigerinoides bollii Blow, 1959

Globigerinoides bollii Blow, 1959: p. 189, pl. 10, figs. 65a-c.

Globigerinoides bollii - Kennett & Srinivasan, 1983: p. 71, pl. 15, figs. 4-6.

Globigerinoides bollii - Spezzaferri, 1994: p. 127, pl. 15, figs. 1a-c.

Globigerinoides bollii - Spezzaferri et al., 2018a: p. 277, pl. 9.2, figs. 1-16.

Observations: as reported by Spezzaferri et al. (2018a), *G. bollii* is distinguished from *G. altiapertura* by the more compact test and the primary aperture which consists of a small rounded arch. This species occurs sporadically throughout the interval.

Globigerinoides obliquus Bolli, 1957

Globigerinoides obliquus Bolli, 1957: p. 113, pl. 25, figs. 10a-c.

Globigerinoides obliquus - Kennett & Srinivasan, 1983: p. 57, pl. 11, figs. 7-9.

Globigerinoides obliquus - Spezzaferri, 1994: p. 125, pl. 14, figs. 2a-c.

Globigerinoides obliquus - Spezzaferri et al., 2018a: p. 285, pl. 9.6, figs. 1-18.

Observations: it probably evolved from *G. altiapertura* at the end of Subzone M1b by developing lateral elongation of the aperture and compression of chambers (Spezzaferri et al., 2018a).

Globigerinoides parawoodi Keller, 1981

Globigerinoides parawoodi Keller, 1981: p. 304, pl. 4, figs. 1-11.

Observations: Spezzaferri et al. (2018a) revised the taxonomy of *G. parawoodi* Keller (1981), considering the holotype of *G. parawoodi* as a junior synonym of *Globigerinoides italicus* Mosna and

Vercesi (1975), introducing a new species, namely *Globigerinoides neoparawoodi*, to describe the paratype of *G. parawoodi* and suggesting a different phylogenetic relationship. *Globigerinoides neoparawoodi* evolved from *Globoturbotalita woodi* in the upper part of Subzone M1a and *G. italicus* probably derived from *G. neoparawoodi* at the top of Subzone M1a. Further Spezzaferri et al. (2018) considered the specimens figured and named *G. parawoodi* by Spezzaferri (1994) as a new species *Globigerinoides joli*.

Within the assemblages of Site 926, specimens associated to *G. italicus*, *G. neoparawoodi* and *G. joli* were counted together as a group to keep the classification consistent.

Globigerinoides subquadratus Brönnimann, 1954

Globigerinoides subquadrata Brönnimann, 1954, in Brönnimann & Todd, 1954: p. 680, pl. 1, figs. 8a-c.

Globigerinoides subquadratus - Kennett & Srinivasan, 1983: p. 55, pl. 10, figs. 2; 75, pl. 16, figs. 1-3.

Globigerinoides subquadratus - Spezzaferri, 1994: p. 121, pl. 12, figs. 5a-c.

Globigerinoides subquadratus - Spezzaferri, 2018a: p. 287, pl. 9.7, figs. 1-20.

Observations: specimens with only one secondary aperture, similar to specimens figured by Spezzaferri (1994) (Plate 12, Figs. 5a-c) are also included.

Genus ***Globoquadrina*** Finlay, 1947

TYPE SPECIES — *Globorotalia dehiscens* Chapman, Parr, and Collins, 1934.

Globoquadrina dehiscens (Chapman, Parr, & Collins, 1934)

Globorotalia dehiscens Chapman, Parr, & Collins, 1934: p. 569, pl. 11, figs. 36a-c.

Globoquadrina dehiscens - Kennett & Srinivasan, 1983: p. 181, pl. 44, figs. 2; 183, pl. 45, figs. 7-9.

Globoquadrina dehiscens - Spezzaferri, 1994: p. 183, pl. 43, figs. 2a-c.

Globoquadrina dehiscens - Wade et al., 2018b: p. 378, pl. 11.17, figs. 1-16.

Observations: it is very rare and occurs very discontinuously.

Genus ***Globorotalia***

TYPE SPECIES - *Pulvinulina menardii* var. *tumida* Brady, 1877 accepted as *Globorotalia tumida* (Brady, 1877) (type by original designation)

Globorotalia praescitula

Globorotalia praescitula (Accepted Name *Globoconella praescitula* (Blow, 1959))

Globorotalia scitula (Brady) sub sp. *praescitula* Blow, 1959: p. 221, pl. 19, figs. 128a-c.

Globorotalia (Globoconella) praescitula - Kennett & Srinivasan, 1983: p. 109, pl. 24, figs. 1; pl. 25, figs. 4-6.

Globorotalia praescitula - Spezzaferri, 1994: p. 149, pl. 26, figs. 7a-c.

Observations: it is very rare and scattered from the top of core 926B/36X (357.12 mcd).

Globorotalia mendacis Blow 1969

Globorotalia (Turborotalia) mendacis Blow, 1969: p. 390-391, pl. 38, figs. 5, 6.

Globorotalia mendacis – Spezzaferri, 1994: p. 145, pl. 24, figs. 1a-d.

Observations: currently, it is placed in synonymy with *P. birnageae* (Leckie et al., 2018), but in this work, the two species were considered separately in order to observe their distribution range.

Globorotalia sp. Spezzaferri, 1994

Globorotalia sp. Spezzaferri, 1994: 147, pl. 25. Figs. 1-5.

Observations: some specimens like *Globorotalia* sp. by Spezzaferri (1994) are identified within the distribution range of *Paragloborotalia kugleri*. They have a morphology very similar to *P. kugleri* but show a different type of wall, while *P. kugleri* has a normal perforate, coarsely cancellate, sacculifer-type wall texture (Olsson et al., 2006; Leckie et al., 2018), *Globorotalia* sp. has a smooth and non-spinose, finely to coarsely perforated wall texture (Spezzaferri, 1994)

Genus *Globorotaloides* Bolli, 1957

TYPE SPECIES— *Globorotaloides variabilis* Bolli, 1957.

Globorotaloides stainforthi (Bolli, Loeblich, & Tappan, 1957)

Catapsydrax stainforthi Bolli, Loeblich, & Tappan, 1957: p. 37, pl. 7, figs. 11a-c.

Catapsydrax stainforthi - Kennett & Srinivasan, 1983: p. 23, pl. 3, figs. 4-6.

Globorotaloides stainforthi - Spezzaferri, 1994: p. 165, pl. 34, figs. 3a-c.

Globorotaloides stainforthi - Coxall & Spezzaferri, 2018: p. 106, pl. 4.8, figs. 1-16.

Observations: *G. stainforthi* differs from *C. dissimilis* by having a more compressed test and a different morphology of the bulla, which extends further towards the equatorial periphery than in *C. dissimilis* and usually has more apertures. It is discontinuously present throughout the interval.

Globorotaloides suteri Bolli, 1957

Globorotaloides suteri Bolli 1957: p. 117 (partim), pl. 27, fig. 13 a-b, holotype, and pl. 27, figs. 9a-c, 11 a-b, paratypes.

Globorotaloides suteri - Kennett & Srinivasan, 1983: p. 215, pl. 53, figs. 1, 3-5.

Globorotaloides suteri - Spezzaferri, 1994: p. 165, pl. 34, figs. 5a-c.

Globorotaloides suteri - Coxall & Spezzaferri, 2018: p. 108, pl. 4.9, figs. 1-16; p. 110, pl. 4.10, figs. 1-16.

Observations: it is continuously present in the entire interval.

Globorotaloides testarugosus (Jenkins, 1960)

Globorotalia testarugosa Jenkins, 1960: p. 368, pl. 5, figs. 8a-c.

Globorotaloides testarugosa - Spezzaferri, 1994: p. 167, pl. 35, figs. 1 a-c; 3a-c; 4a-c

Globorotaloides testarugosa - Coxall & Spezzaferri, 2018: p. 110, pl. 4.11, figs. 1-16.

Observations: it occurs only in a few samples.

Globorotaloides variabilis Bolli, 1957

Globorotaloides variabilis Bolli, 1957: p. 117, pl. 27, figs. 15a-20c.

Globorotaloides variabilis - Kennett & Srinivasan, 1983: p. 215, pl. 53, figs. 2, 6-8.

Globorotaloides variabilis - Spezzaferri, 1994: p. 165, pl. 34, figs. 1a-c; p. 4.12, figs. 1-16.

Observations: it is mostly present in the lower part of the succession and then is scattered.

Globorotaloides sp.1

Observations: it includes *Globorotaloides* forms with 4 chambers and no bulla; it occurs continuously in the first part of the interval (up to about 400 mcd, core 926B/40X) and then discontinuously until the top of the studied interval.

Genus ***Globoturborotalita*** Hofker, 1976, emended by Spezzaferri et al. (2015)

TYPE SPECIES — *Globigerina rubescens* Hofker, 1956.

Globoturborotalita brazieri (Jenkins, 1965)

Globigerina brazieri Jenkins, 1965: p. 1098, figs. 6, 43-51.

Globigerina (Zeaglobigerina) brazieri - Kennett & Srinivasan, 1983: p. 41, pl. 7, figs. 7-9.

Zeaglobigerina brazieri - Spezzaferri, 1994: p. 109, pl. 6, figs. 3a-c; 4a-c.

Globoturborotalita brazieri - Spezzaferri et al., 2018c: p. 239, pl. 8.2, figs. 1-19.

Observations: it is very rare and scattered.

Globoturborotalita connecta (Jenkins, 1964)

Globigerina woodi connecta Jenkins, 1964: p. 72, figs. 1a-c.

Globigerina (Zeaglobigerina) connecta - Kennett & Srinivasan, 1983: p. 45, pl. 8, figs. 1-3.

Zeaglobigerina connecta - Spezzaferri, 1994: p. 105, pl. 4, figs. 4a-c.

Globoturborotalita connecta - Spezzaferri et al., 2018c: p. 243, pl. 8.4, figs. 1-19.

Observations: it occurs discontinuously in the entire interval

Globoturborotalita eolabiacrassata Spezzaferri & Coxall, 2018

Globoturborotalita eolabiacrassata Spezzaferri et al., 2018c: p. 245, pl. 8.5, figs. 1-20.

Observations: it is rare (0.3 - 0.9 %) and recognized only in four samples.

Globoturborotalita euapertura (Jenkins, 1960)

Globigerina euapertura Jenkins, 1960: p. 351, pl. 1, figs. 8a-c.

"*Globigerina*" *euapertura* - Spezzaferri, 1994: p. 173, pl. 39, figs. 1a-d, 2a-c.

Globoturborotalita euapertura - Spezzaferri et al., 2018c: p. 247, pl. 8.6, figs. 1-16.

Observations: it is very rare.

Globoturborotalita martini (Blow & Banner, 1962)

Globigerinita martini martini Blow and Banner, 1962: p. 110, pl. XIV, fig. O.

Catapsydrax martini - Spezzaferri, 1994: p. 163, pl. 33, figs. 7a-c.

Globoturborotalita martini - Spezzaferri et al., 2018c: 253, pl. 8.9, figs. 1-15.

Observations: it is very rare.

Globoturborotalita occlusa (Blow & Banner, 1962)

Globigerina praebulloides occlusa Blow and Banner 1962: p. 93, pl. IX, figs. U-W.

Globoturborotalita occlusa - Spezzaferri et al., 2018c: p. 255, pl. 8.10, figs. 1-17.

Observations: it occurs scattered in the entire interval.

Globoturborotalita paracancellata Olsson & Hemleben in Spezzaferri et al., 2018 *Globoturborotalita paracancellata* Spezzaferri et al., 2018c: p. 261, pl. 8.12, figs. 1-17.

Observations: it is present in a few samples in the top interval.

Globoturborotalita pseudopraebulloides *Globoturborotalita pseudopraebulloides*

Globigerina praebulloides praebulloides Blow, ideotype, 1962: p. 92, pl. IX, figs. O-Q.

Globoturborotalita pseudopraebulloides - Spezzaferri et al., 2018c: p. 263, pl. 8.13, figs. 1-17.

Observations: it occurs discontinuously in the entire interval

Globoturborotalita woodi (Jenkins, 1960)

Globigerina woodi Jenkins, 1960: p. 352, pl. 2, fig. 2a-c.

Globigerina (Zeaglobigerina) woodi - Kennett & Srinivasan, 1983: p. 41, pl. 7, figs. 4-6.

Zeaglobigerina woodi - Spezzaferri, 1994: p. 105, pl. 4, figs. 3a-c, pl. 5 figs. 3a-c.

Globoturborotalita woodi - Spezzaferri et al., 2018c: p. 265, pl. 8.14, figs. 1-17.

Observations: it is present discontinuously in the lower part of the interval, but it becomes continuous and more abundant above 405 mcd (Core 926B/41X) up to the top of the interval.

Globoturborotalita sp. A

Observations: it is like the *G. woodi* but with the loop-shaped aperture; it becomes more abundant in the upper part of the interval.

Genus ***Paragloborotalia*** Cifelli, 1982

TYPE SPECIES — *Globorotalia opima* subsp. *opima* Bolli, 1957.

Paragloborotalia birnageae (Blow, 1959)

Globorotalia birnageae Blow, 1959: p. 210-211, pl. 17, figs. 108a-c.

Globorotalia (Fohsella) birnageae - Kennett & Srinivasan, 1983: p. 95, pl. 21, figs. 6-8.

Globorotalia birnageae - Spezzaferri, 1994: p. 149, pl. 26, figs. 1a-c.

Paragloborotalia birnageae - Leckie et al., 2018: p. 133, pl. 5.2, figs. 1-9; p. 135, pl. 5.3, figs. 1-16.

Observations: It is present throughout the interval but more abundant and continuous in the lower part, then occurs scattered from 405 mcd (Core 926B/41X) up to the top of the interval.

Lekie et al. (2018) considered *Globorotalia mendacis* (Blow, 1969) to be a junior synonym of *P. birnageae* because both taxa have about 6 embracing chambers in the final whorl, a compact test with mostly closed umbilicus and a low aperture with a thin lip, and slightly curved dorsal sutures. However, they noticed a complete gradation between forms with a broadly rounded margin (*P. birnageae* s.s.) and specimens with a subacute margin (*G. mendacis*).

The two species were considered separately range in this work to observe their distribution range.

Paragloborotalia continua group

Paragloborotalia continua (Blow, 1959)

Globorotalia opima subsp. *continua* Blow, 1959: p. 218-219, pl. 19, figs. 125 a-c.

Globorotalia opima Bolli subsp. *continua* Blow, 1959 — Jenkins, 1960: p. 366, pl. 5 (partim), figs. 4a-c.

Paragloborotalia continua - Spezzaferri, 1994: p. 137, pl. 20, figs. 7a-c.

Paragloborotalia continua - Leckie et al., 2018: p. 139, pl. 5.4, figs. 1-4, 8.

Paragloborotalia pseudocontinua (Jenkins, 1967)

Globorotalia pseudocontinua Jenkins, 1967

Paragloborotalia pseudocontinua - Spezzaferri, 1994: p. 137, pl. 20, figs. 1a-c.

Paragloborotalia pseudocontinua - Leckie et al., 2018: p. 139, pl. 5.4, figs. 9-16.

Observations: *Paragloborotalia continua* and *P. pseudocontinua* were counted together to keep the classification consistent because of the intergradation between the two species. *P. continua* differs from *P. pseudocontinua* by its more extraumbilical aperture, less spherical chambers, and flatter spiral side (Leckie et al., 2018).

Paragloborotalia pseudokugleri/ *Paragloborotalia kugleri* group

Paragloborotalia kugleri (Bolli, 1957)

Globorotalia kugleri Bolli, 1957: p. 118, pl. 28, figs. 5a-6.

Globorotalia (Fohsella) kugleri - Kennett & Srinivasan, 1983: p. 95, pl. 21, figs. 1, 3-5.

Paragloborotalia kugleri - Spezzaferri, 1994: p. 143, pl. 23, figs. 5a-c; 6; p. 145, pl. 24, figs. 1a-d; 2a-d

Paragloborotalia kugleri - Leckie et al., 2018: p. 143, pl. 5.5, figs. 1-16.

Paragloborotalia pseudokugleri (Blow, 1969)

Globorotalia (Turborotalia) pseudokugleri Blow, 1969: p. 391, pl. 10, figs. 4-6.

Paragloborotalia pseudokugleri - Spezzaferri, 1994: p. 143, pl. 23, figs. 1a-c.

Paragloborotalia pseudokugleri - Leckie et al., 2018: p. 161, pl. 5.9, figs. 1-16.

Observations: *Paragloborotalia pseudokugleri* and *Paragloborotalia kugleri* were counted together to keep the classification consistent, because of the gradual morphological transition between the end members of the plexus. *Paragloborotalia pseudokugleri* /*P. kugleri* transition forms by Spezzaferri (1994, pl. 23, figs. 2a-d, 3a-d, 4a-c) are also included.

Paragloborotalia nana (Bolli, 1957)

Globorotalia opima nana Bolli, 1957: p. 118, pl. 28, fig. 3a-c.

"*Globorotalia*" *nana* - Kennett & Srinivasan, 1983: p. 107, pl. 24, figs. 3-5.

Paragloborotalia nana - Spezzaferri, 1994: p. 137, pl. 20, figs. 4a-c.

Paragloborotalia nana - Leckie et al., 2018: p. 151, pl. 5.7, figs. 1-16.

Observations: it has a discontinuous distribution pattern but spans the entire interval up to the top, with a higher abundance in the lower part of the interval.

Paragloborotalia siakensis (LeRoy, 1939)

Globorotalia siakensis LeRoy, 1939: p. 262, pl. 4, figs. 20-22.

Globorotalia (Jenkinsella) siakensis - Kennett & Srinivasan, 1983: p. 173, pl. 42, figs. 1, 6-8.

Paragloborotalia siakensis - Spezzaferri, 1994: p. 139, pl. 21, figs. 1a-c; 2a-c.

Globorotalia siakensis - Zachariasse & Sudijono, 2012: p. 162, Fig. 6, 1-13; Fig. 8, 1-5.

Paragloborotalia siakensis - Leckie et al., 2018: p. 167, pl. 5.11, figs. 1-16.

Observations: *P. siakensis* is abundant in the entire studied interval, exhibits a random coiling direction and is distinguished by a decrease in abundance near the B of *H. ampliaperta* (at 421 mcd) and in the upper part of the studied interval at 362 mcd.

Paragloborotalia cf. *P. bella* (Jenkins, 1967)

Globorotalia bella Jenkins, 1967: p. 1069, figs. 3.1-6

Globorotalia (Jenkinsella) bella - Kennett & Srinivasan, 1983: p. 175, pl. 42, Figure 2; pl. 43, figs. 1-3.

Observations: specimens very similar to *Globorotalia bella* figured by Kennett & Srinivasan (1983) occur in the entire interval showing a random coiling direction. They are characterized by five, ovate, inflated chambers (the last one bigger and more prominent), and a low arch aperture with a thick lip.

Paragloborotalia sp.1

Observations: specimens included in this taxon differ from *P. bella* and *P. siakensis* being characterized by the last chamber often smaller than previous ones and a low arch, extraumbilical aperture, sometimes bordered by a prominent lip.

Genus ***Tenuitella*** Fleisher, 1974, emended Li, 1987, Huber et al., 2006

TYPE SPECIES — *Globorotalia gemma* Jenkins, 1965: p. 1115-1118, fig. 11, nos. 97-103.

Tenuitella angustiumbilitata (Bolli, 1957)

Globigerina ciperoensis angustiumbilitata Bolli, 1957: p. 109 (partim), pl. 22, fig. 12.

Globigerina (Globigerina) angustiumbilitata - Kennett & Srinivasan, 1983: p. 29, pl. 4, figs. 3-5.

Tenuitellinata angustiumbilitata - Spezzaferri, 1994: p. 161, pl. 32, figs. 6; 7a-c.

Tenuitella angustiumbilitata Pearson et al. 2018b: p. 445, pl. 16.4, figs. 1-12.

Observations: it occurs throughout the entire interval.

Tenuitella clemenciae (Bermudez, 1961)

Turborotalia clemenciae Bermudez, 1961: p. 1321, pl. 17, figs. 10a-b (fide Ellis & Messina 1949).

Globorotalia (Tenuitella) clemenciae - Kennett & Srinivasan, 1983: p. 165, pl. 39, figs. 1, 3; pl. 40, figs. 1-6.

Observations: specimens of this group are rare and occur sporadically, resulting more continuous between cores 926B/37X and 926B/35X.

According to Kennett & Srinivasan (1983), *Globorotalia minutissima*, which was described from the Miocene of Trinidad by Bolli (1957), closely resembles *Globorotalia clemenciae*. These two taxa may actually be the same species, in which case *G. minutissima* would have priority. However, since they did not examine the type specimens of *G. minutissima*, they were unable to reach a definitive conclusion.

Tenuitella munda (Jenkins, 1965)

Globorotalia munda Jenkins, 1965: p. 1121-1122, fig. 14, nos. 126-133.

Globorotalia (Tenuitella) munda - Kennett & Srinivasan, 1983: p. 163, pl. 39, figs. 5-7.

Tenuitella munda - Spezzaferri, 1994: p. 159, pl. 31, figs. 2a-c.

Tenuitella munda - Pearson et al., 2018b: p. 452, pl. 16.6, figs. 1-16.

Observations: this species is present throughout the interval showing a higher abundance in the lower part of the interval and a slight decrease at 424.05 mcd (core 926B/43X), then the species is discontinuously present up to the top of the studied interval.

Tenuitella praestainforthi Blow, 1969

Globigerinita stainforthi praestainforthi Blow, 1969: p. 383, pl. 25, figs. 3-5.

Tenuitellinata praestainforthi - Spezzaferri, 1994: p. 161, pl. 32, figs. 3a-c

Observations: According to Li (1987) and Li et al. (1992), *T. praestainforthi* and *T. angustiumbilocata* are very similar except for the large umbilical bulla and strongly pustulose surface texture, and they suggested that these species “may be morphs of the same biospecies”. Currently, *T. praestainforthi* is formally placed in synonymy with *T. angustiumbilocata* by Pearson et al. (2018), who consider the presence or absence of an umbilical bulla as not a species-defining characteristic. However, in this work, the two species were considered separated.

Tenuitella sp.

Observations: very small specimens of *Tenuitella* difficult to classify at species level.

Genus ***Trilobatus*** Spezzaferri, Kucera, Pearson, Wade, Rappo, Poole, Morard, & Stalder, 2015

TYPE SPECIES — *Globigerina triloba* Reuss, 1850.

Trilobatus trilobus group

Trilobatus immaturus (LeRoy, 1939)

Globigerinoides sacculiferus (Brady, 1877) var. *immaturus* LeRoy, 1939: p. 236, pl. 3, figs. 19-21.

Globigerinoides immaturus - Kennett & Srinivasan, 1983: p. 63, pl. 13, figs. 7-9.
Globigerinoides immaturus - Spezzaferri, 1994: p. 123, pl. 13, figs. 3a-c.
Trilobatus immaturus - Spezzaferri et al., 2018a: p. 293, pl. 9.9, figs. 1-21.
Trilobatus immaturus Poole & Wade, 2019: p. 1996, fig. 6P; p. 1998, figs. 7A–K.

Trilobatus quadrilobatus (d'Orbigny, 1846)

Globigerina quadrilobata d'Orbigny, 1846: p. 164, pl. 9, figs. 7-10.
Globigerinoides quadrilobatus - Kennett & Srinivasan, 1983: p. 67, pl. 14, figs. 1-3.
Globigerinoides quadrilobatus - Spezzaferri, 1994: p. 119, pl. 11, figs. 2a-c.
Trilobatus quadrilobatus - Spezzaferri et al., 2018a: p. 299, pl. 9.12, figs. 1-20.
Trilobatus quadrilobatus - Poole & Wade, 2019: p. 1998, figs. 7L–N; p. 2000, figs. 8A–K.

Trilobatus trilobus (Reuss, 1850)

Globigerina triloba Reuss, 1850: p. 374, pl. 47, figs. 11a-e.
Globigerinoides triloba - Kennett & Srinivasan, 1983: p. 63, pl. 10, figs. 4; p. 63, pl. 13, figs. 1-3.
Trilobatus trilobus - Spezzaferri et al., 2018a: p. 303, pl. 9.14, figs. 1-21.
Trilobatus trilobus - Poole & Wade, 2019: p. 1996, figs. 6A–O.

Observations: *T. immaturus*, *T. quadrilobatus* and *T. trilobus* were considered as a group, according to Poole & Wade (2019), who observed an intergradation between these species characterized by the morphological progression of *T. trilobus*, *T. immaturus*, *T. quadrilobatus*, and *T. sacculifer*. This progression includes an increase in maximum size, a decrease in the chamber expansion rate, and a change in the final chamber dominance ratio. Additionally, there is looser chamber coiling and modifications in the position and morphology of the primary aperture.

Trilobatus cf. *T. primordius* (Blow & Banner, 1962)

Globigerinoides primordius Blow & Banner, 1962: p. 15, pl. ix, figs. Dd-Ff.
Globigerinoides primordius - Kennett & Srinivasan, 1983: p. 57, pl. 11, figs. 1-3
"*Globigerinoides*" *primordius* - Spezzaferri, 1994: p. 119, pl. 11, figs. 1a-d; p. 121, pl. 12, figs. 2a-b.
Trilobatus primordius - Spezzaferri et al., 2018a: p. 297, pl. 9.11, figs. 1-20.

Observations: forms similar to *T. primordius* were recognized only in a few samples. According to Spezzaferri et al. (2018a), *T. primordius* differs from *T. quadrilobatus* by the primary aperture slightly tending toward the peripheral margin and by its more markedly subovate outline and the larger last chamber.

