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Benthic foraminiferal assemblages from the Mauritanian shelf and upper slope and their association with cold-water coral habitats

Keywords Foraminifera, Mauritania, NW Africa, NE Atlantic, cold-water coral habitats

Abstract This study documents foraminiferal faunas from the Mauritanian upper slope and shelf and analyses their association with cold-water coral habitats (=CWCH). It is based on the analysis of foraminiferal tests in 28 sediment samples of the >250 µm fraction only. One hundred and fifty seven benthic species are recorded, described and one hundred and fifty four are imaged. It increases the number of benthic foraminiferal species so far reported in this area from 102 to 157 and their description from 33 to 157. An analysis of the structure, composition, and diversity of the species-rich benthic foraminiferal faunas is given. It reveals the existence of three main faunal clusters: a living coral cluster, a non-living coral cluster and a low diversity/*Tetragonostomina rhombiformis* Mikhalevich, 1975 cluster. The living coral cluster is dominated by the species *Rosalina vermiculata* (d'Orbigny, 1839 in Jones, 1994), which until now not has been reported specifically reported as an important species from CWCH. The non-living coral cluster lacks a dominant species and is characterised by a set of species more evenly distributed. A subcluster is found to be associated with dead coral debris. The low diversity/*Tetragonostomina rhombiformis*

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cluster is interpreted as an endemic fauna at shallower water-depths with mud as its preferred substrate. This study extends the knowledge on benthic foraminiferal faunas from CWCH and the Mauritanian upper bathyal slope and shelf.

Introduction

As late as from the mid-1990s research interest in cold-water corals and their habitats has grown rapidly. Since then intense mapping, sampling, video documentation and the use of acoustic survey technology and submersibles has led to the discovery of large cold-water coral reefs and the awareness of their worldwide existence (Freiwald et al. 2005). The full extent of their geographical distribution is still unknown (Spezzaferri et al. 2015). For the understanding of the coral associated habitats it is essential to document and study species living in and around them. Foraminifera are single celled organisms present in almost every marine environment of today and in the fossil record of the Phanerozoic. Due to their great numbers and biomass foraminifera are an important taxon in marine realms (Murray 2006). They feed on organic matter and play a role in the ecology of marine habitats. For example in the deep sea they may account for more than 50 % of the eukaryotic biomass (Murray 2006). Referring to their main life-style they are split into the two main groups, planktonic and benthic foraminifera. Each niche in the marine realm is inhabited by specific foraminiferal faunas. About 8.970 extant species are described, of which about 8.920 are benthic foraminifera (Hayward et al. 2022; Schiebel et al. 2017). Benthic foraminifera live in, on and close to the sea floor and depend on the according local conditions including those created by cold-water corals.

The study of benthic foraminifera and their role in CWCH is an ongoing effort. A milestone was reached in 2015 with the publication of an atlas of benthic foraminifera from cold-water coral reefs (Spezzaferri et al. 2015). The atlas is restricted though to the European continental margin. Reymond et al. (2014) is so far the only paper dealing with the association of foraminiferal faunas with CWCH on the Mauritanian slope and shelf. Its focus is the documentation of foraminiferal assemblages in general and includes both benthic and planktonic foraminifera.

This study focuses on the association of benthic foraminifera with CWCH. Despite the limitations given by the available material rich foraminiferal faunas were found and their association with the CWCH is recorded. In contrast to Reymond et al. (2014) planktonic foraminifera are excluded from this investigation. They live well above or off CWCH. The main purpose of this study is to reveal the correlation of benthic foraminiferal faunas with cold-water corals of the upper bathyal Mauritanian slope. Planktonic foraminifera are not or only a little influenced by the conditions at the seafloor. This study follows the approach of Spezzaferri et al. (2015), which deals with benthic foraminifera only and not that of Reymond et al. (2014), which includes planktonic foraminifera. Except for Reymond et al. (2014) the few specific studies of foraminiferal faunas in this area list taxa

without illustrating and describing the species (Lutze & Coulbourn 1984; Jorissen et al. 1998; Jorissen & Wittling 1999). This study extends the documentation and knowledge about benthic foraminiferal faunas on the upper bathyal Mauritanian slope and shelf.

Materials and methods

Sample collection

From the repository of Senckenberg am Meer, Wilhelmshaven all available, thirty surface samples containing the fraction size down to 250 µm were chosen for this investigation. The sample material was collected on the Mauritanian slope and shelf during the expedition MSM16/3 of RV Maria S. Merian in October–November 2010 (Westphal et al. 2014). The samples range from water depths of 13 m on the shelf to 1310 m on the middle bathyal slope. They are from the inner and outer shelf, upper bathyal slope, canyons, coral mounds, the cold-water coral reef chains at 400–600 m water depth and the middle bathyal slope. The geographical positions are shown on the map (Fig. 1) and Table 1 (Westphal et al. 2014). Twenty two samples contain material from 0–1 cm of the surface sediment using a box corer with a sampling area of 50 × 50 cm and length of 55 cm. Seven samples contain the top of the sediment collected by using grabs and one further sample contains the top sediment collected by using a gravity corer of 6 m length (Table 1) (Westphal et al. 2014). It is concluded from previous studies on the equipment used that the samples contain almost undisturbed surface material (Schönfeld 2012). To the extent given in (Table 1) sediment and facies for each sample were recorded by physical observation on board (Westphal et al. 2014).

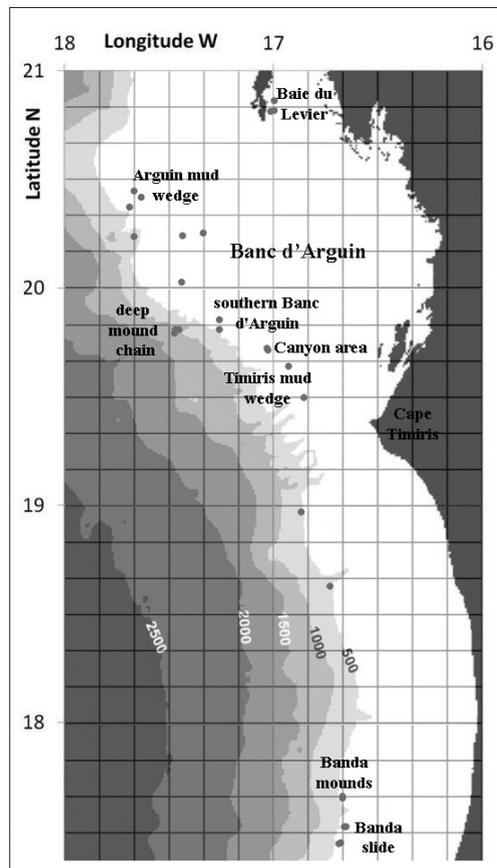


Fig. 1 Map of the Mauritanian shelf and slope. GEBCO Bathymetric Compilation Group 2020 (2020). Sample sites indicated by dots.

Table 1 List of investigated samples of the expedition MSM16/3 of RV Maria S. Merian with information on geographical data, water depth, sampling device, sediment and facies (Westphal et al. 2014).

Sample GeoB	Site	Longitude	Latitude	Depth	Device	Sediment	Facies
14703-1	Arguin mud wedge	20°14.120'	17°26.173'	111	Large Box Corer	not recorded	not recorded
14704-1	Arguin mud wedge	20°21.905'	17°41.001'	246	Large Box Corer	not recorded	not recorded
14705-1	Arguin mud wedge	20°25.291'	17°38.970'	91	Large Box Corer	not recorded	not recorded
14706-1	Arguin mud wedge	20°27.416'	17°40.768'	142	Large Box Corer	not recorded	not recorded
14714-1	outer shelf off Banc d'Arguin	20°02.627'	17°27.420'	52	Large Box Corer	not recorded	not recorded
14780-2	Baie du Levier	20°49.015'	17°01.113'	13	Grab	sand	debris without coral
14782-3	Baie du Levier	20°52.807'	16°59.533'	14	Large Box Corer	mud	debris without coral
14785-4	Baie du Levier	20°49.428'	16°59.616'	14	Grab	mud	debris without coral
14788-1	central outer Banc d'Arguin	20°16.989'	17°20.009'	30	Large Box Corer	not recorded	not recorded
14799-1	northern canyon area west of Banc d'Arguin	20°14.574'	17°40.088'	490	Large Box Corer	sandy mud	living coral
14847-1	southern Banc d'Arguin	19°51.143'	17°15.816'	369	Large Box Corer	not recorded	not recorded
14848-1	southern Banc d'Arguin	19°49.308'	17°15.701'	516	Large Box Corer	not recorded	not recorded
14852-1	deep mound chain	19°48.642'	17°28.228'	1310	Large Box Corer	sandy mud	debris without coral
14853-1	deep mound chain	19°48.487'	17°28.228'	1252	Large Box Corer	sandy mud	debris without coral
14854-1	deep mound chain	19°49.675'	17°27.690'	1196	Large Box Corer	mud	no debris
14856-1	deep mound chain	19°46.324'	17°22.086'	1119	Large Box Corer	sandy mud	no debris
14858-1	Canyon area southern Banc d'Arguin	19°44.283'	17°08.790'	483	Grab	mud	no debris
14860-1	Canyon area southern Banc d'Arguin	19°44.265'	17°08.753'	493	Grab	mud	debris with dead coral
14865-1	Timiris mud wedge	19°30.702'	16°51.706'	52	Large Box Corer	not recorded	not recorded
14867-1	Timiris mud wedge	19°39.295'	16°56.302'	52	Large Box Corer	not recorded	not recorded
14878-1	Timiris deep coral mounds	18°57.934'	16°52.073'	493	Large Box Corer	mud	living coral
14889-1	Canyon South of Timiris mound chain	18°38.875'	16°43.696'	590	Gravity Corer	not recorded	living coral
14895-1	Banda mounds	17°40.191'	16°40.840'	577	Grab	not recorded	debris with dead coral
14896-1	Banda mounds	17°40.191'	16°40.741'	566	Grab	sandy mud	no debris

Sample GeoB	Site	Longitude	Latitude	Depth	Device	Sediment	Facies
14898-1	Banda mounds	17°40.193'	16°40.415'	505	Grab	mud	debris with dead coral
14903-1	Banda slide	17°32.853'	16°39.700'	414	Large Box Corer	mud	living coral
14904-1	Banda slide	17°32.559'	16°39.805'	510	Large Box Corer	mud	living coral
14905-1	Banda slide	17°32.457'	16°39.997'	486	Large Box Corer	mud	living coral
14910-2	southern Banda slide	17°28.998'	16°41.647'	535	Large Box Corer	mud	debris with dead coral
14911-1	southern Banda slide	17°28.910'	16°41.509'	450	Large Box Corer	mud	living coral

Sample processing

Live material in the sediment was not stained with Rose Bengal and it was not possible to distinguish between living and dead specimens. This study is based on the tests of the total assemblages. To clean the surface of the specimens from organic attachments and crystallised salt the surface the subsamples were boiled for 30 minutes in a solution of 10 % sodium carbonate in water and let stand for a day. They were then washed over 63 µm sieves and dried. The dry subsamples were sieved on 250 µm and 2000 µm mesh. The 250 µm to 2000 µm fraction was split into aliquots of 1–2 g using a micro splitter. The first three aliquots of each sample were separated and used to pick well preserved specimens for imaging. For scanning electron microscope images, selected specimens were placed on stubs in the Foraminifera.eu Lab. They were coated with gold and imaged using a VEGA3-TESCAN scanning microscope (SEM) at Senckenberg am Meer. Photomicrographs of selected specimens were taken with a Keyence VHX 900F in the Foraminifera.eu Lab.

Counting method

Counting was done after the systematic descriptions and optical imaging of species were completed. Subsamples of each sample were looked through to find adequate specimens for imaging. It was found that sample 14910-2 showed the highest diversity. Species identification during counting was based on the systematic descriptions and relevant images. The high-diversity sample 14910-2 was used to decide on the number of specimens to be counted in order to achieve an adequate assessment of the diversity. After counting 500 specimens in sample 14910-2 a total of 48 species were found (Fig. 2). The 35 most abundant species were

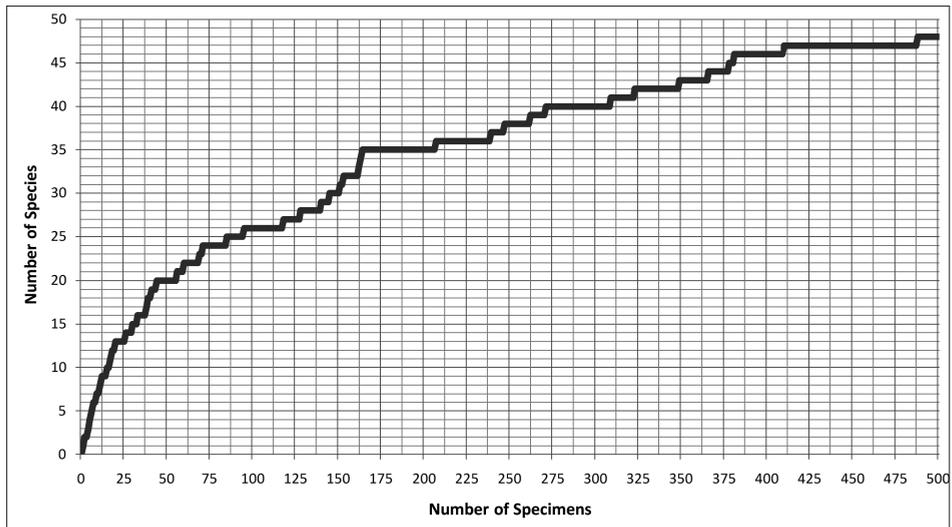


Fig. 2 Relation between number of counted specimens and number of species in sample GeoB 14910-2

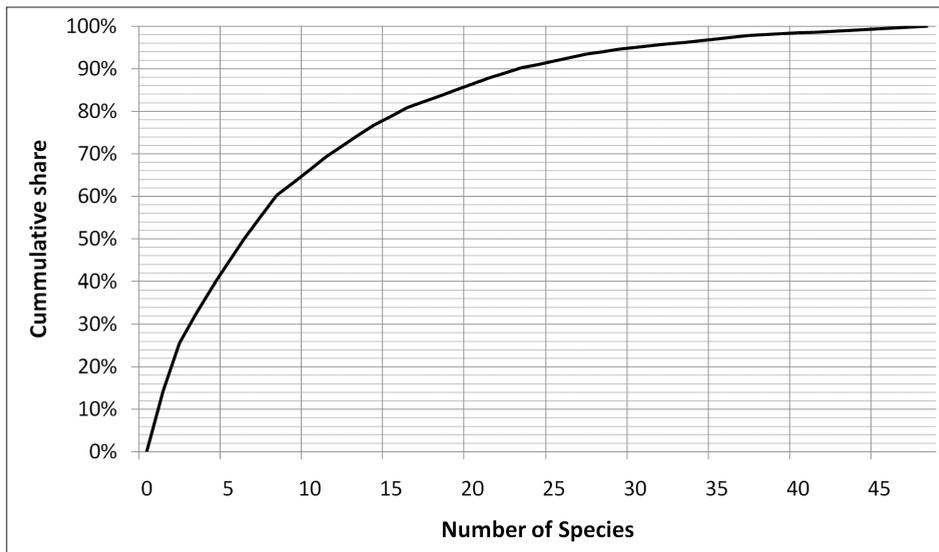


Fig. 3 Relation between numbers of species sorted by abundances and cumulative share of specimens in the assemblage in sample GeoB 14910-2.

found after counting 200 specimens (Fig. 3). They account for 97,0 % of all specimens (Fig. 3). This was seen as sufficient to assess diversity for the purposes of this study. The decision to count 200 specimens is in accordance with the study of Schönfeld (2012) on adequate count numbers. He notes that for low diversity assemblages numbers lower than 200 are sufficient. Reymond et al. (2014) used 100 specimens including planktonic species. Spezzaferri et al. (2015) used varying counts for each sample ranging from 49 to 1211 counted specimens.

A total number of 5.753 specimens from 30 samples were counted by using a standard binocular microscope Will Strübin, Wetzlar No. 771814 in the Foraminifera.eu Lab. For the counting aliquots were evenly dispersed on a picking tray and specimens were counted by species until the number of 200 was reached. The samples GeoB 14780-2 and GeoB 14782-3 were excluded for further investigation as they were barren of foraminifera. For 27 samples a total of 200 specimens was counted. Sample GeoB 14754-1 only contained 53 specimens and was counted in full. After deducting the additional 300 specimens counted in sample GeoB 14910-2 for methodical reasons this study is based on 5.453 specimens.

The test preservation state was used to minimize inaccuracies in the assessment of the diversity of the recent assemblages caused by down-slope and other transport, reworking and mixing with fossil specimens. Damage, lacking parts, change in colour and dissolution indicate that the test does not belong to the recent biocenosis at the locality (Yordanova et al. 2002). If more than 20 % of a resistant to more than 30 % of a delicate test showed such alterations the test was not counted. Boreholes by predators were not considered as bad preservation but interpreted to have occurred when protozoa was present.

Statistical Methods

Statistics and analyses were calculated using PAST ver. 4.05 (Hammer et al. 2001; Hammer 2020) and Microsoft Excel 2013. The species richness and diversity is based on the counts of species per sample (S) which were used to calculate the indices Fisher's alpha (α), Pielou's equitability (J) and Shannon (H) (Fisher et al. 1943, Pielou 1966, Shannon 1948). The Fisher's alpha index (α) describes the relationship between the number of species and the number of specimens by assuming that species abundance follows a log distribution. It is illustrated in Murray (2006). A small sample with a few species may indicate the same species richness as a bigger sample with more species. The values of α rise with increasing species richness. It is used to compare the species richness between samples of different sizes. Fisher's α was used because the number of counted specimens per sample differed and the mere number of taxa could not be used as a reliable measure of diversity. Sample 14785-4 contained only 53 specimens which were counted in full. In all other samples 200 specimens were counted. Pielou's equitability (J) describes how specimens are divided between species and ranges between 0 and 1. The more a sample is dominated by one or a few species the lower the value will be. An equal species distribution results in a value of 1. The number of specimens has no direct effect on J. The Shannon H index takes into account both the number of species and the evenness of distribution. For one specimen it is 0 and rises with the number of species and the evenness of the assemblage. The number of specimens has no direct effect on H.

For each of three different cluster analyses, the multivariate, classical hierarchical cluster analysis in Q-mode with Ward's method algorithm (=HCAQ) was used (Ward 1963). The calculations were made by using PAST ver. 4.05, for which the formulas are given in Hammer (2020). The HCAQ compares each pair of samples based on the raw data per

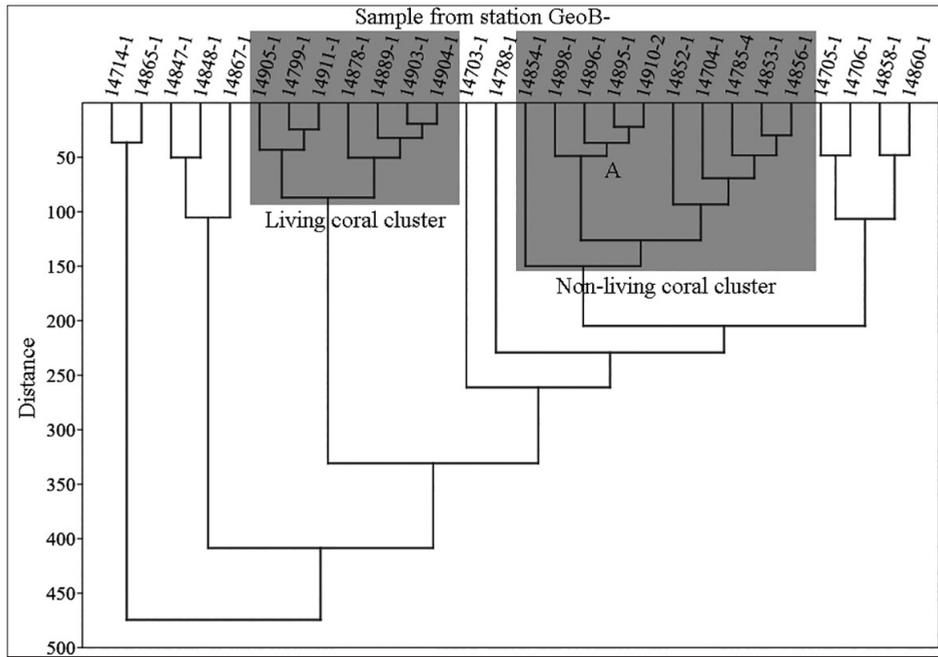


Fig. 4 All Species HCAQ based on all counts.

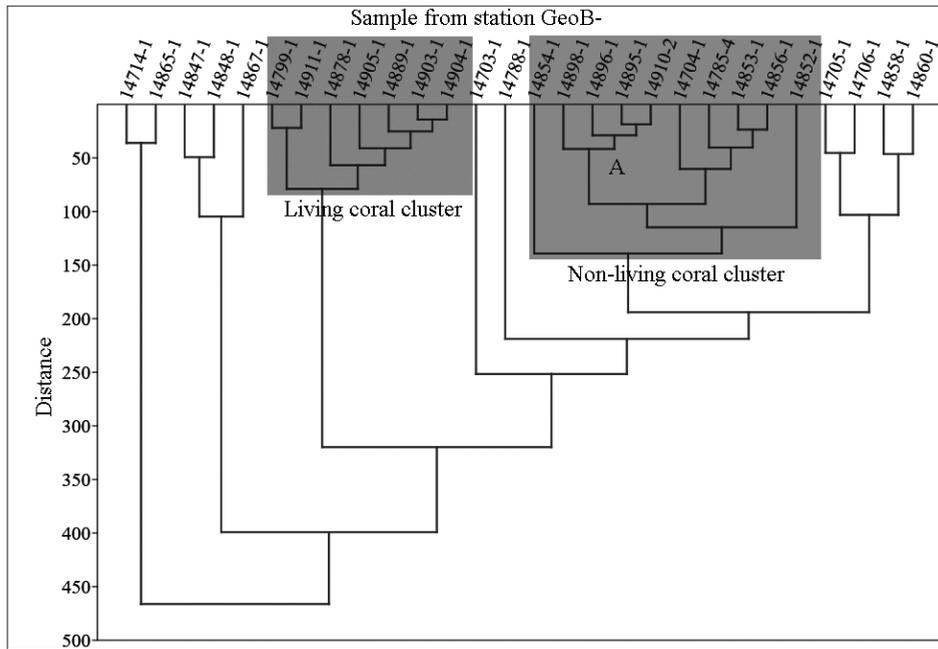


Fig. 5 Important Species HCAQ based on counts of species with a share of at least 10% in a sample.

sample and constructs a dendrogram. The dendrogram clusters the samples according to their similarities in the raw data. The raw data for the different cluster analyses were recorded and calculated using Excel 2013.

A first cluster analysis was based on the counts of all species (Appendix II). It is referred to as All Species HCAQ (Fig. 4). A second cluster analysis was based on the counts of important species, which are defined as having a share of at least 10% in one of the samples (Appendix III). This cluster analysis is referred to as Important Species HCAQ (Fig. 5).

A third cluster analysis relates to the autecology of benthic species. The relationship between single species and faunas to ecological, physical and chemical parameters in habitats is documented by many publications as listed in Murray (2006), Reymond et al. (2014) and in Spezzaferri et al. (2015). These parameters were not recorded during sampling. In this study only the life strategy is analysed due to the lack of more data. It is grouped into infaunal and epifaunal. If known the epifaunal species are differentiated into epifaunal attached and epifaunal free. The life strategies of single species are derived from previous studies as listed in Table 2. If no data were available for a specific species data on related species, the genus and for *Discammina compressa* (Goës, 1882) the observations in the studied material are used. This usage of alternative data is explained in the column remarks of Table 2. Species with a total count in all samples below 35 specimens are excluded in order to reduce background scatter by single specimens living outside their niche and rare species. It reduces the total number of specimens used in the analysis from 5,453 to 4,585. The counts for the life strategy are given in Appendix IV. This third cluster analysis is based on the cumulative counts on the life strategy and the Fisher's alpha (α), Pielou's equitability (J) and Shannon (H) (Appendix V). This cluster analysis is referred to as Faunal HCAQ (Fig. 6). An HCAQ based on available data of the preferred sediment (hard substrate, coarse sediment, sand to silt and silt to mud) did not result in meaningful clusters.

Table 2 Analysis of Foraminifera in 28 samples from the Mauritanian shelf and slope of expedition MSM16/3 of RV Maria S. Merian. List of species with overall counts of at least 35 specimens and their life strategy. References and remarks are given for the life strategy of each taxon.