Trilobatus subsacculifer (Cita, Premoli Silva, & Rossi, 1965)

Globigerinoides sacculifer subsacculifer Cita, Premoli Silva and Rossi, 1965: p. 268, pl. 31, figs. 3a-c.
Globigerinoides subsacculifer - Spezzaferri, 1994: p. 123, pl. 13, figs. 4a-c; figs. 5a-c.
Trilobatus subsacculifer - Spezzaferri et al., 2018a: 301, pl. 9.13, figs. 1-20.

Observations: this species differs from *T. immaturus* and *T. trilobus* by a slightly sac-like last chamber (Spezzaferri et al., 2018a), and it is discontinuously present up to the top of the studied interval.

Trilobatus cf. *T. sicanus*

Globigerinoides sicanus de Stefani, 1952: p. 9, fig. 6.

Globigerinoides sicanus - Kennett & Srinivasan, 1983: p. 63, pl. 13, figs. 4-6

Observations: very few specimens, similar to *Trilobatus sicanus* and characterized by one supplementary aperture (Turco et al., 2011) occur scattered from core 926B/42X until the top of studied interval (core 926C/34X).

Appendix 2 – Tables (Aquitanian – Burdigalian interval)

Taxa relative abundances (%), diversity indices values, preservation indices values (%), productivity indices (%), depth habitat preference values (%) and temperature preferences values (%) along the succession.

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Cassigerinella chipolensis</i>	<i>Cassigerinella</i> sp.	<i>Catapsydrax dissimilis</i>	<i>Catapsydrax unicavus</i>	<i>Ciperoella anguliofficialis</i>	<i>Ciperoella</i> cf. <i>C. fariasi</i>	<i>Dentoglobigerina</i> sp.	<i>Dentoglobigerina altispira</i> gr.	<i>Dentoglobigerina binaiensis</i>	<i>Dentoglobigerina globularis</i>	<i>Dentoglobigerina larmei</i> gr.	<i>Dentoglobigerina tripartita</i>	<i>Dentoglobigerina venezuelana</i>	<i>Globigerina</i> sp.	<i>Globigerina bullaides</i>	<i>Globigerinatella</i> sp.	<i>Globigerinella</i> sp.	<i>Globigerinella obesa</i>	<i>Globigerinella pseudobesa</i>	<i>Globigerinella obesa</i> gr.	<i>Globigerinita</i> sp.	<i>Globigerinita glutinata</i>	<i>Globigerinita uvula</i>	
C	34X	3	154/926C/34X/3/20-22	340,71	1/256	0,36	0,00141	179200,00	17,603			1,1	1,5	2,7			1,1			1,1					0,4	0,8					17,5	20,5	
			154/926C/34X/3/60-62	341,11	1/1024	2,40	0,00234	150186,67	17,614					2,1	3,5		1,5	6,8			1,2		2,1			1,2		0,3		0,3	6,5	12,6	
			154/926C/34X/3/115-117	341,66	1/1024	2,18	0,00213	158297,25	17,630					2,1	6,7		0,6	2,1		0,9	0,9			0,3			0,9	0,9		0,9	3,3	10,9	
		4	154/926C/34X/4/45-47	342,46	1/1024	2,39	0,00233	130677,82	17,652			1,6	1,3	2,3		1,0	1,6		0,7	1,0						0,3	0,3					3,9	14,0
			154/926C/34X/4/105-107	343,06	1/1024	1,95	0,00190	137583,59	17,668	0,4			3,4	1,9		0,8	4,5		0,4							0,4	0,8					7,9	5,7
			154/926C/34X/5/115-117	344,66	1/512	1,29	0,00252	114306,98	17,713					1,4	2,1		0,4	5,3		0,4	2,1		2,1									3,2	6,7
6	154/926C/34X/6/25-27	345,26	1/1024	2,58	0,00252	138517,83	17,729					1,7	4,7		0,3	4,1		0,3	1,2		1,2		0,3		0,3	0,9	0,6		0,6	2,6	12,2		
B	35X	1	154/926B/35X/1/15-17	346,87	1/2048	4,00	0,00195	129536,00	17,770				0,4	4,1		0,8	5,8			0,8		1,2				0,8		1,2		1,2	4,9	9,9	
			154/926B/35X/1/95-97	347,67	1/1024	3,26	0,00318	115278,53	17,791			0,3	1,1	6,0		0,3	1,6			0,5						0,5	1,4	0,5		0,5	8,7	3,6	
		2	154/926B/35X/2/40-42	348,62	1/1024	1,72	0,00168	173841,86	17,819			1,7	2,7	6,5			5,5		0,3	2,1	0,7	1,4				0,3	0,7					6,5	8,9
			154/926B/35X/3/30-32	350,02	1/1024	2,12	0,00207	156015,09	17,859	0,3		0,6	2,2	8,1		0,3	2,2		0,6	0,3		1,6	0,3		0,3		1,2	2,8				4,7	4,7
		3	154/926B/35X/3/125-127	350,97	1/512	2,50	0,00488	73318,40	17,891				2,1	2,5		0,9	1,2		0,3	0,3		1,2				0,9	1,2					5,2	3,7
			154/926B/35X/4/30-32	351,52	1/2048	2,37	0,00116	385404,22	17,917	0,9		0,7	0,5	5,0		1,6	1,6		0,5	0,7	0,2					0,9	2,7	0,7		0,7	9,3	10,9	
		4	154/926B/35X/4/85-87	352,07	1/1024	2,73	0,00267	151912,09	17,939				1,5	3,5		0,8	2,5						0,8		0,8	1,0	1,8					7,1	11,4
			154/926B/35X/5/70-72	353,42	1/1024	2,50	0,00244	146227,20	17,986				1,4	6,0		0,3	0,9			0,6		0,3		0,3		0,3	3,7	0,9		0,9	6,0	4,6	
		6	154/926B/35X/6/30-32	354,52	1/1024	2,51	0,00245	166043,03	18,028			0,2	2,5	4,5		0,5	3,0		0,2	1,0	0,2	0,7				1,0	1,2					11,4	8,0
			154/926B/35X/6/90-92	355,12	1/1024	1,46	0,00143	158509,59	18,053				3,0	3,5		0,9	3,5			0,4	0,4	0,9	0,4	0,4	0,9	0,4	0,4	1,3				10,4	14,7
		7	154/926B/35X/7/15-17	355,87	1/1024	1,93	0,00188	163415,54	18,084			1,3	1,3	4,2		1,6	2,3			0,6		0,3		0,3		0,6	1,0	2,3	0,6		0,6	9,4	9,4
B	36X	1	154/926B/36X/1/15-17	356,47	1/512	1,11	0,00217	155445,05	18,115	0,6				1,2	5,2		1,8	4,9		0,9	0,6		2,4		0,9	0,3	2,1	0,3		0,3	15,9	7,3	
			154/926B/36X/1/80-82	357,12	1/1024	2,92	0,00285	142728,77	18,149			0,2	1,0	3,5		0,5	2,7		0,2	1,0		1,0			1,0	2,0	1,2		1,2	13,0	6,2		
		2	154/926B/36X/2/25-27	358,07	1/1024	1,64	0,00160	156097,56	18,181			0,9	1,3	6,5		1,7	1,7			1,3		0,9				0,4	1,7					11,3	3,0
			154/926B/36X/2/138-140	359,20	1/2048	1,69	0,00083	340525,44	18,213	1,1		0,7	3,2	11,3		2,1	2,8		0,4	1,1		2,1			1,1	1,4	1,1		1,1	8,8	3,5		
		3	154/926B/36X/3/45-47	359,77	1/1024	2,50	0,00244	103628,80	18,231				1,1	9,9		3,8	2,7		0,8	3,1		0,8		0,8		0,4	2,7	0,8		0,8	6,5	2,3	
			154/926B/36X/3/105-107	360,37	1/1024	2,94	0,00287	127477,55	18,259			0,3	2,0	7,6		1,4	6,2		1,4	2,0		1,7				0,6		0,3		0,3	5,1	4,5	
		4	154/926B/36X/4/50-52	361,32	1/1024	1,57	0,00153	171536,31	18,305				1,6	6,7		2,0	6,0			0,4	0,4	0,4	0,4	0,4	0,4	0,4	0,4					4,8	2,8
154/926B/36X/4/110-112	361,92		1/1024	1,53	0,00149	163973,86	18,323				5,1	8,9		2,1	4,2			0,4		0,4				0,8	2,5					8,4	5,1		
B	37X	1	154/926B/37X/1/30-32	366,32	1/512	1,52	0,00297	101389,47	18,422			1,0	0,7	6,8			4,1		0,3	2,0	0,3	1,7			1,4	0,3	0,3		0,3	14,6	6,8		
			154/926B/37X/2/37-39	367,89	1/512	1,48	0,00289	78529,73	18,480						4,0		3,6	4,0			2,2	1,8	0,9			1,3	1,3	2,2		2,2	8,0	4,9	
		2	154/926B/37X/2/115-117	368,67	1/256	0,46	0,00180	182539,13	18,510				0,9	0,6	7,3		0,6	2,4			1,2	0,9	0,6		0,3	0,6		0,3		0,3	21,4	9,2	
			154/926B/37X/3/40-42	369,42	1/256	0,47	0,00184	185191,49	18,536	0,3		1,7	1,7	4,3		2,0	6,4		0,9	1,7		0,6				0,3	0,3					21,7	17,1
		3	154/926B/37X/3/120-122	370,22	1/512	0,90	0,00176	151324,44	18,560					0,4	4,2		0,8	3,0		0,4	1,1		2,3	0,4		0,4	0,8					19,2	6,0
			154/926B/37X/4/25-27	370,77	1/512	0,24	0,00047	633600,00	18,583			1,3	0,7	4,0		0,3	4,0		1,7	0,7	0,7	0,3		0,3		0,7						15,8	11,4
		4	154/926B/37X/4/80-82	371,32	1/512	1,05	0,00205	177493,33	18,604	0,3		0,8	2,2	4,9		3,0	8,2	0,3	0,8	0,5		2,2	0,3			1,1	0,8					22,4	5,5
			154/926B/37X/5/10-12	372,12	1/512	0,92	0,00180	172521,74	18,629	1,3		1,6	1,6	6,2		1,3	2,6		0,3	2,6	0,3	1,0		2,0	1,0	1,6	1,3					14,3	7,8
		5	154/926B/37X/5/105-107	373,07	1/512	2,03	0,00396	84997,04	18,665	0,6			1,9	4,3		4,3	2,5		1,2	1,6		0,9		1,2	1,2	1,2					12,4	3,4	

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Cassigerinella chipolensis</i>	<i>Cassigerinella</i> sp.	<i>Catapsydrax dissimilis</i>	<i>Catapsydrax unicavus</i>	<i>Ciperoella anguliofficalis</i>	<i>Ciperoella</i> cf. <i>C. fariasi</i>	<i>Dentoglobigerina</i> sp.	<i>Dentoglobigerina altispira</i> gr.	<i>Dentoglobigerina binaiensis</i>	<i>Dentoglobigerina globularis</i>	<i>Dentoglobigerina larmeu</i> gr.	<i>Dentoglobigerina tripartita</i>	<i>Dentoglobigerina venezuelana</i>	<i>Globigerina</i> sp.	<i>Globigerina bullaoides</i>	<i>Globigerinatella</i> sp.	<i>Globigerinella</i> sp.	<i>Globigerinella obesa</i>	<i>Globigerinella pseudobesa</i>	<i>Globigerinella obesa</i> gr.	<i>Globigerinita</i> sp.	<i>Globigerinita glutinata</i>	<i>Globigerinita uvula</i>		
C	37X	5	154/926C/37X/5/60-62	373,59	1/1024	1,61	0,00157	155190,06	18,667			3,3	0,8	5,4	1,2	1,2		0,4	2,9				0,4		1,2	2,5					7,1	1,2		
		6	154/926C/37X/6/10-12	374,59	1/1024	1,71	0,00167	158690,06	18,700			0,4	3,4	5,3	2,3	1,1		1,9	2,3	0,4				2,7	0,8					0,4	3,0	3,4		
		7	154/926C/37X/7/10-12	375,59	1/1024	1,19	0,00116	178984,87	18,734	0,5	0,5	2,0	2,5		0,5	3,9		1,5	3,0							0,5	2,0					6,4	14,8	
B	38X	1	154/926B/38X/1/55-57	376,17	1/1024	2,45	0,00239	153808,98	18,763			0,3	1,4	5,5	2,7	3,0		1,6	1,6					2,5	0,3	1,6						10,4	5,7	
			154/926B/38X/1/136-138	376,98	1/1024	2,45	0,00239	175960,82	18,790	0,7	0,2	1,0	4,5	2,9	2,1			0,5	3,1		0,7			0,7	0,7	0,7						6,9	8,1	
		2	154/926B/38X/2/25-27	377,37	1/1024	1,88	0,00184	199897,87	18,805				2,8	5,1	1,4	1,4			2,3	1,4					1,7	0,3	1,1						11,9	7,9
			154/926B/38X/2/105-107	378,17	1/1024	2,26	0,00221	149522,12	18,832			0,3	0,3	3,9	1,8	3,0				2,1		0,9		2,7	0,3		1,8		1,8			10,0	3,3	
		3	154/926B/38X/3/35-37	378,97	1/256	0,44	0,00172	146036,36	18,858			0,8	2,5	6,3	1,7	3,3			2,5	1,7		1,3		0,4	2,1	0,4						12,1	5,4	
			154/926B/38X/3/75-77	379,37	1/1024	2,31	0,00226	157367,97	18,872	0,6	0,3	2,4	2,1			1,5			0,9	2,1	1,8	1,8		0,3		1,8						11,2	3,8	
		4	154/926B/38X/4/5-7	380,17	1/512	1,08	0,00211	229451,85	18,905	1,2	0,6	0,4	1,7	0,8	0,6			0,8	0,6		2,9	1,2		0,6	0,2	0,6						17,6	9,9	
			154/926B/38X/4/45-47	380,57	1/1024	2,01	0,00196	191554,23	18,920			0,8	1,9	4,8	1,1	1,1			1,6	0,5		0,5		1,6	1,1		0,5		0,5	0,5		11,7	4,5	
			154/926B/38X/4/125-127	381,37	1/2048	1,62	0,00079	348918,52	18,949			0,4	2,2	1,1	3,3	2,2	0,4	0,4	2,2		0,7			1,5						0,7	17,0	2,6		
		5	154/926B/38X/5/55-57	382,17	1/512	1,18	0,00230	126698,31	18,979	0,3	2,4	0,3	3,8	0,3	3,5			1,7	2,8						1,7							18,1	8,0	
			154/926B/38X/5/95-97	382,57	1/1024	2,40	0,00234	130560,00	18,995			0,4	1,8	2,5	2,9	5,1			0,7	1,8							1,8	1,1	1,1	1,1	17,3	7,2		
		6	154/926B/38X/6/5-7	383,17	1/1024	2,79	0,00272	110107,53	19,020		0,7	3,4	1,7	3,4	2,1			2,8	2,4	1,0			0,3	0,3		1,0			1,0			20,7	5,2	
			154/926B/38X/6/45-47	383,57	1/2048	2,86	0,00140	221269,93	19,036				0,3	2,4	3,4	0,3			3,4	0,3	0,3	0,7		0,3	1,4					0,3	12,9	2,0		
			154/926B/38X/6/110-112	384,22	1/1024	1,78	0,00174	128287,64	19,065				1,8	2,7	1,4	6,4			3,7	1,8	0,5	1,4		0,9		0,5		0,5			14,6	2,3		
		7	154/926B/38X/7/40-42	385,02	1/256	0,69	0,00270	119095,65	19,103		0,3	1,9	2,5	1,3	1,9			3,5	0,6	0,9	1,3		1,6	0,6					0,3	15,1	2,8			
	39X	1	154/926B/39X/1/10-12	385,42	1/1024	2,07	0,00202	128123,67	19,120				1,2	2,3	1,2	2,3			1,9			1,5			1,5	1,2					0,8	8,9	6,6	
			154/926B/39X/1/71-73	386,03	1/512	1,07	0,00209	117233,64	19,143			1,6	1,2	2,0	1,6	3,3	0,4	4,1	1,2	0,4	1,2				0,4	1,2						13,5	4,1	
			154/926B/39X/1/110-112	386,42	1/1024	1,92	0,00188	148800,00	19,153		0,7	0,4	5,2	1,1	4,1			3,3	0,4		0,4			0,7	1,5	2,2		2,2	2,2	14,8	4,1			
		2	154/926B/39X/2/50-52	387,32	1/512	1,13	0,00221	157677,88	19,173				2,3	4,9	3,2	4,1			2,0	0,9		0,9		0,6	0,3	0,6						10,2	6,7	
			154/926B/39X/2/90-92	387,72	1/512	1,88	0,00367	76255,32	19,184			0,4		6,1	1,4	2,5			4,7	0,4	0,4	0,4				2,9	0,7		0,7		11,9	6,8		
		3	154/926B/39X/3/55-57	388,87	1/1024	1,90	0,00186	125035,79	19,218			0,4	3,1	4,0	1,8	2,2			3,1	1,8	0,4	1,3				1,8	2,2		2,2		13,5	6,7		
			154/926B/39X/3/95-97	389,27	1/512	0,71	0,00139	145667,61	19,237			0,5	1,5	7,5	0,5	5,5			3,5	1,5			1,0			1,0	1,5		1,5		13,4	4,5		
		4	154/926B/39X/4/50-52	390,32	1/1024	2,75	0,00269	75589,82	19,273			0,5	3,0	4,6	1,5	4,6			3,6	1,5		4,6			1,5						13,7	2,5		
			154/926B/39X/4/75-77	390,57	1/1024	1,59	0,00155	137821,38	19,281			1,9	0,5	4,7	1,4	5,2			3,8	1,4		2,3			0,5						12,2	11,3		
		5	154/926B/39X/4/135-137	391,17	1/256	0,64	0,00250	156000,00	19,299			0,3	1,9	2,7			3,5		2,7	2,2	0,5	1,6				0,5	0,5		0,5			13,2	12,9	
			154/926B/39X/5/20-22	391,52	1/1024	2,43	0,00237	106613,99	19,309			1,2	1,2	6,9	0,8	4,4			3,2	4,8	0,4	1,2				0,4					9,3	3,6		
			154/926B/39X/5/115-117	392,47	1/512	1,08	0,00211	97659,26	19,344				2,5	3,0			8,4		4,9			2,5				1,5					6,9	6,9		
		6	154/926B/39X/5/145-147	392,77	1/256	0,64	0,00250	147600,00	19,360			0,9	1,2	3,6			2,7		4,0	0,3		1,5									7,9	8,2		
			154/926B/39X/6/30-32	393,12	1/1024	2,01	0,00196	102909,45	19,371			0,5	0,9	6,6			13,2		2,4			3,3					0,9		0,9		3,8	4,2		
C	39X	5	154/926C/39X/5/80-82	393,52	1/256	0,70	0,00273	119222,86	19,383		1,1	1,1	4,9		0,3	2,6		2,0	1,4		2,9									0,3	10,1	6,6		
			154/926C/39X/5/120-122	393,92	1/1024	1,72	0,00168	203013,95	19,397			0,6	2,1	3,0			4,5		3,0	0,6		4,5				1,5				0,3	3,0	5,7		
		6	154/926C/39X/6/50-52	394,72	1/128	0,88	0,00688	53090,91	19,423			0,8	2,5	12,8			4,5		4,5	0,8	0,3	3,6				0,6					5,6	3,9		
			154/926C/39X/6/110-112	395,32	1/512	1,29	0,00252	122244,96	19,443			0,3	2,0	13,2		0,3	8,9		4,6	0,3	0,3	2,3				1,0	0,3		0,3		6,3	3,0		

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Cassigerinella chipolensis</i>	<i>Cassigerinella</i> sp.	<i>Catapsydrax dissimilis</i>	<i>Catapsydrax unicavus</i>	<i>Ciperoella anguliofficialis</i>	<i>Ciperoella</i> cf. <i>C. fariasi</i>	<i>Dentoglabigerina</i> sp.	<i>Dentoglabigerina altispira</i> gr.	<i>Dentoglabigerina binaoensis</i>	<i>Dentoglabigerina globularis</i>	<i>Dentoglabigerina larmeuil</i> gr.	<i>Dentoglabigerina tripartita</i>	<i>Dentoglabigerina venezuelana</i>	<i>Glabigerina</i> sp.	<i>Glabigerina bulloides</i>	<i>Glabigerinatella</i> sp.	<i>Glabigerinella</i> sp.	<i>Glabigerinella obesa</i>	<i>Glabigerinella pseudobesa</i>	<i>Glabigerinella obesa</i> gr.	<i>Glabigerinita</i> sp.	<i>Glabigerinita glutinata</i>	<i>Glabigerinita uvula</i>	
B	40X	1	154/926B/40X/1/45-47	395,37	1/256	0,75	0,00293	96256,00	19,447			0,7	0,7	8,1		0,4	4,8	0,4	4,8	1,5	0,4	1,5				1,5						9,2	6,6
			154/926B/40X/1/105-107	395,97	1/512	1,05	0,00205	113127,62	19,465			0,9		8,3		0,4	3,5		7,4	0,9	0,4	1,7				1,3						2,2	0,9
		2	154/926B/40X/2/75-77	397,17	1/512	1,25	0,00244	126566,40	19,501				2,3	9,6			5,9		5,6	3,3	0,3				2,6	1,3		1,3	0,3	8,9	2,0		
			154/926B/40X/2/135-137	397,77	1/1024	1,85	0,00181	143913,51	19,517				2,0	5,3			2,9		5,7	1,6			1,2		0,8	3,3	0,4		0,4	0,4	7,3	1,2	
		3	154/926B/40X/3/45-47	398,37	1/256	1,11	0,00434	61117,12	19,536				0,9	4,8		0,4	5,7	7,0	0,4	0,4	0,4				0,9				0,4	7,0	1,7		
			154/926B/40X/3/120-122	399,12	1/512	1,25	0,00244	100761,60	19,562					8,2			7,3	6,1	0,4	0,8	0,8				0,8						4,9	3,3	
		4	154/926B/40X/4/85-87	400,27	1/512	1,04	0,00203	120615,38	19,603			0,9		3,9			5,7		2,2		0,4	2,2				0,9	1,3		1,3	0,4	9,2	3,5	
			154/926B/40X/4/145-147	400,87	1/1024	1,58	0,00154	137397,47	19,626			0,5	1,5	1,0			5,9	5,4			2,0				2,0	1,5		1,5	0,5	6,9	10,9		
		5	154/926B/40X/5/11-13	401,03	1/256	0,83	0,00324	98698,80	19,633					7,4			7,0		4,1	0,7		0,7				0,7				0,4	12,5	6,3	
			154/926B/40X/5/52,5-54,5	401,45	1/256	1,49	0,00582	64257,72	19,655					1,3	8,6		1,3	5,1	4,5			1,6				2,7	0,3		0,3		6,7	1,6	
			154/926B/40X/5/100-102	401,92	1/256	0,86	0,00336	69358,14	19,670					3,1	10,3	2,2	2,2	4,9			4,0					3,1	0,9		0,9	0,4	13,8	7,1	
		6	154/926B/40X/6/13-15	402,55	1/1024	1,80	0,00176	216746,67	19,692			1,1	3,0	3,2		5,9	2,2	4,9	1,6		2,4			0,3		1,3	0,3		0,3	8,9	6,7		
			154/926B/40X/6/69-71	403,11	1/1024	2,08	0,00203	138830,77	19,717			0,7	3,6	7,5			2,1	6,4		0,4	1,4						1,8	1,8	3,6	10,7			
C	40X	6	154/926C/40X/6/15-17	404,06	1/512	0,91	0,00178	138971,43	19,767			1,2	3,1	10,9		2,0	7,4			3,1					3,1	3,1		3,1	5,9	5,9			
B	41X	1	154/926B/41X/1/35-37	404,57	1/128	0,23	0,00180	173634,78	19,815			3,3	2,7	6,0		0,3	3,3			2,7						2,7	0,3	24,3	15,0				
			154/926B/41X/1/90-92	405,12	1/256	0,41	0,00160	235395,12	19,835			0,9	2,1	19,3	1,5		1,2	8,3	0,6	0,3	3,6					2,4	2,4	0,6	9,8	10,4			
		2	154/926B/41X/2/48-50	405,70	1/256	0,23	0,00090	287165,22	19,869			0,4	1,2	3,5	1,2		0,8	4,3			0,8				0,8			0,8	24,4	7,5			
			154/926B/41X/2/108-110	406,30	1/64	0,12	0,00188	201600,00	19,891			1,6	1,6	3,7	0,5		0,8	2,9	0,3	0,8	0,8						1,1	1,1		6,9	3,2		
		3	154/926B/41X/3/45-47	407,17	1/512	2,14	0,00418	79910,28	19,913					7,1	2,8			7,7	1,5	0,3	0,6					3,7	3,7	0,9	11,3	4,6			
			154/926B/41X/4/15-17	408,37	1/128	0,23	0,00180	121321,74	19,949			1,4	2,3	7,5	0,9		0,9	8,4	2,8		3,3				0,9	0,9	1,4	15,4	7,9				
		4	154/926B/41X/4/125-127	409,17	1/256	1,02	0,00398	81317,65	19,997			0,6	0,6	9,7	1,3		1,3	3,1	3,8		3,8			0,3		3,1	3,1	0,6	11,0	2,5			
			154/926B/41X/5/15-17	409,87	1/1024	0,94	0,00092	267982,98	20,011			0,5	2,9	18,3	1,0			5,3	1,4		1,4				1,0	1,4	1,4	0,5	8,2	9,6			
		C	41X	3	154/926C/41X/3/140-142	410,28	1/128	0,24	0,00188	155733,33	20,081			0,7	9,7	1,0		3,1	13,8	3,1	0,3	1,0					0,7	0,7		5,9	4,5		
				4	154/926C/41X/4/70-72	411,08	1/128	0,24	0,00188	121066,67	20,118				3,2	4,1		4,6	7,3	2,8		5,5	0,5							14,7	2,3		
				154/926C/41X/4/145-147	411,83	1/2048	1,42	0,00069	429791,55	20,152				0,7	7,3			0,7	15,3	1,7		4,2	0,3			0,3		0,3		7,0	3,5		
5	154/926C/41X/5/50-52			412,38	1/1024	1,03	0,00101	338019,42	20,178				2,8	6,5	2,8		1,5	10,8	2,2		2,2	0,6			2,2	2,2	0,9	7,7	3,4				
154/926C/41X/5/110-112	412,98	1/256	0,55	0,00215	179665,45	20,205				0,5	5,8	0,5			1,6	10,3	2,6		4,2					0,3	0,3		4,5	5,0					
B	42X	1	154/926B/42X/1/101-103	414,93	1/512	0,50	0,00098	260096,00	20,232					4,9	2,8	1,8	6,4	11,7		3,2	0,7					0,4	0,4	0,7	15,9	8,8			
			154/926B/42X/2/10-12	415,52	1/512	1,08	0,00211	189629,63	20,247				1,1	5,6	1,9		5,0	10,8	1,6					0,3		0,8	0,8	1,3	16,1	8,2			
		2	154/926B/42X/2/88-90	416,30	1/512	0,88	0,00172	143127,27	20,269				1,7	10,1	5,0		0,8	8,8	2,1		2,9								10,9	6,3			
			154/926B/42X/2/145-147	416,87	1/1024	1,41	0,00138	236028,37	20,288				0,3	6,0	4,1		1,6	5,0	1,9		1,6				1,9				12,6	8,2			
		3	154/926B/42X/3/73-75	417,65	1/2048	1,72	0,00084	320297,67	20,314				1,3	2,2	1,8		2,7	7,1	0,4		4,0				0,4			0,9	13,4	9,4			
			154/926B/42X/3/135-137	418,27	1/1024	1,86	0,00182	114511,83	20,333				3,0	3,5				10,0	1,0		1,5	0,5							9,0	7,5			
		4	154/926B/42X/4/86-88	419,28	1/256	0,30	0,00117	174933,33	20,359				3,9	8,3	0,5		0,5	12,3	1,0		2,0					0,5		0,5	0,5	9,8	8,3		

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Cassigerinella chipolensis</i>	<i>Cassigerinella</i> sp.	<i>Catapsydrax dissimilis</i>	<i>Catapsydrax unicavus</i>	<i>Ciperoella angulioffinalis</i>	<i>Ciperoella</i> cf. <i>C. fariasi</i>	<i>Dentaglobigerina</i> sp.	<i>Dentaglobigerina altispira</i> gr.	<i>Dentaglobigerina binaiensis</i>	<i>Dentaglobigerina globularis</i>	<i>Dentaglobigerina larmei</i> gr.	<i>Dentaglobigerina tripartita</i>	<i>Dentaglobigerina venezuelana</i>	<i>Globigerina</i> sp.	<i>Globigerina bulloides</i>	<i>Globigerinatella</i> sp.	<i>Globigerinella</i> sp.	<i>Globigerinella obesa</i>	<i>Globigerinella pseudobesa</i>	<i>Globigerinella obesa</i> gr.	<i>Globigerinita</i> sp.	<i>Globigerinita glutinata</i>	<i>Globigerinita uvula</i>
B	42X	5	154/926B/42X/5/80-82	420,72	1/1024	2,24	0,00219	174628,57	20,398					2,2	3,6	0,8		2,7	1,6		1,6		0,5		0,3					0,3	11,8	9,1
		6	154/926B/42X/6/10-12	421,52	1/1024	1,20	0,00117	175786,67	20,427					8,0	2,5	1,0		7,0	1,0							2,0		2,0	0,5	4,5	10,0	
			154/926B/42X/6/65-67	422,07	1/1024	1,45	0,00142	242228,97	20,451				0,6	5,9	0,6	0,6	0,3	7,1	0,9							1,5		1,5		4,9	7,4	
			154/926B/42X/6/145-147	422,87	1/512	0,71	0,00139	172349,30	20,475					3,0	4,7	3,0		6,0	0,4	0,4	2,1					1,3				17,0	5,1	
		7	154/926B/42X/7/20-22	423,12	1/512	1,38	0,00270	141727,54	20,482				0,8	6,1	0,8			4,0	0,3		1,3	0,3		1,6						10,9	8,0	
C	42X	5	154/926C/42X/5/45-47	423,67	1/256	0,48	0,00188	152533,33	20,469			1,5	4,4				5,2	0,7		3,3					0,7					14,0	8,1	
B	43X	2	154/926B/43X/1/90-92	424,42	1/256	0,69	0,00270	140614,49	20,525			0,6	3,8	6,5	1,2	1,5	0,3		1,8	0,6	0,3	3,8		0,3			2,7		2,7	0,6	6,5	4,7
			154/926B/43X/2/35-37	425,37	1/128	0,48	0,00375	106133,33	20,552			0,5	4,6	3,5					1,3	0,3		2,5								1,3	5,1	4,1
			154/926B/43X/2/90-92	425,92	1/512	1,22	0,00238	153180,33	20,571				0,7	1,7		2,0	0,3	0,7					3,3	0,3						1,0	16,8	3,3
		3	154/926B/43X/3/10-12	426,62	1/512	0,80	0,00156	132480,00	20,599				0,5	1,5	0,5		1,0					1,5					0,5		0,5	0,5	4,9	7,8
			154/926B/43X/3/72-74	427,24	1/256	0,68	0,00266	121600,00	20,620			1,4	1,0	1,0		0,7				0,3	3,1					1,0	1,0		7,5	2,4		
			4	154/926B/43X/4/30-32	428,32	1/1024	1,54	0,00150	141631,17	20,650				0,9	1,9		0,9			0,5	0,5		0,9	0,5	0,9		0,5	0,5		7,1	4,2	
		154/926B/43X/4/130-132		429,32	1/512	1,07	0,00209	127760,75	20,685				0,8	11,7	1,1	1,5	0,4					1,5		0,4		1,1	1,1	1,9	7,2	3,4		
		5	154/926B/43X/5/65-67	430,17	1/512	0,29	0,00057	368993,10	20,714					4,3	0,5							1,0	0,5	0,5			0,5			0,5	8,2	2,4
			154/926B/43X/5/145-147	430,97	1/128	0,20	0,00156	138880,00	20,737				1,9	2,9		0,5				1,0		1,0							3,8	13,3	1,9	
		6	154/926B/43X/6/75-77	431,77	1/256	0,49	0,00191	119640,82	20,762				2,3	10,6			0,9		1,4	0,5							2,8	2,8		7,9	0,9	
		CC	154/926B/43X/CC/25-27	432,27	1/512	0,57	0,00111	195817,54	20,778					8,4			1,0													0,5	7,9	6,4
		44X	1	154/926B/44X/1/115-117	434,37	1/512	1,03	0,00201	166027,18	20,850			0,3	2,0	4,0	4,6		0,6	2,0	1,1		1,7		2,3			1,4	1,4	0,6	6,6	1,4	
	2		154/926B/44X/2/85-87	435,57	1/256	0,47	0,00184	151965,96	20,896					3,2	2,9		3,2	3,2						0,4		1,1	1,1	1,4	9,7	2,9		
	3		154/926B/44X/3/36,5-38,5	436,59	1/4096	1,25	0,00031	697958,40	20,931				0,9	4,2	1,9		2,8	0,9	0,5		0,5	0,5							2,8	20,8	2,8	
			154/926B/44X/3/135-137	437,57	1/256	0,35	0,00137	154331,43	20,963				3,8	2,4	3,3		1,4	2,8			0,5							1,4	10,0	1,4		
	4		154/926B/44X/4/125-127	438,97	1/256	0,31	0,00121	199845,16	21,003			0,8	0,8	2,4	2,4		0,8	2,0	0,8	0,4	2,0							1,6	11,0	1,2		
	5		154/926B/44X/5/96-98	440,18	1/1024	1,44	0,00141	164977,78	21,039				0,9	2,6	2,6			1,7	3,0		3,5					1,3		1,3		6,5	0,4	
	6	154/926B/44X/6/110-112	441,82	1/512	0,63	0,00123	194234,92	21,092				0,4		8,8	5,9			1,7					1,7		2,5	2,5		3,4	0,4			
	45X	1	154/926B/45X/1/85-87	443,77	1/256	0,83	0,00324	98390,36	21,165				0,3	1,3	2,8		0,9	1,3	0,6			0,3	1,3			2,8	2,8		4,1			
		2	154/926B/45X/2/55-57	444,97	1/1024	1,27	0,00124	174160,63	21,200				1,4	6,9	1,4	0,5		0,5			0,9									6,4	6,4	
		3	154/926B/45X/3/45-47	446,37	1/512	1,01	0,00197	101893,07	21,250				2,0	6,9	2,5			0,5			1,5	0,5			1,0	0,5		0,5		3,9		
			154/926B/45X/3/125-127	447,17	1/1024	1,64	0,00160	141112,20	21,279					0,4	6,3		3,1				0,4		5,4			1,8		1,8	0,9	7,1	1,3	
		4	154/926B/45X/4/100-102	448,42	1/512	1,13	0,00221	138194,69	21,321				0,3	1,9	0,3			0,3			1,6		1,9					2,6	10,3	0,6		
		5	154/926B/45X/5/10-12	449,02	1/512	1,08	0,00211	115674,07	21,341				1,2	2,5	2,5		0,8				1,2								2,5	4,1	4,5	
154/926B/45X/5/90-92			449,82	1/512	0,56	0,00109	234057,14	21,367				0,8	0,4	7,5		0,4				0,8		1,6			1,6	1,2	2,7		4,3	2,4		
6		154/926B/45X/6/60-62	451,02	1/256	0,59	0,00230	155335,59	21,406				0,3	5,6	4,2		6,4		1,4	0,3		0,6		1,1		0,8		0,8		0,3	1,7		

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globigerinoides</i> sp.	<i>Globigerinoides altiaperturus</i>	<i>Globigerinoides bolli</i>	<i>Globigerinoides obliquus</i>	<i>Globigerinoides parawoodi</i> gr.	<i>Globigerinoides subquadratus</i>	<i>Globoquadrina dehiscens</i>	<i>Globorotalia mendacis</i>	<i>Globorotalia</i> sp. (Spezzaferri, 1994)	<i>Globorotalia praescitula</i>	<i>Globorotaloides</i> spp.	<i>Globorotaloides</i> sp.1	<i>Globorotaloides stainforthi</i>	<i>Globorotaloides suteri</i>	<i>Globorotaloides testarugosus</i>	<i>Globorotaloides variabilis</i>	<i>Globoturborotalita</i> spp.	<i>Globoturborotalita</i> sp.A	<i>Globoturborotalita brazieri</i>	<i>Globoturborotalita connecta</i>	<i>Globoturborotalita</i> cf. <i>druryi</i>	<i>Globoturborotalita eolabiocrassata</i>	<i>Globoturborotalita euapertura</i>		
C	34X	3	154/926C/34X/3/20-22	340,71	1/256	0,36	0,00141	179200,00	17,603					0,4									2,7				2,3			0,4				
			154/926C/34X/3/60-62	341,11	1/1024	2,40	0,00234	150186,67	17,614			0,3	0,3	7,9	2,1							0,6					4,1		1,2	0,6				
			154/926C/34X/3/115-117	341,66	1/1024	2,18	0,00213	158297,25	17,630	3,0	0,3	1,5	6,4	3,6						0,3			0,9				2,7		0,6			0,3		
		4	154/926C/34X/4/45-47	342,46	1/1024	2,39	0,00233	130677,82	17,652	2,0		0,3	7,2	2,0					0,3					1,3				0,7		1,0				
			154/926C/34X/4/105-107	343,06	1/1024	1,95	0,00190	137583,59	17,668	0,8		1,9	9,8	1,9									0,4	1,9				3,0		0,4			0,8	
			154/926C/34X/5/115-117	344,66	1/512	1,29	0,00252	114306,98	17,713	0,7		1,4	4,6	0,4					0,4				0,4	1,8				1,8						
B	35X	1	154/926C/34X/6/25-27	345,26	1/1024	2,58	0,00252	138517,83	17,729	0,9		0,3	5,0	1,5										2,6				2,0		0,6	0,9			
			154/926B/35X/1/15-17	346,87	1/2048	4,00	0,00195	129536,00	17,770	0,4			7,0								0,4				3,3				0,4		0,8			
			154/926B/35X/1/95-97	347,67	1/1024	3,26	0,00318	115278,53	17,791	1,6	0,5	1,9	7,4	0,8										4,6				1,4		0,8				
		2	154/926B/35X/2/40-42	348,62	1/1024	1,72	0,00168	173841,86	17,819	0,7	0,7	1,7	1,7	0,3								2,1			8,2		0,3	2,4						
			154/926B/35X/3/30-32	350,02	1/1024	2,12	0,00207	156015,09	17,859	0,6	0,6	0,3	7,8	1,6					0,3		1,2		5,6				0,6	6,2		0,3	0,3			
			154/926B/35X/3/125-127	350,97	1/512	2,50	0,00488	73318,40	17,891	1,8	1,2	1,5	14,4	0,6					0,3		0,9		4,6					4,3						
		4	154/926B/35X/4/30-32	351,52	1/2048	2,37	0,00116	385404,22	17,917	1,8	1,4	0,9	9,1	0,5							0,5		3,4					2,5						
			154/926B/35X/4/85-87	352,07	1/1024	2,73	0,00267	151912,09	17,939	2,3	1,3		8,3	3,0					0,3		0,5	0,3	3,5					1,3						
			154/926B/35X/5/70-72	353,42	1/1024	2,50	0,00244	146227,20	17,986	0,3		2,3	9,5	1,7						1,1	0,6			2,3				1,7			1,1			
		6	154/926B/35X/6/30-32	354,52	1/1024	2,51	0,00245	166043,03	18,028	0,2	0,2	0,2	3,7	0,2							0,7	0,5	4,0					0,7		0,5				
			154/926B/35X/6/90-92	355,12	1/1024	1,46	0,00143	158509,59	18,053				4,3									2,2		2,2			5,2	0,4						
			7	154/926B/35X/7/15-17	355,87	1/1024	1,93	0,00188	163415,54	18,084		0,3	0,3	1,0	3,9	2,6					0,3			1,9				0,6	1,3		0,3			
		1	154/926B/36X/1/15-17	356,47	1/512	1,11	0,00217	155445,05	18,115			0,9		2,4	0,9					0,6		0,9		4,9				0,3	1,5	0,3	0,3			
			154/926B/36X/1/80-82	357,12	1/1024	2,92	0,00285	142728,77	18,149	0,2	0,5		1,2	7,2	0,7					0,5		1,2		2,5				0,2	1,5		0,5	0,2		0,5
			154/926B/36X/2/25-27	358,07	1/1024	1,64	0,00160	156097,56	18,181	0,9	2,2			8,7										3,0				0,4	2,6			0,4		
			154/926B/36X/2/138-140	359,20	1/2048	1,69	0,00083	340525,44	18,213				0,4	3,9							0,7	1,4	0,7	4,2				1,1	1,8		0,4			
			154/926B/36X/3/45-47	359,77	1/1024	2,50	0,00244	103628,80	18,231		1,5			3,8									0,8						3,1					
			154/926B/36X/3/105-107	360,37	1/1024	2,94	0,00287	127477,55	18,259		0,3		0,8	2,0	0,3									0,3	7,3				1,1		0,3			
154/926B/36X/4/50-52	361,32		1/1024	1,57	0,00153	171536,31	18,305	0,4	0,4			2,4	7,5	0,4									1,6			1,2	1,2	0,4	0,4					
154/926B/36X/4/110-112	361,92		1/1024	1,53	0,00149	163973,86	18,323			1,7	0,8	3,8	0,4								0,4	8,4				1,7	1,3		0,4		0,8	0,8		
B	37X		1	154/926B/37X/1/30-32	366,32	1/512	1,52	0,00297	101389,47	18,422		0,3	1,0	0,7	1,7	0,3								4,8				0,7	0,3			0,3		
		154/926B/37X/2/37-39		367,89	1/512	1,48	0,00289	78529,73	18,480	0,4	0,9	1,8	1,8	4,5	0,4									4,0					0,9			0,9	0,9	
		154/926B/37X/2/115-117		368,67	1/256	0,46	0,00180	182539,13	18,510					1,2	0,9	0,3					0,6			3,1				0,3	0,3			0,3		
		3	154/926B/37X/3/40-42	369,42	1/256	0,47	0,00184	185191,49	18,536					0,9										6,1					0,9					
			154/926B/37X/3/120-122	370,22	1/512	0,90	0,00176	151324,44	18,560				0,8	1,1								0,4			9,8			0,8	0,8		0,4			
			154/926B/37X/4/25-27	370,77	1/512	0,24	0,00047	633600,00	18,583		0,3			1,0											3,0				1,0			0,3		
		154/926B/37X/4/80-82	371,32	1/512	1,05	0,00205	177493,33	18,604		0,5			2,2	0,5										0,3	3,8			0,8	1,1					
		154/926B/37X/5/10-12	372,12	1/512	0,92	0,00180	172521,74	18,629		0,3	0,3	0,3	4,2								0,3	0,3	3,6				0,3	2,0		0,3				
		154/926B/37X/5/105-107	373,07	1/512	2,03	0,00396	84997,04	18,665		0,6		1,2	1,2	0,6	0,9							1,2		10,9			0,3	0,3	0,3					

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globigerinoides</i> sp.	<i>Globigerinoides altiaperturus</i>	<i>Globigerinoides bolli</i>	<i>Globigerinoides obliquus</i>	<i>Globigerinoides parawoodi</i> gr.	<i>Globigerinoides subquadratus</i>	<i>Giobaquadrina dehliscens</i>	<i>Glaborotalia mendacis</i>	<i>Glaborotalia</i> sp. (Spezzaferri, 1994)	<i>Glaborotalia praescitula</i>	<i>Glaborataloides</i> spp.	<i>Glaborataloides</i> sp.1	<i>Glaborataloides stainforthi</i>	<i>Glaborataloides suteri</i>	<i>Glaborataloides testarugosus</i>	<i>Glaborataloides variabilis</i>	<i>Globoturborotalita</i> spp.	<i>Globoturborotalita</i> sp.A	<i>Globoturborotalita brazieri</i>	<i>Globoturborotalita connecta</i>	<i>Globoturborotalita cf. druyi</i>	<i>Globoturborotalita eolabiocrassata</i>	<i>Globoturborotalita euapertura</i>			
C	37X	5	154/926C/37X/5/60-62	373,59	1/1024	1,61	0,00157	155190,06	18,667	0,4	1,7			2,9		1,7				1,1		0,4	0,4	7,9				0,4		1,2					
		6	154/926C/37X/6/10-12	374,59	1/1024	1,71	0,00167	158690,06	18,700		1,1	0,4	0,4	6,1	1,1						1,1		4,2			1,1	0,4	0,4	0,4						
		7	154/926C/37X/7/10-12	375,59	1/1024	1,19	0,00116	178984,87	18,734					2,0								2,5		3,9				1,0							
B	38X	1	154/926B/38X/1/55-57	376,17	1/1024	2,45	0,00239	153808,98	18,763	0,3	0,3	1,6	0,5	2,5		0,5					1,9		3,6			1,1	1,1								
			154/926B/38X/1/136-138	376,98	1/1024	2,45	0,00239	175960,82	18,790	0,2	0,2	0,2		0,7								0,2	4,3							0,2					
		2	154/926B/38X/2/25-27	377,37	1/1024	1,88	0,00184	199897,87	18,805	0,3	0,6			2,0	0,8					0,6				5,1				0,8	0,3						
			154/926B/38X/2/105-107	378,17	1/1024	2,26	0,00221	149522,12	18,832		0,3	0,6	0,6	4,5	0,3					0,3			9,4			0,3	0,6				0,3				
		3	154/926B/38X/3/35-37	378,97	1/256	0,44	0,00172	146036,36	18,858			0,4												15,1				1,3							
			154/926B/38X/3/75-77	379,37	1/1024	2,31	0,00226	157367,97	18,872	0,3					1,8							1,5		8,8											
		4	154/926B/38X/4/5-7	380,17	1/512	1,08	0,00211	229451,85	18,905			0,2	0,2										6,6				0,6			0,2					
			154/926B/38X/4/45-47	380,57	1/1024	2,01	0,00196	191554,23	18,920					0,3	0,8	0,8						1,6		11,7					0,3						
		5	154/926B/38X/4/125-127	381,37	1/2048	1,62	0,00079	348918,52	18,949		1,1	0,4		2,6										1,8				1,8		0,7	0,7				
			154/926B/38X/5/55-57	382,17	1/512	1,18	0,00230	126698,31	18,979		0,3			0,3											1,8				0,3	0,3		0,3			
		6	154/926B/38X/5/95-97	382,57	1/1024	2,40	0,00234	130560,00	18,995		1,1	0,7										0,4		6,1					1,1		0,4				
			154/926B/38X/6/5-7	383,17	1/1024	2,79	0,00272	110107,53	19,020		0,3				4,1	0,3						1,7	0,3	4,1				0,3							
		7	154/926B/38X/6/45-47	383,57	1/2048	2,86	0,00140	221269,93	19,036		1,0	1,4		1,7									0,3	6,8				0,7		1,4					
			154/926B/38X/6/110-112	384,22	1/1024	1,78	0,00174	128287,64	19,065		0,5	0,9	0,5	1,8	0,5						2,7		9,6		0,5	0,9									
		39X	7	154/926B/38X/7/40-42	385,02	1/256	0,69	0,00270	119095,65	19,103		1,3	0,6	0,3	1,3						0,3		0,6	11,0											
			1	154/926B/39X/1/10-12	385,42	1/1024	2,07	0,00202	128123,67	19,120		1,2			2,7								3,1		6,6										
				154/926B/39X/1/71-73	386,03	1/512	1,07	0,00209	117233,64	19,143				0,4	0,8								0,4	0,4	8,2				0,4		0,8			0,4	
			154/926B/39X/1/110-112	386,42	1/1024	1,92	0,00188	148800,00	19,153		0,4			1,5								3,0	0,7	7,0				0,4		1,1			0,4		
			2	154/926B/39X/2/50-52	387,32	1/512	1,13	0,00221	157677,88	19,173		0,3			0,3	0,3						0,9		6,1						0,6					
				154/926B/39X/2/90-92	387,72	1/512	1,88	0,00367	76255,32	19,184		0,7			2,5									2,9				0,7		2,2					
			3	154/926B/39X/3/55-57	388,87	1/1024	1,90	0,00186	125035,79	19,218					2,7	0,4							6,7	4,9							0,4				
				154/926B/39X/3/95-97	389,27	1/512	0,71	0,00139	145667,61	19,237	0,5	0,5												9,0											
			4	154/926B/39X/4/50-52	390,32	1/1024	2,75	0,00269	75589,82	19,273		0,5	0,5		0,5									6,1					3,0						
				154/926B/39X/4/75-77	390,57	1/1024	1,59	0,00155	137821,38	19,281														0,5	9,4	0,5									
			5	154/926B/39X/4/135-137	391,17	1/256	0,64	0,00250	156000,00	19,299														7,8							0,5				
				154/926B/39X/5/20-22	391,52	1/1024	2,43	0,00237	106613,99	19,309		0,4			0,8	0,4								12,5						0,8					
			6	154/926B/39X/5/115-117	392,47	1/512	1,08	0,00211	97659,26	19,344					1,0						0,5			1,0	9,9			0,5		0,5					
				154/926B/39X/5/145-147	392,77	1/256	0,64	0,00250	147600,00	19,360					0,3									8,5											
			7	154/926B/39X/6/30-32	393,12	1/1024	2,01	0,00196	102909,45	19,371					0,5								3,3		8,5	0,5									
				154/926C/39X/5/80-82	393,52	1/256	0,70	0,00273	119222,86	19,383		0,3				0,3							1,1	9,5											
C	39X		5	154/926C/39X/5/120-122	393,92	1/1024	1,72	0,00168	203013,95	19,397					1,5								0,3	9,9			0,3			0,6					
			6	154/926C/39X/6/50-52	394,72	1/128	0,88	0,00688	53090,91	19,423												2,2	0,8	13,1						0,3					
				154/926C/39X/6/110-112	395,32	1/512	1,29	0,00252	122244,96	19,443				0,3								2,0	0,3	11,5						0,7					