Species	Count \geq 35	Infaunal	Epifaunal	Epifaunal attached	Epifaunal free	References	Remark
Total	4585						
<i>Acervulina inhaerens</i>	97		X	X		(Murray 2006)	
<i>Ammonia neobeccarii</i>	376	X				(Murray 2006)	<i>A. falso-beccarii</i>
<i>Bolivina beyrichi</i>	38	X				(Spezzaferri et al. 2015)	
<i>Bolivina subaenariensis</i>	70	X				(Spezzaferri et al. 2015)	
<i>Cancris aurculus</i>	75		X		X	(Murray 2006)	

Species	Count \geq 35	Infaunal	Epifaunal	Epifaunal attached	Epifaunal free	References	Remark
Cassidulina laevigata	40	X				(Spezzaferri et al. 2015)	
Chilostomella oolina	90	X				(Jorissen et al. 1998; Murray 2006)	
Cibicoides lobatulus	132		X	X		(Spezzaferri et al. 2015)	
Cibicoides mundulus	219	X				(Jorissen et al. 1998; Murray 2006)	<i>C. kullenbergi</i>
Cibicoides wuellerstorfi	41		X		X	(Spezzaferri et al. 2015)	
Connemarella rudis	60		X	X		(Murray 2006)	genus <i>Gaudryina</i>
Discamina compressa	188		X			this study	occurrence
Dorothia pseudoturris	111		X			(Murray 2006)	<i>Textularia</i>
Ehrenbergina serrata	52		X		X	(Murray 2006)	genus
Elphidium crispum	171		X		X	(Murray 2006)	genus
Globobulimina turgida	119	X				(Spezzaferri et al. 2015)	<i>G. affinis</i>
Gyroidina orbicularis	54		X		X	(Spezzaferri et al. 2015)	<i>G. soldanii</i>
Hyrrokin sarcophaga	105		X	X		(Spezzaferri et al. 2015)	
Lagenamina arenulata	43	X				(Murray 2006)	genus
Lenticulina rotulata	67		X		X	(Murray 2006)	genus
Melonis zaandamae	60	X				(Jorissen et al. 1998; Spezzaferri et al. 2015)	<i>M. barleeanum</i>
Nonion fabum	65	X				(Murray 2006)	genus
Planulina ariminensis	230		X	X		(Spezzaferri et al. 2015)	
Pyrgo williamsoni	56		X			(Murray 2006)	genus
Quinqueloculina lamarckiana	478		X			(Murray 2006)	genus
Rosalina semipunctata	49		X	X		(Murray 2006)	genus
Rosalina vermiculata	770		X	X		(Murray 2006)	genus
Sigmoilopsis schlumbergeri	124		X		X	(Spezzaferri et al. 2015)	
Spiroloculina excavata	37		X			(Murray 2006)	genus

Species	Count ≥ 35	Infaunal	Epifaunal	Epifaunal attached	Epifaunal free	References	Remark
<i>Spiroplectinella wrighti</i>	71		X	X		(Spezzaferri et al. 2015)	
<i>Tetragonostomina rhombiformis</i>	352		X			(Murray 2006)	<i>Textularia</i>
<i>Uvigerina peregrina</i>	145	X				(Jorissen et al. 1998; Spezzaferri et al. 2015)	

Results

A total of 157 species were found and they are listed in appendix I. Thirty six rare species did not occur among the counted specimens but were found when looking through the samples in search of species. Twenty eight of thirty investigated samples contain foraminifera and are used for this study. The samples GeoB 14780-2 and GeoB 14782-3 were barren. The raw count data for 121 species are given in the appendices II–IV. They are the basis for the following analysis. Table 3 shows the species richness and diversity measures. In Appendix V the cumulative data on the living strategies and diversity param-

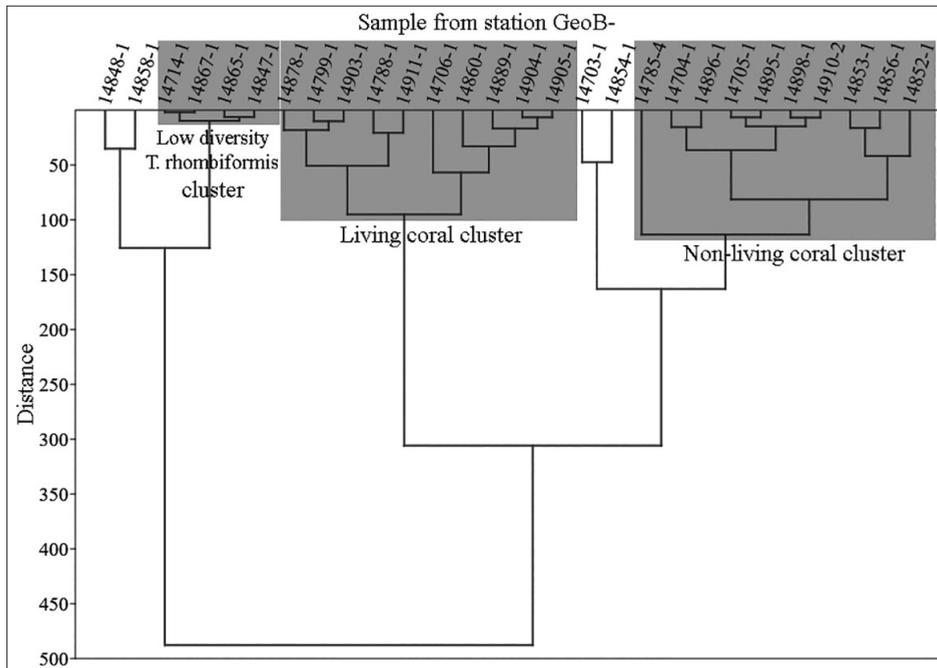


Fig. 6 Faunal HCAQ for selected species based on the faunal parameters species living strategy, Fisher’s alpha (α), Pielou’s equitability (J) and Shannon (H).

eters Fisher's alpha (α), Pielou's equitability (J) and Shannon (H) per sample are given. Appendix VI shows the counts and shares of important species of the two main clusters.

The dendrogram of the All Species HCAQ is given in Fig. 4, of the Important Species HCAQ in Fig. 5 and of the Faunal HCAQ in Fig. 6.

In all HCAQs the assemblages show two main clusters, which comprise in the All Species HCAQ seventeen of the twenty eight investigated samples with foraminiferal content. They are addressed as living coral and non-living coral clusters. In the All Species HCAQ the living coral cluster exactly comprises the seven samples which contain living corals as accompanying material (GeoB- 14799-1, 14878-1, 14889-1, 14903-1, 14904-1, 14905-1 and 14911-1). They are from water depths between 414 m and 590 m, a range where living coral habitats are observed. Also in the Important Species HCAQ the living coral cluster exactly comprises the seven samples which contain living corals. *Rosalina vermiculata* (d'Orbigny, 1839 in Jones, 1994) is the dominating species in this cluster and is accompanied by *Planulina ariminensis* d'Orbigny, 1826, *Globobulimina turgida* (Bailey, 1851) and *Hyrrokkin sarcophaga* Cedhagen, 1994. The average share in the cluster and the share in the single samples are given in Appendix VI.

The non-living coral cluster comprises ten samples in the All Species HCAQ, none of which contain living coral material. Four samples are from water depth below 1100 m and well below the coral habitats (GeoB- 14852-1, 14853-1, 14854-1 and 14856-1). From above the coral habitats are the samples GeoB- 14785-4 and 14704-1 with water depths of 14 m and 246 m respectively. Four samples are from water depths where corals can occur between 505 m and 577 m (GeoB- 14895-1, 14896-1, 14898-1 and 14910-2) and are clustered into the subcluster named A. They lack living coral as accompanying material, which indicates that they are not from living coral habitats. In the Important Species HCAQ the non-living coral cluster comprises the same ten samples as in the All Species HCAQ.

In the remaining eleven samples small, separate clusters are observed. The samples GeoB- 14714-1 and 14865-1 share *Tetragonostomina rhombiformis* Mikhalevich, 1975 as an extraordinary dominant species with shares above 75 %. Six samples are clustered into three clusters based on the proximity of the sampling point (GeoB- 14847-1/14848-1, GeoB- 14705-1/14706-1 and GeoB- 14858-1/14860-1). The remaining three samples GeoB- 14703-1, 14788-1 and 14867-1 stand alone.

The Faunal HACQ also results in two main clusters shown in Fig. 6. It contains in its living coral cluster the same samples as in the All Species HCAQ and adds the samples GeoB- 14706-1, 14788-1 and 14860-1. Its non-living cluster contains nine samples which are the same as in the All Species HCAQ. It additionally includes the sample 14705-1 and excludes the sample GeoB 14854-1. Four low diversity samples with *Tetragonostomina rhombiformis* present GeoB- 14714-1, 14847-1, 14865-1 and 14867-1 build a own closely related cluster addressed as Low diversity/*T. rhombiformis* cluster. It is also found in the All Species and Important Species HCAQs where it contains GeoB- 14714-1, 14865-1 and 14867-1. The latter two samples are from the Timiris mud wedge which is characterized by a muddy substrate.

Table 3 Analysis of Foraminifera in 28 samples from the Mauritanian shelf and slope of expedition MSM16/3 of RV Maria S. Merian. List of faunal and diversity parameters. The data are derived from counts of 200 specimens in 27 samples and of all found 53 specimens in one sample.

Sample	Site	Depth (m)	Fauna	No. of species	No. of individuals	Fisher's alpha α	Shannon H	Pielou's Equitability J
14703-1	Arguin mud wedge	111	not recorded	13	200	3,11	1,29	0,50
14704-1	Arguin mud wedge	246	not recorded	32	200	10,76	2,81	0,81
14705-1	Arguin mud wedge	91	not recorded	20	200	5,53	2,39	0,80
14706-1	Arguin mud wedge	142	not recorded	18	200	4,79	2,38	0,82
14714-1	outer shelf off Banc d'Arguin	52	not recorded	5	200	0,93	0,27	0,17
14780-2	Baie du Levier	13	debris without coral	0	0	-	-	-
14782-3	Baie du Levier	14	debris without coral	0	0	-	-	-
14785-4	Baie du Levier	14	debris without coral	7	53	2,16	1,60	0,82
14788-1	central outer Banc d'Arguin	30	not recorded	17	200	4,44	1,74	0,62
14799-1	northern canyon area west of Banc d'Arguin	490	living coral	24	200	7,12	2,04	0,64
14847-1	southern Banc d'Arguin	369	not recorded	4	200	0,71	0,86	0,62
14848-1	southern Banc d'Arguin	516	not recorded	13	200	3,11	1,81	0,70
14852-1	deep mound chain	1310	debris without coral	27	200	8,41	2,47	0,75
14853-1	deep mound chain	1252	debris without coral	39	200	14,46	3,39	0,93
14854-1	deep mound chain	1196	no debris	32	200	10,76	2,51	0,72
14856-1	deep mound chain	1119	no debris	33	200	11,25	3,13	0,90
14858-1	Canyon area southern Banc d'Arguin	483	no debris	28	200	8,86	2,52	0,76
14860-1	Canyon area southern Banc d'Arguin	493	debris with dead coral	15	200	3,76	1,96	0,72
14865-1	Timiris mud wedge	52	not recorded	4	200	0,71	0,71	0,51
14867-1	Timiris mud wedge	52	not recorded	4	200	0,71	0,31	0,22
14878-1	Timiris deep coral mounds	493	living coral	23	200	6,71	2,52	0,80
14889-1	Canyon South of Timiris mound chain	590	living coral	22	200	6,31	2,12	0,68
14895-1	Banda mounds	577	debris with dead coral	26	200	7,97	2,79	0,86
14896-1	Banda mounds	566	no debris	26	200	7,97	2,84	0,87
14898-1	Banda mounds	505	debris with dead coral	35	200	12,28	2,83	0,80
14903-1	Banda slide	414	living coral	30	200	9,79	2,35	0,69
14904-1	Banda slide	510	living coral	22	200	6,31	2,36	0,76
14905-1	Banda slide	486	living coral	23	200	6,71	2,04	0,65
14910-2	southern Banda slide	535	debris with dead coral	35	200	12,28	3,09	0,87
14911-1	southern Banda slide	450	living coral	22	200	6,31	1,71	0,55

Discussion

Discussion of the sample processing

For the assessment of benthic foraminiferal assemblages the investigated size fractions differ from author to author. Comprehensive documentation, comparison with previous and future studies would require all size fractions with possible foraminiferal content to be investigated. Practical and scientific reasons though lead to less comprehensive approaches. The size fractions used in Recent benthic foraminiferal studies published from 2008 to 2010 range at the lower end from $>32\ \mu\text{m}$ to $>250\ \mu\text{m}$ and the upper end from $<125\ \mu\text{m}$ to open ended (Schönfeld 2012). Large size fractions are chosen to reduce the time of picking, facilitate the microscopic work or to keep the data comparable with previous studies. Scientific reasons for large size fractions are that bigger foraminifera lead to less errors in identification and for the identification of indicator species a comprehensive study is not needed (Schönfeld 2012). In the fraction below $125\ \mu\text{m}$ juvenile, difficult or not identifiable specimens often form a substantial part of the assemblage.

For this study the fraction between $250\ \mu\text{m}$ and $2000\ \mu\text{m}$ was chosen to investigate. In this fraction the diversity was high enough to characterize the faunas and misidentifications of smaller and juvenile specimens were avoided. The chosen fraction falls into the range commonly used for studies of recent foraminiferal assemblages (Schönfeld 2012). Furthermore it facilitated the microscopic work.

Discussion of the results

This study is based on the analysis of total assemblages of foraminifera in 28 sediment samples of the fraction-size $>250\ \mu\text{m}$ only. It reveals the rich benthic foraminiferal fauna of the upper bathyal Mauritanian slope and the affiliation of specific foraminiferal faunas with single facies of the CWCH and other habitats. The three different HCAQs result in a meaningful clustering. With minor differences the All Species, Important Species and Faunal HCAQs show the same two main clusters. These are the living coral cluster and the non-living coral cluster.

The All Species and Important Species HCAQs exactly cluster those seven samples, which have accompanying living coral material into the living coral cluster. The Faunal HCAQ also builds a cluster with these seven samples but differs by adding three samples. GeoB-14706-1 and 14788-1 being from water depths of 142 m and 30 m have no affiliation to CWCH and are put in this cluster due to their similar share of species with an epifaunal attached life style. The sample GeoB 14860-1 with a water depth of 493 m is from a potential CWCH habitat, but contained only dead coral as accompanying material. The All Species and Important Species HCAQs thus prove to be the most meaningful ones and further discussion is only based on them.

The living coral cluster is dominated by the species *Rosalina vermiculata*, which has assemblage shares between 24 % to 61 %, on average 43 %. This species has not so far been explicitly reported from other CWCH. Hawkes and Scott (2005) report the closely related species *Rosalina semipunctata* (Bailey, 1851) as important species with maximal shares of more than 40 % from living coral habitats on the Scotian margin. They found it to be attached to the basal sections of the octocoral *Primnoa resedaeformis* (Gunnerus, 1763). From their figured specimens it is likely that they include *Rosalina vermiculata* into their species concept of *Rosalina semipunctata*. Their placement of the species into the planispiral genus *Discanomalina* Asano, 1951 is not followed here and the species is assigned to the trochospiral genus *Rosalina* d'Orbigny, 1826 as discussed in the systematic descriptions (Hayward et al. 2022). The more distantly related species *Rosalina bradyi* (Cushman, 1915) together with *Rosalina semipunctata* are reported too by Spezzaferri et al. (2015) but only as occurring rarely in facies containing dead coral material. They do not report these species from living coral habitats. Furthermore Hawkes and Scott (2005) report the only distantly related species *Rosalina* sp. as important species in living coral habitats.

In the living coral cluster the species *Planulina ariminensis* and *Globobulimina turgida* are found to be additional important species with presence in all samples and overall average shares of 8,2 % and 6,1 %. They are also reported by Spezzaferri et al. (2015) as important in different facies. The species *Hyrrokin sarcophaga* is found in all samples of the living coral cluster with an average share of 5,2 %. It is reported to be parasitic and boring into the soft tissue of corals (Cedhagen 1994, Freiwald & Schönfeld 1996). In this study it occurs with a share of up to 8,5 %. *Globobulimina turgida* is the only important species with an infaunal lifestyle. It indicates that the habitat is not fully covered by hard ground.

In the non-living coral cluster the subcluster A from water-depths between 500 m and 600 m is found to be associated with dead coral debris. The three samples GeoB-14895-1, 14898-1 and 14910-2 contain accompanying dead coral debris and the fourth sample GeoB 14896-1 is geographically very close to 14895-1. The subcluster A is not dominated by a single species. Six important species are identified which occur in each sample and sum up to a share of 54,8 % in this subcluster: *Uvigerina peregrina* Cushman, 1923, *Rosalina vermiculata*, *Cibicidoides mundulus* (Brady, Parker & Jones, 1888), *Planulina ariminensis*, *Ehrenbergina serrata* Reuss, 1850 and *Melonis zaandamae* (van Voorthuysen, 1950). The three species *Uvigerina peregrina*, *Cibicidoides mundulus* and *Melonis zaandamae* live infaunally which indicates that mud to silt predominates the substrate in this habitat. The species *Rosalina vermiculata* and *Planulina ariminensis* live epifaunally attached and indicate that there is enough debris to cling to. The other six samples in the non-living cluster share their distance to the living coral and coral debris clusters. They are not clustered into meaningful subclusters according to depth, geographical proximity and or any other addressable parameter. It is seen as likely, that more samples and the inclusion of the fraction below 250 µm would yield a better understanding of these faunas and their habitats. The different faunas indicate that further sampling and studies will yield fruitful insights into the diverse habitats on the upper bathyal Mauritanian slope.

The low diversity/*T. rhombiformis* cluster is interpreted as indicative of a specific habitat with mud as substrate. It is not associated with coral habitats and to reveal its nature further investigations based on living specimens would be needed.

The findings of this study differ substantially from the previous study of foraminiferal faunas on the upper bathyal Mauritanian slope by Reymond et al. (2014). They do not report *Rosalina vermiculata* as important in any cluster. From six samples with an important share of *Hyrrokkina sarcophaga*, indicative of living corals, they report an important share of *Discanomalina coronata* (Parker & Jones, 1865). In this study *Discanomalina coronata* was not found at all. The reason might be misidentification as Reymond et al. (2014) incorrectly figure a *Hyrrokkina* as *Discanomalina coronata*. Reymond et al. (2014) include planktonic foraminifera in their study and thus the clusters built are mainly depth-related. However, as in this study they do report low diversity faunas from shallower water-depth of 23 m to 86 m with dominance or significant numbers of *Tetragonostomina rhombiformis*. They associate this species with mud mounds, but do not elaborate whether the samples with a high abundance are from mud mounds.

Conclusions

The Mauritanian upper bathyal slope and shelf show a rich benthic foraminiferal fauna of at least 157 species. Two main clusters of benthic foraminifera are observed: the living and non-living coral cluster. The living coral cluster represents the foraminiferal fauna associated with living corals. All samples in this cluster have living corals as accompanying material. The fauna is characterized by the dominant species *Rosalina vermiculata* and the accompanying species *Planulina ariminensis*, *Globbulimina turgida* and *Hyrrokkina sarcophaga*.

The non-living coral cluster represents foraminiferal faunas which are not associated with living corals. None of the samples have living corals as accompanying material. However a subcluster from water-depths with possible living corals is associated with coral debris. In this subcluster, no dominant species was observed, but six important species were identified of which three live infaunally and two epifaunally attached. They are indicative of a mud to silt substrate with enough debris to cling to. The species are *Uvigerina peregrina*, *Rosalina vermiculata*, *Cibicidoides mundulus*, *Planulina ariminensis*, *Ehrenbergina serrata* and *Melonis zaandamae*. The other six samples in the non-living coral cluster are from water depths either well above or below the coral habitats.

A characteristic low diversity/*Tetragonostomina rhombiformis* fauna well above the coral habitats is found. It is associated with mud as substrate and indicates a specific habitat, whose nature needs further investigation.

Methodologically it is noteworthy that the exclusion of foraminifera smaller than 250 µm from the analysis did not obstruct a meaningful result. Furthermore the exclusion of species with shares below 10 % in any sample had no negative impact on the main find-

ings. Possibly the focus on bigger and more important species reduces background scatter and sharpens the clarity of results. This hypothesis needs further investigation beyond the scope of this study.

Systematic descriptions

The recorded foraminiferal species are taxonomically listed and described with remarks on morphology, abundance, distribution and association to cold-water reef habitats (=CWCH). Terms relating to the overall appearance and relative position of features such as top/bottom, vertical/horizontal etc. refer to the standard orientation of specimens, used in the literature and the images presented in this article where the aperture is shown towards the top. The identifications of benthic foraminifera are primarily based on the holotypes described and illustrated in the Ellis and Messina catalogue (Ellis & Messina 2020). Additional resources that were consulted were Debenay (2013) and Spezzaferri et al. (2015). The nomenclature is updated to that of the World Foraminifera Database (Hayward et al. 2022). Synonyms are noted only for taxa named differently in publications about foraminifera from the Mauritanian shelf and slope: Reymond et al. (2014), Westphal et al. (2014), Spezzaferri et al. (2015) and in Hayward et al. (2022). The naming of the first describer may be found for all taxa of this study in Hayward et al. (2022). The non-agglutinated families are presented following the suprageneric categorisation in Hayward et al. (2022) and then as presented in Loeblich and Tappan (1987). The genera of each family are listed alphabetically. Agglutinated taxa are presented following Kaminski (2004, 2014).

The remarks on size, abundance, bathymetry and association with CWCH refer only to the investigated material and not to the taxa in general. Samples with living or dead coral are interpreted as coming from CWCH. For the samples GeoB 14848-1 from 516 m and GeoB 14858-1 from 483 m depth no data on the facies are given. Due to the depth they are interpreted as coming from CWCH.

Abundances of single taxa of 0,5 % or under are described as 'present', above 0,5 % and under 3 % as 'rare', between 3 % and under 7 % as 'occasional', between 7 % and under 20 % as 'frequent' and of 20 % and more as 'dominant'. The comment 'not in counts' refers to species, which were found in the material, but not among the 200 specimens of the count.

Phylum FORAMINIFERA d'Orbigny, 1826

Order ASTRORHIZIDA Lankester, 1885

Suborder ASTRORHIZINA Lankester, 1885

Family RHABDAMMINIDAE Brady, 1884

Genus *Marsipella* Norman, 1878

Marsipella elongata Norman, 1878

Fig. 7A, B

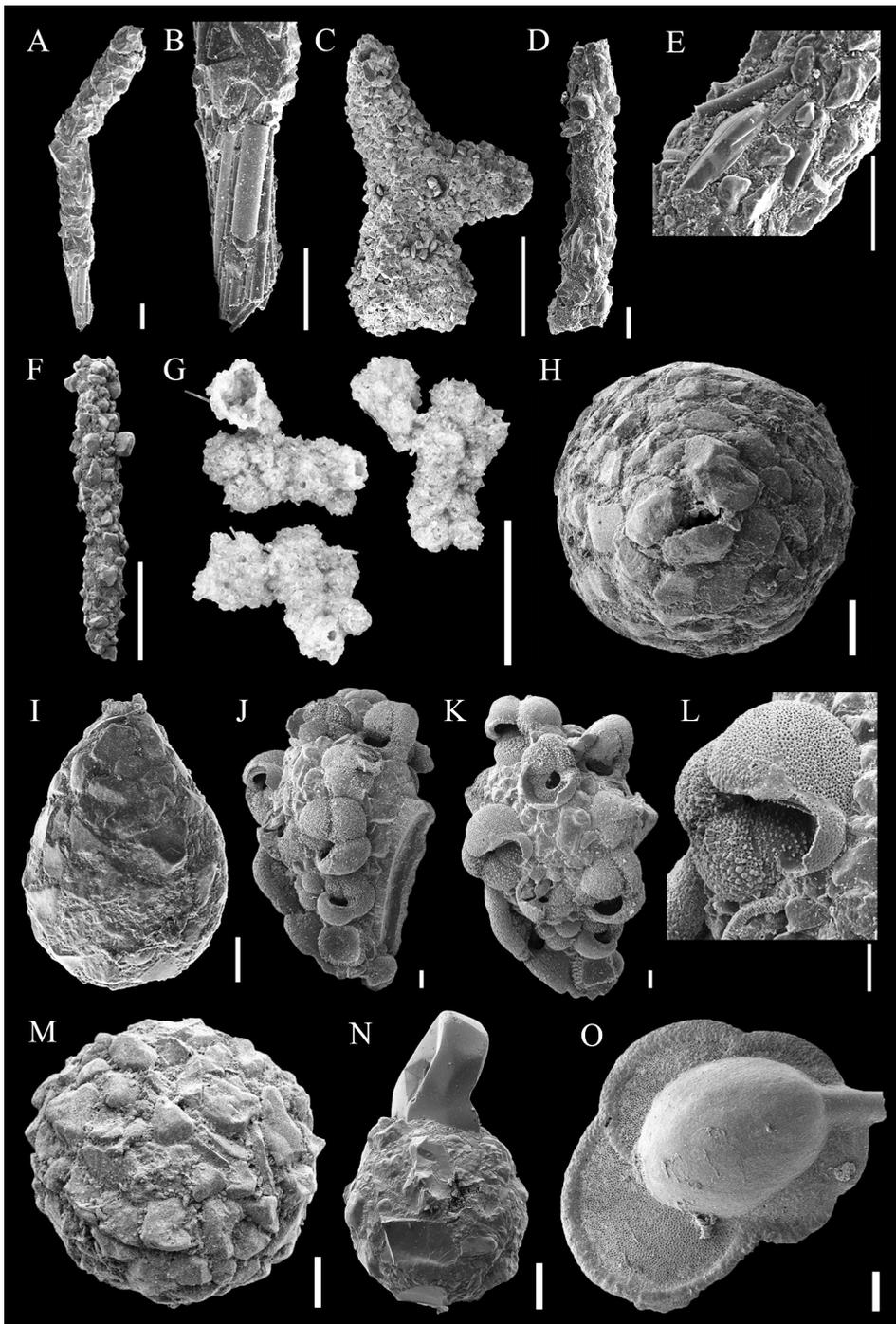


Fig. 7 A, B: *Marsipella elongata* GeoB 14788-1; C: *Rhabdammina abyssorum* GeoB 14865-1; D–F: *Rhabdammina scabra* D, E: GeoB 14865-1; F: GeoB 14853-1; G: *Dendrophrya radiata* GeoB 14910-2; H, I: *Lagenammina arenulata*, H: GeoB 14910-2; I: GeoB 14910-2; J–L: *Lagenammina testacea* GeoB 14889-1; M, N: *Psammospaera fusca*, M: GeoB 14910-2; N: GeoB 14856-1; O: *Ammolagena clavata* on *Globorotalia menardii* GeoB 14853-1. Scale bars 100 μm except for fig. C, E, F, G 1000 μm.

Diagnostic Features Test free, elongated, large, one tubular chamber thinning in diameter towards the ends; wall coarsely agglutinated with sand grains and sponge spicules; aperture at the open end of the tube, surrounded by longitudinal and parallel orientated sponge spicules cemented together.

Abundance and depth range Rare in sample GeoB 14878-1 at 493 m depth only.

Association with CWCH Found in CWCH only, too rare to be of significance.