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 µm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globigerinoides</i> sp.	<i>Globigerinoides altiaperturus</i>	<i>Globigerinoides bolli</i>	<i>Globigerinoides obliquus</i>	<i>Globigerinoides parawoodi</i> gr.	<i>Globigerinoides subquadratus</i>	<i>Globobuccina de hiscens</i>	<i>Globorotalia mendacis</i>	<i>Globorotalia</i> sp. (Spezzaferri, 1994)	<i>Globorotalia praescitula</i>	<i>Globorotaloides</i> spp.	<i>Globorotaloides</i> sp.1	<i>Globorotaloides stainforthi</i>	<i>Globorotaloides suteri</i>	<i>Globorotaloides testarugosus</i>	<i>Globorotaloides variabilis</i>	<i>Globoturborotalita</i> spp.	<i>Globoturborotalita</i> sp.A	<i>Globoturborotalita brazieri</i>	<i>Globoturborotalita connecta</i>	<i>Globoturborotalita cf. druryi</i>	<i>Globoturborotalita eolabiocrassata</i>	<i>Globoturborotalita euapertura</i>
B	40X	1	154/926B/40X/1/45-47	395,37	1/256	0,75	0,00293	96256,00	19,447											4,0		0,4	6,6							0,7		
			154/926B/40X/1/105-107	395,97	1/512	1,05	0,00205	113127,62	19,465							1,3								7,4						1,7		
		2	154/926B/40X/2/75-77	397,17	1/512	1,25	0,00244	126566,40	19,501														0,7	9,6					0,3	0,7		
			154/926B/40X/2/135-137	397,77	1/1024	1,85	0,00181	143913,51	19,517					0,4	1,6							3,3	0,8	8,2			0,8	1,2	0,4	0,4		
		3	154/926B/40X/3/45-47	398,37	1/256	1,11	0,00434	61117,12	19,536													0,9		14,8						0,4		
			154/926B/40X/3/120-122	399,12	1/512	1,25	0,00244	100761,60	19,562						2,0							2,0		12,2						0,8		
		4	154/926B/40X/4/85-87	400,27	1/512	1,04	0,00203	120615,38	19,603	0,4			0,4	1,7										13,5			0,4			0,4		
			154/926B/40X/4/145-147	400,87	1/1024	1,58	0,00154	137397,47	19,626						1,5									17,8						1,0		
		5	154/926B/40X/5/11-13	401,03	1/256	0,83	0,00324	98698,80	19,633							1,1								14,4								
			154/926B/40X/5/52,5-54,5	401,45	1/256	1,49	0,00582	64257,72	19,655						0,3	2,1							0,3	15,0			0,3					
		6	154/926B/40X/5/100-102	401,92	1/256	0,86	0,00336	69358,14	19,670					0,4	1,3									8,9								
			154/926B/40X/6/13-15	402,55	1/1024	1,80	0,00176	216746,67	19,692	0,5			0,5	0,8								3,5		8,1								
6	154/926B/40X/6/69-71	403,11	1/1024	2,08	0,00203	138830,77	19,717					1,1	3,6	2,1						0,7	0,4	8,2					1,1			0,7		
	154/926C/40X/6/15-17	404,06	1/512	0,91	0,00178	138971,43	19,767					0,4	0,8	0,4						2,7		19,1			0,8							
C	40X	6	154/926B/41X/1/35-37	404,57	1/128	0,23	0,00180	173634,78	19,815											1,0		6,6		1,0								
B	41X	1	154/926B/41X/1/90-92	405,12	1/256	0,41	0,00160	235395,12	19,835											2,4	0,6	1,5		0,9								
			154/926B/41X/2/48-50	405,70	1/256	0,23	0,00090	287165,22	19,869												0,8	0,4	13,0		1,2	0,4						
		2	154/926B/41X/2/108-110	406,30	1/64	0,12	0,00188	201600,00	19,891					0,3							2,9		15,1		1,1				0,3			
			154/926B/41X/3/45-47	407,17	1/512	2,14	0,00418	79910,28	19,913					0,3	0,6						2,8	0,6	11,7		0,3				1,2			
		4	154/926B/41X/4/15-17	408,37	1/128	0,23	0,00180	121321,74	19,949												0,9	0,9	7,5		0,9							
			154/926B/41X/4/125-127	409,17	1/256	1,02	0,00398	81317,65	19,997	0,3		0,3	0,3								2,5	0,9	16,6									
		5	154/926B/41X/5/15-17	409,87	1/1024	0,94	0,00092	267982,98	20,011					2,9	4,8						2,9	0,5	11,1		1,0							
			154/926C/41X/3/140-142	410,28	1/128	0,24	0,00188	155733,33	20,081		0,3		0,7						0,3		0,7	1,7	12,8		1,0	0,3						
C	41X	4	154/926C/41X/4/70-72	411,08	1/128	0,24	0,00188	121066,67	20,118									0,9		0,9		8,7		0,9								
			154/926C/41X/4/145-147	411,83	1/2048	1,42	0,00069	429791,55	20,152					1,0				2,1		2,1	1,0	11,5		3,5								
		5	154/926C/41X/5/50-52	412,38	1/1024	1,03	0,00101	338019,42	20,178					1,2				3,1		3,4	0,9	7,4		1,5					0,3			
			154/926C/41X/5/110-112	412,98	1/256	0,55	0,00215	179665,45	20,205					0,8				2,4		1,6	1,3	6,3		1,1								
B	42X	1	154/926B/42X/1/101-103	414,93	1/512	0,50	0,00098	260096,00	20,232					1,1	0,4				4,9		3,9	0,4	10,2		1,4							
			154/926B/42X/2/10-12	415,52	1/512	1,08	0,00211	189629,63	20,247				0,3	0,8					6,6		2,1		7,9		1,3							
		2	154/926B/42X/2/88-90	416,30	1/512	0,88	0,00172	143127,27	20,269					0,8						1,3		2,9		11,3		0,8						
			154/926B/42X/2/145-147	416,87	1/1024	1,41	0,00138	236028,37	20,288							1,6			5,7		3,5	1,3	7,5		0,9			0,6				
		3	154/926B/42X/3/73-75	417,65	1/2048	1,72	0,00084	320297,67	20,314							0,9			4,5			1,3	10,3		1,8							
			154/926B/42X/3/135-137	418,27	1/1024	1,86	0,00182	114511,83	20,333					0,5	0,5		1,0	5,0				1,0	6,0		2,0							
		4	154/926B/42X/4/86-88	419,28	1/256	0,30	0,00117	174933,33	20,359					0,5	0,5			1,5			2,9	1,0	5,4		2,5							

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 µm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globigerinoides</i> sp.	<i>Globigerinoides altiapertura</i>	<i>Globigerinoides bolli</i>	<i>Globigerinoides obliquus</i>	<i>Globigerinoides parawoodi</i> gr.	<i>Globigerinoides subquadratus</i>	<i>Globoquadrina dehiscentis</i>	<i>Globorotalia mendacis</i>	<i>Globorotalia</i> sp. (Spezzaferri, 1994)	<i>Globorotalia praescitula</i>	<i>Globorotaloides</i> spp.	<i>Globorotaloides</i> sp.1	<i>Globorotaloides stainforthi</i>	<i>Globorotaloides suteri</i>	<i>Globorotaloides testarugosus</i>	<i>Globorotaloides variabilis</i>	<i>Globoturborotalita</i> spp.	<i>Globoturborotalita</i> sp.A	<i>Globoturborotalita brazieri</i>	<i>Globoturborotalita connecta</i>	<i>Globoturborotalita cf. druryi</i>	<i>Globoturborotalita eolabiocrassata</i>	<i>Globoturborotalita euapertura</i>
B	42X	5	154/926B/42X/5/80-82	420,72	1/1024	2,24	0,00219	174628,57	20,398					0,3	0,3			17,3				1,6	0,5	4,1		1,4						
			154/926B/42X/6/10-12	421,52	1/1024	1,20	0,00117	175786,67	20,427				1,0		2,0		2,0	7,0				1,5	1,5	8,5			0,5					
		6	154/926B/42X/6/65-67	422,07	1/1024	1,45	0,00142	242228,97	20,451				0,6	0,6	0,9			21,3				2,5	1,2	9,0								
			154/926B/42X/6/145-147	422,87	1/512	0,71	0,00139	172349,30	20,475									10,6						0,4	5,5		0,4					
C	42X	7	154/926B/42X/7/20-22	423,12	1/512	1,38	0,00270	141727,54	20,482	0,3			0,3		0,3			4,2				1,3	0,3	5,0		1,3			0,3			
		5	154/926C/42X/5/45-47	423,67	1/256	0,48	0,00188	152533,33	20,469									1,1				1,8	1,1	4,1		2,2						
			154/926B/43X/1/90-92	424,42	1/256	0,69	0,00270	140614,49	20,525									2,9				0,6		3,8		0,3			0,3			
			154/926B/43X/2/35-37	425,37	1/128	0,48	0,00375	106133,33	20,552									1,0						0,3	3,5		3,0			0,3		
B	43X		154/926B/43X/2/90-92	425,92	1/512	1,22	0,00238	153180,33	20,571								3,3					2,0	2,0	1,7		3,0				0,3		
		2	154/926B/43X/3/10-12	426,62	1/512	0,80	0,00156	132480,00	20,599									1,0				0,5	1,5	4,4		4,4						
			154/926B/43X/3/72-74	427,24	1/256	0,68	0,00266	121600,00	20,620																							
		3	154/926B/43X/4/30-32	428,32	1/1024	1,54	0,00150	141631,17	20,650			0,5		0,9									2,4		6,1		1,9					
			154/926B/43X/4/130-132	429,32	1/512	1,07	0,00209	127760,75	20,685									0,8					3,8	0,8	10,9		4,5					
		4	154/926B/43X/5/65-67	430,17	1/512	0,29	0,00057	368993,10	20,714			0,5					1,0			2,9		1,9	1,0	10,1		1,4						
			154/926B/43X/5/145-147	430,97	1/128	0,20	0,00156	138880,00	20,737									1,0					1,9	6,7		1,0						
		6	154/926B/43X/6/75-77	431,77	1/256	0,49	0,00191	119640,82	20,762								0,5						1,4	9,3		4,2						
		CC	154/926B/43X/CC/25-27	432,27	1/512	0,57	0,00111	195817,54	20,778			0,5						7,4				8,9		12,4		4,0						
	44X	1	154/926B/44X/1/115-117	434,37	1/512	1,03	0,00201	166027,18	20,850					0,9			0,3					6,0	0,3	12,3		0,9				0,3		
		2	154/926B/44X/2/85-87	435,57	1/256	0,47	0,00184	151965,96	20,896													5,0	0,4	11,9						0,4		
			154/926B/44X/3/36,5-38,5	436,59	1/4096	1,25	0,00031	697958,40	20,931								0,9					5,1	0,5	7,4		1,4			0,5			
		3	154/926B/44X/3/135-137	437,57	1/256	0,35	0,00137	154331,43	20,963								0,9					5,2	2,4	14,7		0,9			0,9	0,5		
			154/926B/44X/4/125-127	438,97	1/256	0,31	0,00121	199845,16	21,003				0,4									4,5	0,4	11,0		1,6						
		5	154/926B/44X/5/96-98	440,18	1/1024	1,44	0,00141	164977,78	21,039				0,9	0,4			1,7					9,6		9,1	0,4	0,4						
			154/926B/44X/6/110-112	441,82	1/512	0,63	0,00123	194234,92	21,092					0,8			1,3					12,2		14,3								
		6	154/926B/44X/6/110-112	441,82	1/512	0,63	0,00123	194234,92	21,092					0,8			1,3					12,2		14,3								
	45X	1	154/926B/45X/1/85-87	443,77	1/256	0,83	0,00324	98390,36	21,165				0,3				0,6			0,6		0,9	0,6	1,3					0,3	0,3		
			154/926B/45X/2/55-57	444,97	1/1024	1,27	0,00124	174160,63	21,200											1,4			0,9	2,8		0,5						
		2	154/926B/45X/3/45-47	446,37	1/512	1,01	0,00197	101893,07	21,250	2,0			0,5	3,0			2,0			2,5		6,4	0,5	3,0								
			154/926B/45X/3/125-127	447,17	1/1024	1,64	0,00160	141112,20	21,279						0,9					4,5			0,4	7,1						0,4		
		4	154/926B/45X/4/100-102	448,42	1/512	1,13	0,00221	138194,69	21,321				0,3	0,6	1,0		1,9			2,6		1,9		0,3	0,3	1,9						
			154/926B/45X/5/10-12	449,02	1/512	1,08	0,00211	115674,07	21,341								0,8			5,0		2,1		2,5								
		5	154/926B/45X/5/90-92	449,82	1/512	0,56	0,00109	234057,14	21,367					0,4			0,4			2,7			0,8	1,6		1,2						
		6	154/926B/45X/6/60-62	451,02	1/256	0,59	0,00230	155335,59	21,406					0,6			1,4			4,7		2,2	1,1	6,4		1,9						

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globotuborotalita martini</i>	<i>Globotuborotalita oclusa</i>	<i>Globotuborotalita paracancellata</i>	<i>Globotuborotalita pseudoprae-bulloidis</i>	<i>Globotuborotalita woodi</i>	<i>Paragloborotalia</i> sp.1	<i>Paragloborotalia</i> spp.	<i>Paragloborotalia</i> cf. <i>P. bella</i> [DX]	<i>Paragloborotalia</i> cf. <i>P. bella</i> [SX]	<i>Paragloborotalia</i> cf. <i>bella</i>	<i>Paragloborotalia</i> birnageae	<i>Paragloborotalia</i> siakensis [4 camere]	<i>Paragloborotalia continuosa</i> gr.	<i>Paragloborotalia nana</i>	<i>P. pseudokugleri</i> / <i>P. kugleri</i>	<i>Paragloborotalia</i> siakensis [DX]	<i>Paragloborotalia</i> siakensis [SX]	<i>Paragloborotalia</i> siakensis gr.	<i>Tenuitella</i> sp.	<i>Tenuitella angustiumblicata</i>	<i>Tenuitella clemenciae</i> gr.	<i>Tenuitella munda</i>	<i>Tenuitella praestainforthi</i>		
C	34X	3	154/926C/34X/3/20-22	340,71	1/256	0,36	0,00141	179200,00	17,603		0,4			0,4	4,6		0,8	1,5	2,3			2,3	0,4			7,6	9,5	17,1		0,4		0,4		
			154/926C/34X/3/60-62	341,11	1/1024	2,40	0,00234	150186,67	17,614		0,9				1,8	3,8					1,5		0,6	1,2			3,5	1,8	5,3	2,1		0,6		
			154/926C/34X/3/115-117	341,66	1/1024	2,18	0,00213	158297,25	17,630			1,2			2,4	4,6		0,9	0,6	1,5	0,3	0,6				4,9	6,1	10,9	2,1		0,3	0,3		
		4	154/926C/34X/4/45-47	342,46	1/1024	2,39	0,00233	130677,82	17,652		0,3				1,3	6,8					0,3	1,6					3,6	4,6	8,1	1,0				
			154/926C/34X/4/105-107	343,06	1/1024	1,95	0,00190	137583,59	17,668		0,4	0,4			0,8	8,3					0,4						6,8	6,4	13,2	1,1				
			154/926C/34X/5/115-117	344,66	1/512	1,29	0,00252	114306,98	17,713						1,4	14,8					0,4						8,1	10,9	19,0	1,4			0,4	
B	35X	1	154/926B/35X/6/25-27	345,26	1/1024	2,58	0,00252	138517,83	17,729					2,3	12,5					0,3		1,2				5,5	4,1	9,6	2,3				0,3	
			154/926B/35X/1/15-17	346,87	1/2048	4,00	0,00195	129536,00	17,770				0,4	0,4	12,8					0,4						8,2	10,7	18,9	1,2		1,2			
		2	154/926B/35X/1/95-97	347,67	1/1024	3,26	0,00318	115278,53	17,791			1,4	0,3	1,9	9,8							0,3					3,8	8,7	12,6	1,6				
			154/926B/35X/2/40-42	348,62	1/1024	1,72	0,00168	173841,86	17,819						0,7	4,5							0,7	0,3			4,5	8,6	13,0	1,4				
		3	154/926B/35X/3/30-32	350,02	1/1024	2,12	0,00207	156015,09	17,859		0,3				2,8	1,6						0,6	0,3				3,4	3,4	6,9	0,3		0,6		
			154/926B/35X/3/125-127	350,97	1/512	2,50	0,00488	73318,40	17,891						4,3	2,1		0,3	0,3								4,3	5,8	10,1	1,2				
		4	154/926B/35X/4/30-32	351,52	1/2048	2,37	0,00116	385404,22	17,917		0,2				3,6	2,7					0,2		0,9	0,2			3,0	3,0	5,9	2,7		0,7		
			154/926B/35X/4/85-87	352,07	1/1024	2,73	0,00267	151912,09	17,939					0,3	5,8	1,0											3,5	5,8	9,3	1,3	0,3	0,3		
		5	154/926B/35X/5/70-72	353,42	1/1024	2,50	0,00244	146227,20	17,986		0,6				1,4	5,2							0,9				2,0	2,9	4,9	2,3		0,3		
			154/926B/35X/6/30-32	354,52	1/1024	2,51	0,00245	166043,03	18,028		0,2				2,7	4,7					1,0	0,7					2,7	4,0	6,7	1,0	0,7		0,2	
		6	154/926B/35X/6/90-92	355,12	1/1024	1,46	0,00143	158509,59	18,053						1,3	1,3							0,4				4,3	6,9	11,3	1,3	1,3			
			154/926B/35X/7/15-17	355,87	1/1024	1,93	0,00188	163415,54	18,084						1,9	5,8		1,6	0,3	1,9	0,3						7,1	11,0	18,2	1,9	0,3	1,0		
B	36X	1	154/926B/36X/1/15-17	356,47	1/512	1,11	0,00217	155445,05	18,115		0,6		0,9	2,4	2,1		0,6	0,6	1,2			0,9				5,2	4,6	9,8	2,8	1,2	0,9			
			154/926B/36X/1/80-82	357,12	1/1024	2,92	0,00285	142728,77	18,149					0,5	5,0	2,5										3,2	3,5	6,7	2,0	1,5	0,5	0,5		
		2	154/926B/36X/2/25-27	358,07	1/1024	1,64	0,00160	156097,56	18,181		0,9				3,9	1,7						0,4	0,4				3,5	1,7	5,2	3,9	1,3	0,4		
			154/926B/36X/2/138-140	359,20	1/2048	1,69	0,00083	340525,44	18,213					1,1	3,5	3,2		0,4		0,4				0,7			1,8	3,2	4,9	1,1	2,8	1,1	0,4	
		3	154/926B/36X/3/45-47	359,77	1/1024	2,50	0,00244	103628,80	18,231		2,3				3,1	4,2		0,8	0,8	1,5		0,4	0,4				3,8	3,8	7,6		4,2		1,1	
			154/926B/36X/3/105-107	360,37	1/1024	2,94	0,00287	127477,55	18,259		0,3		0,3	4,2	6,2		0,3	0,3	0,6				0,8	0,6			3,7	7,0	10,7	0,8	1,1			
		4	154/926B/36X/4/50-52	361,32	1/1024	1,57	0,00153	171536,31	18,305		1,2		0,4	4,4	4,8		0,4	0,4	0,8	2,4			0,8				4,0	1,6	5,6			2,4	1,2	
			154/926B/36X/4/110-112	361,92	1/1024	1,53	0,00149	163973,86	18,323		0,8				5,1	3,0											5,1	6,3	11,4		1,3	1,7		
B	37X	1	154/926B/37X/1/30-32	366,32	1/512	1,52	0,00297	101389,47	18,422		0,7	0,3		3,7						0,7						8,8	18,0	26,9	1,4	0,7				
			154/926B/37X/2/37-39	367,89	1/512	1,48	0,00289	78529,73	18,480		0,9				6,3	7,6			0,4	0,4						4,9	7,6	12,5			0,9			
		2	154/926B/37X/2/115-117	368,67	1/256	0,46	0,00180	182539,13	18,510		0,3					4,3			0,6	0,6	0,6				0,3		7,6	9,8	17,4	1,2	1,8			
			154/926B/37X/3/40-42	369,42	1/256	0,47	0,00184	185191,49	18,536						1,7	1,4			0,3	0,3			0,9	0,3			10,7	12,4	23,1			1,2		
		3	154/926B/37X/3/120-122	370,22	1/512	0,90	0,00176	151324,44	18,560					0,4	1,5	6,0		0,4	0,4	0,8						11,7	15,5	27,2	1,1	1,5				
			154/926B/37X/4/25-27	370,77	1/512	0,24	0,00047	633600,00	18,583						0,3	4,4		0,7	0,7	1,3	0,3					11,1	9,4	20,5	0,7			0,3		
		4	154/926B/37X/4/80-82	371,32	1/512	1,05	0,00205	177493,33	18,604		0,3				0,3	3,6		0,8	0,5	1,4			2,7	0,3			8,7	11,7	20,5	1,1	0,3			
			154/926B/37X/5/10-12	372,12	1/512	0,92	0,00180	172521,74	18,629		1,6		0,7	3,3	4,2												6,8	7,8	14,7		1,6	1,6		
5	154/926B/37X/5/105-107	373,07	1/512	2,03	0,00396	84997,04	18,665		0,9				3,7	1,6		2,2	0,3	2,5				0,3	0,3			4,7	6,5	11,2		1,9	0,6	0,3		

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globoturbotalita martini</i>	<i>Globoturbotalita oclusa</i>	<i>Globoturbotalita paracancellata</i>	<i>Globoturbotalita pseudopraeuloides</i>	<i>Globoturbotalita woodi</i>	<i>Paragloborotalia</i> sp.1	<i>Paragloborotalia</i> spp.	<i>Paragloborotalia</i> cf. <i>P. bella</i> [DX]	<i>Paragloborotalia</i> cf. <i>P. bella</i> [SX]	<i>Paragloborotalia</i> cf. <i>bella</i>	<i>Paragloborotalia birnagaeae</i>	<i>Paragloborotalia siakensis</i> [4 camere]	<i>Paragloborotalia continuosa</i> gr.	<i>Paragloborotalia nana</i>	<i>P. pseudokugleri</i> / <i>P. kugleri</i>	<i>Paragloborotalia siakensis</i> [DX]	<i>Paragloborotalia siakensis</i> [SX]	<i>Paragloborotalia siakensis</i> gr.	<i>Tenuitella</i> sp.	<i>Tenuitella angustumilicata</i>	<i>Tenuitella clemenciae</i> gr.	<i>Tenuitella munda</i>	<i>Tenuitella praestainforthi</i>				
C	37X	5	154/926C/37X/5/60-62	373,59	1/1024	1,61	0,00157	155190,06	18,667				0,8	3,3	4,1							1,7	0,4			6,6	5,8	12,4		1,2		0,4				
		6	154/926C/37X/6/10-12	374,59	1/1024	1,71	0,00167	158690,06	18,700		1,1			0,8	8,7	1,5							0,4		0,4		5,3	4,2	9,5				0,4			
		7	154/926C/37X/7/10-12	375,59	1/1024	1,19	0,00116	178984,87	18,734					1,5	1,5	8,4								0,5		7,4	5,4	12,8								
B	38X	1	154/926B/38X/1/55-57	376,17	1/1024	2,45	0,00239	153808,98	18,763		0,5		0,3	3,8	3,6								0,3			5,7	6,3	12,0		0,8						
			154/926B/38X/1/136-138	376,98	1/1024	2,45	0,00239	175960,82	18,790		1,4			2,9	5,7							0,2	0,5			9,0	10,0	19,0		1,7						
		2	154/926B/38X/2/25-27	377,37	1/1024	1,88	0,00184	199897,87	18,805		1,1		0,3	4,5	3,1		0,3		0,3			0,3				5,1	4,2	9,3		1,1	1,4					
			154/926B/38X/2/105-107	378,17	1/1024	2,26	0,00221	149522,12	18,832		1,5		2,7	3,0	3,0		0,6		0,6			0,9				3,3	6,3	9,7		0,9		0,3	0,6			
		3	154/926B/38X/3/35-37	378,97	1/256	0,44	0,00172	146036,36	18,858					0,4	0,8	5,0		0,4	0,4	0,8						15,5	12,1	27,6				0,4				
			154/926B/38X/3/75-77	379,37	1/1024	2,31	0,00226	157367,97	18,872	0,3	2,9		1,2	8,5	2,1							0,3	0,3			3,2	4,4	7,6		0,6		0,6				
		4	154/926B/38X/4/5-7	380,17	1/512	1,08	0,00211	229451,85	18,905		0,4				3,9				0,8	0,8			1,0	0,2			11,8	7,5	19,3		0,8			0,4		
			154/926B/38X/4/45-47	380,57	1/1024	2,01	0,00196	191554,23	18,920		1,6			0,5	4,3	4,0		0,5	0,8	1,3			0,5			7,4	3,7	11,2		0,5	1,3					
			154/926B/38X/4/125-127	381,37	1/2048	1,62	0,00079	348918,52	18,949						5,9	5,5		1,5	1,5	3,0			0,4	0,7		5,9	7,7	13,7		0,7						
		5	154/926B/38X/5/55-57	382,17	1/512	1,18	0,00230	126698,31	18,979					2,4	6,3		1,0	0,7	1,7				1,0	0,3		7,7	13,6	21,3					0,3			
			154/926B/38X/5/95-97	382,57	1/1024	2,40	0,00234	130560,00	18,995					2,2	8,3		3,6	1,8	5,4				1,1	1,1		11,2	6,5	17,7		1,4	0,4					
			154/926B/38X/6/5-7	383,17	1/1024	2,79	0,00272	110107,53	19,020		1,0			0,7	3,8		0,3	1,0	1,4				1,7	0,7		6,6	6,9	13,4		0,7						
		6	154/926B/38X/6/45-47	383,57	1/2048	2,86	0,00140	221269,93	19,036					1,0	9,5								0,3			12,2	13,6	25,8		0,7	0,3		0,7			
			154/926B/38X/6/110-112	384,22	1/1024	1,78	0,00174	128287,64	19,065		1,4			5,9	5,9							0,9				7,3	8,2	15,5								
		7	154/926B/38X/7/40-42	385,02	1/256	0,69	0,00270	119095,65	19,103					1,3	7,3						0,3						14,2	13,6	27,8		0,3					
		B	39X	1	154/926B/39X/1/10-12	385,42	1/1024	2,07	0,00202	128123,67	19,120		0,8			3,1	5,8							0,4			5,8	5,0	10,8		0,4	0,4				
					154/926B/39X/1/71-73	386,03	1/512	1,07	0,00209	117233,64	19,143					2,4	12,2											12,2	7,3	19,6					0,4	
					154/926B/39X/1/110-112	386,42	1/1024	1,92	0,00188	148800,00	19,153		1,5			1,5	4,8											5,9	12,5	18,5		0,4		0,4		
				2	154/926B/39X/2/50-52	387,32	1/512	1,13	0,00221	157677,88	19,173		1,5			3,2	7,3							0,3				8,7	9,9	18,6		0,3				
					154/926B/39X/2/90-92	387,72	1/512	1,88	0,00367	76255,32	19,184		0,4		0,4	3,2	5,8											8,6	10,8	19,4						
				3	154/926B/39X/3/55-57	388,87	1/1024	1,90	0,00186	125035,79	19,218		0,4			0,9	4,9	3,6						0,5					3,6	4,0	7,6					
					154/926B/39X/3/95-97	389,27	1/512	0,71	0,00139	145667,61	19,237						7,0	9,5											10,9	10,4	21,4				0,5	
				4	154/926B/39X/4/50-52	390,32	1/1024	2,75	0,00269	75589,82	19,273		1,5			5,1	5,1												4,1	2,5	6,6				0,5	
					154/926B/39X/4/75-77	390,57	1/1024	1,59	0,00155	137821,38	19,281		1,4			3,3	1,9												8,5	8,5	16,9		0,9	0,5		
					154/926B/39X/4/135-137	391,17	1/256	0,64	0,00250	156000,00	19,299		0,8			0,8	5,9						0,3			0,5			11,6	12,1	23,7		0,5	0,3		
				5	154/926B/39X/5/20-22	391,52	1/1024	2,43	0,00237	106613,99	19,309		1,6			1,2	11,3												10,9	6,0	16,9		0,8			
					154/926B/39X/5/115-117	392,47	1/512	1,08	0,00211	97659,26	19,344		0,5			1,5	3,0												13,3	13,3	26,6		3,0			
					154/926B/39X/5/145-147	392,77	1/256	0,64	0,00250	147600,00	19,360		0,3			1,2	8,2		0,9	0,6	1,5			0,6	0,6				14,6	19,1	33,7		1,5			
				6	154/926B/39X/6/30-32	393,12	1/1024	2,01	0,00196	102909,45	19,371		0,5			0,5	8,5		0,9	0,9	1,9				0,5				13,2	12,3	25,5		0,9			
				C	39X	5	154/926C/39X/5/80-82	393,52	1/256	0,70	0,00273	119222,86	19,383		1,1		0,9	9,8		0,3		0,3								15,5	15,8	31,3		2,9		0,3
	154/926C/39X/5/120-122					393,92	1/1024	1,72	0,00168	203013,95	19,397		2,4			1,8	8,7		1,2	2,4	3,6			0,6	0,9			5,4	10,2	15,7		3,6	1,2			
6	154/926C/39X/6/50-52					394,72	1/128	0,88	0,00688	53090,91	19,423		0,3			0,3	8,1											13,1	13,4	26,5		2,2	0,8	0,3		
	154/926C/39X/6/110-112					395,32	1/512	1,29	0,00252	122244,96	19,443		0,7			0,7	4,3		0,7	1,0	1,6							10,5	12,8	23,4		2,0	0,3			

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globoturbotalita martini</i>	<i>Globoturbotalita oclusa</i>	<i>Globoturbotalita paracancellata</i>	<i>Globoturbotalita pseudopraebulloides</i>	<i>Globoturbotalita woodi</i>	<i>Paragloborotalia</i> sp.1	<i>Paragloborotalia</i> spp.	<i>Paragloborotalia</i> cf. <i>P. bella</i> [DX]	<i>Paragloborotalia</i> cf. <i>P. bella</i> [SX]	<i>Paragloborotalia</i> cf. <i>bella</i>	<i>Paragloborotalia birnagae</i>	<i>Paragloborotalia siakensis</i> [4 camere]	<i>Paragloborotalia continuosa</i> gr.	<i>Paragloborotalia nana</i>	<i>P. pseudokugleri</i> / <i>P. kugleri</i>	<i>Paragloborotalia siakensis</i> [DX]	<i>Paragloborotalia siakensis</i> [SX]	<i>Paragloborotalia siakensis</i> gr.	<i>Tenuitella</i> sp.	<i>Tenuitella angustumbilicata</i>	<i>Tenuitella clemenciae</i> gr.	<i>Tenuitella munda</i>	<i>Tenuitella praestainforthi</i>	
B	40X	1	154/926B/40X/1/45-47	395,37	1/256	0,75	0,00293	96256,00	19,447		2,6				7,7								0,4			11,0	13,2	24,2	2,9		0,7	0,4	
			154/926B/40X/1/105-107	395,97	1/512	1,05	0,00205	113127,62	19,465					0,9	13,5											18,3	20,9	39,1	1,3				
		2	154/926B/40X/2/75-77	397,17	1/512	1,25	0,00244	126566,40	19,501					3,0	5,0						0,3	0,3	0,3				14,5	9,2	23,8	2,0		0,3	
			154/926B/40X/2/135-137	397,77	1/1024	1,85	0,00181	143913,51	19,517				1,2	9,4			1,2	1,2	2,4			4,1				2,9	2,4	5,3	2,9		0,8		
		3	154/926B/40X/3/45-47	398,37	1/256	1,11	0,00434	61117,12	19,536		0,9			1,3			1,3	0,4	1,7		0,9	2,2	0,4				11,8	22,7	34,5	3,5	0,9	1,7	
			154/926B/40X/3/120-122	399,12	1/512	1,25	0,00244	100761,60	19,562		0,8	0,4	3,3	4,5	0,4	0,4			0,4	0,8	0,8					13,1	13,1	26,1	6,1		0,8		
		4	154/926B/40X/4/85-87	400,27	1/512	1,04	0,00203	120615,38	19,603		0,4	0,9	0,4	15,3	1,3		1,3	0,4									8,7	13,1	21,8	2,2		0,4	
			154/926B/40X/4/145-147	400,87	1/1024	1,58	0,00154	137397,47	19,626		2,0			0,5	6,4	2,0	0,5	2,5			1,0	1,0	0,5			5,0	4,0	8,9	5,4		0,5		
		5	154/926B/40X/5/11-13	401,03	1/256	0,83	0,00324	98698,80	19,633		0,4			2,2	5,2						0,4			0,7	0,4					0,4			
			154/926B/40X/5/52,5-54,5	401,45	1/256	1,49	0,00582	64257,72	19,655					0,3	3,5	2,7	2,4	1,1	3,5			0,3	1,1			5,6	8,3	13,9	1,6		0,3		
		6	154/926B/40X/5/100-102	401,92	1/256	0,86	0,00336	69358,14	19,670					0,9	6,7							0,9	0,4				6,3	4,9	11,2	2,2		0,9	
			154/926B/40X/6/13-15	402,55	1/1024	1,80	0,00176	216746,67	19,692		0,3	0,5	1,1	4,0	2,2	2,2	4,3	0,5				0,5			0,5		9,2	5,7	14,8	1,3		0,5	
		6	154/926B/40X/6/69-71	403,11	1/1024	2,08	0,00203	138830,77	19,717		0,7	2,1	8,5			0,7	0,7	1,4				0,4					2,8	4,3	7,1				
			154/926C/40X/6/15-17	404,06	1/512	0,91	0,00178	138971,43	19,767		0,8			2,3	0,8	0,4	0,4	0,8			0,8	1,2					2,0	5,5	7,4	0,8		0,4	
C	40X	6	154/926C/40X/6/15-17	404,06	1/512	0,91	0,00178	138971,43	19,767		0,8			2,3	0,8	0,4	0,4	0,8			0,8	1,2				2,0	5,5	7,4	0,8		0,4		
			154/926B/41X/1/35-37	404,57	1/128	0,23	0,00180	173634,78	19,815						1,0	1,0	1,7	2,7		0,7	1,7	1,3				6,3	5,3	11,6	2,0		0,7		
		1	154/926B/41X/1/90-92	405,12	1/256	0,41	0,00160	235395,12	19,835					0,3	4,5	0,3	1,2	1,5	1,2			1,2				8,0	8,3	16,3			0,3		
			154/926B/41X/2/48-50	405,70	1/256	0,23	0,00090	287165,22	19,869						5,5		0,4	0,8	1,2	1,2	0,8	1,6	1,6			7,5	9,4	16,9					
		2	154/926B/41X/2/108-110	406,30	1/64	0,12	0,00188	201600,00	19,891		0,3				7,7							1,6	4,0	0,5			14,1	11,9	26,0			0,5	
			154/926B/41X/3/45-47	407,17	1/512	2,14	0,00418	79910,28	19,913		0,9			3,1	4,0					0,3		0,9				3,1	3,7	6,7	0,3		0,6		
		4	154/926B/41X/4/15-17	408,37	1/128	0,23	0,00180	121321,74	19,949		0,5				5,6			1,4	1,4	0,5	0,5	1,4	1,9				8,9	6,5	15,4			0,5	0,5
			154/926B/41X/4/125-127	409,17	1/256	1,02	0,00398	81317,65	19,997					2,2	6,9						0,6	1,3	0,6				7,5	2,8	10,3	0,3	0,6	0,9	
		5	154/926B/41X/5/15-17	409,87	1/1024	0,94	0,00092	267982,98	20,011					1,0	2,9		1,0	1,0				0,5					3,8	2,9	6,7			1,4	
			154/926C/41X/3/140-142	410,28	1/128	0,24	0,00188	155733,33	20,081					1,7	1,4						1,0	1,0	0,3	0,3			6,2	4,8	11,1				
		4	154/926C/41X/4/70-72	411,08	1/128	0,24	0,00188	121066,67	20,118		0,5				0,5	2,3	2,3	2,3	2,3	2,3	0,5	0,9	6,9	9,2	16,1		0,5						
			154/926C/41X/4/145-147	411,83	1/2048	1,42	0,00069	429791,55	20,152		0,3				2,8	0,7	1,0	1,7			1,4	1,0	0,3				7,3	2,4	9,8	0,3	0,3		
		5	154/926C/41X/5/50-52	412,38	1/1024	1,03	0,00101	338019,42	20,178		1,2			1,8	7,1			0,6	0,6			0,9		1,2	2,8	3,4	6,2		0,3		0,6		
			154/926C/41X/5/110-112	412,98	1/256	0,55	0,00215	179665,45	20,205		0,5			1,8	2,1						0,3	0,8				1,3	7,7	10,0	17,7				
B	42X	1	154/926B/42X/1/101-103	414,93	1/512	0,50	0,00098	260096,00	20,232				0,4	0,7	1,1							0,4	1,1	1,4	1,8	3,2							
			154/926B/42X/2/10-12	415,52	1/512	1,08	0,00211	189629,63	20,247		0,5				2,1							0,3	0,5	1,9	3,4	3,7	7,1						
		2	154/926B/42X/2/88-90	416,30	1/512	0,88	0,00172	143127,27	20,269		0,4				4,6						0,8			1,3	0,8	1,3	3,4	4,6		0,8		0,8	0,4
			154/926B/42X/2/145-147	416,87	1/1024	1,41	0,00138	236028,37	20,288		0,6			1,9	2,5	1,6		1,6			0,6	0,6	0,3	3,8	1,9	1,3	3,1		0,6				
		3	154/926B/42X/3/73-75	417,65	1/2048	1,72	0,00084	320297,67	20,314		0,4			0,4	0,4						1,3		0,9			6,3	1,8	2,2	4,0				0,4
			154/926B/42X/3/135-137	418,27	1/1024	1,86	0,00182	114511,83	20,333					2,0	3,0			0,5	0,5	2,0		0,5	0,5	3,0	1,5	1,5	3,0		3,0				
		4	154/926B/42X/4/86-88	419,28	1/256	0,30	0,00117	174933,33	20,359					0,5	5,9		0,5		0,5	1,0		0,5	0,5	0,5	9,8	10,3	20,1	0,5					

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globotuboralita martini</i>	<i>Globotuboralita oclusa</i>	<i>Globotuboralita paracancellata</i>	<i>Globotuboralita pseudopraebulloides</i>	<i>Globotuboralita woodi</i>	<i>Paragloborotalia</i> sp.1	<i>Paragloborotalia</i> spp.	<i>Paragloborotalia</i> cf. <i>P. bella</i> [DX]	<i>Paragloborotalia</i> cf. <i>P. bella</i> [SX]	<i>Paragloborotalia</i> cf. <i>bella</i>	<i>Paragloborotalia birnageae</i>	<i>Paragloborotalia siakensis</i> [4 camere]	<i>Paragloborotalia continuosa</i> gr.	<i>Paragloborotalia nana</i>	<i>P. pseudokugleri</i> / <i>P. kugleri</i>	<i>Paragloborotalia siakensis</i> [DX]	<i>Paragloborotalia siakensis</i> [SX]	<i>Paragloborotalia siakensis</i> gr.	<i>Tenuitella</i> sp.	<i>Tenuitella angustumbilicata</i>	<i>Tenuitella demenciae</i> gr.	<i>Tenuitella munda</i>	<i>Tenuitella praestainforthi</i>	
B	42X	5	154/926B/42X/5/80-82	420,72	1/1024	2,24	0,00219	174628,57	20,398					1,1	5,2		1,9	1,9	1,9	0,5	1,9	0,5			1,9	1,9	3,8						
		6	154/926B/42X/6/10-12	421,52	1/1024	1,20	0,00117	175786,67	20,427						4,5					1,5	1,5		1,0	0,5	3,5	4,0							
			154/926B/42X/6/65-67	422,07	1/1024	1,45	0,00142	242228,97	20,451	0,6		0,3	1,2	0,6		3,4		3,4	0,3	1,9	2,5	0,3	3,4	2,2	1,5	3,7					0,6		
			154/926B/42X/6/145-147	422,87	1/512	0,71	0,00139	172349,30	20,475				0,4	4,7		0,9	0,9	1,7		1,7	3,0	1,7		9,4	7,7	17,0	0,4		0,4				
7	154/926B/42X/7/20-22	423,12	1/512	1,38	0,00270	141727,54	20,482						0,3	4,5		0,5	0,3	1,6	3,4	1,1	0,8	11,7	9,8	21,5	1,1			0,8					
C	42X	5	154/926C/42X/5/45-47	423,67	1/256	0,48	0,00188	152533,33	20,469	0,4				6,3	1,1	1,1		1,8	2,6	2,2	0,7	11,8	11,4	23,2									
B	43X		154/926B/43X/1/90-92	424,42	1/256	0,69	0,00270	140614,49	20,525	0,6			0,3	5,6	0,9	0,9		2,1	3,8		1,2	13,9	15,9	29,8	2,7						0,3		
		2	154/926B/43X/2/35-37	425,37	1/128	0,48	0,00375	106133,33	20,552	0,3				11,6	1,5	1,0	2,5	5,6	9,1	2,3		13,4	15,9	29,4	1,0		2,3	2,0					
			154/926B/43X/2/90-92	425,92	1/512	1,22	0,00238	153180,33	20,571				0,7			1,3	1,3		1,3	3,0	1,3	1,0	17,2	20,8	38,0	0,3		1,3					
			3	154/926B/43X/3/10-12	426,62	1/512	0,80	0,00156	132480,00	20,599						8,3				1,5	7,3	9,2	2,9		19,4	18,0	37,4	0,5					
		154/926B/43X/3/72-74		427,24	1/256	0,68	0,00266	121600,00	20,620						7,5		0,7	3,4	4,1		6,2	7,2	2,7	1,4	13,0	18,5	31,5	0,3		1,7			
		4		154/926B/43X/4/30-32	428,32	1/1024	1,54	0,00150	141631,17	20,650						0,9	3,8	0,5			2,4	5,2	10,4	2,4		14,6	18,9	33,5	1,9		2,8	0,5	
			154/926B/43X/4/130-132	429,32	1/512	1,07	0,00209	127760,75	20,685							2,6		2,6	0,8	3,4	0,4	0,8	5,7	0,4	2,6	9,4	11,3	20,8	1,9	0,4	1,9		
			154/926B/43X/5/65-67	430,17	1/512	0,29	0,00057	368993,10	20,714							1,0		1,0	2,4	3,4	3,4	5,8	9,2	1,4	7,7	7,2	10,1	17,4	0,5		2,4		
		154/926B/43X/5/145-147	430,97	1/128	0,20	0,00156	138880,00	20,737							0,5	4,8		1,0		1,0	5,2	1,0	5,7	2,4	1,0	12,4	17,6	30,0	0,5	0,5	1,0		
		6	154/926B/43X/6/75-77	431,77	1/256	0,49	0,00191	119640,82	20,762						0,5	3,7	0,9			3,2		8,3		0,9	13,4	17,1	30,6	0,5	0,9	2,8			
		CC	154/926B/43X/CC/25-27	432,27	1/512	0,57	0,00111	195817,54	20,778						0,5	4,0				0,5		2,5	1,5	8,4	8,4	14,4	22,8				0,5		
	44X	1	154/926B/44X/1/115-117	434,37	1/512	1,03	0,00201	166027,18	20,850	1,7				2,0	2,0	0,6	3,4	3,2	6,6		1,1	2,0	1,7	0,3	12,0	9,7	21,8	0,9	1,4		1,7		
		2	154/926B/44X/2/85-87	435,57	1/256	0,47	0,00184	151965,96	20,896	0,4				0,7	1,4	0,7	3,6	3,6	7,2	1,8	1,4	3,6	0,4	1,8	13,7	14,0	27,7		1,4		1,4		
		3	154/926B/44X/3/36,5-38,5	436,59	1/4096	1,25	0,00031	697958,40	20,931	1,4				0,9	1,4	0,9	5,1	3,2	8,3			1,9	1,4	2,3	7,4	8,3	15,7	0,9	0,5	1,9			
			154/926B/44X/3/135-137	437,57	1/256	0,35	0,00137	154331,43	20,963						3,3	1,4	2,4	1,9	4,3	1,9		3,8	1,4	0,9	10,0	14,2	24,2		1,4		0,5	0,9	
		4	154/926B/44X/4/125-127	438,97	1/256	0,31	0,00121	199845,16	21,003						0,8	1,6	2,9	1,6	2,0	3,7	2,0	3,7	5,3	3,3	0,8	8,2	4,9	13,1	2,4	3,3	1,6	4,9	
		5	154/926B/44X/5/96-98	440,18	1/1024	1,44	0,00141	164977,78	21,039	0,9					0,9	2,6	1,3	1,3	1,7	3,0		0,9	3,0	0,4	6,1	9,6	11,3	20,9	0,4	1,7		3,5	
	6	154/926B/44X/6/110-112	441,82	1/512	0,63	0,00123	194234,92	21,092							3,8		2,5	1,3	3,8	0,8	0,4	0,8	1,7	5,0	8,8	10,9	19,7		2,5		0,8		
	45X	1	154/926B/45X/1/85-87	443,77	1/256	0,83	0,00324	98390,36	21,165	0,3					0,9		4,4	3,1	7,5	2,2	0,3	0,3	1,9	39,6	8,5	9,4	17,9		1,3		0,6	0,9	
		2	154/926B/45X/2/55-57	444,97	1/1024	1,27	0,00124	174160,63	21,200	0,5	0,5				0,5		1,8	3,2	5,0	3,2	0,9	0,9	0,5	17,9	7,8	7,3	15,1		4,1		2,3		
		3	154/926B/45X/3/45-47	446,37	1/512	1,01	0,00197	101893,07	21,250						2,0		3,4	2,0	5,4		0,5	0,5	0,5	22,2	7,9	6,9	14,8		3,9		1,5		
			154/926B/45X/3/125-127	447,17	1/1024	1,64	0,00160	141112,20	21,279						3,6	0,9		1,3	3,1	4,5	2,2			0,4	12,9	11,6	8,0	19,6		1,8		0,9	
		4	154/926B/45X/4/100-102	448,42	1/512	1,13	0,00221	138194,69	21,321								6,8	5,8	12,6				2,3	26,5	5,5	4,8	10,3		5,5		2,6	3,9	
		5	154/926B/45X/5/10-12	449,02	1/512	1,08	0,00211	115674,07	21,341							0,4	4,1	4,1	8,3				2,5	15,7	17,8	10,7	28,5		3,7		2,5		
	6	154/926B/45X/5/90-92	449,82	1/512	0,56	0,00109	234057,14	21,367							0,4		7,8	4,3	12,2				0,4	21,6	11,4	11,4	22,7		3,1		0,4		
				154/926B/45X/6/60-62	451,02	1/256	0,59	0,00230	155335,59	21,406	1,1			1,7		3,9	5,6	9,5		0,3	1,4	0,8	4,7	8,4	9,5	17,8		5,6		1,1			

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Trilobatus</i> sp.	<i>Trilobatus sicanus</i> gr.	<i>Trilobatus</i> cf. <i>T. primordius</i>	<i>Trilobatus subsacculifer</i>	<i>Trilobatus trilobus</i> gr.	indeterminabili		TOT planktonic	fragments	benthic foraminifera	radiolarians	plank/bent (%)	plank fragments/plank whole (%)	radiolarians (%)			<i>Cassigerinella</i> spp.	<i>Catapsydrax</i> spp.	<i>Ciperoella</i> spp.	<i>Dentaglobigerina</i> spp.	<i>Glabigerina</i> spp.	<i>Glabigerinella</i> spp.	<i>Glabigerinita</i> spp.	<i>Glabigerinoides</i> spp.	<i>Glaborotalia</i> spp.		
C	34X	3	154/926C/34X/3/20-22	340,71	1/256	0,36	0,00141	179200,00	17,603					2,7	16,7		263	262	3	21	98,9	49,9	7,4				2,7	2,7	2,3		0,8	38,0	0,4			
			154/926C/34X/3/60-62	341,11	1/1024	2,40	0,00234	150186,67	17,614		0,3				10,6	16,8		340	155	1	2	99,7	31,3	0,6				2,1	3,5	11,5		0,3	19,1	10,6		
		4	154/926C/34X/3/115-117	341,66	1/1024	2,18	0,00213	158297,25	17,630						9,7	16,4		329	96			100,0	22,6					2,1	6,7	4,9		1,8	14,3	14,9		
			154/926C/34X/4/45-47	342,46	1/1024	2,39	0,00233	130677,82	17,652						8,8	29,0		307	137	2		100,0	30,9	0,6				2,9	2,3	4,2		0,3	17,9	11,4	0,3	
			154/926C/34X/4/105-107	343,06	1/1024	1,95	0,00190	137583,59	17,668		0,8				17,7	10,2		265	106	1	4	99,6	28,6	1,5	0,4	3,4	1,9	5,7		0,8	13,6	14,3				
			154/926C/34X/5/115-117	344,66	1/512	1,29	0,00252	114306,98	17,713			0,4			12,3	15,1		284	125		1	100,0	30,6	0,4				1,4	2,1	10,2			9,9	7,0	0,4	
B	35X	6	154/926C/34X/6/25-27	345,26	1/1024	2,58	0,00252	138517,83	17,729			0,6		12,8	14,0		343	124			100,0	26,6					1,7	4,7	7,0	0,3	1,5	14,9	7,6			
			154/926B/35X/1/15-17	346,87	1/2048	4,00	0,00195	129536,00	17,770						9,5	12,8		243	84	1		100,0	25,7	0,4				0,4	4,1	8,6	1,2	14,8	7,4			
		1	154/926B/35X/1/95-97	347,67	1/1024	3,26	0,00318	115278,53	17,791		0,5				11,2	16,7		366	119			100,0	24,5					1,4	6,0	2,5		1,9	12,3	12,3		
			2	154/926B/35X/2/40-42	348,62	1/1024	1,72	0,00168	173841,86	17,819			0,3			8,6	15,1		292	124	1		99,7	29,8				4,5	6,5	9,9		0,7	15,4	5,1		
		3	154/926B/35X/3/30-32	350,02	1/1024	2,12	0,00207	156015,09	17,859		0,3				14,6	16,2		321	57			100,0	15,1		0,3			2,8	8,1	5,0	0,3	2,8	9,3	10,9	0,3	
			154/926B/35X/3/125-127	350,97	1/512	2,50	0,00488	73318,40	17,891		0,3	1,5			12,9	17,8		326	92			100,0	22,0					2,1	2,5	4,0		1,2	8,9	19,6	0,3	
		4	154/926B/35X/4/30-32	351,52	1/2048	2,37	0,00116	385404,22	17,917		0,7	0,5			10,0	15,5		440	149	1		99,8	25,3		0,9			1,1	5,0	4,5	3,4	20,2	13,6			
			154/926B/35X/4/85-87	352,07	1/1024	2,73	0,00267	151912,09	17,939		0,5	0,5			11,9	17,2		396	144	1	1	99,7	26,7	0,3				1,5	3,5	4,0	0,8	1,8	18,4	14,9	0,3	
		5	154/926B/35X/5/70-72	353,42	1/1024	2,50	0,00244	146227,20	17,986		0,6	0,6			10,6	27,2		349	96	1	6	99,7	21,6	1,7				1,4	6,0	2,0	4,6	10,6	13,8			
			6	154/926B/35X/6/30-32	354,52	1/1024	2,51	0,00245	166043,03	18,028		0,5	0,7			9,0	25,9		402	183	1	1	99,8	31,3	0,2				2,7	4,5	5,7		1,2	19,4	4,7	
		6	154/926B/35X/6/90-92	355,12	1/1024	1,46	0,00143	158509,59	18,053		1,3	1,3			8,7	17,7		231	76	2		100,0	24,8	0,9				3,0	3,5	6,1	0,4	1,3	25,1	4,3		
			7	154/926B/35X/7/15-17	355,87	1/1024	1,93	0,00188	163415,54	18,084						11,7	9,1		308	152	4		100,0	33,0	1,3				2,6	4,2	4,9	0,6	2,9	18,8	8,1	
B	36X	1	154/926B/36X/1/15-17	356,47	1/512	1,11	0,00217	155445,05	18,115		0,9	0,9		6,1	11,3		327	196	1		99,7	37,5		0,6			1,2	5,2	10,7	0,9	2,4	23,2	4,3	0,6		
			154/926B/36X/1/80-82	357,12	1/1024	2,92	0,00285	142728,77	18,149		1,0	0,2			9,0	19,7		401	109	1	4	99,8	21,4	1,0				1,2	3,5	5,5		3,2	19,2	10,0	0,5	
		2	154/926B/36X/2/25-27	358,07	1/1024	1,64	0,00160	156097,56	18,181			0,9	0,1		22,9			231	72	2		100,0	23,8	0,9				2,2	6,5	5,6		1,7	14,3	11,7		
			154/926B/36X/2/138-140	359,20	1/2048	1,69	0,00083	340525,44	18,213		0,4				0,7	6,7		284	115	1		100,0	28,8	0,4	1,1		3,9	11,3	8,5		2,5	12,3	4,2			
		3	154/926B/36X/3/45-47	359,77	1/1024	2,50	0,00244	103628,80	18,231				0,8		10,3	13,0		262	102	2		100,0	28,0	0,8				1,1	9,9	11,1		3,4	8,8	5,3		
			154/926B/36X/3/105-107	360,37	1/1024	2,94	0,00287	127477,55	18,259						5,3	23,9		356	126	1	8	99,7	26,1	2,2				2,2	7,6	12,6		0,3	9,6	3,4		
		4	154/926B/36X/4/50-52	361,32	1/1024	1,57	0,00153	171536,31	18,305			0,8			9,1	23,8		252	86	3		100,0	25,4	1,2				1,6	6,7	9,1	0,1	0,8	0,4	7,5	11,1	
			154/926B/36X/4/110-112	361,92	1/1024	1,53	0,00149	163973,86	18,323						4,6	13,5		237	85	3		100,0	26,4	1,3				5,1	8,9	7,2		2,5	13,5	6,8		
B	37X	1	154/926B/37X/1/30-32	366,32	1/512	1,52	0,00297	101389,47	18,422					2,0	12,9		294	138	1	2	99,7	31,9	0,7				1,7	6,8	8,5		0,7	21,4	4,1			
			154/926B/37X/2/37-39	367,89	1/512	1,48	0,00289	78529,73	18,480						2,7	17,9		224	87		3	100,0	28,0	1,3					4,0	12,5		3,6	12,9	9,8		
		2	154/926B/37X/2/115-117	368,67	1/256	0,46	0,00180	182539,13	18,510						1,8	18,0		327	206		14	100,0	38,6	4,1				1,5	7,3	5,8	0,3	0,3	30,6	2,4		
			154/926B/37X/3/40-42	369,42	1/256	0,47	0,00184	185191,49	18,536						0,3	4,0		346	164	1	7	99,7	32,2	2,0	0,3			3,5	4,3	11,6		0,3	38,7	0,9		
		3	154/926B/37X/3/120-122	370,22	1/512	0,90	0,00176	151324,44	18,560						0,8	7,9		265	158		7	100,0	37,4	2,6				0,4	4,2	7,5	0,4	0,8	25,3	1,9		
			154/926B/37X/4/25-27	370,77	1/512	0,24	0,00047	633600,00	18,583		0,3				0,7	23,2		297	226	1	23	99,7	43,2	7,2				2,0	4,0	7,7	0,3		27,3	1,3		
		4	154/926B/37X/4/80-82	371,32	1/512	1,05	0,00205	177493,33	18,604		0,3		1,4		0,5	4,9		366	134	1	3	99,7	26,8	0,8		0,3		3,0	4,9	15,0	0,3	0,8	27,9	3,3		
			154/926B/37X/5/10-12	372,12	1/512	0,92	0,00180	172521,74	18,629		0,3	0,3			2,6	10,1		307	176	1	4	99,7	36,4	1,3		1,3		3,3	6,2	8,1	2,0	2,9	22,1	5,2		
		5	154/926B/37X/5/105-107	373,07	1/512	2,03	0,00396	84997,04	18,665			0,3	0,6	4,3	16,8			322	136	1	1	99,7	29,7	0,3	0,6	1,9	4,3	10,6	1,2	1,2	15,8	3,7				