Genus *Rhabdammina* Sars in Carpenter, 1869

Rhabdammina abyssorum Sars in Carpenter, 1869

Fig. 7C

Diagnostic Features Test free, one central amorphous chamber with branching tubular prolongations, length up to 2800 µm; wall coarsely agglutinated; one or more apertures at the end of each single tubular prolongation, round.

Abundance and depth range Present to rare in three samples from 450 m, 535 m and 1252 m depth, occasional in sample GeoB 14878-1 at 493 m depth.

Association with CWCH Present to occasional in CWCH, overall of no significance. Also found below CWCH.

Rhabdammina scabra Höglund, 1947

Fig. 7D–F

Diagnostic Features Test free, one tubular chamber, not branched, mainly straight or slightly curved, elongated, length up to 1020 µm, width up to 210 µm; wall a finely agglutinated matrix incorporating many coarse particles, which protrude from the test; apertures at both ends of the tube, round. It is unclear whether the specimens found are broken pieces or fully intact.

Abundance and depth range Rare in two samples from 1119 m and 1196 m depth only.

Association with CWCH Not associated as only found at water depths well below CWCH.

Family DENDROPHRYIDAE Haeckel, 1894

Genus *Dendrophrya* Wright, 1861

Dendrophrya radiata Wright, 1861

Fig. 7G, 34A

Diagnostic Features Test attached, length up to 2300 µm, proloculus not identifiable, branching elongated tubular chamber, irregularly shaped, with constrictions; wall coarsely agglutinated; aperture at open ends of the tubular chamber. The open ends might represent broken tubes. The identification is based upon Cushman (1918) pl. 32, figs. 6–7.

Abundance and depth range Present in sample GeoB 14910-2 from 535 m depth only, not in counts.

Association with CWCH Present in CWCH, of no significance.

Suborder SACCAMMININA Lankester, 1885

Family SACCAMMINIDAE Brady, 1884

Genus *Lagenammina* Rhumbler, 1911

Lagenammina arenulata (Skinner, 1961)

Fig. 7H, I

Diagnostic Features Test free, length 480 µm – 620 µm, single chamber, teardrop shape; wall coarsely agglutinated; aperture terminal at the end of the narrowing part of the chamber, not round but depending on the particles used for the wall triangular to rectangular.

Abundance and depth range Occasional in four samples from 1119 m to 1310 m depth, present to rare in two samples from 450 m and 590 m depth.

Association with CWCH Present and rare in CWCH, of no significance. Found mainly below.

Lagenammina testacea (Flint, 1899)

Fig. 7J–L

Synonyms *Reophax agglutinatus* Cushman, 1913 in Reymond et al. (2014), p. 79, pl. 3, figs. 15.
Saccamina testacea (Flint, 1899) in Hayward et al. (2022).

Diagnostic Features Test free, length up to 1710 µm, the chamber arrangement is obscured by large foraminiferal tests incorporated into the test, the few small particles indicate a flask-like single chamber; wall coarsely agglutinated with foraminiferal tests cemented together; aperture terminal, rounded.

Remarks It differs from other *Lagenammina* Rhumbler 1991 by mainly cementing together other foraminiferal tests. It differs from *Reophax bilocularis* Flint, 1899 and other *Reophax* Montfort 1808 by having only one chamber. Reymond et al. (2014) figure on their plate 3 in fig. 15 a similar specimen which they identify as *Reophax agglutinatus* though a uniseptate chamber arrangement is not visible. It differs from *Saccamina* Sars in Carpenter, 1869 by being elongated, not globular.

Abundance and depth range Present only in GeoB 14854-1 from 1196 m depth.

Association with CWCH Not associated as only found at water depths well below CWCH.

Family PSAMMOSPHAERIDAE Haeckel, 1894

Genus *Psammosphaera* Schulze, 1875

Psammosphaera fusca Schulze, 1875

Fig. 7M, N

Diagnostic Features Test free, diameter up to 610 µm, single, spherical to slightly ovoid chamber; wall coarsely agglutinated; aperture(s) not visible.

Abundance and depth range Present to occasional in three sample from 1119 m to 1310 m depth. Rare in a sample from 490 m and present at 535 m depth. The latter not in counts.

Association with CWCH Present and rare in CWCH, overall of no significance. Found mainly below.

Order AMMODISCIDA Mikhalevich, 1980

Suborder HIPPOCREPININA Saidova, 1981

Family AMMOLAGENIDAE Kaminski, Henderson, Cetean & Waskowska, 2009

Genus *Ammolagena* Eimer & Fickert, 1899

Ammolagena clavata (Jones & Parker, 1860)

Fig. 7O, Fig. 34B

Diagnostic Features Test attached to shell fragments, length up to 2100 µm, large, hemispheric proloculus followed by an elongated tubular chamber; wall finely agglutinated and smooth; aperture terminal, if free fully round, if attached flat on one half and rounded on the other.

Abundance and depth range Occasional in two samples from 1252 m and 1310 m depth, present and rare in three samples from 450 m to 590 m depth.

Association with CWCH Present and rare in CWCH, overall of no significance. Found mainly below.

Suborder AMMODISCINA Mikhalevich, 1980

Family AMMODISCIDAE Reuss, 1862

Genus *Ammodiscus* Reuss, 1862

Ammodiscus tenuis (Brady, 1881)

Fig. 8A–C, Fig. 34C

Diagnostic Features Test free, diameter up to 1100 µm, proloculus followed by a planispirally enrolled tubular second chamber with 2–6 volutions, the last tubular chamber broadens slightly and in the last volution significantly; wall agglutinated; aperture terminal, round. It differs from *Ammodiscus incertus* (d'Orbigny, 1839) by having a bigger proloculus, less volutions and an overall broader second chamber.

Abundance and depth range Present in two samples from 450 m and 535 m depth.

Association with CWCH Present in CWCH only, of no significance.

Order LITUOLIDA Lankester, 1885

Suborder HORMOSININA Mikhalevich, 1980

Family HORMOSINELLIDAE Rauzer-Chemousova & Reitlinger, 1986

Genus *Subreophax* Saidova, 1975

Subreophax sp.

Fig. 8D, E

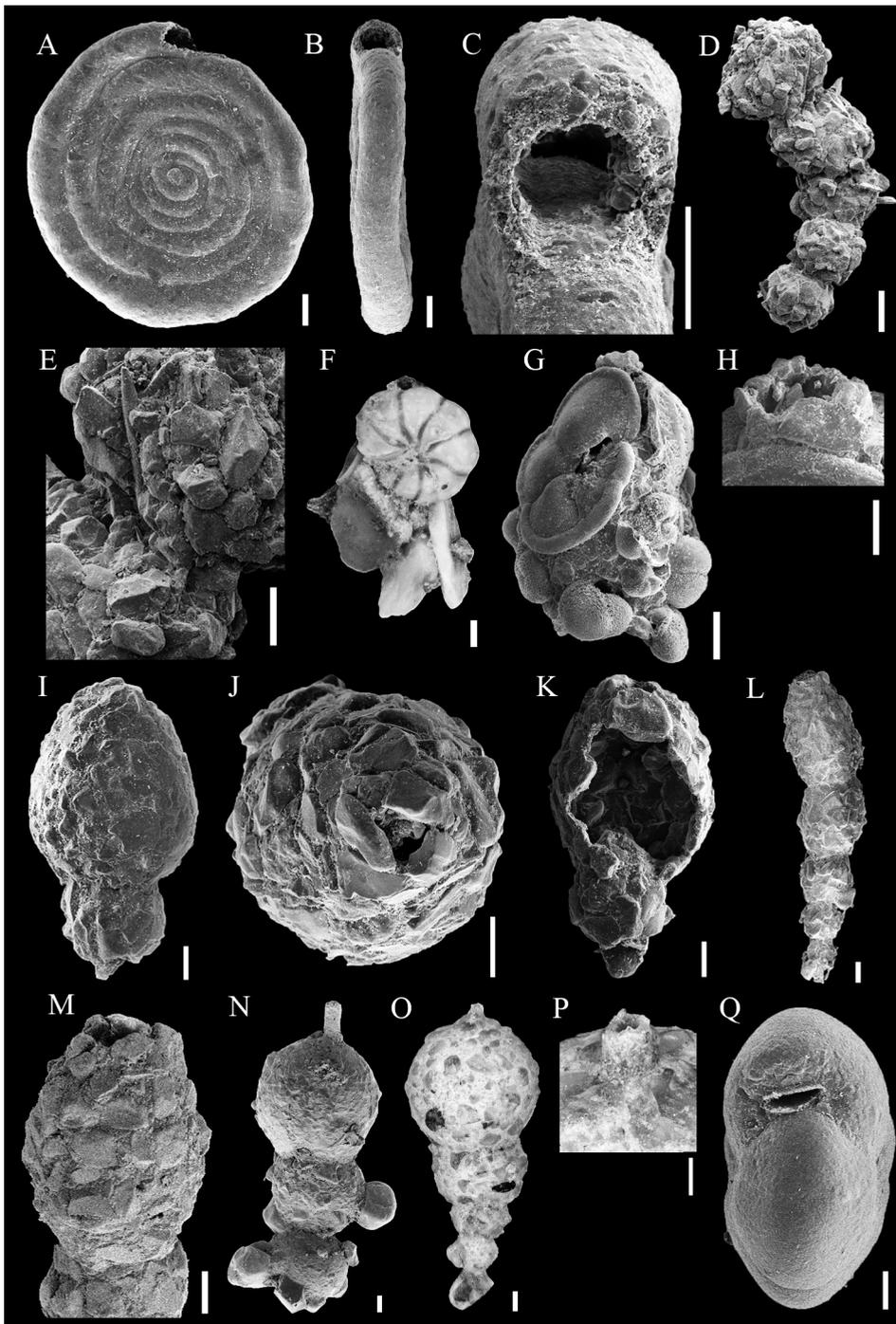


Fig. 8 A–C: *Ammodiscus tenuis* GeoB 14910-2; D, E: *Subreophax* sp. GeoB 14910-2; F–H: *Reophax agglutinatus* F: GeoB 14853-1; G, H: GeoB 14889-1; I–K: *Reophax bilocularis*, I: GeoB 14910-2; J: GeoB 14910-2; K: GeoB 14910-2; L, M: *Reophax bradyi* L: GeoB 14903-1; M: 14903-1; N–P: *Hormosina globulifera* N: GeoB 14910-2; O, P: GeoB 14910-2; Q: *Haplophragmoides tenuis* GeoB 14889-1. Scale bars 100 μm except for E 200 μm

Diagnostic Features	Test free, length 950 µm to 1220 µm, uniserial, four to six subglobular chambers increasing in size; wall agglutinated with coarse particles; sutures deeply depressed; aperture terminal.
Abundance and depth range	Present in sample GeoB 14910-2 from 535 m depth, not in counts.
Association with CWCH	Present in CWCH only, of no significance.

Family REOPHACIDAE Cushman, 1927

Genus *Reophax* Montfort, 1808

Reophax agglutinatus Cushman, 1913

Fig. 8F–H

Diagnostic Features	Test free, large, length up to 960 µm; chamber arrangement obscured by the large particles used for building the test; wall coarsely agglutinated with large foraminiferal tests, particles and shell debris cemented together; aperture terminal, rounded.
Remarks	The specimens found differ from common <i>R. agglutinatus</i> by using large particles.
Abundance and depth range	Present to occasional in six samples ranging from 490 m to 1190 m depth.
Association with CWCH	Present to occasional in CWCH, overall of no significance. Also found below.

Reophax bilocularis Flint, 1899

Fig. 8I–K

Diagnostic Features	Test free, length up to 520 µm, ovoid proloculus followed by a much bigger ovoid second chamber; wall coarsely agglutinated; aperture terminal, rounded angular, might be surrounded by 3–4 particles, which protrude from the test. As the specimens do not show any damage on the proloculus and aperture it can be ruled out that they are pieces of other species of <i>Reophax</i> Montfort 1808. The specimens found resemble the figured specimen 2a in Flint (1899).
Abundance and depth range	Present to rare in three samples from 1310 m, 450 m and 535 m depth, the latter one not in counts.
Association with CWCH	Present in CWCH, of no significance. Also found below.

Reophax bradyi Brönnimann & Whittaker 1980

Fig. 8L, M

Synonym *Reophax scorpiurus* Montfort, 1808 in Reymond et al. (2014), p. 79, pl. 3, figs. 16–17.

Diagnostic Features	Test free, large, length up to 1540 µm, width up to 410 µm; uniserial, slightly curved, with 4–6 inflated chambers, last chamber ovoid, sutures significantly depressed; wall coarsely agglutinated; aperture terminal, rounded angular, surrounded by a rim of grains.
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Remarks	Reymond et al. (2014) identify similar specimens on plate 3 figs. 16–17 as <i>Reophax scorpiurus</i> . They lack though the pronounced neck or chimney on top of the last chamber and are identified in this publication as <i>Reophax bradyi</i> .
Abundance and depth range	Occasional in sample GeoB 14854-1 from 1196 m depth and present in two samples from 414 m and 566 m depth.
Association with CWCH	Present in CWCH, of no significance. Also found below.

Family HORMOSINIDAE Haeckel, 1894

Genus *Hormosina* Brady, 1879

Hormosina globulifera Brady 1879

Fig. 8N–P, Fig. 34D

Diagnostic Features	Test free, length up to 1780 µm; uniserial, two to four globular chambers increasing rapidly in size; wall agglutinated with coarse and fine particles; aperture terminal at the end of an elongated tubular neck, round. A large particle may be included in the test at the bottom of the first chamber.
Abundance and depth range	Rare in two samples from 1252 m and 1310 m depth and present in one sample from 535 m depth, which is not in the counts.
Association with CWCH	Present in CWCH, of no significance. Found more below.

Suborder LITUOLINA Lankester, 1885

Family HAPLOPHRAGMOIDIDAE Maync, 1952

Genus *Haplophragmoides* Cushman, 1910

Haplophragmoides tenuis Cushman, 1927

Fig. 8Q, Fig. 9A, B

Reference: Cushman (1927b)

Diagnostic Features	Test free, diameter up to 720 µm; planispiral involute with 5–6 chambers, biconvex in apertural view, outline almost round, slightly lobate; the umbilici on both sides are slightly depressed; wall agglutinated; sutures slightly depressed; aperture crescentic to slit-like at the base of the last chamber, the aperture is coated by a very finely agglutinated cover from the inside towards a rim, which stands out from the test.
Remarks	It differs from other species of the genus <i>Haplophragmoides</i> by its biconvex shape in apertural view and lacking deeply depressed umbilici. In McCulloch (1981) a similar specimen is illustrated on their plate 2, figure 6 and identified as <i>H. tenuis</i> .
Abundance and depth range	Present in sample 14889-1 from 590 m depth only, not in counts.
Association with CWCH	Present in CWCH, of no significance.

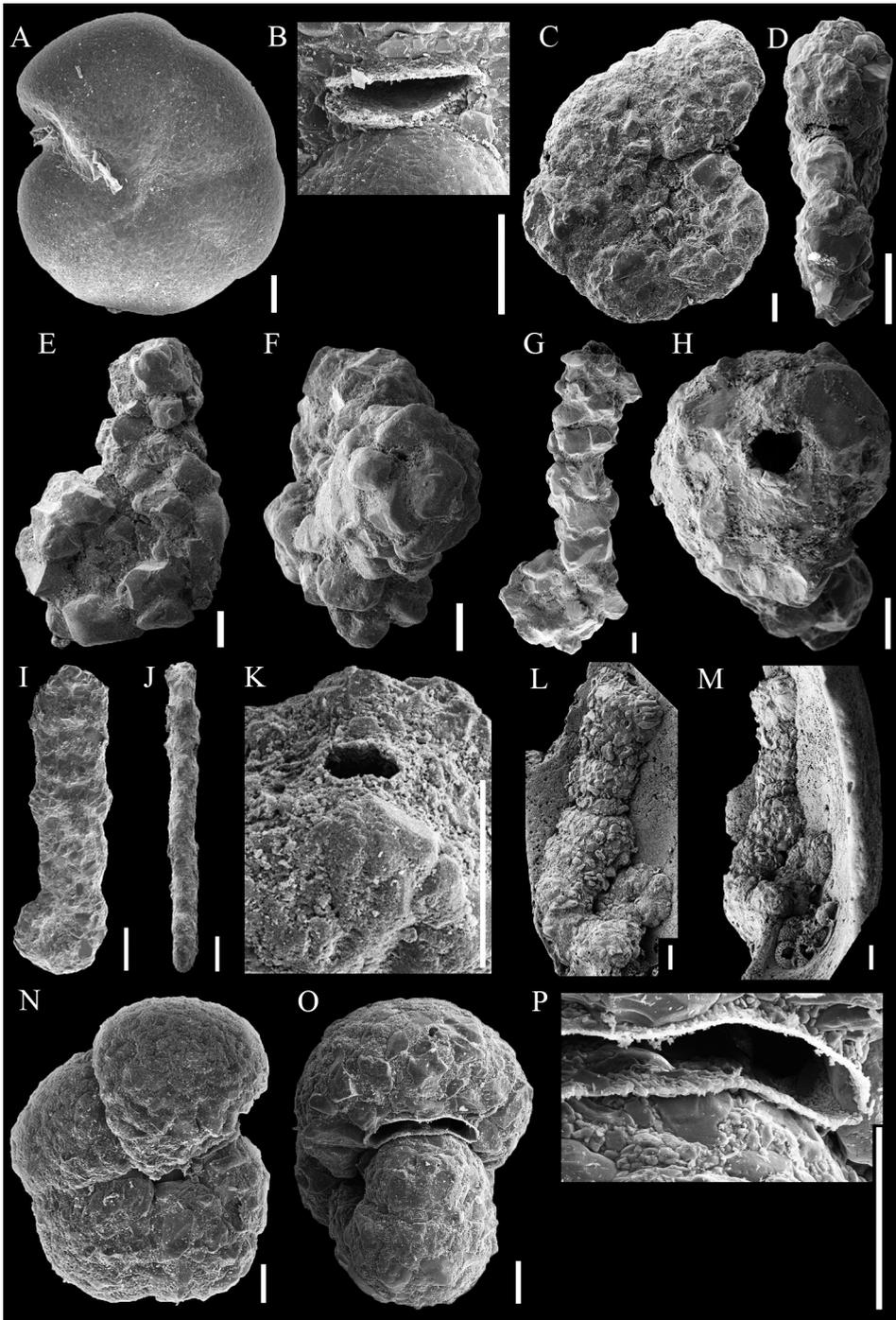


Fig. 9 A, B: *Haplophragmoides tenuis* GeoB 14889-1; C, D: *Discammina compressa* C: GeoB 14854-1; D: GeoB 14865-1; E, F: *Ammobaculites agglutinans* GeoB 14853-1; G, H: *Ammobaculites crassaformis* GeoB 14853-1; I–K: *Ammobaculites filiformis* I, J: GeoB 14853-1; K: GeoB 14853-1; L, M: *Placopsilina bradyi* GeoB 14706-1, M with *A. inhaerens*; N–P: *Crirostomoides subglobosus* GeoB 14889-1. Scale bars 100 μm except for K 50 μm .

Family DISCAMMINIDAE Mikhalevich, 1980

Genus *Discammina* Lacroix, 1932

Discammina compressa (Goës 1882)

Fig. 9C, D

Diagnostic Features Test free, length up to 480 µm, width up to 160 µm, disc like; planispiral, compressed and depressed in the umbilicus; wall coarsely agglutinated; aperture a crescentic slit at the base of the last chamber. The species differs from specimens of *Ammobaculites agglutinans* (d'Orbigny, 1846) with a short uniserial part by having a crescentic aperture at the base of the last chamber.

Abundance and depth range Rare to dominant in nine samples from 142 m to 1310 m depth.

Association with CWCH Associated as dominant in a sample from 516 m and occasional in a sample from 493 m depth. Found in higher numbers below and to a much lesser extent above.

Family LITUOLIDAE Blainville, 1827

Genus *Ammobaculites* Cushman, 1910

Ammobaculites agglutinans (d'Orbigny, 1846)

Fig. 9E, F

Diagnostic Features Test free, length from 550 µm to 1080 µm; initially planispiral then uncoiling into a uniserial chamber arrangement, the number of chambers in the uniserial part ranges from one to numerous, diameter of the initial spire almost double the width of the preceding chambers; wall coarsely agglutinated; aperture terminal somewhat obscured by the agglutinated grains. The species differs from *Discammina compressa* (Goës 1882) by having a terminal aperture.

Abundance and depth range Present in GeoB 14853-1 from 1252 m depth, not in counts.

Association with CWCH Not associated as only found well below CWCH.

Ammobaculites crassaformis Zheng, 1988

Fig. 9G, H

Diagnostic Features Test free, length from 1380 µm to 1920 µm; initially planispiral then uncoiling into a uniserial chamber arrangement, the uniserial part is not straight but somewhat irregular and curved, the diameter of the initial spire is more than double the width of the preceding chambers; wall coarsely agglutinated; aperture terminal somewhat obscured by the agglutinated grains. The species differs from *Ammobaculites agglutinans* (d'Orbigny, 1846) by being larger and having a curved uniserial part.

Abundance and depth range Present in GeoB 14853-1, not in counts.

Association with CWCH Present in CWCH, of no significance.

Ammobaculites filiformis Earland, 1934

Fig. 9I–K, Fig. 34E

Diagnostic Features

Test free, length about 500 µm, compressed in lateral view; initially planispiral then uncoiling into a uniserial chamber arrangement, chambers not or only slightly increasing in size; sutures barely visible, lateral outline almost straight; wall coarsely agglutinated; aperture terminal, oval to rectangular with rounded edges.

Abundance and depth range

Present in a sample from 1252 m and rare in a sample from 1196 m depth.

Association with CWCH

Not associated as only found well below CWCH.

Family PLACOPSILINIDAE Rhumbler, 1913

Genus *Placopsilina* d'Orbigny, 1850

Placopsilina bradyi Cushman & McCulloch, 1939

Fig. 9L, M, Fig. 34F

Diagnostic Features

Test attached to shell fragments, the last chambers may be free, elongated and large, length up to 1550 µm, width up to 310 µm; uniserial with numerous chambers slightly increasing in size, last chamber inflated, not branching, test curved, following the substrate it is attached to; wall finely agglutinated with some bigger particles; aperture terminal, round.

Abundance and depth range

Occasional in two samples from 30 m and 142 m depth.

Association with CWCH

Not associated as only found at water depths above CWCH.

Family AMMOSPHAEROIDINIDAE Cushman, 1927 in Cushman (1927a)

Genus *Cribrostomoides* Cushman, 1910

Cribrostomoides subglobosus (Cushman, 1910)

Fig. 9N–P, Fig. 34G

Synonyms

Haplophragmoides subglobosum (M. Sars, 1868) in Reymond et al. (2014), p. 79, pl. 3, figs. 5–6.

Cribrostomoides subglobosum (M. Sars, 1868) in Spezzaferri et al. (2015), p. 53–54, pl. 2, figs. 6a–b.

Diagnostic Features

Test free, subglobose, periphery in lateral view oval, slightly lobate, length up to 1250 µm, width up to 800 µm; planispiral involute with 5–7 chambers; sutures slightly depressed; wall coarsely agglutinated; aperture crescentic to slit-like at the base of the last chamber. The apertural part may be coated by a finely agglutinated cover extending as a rim to the outside.

Abundance and depth range

Present to occasional in five samples from 450 m to 590 m depth, rare and occasional in two samples from 1252 m and 1310 m depth.

Association with CWCH

Associated with CWCH, also found below.

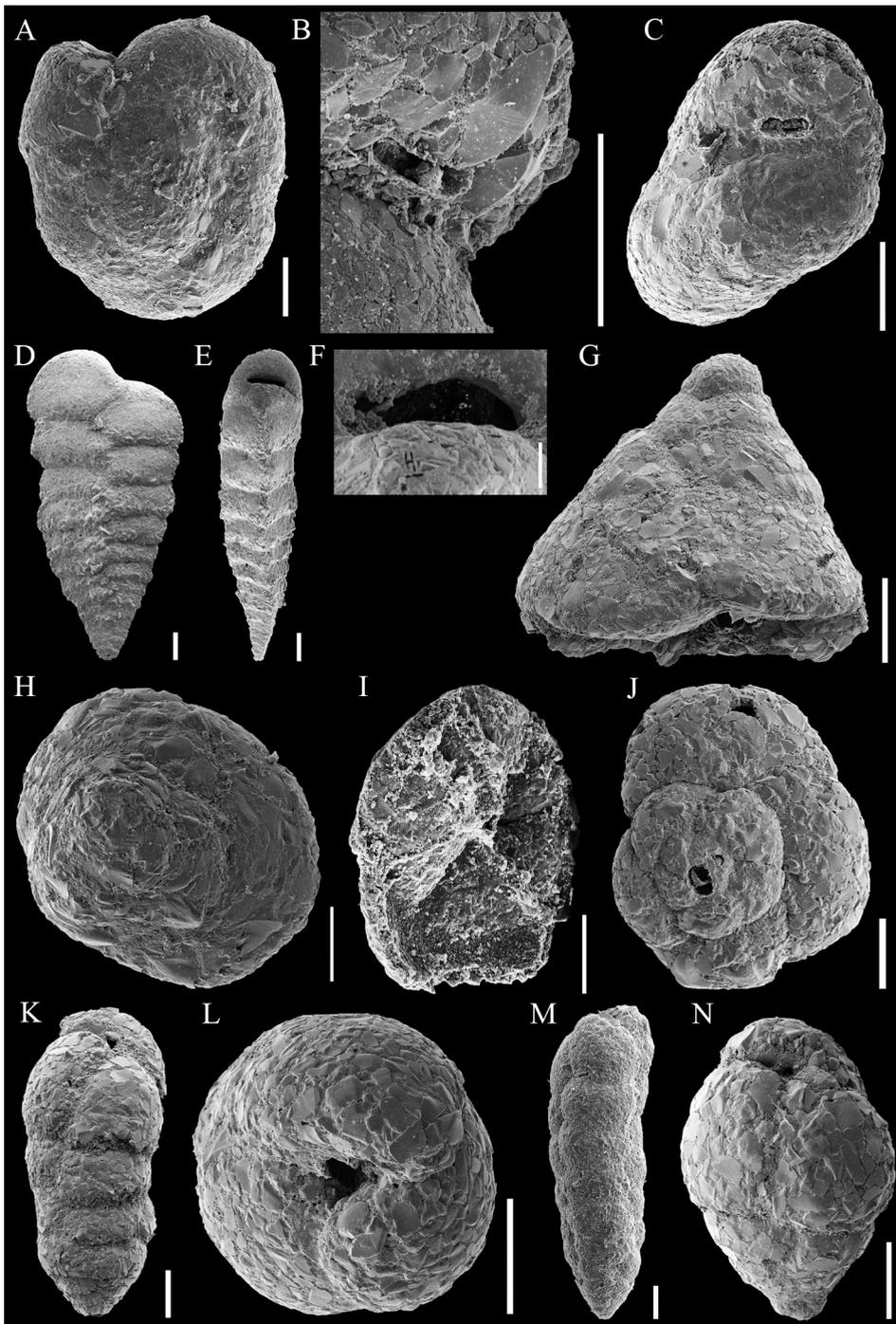


Fig. 10 A–C: *Recurvoides contortus* A, B: GeoB 14854-1; C: GeoB 14854-1; D–F: *Spiroplectinella wrighti* D, E: GeoB 14799-1; F: GeoB 14799-1; G–I: *Tritaxis conica*; G: GeoB 14856-1; H: GeoB 14856-1; I: GeoB 14856-1; J: *Trochammina inflata* GeoB 14704-1; K–M: *Eggerelloides advenus* K: GeoB 14910-2; L: GeoB 14889-1; M: GeoB 14889-1; N: *Eggerelloides scaber* GeoB 14910-2. Scale bars 100 µm except for F 20 µm.

Genus *Recurvoides* Earland, 1934

Recurvoides contortus Earland, 1934

Fig. 10A–C

Diagnostic Features Test free, subglobose; irregularly coiled with a planispiral habitus; wall coarsely agglutinated; sutures slightly depressed; aperture crescentic to slit-like at the base of the last chamber. The apertural part may be coated by a finely agglutinated cover extending as a rim to the outside.

Abundance and depth range Rare in sample GeoB 14854-1 from 1196 m depth.

Association with CWCH Not associated as only found at water depths well below CWCH.

Suborder SPIROPLECTAMMININA Mikhalevich 1992

Family SPIROPLECTAMMINIDAE Cushman, 1927 in Cushman (1927a)

Genus *Spiroplectinella* Kisel'man, 1972

Spiroplectinella wrighti (Silvestri, 1903)

Fig. 10D–F

Diagnostic Features Test free, elongate, length up to 1060 µm and width up to 350 µm; early chambers coiled followed by a biserial part, chambers slightly increasing in size, last 2–3 chambers inflated, margins sharply edged and slightly lobate; sutures depressed and curved; wall finely agglutinated with some coarser particles near sutures; aperture an arch at the base of the last chamber.

Abundance and depth range Present to frequent in five samples ranging from 30 m to 246 m depth, present to rare in four samples from 483 m to 493 m depth.

Association with CWCH Present to rare in CWCH, overall of no significance. Found more frequently above.

Suborder TROCHAMMININA Saidova, 1981

Family TROCHAMMINIDAE Schwager, 1877

Genus *Tritaxis* Schubert, 1921

Tritaxis conica (Parker & Jones, 1865)

Fig. 10G–I, Fig. 34H

Diagnostic Features Test free, planoconvex, conical, length up to 320 µm, diameter at the base up to 460 µm; high trochospiral, large proloculus; sutures slightly depressed, chambers crescentic in spiral view; wall coarsely agglutinated; aperture an interiomarginal slit.

Remarks The material contains two varieties. One is strictly conical with two straight peripheral lines in side view. In the other variety the cone broadens at its base to a broad and flat part, the peripheral lines are curved bending outward at the base. Parker & Jones (1865)

show a specimen with curved peripheral lines though it lacks a flat part in side view. It falls in between our two varieties.

The specimens found were not attached.

Abundance and depth range

Rare to occasional in four samples ranging from 1119 m and 1310 m depth.

Association with CWCH

Not associated as only found at water depths well below CWCH.

Genus *Trochammina* Parker & Jones, 1859

Trochammina inflata (Montagu, 1808)

Fig. 10J

Diagnostic Features

Test free, outline oval, lobate periphery, length up to 390 µm, width up to 280 µm, low trochospiral; sutures depressed, chambers kidney-shaped in spiral view, last chambers increasing rapidly in size; wall coarsely agglutinated; aperture an interiomarginal slit.

Abundance and depth range

Present in one sample from 246 m depth.

Association with CWCH

Not associated as only found at water depths above CWCH.

Suborder VERNEUILININA Kaminski & Mikhalevich in Kaminski, 2004

Family PROLIXOPLECTIDAE Loeblich & Tappan, 1985

Genus *Eggerelloides* Haynes, 1973

Eggerelloides advenus (Cushman, 1922) in Cushman (1922a)

Fig. 10K–M, Fig. 34J

Diagnostic Features

Test free, elongate, length up to 680 µm, width up to 300 µm; triserial, last three chambers inflated, extending over 40 % of the test, sutures depressed; wall agglutinated; aperture a small hole in the middle of the apertural face near to the base of the last chamber.

Abundance and depth range

Present in two samples from 505 m and 1119 m depth.

Association with CWCH

Present in one sample from CWCH, of no significance. Also found below.

Eggerelloides scaber (Williamson, 1858)

Fig. 10N

Diagnostic Features

Test free, elongate fusiform, length up to 520 µm, width up to 310 µm, triserial; wall agglutinated; last three chambers inflated, extending over two thirds of the test, sutures slightly depressed; aperture an arch in the middle of the apertural face.

Abundance and depth range

Rare to occasional in three samples from 1119 m to 1252 m depth. Rare in one sample from 535 m depth.

Association with CWCH

Rare in one sample from CWCH, of no significance. Found more frequently below.

Order LUFTOSIIDA Kaminski & Mikhalevich in Kaminski, 2004
 Suborder LUFTOSIINA Kaminski & Mikhalevich in Kaminski, 2004
 Superfamily LOFTUSIOIDEA Brady, 1884
 Family CYCLAMMINIDAE Marie, 1941
 Genus *Cyclammina* Brady, 1879

Cyclammina cancellata Brady, 1879

Fig. 11A–C, Fig. 34K

Diagnostic Features Test free, big, semicircular in outline, somewhat flattened, length up to 1850 µm, width up to 1410 µm, thickness up to 810 µm; planispiral, involute, about 7–9 chambers in the last whorl, each like a piece of cake, sutures slightly depressed, running in irregular, s-shaped lines in a radial pattern to the periphery; wall finely agglutinated with embedded bigger particles, especially on the apertural face, in cross section a thick, interior, labyrinthic meshwork below the surface; aperture an interiomarginal, equatorial slit and additional openings on the apertural face.

Remarks The specimens found resemble *Cyclammina trullissata* (Brady, 1879) by having fewer chambers, but differ from the latter which lacks the embedded larger particles.

Abundance and depth range Present in three samples from 590 m, 483 m and 414 m depth. The latter one not in counts.

Association with CWCH Present in CWCH only, overall of no significance.

Order TEXTULARIIDA Delage & Hérouard, 1896
 Suborder TEXTULARIINA Delage & Hérouard, 1896
 Family EGGERELLIDAE Cushman, 1937
 Genus *Dorothia* Plummer, 1931

Dorothia pseudoturris (Cushman, 1922) in Cushman (1922a)

Fig. 11D, F, G, Fig. 34I

Diagnostic Features Test free, elongate conical, length up to 1600 µm, width up to 650 µm, outline in apertural view round; early stage trochospiral, then biserial with up to 5 pairs of chambers, chambers and sutures horizontally arranged with a zigzag shaped suture line running between the two sides; wall coarsely agglutinated; aperture arched at the base of the last chamber.

Abundance and depth range Rare to occasional in five samples ranging from 414 m to 510 m depth, dominant and frequent in two samples from the Canyon area southern Banc d'Arguin from 483 m and 493 m depth.

Association with CWCH Closely associated as found in CWCH only, in part frequent to dominant.

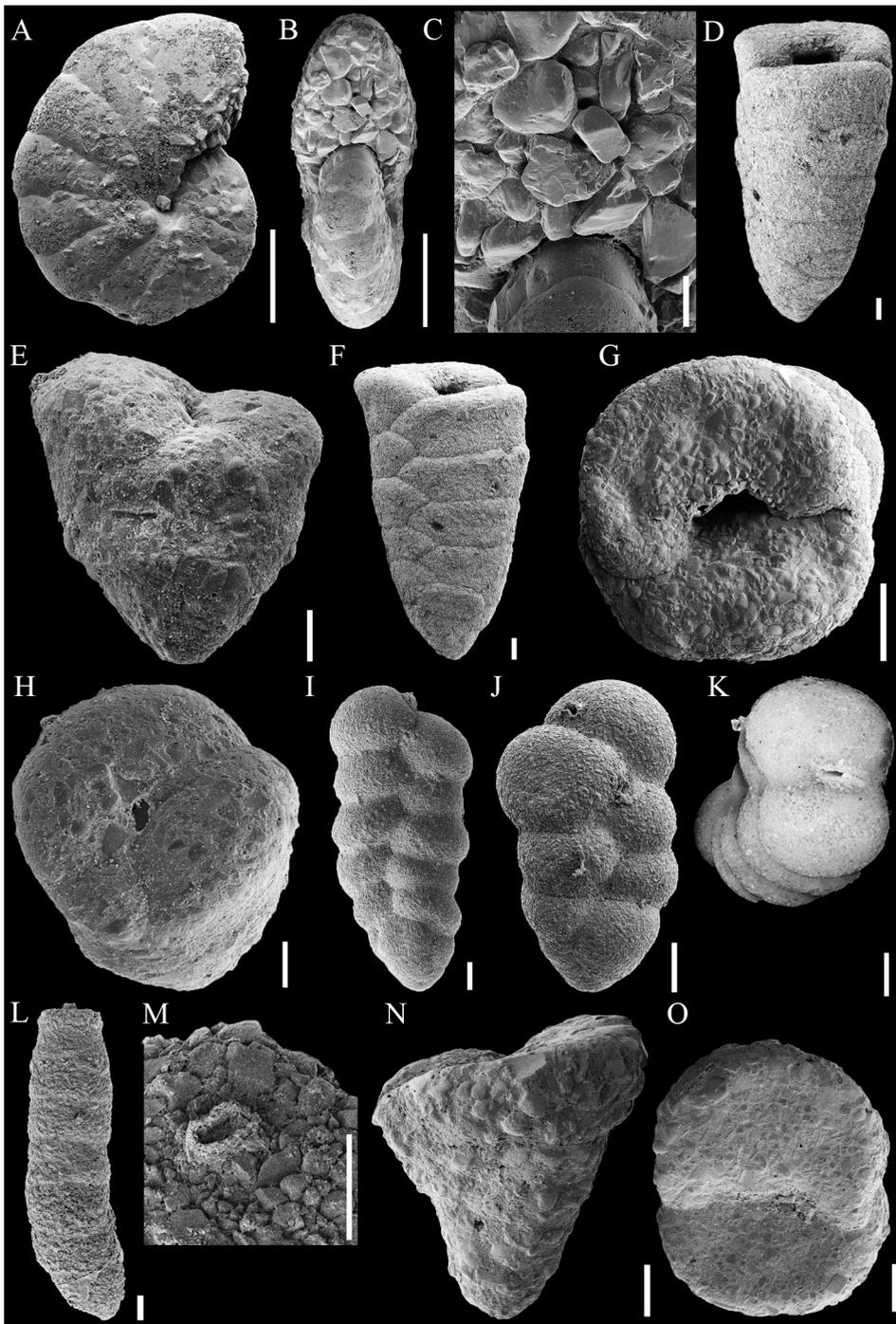


Fig. 11 A–C: *Cyclammina cancellata* GeoB 14799-1; D, F, G: *Dorothis pseudoturris* D, F: GeoB 14910-2; G: GeoB 14799-1; E, H: *Eggerella* sp. GeoB 14860-1; I–K: *Karreriella bradyi* I: GeoB 14853-1; J: GeoB 14853-1; K: GeoB 14852-1; L, M: *Martinottiella communis* GeoB 14905-1; N, O: *Connemarella rudis* GeoB 14704-1. Scale bars 100 μm except for A, B 500 μm.

Genus *Eggerella* Cushman, 1933*Eggerella* sp.

Fig. 11E, H

Synonym *Eggerella humboldti* Todd & Brönnimann, 1957 in Spezzaferri et al., (2015) p. 56, pl. 5, figs. 2.

Diagnostic Features Test free, short, broader than high, conical, length up to 600 µm, width up to 720 µm, outline in apertural view round; initial part indistinct, followed by a triserial part with up to 6 chambers, in apertural view one chamber covers over 180 degrees, another over 150 degrees, living 30 degrees visible of the third chamber; sutures slightly depressed; wall coarsely agglutinated; aperture a small, half round hole in the middle of the base of the last chamber. It differs from the genus *Gaudryina* d'Orbigny, 1839 in d'Orbigny (1839a) by lacking edges and the biserial, later portion. It differs from the genus *Vermeulina* d'Orbigny, 1839 in d'Orbigny (1839a) by lacking edges and the triangular shape in apertural view. Spezzaferri et al. (2015) illustrate the species on their plate 5 in figs. 2a–b and identify it as *Eggerella humboldti*. It does not fit the holotype by lacking spherical chambers, deeply depressed sutures, a grape like appearance and by being broader than high. To the knowledge of the authors, a species of the genus *Eggerella* being broader than high has yet not been described.

Abundance and depth range Present to rare in six samples ranging from 414 m to 510 m depth. Present in one sample from 1196 m depth.

Association with CWCH Associated with CWCH as present to rare in CWCH, overall of no significance. Found in one more sample from below.

Genus *Karreriella* Cushman 1933*Karreriella bradyi* (Cushman, 1911)

Fig. 11I–K

Diagnostic Features Test free, elongate, length up to 1010 µm, width up to 500 µm, early stage trochospiral, followed by a short or missing triserial and finally biserial stage which makes over up to two thirds of the test; wall finely agglutinated; last two chambers inflated, sutures depressed; aperture an elongated slit produced on a short neck standing out in the middle of the apertural face near to the base of the last chamber. Some authors such as Loeblich & Tappan (1994) include specimens with no biserial part into this species. This is not done in this study.

Abundance and depth range Present and rare in two samples from 1252 m and 1310 m only.

Association with CWCH Not associated as only found at water depths well below CWCH.

Genus *Martinottiella* Cushman, 1933

Martinottiella communis (d'Orbigny, 1846)

Fig. 11L, M

Synonym *Clavulina multicamerata* Chapman, 1907 in Raymond et al. (2014), p. 79, pl. 3, figs. 7–8.

Diagnostic Features Test free, elongate, in cross section oval, length up to 1480 µm and width up to 390 µm, trochospiral coil followed by a short triserial and biserial and mainly uniserial stage; sutures slightly depressed; wall finely agglutinated; aperture an oval opening at the end of a small, distinct neck, produced on the almost flat top of the last chamber.

Remarks Raymond et al. (2014) figure on their plate 3 in figs. 7–8 a specimen as *Clavulina multicamerata* with a neck and lacking a tooth. In this publication such specimens are identified as *Martinottiella communis*.

Abundance and depth range Present to frequent in three samples from 1119 m to 1310 m depth. Present to rare in three samples from 505 m to 577 m depth.

Association with CWCH Present to rare in CWCH, overall of no significance. Also found below.

Family PSEUDOGAUDRYINIDAE Loeblich & Tappan, 1985

Genus *Connemarella* Loeblich & Tappan, 1989

Connemarella rudis (Wright, 1900)

Fig. 11N, O

Diagnostic Features Test free, triangular in side view, in cross section oval to round, length and width up to 510 µm; biserial, last chambers strongly enlarged; sutures slightly depressed; wall agglutinated with particles from coarse to fine, coarse particles protruding; aperture at the base of the last chamber, broad slit.

Abundance and depth range Rare in two samples from 91 m and 246 m depth and dominant in a sample from 142 m depth.

Association with CWCH Not associated as only found at water depths above CWCH.

Family VALVULINIDAE Berthelin, 1880

Genus *Clavulina* d'Orbigny, 1826

Clavulina multicamerata Chapman, 1907

Fig. 12A, B

Diagnostic Features Test free, very large and elongate, in cross section oval to round, length up to 3150 µm and width up to 430 µm; trochospiral coil followed by a short triserial and biserial and mainly uniserial stage; sutures slightly depressed; wall finely agglutinated with some coarse particles; aperture terminal, oval to round, with a tooth.

Remarks Reymond et al. (2014) figure on their plate 3 in figs. 7–8 a specimen with a neck and lacking a tooth. In this publication such specimens are identified as *Martinottiella communis*.
 Abundance and depth range The species is present in sample 14910-2 from a depth of 535 m only.
 Association with CWCH Present in CWCH only, of no significance.

Genus *Goesella* Cushman, 1933

Goesella cylindrica (Cushman, 1922) in Cushman (1922a)
 Fig. 12C, D

Synonym *Bigenerina cylindrica* Cushman 1922 in Spezzaferri et al. (2015), p. 82–83, pl. 5, figs. 6a–b.
 The illustrated specimen with its neck seems to be a *Martinottiella* Cushman 1933.

Diagnostic Features Test free, length up to 1650 µm, width up to 510 µm; early stage indistinct, tapered and angled up to 45 degrees to the following chambers, early stage followed by a triserial, biserial and finally uniserial chamber arrangement; wall coarsely agglutinated; aperture terminal, a large round hole surrounded by particles standing out of the cemented wall.

Abundance and depth range Present to occasional in four samples from depth between 414 m to 590 m depth, present in one sample from 246 m depth.

Association with CWCH Associated with CWCH as present to occasional. Also found above.

Family KAMINSKIIDAE Neagu, 1999

Genus *Spirorutilus* Hofker, 1976

Spirorutilus carinatus (d'Orbigny, 1846)
 Fig. 12E, F

Diagnostic Features Test free, elongate, in length up to 1110 µm and width up to 540 µm; early chambers coiled followed by a biserial part, chambers slightly increasing in size, last 1–2 chambers inflated, margins sharply edged, lobate and slightly carinate; sutures depressed and almost straight and perpendicular to the main axis; wall finely agglutinated with some coarser particles near sutures; aperture an arch at the base of the last chamber. It differs from *Spiroplectinella wrighti* by being lobate and carinate.

Abundance and depth range Present to rare in three samples from 142 m, 246 m and 535 m depth.

Association with CWCH Present in CWCH, of no significance. Also found above.

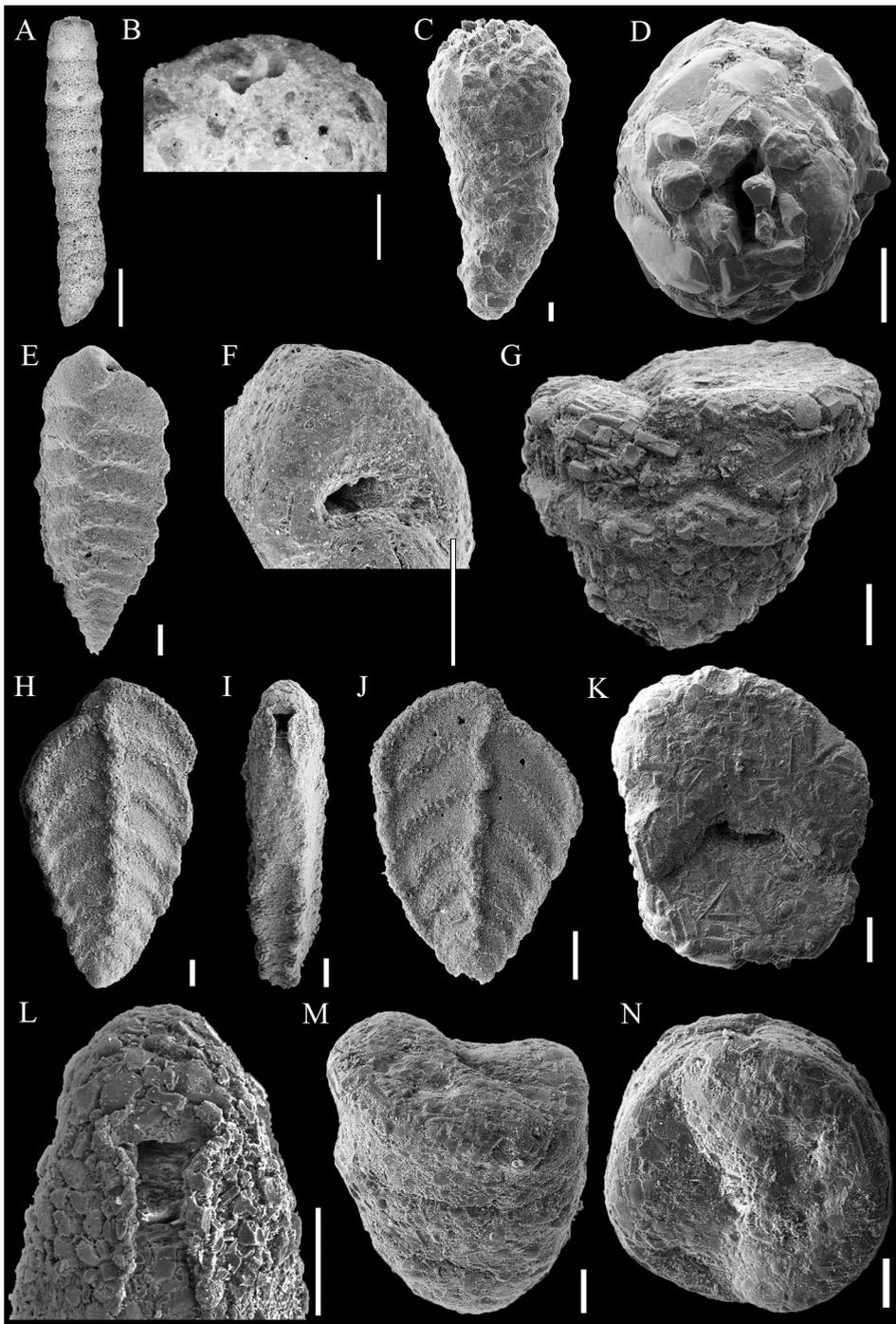


Fig. 12 A, B: *Clavulina multicamerata* GeoB 14910-2; C, D: *Goesella cylindrical* GeoB 14889-1; E, F: *Spirorutilus carinatus* GeoB 14910-2; G, K: *Sahulula barkeri* G: GeoB 14705-1; K: GeoB 14705-1; H–J, L: *Tetragonostomina rhombiformis* H, I, L: GeoB 14865-1; J: GeoB 14865-1; M, N: *Textularia pseudotrochus* GeoB 14889-1. Scale bars 100 μm except for A 500 μm .

Family TEXTULARIIDAE Ehrenberg, 1838

Genus *Sahulia* Loeblich & Tappan, 1985

Sahulia barkeri (Hofker, 1978)

Fig. 12G, K

Diagnostic
Features

Test free, low conical, broader than high, length up to 500 µm and width up to 610 µm; biserial, sutures in some specimens hardly visible, nearly perpendicular to the main axis, apertural face broad oval; wall coarsely agglutinated; aperture an arch in the middle of the base of the last chamber extending over one third of the apertural face, partly covered by a central flap. It is identified as a *Sahulia* rather than *Textularia* Defrance 1824 due to its low conical test and broad apertural face. It differs from the description of Hofker (1978) by being coarsely and not finely agglutinated.

Abundance and
depth range

Present in two samples from 52 m and 91 m depth, one in counts.

Association
with CWCH

Not associated as only found at water depths well above CWCH.

Genus *Tetragonostomina* Mikhalevich, 1975

Tetragonostomina rhombiformis Mikhalevich, 1975

Fig. 12H–J, L

Diagnostic
Features

Test free, elongate, flat, length up to 1280 µm, width up to 630 µm and thickness up to 290 µm, in wide side view the length to width ratio ranges from 1.5 to 2.3; early chambers coiled followed by a biserial part, flat in narrow side view; sutures raised and thickened, forming a straight or zigzagged line in the middle of the test in broad side view; wall agglutinated, the sutures may contain coarser particles than the chamber surfaces; in slender side view double keeled over almost the whole test; aperture a square with lines curved inward, bordered by the double keel.

Abundance and
depth range

Dominant in two sample from 52 m depth, occasional in one sample from 52 m depth, present in one sample from 369 m depth.

Association
with CWCH

Not associated as only found at water depths well above CWCH.

Genus *Textularia* Defrance, 1824

Textularia pseudotrochus Cushman, 1922 in Cushman (1922a)

Fig. 12M, N

Diagnostic
Features

Test free, length up to 780 µm and width up to 600 µm; early chambers indistinct, later part biserial, outline in apertural view round; wall agglutinated; aperture a half rounded opening in the middle of the last chamber.

Abundance and depth range Present to occasional in seven samples ranging from 30 m to 590 m depth. Six in counts.
Association with CWCH Associated with CWCH, as present to occasional in four samples. Present to occasional above.

Textularia truncata Höglund, 1947

Fig. 13A, B

Diagnostic Features Test free, length up to 840 µm, width up to 720 µm and in apertural view up to 360 µm, outline in apertural view elongated oval and pointed at both ends, outline in lateral view lobate; early chambers coiled followed by a biserial part; sutures run perpendicular to the main axis and are slightly curved; wall finely agglutinated with some larger pieces; on both sides the chambers run into keels, which run from bottom to the top; aperture a slit in the middle of the base of the last chamber, extending over half of the suture. The species commonly has straight sutures and a triangular outline with sharp edges.

Abundance and depth range Rare to occasional in eight samples ranging from 91 m to 1252 m depth.
Association with CWCH Rare in one sample from CWCH, of no significance. Found above and below.

Textularia sp.

Not figured

Diagnostic Features Test free; biserial; wall agglutinated; aperture a rounded to oval opening in the middle of the last chamber. Single specimens which could not be assigned to a single species.