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 µm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Trilobatus</i> sp.	<i>Trilobatus sicanus</i> gr.	<i>Trilobatus</i> cf. <i>T. primordius</i>	<i>Trilobatus subsacculifer</i>	<i>Trilobatus trilobus</i> gr.	indeterminabili	TOT planktonic	fragments	benthic foraminifera	radiolarians	plank/bent (%)	plank fragments/plank whole (%)	radiolarians (%)	<i>Cassigerinella</i> spp.	<i>Catapsydrax</i> spp.	<i>Ciperoella</i> spp.	<i>Dentaglobigerina</i> spp.	<i>Globigerina</i> spp.	<i>Globigerinella</i> spp.	<i>Globigerinita</i> spp.	<i>Globigerinoides</i> spp.	<i>Globorotalia</i> spp.
C	37X	5	154/926C/37X/5/60-62	373,59	1/1024	1,61	0,00157	155190,06	18,667							241	94		2	100,0	28,1	0,8		4,1	5,4	5,8	0,4	2,5	8,3	5,0	
		6	154/926C/37X/6/10-12	374,59	1/1024	1,71	0,00167	158690,06	18,700			0,4	0,4	11,0	22,0	264	74		5	100,0	21,9	1,9		3,8	5,3	8,0	2,7		6,8	9,1	
		7	154/926C/37X/7/10-12	375,59	1/1024	1,19	0,00116	178984,87	18,734	0,5		1,0	4,4	22,2		203	109	1	6	99,5	34,9	2,9	0,5	2,5	2,5	8,9		2,0	21,2	2,0	
B	38X	1	154/926B/38X/1/55-57	376,17	1/1024	2,45	0,00239	153808,98	18,763				0,3	3,6	24,9	366	176		2	100,0	32,5	0,5	0,3	1,4	5,5	9,0	2,5	1,6	16,1	5,2	
			154/926B/38X/1/136-138	376,98	1/1024	2,45	0,00239	175960,82	18,790	0,2		0,5	2,6	26,4		421	227	3	6	99,3	35,0	1,4	0,7	1,2	4,5	9,3	0,7	0,7	15,0	1,4	
		2	154/926B/38X/2/25-27	377,37	1/1024	1,88	0,00184	199897,87	18,805	0,6		0,3	5,6	24,3		354	164			100,0	31,7			2,8	5,1	6,5	1,7	1,1	19,8	3,7	
			154/926B/38X/2/105-107	378,17	1/1024	2,26	0,00221	149522,12	18,832					3,0	26,0	331	116		3	100,0	26,0	0,9		0,6	3,9	7,9	2,7	1,8	13,3	6,3	
		3	154/926B/38X/3/35-37	378,97	1/256	0,44	0,00172	146036,36	18,858					0,8	6,7	239	146	2	3	99,2	37,9	1,2		3,3	6,3	10,5	0,4	0,4	17,6	0,4	
			154/926B/38X/3/75-77	379,37	1/1024	2,31	0,00226	157367,97	18,872			0,9	6,5	25,6		340	158		1	100,0	31,7	0,3	0,6	2,6	2,1	7,9	0,3	1,8	15,0	2,1	
		4	154/926B/38X/4/5-7	380,17	1/512	1,08	0,00211	229451,85	18,905			0,2	0,4	26,1		483	347	2	19	99,6	41,8	3,8	1,2	1,0	1,7	5,6	0,8		27,5	0,4	
			154/926B/38X/4/45-47	380,57	1/1024	2,01	0,00196	191554,23	18,920	0,3		0,3	3,5	3,7	19,4	376	172		2	100,0	31,4	0,5		2,7	4,8	4,8	1,6	0,5	16,8	1,9	
			154/926B/38X/4/125-127	381,37	1/2048	1,62	0,00079	348918,52	18,949	0,4	0,4		0,4	3,0	22,1	271	148		5	100,0	35,3	1,8		2,6	1,1	9,2			20,3	4,1	
		5	154/926B/38X/5/55-57	382,17	1/512	1,18	0,00230	126698,31	18,979					1,7	9,1	287	274	6	12	98,0	48,8	4,0	0,3	2,8	3,8	8,4			26,1	0,7	
			154/926B/38X/5/95-97	382,57	1/1024	2,40	0,00234	130560,00	18,995					2,5	6,5	277	158			100,0	36,3			2,2	2,5	10,5		1,1	25,6	1,8	
		6	154/926B/38X/6/5-7	383,17	1/1024	2,79	0,00272	110107,53	19,020					1,7	17,6	290	232		5	100,0	44,4	1,7		4,1	1,7	11,7	0,3	1,0	25,9	4,8	
			154/926B/38X/6/45-47	383,57	1/2048	2,86	0,00140	221269,93	19,036					3,1	17,3	295	189		1	100,0	39,0	0,3		0,3	2,4	8,5	0,3		15,3	4,1	
			154/926B/38X/6/110-112	384,22	1/1024	1,78	0,00174	128287,64	19,065					2,7	11,9	219	129		2	100,0	37,1	0,9		1,8	2,7	15,1		0,5	16,9	4,1	
		7	154/926B/38X/7/40-42	385,02	1/256	0,69	0,00270	119095,65	19,103					1,3	11,7	317	243		8	100,0	43,4	2,5		2,2	2,5	9,5		0,6	18,3	3,5	
	39X	1	154/926B/39X/1/10-12	385,42	1/1024	2,07	0,00202	128123,67	19,120				0,8	3,1	31,7	259	138			100,0	34,8			1,2	2,3	6,9		1,2	16,2	3,9	
			154/926B/39X/1/71-73	386,03	1/512	1,07	0,00209	117233,64	19,143				0,4	2,0	14,7	245	146	3		98,8	37,3			2,9	2,0	12,2		1,2	17,6	1,2	
			154/926B/39X/1/110-112	386,42	1/1024	1,92	0,00188	148800,00	19,153					0,4	17,3	271	123		3	100,0	31,2	1,1		1,1	5,2	9,2		3,7	21,0	1,8	
		2	154/926B/39X/2/50-52	387,32	1/512	1,13	0,00221	157677,88	19,173				0,3	1,2	22,4	344	192	4	8	98,9	35,8	2,3		2,3	4,9	11,0	0,6	0,6	16,9	0,9	
			154/926B/39X/2/90-92	387,72	1/512	1,88	0,00367	76255,32	19,184		0,7			4,0	18,7	278	257	1	2	99,6	48,0	0,7		0,4	6,1	9,7		3,6	18,7	3,2	
		3	154/926B/39X/3/55-57	388,87	1/1024	1,90	0,00186	125035,79	19,218					6,7	17,9	223	96			100,0	30,1			3,6	4,0	10,8		4,0	20,2	3,1	
			154/926B/39X/3/95-97	389,27	1/512	0,71	0,00139	145667,61	19,237						9,5	201	125	2		99,0	38,3			2,0	7,5	11,9		2,5	17,9	1,0	
		4	154/926B/39X/4/50-52	390,32	1/1024	2,75	0,00269	75589,82	19,273					4,1	24,9	197	100			100,0	33,7			3,6	4,6	15,7		1,5	16,2	1,5	
			154/926B/39X/4/75-77	390,57	1/1024	1,59	0,00155	137821,38	19,281			1,9	2,3	15,5		213	176	1	2	99,5	45,2	0,9		2,3	4,7	14,1		0,5	23,5		
			154/926B/39X/4/135-137	391,17	1/256	0,64	0,00250	156000,00	19,299			0,3	1,3	14,8		372	266	2	4	99,5	41,7	1,1		2,2	2,7	10,5		1,1	26,1		
		5	154/926B/39X/5/20-22	391,52	1/1024	2,43	0,00237	106613,99	19,309					2,8	12,9	248	140	1		99,6	36,1			2,4	6,9	14,9		0,4	12,9	1,6	
			154/926B/39X/5/115-117	392,47	1/512	1,08	0,00211	97659,26	19,344	0,5				2,5	12,8	203	92			100,0	31,2			2,5	3,0	15,8		1,5	13,8	1,0	
			154/926B/39X/5/145-147	392,77	1/256	0,64	0,00250	147600,00	19,360					0,9	12,2	329	249	4	3	98,8	43,1	0,9		2,1	3,6	8,5			16,1	0,3	
		6	154/926B/39X/6/30-32	393,12	1/1024	2,01	0,00196	102909,45	19,371					3,3	9,9	212	115	1		99,5	35,2			1,4	6,6	18,9		0,9	8,0	0,5	
	39X	5	154/926C/39X/5/80-82	393,52	1/256	0,70	0,00273	119222,86	19,383					2,9	6,0	348	255	2		99,4	42,3			2,3	4,9	9,2			17,0	0,6	
			154/926C/39X/5/120-122	393,92	1/1024	1,72	0,00168	203013,95	19,397	0,6				6,9	12,3	332	241	1		99,7	42,1			2,7	3,0	12,7		1,5	9,0	1,5	
			154/926C/39X/6/50-52	394,72	1/128	0,88	0,00688	53090,91	19,423					2,8	2,2	358	244			100,0	40,5			3,4	12,8	13,7		0,6	9,5		
		6	154/926C/39X/6/110-112	395,32	1/512	1,29	0,00252	122244,96	19,443					3,3	6,3	304	194	2		99,3	39,0			2,3	13,2	16,8		1,3	9,2	0,3	

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 µm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Trilobatus</i> sp.	<i>Trilobatus sicanus</i> gr.	<i>Trilobatus</i> cf. <i>T. primordius</i>	<i>Trilobatus subsacculifer</i>	<i>Trilobatus trilobus</i> gr.	indeterminabili	TOT planktonic fragments	benthic foraminifera	radiolarians	plank/bent (%)	plank fragments/plank whole (%)	radiolarians (%)	<i>Cassigerinella</i> spp.	<i>Catapsydrax</i> spp.	<i>Ciperoella</i> spp.	<i>Dentaglobigerina</i> spp.	<i>Globigerina</i> spp.	<i>Globigerinella</i> spp.	<i>Globigerinita</i> spp.	<i>Globigerinoides</i> spp.	<i>Globorotalia</i> spp.			
B	40X	1	154/926B/40X/1/45-47	395,37	1/256	0,75	0,00293	96256,00	19,447					0,7	8,4	273	249	5	98,2	47,7			1,5	8,1	13,6		1,5	15,8					
			154/926B/40X/1/105-107	395,97	1/512	1,05	0,00205	113127,62	19,465		0,4		0,4	0,9	5,2	230	129		100,0	35,9			0,9	8,3	14,3		1,3	3,0					
		2	154/926B/40X/2/75-77	397,17	1/512	1,25	0,00244	126566,40	19,501				0,3	3,3	8,3	303	127		100,0	29,5			2,3	9,6	15,2		4,0	11,2					
			154/926B/40X/2/135-137	397,77	1/1024	1,85	0,00181	143913,51	19,517				0,8	2,9	20,8	245	74	1	99,6	23,2			2,0	5,3	11,4	0,8	3,7	9,0	2,0				
		3	154/926B/40X/3/45-47	398,37	1/256	1,11	0,00434	61117,12	19,536				0,9	0,9	4,8	229	138	2	1	99,1	37,6	0,4		0,9	4,8	14,4		0,9	9,2				
			154/926B/40X/3/120-122	399,12	1/512	1,25	0,00244	100761,60	19,562					2,9	4,1	245	96	2	2	100,0	28,2	0,8			8,2	15,5		0,8	8,2	2,0			
		4	154/926B/40X/4/85-87	400,27	1/512	1,04	0,00203	120615,38	19,603					3,9	5,2	229	100	1	1	99,6	30,4	0,4		0,9	3,9	10,5		2,2	13,1	2,6			
			154/926B/40X/4/145-147	400,87	1/1024	1,58	0,00154	137397,47	19,626						13,9	202	96	4	4	100,0	32,2	1,9		2,0	1,0	13,4		3,5	18,3	1,5			
		5	154/926B/40X/5/11-13	401,03	1/256	0,83	0,00324	98698,80	19,633						35,1	271	173	1	3	99,6	39,0	1,1			7,4	12,5		0,7	19,2	1,1			
			154/926B/40X/5/52,5-54,5	401,45	1/256	1,49	0,00582	64257,72	19,655		0,3		0,3	2,1	20,1	374	322	2	6	99,5	46,3	1,6			8,6	12,6		2,9	8,3	2,4			
		6	154/926B/40X/5/100-102	401,92	1/256	0,86	0,00336	69358,14	19,670					1,3	14,7	224	159	1	1	100,0	41,5	0,4		3,1	10,3	11,2		4,0	21,4	1,8			
			154/926B/40X/6/13-15	402,55	1/1024	1,80	0,00176	216746,67	19,692					1,3	15,4	371	301	4	8	98,9	44,8	2,1		4,0	3,2	17,0	0,3	1,6	15,6	1,9			
		6	154/926B/40X/6/69-71	403,11	1/1024	2,08	0,00203	138830,77	19,717					2,8	21,0	281	94	1	2	99,6	25,1	0,7		4,3	7,5	10,3		1,8	14,2	6,8			
			154/926C/40X/6/15-17	404,06	1/512	0,91	0,00178	138971,43	19,767					1,6	13,3	256	154	1	4	99,6	37,6	1,5		4,3	10,9	12,5		6,3	11,7	1,6			
C	40X	6	154/926C/40X/6/15-17	404,06	1/512	0,91	0,00178	138971,43	19,767					1,6	13,3	256	154	1	4	99,6	37,6	1,5		4,3	10,9	12,5		6,3	11,7	1,6			
B	41X	1	154/926B/41X/1/35-37	404,57	1/128	0,23	0,00180	173634,78	19,815					0,7	9,3	301	200	4	29	98,7	39,9	8,8		6,0	6,0	6,3		2,7	39,5				
			154/926B/41X/1/90-92	405,12	1/256	0,41	0,00160	235395,12	19,835				1,2	7,4	337	310	5	6	98,5	47,9	1,7		3,0	20,8	13,9		2,4	20,8					
		2	154/926B/41X/2/48-50	405,70	1/256	0,23	0,00090	287165,22	19,869					0,4	10,2	254	171	3	12	98,8	40,2	4,5		1,6	4,7	5,9		0,8	32,7				
			154/926B/41X/2/108-110	406,30	1/64	0,12	0,00188	201600,00	19,891						17,2	377	268	3	36	99,2	41,6	8,7		3,2	4,2	5,6		1,1	10,1	0,3			
		3	154/926B/41X/3/45-47	407,17	1/512	2,14	0,00418	79910,28	19,913					1,5	23,6	326	177	15	100,0	35,2	4,4			7,1	12,9		3,7	16,9	0,9				
			154/926B/41X/4/15-17	408,37	1/128	0,23	0,00180	121321,74	19,949						9,8	214	165	1	10	99,5	43,5	4,5		3,7	7,5	15,4		0,9	24,8				
		4	154/926B/41X/4/125-127	409,17	1/256	1,02	0,00398	81317,65	19,997					1,9	13,5	319	122	3	7	99,1	27,7	2,1		1,3	9,7	11,9	0,3	3,1	14,1	0,9			
			154/926B/41X/5/15-17	409,87	1/1024	0,94	0,00092	267982,98	20,011					2,4	9,6	208	57			100,0	21,5			3,4	19,2	8,2		2,4	18,3	7,7			
		3	154/926C/41X/3/140-142	410,28	1/128	0,24	0,00188	155733,33	20,081					0,7	21,5	289	155	5	28	98,3	34,9	8,8		0,7	10,7	21,5		0,7	10,4	1,0	0,3		
			154/926C/41X/4/70-72	411,08	1/128	0,24	0,00188	121066,67	20,118						20,2	218	190	1	8	99,5	46,6	3,5		3,2	4,1	20,2	0,5		17,0		0,9		
C	41X	4	154/926C/41X/4/145-147	411,83	1/2048	1,42	0,00069	429791,55	20,152			0,3	0,7	18,5	287	103	1	1	99,7	26,4	0,3		0,7	7,3	22,0	0,3	0,3	10,5	1,0	2,1			
			154/926C/41X/5/50-52	412,38	1/1024	1,03	0,00101	338019,42	20,178		0,3		0,3	1,5	16,6	325	126	3	3	100,0	27,9	0,9		2,8	9,2	16,6	0,6	2,2	12,0	1,2	3,1		
		5	154/926C/41X/5/110-112	412,98	1/256	0,55	0,00215	179665,45	20,205		0,3		0,3	1,1	25,3	379	178	1	8	99,7	32,0	2,1		0,5	6,3	18,7		0,3	9,5	0,8	2,4		
			154/926B/42X/1/101-103	414,93	1/512	0,50	0,00098	260096,00	20,232					0,7	13,1	283	94	6	6	100,0	24,9	2,1			7,8	23,0	0,7	0,4	25,4	1,4	4,9		
B	42X	1	154/926B/42X/2/10-12	415,52	1/512	1,08	0,00211	189629,63	20,247				0,5	15,3	378	215	2	22	99,5	36,3	5,5		1,1	7,4	17,5	0,3	0,8	25,7	1,1	6,6			
			154/926B/42X/2/88-90	416,30	1/512	0,88	0,00172	143127,27	20,269					2,5	16,8	238	70	1	9	99,6	22,7	3,6		1,7	15,1	14,7					1,8	1,3	
		2	154/926B/42X/2/145-147	416,87	1/1024	1,41	0,00138	236028,37	20,288					1,9	18,9	318	122	1	12	99,7	27,7	3,6		0,3	10,1	10,1		1,9	20,8	1,6	5,7		
			154/926B/42X/3/73-75	417,65	1/2048	1,72	0,00084	320297,67	20,314					1,8	21,4	224	55	8	8	100,0	19,7	3,4		1,3	4,0	14,3		0,4	23,7	0,9	4,5		
		3	154/926B/42X/3/135-137	418,27	1/1024	1,86	0,00182	114511,83	20,333					1,0	29,9	201	91	3	3	100,0	31,2	1,5		3,0	3,5	12,4	0,5		16,4	1,0	6,0		
			154/926B/42X/4/86-88	419,28	1/256	0,30	0,00117	174933,33	20,359					0,5	7,8	204	147	9	9	100,0	41,9	4,2		3,9	8,8	15,7		0,5	18,6	1,0	1,5		

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 µm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Trilobatus</i> sp.	<i>Trilobatus sicanus</i> gr.	<i>Trilobatus</i> cf. <i>T. primordius</i>	<i>Trilobatus subsacculifer</i>	<i>Trilobatus trilobus</i> gr.	indeterminabili	TOT planktonic fragments	benthic foraminifera	radiolarians	plank/bent (%)	plank fragments/plank whole (%)	radiolarians (%)	<i>Cassigerinella</i> spp.	<i>Catapsydrax</i> spp.	<i>Ciperoella</i> spp.	<i>Dentaglobigerina</i> spp.	<i>Globigerina</i> spp.	<i>Globigerinella</i> spp.	<i>Globigerinita</i> spp.	<i>Globigerinoides</i> spp.	<i>Globorotalia</i> spp.			
B	42X	5	154/926B/42X/5/80-82	420,72	1/1024	2,24	0,00219	174628,57	20,398				0,5	1,4	20,6	364	188	1	18	99,7	34,1	4,7			2,2	10,4	0,5	0,3	21,2	0,5	17,3		
			154/926B/42X/6/10-12	421,52	1/1024	1,20	0,00117	175786,67	20,427		0,5				26,9	201	81		14	100,0	28,7	6,5			8,0	11,4		2,0	14,9	3,0	9,0		
		6	154/926B/42X/6/65-67	422,07	1/1024	1,45	0,00142	242228,97	20,451						17,0	324	77	1	7	99,7	19,2	2,1		0,6	6,5	9,0		1,5	12,3	2,2	21,3		
			154/926B/42X/6/145-147	422,87	1/512	0,71	0,00139	172349,30	20,475						10,6	235	150	1	29	99,6	39,0	11,0			3,0	16,6		1,3	22,1		10,6		
C	42X	7	154/926B/42X/7/20-22	423,12	1/512	1,38	0,00270	141727,54	20,482					0,5	18,0	377	209	49	100,0	35,7	11,5		0,8	6,1	6,4	0,3	1,6	18,8	0,8	4,2			
B	43X	5	154/926C/42X/5/45-47	423,67	1/256	0,48	0,00188	152533,33	20,469						15,1	271	156	26	100,0	36,5	8,8		1,5	4,4	9,2		0,7	22,1		1,1			
			154/926B/43X/1/90-92	424,42	1/256	0,69	0,00270	140614,49	20,525					0,3	11,5	339	206	3	26	99,1	37,8	7,1		4,4	7,7	8,3	0,3	2,7	11,8		2,9		
		2	154/926B/43X/2/35-37	425,37	1/128	0,48	0,00375	106133,33	20,552						8,4	395	374	2	47	99,5	48,6	10,6		5,1	3,5	4,1			10,4		1,0		
			154/926B/43X/2/90-92	425,92	1/512	1,22	0,00238	153180,33	20,571						10,9	303	172	1	25	99,7	32,0	7,6		0,7	1,7	6,3	0,3		21,1		3,3		
		3	154/926B/43X/3/10-12	426,62	1/512	0,80	0,00156	132480,00	20,599						0,5	9,7	206	158	3	35	98,6	43,4	14,5		0,5	1,9	2,4		0,5	13,1		1,0	
			154/926B/43X/3/72-74	427,24	1/256	0,68	0,00266	121600,00	20,620						5,8	292	216	1	30	99,7	42,5	9,3		2,4	1,0	4,1		1,0	9,9	0,3	6,2		
		4	154/926B/43X/4/30-32	428,32	1/1024	1,54	0,00150	141631,17	20,650						11,3	212	84	2	13	99,1	28,4	5,8			1,9	2,8	1,4	0,5	11,3	1,4			
			154/926B/43X/4/130-132	429,32	1/512	1,07	0,00209	127760,75	20,685						0,4	7,9	265	85	2	5	99,3	24,3	1,9		0,8	12,8	3,4	0,4	1,1	12,5		0,8	
		5	154/926B/43X/5/65-67	430,17	1/512	0,29	0,00057	368993,10	20,714						16,9	207	137	2	13	99,0	39,8	5,9			4,8	1,4	0,5	0,5	10,6	0,5	1,0		
			154/926B/43X/5/145-147	430,97	1/128	0,20	0,00156	138880,00	20,737						11,0	210	141	2	26	99,1	40,2	11,0		1,9	2,9	2,4			19,0		1,0		
		6	154/926B/43X/6/75-77	431,77	1/256	0,49	0,00191	119640,82	20,762						5,1	216	80		13	100,0	27,0	5,7		2,3	10,6	2,8		2,8	8,8		0,5		
		CC	154/926B/43X/CC/25-27	432,27	1/512	0,57	0,00111	195817,54	20,778						2,0	202	98	3	12	98,5	32,7	5,6			8,4	1,0			14,9	0,5	7,4		
		44X	1	154/926B/44X/1/115-117	434,37	1/512	1,03	0,00201	166027,18	20,850					0,9	6,9	349	169	1	7	99,7	32,6	2,0		2,3	8,6	5,4	2,3	1,4	8,6	0,9	0,3	
			2	154/926B/44X/2/85-87	435,57	1/256	0,47	0,00184	151965,96	20,896						5,8	278	153	2	12	99,3	35,5	4,1			6,1	6,5	0,4	1,1	14,0			
				154/926B/44X/3/36,5-38,5	436,59	1/4096	1,25	0,00031	697958,40	20,931						8,3	216	115		4	100,0	34,7	1,8		0,9	6,0	4,6	0,5		26,4		0,9	
			3	154/926B/44X/3/135-137	437,57	1/256	0,35	0,00137	154331,43	20,963						3,3	211	102	3	7	98,6	32,6	3,2		3,8	5,7	4,7			12,8		0,9	
			4	154/926B/44X/4/125-127	438,97	1/256	0,31	0,00121	199845,16	21,003					0,4	9,4	245	118	1	13	99,6	32,5	5,0		1,6	4,9	6,1			13,9	0,4		
			5	154/926B/44X/5/96-98	440,18	1/1024	1,44	0,00141	164977,78	21,039					1,7	8,3	230	111	1	5	99,6	32,6	2,1		0,9	5,2	8,3		1,3	7,0	1,3	1,7	
		6	154/926B/44X/6/110-112	441,82	1/512	0,63	0,00123	194234,92	21,092						0,4	7,1	238	100		5	100,0	29,6	2,1		0,4	14,7	1,7	1,7	2,5	3,8	0,8	1,3	
		45X	1	154/926B/45X/1/85-87	443,77	1/256	0,83	0,00324	98390,36	21,165						5,7	318	125	3	11	99,1	28,2	3,3		0,3	4,1	2,8	1,6	2,8	4,1	0,3	0,6	
			2	154/926B/45X/2/55-57	444,97	1/1024	1,27	0,00124	174160,63	21,200						1,4	18,3	218	82		5	100,0	27,3	2,2		1,4	8,3	1,8			12,8		
			3	154/926B/45X/3/45-47	446,37	1/512	1,01	0,00197	101893,07	21,250				0,5	0,5	9,4	203	128	1	2	99,5	38,7	1,0		2,0	9,4	2,0	0,5	1,5	3,9	5,4	2,0	
				154/926B/45X/3/125-127	447,17	1/1024	1,64	0,00160	141112,20	21,279						4,9	8,0	224	163	3	100,0	42,1	1,3			6,7	3,6	5,4	1,8	9,4	0,9		
			4	154/926B/45X/4/100-102	448,42	1/512	1,13	0,00221	138194,69	21,321					0,3	5,2	310	218	2	8	99,4	41,3	2,5		0,3	2,3	1,9	1,9		13,5	1,9	1,9	
5	154/926B/45X/5/10-12		449,02	1/512	1,08	0,00211	115674,07	21,341						8,7	242	231	2	7	99,2	48,8	2,8		1,2	5,0	2,1			11,2		0,8			
6	154/926B/45X/5/90-92	449,82	1/512	0,56	0,00109	234057,14	21,367						11,4	255	108	2	3	99,2	29,8	1,2		1,2	7,5	1,2	1,6	2,7	6,7	0,4	0,4				
6	154/926B/45X/6/60-62	451,02	1/256	0,59	0,00230	155335,59	21,406						15,3	359	258	4	11	98,9	41,8	3,0		0,3	9,7	8,6	1,1	0,8	1,9	0,6	1,4				

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 µm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globorotaloides</i> spp.	<i>Globoturborotalita</i> spp.	<i>Paragloborotalia</i> spp.	<i>Tenuitella</i> spp.	<i>Trilobatus</i> spp.		Dominance (D)	Shannon (H)	Equitability (I)	surface-dwellers	mixed layer	thermocline	sub-thermocline	eutrophic taxa	warm taxa	warm temperate taxa	cold taxa	warm/warm temperate taxa	warm/cold taxa
C	34X	3	154/926C/34X/3/20-22	340,71	1/256	0,36	0,00141	179200,00	17,603	2,7	3,4	26,6	0,8	2,7		0,1527	2,3230	0,7407	2,3	28,5	19,8	5,3	43,3	4,9	1,9	23,2	6,8	22,8
			154/926C/34X/3/60-62	341,11	1/1024	2,40	0,00234	150186,67	17,614	0,6	8,5	12,4	2,6	10,9		0,0728	2,9230	0,8682	2,9	37,6	6,5	2,6	21,8	30,9	4,4	9,7	35,3	78,4
			154/926C/34X/3/115-117	341,66	1/1024	2,18	0,00213	158297,25	17,630	1,2	7,3	17,9	2,7	9,7		0,0701	2,9810	0,8602	8,8	37,7	12,8	3,0	17,6	28,3	3,0	7,0	31,3	81,7
		4	154/926C/34X/4/45-47	342,46	1/1024	2,39	0,00233	130677,82	17,652	1,3	3,3	16,9	1,0	8,8		0,0919	2,7620	0,8379	5,9	27,7	8,1	4,2	22,1	23,8	2,0	8,5	25,7	75,2
			154/926C/34X/4/105-107	343,06	1/1024	1,95	0,00190	137583,59	17,668	2,3	5,7	21,9	1,1	18,5		0,0967	2,7030	0,8110	4,9	40,8	14,0	5,7	19,6	38,9	1,1	13,6	40,0	74,6
			154/926C/34X/5/115-117	344,66	1/512	1,29	0,00252	114306,98	17,713	2,1	3,2	34,2	1,8	12,7		0,1164	2,5540	0,7933	2,5	31,0	19,0	3,5	13,4	25,4	3,5	7,0	28,9	80,4
B	35X	6	154/926C/34X/6/25-27	345,26	1/1024	2,58	0,00252	138517,83	17,729	2,6	5,8	23,6	2,6	13,4		0,0874	2,8010	0,8234	3,8	35,6	9,6	4,4	19,5	26,8	3,5	7,3	30,3	80,6
			154/926B/35X/1/15-17	346,87	1/2048	4,00	0,00195	129536,00	17,770	3,7	2,1	32,1	2,5	9,5		0,1078	2,5600	0,8057	0,4	27,6	18,9	3,7	18,9	23,9	2,1	10,3	25,9	71,6
			154/926B/35X/1/95-97	347,67	1/1024	3,26	0,00318	115278,53	17,791	4,6	5,7	22,7	1,6	11,7		0,0844	2,7830	0,8351	4,6	38,0	12,6	6,0	18,3	26,8	2,2	14,8	29,0	66,3
		2	154/926B/35X/2/40-42	348,62	1/1024	1,72	0,00168	173841,86	17,819	10,3	3,4	18,5	1,4	8,9		0,0742	2,8900	0,8583	3,4	35,3	13,4	12,7	30,1	19,9	4,5	21,2	24,3	53,4
			154/926B/35X/3/30-32	350,02	1/1024	2,12	0,00207	156015,09	17,859	6,9	10,6	9,3	0,9	15,0		0,0736	2,9870	0,8335	3,1	37,7	6,9	8,4	19,3	29,9	0,6	15,3	30,5	66,7
			154/926B/35X/3/125-127	350,97	1/512	2,50	0,00488	73318,40	17,891	5,5	8,6	12,6	1,2	14,7		0,0868	2,8220	0,8469	4,0	33,7	10,4	6,7	16,6	35,9	1,5	13,2	37,4	73,9
		4	154/926B/35X/4/30-32	351,52	1/2048	2,37	0,00116	385404,22	17,917	3,9	6,4	10,0	3,4	11,1		0,0701	2,9900	0,8480	5,0	39,8	6,1	4,5	26,1	28,0	3,9	15,0	31,8	68,0
			154/926B/35X/4/85-87	352,07	1/1024	2,73	0,00267	151912,09	17,939	4,3	7,3	10,4	1,8	12,9		0,0805	2,8270	0,8396	5,3	39,4	9,3	5,3	25,0	30,6	1,3	14,1	31,8	69,2
			154/926B/35X/5/70-72	353,42	1/1024	2,50	0,00244	146227,20	17,986	4,0	4,9	10,9	2,6	11,7		0,0704	2,9560	0,8691	5,2	34,7	4,9	3,7	16,0	28,1	2,9	11,7	30,9	72,5
		6	154/926B/35X/6/30-32	354,52	1/1024	2,51	0,00245	166043,03	18,028	5,2	4,2	13,2	2,0	10,2		0,0742	2,9600	0,8325	1,5	36,3	6,7	7,2	27,4	18,9	2,2	19,4	21,1	52,1
			154/926B/35X/6/90-92	355,12	1/1024	1,46	0,00143	158509,59	18,053	4,3	6,9	13,0	2,6	11,3		0,0882	2,7730	0,8513	0,4	32,5	11,3	5,2	32,9	19,0	2,2	18,2	21,2	53,8
			154/926B/35X/7/15-17	355,87	1/1024	1,93	0,00188	163415,54	18,084	2,3	4,2	26,3	3,2	11,7		0,0883	2,8620	0,8258	3,9	37,0	20,1	4,5	24,4	22,4	2,6	15,9	25,0	61,1
	36X	1	154/926B/36X/1/15-17	356,47	1/512	1,11	0,00217	155445,05	18,115	5,8	6,4	14,1	4,9	8,0		0,0693	3,1100	0,8613	2,4	46,2	11,0	6,1	31,8	20,8	3,4	25,4	24,2	48,8
			154/926B/36X/1/80-82	357,12	1/1024	2,92	0,00285	142728,77	18,149	3,7	8,5	9,2	4,5	10,2		0,0696	3,0610	0,8476	2,5	41,4	7,2	3,7	24,2	24,2	3,0	19,0	27,2	58,9
			154/926B/36X/2/25-27	358,07	1/1024	1,64	0,00160	156097,56	18,181	3,0	8,2	7,8	5,6	10,0		0,0681	2,9930	0,8889	2,6	42,9	5,6	5,2	19,5	23,8	5,6	16,9	29,4	63,6
		2	154/926B/36X/2/138-140	359,20	1/2048	1,69	0,00083	340525,44	18,213	7,0	7,7	9,2	5,3	7,7		0,0552	3,2240	0,8996	1,4	41,2	6,0	8,8	24,3	17,6	4,6	20,1	22,2	52,5
			154/926B/36X/3/45-47	359,77	1/1024	2,50	0,00244	103628,80	18,231	8,0	8,4	14,1	5,3	11,1		0,0600	3,0330	0,9103	1,9	45,4	9,5	8,4	17,9	22,1	7,6	16,8	29,8	63,9
			154/926B/36X/3/105-107	360,37	1/1024	2,94	0,00287	127477,55	18,259	7,6	6,2	18,8	2,0	5,3		0,0687	2,9500	0,8591	2,2	35,7	11,8	9,8	19,4	17,1	3,4	14,9	20,5	57,9
		4	154/926B/36X/4/50-52	361,32	1/1024	1,57	0,00153	171536,31	18,305	1,6	9,1	14,3	3,6	9,9		0,0571	3,1470	0,8852	4,0	39,3	6,3	3,2	11,1	29,0	0,8	9,5	29,8	75,8
			154/926B/36X/4/110-112	361,92	1/1024	1,53	0,00149	163973,86	18,323	8,9	11,0	14,3	3,0	4,6		0,0646	2,9790	0,8941	1,3	35,4	12,2	13,9	27,4	16,9	1,7	22,4	18,6	45,4
			154/926B/37X/1/30-32	366,32	1/512	1,52	0,00297	101389,47	18,422	4,8	2,4	31,3	2,0	2,0		0,1425	2,5410	0,7472	1,4	33,7	26,9	6,5	27,9	11,9	3,7	21,1	15,6	42,6
	37X	2	154/926B/37X/2/37-39	367,89	1/512	1,48	0,00289	78529,73	18,480	4,0	9,8	20,5	0,9	2,7		0,0630	3,0300	0,9092	3,1	31,7	12,9	4,0	17,0	17,9	4,0	12,1	21,9	64,5
			154/926B/37X/2/115-117	368,67	1/256	0,46	0,00180	182539,13	18,510	3,7	1,2	23,2	3,1	1,8		0,1384	2,5090	0,7377	1,5	37,6	18,3	4,6	36,1	7,3	3,7	26,9	11,0	29,0
			154/926B/37X/3/40-42	369,42	1/256	0,47	0,00184	185191,49	18,536	6,1	2,6	26,0	1,2	0,3		0,1511	2,3090	0,7265	1,2	38,2	23,7	9,5	48,6	8,7	2,0	31,2	10,7	25,5
		3	154/926B/37X/3/120-122	370,22	1/512	0,90	0,00176	151324,44	18,560	10,2	3,8	34,0	2,6	0,8		0,1525	2,4100	0,7312	0,8	32,8	27,9	10,2	35,8	6,8	2,3	29,8	9,1	23,3
			154/926B/37X/4/25-27	370,77	1/512	0,24	0,00047	633600,00	18,583	3,0	1,7	26,6	1,0	1,0		0,1450	2,4230	0,7352	0,3	29,0	21,9	5,1	32,7	8,4	2,0	21,2	10,4	33,0
			154/926B/37X/4/80-82	371,32	1/512	1,05	0,00205	177493,33	18,604	4,1	2,5	28,4	1,4	2,2		0,1206	2,6810	0,7602	4,1	44,8	22,4	7,1	35,2	15,0	1,9	29,5	16,9	36,5
		5	154/926B/37X/5/10-12	372,12	1/512	0,92	0,00180	172521,74	18,629	4,2	8,1	18,9	3,3	3,3		0,0748	3,0370	0,8476	2,0	39,1	14,7	7,2	32,9	15,3	2,9	25,4	18,2	41,8
			154/926B/37X/5/105-107	373,07	1/512	2,03	0,00396	84997,04	18,665	12,1	5,6	15,8	2,8	5,3		0,0716	3,0650	0,8552	3,4	38,8	14,9	12,7	31,7	14,3	3,7	28,0	18,0	39,2

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 µm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globorotaloides</i> spp.	<i>Globobulborotalia</i> spp.	<i>Paragloborotalia</i> spp.	<i>Tenuitella</i> spp.	<i>Trilobatus</i> spp.		Dominance (D)	Shannon (H)	Equitability (J)	surface-dwellers	mixed layer	thermodine	sub-thermocline	eutrophic taxa	warm taxa	warm temperate taxa	cold taxa	warm/warm temperate taxa	warm/cold taxa
C	37X	5	154/926C/37X/5/60-62	373,59	1/1024	1,61	0,00157	155190,06	18,667	8,7	5,8	18,7	1,7	3,3		0,0681	3,0410	0,8857	3,3	30,7	14,5	12,4	21,2	11,6	4,6	20,3	16,2	44,3
		6	154/926C/37X/6/10-12	374,59	1/1024	1,71	0,00167	158690,06	18,700	5,3	12,9	11,4	0,4	11,7		0,0669	3,0520	0,8654	2,7	42,0	9,8	8,0	18,2	26,1	3,0	14,8	29,2	66,4
		7	154/926C/37X/7/10-12	375,59	1/1024	1,19	0,00116	178984,87	18,734	6,4	3,9	21,7		5,9		0,0911	2,7470	0,8642		26,1	13,3	6,4	30,0	14,8	3,4	15,3	18,2	54,4
B	38X	1	154/926B/38X/1/55-57	376,17	1/1024	2,45	0,00239	153808,98	18,763	5,5	6,8	15,8	0,8	3,8		0,0705	2,9890	0,8703	0,8	35,0	12,8	4,9	25,4	14,2	2,7	19,7	16,9	46,3
			154/926B/38X/1/136-138	376,98	1/1024	2,45	0,00239	175960,82	18,790	4,5	4,5	25,4	1,7	3,3		0,1063	2,7350	0,7966	0,5	28,0	19,5	5,7	21,4	8,8	5,2	13,3	14,0	51,3
		2	154/926B/38X/2/25-27	377,37	1/1024	1,88	0,00184	199897,87	18,805	5,6	7,1	13,0	2,5	6,5		0,0731	2,9460	0,8578	1,7	39,5	9,6	7,9	29,9	15,3	2,5	22,0	17,8	44,7
			154/926B/38X/2/105-107	378,17	1/1024	2,26	0,00221	149522,12	18,832	9,7	8,5	14,2	1,8	3,0		0,0687	3,0170	0,8628	2,1	35,0	10,3	10,0	26,3	16,6	3,0	23,3	19,6	45,8
		3	154/926B/38X/3/35-37	378,97	1/256	0,44	0,00172	146036,36	18,858	15,1	2,5	33,5	0,4	0,8		0,1422	2,4230	0,7729		28,5	28,5	18,4	36,4	7,5	1,7	31,4	9,2	22,7
			154/926B/38X/3/75-77	379,37	1/1024	2,31	0,00226	157367,97	18,872	10,3	12,9	10,3	1,2	7,4		0,0756	2,9010	0,8616	0,3	39,4	7,9	11,5	28,2	15,9	4,7	25,0	20,6	45,2
		4	154/926B/38X/4/5-7	380,17	1/512	1,08	0,00211	229451,85	18,905	6,6	1,2	25,3	1,2	0,6		0,1548	2,3480	0,7046	1,2	26,7	20,3	7,7	35,4	5,2	1,4	25,5	6,6	20,6
			154/926B/38X/4/45-47	380,57	1/1024	2,01	0,00196	191554,23	18,920	13,3	6,6	17,0	1,9	7,7		0,0781	2,9470	0,8428	1,6	37,5	12,5	14,4	33,8	14,1	1,1	3,7	20,7	33,1
			154/926B/38X/4/125-127	381,37	1/2048	1,62	0,00079	348918,52	18,949	1,8	9,2	23,2	0,7	4,1		0,0967	2,8460	0,8287	1,5	35,4	17,7	4,4	24,0	11,8	3,7	21,4	15,5	42,0
		5	154/926B/38X/5/55-57	382,17	1/512	1,18	0,00230	126698,31	18,979	10,8	3,5	30,7	0,3	1,7		0,1218	2,5330	0,7775	1,4	35,9	23,7	12,2	39,7	8,4	3,1	31,7	11,5	26,6
			154/926B/38X/5/95-97	382,57	1/1024	2,40	0,00234	130560,00	18,995	6,5	3,6	33,6	1,8	2,5		0,0964	2,7450	0,8330	2,2	36,1	24,2	8,3	33,2	10,5	4,3	26,0	14,8	36,3
		6	154/926B/38X/6/5-7	383,17	1/1024	2,79	0,00272	110107,53	19,020	6,2	2,1	21,0	0,7	2,4		0,1061	2,7890	0,8200	2,4	37,2	15,5	8,6	36,6	13,1	4,8	31,4	17,9	36,4
			154/926B/38X/6/45-47	383,57	1/2048	2,86	0,00140	221269,93	19,036	7,1	3,1	35,6	1,7	3,1		0,1458	2,4890	0,7468	1,0	26,8	26,1	7,5	22,7	12,2	1,7	20,7	13,9	40,2
			154/926B/38X/6/110-112	384,22	1/1024	1,78	0,00174	128287,64	19,065	12,8	8,2	22,4		2,7		0,0879	2,8050	0,8510	2,3	41,6	15,5	11,4	31,5	18,3	2,3	29,2	20,5	41,3
		7	154/926B/38X/7/40-42	385,02	1/256	0,69	0,00270	119095,65	19,103	12,0	1,3	35,3	0,3	1,3		0,1538	2,4280	0,7368	1,6	28,1	27,8	13,9	32,2	10,1	1,9	29,3	12,0	29,0
			154/926B/39X/1/10-12	385,42	1/1024	2,07	0,00202	128123,67	19,120	9,7	3,9	17,0	0,8	3,9		0,0758	2,8460	0,8956	1,2	24,7	11,2	7,7	26,3	12,7	0,8	19,7	13,5	40,7
		1	154/926B/39X/1/71-73	386,03	1/512	1,07	0,00209	117233,64	19,143	9,0	4,1	31,8	0,4	2,4		0,1132	2,6330	0,7902	0,4	30,2	20,4	11,4	29,4	11,8	1,6	25,3	13,5	34,7
			154/926B/39X/1/110-112	386,42	1/1024	1,92	0,00188	148800,00	19,153	10,7	4,8	23,2	0,7	0,4		0,1034	2,7380	0,8130	0,4	32,8	18,8	8,9	30,6	12,2	0,7	26,9	12,9	32,4
		2	154/926B/39X/2/50-52	387,32	1/512	1,13	0,00221	157677,88	19,173	7,0	5,2	26,2	0,3	1,5		0,1067	2,6270	0,8063	0,6	30,2	18,9	8,4	26,7	10,5	1,5	20,1	11,9	37,3
			154/926B/39X/2/90-92	387,72	1/512	1,88	0,00367	76255,32	19,184	2,9	6,8	25,2		4,7		0,1053	2,6350	0,8290	0,7	37,1	19,4	3,2	21,9	17,3	0,7	15,1	18,0	54,3
		3	154/926B/39X/3/55-57	388,87	1/1024	1,90	0,00186	125035,79	19,218	11,7	6,7	11,2		6,7		0,0696	2,8860	0,9082	0,4	38,6	7,6	8,5	35,4	17,0	2,2	28,7	19,3	40,2
			154/926B/39X/3/95-97	389,27	1/512	0,71	0,00139	145667,61	19,237	9,0	7,0	31,3	0,5			0,1152	2,4610	0,8216	0,5	39,3	21,4	10,9	28,9	9,5	1,5	24,9	10,9	30,6
		4	154/926B/39X/4/50-52	390,32	1/1024	2,75	0,00269	75589,82	19,273	6,1	9,6	11,7	0,5	4,1		0,0730	2,8350	0,9171	0,5	39,1	6,6	9,6	25,9	15,2	1,5	23,9	16,8	41,3
			154/926B/39X/4/75-77	390,57	1/1024	1,59	0,00155	137821,38	19,281	10,3	4,7	18,8	1,4	4,2		0,1004	2,6200	0,8477		37,1	16,9	12,2	36,2	14,6	2,3	25,4	16,9	40,0
			154/926B/39X/4/135-137	391,17	1/256	0,64	0,00250	156000,00	19,299	7,8	2,2	30,4	0,8	1,6		0,1402	2,3900	0,7519		28,5	24,2	9,9	36,0	9,1	3,8	23,4	12,9	35,6
		5	154/926B/39X/5/20-22	391,52	1/1024	2,43	0,00237	106613,99	19,309	12,5	3,6	28,2	0,8	2,8		0,1000	2,6140	0,8336	0,8	36,7	16,9	14,9	27,8	14,5	6,0	24,2	20,6	45,9
			154/926B/39X/5/115-117	392,47	1/512	1,08	0,00211	97659,26	19,344	11,3	3,0	29,6	3,0	3,0		0,1327	2,4860	0,8165		31,5	26,6	13,3	27,6	18,2	3,0	20,7	21,2	50,6
			154/926B/39X/5/145-147	392,77	1/256	0,64	0,00250	147600,00	19,360	8,5	1,5	44,7	1,5	0,9		0,1860	2,2170	0,7402	0,6	23,1	35,9	10,6	26,7	8,2	2,4	18,5	10,6	36,5
		6	154/926B/39X/6/30-32	393,12	1/1024	2,01	0,00196	102909,45	19,371	12,3	0,9	36,3	0,9	3,3		0,1296	2,4530	0,8056		31,1	27,8	9,9	21,7	19,8	1,4	17,5	21,2	54,9
		5	154/926C/39X/5/80-82	393,52	1/256	0,70	0,00273	119222,86	19,383	10,6	2,0	41,4	3,2	2,9		0,1536	2,3760	0,7578	0,6	29,3	31,6	11,8	29,6	9,2	4,3	23,3	13,5	36,7
			154/926C/39X/5/120-122	393,92	1/1024	1,72	0,00168	203013,95	19,397	10,2	5,1	29,5	4,8	7,5		0,0772	2,8680	0,8701	0,6	30,7	20,2	13,0	21,7	19,6	5,1	17,2	24,7	59,0
		6	154/926C/39X/6/50-52	394,72	1/128	0,88	0,00688	53090,91	19,423	16,2	0,8	34,6	3,4	2,8		0,1267	2,4700	0,7876		34,1	26,5	17,3	29,1	12,3	3,4	26,0	15,6	37,6
			154/926C/39X/6/110-112	395,32	1/512	1,29	0,00252	122244,96	19,443	13,8	2,0	29,3	2,3	3,3		0,1165	2,5590	0,7855	0,3	40,8	25,0	14,1	25,3	18,4	2,6	22,7	21,1	48,1