Abundance and depth range Present in six samples from 30 m to 1196 m depth.
Association with CWCH Present in two samples from CWCH, of no significance. Found above and below.

Order MILIOLIDA Delage & Hérouard, 1896

Suborder MILIOLINA Delage & Hérouard, 1896

Superfamily MILIOLOIDEA Ehrenberg, 1839

Family SPIROLOCULINIDAE Wiesner, 1920

Genus *Spiroloculina* d'Orbigny, 1826

Spiroloculina dilatata d'Orbigny, 1846

Fig. 13C, D

Diagnostic Features Test free, outline of the broad side fusiform, biconcave, length up to 1140 µm, width up to 740 µm, thickness up to 170 µm; coiling miliolid, five to six chamber-pairs visible, chambers compressed tubular, subsequent chamber pairs rise against previous ones in steps due to being thicker and having an acute inner margin; sutures before the steps flush, central depression; wall porcelaneous; aperture terminal, trapezoid with rounded edges, bordered by a small rim and with a tooth.

Remarks This species differs from *Spiroloculina excavata* d'Orbigny, 1846 by being much thinner, less biconcave and lacking the central ridge on each chamber.

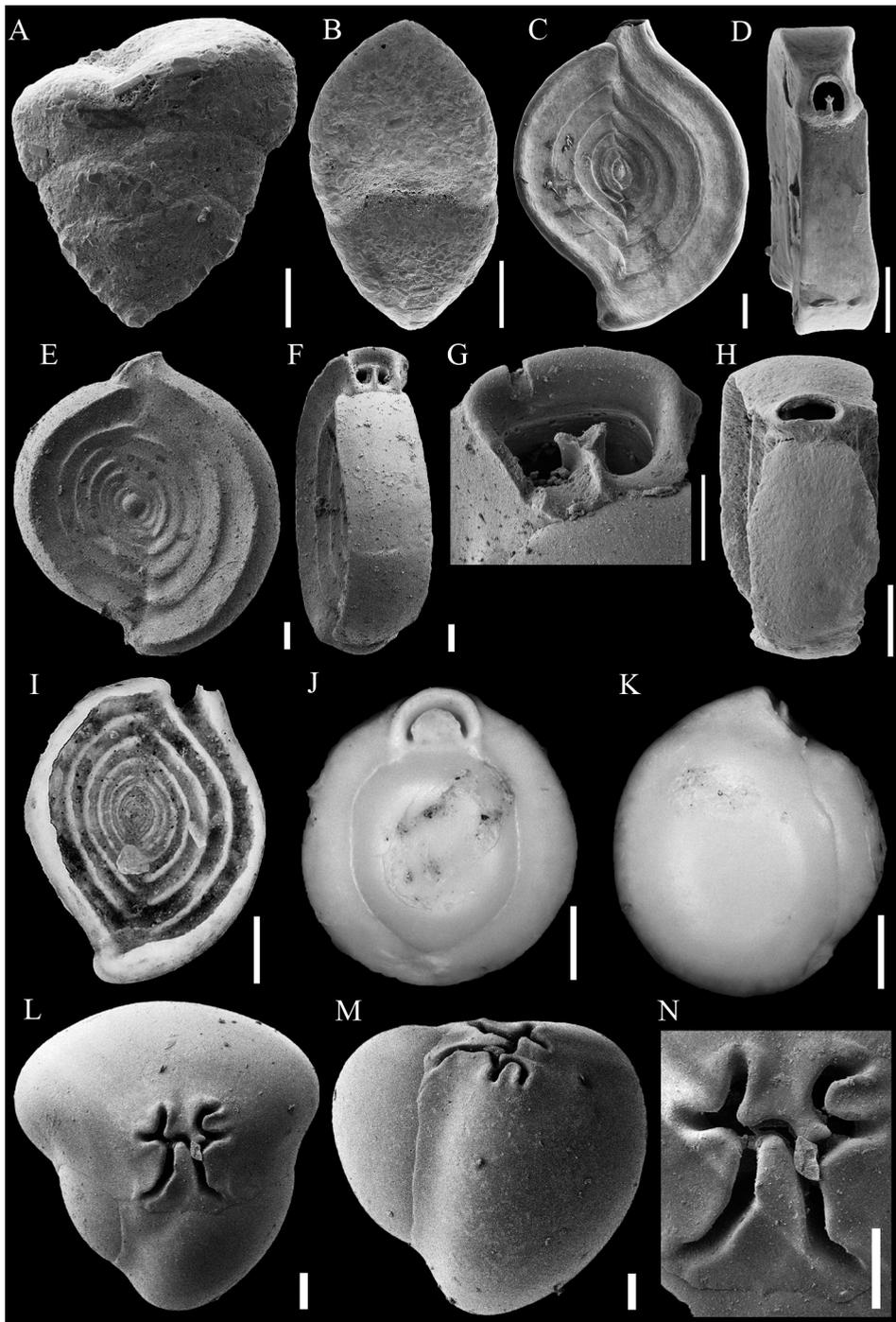


Fig. 13 A, B: *Textularia truncata* A: GeoB 14704-1; B: GeoB 14704-1; C, D: *Spiroloculina dilatata* C: GeoB 14704-1; D: GeoB 14704-1; E-G: *Spiroloculina excavata* E, F: GeoB 14911-1; G: GeoB 14911-1; H, I: *Spiroloculina tenuiseptata* H: GeoB 14898-1; I: GeoB 14878-1; J, K: *Biloculinella globula* GeoB 14704-1; L-N: *Cribromiliolinella subvalvularis* GeoB 14910-2. Scale bars 100 μ m.

Abundance and depth range Rare in three samples from 91 m to 246 m depth.

Association with CWCH Not associated as only found at water depths above CWCH.

Spiroloculina excavata d'Orbigny, 1846

Fig. 13E–G, Fig. 35A

Diagnostic Features Test free, big, almost round in outline, much biconcave, length up to 1170 µm, width up to 990 µm, thickness up to 300 µm; coiling miliolid, about seven chamber-pairs visible, chambers compressed tubular with a central ridge; sutures flush, central depression; wall porcelaneous; aperture terminal, trapezoid with rounded edges, bordered by a lip and with a bifid tooth.

Abundance and depth range Present to occasional in eight samples ranging from 30 m to 566 m depth.

Association with CWCH Associated with CWCH as rare to occasional with a share of up to 4 %. Also found above.

Spiroloculina tenuiseptata Brady, 1884

Fig. 13H, I, Fig. 35B

Synonym *Spirophthalmidium tenuiseptatum* (Brady, 1884) in Hayward et al. (2022).

Diagnostic Features Test free, in view of the broad sides ovate in outline, in view of the slender side elongated, almost rectangular, biconcave, length up to 480 µm, width up to 390 µm, thickness up to 190 µm; coiling miliolid, chambers compressed tubular; sutures deeply depressed and commonly filled with sediment, the edges of the tubular chambers stand significantly out, building at the periphery a bent, flat and broad strip; wall porcelaneous; aperture terminal, elongated oval.

Abundance and depth range Present and occasional in two samples from 505 m and 493 m depth.

Association with CWCH Found in two samples of CWCH only. In one occasional with a 5,5 % share of the assemblage.

Family HAUERINIDAE Schwager, 1876

Genus *Biloculinella* Wiesner, 1931

Biloculinella globula (Bornemann, 1855)

Fig. 13J–K

Synonym *Biloculinella globulus* (Bornemann, 1855) in Hayward et al. (2022).

Diagnostic Features Test free, globular, discoid in outline, diameter up to 430 µm; biloculine, involute, last inflated chambers embracing all previous ones, penultimate chamber significantly smaller than the last one; sutures slightly depressed; wall porcelaneous, imperforate, surface smooth; aperture subterminal, half rounded, largely covered by a broad, half rounded tooth which leaves only a half rounded slit as an opening, bordered by thick lip.

Abundance and depth range Present in sample 14704-1 from 246 m depth only, not in counts.

Association with CWCH Not associated as only found above CWCH.

Genus *Cribromiliolinella* Saidova, 1981

Cribromiliolinella subvalvularis (Parr, 1950)

Fig. 13L–N

Synonym *Cruciloculina navarroi* Colom, 1964 in Reymond et al. (2014), p. 77, pl. 1, figs. 29–30.

Diagnostic Features Test free, in side view oval, in apertural view triangular with rounded edges, dimensions up to 1030 µm × 920 µm × 770 µm; miliolid coiling, triloculine with three chambers seen on one side and two on the other, chambers inflated; wall porcelaneous, surface smooth; aperture terminal, variable in multiple furcations, commonly ovate opening covered partly by six flaps, of which three are almost double the length of the other three.

Abundance and depth range Rare in two samples from 483 m and 493 m depth, present in one sample from 535 m depth, not in counts.

Association with CWCH Present in one, rare in two samples from CWCH, overall of no significance.

Genus *Lachlanella* Vella, 1957

Lachlanella barnardi (Rasheed, 1971)

Fig. 14A, B

Diagnostic Features Test free, almost oval outline, length up to 910 µm, width up to 770 µm, thickness up to 340 µm; miliolid, quinqueloculine coiling, chambers tubular, each building half of the whorl, four chambers visible on one side and three on the other; sutures depressed; wall porcelaneous, imperforate, surface with grooves and humps; aperture terminal, elongate rectangular bordered by a thin lip, with a long, slim tooth.

Abundance and depth range Present in sample GeoB 14704-1 from 246 m depth only. Not in counts.

Association with CWCH Not associated as only found above CWCH.

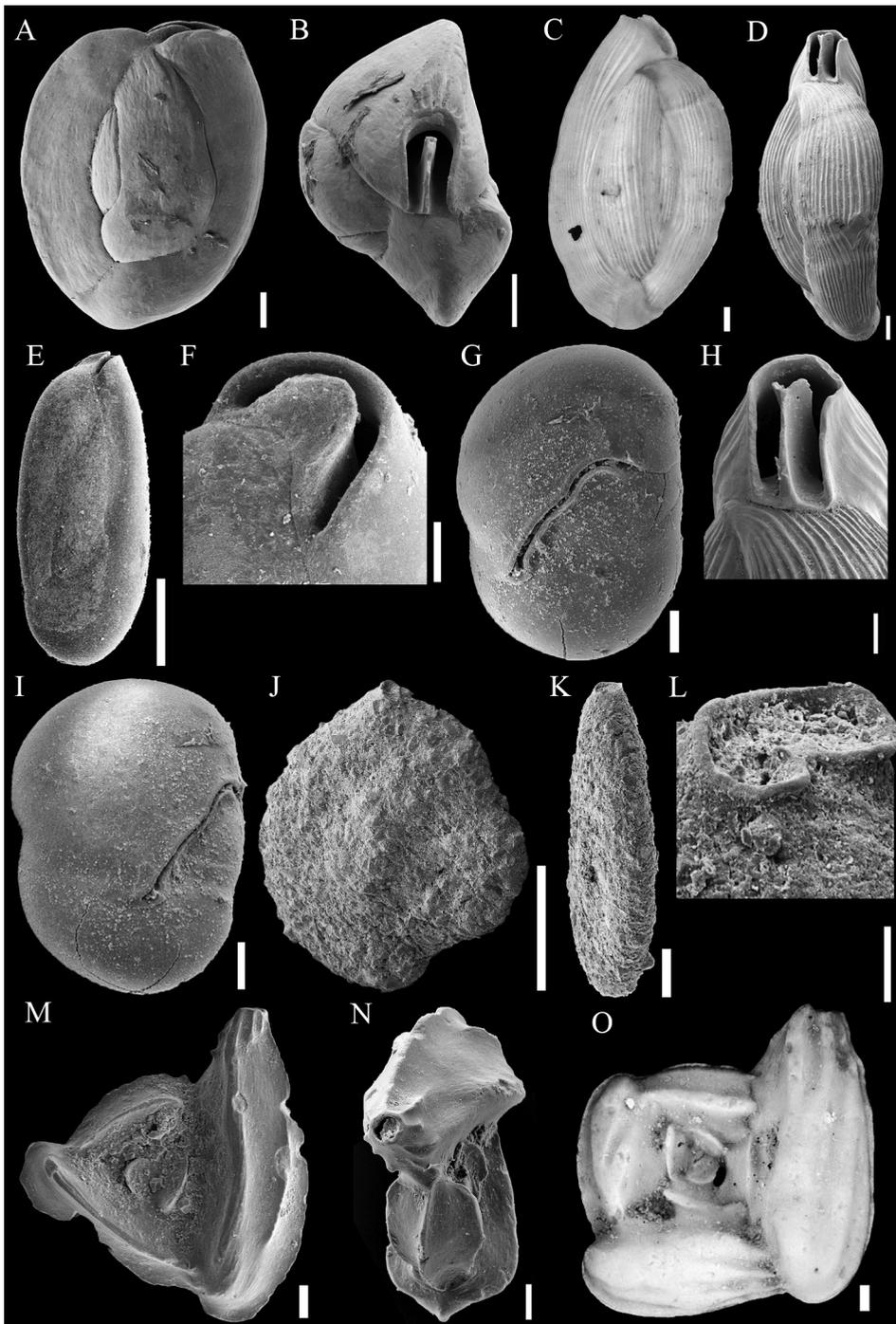


Fig. 14 A, B: *Lachlanella barnardi* GeoB 14704-1; C, D, H: *Lachlanella bicornis* C: GeoB 14704-1; D, H: GeoB 14704-1; E, F: *Miliolinella oblonga* GeoB 14878-1; G, I: *Miliolinella* sp. GeoB 14905-1; J–L: *Proemassilina arenaria* J: GeoB 14905-1; K, L: GeoB 14905-1; M–O: *Ptychomiliola separans* M, N: GeoB 14889-1; O: GeoB 14889-1. Scale bars 100 μ m.

Lachlanella bicornis (Walker & Jacob, 1798)

Fig. 14C, D, H

Synonym *Adelosina bicornis* (Walker & Jacob, 1798) in Hayward et al. (2022).

Diagnostic Features Test free, elongate oval outline, length up to 1340 µm, width up to 750 µm, thickness up to 520 µm; miliolid, quinqueloculine coiling, chambers tubular each building half of the whorl; sutures depressed; wall porcelaneous, imperforate, surface of each chamber with numerous longitudinal striae; aperture terminal, elongate rectangular bordered by a thin lip, with a long, narrow bifid tooth.

Remarks The specimens found differ from *Adelosina* d'Orbigny, 1826 by lacking a neck and a round aperture.

Abundance and depth range Present to rare in two samples from 52 m and 91 m depth.

Association with CWCH Not associated as only found well above CWCH.

Genus *Miliolina* Williamson, 1858*Miliolina oblonga* (Montagu, 1803) *sensu* Goës (1894)

Fig. 14E, F

Diagnostic Features Test free, elongate, subrectangular with rounded sides, length up to 390 µm, width up to 180 µm; miliolid coiling; wall porcelaneous, surface smooth; aperture terminal a broad arch with an apertural flap.

Remarks Due its apertural flap it is seen as appropriate to place this species into the genus *Miliolina* as done by Goës (1894) and separate it from *Triloculina oblonga* (Montagu, 1803).

Abundance and depth range Present in one sample from 414 m depth and occasional in one sample from 493 m depth.

Association with CWCH Present to occasional in CWCH only, overall of no significance.

Genus *Miliolinella* Wiesner, 1931*Miliolinella* sp.

Fig. 14G, I

Diagnostic Features Test free, biloculine appearance, dimensions up to 690 µm × 580 µm × 460; miliolid coiling; wall porcelaneous, surface smooth; aperture an elongated, slightly curved slit bordered by a thick lip.

Abundance and depth range Present to occasional in three samples from 414 m to 486 m depth.

Association with CWCH Present to occasional in CWCH only, overall of no significance.

Genus *Proemassilina* Lacroix, 1938

Proemassilina arenaria (Brady, 1884)

Fig. 14J–L, Fig. 35C

Synonym *Ammomassilina arenaria* (Brady, 1884) in Spezzaferri et al. (2015), p. 60, pl. 7, figs. 4.

Diagnostic Features Test free, much compressed, outline rounded on one side and bulging on the other, both sides flat, length up to 580 µm, width up to 520 µm, thickness up to 120 µm; miliolid coiling; sutures slightly depressed to flush; wall coarsely agglutinated on a porcelaneous layer which is visible from the outside only at and in the aperture; aperture terminal, round, bordered by a thin lip and with a tooth.

Remarks The specimens found lack a pronounced neck and are seen as falling into the variance of the species.

Abundance and depth range Present in two samples from 486 m and 1252 m depth.

Association with CWCH Present in one sample from CWCH, of no significance. Also found below.

Genus *Ptychomiliola* Eimer & Fickert, 1899

Ptychomiliola separans (Brady, 1881)

Fig. 14M–O, Fig. 35D

Diagnostic Features Test free, tri- or rectangular in outline, length up to 1210 µm, width up to 1180 µm, thickness up to 590 µm; miliolid coiling, last three to four tubular chambers enclose a central depression; wall porcelaneous, surface of the last chambers ornamented with a few longitudinal costae; aperture terminal, round, bordered by a lip and with a small tooth.

Remarks the specimens with a rectangular outline are interpreted as falling into the variance of this species.

Abundance and depth range Present in sample GeoB 14889-1 from 590 m depth, not in counts.

Association with CWCH Present in one sample from CWCH, of no significance.

Genus *Pyrgo* Defrance, 1824

Pyrgo depressa (d'Orbigny, 1826) **Forma A**

Fig. 15A, B, Fig. 35E

Diagnostic Features Test free, ovate in outline, broader than high, in cross section compressed biconvex, length up to 740 µm, width up to 840 µm; biloculine, miliolid coiling; wall porcelaneous, surface smooth; aperture a broad peripheral slit, the opening restricted by a much elongated tooth.

Abundance and depth range Present to rare in four samples from 246 m to 1196 m depth.

Association with CWCH Present in CWCH, of no significance. Also found above and below.

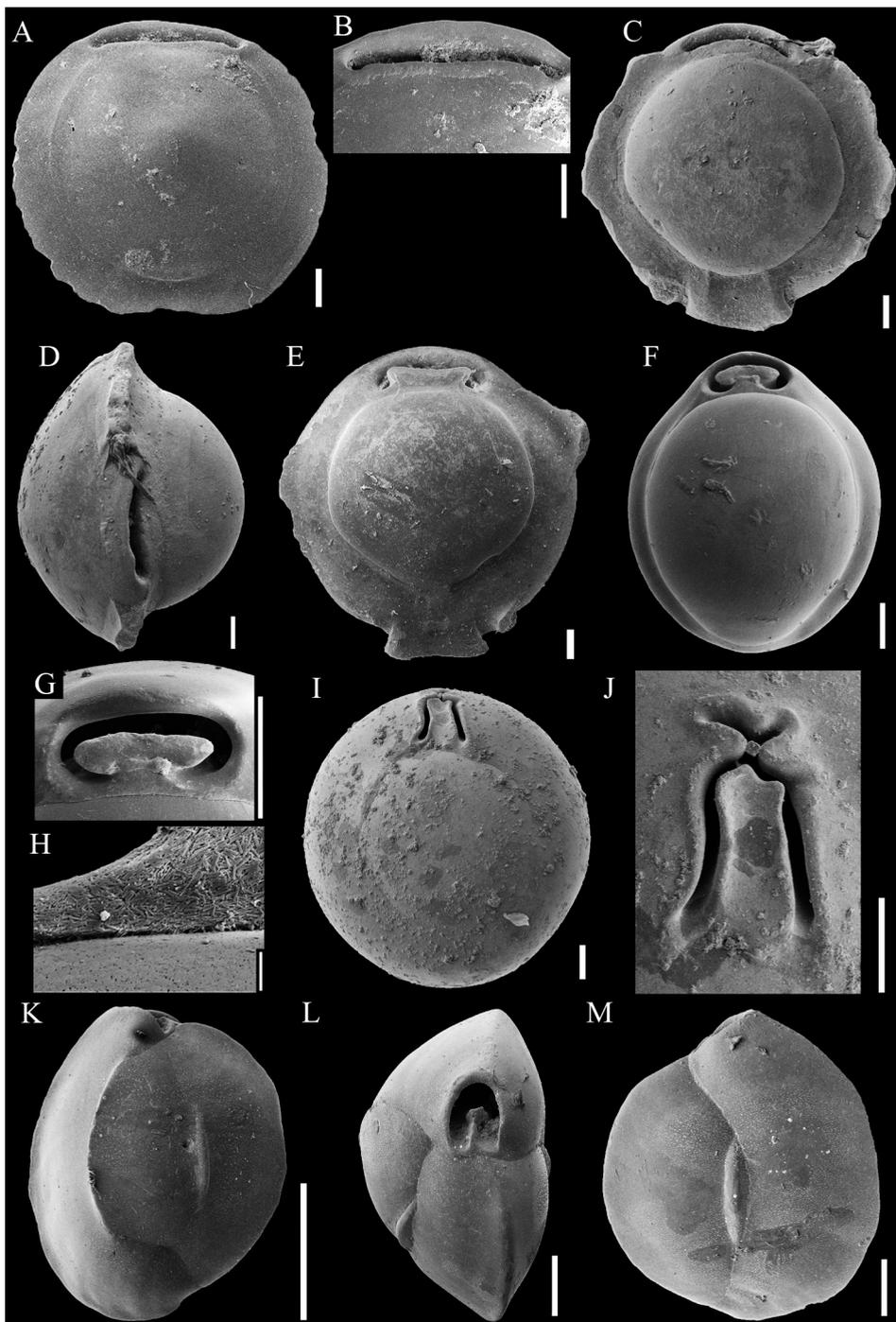


Fig. 15 A, B: *Pyrgo depressa* Forma A GeoB 14854-1; C–E: *Pyrgo depressa* Forma B, C, D: GeoB 14858-1; E: GeoB 14858-1; F–H: *Pyrgo williamsoni* GeoB 14799-1, H: surface detail at the aperture; I, J: *Pyrgoella sphaera* GeoB 14905-1; K–M: *Quinqueloculina lamarckiana* K: GeoB 14704-1; L, M: GeoB 14704-1. Scale bars 100 μm except for H: 5 μm , K: 500 μm .

***Pyrgo depressa* (d'Orbigny, 1826) Forma B**

Fig. 15C, D, E

Diagnostic Features	Test free, biloculine, large, in side view spherical and symmetrical, in cross section compressed biconvex, diameter up to 1010 µm; miliolid coiling; wall porcelaneous, surface smooth; aperture oval, large, below the periphery, with a laterally elongated tooth having lateral extensions.
Abundance and depth range	Present to rare in five samples from 246 m to 510 m depth.
Association with CWCH	Associated with CWCH as rare in four samples, overall of no significance. Also found above.

***Pyrgo williamsoni* (Silvestri, 1923)**

Fig. 15F–H

Diagnostic Features	Test free, biloculine, elongated ovate in outline, in apertural view asymmetrical, in cross section strongly biconvex, length up to 450 µm, width up to 270 µm; miliolid coiling; wall porcelaneous, surface smooth; aperture oval, large, slightly below the periphery, with a broad tooth having lateral extensions.
Remarks	The species differs from <i>Pyrgo oblonga</i> (d'Orbigny, 1839) in d'Orbigny (1839a) by having a smaller tooth base.
Abundance and depth range	Present to rare in two samples from 1196 m and 1252 m depth and rare to occasional in six samples ranging from 414 m to 510 m depth.
Association with CWCH	Associated with CWCH as rare to occasional in six samples of CWCH. Found to a lesser extent in two samples below.

Genus *Pyrgoella* Cushman & White, 1936***Pyrgoella sphaera* (d'Orbigny, 1839) in d'Orbigny (1839b)**

Fig. 15I, J

Diagnostic Features	Test free, globular, in cross section round, diameter up to 710 µm; biloculine, miliolid coiling, last chamber largely embracing previous chambers and leaving just a small, round window in which the previous chamber is exposed; wall porcelaneous, surface smooth; aperture above the window at the base of the last chamber, very variable, commonly Y-shaped or oval with an elongated apertural flap.
Abundance and depth range	Present to occasional in three samples from 414 m to 486 m depth.
Association with CWCH	Present to occasional in CWCH only, overall of no significance.

Genus *Quinqueloculina* d'Orbigny, 1826*Quinqueloculina lamarckiana* d'Orbigny, 1839 in d'Orbigny (1839a)

Fig. 15K–M

Diagnostic Features Test free, ovate in outline, almost triangular in apertural view, length up to 960 µm, width up to 800 µm, thickness up to 680 µm; miliolid, quinqueloculine coiling with four chambers visible from one side and three from the other, in apertural view at least three chambers acutely angled showing a sharp ridge; wall porcelaneous, surface smooth; aperture at the end of the last chamber, ovate, with a bifid tooth.

Abundance and depth range Present to dominant in 18 samples ranging from 52 m to 1310 m depth. Dominant in two samples from the southern Banc d'Arguin at 369 m and 520 m depth. Frequent to dominant in two samples from the Timiris mud wedge at 52 m depth.

Association with CWCH Closely associated as present to dominant in twelve samples from CWCH. Found in lower numbers above and below.

Quinqueloculina viennensis Le Calvez & Le Calvez, 1958

Fig. 16A–C

Diagnostic Features Test free, ovate in outline, length up to 510 µm, width up to 780 µm; miliolid, quinqueloculine coiling, chambers broad tubular; wall porcelaneous, surface smooth; aperture at the end of the last tubular chamber, ovate, with a bifid tooth.

Abundance and depth range Frequent in sample GeoB 14703-1 from 111 m depth and rare in samples GeoB 14848-1 from 516 m depth and GeoB 14858-1 from 483 m depth.

Association with CWCH Rare in one sample from CWCH, of no significance.

Quinqueloculina sp.

Not figured

Diagnostic Features Test free, ovate in outline; miliolid, quinqueloculine coiling; wall porcelaneous, surface smooth; aperture at the end of the last tubular chamber. Specimens which could not be assigned to a single species are lumped together.

Abundance and depth range Thirteen samples contain specimens of different species of *Quinqueloculina*. Lumped together the occurrence ranges from present to rare and in one sample occasional. Each single form is present to rare.