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 μm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globorotaloides</i> spp.	<i>Globoturborotalita</i> spp.	<i>Paragloborotalia</i> spp.	<i>Tenuitella</i> spp.	<i>Trilobatus</i> spp.		Dominance (D)	Shannon (H)	Equitability (J)	surface-dwellers	mixed layer	thermocline	sub-thermocline	eutrophic taxa	warm taxa	warm temperate taxa	cold taxa	warm/warm temperate taxa	warm/cold taxa
B	40X	1	154/926B/40X/1/45-47	395,37	1/256	0,75	0,00293	96256,00	19,447	11,0	3,3	32,2	4,0	0,7		0,1116	2,6100	0,8108		35,2	24,9	8,4	28,2	13,6	5,1	22,3	18,7	45,5
			154/926B/40X/1/105-107	395,97	1/512	1,05	0,00205	113127,62	19,465	7,4	2,6	52,6	1,3	1,7		0,2104	2,1450	0,7044		27,8	40,4	8,3	11,3	14,3	2,6	10,4	17,0	61,9
		2	154/926B/40X/2/75-77	397,17	1/512	1,25	0,00244	126566,40	19,501	10,2	4,0	29,4	2,3	3,6		0,1124	2,5790	0,8116	0,3	43,2	23,8	12,5	23,4	16,2	5,6	21,8	21,8	50,0
			154/926B/40X/2/135-137	397,77	1/1024	1,85	0,00181	143913,51	19,517	12,2	13,5	11,8	3,7	3,7		0,0567	3,1010	0,9118	4,5	46,1	7,8	11,0	23,7	16,3	4,5	23,3	20,8	47,2
		3	154/926B/40X/3/45-47	398,37	1/256	1,11	0,00434	61117,12	19,536	15,7	2,6	38,9	6,1	1,7		0,1725	2,3780	0,7300	2,2	34,9	36,7	15,7	25,3	15,7	4,8	25,3	20,5	44,8
			154/926B/40X/3/120-122	399,12	1/512	1,25	0,00244	100761,60	19,562	14,3	5,3	31,8	6,9	2,9		0,1174	2,5690	0,8193	0,8	42,0	26,5	12,2	22,4	20,4	7,3	20,0	27,8	58,1
		4	154/926B/40X/4/85-87	400,27	1/512	1,04	0,00203	120615,38	19,603	13,5	2,6	38,9	2,6	3,9		0,1160	2,5810	0,7831	0,4	30,1	23,1	14,4	27,1	15,7	2,6	24,0	18,3	43,3
			154/926B/40X/4/145-147	400,87	1/1024	1,58	0,00154	137397,47	19,626	17,8	3,5	19,3	5,9			0,0930	2,6900	0,8579	1,0	29,2	11,9	19,8	37,6	15,8	5,9	27,2	21,8	44,4
		5	154/926B/40X/5/11-13	401,03	1/256	0,83	0,00324	98698,80	19,633	14,4	2,6	6,6	0,4			0,1277	2,3230	0,8036	0,7	35,4	0,4	14,4	33,2	12,5	1,5	26,9	14,0	34,2
			154/926B/40X/5/52,5-54,5	401,45	1/256	1,49	0,00582	64257,72	19,655	15,2	4,0	21,4	1,9	2,7		0,0972	2,6710	0,8199	0,5	33,4	18,4	15,2	23,5	15,0	2,7	22,2	17,6	44,3
		6	154/926B/40X/5/100-102	401,92	1/256	0,86	0,00336	69358,14	19,670	8,9	0,9	19,2	3,1	1,3		0,0880	2,6580	0,8729	1,3	37,1	11,6	12,1	33,0	10,3	2,7	26,8	12,9	32,6
			154/926B/40X/6/13-15	402,55	1/1024	1,80	0,00176	216746,67	19,692	11,6	1,9	24,3	1,9	1,3		0,0750	2,9060	0,8630	1,1	26,7	19,7	12,1	31,5	11,1	3,5	25,3	14,6	36,5
		6	154/926B/40X/6/69-71	403,11	1/1024	2,08	0,00203	138830,77	19,717	9,3	13,2	8,9		2,8		0,0716	2,8640	0,8898	3,2	37,0	8,9	12,8	27,8	21,0	0,7	17,1	21,7	56,0
			154/926C/40X/6/15-17	404,06	1/512	0,91	0,00178	138971,43	19,767	21,9	3,9	10,9	1,2	1,6		0,0931	2,7660	0,8488	1,6	33,2	9,4	23,4	37,9	13,3	2,0	32,4	15,2	32,0
C	40X	6	154/926C/40X/6/15-17	404,06	1/512	0,91	0,00178	138971,43	19,767	21,9	3,9	10,9	1,2	1,6		0,0931	2,7660	0,8488	1,6	33,2	9,4	23,4	37,9	13,3	2,0	32,4	15,2	32,0
B	41X	1	154/926B/41X/1/35-37	404,57	1/128	0,23	0,00180	173634,78	19,815	8,6		18,3	2,7	0,7		0,1293	2,4580	0,8072	1,7	38,2	15,6	12,6	53,8	4,3	3,3	39,5	7,6	16,2
			154/926B/41X/1/90-92	405,12	1/256	0,41	0,00160	235395,12	19,835	5,3	0,3	24,6	0,3	1,2		0,1108	2,5790	0,8011		40,7	19,0	5,0	28,5	10,7	2,1	18,4	12,8	41,0
		2	154/926B/41X/2/48-50	405,70	1/256	0,23	0,00090	287165,22	19,869	15,4	0,4	28,0		0,4		0,1432	2,3790	0,7586	1,6	35,0	19,7	15,0	48,8	5,5	1,6	41,3	7,1	14,6
			154/926B/41X/2/108-110	406,30	1/64	0,12	0,00188	201600,00	19,891	19,1	0,5	38,2	0,5			0,1547	2,3520	0,7502	4,0	19,1	26,5	18,3	32,4	4,5	1,6	29,7	6,1	17,0
		3	154/926B/41X/3/45-47	407,17	1/512	2,14	0,00418	79910,28	19,913	15,3	5,2	12,0	0,9	1,5		0,0829	2,7730	0,8511	0,3	35,0	7,7	12,3	31,3	12,3	3,1	27,3	15,3	36,0
			154/926B/41X/4/15-17	408,37	1/128	0,23	0,00180	121321,74	19,949	10,3	0,5	26,2	0,9			0,0928	2,6920	0,8472	1,4	36,9	18,7	12,1	37,4	9,8	4,7	29,9	14,5	32,6
		4	154/926B/41X/4/125-127	409,17	1/256	1,02	0,00398	81317,65	19,997	20,1	2,2	19,1	1,9	1,9		0,0931	2,7230	0,8262	1,9	35,4	11,0	18,8	35,1	7,2	4,7	33,5	11,9	26,2
			154/926B/41X/5/15-17	409,87	1/1024	0,94	0,00092	267982,98	20,011	15,4	1,0	11,1	1,4	2,4		0,0888	2,7690	0,8601	2,9	39,4	8,2	14,9	36,5	15,4	1,9	28,4	17,3	37,9
C	41X	3	154/926C/41X/3/140-142	410,28	1/128	0,24	0,00188	155733,33	20,081	16,3	2,1	14,2		0,7		0,1033	2,6250	0,8056	1,0	39,4	11,4	15,2	27,7	19,0	3,8	22,8	22,8	50,0
			154/926C/41X/4/70-72	411,08	1/128	0,24	0,00188	121066,67	20,118	10,6	0,5	22,5	0,5			0,1062	2,5590	0,8407	2,3	38,1	18,8	11,9	32,1	13,3	3,7	28,9	17,0	37,0
		4	154/926C/41X/4/145-147	411,83	1/2048	1,42	0,00069	429791,55	20,152	18,1	0,3	17,1	0,7	1,0		0,0919	2,7390	0,8309	1,4	35,9	12,5	13,2	30,0	18,8	3,1	26,1	22,0	45,7
			154/926C/41X/5/50-52	412,38	1/1024	1,03	0,00101	338019,42	20,178	13,2	3,4	16,0	0,9	2,2		0,0598	3,0780	0,8965	0,9	37,2	6,8	11,1	28,9	18,5	2,5	24,9	20,9	45,6
		5	154/926C/41X/5/110-112	412,98	1/256	0,55	0,00215	179665,45	20,205	10,3	2,4	21,9		1,6		0,1024	2,6850	0,8341	0,8	30,9	17,7	8,2	21,6	16,1	2,6	15,3	18,7	55,0
B	42X	1	154/926B/42X/1/101-103	414,93	1/512	0,50	0,00098	260096,00	20,232	15,9	1,1	5,7		0,7		0,0910	2,6990	0,8385	0,4	44,5	3,5	10,6	42,4	11,7	12,0	32,5	23,7	42,1
			154/926B/42X/2/10-12	415,52	1/512	1,08	0,00211	189629,63	20,247	11,4	0,5	11,9		0,5		0,0927	2,6650	0,8386	0,5	42,9	7,7	9,0	38,9	19,8	2,1	28,8	22,0	43,2
		2	154/926B/42X/2/88-90	416,30	1/512	0,88	0,00172	143127,27	20,269	15,1	0,4	12,2	2,1	2,5		0,0784	2,7960	0,8798	0,8	38,2	5,9	13,0	34,9	14,3	4,2	28,6	18,5	39,3
			154/926B/42X/2/145-147	416,87	1/1024	1,41	0,00138	236028,37	20,288	13,2	3,1	11,9	0,6	1,9		0,0667	2,9690	0,9008	2,2	38,7	5,0	9,1	38,1	15,1	2,8	26,1	17,9	40,7
		3	154/926B/42X/3/73-75	417,65	1/2048	1,72	0,00084	320297,67	20,314	13,4	0,9	12,9	0,4	1,8		0,0832	2,7870	0,8659	1,8	36,6	4,0	12,9	43,8	19,2	0,4	28,1	19,6	41,1
			154/926B/42X/3/135-137	418,27	1/1024	1,86	0,00182	114511,83	20,333	9,0	2,0	12,4	3,0	1,0		0,0689	2,9190	0,9067	1,5	34,3	4,0	10,0	31,8	14,9	4,5	21,4	19,4	47,6
		4	154/926B/42X/4/86-88	419,28	1/256	0,30	0,00117	174933,33	20,359	11,8	0,5	28,9	0,5	0,5		0,1006	2,6830	0,8051	1,5	34,8	21,1	10,3	34,3	14,7	1,5	25,5	16,2	38,8

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	WEIGHT >125 µm (gr.)	FRACTION WEIGHT	FAUNAL DENSITY	AGE (Ma)	<i>Globorotaloides</i> spp.	<i>Globoturbarotalita</i> spp.	<i>Paragloborotalia</i> spp.	<i>Tenuitella</i> spp.	<i>Trilobatus</i> spp.		Dominance (D)	Shannon (H)	Equitability (J)	surface-dwellers	mixed layer	thermocline	sub-thermocline	eutrophic taxa	warm taxa	warm temperate taxa	cold taxa	warm/warm temperate taxa	warm/cold taxa
B	42X	5	154/926B/42X/5/80-82	420,72	1/1024	2,24	0,00219	174628,57	20,398	7,7	1,4	15,4	0,5	1,9		0,0972	2,7750	0,8241	2,2	25,8	6,3	4,7	29,1	6,3	2,7	20,1	9,1	31,1
		6	154/926B/42X/6/10-12	421,52	1/1024	1,20	0,00117	175786,67	20,427	11,4	0,5	12,4		0,5		0,0719	2,8480	0,9083	4,5	27,4	4,0	10,0	26,9	12,4	1,0	15,9	13,4	45,8
			154/926B/42X/6/65-67	422,07	1/1024	1,45	0,00142	242228,97	20,451	12,7	2,2	14,2	0,6			0,1065	2,7040	0,8114	4,0	28,7	7,4	10,8	29,0	13,9	1,2	18,8	15,1	44,5
			154/926B/42X/6/145-147	422,87	1/512	0,71	0,00139	172349,30	20,475	6,4	0,4	28,1	0,9			0,1045	2,5790	0,8344	3,0	33,2	20,4	6,0	28,5	8,9	3,0	23,8	11,9	33,3
			154/926B/42X/7/20-22	423,12	1/512	1,38	0,00270	141727,54	20,482	8,0	0,5	32,1	1,9	0,5		0,1141	2,6520	0,7796	4,0	28,6	23,1	6,1	28,6	6,1	2,4	20,7	8,5	29,1
		7	154/926B/42X/7/20-22	423,12	1/512	1,38	0,00270	141727,54	20,482	8,0	0,5	32,1	1,9	0,5		0,1141	2,6520	0,7796	4,0	28,6	23,1	6,1	28,6	6,1	2,4	20,7	8,5	29,1
B	42X	5	154/926C/42X/5/45-47	423,67	1/256	0,48	0,00188	152533,33	20,469	9,2	0,4	36,2				0,1272	2,4750	0,8261	2,6	28,0	26,6	6,6	33,6	6,3	3,0	24,7	9,2	27,2
		2	154/926B/43X/1/90-92	424,42	1/256	0,69	0,00270	140614,49	20,525	4,7	1,2	41,3	2,9	0,3		0,1400	2,6240	0,7714	3,8	25,1	30,7	8,3	21,8	4,4	3,5	15,9	8,0	33,3
			154/926B/43X/2/35-37	425,37	1/128	0,48	0,00375	106133,33	20,552	6,8	0,5	54,9	5,3			0,1419	2,4760	0,7898	9,1	20,8	34,2	8,9	21,0	1,8	3,5	19,2	5,3	21,6
			154/926B/43X/2/90-92	425,92	1/512	1,22	0,00238	153180,33	20,571	8,6	1,0	44,6	1,7			0,2238	2,1950	0,6905	3,0	25,1	40,6	4,3	30,7	2,3	1,7	27,7	4,0	12,5
		3	154/926B/43X/3/10-12	426,62	1/512	0,80	0,00156	132480,00	20,599	10,7		59,2	0,5	0,5		0,2034	2,2030	0,7236	9,2	17,5	40,3	6,3	23,8	1,5	3,4	16,0	4,9	23,3
			154/926B/43X/3/72-74	427,24	1/256	0,68	0,00266	121600,00	20,620	12,7		54,5	2,1			0,1421	2,5400	0,7993	7,2	17,8	38,4	6,2	26,4	1,7	3,4	24,3	5,1	17,4
		4	154/926B/43X/4/30-32	428,32	1/1024	1,54	0,00150	141631,17	20,650	10,4	0,9	52,8	5,2			0,1724	2,4310	0,7551	10,4	24,1	35,8	6,1	22,6	1,9	4,7	21,2	6,6	23,7
			154/926B/43X/4/130-132	429,32	1/512	1,07	0,00209	127760,75	20,685	20,0		35,8	4,2	0,4		0,0981	2,7360	0,8302	5,7	30,2	24,5	12,5	34,3	3,4	2,3	30,2	5,7	15,8
		5	154/926B/43X/5/65-67	430,17	1/512	0,29	0,00057	368993,10	20,714	17,4		43,5	2,9			0,0949	2,6970	0,8487	9,2	30,4	22,2	11,1	36,2	8,2	2,9	28,5	11,1	28,0
			154/926B/43X/5/145-147	430,97	1/128	0,20	0,00156	138880,00	20,737	9,5	0,5	50,0	1,9			0,1533	2,4440	0,7793	5,7	24,8	33,3	10,5	27,6	1,0	3,8	25,7	4,8	15,6
		6	154/926B/43X/6/75-77	431,77	1/256	0,49	0,00191	119640,82	20,762	14,8	0,5	47,7	4,2			0,1441	2,4380	0,7889	8,3	31,5	30,6	13,0	26,9	3,2	0,9	27,8	4,2	13,0
		CC	154/926B/43X/CC/25-27	432,27	1/512	0,57	0,00111	195817,54	20,778	25,2	0,5	39,6	0,5			0,1094	2,4560	0,8497	3,0	29,2	24,3	12,4	48,0	9,9	1,5	33,7	11,4	25,3
	44X	1	154/926B/44X/1/115-117	434,37	1/512	1,03	0,00201	166027,18	20,850	19,5	4,0	35,0	4,0	0,9		0,0935	2,8940	0,8278	2,0	25,2	30,1	14,9	32,4	6,6	4,3	32,4	10,9	25,2
		2	154/926B/44X/2/85-87	435,57	1/256	0,47	0,00184	151965,96	20,896	17,3	1,4	44,6	2,9			0,1271	2,5770	0,8007	3,6	28,1	35,3	12,2	32,0	9,0	1,8	28,8	10,8	27,3
		3	154/926B/44X/3/36,5-38,5	436,59	1/4096	1,25	0,00031	697958,40	20,931	14,4	2,8	31,9	3,2			0,1029	2,7720	0,8233	1,9	37,0	25,5	8,8	41,7	7,9	2,3	38,4	10,2	21,0
			154/926B/44X/3/135-137	437,57	1/256	0,35	0,00137	154331,43	20,963	23,2	1,4	41,2	2,8			0,1064	2,7510	0,8347	3,8	24,2	29,9	20,9	39,3	6,6	2,8	37,4	9,5	20,2
		4	154/926B/44X/4/125-127	438,97	1/256	0,31	0,00121	199845,16	21,003	17,6	0,8	32,7	12,2	0,4		0,0660	3,0590	0,8908	5,3	27,8	20,0	13,1	32,2	4,5	7,8	31,8	12,2	27,8
		5	154/926B/44X/5/96-98	440,18	1/1024	1,44	0,00141	164977,78	21,039	19,6	1,7	37,4	5,7	1,7		0,0886	2,8780	0,8546	3,9	29,1	24,3	10,0	33,5	11,7	5,2	30,4	17,0	35,8
	45X	6	154/926B/44X/6/110-112	441,82	1/512	0,63	0,00123	194234,92	21,092	26,5		35,7	3,4	0,4		0,1057	2,5840	0,8361	0,8	24,4	25,2	14,7	37,4	8,0	4,2	32,8	12,2	27,1
		1	154/926B/45X/1/85-87	443,77	1/256	0,83	0,00324	98390,36	21,165	3,5	0,9	70,4	2,8			0,2225	2,2130	0,6572	0,6	51,9	27,4	2,2	48,7	43,1	3,8	9,7	46,9	82,8
		2	154/926B/45X/2/55-57	444,97	1/1024	1,27	0,00124	174160,63	21,200	5,5	1,4	42,7	6,4	1,4		0,1084	2,6130	0,8223	0,9	39,4	20,6	5,0	37,6	20,6	4,6	15,6	25,2	61,8
		3	154/926B/45X/3/45-47	446,37	1/512	1,01	0,00197	101893,07	21,250	12,3	2,0	43,3	5,4	1,0		0,1061	2,7260	0,8270	1,0	43,3	20,7	5,4	40,4	27,1	4,4	19,7	31,5	61,5
			154/926B/45X/3/125-127	447,17	1/1024	1,64	0,00160	141112,20	21,279	12,1	4,0	40,6	2,7	4,9		0,0934	2,7120	0,8534	0,9	40,6	24,6	7,6	38,8	22,3	2,2	25,4	24,6	49,1
		4	154/926B/45X/4/100-102	448,42	1/512	1,13	0,00221	138194,69	21,321	7,1		51,6	11,9	0,3		0,1266	2,5440	0,7809	1,3	48,1	25,2	0,6	46,8	29,0	7,7	22,3	36,8	62,3
		5	154/926B/45X/5/10-12	449,02	1/512	1,08	0,00211	115674,07	21,341	9,5		55,4	6,2			0,1460	2,4020	0,8157		26,9	39,3	3,7	35,1	16,5	6,2	17,4	22,7	56,7
			154/926B/45X/5/90-92	449,82	1/512	0,56	0,00109	234057,14	21,367	6,3	0,4	56,9	3,5			0,1547	2,2910	0,7411		38,8	35,3	3,5	37,3	22,4	3,5	13,7	25,9	65,3
		6	154/926B/45X/6/60-62	451,02	1/256	0,59	0,00230	155335,59	21,406	16,4	2,8	34,3	6,7			0,0864	2,8170	0,8548	1,4	29,5	28,1	7,8	24,5	14,2	6,7	19,2	20,9	52,1

Appendix 3 – Tables (upper Chattian – Aquitanian interval)

Paragloborotalia pseudokugleri / *P. kugleri* group relative abundances (%)

HOLE	CORE	SECTION	SAMPLE	AVERAGE DEPTH (mcd)	FRACTION EXAMINED	AGE (Ma)	<i>Paragloborotalia pseudokugleri</i> / <i>P. kugleri</i> gr.	TOT planktonic	fragments	benthic foraminifera	radiolarians	plank/bent (%)	plank fragments/plank whole (%)
B	46X	1	154/926B/46X/1/85-87	453,47	1/1024	21,491	14,5	200	22		2	50,0	50,0
		2	154/926B/46X/2/40-42	454,52	1/1024	21,522	11,8	255	65	3	14	38,8	38,8
			154/926B/46X/2/75-77	454,87	1/1024	21,531	25,4	205	24		3	48,8	48,8
		3	154/926B/46X/3/20-22	455,82	1/512	21,555	12,1	232	69	1	5	42,9	42,9
			154/926B/46X/3/65-67	456,27	1/512	21,568	11,9	201	54		3	49,8	49,8
		4	154/926B/46X/4/24-26	457,36	1/1024	21,601	20,3	261	48	1	2	38,2	38,2
		5	154/926B/46X/5/20-22	458,82	1/512	21,648	24,5	229	39		6	43,7	43,7
			154/926B/46X/5/115-117	459,77	1/256	21,680	1,0	206	71	2	9	48,1	48,1
		6	154/926B/46X/6/95-97	461,07	1/128	21,728	27,4	215	71	5	95	45,5	45,5
	47X	1	154/926B/47X/1/80-82	463,02	1/1024	21,802	19,4	232	34		12	43,1	43,1
		2	154/926B/47X/2/40-42	464,12	1/512	21,842	23,0	235	66	2	16	42,2	42,2
			154/926B/47X/2/90-92	464,62	1/512	21,860	26,9	201	36	1	11	49,5	49,5
		3	154/926B/47X/3/29-31	465,51	1/1024	21,889	32,5	255	52	2	14	38,9	38,9
			154/926B/47X/3/125-127	466,47	1/512	21,916	30,5	311	100	2	14	31,9	31,9
		4	154/926B/47X/4/30-32	467,02	1/512	21,930	34,4	311	84	5	6	31,6	31,6
			154/926B/47X/4/115-117	467,87	1/512	21,959	22,7	225	53	1	14	44,2	44,2
		5	154/926B/47X/5/120-122	469,42	1/512	22,017	37,4	302	83	2	3	32,9	32,9
		6	154/926B/47X/6/70-72	470,42	1/512	22,048	19,5	339	63	3	14	29,2	29,2
	48X	1	154/926B/48X/1/100-102	472,92	1/512	22,127	41,3	264	59		3	37,9	37,9
		2	154/926B/48X/2/70-72	474,12	1/1024	22,169	26,2	275	41		8	36,4	36,4
		3	154/926B/48X/3/75-77	475,67	1/2048	22,224	33,3	243	56		11	41,2	41,2
		4	154/926B/48X/4/36-38	476,78	1/512	22,260	8,9	236	75	7	6	41,2	41,2
			154/926B/48X/4/145-147	477,87	1/512	22,296	14,0	235	56	2	11	42,2	42,2
		5	154/926B/48X/5/94-96	478,86	1/1024	22,326	22,8	416	76		6	24,0	24,0
		6	154/926B/48X/6/80-82	480,22	1/1024	22,374	16,7	449	135	2		22,2	22,2
		7	154/926B/48X/7/35-37	481,27	1/1024	22,416	17,2	297	106			33,7	33,7
	49X	1	154/926B/49X/1/70-72	482,22	1/512	22,452	14,8	216	54			46,3	46,3
		2	154/926B/49X/2/20-22	483,22	1/512	22,485	19,7	325	130			30,8	30,8
		3	154/926B/49X/3/15-17	484,67	1/512	22,541	8,3	398	163	2		25,0	25,0
			154/926B/49X/3/110-112	485,62	1/1024	22,577	12,6	231	107	1		43,1	43,1
		4	154/926B/49X/4/85-87	486,87	1/256	22,612	23,7	316	158	1		31,5	31,5
		5	154/926B/49X/5/30-32	487,82	1/1024	22,648	27,9	376	134	2		26,5	26,5
			154/926B/49X/5/135-137	488,87	1/512	22,691	39,4	249	127	1		40,0	40,0
		6	154/926B/49X/6/75-77	489,77	1/512	22,727	23,7	342	180	1		29,2	29,2
	50X	1	154/926B/50X/1/80-82	492,02	1/2048	22,816	40,1	262	127			38,2	38,2
		2	154/926B/50X/2/25-27	492,97	1/512	22,852	26,9	264	107	1		37,7	37,7
			154/926B/50X/2/115-117	493,87	1/1024	22,889	38,3	253	87	1		39,4	39,4
		3	154/926B/50X/3/65-67	494,87	1/256	22,930	39,5	248	46	6		39,4	39,4
		4	154/926B/50X/4/21,5-23,5	495,94	1/512	22,971	42,0	205	42			48,8	48,8
			154/926B/50X/4/120-122	496,92	1/512	23,006	31,0	303	108	2		32,8	32,8
		5	154/926B/50X/5/80-82	498,02	1/1024	23,045	18,1	237	103			42,2	42,2
		6	154/926B/50X/6/74-76	499,46	1/512	23,102	12,0	274	134			36,5	36,5
	51X	1	154/926B/51X/1/60-62	501,42	1/512	23,172	9,5	242	76	2		41,0	41,0
		2	154/926B/51X/2/105-107	503,37	1/128	23,248	11,7	385	126	1		25,9	25,9