Association with CWCH The occurrences of each form are too rare to draw conclusions.

Genus *Sigmoilopsis* Finlay, 1947*Sigmoilopsis schlumbergeri* (Silvestri, 1904)

Fig. 16D–F

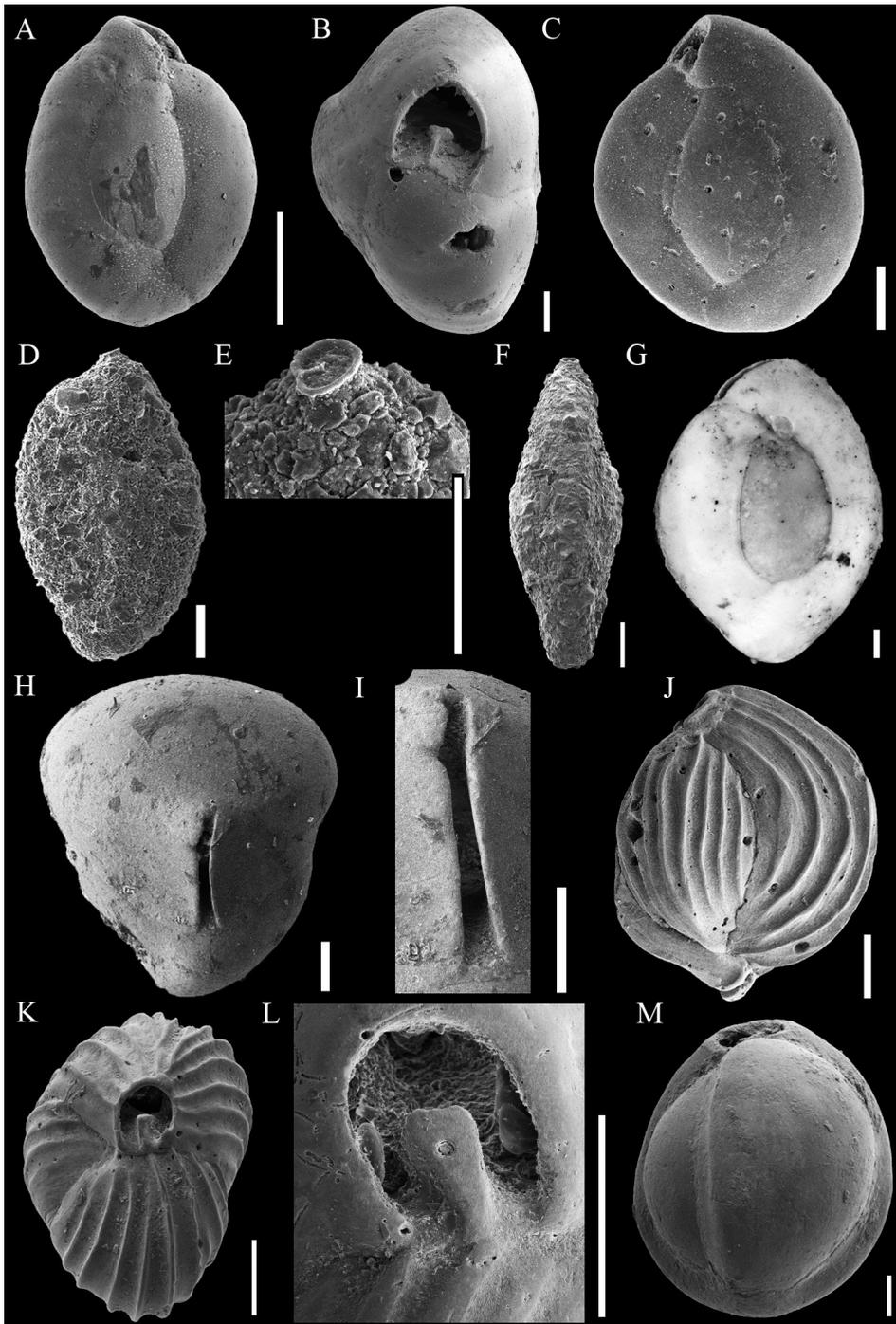


Fig. 16 A–C: *Quinqueloculina viennensis* A: GeoB 14848-1; B: GeoB 14848-1; C: GeoB 14848-1; D–F: *Sigmoilopsis schlumbergeri* D, E: GeoB 14856-1; F: 14889-1; G–I: *Triloculina angusteoralis* G: GeoB 14903-1; H, I: GeoB 14910-2; J–L: *Triloculina fichteliana* J: GeoB 14703-1; K: GeoB 14788-1; L: GeoB 14788-1; M: *Triloculina trigonula* GeoB 14799-1. Scale bars 100 µm except for A 500 µm.

Diagnostic Features	Test free, fusiform, compressed, biconvex, length up to 650 µm, width up to 370 µm; miliolid coiling, sutures slightly depressed to flush; wall coarsely agglutinated on a porcelaneous layer, which is visible from the outside only at and in the aperture; aperture terminal, round, bordered by a thin lip and with a tooth.
Abundance and depth range	Occasional to dominant in three samples from 1119 m to 1310 m depth, rare to occasional in four samples from 535 m to 590 m depth.
Association with CWCH	Rare to occasional in CWCH, more frequent below.

Genus *Triloculina* d'Orbigny, 1826

Triloculina angusteoralis (Wiesner, 1923)

Fig. 16G–I

Diagnostic Features	Test free, big, outline from two sides broad fusiform, in cross section triangular with rounded sides and angles, length up to 1120 µm, width up to 850 µm, thickness up to 1080 µm; triloculine coiling, with two chambers visible on one side and three on the other, chambers inflated tubular; sutures depressed; wall porcelaneous, surface uneven; aperture a much elongated, broad slit, centric in the apertural face.
Remarks	Due its triloculine morphology it is seen as appropriate to place this foraminifera into its own species of the genus <i>Triloculina</i> as done by Sgarrella & Moncharmont Zei (1993).
Abundance and depth range	Rare in three samples ranging from 414 m to 486 m depth.
Association with CWCH	Rare in CWCH only, overall of no significance.

Triloculina fichteliana d'Orbigny, 1839 in d'Orbigny (1839a)

Synonyms *Quinqueloculina boueana* (d'Orbigny, 1846) in Reymond et al. (2014), p. 77, pl. 1, figs. 13–14.
Quinqueloculina disparilis d'Orbigny in Schlumberger (1893) in Reymond et al. (2014), p. 77, pl. 1, figs. 11–12.
Miliolinella fichteliana (d'Orbigny, 1839) in Hayward et al. (2022).

Fig. 16J–L

Diagnostic Features	Test free, outline in side view round and in apertural view ovate, length up to 510 µm, width up to 390 µm; miliolid, triloculine coiling with two chambers visible on one side and three on the other, chambers inflated tubular; sutures depressed; wall porcelaneous, surface ornamented with thick, well spaced costae; aperture terminal, oval with a prominent tooth, bordered by a broad rim.
Remarks	Due to its tooth it is seen as appropriate to place this species into the genus <i>Triloculina</i> as done by Cushman (1932a) rather than into <i>Miliolina</i> which has an apertural flap.
Abundance and depth range	Rare in two samples from 14 m and 30 m depth.
Association with CWCH	Not associated as only found well above CWCH.

Triloculina trigonula (Lamarck, 1804)

Fig. 16M, Fig. 17A

Diagnostic Features

Test free, outline in one view oval and in apertural view somewhat quadrate with well rounded edges, length up to 690 µm, width up to 470 µm; triloculine coiling, chambers inflated tubular; sutures depressed; wall porcelaneous, surface uneven; aperture oval, with a bifid tooth.

Abundance and depth range

Present in sample GeoB 14799-1 from 490 m depth only, not in counts.

Association with CWCH

Present in one sample from CWCH only, of no significance.

Superfamily NUBECULARIOIDEA Jones, 1875

Family FISCHERINIDAE Millett, 1898

Genus *Planispirinella* Wiesner, 1931

Planispirinella exigua (Brady, 1879)

Fig. 17B–E

Diagnostic Features

Test free, large, discoidal, thin, much compressed with a central depression on both sides, length up to 1650 µm, width up to 1050 µm, thickness up to 310 µm; low trochospiral to planispiral, involute, 4–6 chambers increasing in size in the last whorl, last chamber enlarged up to half the size of the whole test, sutures slightly depressed, may be overgrown by a radiate margin of the preceding chamber, initial chambers tubular and spirally arranged; wall porcelaneous, surface uneven, few striae may occur at the periphery of the last chamber; aperture an elongated, broad slit, centric in the apertural face, varying from a third to half of the length of the test, no tooth and no lip.

Abundance and depth range

Present to rare in five samples ranging from 414 m to 535 m depth, one not in counts.

Association with CWCH

Associated as only found in CWCH.

Order NODOSARIIDA Calkins, 1926

Suborder NODOSARIINA Calkins, 1926

Superfamily NODOSARIOIDEA Ehrenberg, 1838

Family LAGENIDAE Reuss, 1862

Genus *Lagena* Walker & Jacob, 1798

Lagena aspera Reuss, 1862

Fig. 17F–I

Diagnostic Features

Test free, length up to 520 µm, width up to 220 µm, ovate; unilocular; wall hyaline, surface covered with papillae; aperture terminal, round, sitting on a much elongated neck with corkscrew-like twisted costae.

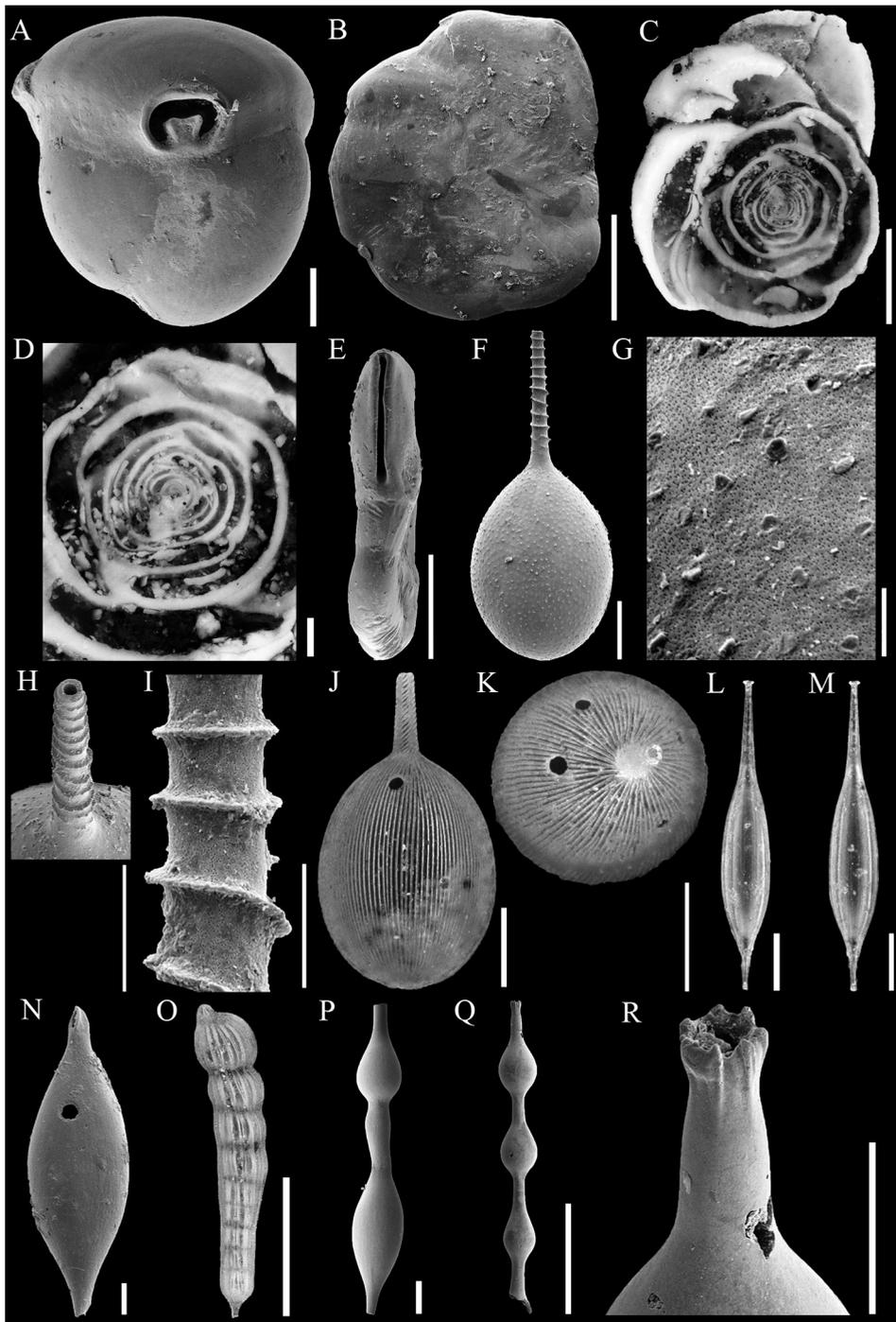


Fig. 17 A: *Triloculina trigonula* GeoB 14799-1; B–E: *Planispirinella exigua* B, E: GeoB 14910-2; C, D: sliced, showing initial coiling GeoB 14799-1; F–I: *Lagena aspera* GeoB 14856-1; J, K: *Lagena striata* GeoB 14856-1; L, M: *Procerolagena gracilis* GeoB 14856-1; N: *Reussolina strangeri* GeoB 14910-2; O: *Dentalina vertebralis* GeoB 14910-2; P–R: *Grigelis orectus* P: GeoB 14898-1; Q, R: GeoB 14898-1. Scale bars 100 μm except for I: 20 μm , B, C, E, O, Q: 500 μm .

Abundance and depth range Present in sample GeoB 14856-1 from 1119 m depth only, not in counts.
Association with CWCH Not associated as only found well below CWCH.

Lagena gibbera Buchner, 1940

Not figured

Synonym *Geminiella gibbera* (Buchner, 1940) in Hayward et al. (2022).

Diagnostic Features Test free, length up to 510 µm, width up to 290 µm, ovate; unilocular; wall hyaline, surface covered by small irregular nodules; aperture terminal, round, sitting on a broad neck with a rough surface.

Abundance and depth range Present in sample GeoB 14856-1 from 1119 m depth only.
Association with CWCH Not associated as only found well below CWCH.

Lagena striata (d'Orbigny, 1839) in d'Orbigny (1839b)

Fig. 17J, K, Fig. 36A

Diagnostic Features Test free, length up to 390 µm, width up to 220 µm, ovate; unilocular; wall hyaline, surface fully covered with fine, longitudinal costae, which extend twisted on the long neck; aperture round terminal on the neck.

Abundance and depth range Present to rare in two samples from 450 m and 493 m depth.
Association with CWCH Present to rare in CWCH only, of no significance.

Genus *Procerolagena* Puri, 1954

Procerolagena gracilis (Williamson, 1848)

Fig. 17L, M, Fig. 36B

Diagnostic Features Test free, length up to 530 µm, elongate, flask-shaped, circular in cross section, tapering gradually to both ends; unilocular; wall calcareous, hyaline, surface with about 6–8 costae in lateral view, running from the bottom into the neck; aperture terminal round, sitting on an elongated neck, bordered by a lip.

Abundance and depth range Present in sample GeoB 14856-1 from 1119 m depth only.
Association with CWCH Not associated as only found well below CWCH.

Genus *Reusoolina* Colom, 1956

Reusoolina strangeri Loeblich & Tappan, 1994

Fig. 17N

Diagnostic Features	Test free, length up to 1010 µm, ovate with tapered ends on both sides; unilocular; wall calcareous, hyaline, surface smooth; aperture terminal at a tapered end, radiate.
Abundance and depth range	Present in sample GeoB 14910-2 from 535 m depth only, not in counts.
Association with CWCH	Present in CWCH only, of no significance.
Family NODOSARIIDAE Ehrenberg, 1838	
Genus <i>Dentalina</i> Risso, 1826	
<i>Dentalina vertebralis</i> (Batsch, 1791)	
Fig. 17O	
Diagnostic Features	Test free, length up to 2270 µm, width up to 450 µm, elongate, very slightly curved; uniserial, 7–10 chambers, last chamber inflated; sutures oblique, between last 3 chambers depressed, initial spine; wall calcareous, hyaline, surface covered with longitudinal costae ending a bit below the top of the last chamber; aperture terminal, radiate, produced on a short robust neck.
Abundance and depth range	Present in sample 14910-2 from 535 m depth only, not in counts.
Association with CWCH	Present in CWCH only, of no significance.
Genus <i>Grigelis</i> Mikhalevich, 1981	
<i>Grigelis orectus</i> Loeblich & Tappan, 1994	
Fig. 17P–R, Fig. 36C	
Diagnostic Features	Test free, large, elongate, slender, length unknown in broken specimens up to 1300 µm, width up to 170 µm; uniserial, chambers pyriform, irregularly separated by long tubes; wall calcareous, hyaline, surface smooth, imperforate; aperture terminal with a crown.
Remarks	Only broken specimens were found.
Abundance and depth range	Present in sample 14898-1 from a depth of 505 m only, not in counts.
Association with CWCH	Present in CWCH only, of no significance.
Genus <i>Laevidentalina</i> Loeblich & Tappan, 1986	
<i>Laevidentalina communis</i> (d'Orbigny, 1826)	
Fig. 18A, B, Fig. 36D	
Diagnostic Features	Test free, length up to 2190 µm, width up to 270 µm, elongate, curved; uniserial, 6–9 cylindrical chambers, initial chamber spherical with spine; sutures oblique, increasingly depressed; wall calcareous, hyaline, surface smooth; aperture terminal, eccentric, radiate.
Abundance and depth range	Present in sample 14895-1 from a depth of 577 m only.
Association with CWCH	Present in CWCH only, of no significance.

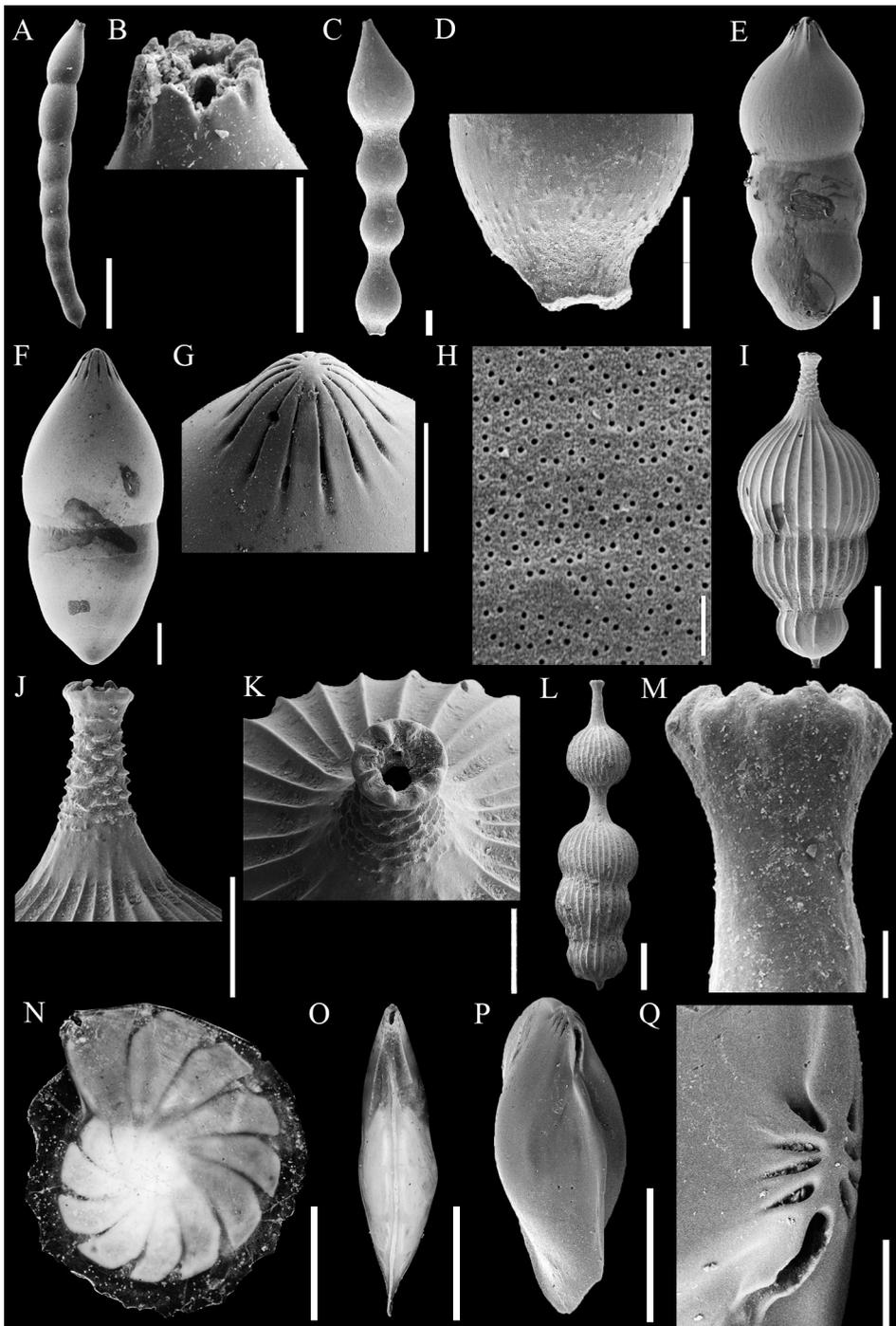


Fig. 18 A, B: *Laevidentalina communis* GeoB 14895-1; C, D: *Laevidentalina subsoluta* GeoB 14905-1; E–H: *Pseudonodosaria brevis* E: GeoB 14852-1; F–H GeoB 14852-1; I–K: *Amphicoryna scalaris* GeoB 14896-1; L, M: *Amphicoryna separans* GeoB 14858-1; N–Q: *Lenticulina iota* N, O: GeoB 14910-2; P, Q: GeoB 14896-1. Scale bars 100 μm except for H: 5 μm , K: 50 μm , A: 500 μm , N–P: 1000 μm .

Laevidentalina subsoluta (Cushman, 1923)

Fig. 18C, D

Diagnostic Features Test free, large, elongate, length unknown as only broken specimens of up to 1200 µm were found, width up to 250 µm, slightly curved, chambers pyriform, gradually increasing in size; uniserial; chambers separated by deep constrictions, sutures straight; wall calcareous, hyaline, surface smooth, with rows of small dots at the bottom of each chamber; aperture terminal, eccentric, broken in all specimens.

Remarks Only broken specimens were found.

Abundance and depth range Present in sample 14905-1 from a depth of 486 m only, not in counts.

Association with CWCH Present in CWCH only, of no significance.

Genus *Pseudonodosaria* Boomgaard, 1949*Pseudonodosaria brevis* (d'Orbigny, 1846)

Fig. 18E–H

Diagnostic Features Test free, elongate, straight, length up to 850 µm, width up to 340 µm; uniserial, 2–3 subglobular chambers; sutures depressed; wall calcareous, hyaline, surface smooth; aperture terminal, centric, radiate.

Abundance and depth range Rare in sample GeoB 14852-1 from 1310 m depth only, not in counts.

Association with CWCH Not associated as only found well below CWCH.

Order VAGINULINIDA Mikhalevich, 1993

Family VAGINULINIDAE Reuss, 1860

Genus *Amphicoryna* Schlumberger in Milne-Edwards 1881*Amphicoryna scalaris* (Batsch, 1791)

Fig. 18I–K, Fig. 36E

Diagnostic Features Test free, length up to 1020 µm, width up to 410 µm; uniserial, straight linear series of 3–5 subglobular chambers, overlapping each other and increasing rapidly in size, spine on the initial chamber; wall calcareous, hyaline, surface ornamented with longitudinal costae, which run from the base of the test to the base of the neck; aperture round, at the end of a long neck topped by a crown, having radiate structures extending almost horizontally into the aperture.

Abundance and depth range Present to rare in three samples from 493 m to 590 m depth.

Association with CWCH Present in CWCH, of no significance.

Amphicoryna separans (Brady, 1884)

Fig. 18L, M

Diagnostic Features	Test free, length up to 1340 µm, width up to 350 µm; uniserial, straight linear series of 4–5 subglobular chambers, overlapping each other and increasing rapidly in size, last chamber globular, separated by a tube from the previous ones, spine on the initial chamber; wall calcareous, hyaline, surface ornamented with longitudinal costae, which run from the initial chamber to the base of the tube and over the last chamber to the base of the neck; aperture round, at the end of a long neck topped by a crown, having radiate structures extending almost horizontally into the aperture.
Abundance and depth range	Present in sample 14858-1 from a depth of 483 m only, not in counts.
Association with CWCH	Present in CWCH only, of no significance.

Genus *Lenticulina* Lamarck, 1804

Lenticulina iota (Cushman, 1923)

Fig. 18N–Q, Fig. 36F

Diagnostic Features	Test free, globular in outline, compressed, diameter up to 1150 µm; planispiral, close-coiled, 12–14 slender, crescentic chambers in the last whorl, periphery with a thin, broad and transparent keel, umbilical knob; wall calcareous, hyaline, surface smooth; aperture on the last chamber at the peripheral angle, radiate, in apertural view one slit extends on one side into an opening bordered by a double keel.
Abundance and depth range	Rare in sample Geob 14896-1 from 566 m depth and present in sample Geob 14910-2 (not in counts) from 535 m depth.
Association with CWCH	Present to rare in CWCH only, of no significance.

Lenticulina rotulata (Lamarck, 1804)

Fig. 19A–D

Diagnostic Features	Test free, globular in outline, biconvex, diameter up to 810 µm, thickness up to 490 µm; planispiral, close-coiled, periphery keeled, large umbilical knob; wall calcareous, hyaline, surface smooth, sutures flush, curved backward; aperture on the last chamber, at the peripheral angle, radiate, on the apertural face a slit bordered by two rims.
Abundance and depth range	Present to occasional in fourteen samples ranging from 142 m to 1310 m depth.
Association with CWCH	Present to occasional in ten samples from CWCH, also found above and in lower numbers below.

Lenticulina submamilligera (Cushman, 1917)

Fig. 19E, F

Diagnostic Features	Test free, globular in outline, biconvex, diameter up to 870 µm; planispiral, close-coiled, 10–12 slender, crescentic chambers in the last whorl, periphery with a thin, broad and transparent keel, protuberant umbilical knob; sutures raised and thickened; wall calcareous,
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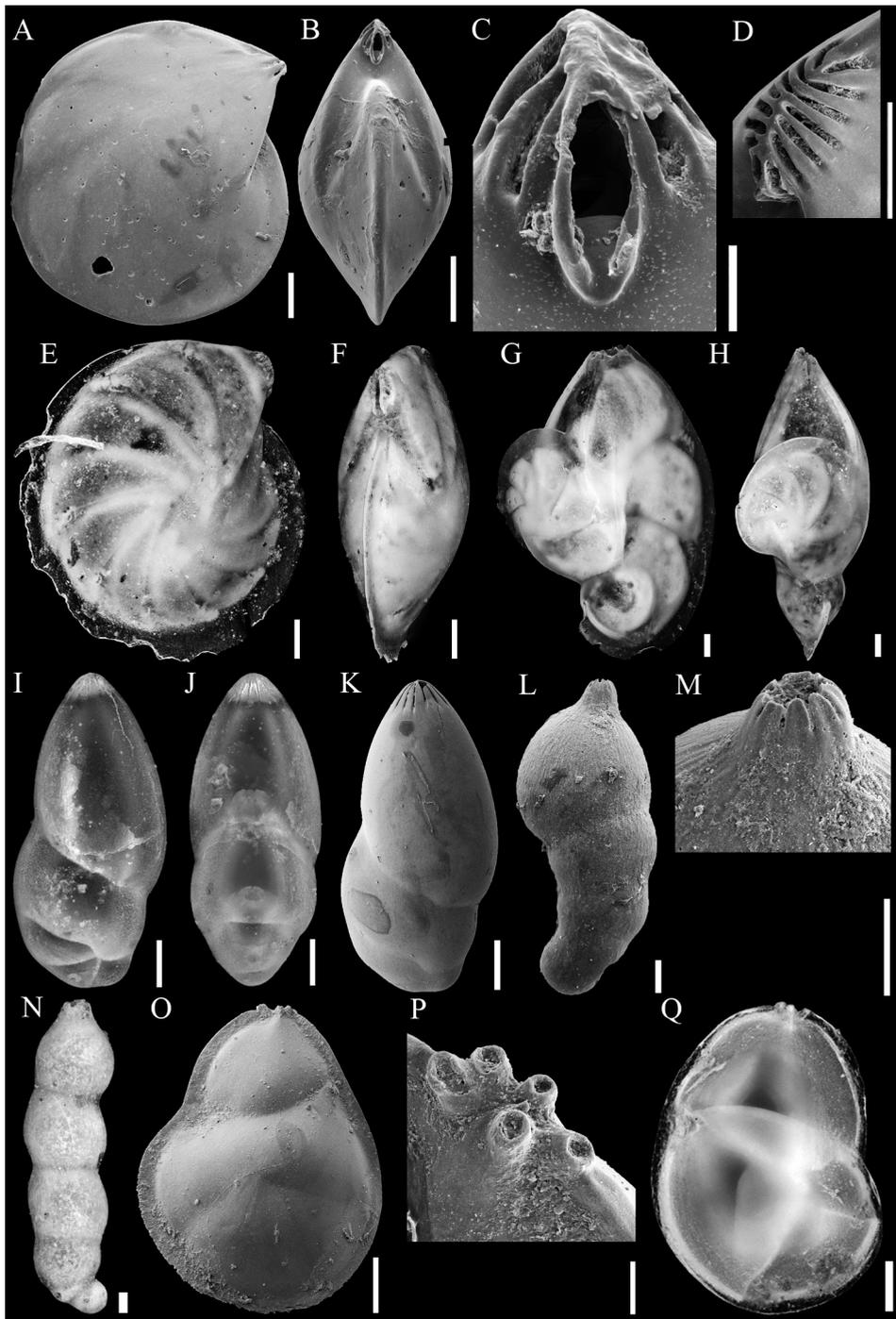


Fig. 19 A–D: *Lenticulina rotulata* A: GeoB 14704-1; B, C: GeoB 14706-1; D: GeoB 14898-1; E, F: *Lenticulina submamilligera* GeoB 14903-1; G, H: *Lenticulina* sp. GeoB 14910-2; I–K: *Marginulina glabra* I, J: GeoB 14904-1; K: GeoB 14910-2; L, M: *Marginulina striatula* GeoB 14910-2; N: *Marginulina* sp. GeoB 14910-2; O–Q: *Neolenticulina peregrina* O, P: GeoB 14898-1; Q: GeoB 14910-2. Scale bars 100 μ m except for C, P: 20 μ m.

ous, hyaline, surface between raised sutures smooth; aperture on the last chamber, at the peripheral angle, radiate, on the apertural face a slit bordered by two rims, which merge into the peripheral keel.

Abundance and depth range

Present in two samples from 510 m and 414 m depth. The latter one not in counts.

Association with CWCH

Present in CWCH only, of no significance.

Lenticulina sp.

Fig. 19G–H, Fig. 36G

Diagnostic Features

Test free, elongate, length up to 1520 µm, width up to 980 µm; irregularly planispiral with different interlocking coils of which one is uncoiling, periphery with a thin, broad and transparent keel, protuberant umbilical knob; sutures raised and thickened; wall calcareous, hyaline, surface between raised sutures smooth; aperture on the last chamber, at the peripheral angle, radiate, on the apertural face a slit bordered by two rims, which merge into the peripheral keel.

Remarks

The specimens found are not interpreted as aberrant, as such an irregular coiling mode is also reported from other areas as for example reported in Brady (1884).

Abundance and depth range

Present to occasional in five samples from 510 m to 590 m depth, of which one is not in counts.

Association with CWCH

Associated as only found in CWCH.

Genus *Marginulina* d'Orbigny, 1826

Marginulina glabra d'Orbigny, 1826

Fig. 19I–K, Fig. 36H

Synonym

Marginulina similis d'Orbigny, 1846 in Hayward et al. (2022).

Diagnostic Features

Test free, length up to 680 µm, width up to 430 µm; after a half initial coil uniserial, elongate, 2–3 chambers increasing rapidly in size, last chamber inflated; sutures depressed; wall calcareous, hyaline, surface smooth; aperture terminal, slightly eccentric, radiate.

Remarks

Loeblich & Tappan (1994) figure similar specimens on their plate 129, figures 13 and 14. The species differs from *M. similis* by its inflated chambers.

Abundance and depth range

Present to rare in three samples ranging from 246 m to 535 m depth, of which one is not in counts.

Association with CWCH

Present to rare in two samples from CWCH, overall of no significance. Also found above.

Marginulina striatula Cushman, 1913 in Cushman (1913b)

Fig. 19L, M

Diagnostic Features Test free, length up to 1010 µm, width up to 430 µm; uniserial, elongate, curved, 5–6 chambers increasing rapidly in size, last chamber inflated, length slightly less than half of the whole test; sutures almost straight, increasingly depressed; wall calcareous, hyaline, surface with very fine, discontinuous striae on the last chambers; aperture terminal, eccentric, radiate, produced on a short robust neck.

Abundance and depth range Present in sample GeoB 14910-2 from 535 m depth only, not in counts.

Association with CWCH Present in one sample from CWCH only, of no significance.

Marginulina sp.

Fig. 19N

Diagnostic Features Test free, elongate, length up to 1450 µm, width up to 430 µm; uniserial, almost straight except for the first two chambers which are at an angle to the main axis, 6 chambers increasing in size; sutures almost straight, increasingly depressed; wall calcareous, hyaline, surface smooth; aperture terminal, produced on a short robust neck. The aperture of the specimens found are partly broken but are interpreted as being radiate.

Abundance and depth range Present in sample GeoB 14910-2 from 535 m depth only, not in counts.

Association with CWCH Present in one sample from CWCH only, of no significance.

Genus *Neolenticulina* McCulloch, 1977*Neolenticulina peregrina* (Schwager, 1866)

Fig. 19O–Q, Fig. 20A

Synonym *Neolenticulina variabilis* (Reuss, 1850) in Hayward et al. (2022).

Diagnostic Features Test free, biconvex, oval to lenticular in outline, length up to 580 µm, width up to 420 µm; planispiral with the last chamber uncoiling; sutures flat and becoming depressed between the last chambers, broad peripheral carina throughout; wall calcareous, hyaline, surface smooth, imperforate; aperture at the peripheral angle of the last chamber, crown-like and with tubes extending beyond the carina.

Remarks It differs from *Neolenticulina variabilis* by having a broad peripheral carina which the holotype illustrated by Reuss (1850) lacks.

Abundance and depth range Present to occasional in five samples from 486 m to 566 m depth.

Association with CWCH Associated as only found in samples from CWCH.

Genus *Planularia* DeFrance, 1826

Planularia cassis (Fichtel & Moll, 1798)

Fig. 20B–D

Diagnostic Features Test free, flat, compressed, outline oval, length up to 890 µm, width up to 690 µm, thickness up to 180 µm; planispiral, uncoiling, chambers increasing much in length; sutures slightly depressed to flush, apertural face flanked by two rims; wall calcareous, hyaline, surface ornamented with two to four knobs and a few curved costae, elsewhere smooth; aperture at the peripheral angle of the last chamber, radiate to crowned.

Remarks Only broken specimens were found.

Abundance and depth range Present in sample 14889-1 from a depth of 590 m only, not in counts.

Association with CWCH Present only in one sample from CWCH, of no significance.

Genus *Vaginulinopsis* Silvestri, 1904

Vaginulinopsis sublegumen Parr, 1950

Fig. 20E–G, Fig. 36I

Synonym *Laevidentalina sidebottomi* (Cushman, 1933) in Spezzaferri et al. (2015), p. 65, pl. 12, figs. 4a–b.

Diagnostic Features Test free, elongate, circular in section, length up to 1860 µm, width up to 380 µm; uniserial, elongate, curved, 5–6 cylindrical chambers, initial part curved but not fully enrolled; sutures oblique, later depressed, in side view the outline is straight on one side and lapped on the other; wall calcareous, hyaline, surface smooth; aperture terminal, eccentric, radiate.

Abundance and depth range Present in two samples from 535 m and 590 m depth, both not in counts.

Association with CWCH Present in two samples from CWCH, of no significance.

Order POLYMORPHINIDA Mikhalevich, 1980 in Mikhalevich (1980b)

Suborder POLYMORPHININA Mikhalevich, 1980 in Mikhalevich (1980b)

Family ELLIPSOLAGENIDAE Silvestri, 1923

Genus *Fissurina* Reuss, 1850

Fissurina spinosiformis McCulloch, 1977

Fig. 20K

Diagnostic Features Test free, subcircular outline in lateral view, pill shaped, length up to 290 µm, width up to 200 µm; unilocular; wall calcareous, hyaline, surface smooth, in the lower part keeled with two large spinose projections; aperture terminal, slit, entosolenian tube straight.

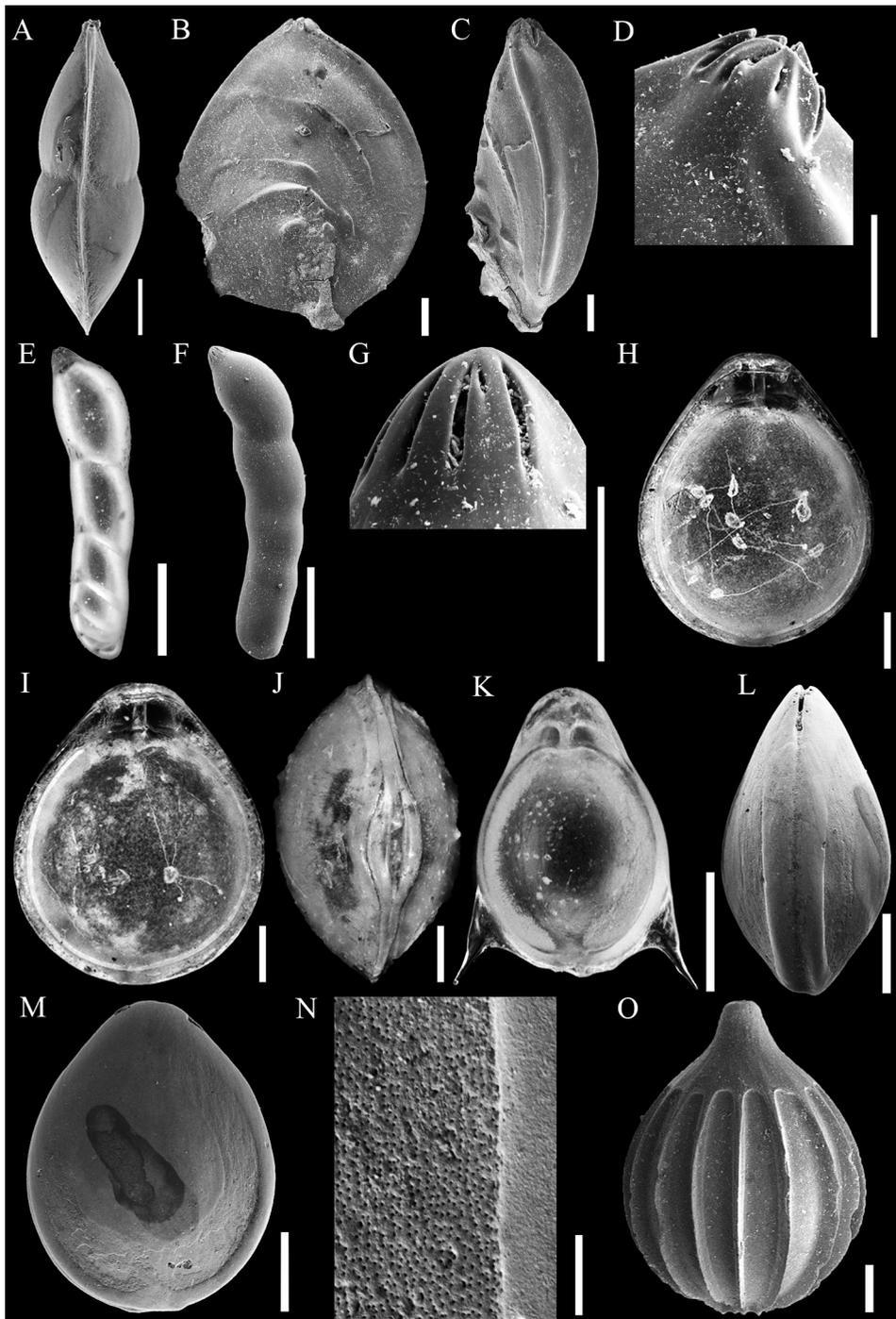


Fig. 20 A: *Neolenticulina peregrina* GeoB 14910-2; B–D: *Planularia cassis* GeoB 14889-1; E–G: *Vaginulinopsis sublegumen* GeoB 14910-2; F, G: GeoB 14889-1; H–J: *Fissurina* sp. GeoB 14856-1; K: *Fissurina spinosiformis* GeoB 14852-1; L–N: *Fissurina variocarinata* GeoB 14856-1; O: *Homalohedra borealis* GeoB 14903-1. Scale bars 100 μ m except for N: 20 μ m, E, F: 500 μ m.

Abundance and depth range Present in sample GeoB 14852-1 from 1310 m depth only.

Association with CWCH Not associated as only found well below CWCH.

Fissurina variocarinata (Buchner, 1940)

Fig. 20L–N

Diagnostic Features Test free, oval outline in lateral view, pill shaped, length up to 380 µm, width up to 310 µm, thickness up to 200 µm; unilocular; wall calcareous, hyaline, surface smooth, with numerous perforations sized about 5 µm, with two broad, unornamented keels; aperture terminal, slit.

Abundance and depth range Present in sample GeoB 14856-1 from 1119 m depth only.

Association with CWCH Not associated as only found well below CWCH.

Fissurina sp.

Fig. 20H–J, Fig. 36J

Synonym *Fissurina eburnea* (Buchner 1940) in Spezzaferri et al. (2015), p. 70, pl. 16, figs. 2a–c.

Diagnostic Features Test free, subcircular outline in lateral view, pill shaped, length up to 440 µm, width up to 360 µm; unilocular; wall calcareous, hyaline, surface smooth, lateral keel, which divides into two rims at the aperture; aperture terminal, lenticular with a lip, entosolenian tube straight.

Abundance and depth range Present to rare in three samples from 505 m to 1252 m depth.

Association with CWCH Present in one sample of CWCH, of no significance. Also found below.

Genus *Homalohedra* Patterson & Richardson, 1988

Homalohedra borealis (Loeblich & Tappan, 1954)

Fig. 20O, Fig. 21A, B

Synonym *Oolina borealis* Loeblich & Tappan, 1954 in Hayward et al. (2022)

Diagnostic Features Test free, globular to ovate; length up to 650 µm, width up to 500 µm; unilocular; wall calcareous, hyaline, surface with 6–7 heavy ribs in side view, which extend from a circular ring at the bottom to a collar well below the neck, the ribs then extend very much thinner over the collar to the neck; the aperture is round, terminal on a thick, slightly thinning neck.

Remarks *Homalohedra borealis* differs from ribbed *Oolina* species by carrying a collar without ribs or with very thin ribs.

Abundance and depth range Rare in two samples from 414 m and 566 m depth.

Association with CWCH Rare in two samples from CWCH, overall of no significance.

Homalohedra williamsoni (Alcock, 1865)

Fig. 21D, E

Diagnostic Features

Test free, pyriform, length up to 460 µm, width up to 300 µm; unilocular; wall calcareous, hyaline, surface with 8–11 heavy ribs in side view, which extend slightly twisted from a circular ring at the bottom to a collar well below the neck, the collar carries a reticulate network up to the neck; the aperture is round, terminal on a short smooth neck extending from the collar.

Remarks

A variant of this species in the material shows ribs running spirally in the lower part of the test. It is not interpreted as a new species.

Abundance and depth range

Present to rare in two samples from 414 m and 505 m depth.

Association with CWCH

Present to rare in two samples from CWCH, overall of no significance.

Genus *Oolina* d'Orbigny, 1839 in d'Orbigny (1839b)

Oolina laevigata d'Orbigny, 1839 in d'Orbigny (1839b)

Fig. 21C, F

Diagnostic Features

Test free, ovate, length up to 580 µm, width up to 390 µm; unilocular; wall hyaline, surface smooth; aperture terminal, round, radiate, sitting on a broad, short neck.

Abundance and depth range

Present in sample 14852-1 from a depth of 1310 m only, not in counts.

Association with CWCH

Not associated as only found well below CWCH.

Family GLANDULINIDAE Reuss, 1860

Genus *Glandulina* d'Orbigny, 1839 in d'Orbigny (1839a)

Glandulina ovula d'Orbigny, 1846

Fig. 21G–H, Fig. 36K

Diagnostic Features

Test free, fusiform, in cross section round, length up to 610 µm, width up to 380 µm; uniserial; sutures flush; wall hyaline, surface smooth, initial chamber may carry one or two thick spines; aperture terminal, round, radiate.

Abundance and depth range

Present in sample 14856-1 from a depth of 1119 m only, not in counts.

Association with CWCH

Not associated as only found well below CWCH.

Family POLYMORPHINIDAE d'Orbigny, 1839 in d'Orbigny (1839a)

Genus *Globulina* d'Orbigny, 1839 in d'Orbigny (1839a)

Globulina gibba (d'Orbigny in Deshayes, 1832)

Fig. 21I, J

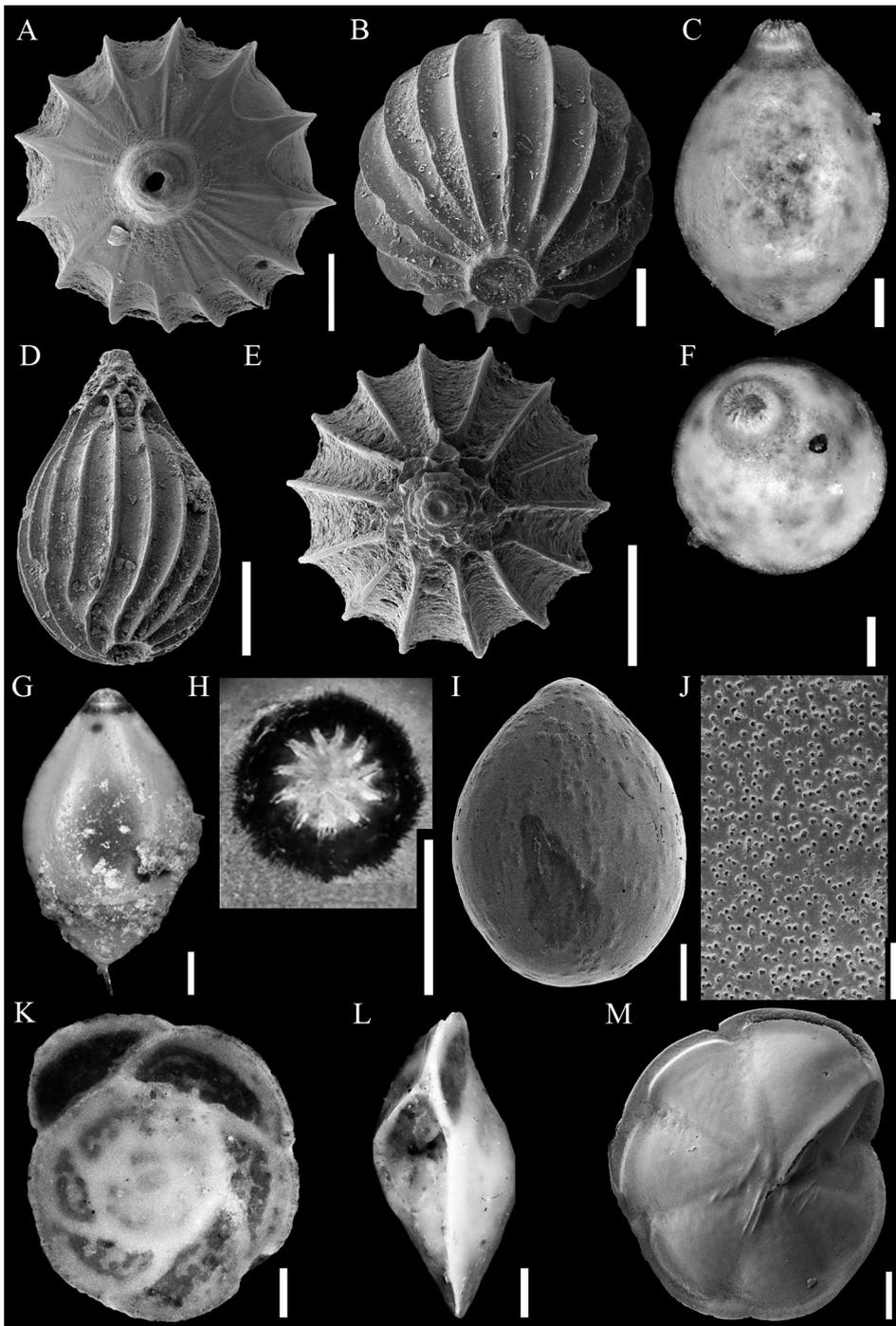


Fig. 21 A, B: *Homalohedra borealis* A: GeoB 14898-1; B: GeoB 14905-1; C, F: *Oolina laevigata* GeoB 14852-1; D, E: *Homalohedra williamsoni* D: GeoB 14898-1; E: GeoB 14898-1; G, H: *Glandulina ovula* GeoB 14856-1; I, J: *Globulina gibba* GeoB 14788-1; K–M: *Hoeglundina elegans* K, L: GeoB 14895-1; M: GeoB 14898-1. Scale bars 100 μm except for J: 10 μm .

Diagnostic Features Test free, globular to ovate, one chamber seen from the outside; polymorphine coiling; wall hyaline, ornamented with scattered pustules sometimes forming a curved line, surface smooth in between and covered by many perforations of 1–3 µm in size; aperture terminal, radiate.

Abundance and depth range Present to occasional in three samples from 30 m to 490 m depth.

Association with CWCH Present only in one sample from CWCH, of no significance. Also found above.

Order ROBERTINIDA Loeblich & Tappan, 1984

Superfamily CERATOBULIMINOIDEA Cushman, 1927 in Cushman (1927a)

Family EPISTOMINIDAE Wedekind, 1937

Genus *Hoeglundina* Brotzen, 1948

Hoeglundina elegans (d'Orbigny, 1826)

Fig. 21K–M

Diagnostic Features Test free, outline in spiral view almost round with a bulge, unequally biconvex, diameter up to 620 µm, thickness up to 340 µm; trochospiral, spiral side evolute, umbilical side involute, chambers on the spiral side trapezoid and becoming crescentic, on the umbilical side triangular; sutures on the spiral side flush and curved backward and on the umbilical side slightly depressed and straight; wall calcareous, hyaline, surface smooth, finely perforate; aperture a long slit running parallel to the periphery on the umbilical side, slit on early chambers may be closed, but still depressed.

Abundance and depth range Present to occasional in four samples from 493 m to 590 m depth.

Association with CWCH Associated as found in four samples from CWCH only.

Superfamily ROBERTINOIDEA Reuss, 1850

Family ROBERTINIDAE Reuss, 1850

Genus *Robertinoides* Höglund, 1947

Robertinoides bradyi (Cushman & Parker, 1936)

Fig. 22A, B, Fig. 36L

Diagnostic Features Test free, fusiform, length up to 410 µm, width up to 300 µm; high trochospiral, chambers inflated, increasing in size, with the last chamber almost comprising half of the whole test; sutures on the umbilical side depressed and curved, initial chamber bluntly pointed; wall calcareous, hyaline, surface smooth, imperforate; aperture two slightly curved slits of different length, the shorter slit extends along the lower margin of the last chamber, the longer slit extends from the lower margin of the last chamber upwards on the apertural face.

Abundance and depth range Rare in sample 14910-2 from a depth of 535 m only, not in counts.

Association with CWCH Rare in one sample of CWCH, of no significance.

Order ROTALIIDA Delage & Hérouard, 1896

Superfamily CASSIDULINOIDEA d'Orbigny, 1839 in d'Orbigny (1839a)

Family BOLIVINITIDAE Cushman, 1927 in Cushman (1927a)

Genus *Abditodentrix* Patterson, 1985

Abditodentrix pseudothalmanni (Boltovskoy & Giussani de Kahn, 1981)

Fig. 22C, D

Diagnostic Features

Test free, small, length up to 220 µm, width up to 120 µm, thickness up to 30 µm; biserial, flattened sides forming almost rectangular edges, outline lapped, margins serrated; sutures flat to slightly depressed; wall calcareous, hyaline, ornamented with a network of curled ridges along the sutures and reticulate smaller ridges in between; aperture at the base of the last chamber, elliptical, with a toothplate.

Abundance and depth range

Present in sample 14856-1 from a depth of 1119 m only, not in counts.

Association with CWCH

Not associated as only found well below CWCH.

Genus *Bolivina* d'Orbigny, 1839 in d'Orbigny (1839a)

Bolivina beyrichi Reuss, 1851

Fig. 22E, F, Fig. 36M

Diagnostic Features

Test free, elongate, length up to 710 µm, width up to 280 µm, thickness up to 160 µm; a spherical initial chamber followed by 8–10 biserially arranged chambers, last two chambers significantly enlarged, outline lanceolate and lobulate, end of the chambers curved backwards and pointed, sometimes carrying a small spine; sutures depressed and curved downward; wall calcareous, hyaline, irregularly finely perforate; aperture terminal, an elongated opening, bordered by a rim.

Remarks

The specimens found do not carry the distinct spines as illustrated by Reuss (1851). He says that chambers may lack a distinct spine and just have a pointed end.

Abundance and depth range

Rare to frequent in four samples from 1119 m to 1310 m depth and rare in one sample from 510 m depth.

Association with CWCH

Rare in one sample from CWCH only, of no significance. Found more frequently below.

Bolivina earlandi Parr, 1950

Fig. 22G, H

Diagnostic Features

Test free, elongate, slender, length up to 450 µm, width up to 110 µm; biserial; wall calcareous, hyaline, surface smooth, perforate with the pores concentrated in the lower part of each chamber and towards the periphery, leaving areas especially around the line connecting the chamber pairs free of pores; aperture at the base of the last chamber, subterminal, slit.

Abundance and depth range

Present in three samples from 111 m, 505 m and 535 m depth, the latter one not in counts.

Association with CWCH

Present in two samples from CWCH, of no significance.

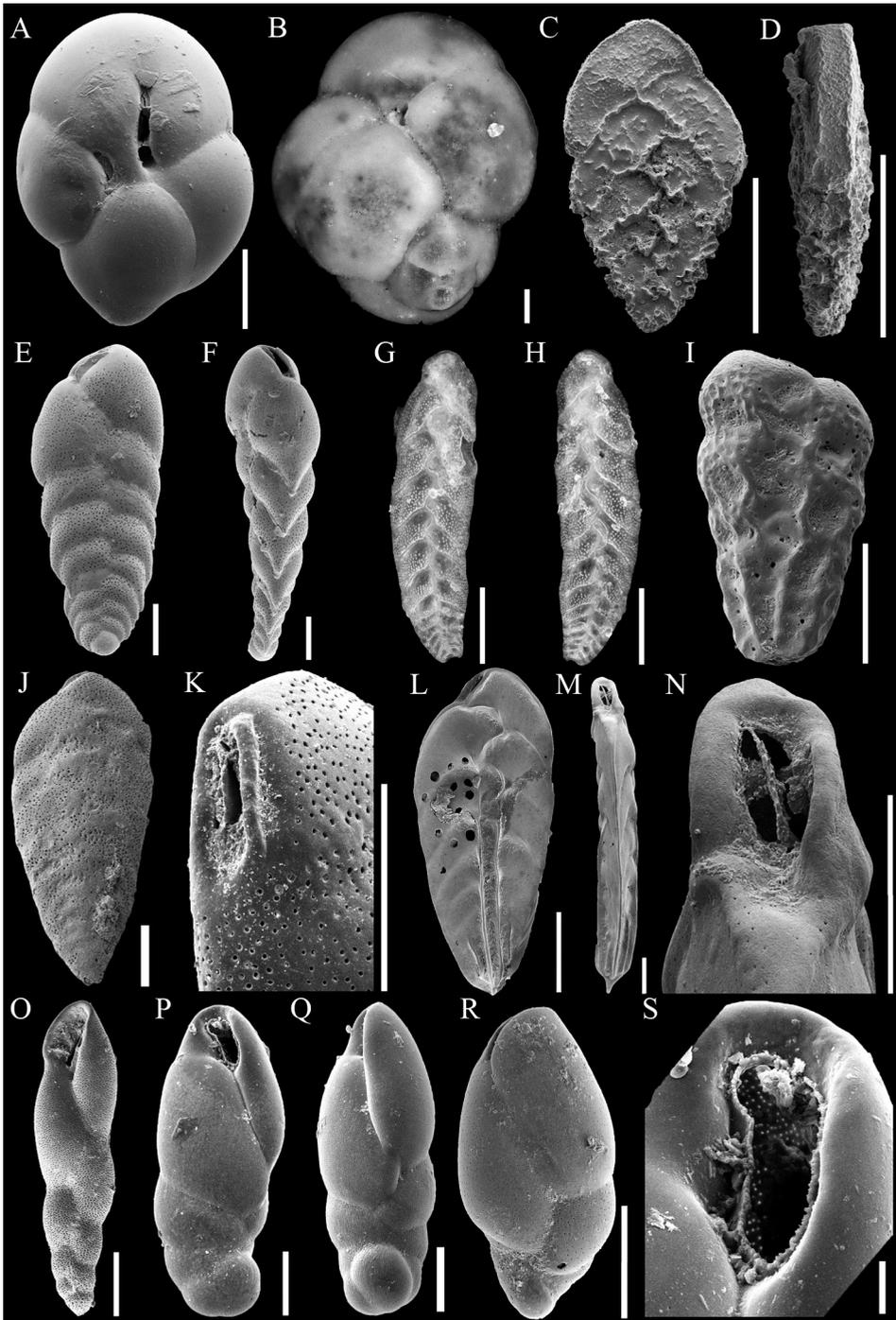


Fig. 22 A, B: *Robertinoides bradyi* A: GeoB 14910-2; B: GeoB 14910-2; C, D: *Abditodentrix pseudothalmanni* GeoB 14856-1; E, F: *Bolivina beyrichi* E: GeoB 14856-1; F: GeoB 14856-1; G, H: *Bolivina earlandi* GeoB 14910-2; I: *Bolivina pseudoplicata* GeoB 14910-2; J, K: *Bolivina spathulata* GeoB 14703-1; L–N: *Bolivina subaenariensis* L: GeoB 14910-2; M, N: GeoB 14910-2; O: *Fursenkoina complanata* GeoB 14910-2; P–S: *Rutherfordoides rotundiformis* P, Q, S: GeoB 14854-1; R: GeoB 14854-1. Scale bars 100 μ m except for S: 20 μ m.

Bolivina pseudoplicata Heron-Allen & Earland, 1930

Fig. 22I

Diagnostic Features Test free, elongate, small, length up to 270 µm, width up to 120 µm, thickness up to 59 µm; biserial; wall calcareous, hyaline, surface rough, with scattered pores, 4–5 raised, zigzagging costae running parallel over the whole test, sutures with raised ridges, parts of the test covered with ridges forming a network; aperture terminal, with a small rim and tooth plate.

Abundance and depth range Present in sample GeoB 14910-2 from 535 m depth only.

Association with CWCH Present in one sample from CWCH only, of no significance.

Bolivina spathulata (Williamson, 1858)

Fig. 22J, K

Diagnostic Features Test free, elongate, lanceolate, length up to 560 µm, width up to 230 µm; biserial; wall calcareous, hyaline, surface smooth, with perforations, which are unevenly distributed and tend to concentrate around the sutures and towards the periphery, some areas are free of perforations; sutures slightly depressed and slightly curved backwards; aperture at the base of the last chamber, subterminal, broad elongate opening with a small rim and tooth plate.

Abundance and depth range Present to rare in four samples from 91 m and 505 m depth.

Association with CWCH Present in one sample from CWCH only, of no significance.

Bolivina subaenariensis Cushman, 1922 in Cushman (1922a)

Fig. 22L–N, Fig. 37A

Diagnostic Features Test free, elongate, length up to 810 µm, width up to 310 µm, thickness up to 125 µm, much compressed; initial chamber with a spine, followed by up to eight biserially arranged chambers, chambers curved, widest near the centre, periphery bordered by a double keel which merges in the middle; wall calcareous, hyaline, finely perforate, surface smooth, with up to five raised costae on the initial part, of which two run to the top, sutures thickened, curved backwards; aperture terminal, an elongated, oval opening, bordered by a lip, which runs into the aperture to form a tooth plate, on one side the lip merges with one side of the keel, whereas on the other side, both run parallel.

Abundance and depth range Rare to frequent in six samples ranging from 486 m to 577 m depth, present in one sample from 1196 m depth.

Association with CWCH Closely associated as found rare to frequent in six samples from CWCH. Only present in one more sample from 1196 m depth.

Genus *Fursenkoina* Loeblich & Tappan, 1961*Fursenkoina complanata* (Egger, 1893)

Fig. 22O

Diagnostic Features

Test free, small, elongate, slender, periphery lobulate, length up to 480 µm, width up to 120 µm; biserial, alternately arranged, chambers elongate, increasing rapidly in size; sutures depressed, initial chamber may carry a spine; wall calcareous, hyaline, finely perforate throughout; aperture at the base of the last chamber, elongated oval opening, boarded by a rim running in a broad loop into the aperture.

Abundance and depth range

Present to rare in two samples from 1252 m and 535 m depth, the latter one not in counts.

Association with CWCH

Present in one sample from CWCH only, of no significance.

Genus *Rutherfordoides* McCulloch, 1981*Rutherfordoides rotundiformis* (McCulloch, 1977)

Fig. 22P–S

Diagnostic Features

Test free, length up to 440 µm, width up to 190 µm, thickness up to 110 µm; biserial, initial part angled, then chambers arranged in a curved line, increasing rapidly in size, last chambers inflated, covering two thirds of the whole test; sutures depressed; wall calcareous, hyaline, finely perforate throughout except for the apertural face, some pores elongated especially on the initial chamber; aperture at the base and inner face of the last chamber, elongated oval opening, boarded by a small rim, built by the inner lining of the aperture bending out.

Abundance and depth range

Rare to occasional in three samples from 1119 m to 1252 m depth.

Association with CWCH

Not associated as only found in samples below CWCH.

Rutherfordoides sp.

Fig. 23A–C

Diagnostic Features

Test free, length up to 620 µm, width up to 260 µm; biserial, chambers arranged in a curved line, increasing rapidly in size, last chambers inflated, covering 75 % of the whole test; sutures depressed; wall calcareous, hyaline, finely perforate throughout; aperture at the base and inner face of the last chamber, elongated oval opening.

Remarks

This species differs from *Rutherfordoides rotundiformis* by being bigger and lacking the initial, angled chamber arrangement.

Abundance and depth range

Present in sample GeoB 14854-1 from 1196 m depth.

Association with CWCH

Not associated as only found in one sample below CWCH.

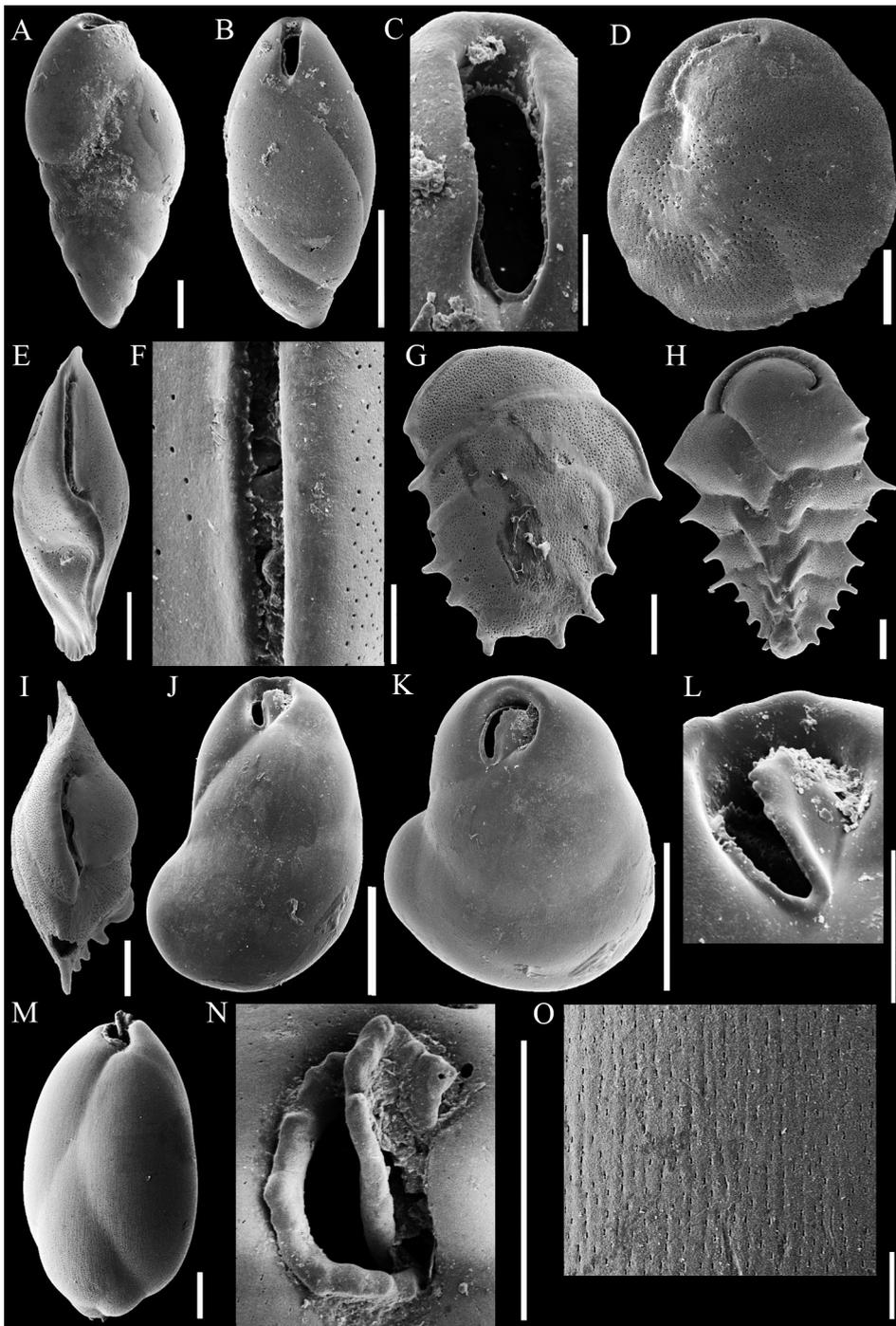


Fig. 23 A–C: *Rutherfordoides* sp. A: GeoB 14854-1; B, C: GeoB 14854-1; D–F: *Cassidulina laevigata* D: GeoB 14856-1; E, F: GeoB 14898-1; G–I: *Ehrenbergina serrata* G: GeoB 14898-1; H: GeoB 14910-2; I: GeoB 14910-2; J–L: *Evolvocassidulina bradyi* J–L: GeoB 14898-1; M–O: *Globulimina doliolum* M: GeoB 14704-1; N, O: GeoB 14856-1. Scale bars 100 μm except for C, F, L, O: 20 μm .

Family CASSIDULINIDAE d'Orbigny, 1839 in d'Orbigny (1839a)

Genus *Cassidulina* d'Orbigny 1826

Cassidulina laevigata d'Orbigny, 1826

Fig. 23D–F

Diagnostic Features Test free, nearly circular in outline, diameter up to 390 µm; biserial with the plane of biseriality planispirally enrolled, periphery lobulate, keeled, chambers strongly curved, in side view with almost parallel sutures; sutures slightly depressed and curved; wall calcareous, hyaline, finely perforate, surface smooth; aperture a slit running for some distance parallel to the terminal edge, partly covered by an elongated flap.

Abundance and depth range Rare to frequent in three samples from 91 m to 142 m depth and present to rare in four samples from 505 m to 1196 m depth.

Association with CWCH Present in one sample from CWCH, of no significance.

Genus *Ehrenbergina* Reuss, 1850

Ehrenbergina serrata Reuss, 1850

Fig. 23G–I, Fig. 37B

Diagnostic Features Test free, length up to 770 µm, width up to 520 µm; biserial, last chambers inflated, test triangular in outline with a rounded upper side, periphery carinate with strong spines, lenticular in section, sutures on dorsal side curved, thickened, not depressed; sutures on umbilical side straight, depressed; wall calcareous, hyaline, finely perforate on both sides; aperture a slit running with some distance parallel to the terminal edge, the lower rim bordered by a thin lip.

Remarks The species differs from *Ehrenbergina trigona* Goës, 1896 by being much flatter and lenticular in end view.

Abundance and depth range Present to frequent in five samples from 505 m to 590 m depth.

Association with CWCH Closely associated as only found in samples from CWCH with an overall significant share.

Genus *Evolvocassidulina* Eade, 1967

Evolvocassidulina bradyi (Brady, 1881)

Fig. 23J–L

Diagnostic Features Test free, pyriform, length up to 290 µm, width up to 200 µm; biserial, last chambers inflated; sutures on dorsal side curved, thickened, not depressed, curved and flush; wall calcareous, hyaline, finely perforated; aperture subterminal, half round with a looped and sigmoid toothplate, which runs into the aperture. Toothplate with a serrated to notched margin.

Abundance and depth range Present in sample GeoB 14898-1 from 505 m depth only, not in counts.

Association with CWCH Present in one sample from CWCH only, of no significance.

Family GLOBOBULIMINIDAE Hofker, 1956

Genus *Globobulimina* Cushman, 1927 in Cushman (1927a)

Globobulimina doliolum (Terquem & Terquem, 1886)

Fig. 23M–O

Diagnostic Features Test free, ovate in outline, oval in section, length up to 650 µm, width up to 380 µm, broadest in the lower part of the test; triserial, chambers inflated, last three chambers overlapping almost completely previous ones; sutures depressed; wall calcareous, hyaline, smooth and covered with minute, elongated perforations which are irregularly aligned; aperture an oval opening extending from the base of the last chamber up the face, with a looped and sigmoid toothplate, a lip on one side.

Abundance and depth range Rare to occasional in two samples from 1119 m to 1196 m depth, present in one sample from 486 m depth, not in counts.

Association with CWCH Present in one sample from CWCH, of no significance.

Globobulimina turgida (Bailey, 1851)

Fig. 24A–D

Diagnostic Features Test free, ovate in outline, oval in section, length up to 910 µm, width up to 600 µm, broadest in the lower part of the test; triserial, chambers inflated, last three chambers overlapping almost completely previous ones; sutures slightly depressed; wall calcareous, hyaline, smooth and covered with minute perforations, which in some parts are aligned, forming shallow grooves, about 5 initial small spines; aperture an oval opening extending from the base of the last chamber up the face, with a looped and sigmoid toothplate.

Abundance and depth range Rare to frequent in eleven samples from 414 m to 590 m depth, rare in three samples from 1119 m to 1310 m depth, present in sample GeoB 14704-1 from 246 m depth.

Association with CWCH Occasional and of importance overall in samples from CWCH. Found in significantly lower numbers below and above.

Family SPHAEROIDINIDAE Cushman, 1927 in Cushman (1927b)

Genus *Sphaeroidina* d'Orbigny, 1826

Sphaeroidina bulloides d'Orbigny in Deshayes, 1828

Fig. 24E–G

Diagnostic Features Test free, subglobular, length up to 680 µm, width up to 560 µm; trochospiral, chambers inflated, increasing in size and strongly embracing, last chamber covering almost half of

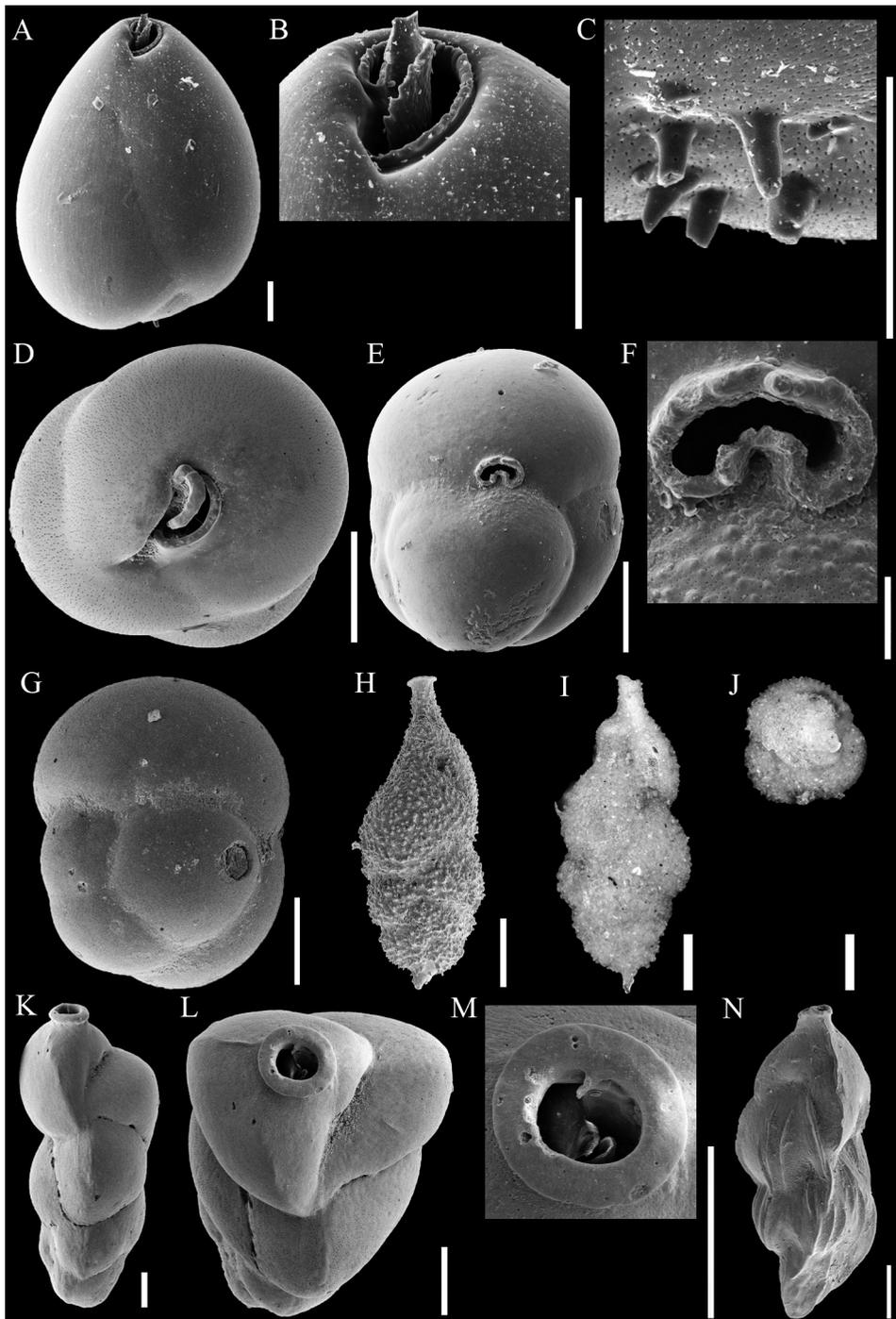


Fig. 24 A–D: *Globobulimina turgida* A–C: GeoB 14910-2; D: GeoB 14704-1; E–G: *Sphaeroidina bulloides* E, F: GeoB 14898-1; G: GeoB 14853-1; H–J: *Siphonigerina proboscidea* H: GeoB 14898-1; I, J: GeoB 14865-1; K–M: *Trifarina albatrossi* GeoB 14895-1; N: *Trifarina angulosa* GeoB 14898-1. Scale bars 100 μm except for F: 20 μm.

the test; wall calcareous, hyaline, smooth except for flat pustules below the aperture and along some sutures, finely perforate; sutures depressed; wall calcareous, hyaline; aperture crescentic, at the base of the last chamber, with a lip and flap-like tooth.

Abundance and depth range

Present to occasional in six samples from 493 m to 1196 m depth.

Association with CWCH

Present to rare in three samples from CWCH, overall of no significance. Found in greater numbers below.

Family UVIGERINIDAE Haeckel, 1894

Genus *Siphouvigerina* Parr, 1950

Siphouvigerina proboscidea (Schwager, 1866)

Fig. 24H–J

Diagnostic Features

Test free, elongate, amphora like, in section lapped round, length up to 580 µm, width up to 260 µm; triserial, botryoid chamber arrangement, test widest in the middle, lower end round, chambers becoming more elongated; wall calcareous, hyaline, hispid, densely covered with short dots and spines, initial chamber with a pronounced spine; aperture terminal, round, on a long, broad neck rising from the elongated last chamber.

Abundance and depth range

Present in sample GeoB 14898-1 from 505 m depth only.

Association with CWCH

Present in one sample from CWCH, of no significance.

Genus *Trifarina* Cushman, 1923

Trifarina albatrossi (Cushman, 1932) in Cushman (1932b)

Fig. 24K–M

Diagnostic Features

Test free, elongate, length up to 810 µm, width up to 330 µm; triserial, botryoid chamber arrangement, test widest below the middle, becoming slender and irregularly uniserial towards the last chambers; wall calcareous, hyaline, few scattered pores, surface smooth, with flat pustules all over, except for the upper part of the last chamber; aperture terminal, round, at the end of a narrowing chamber, on a short, central neck, surrounded by a thick lip. The found specimens lack a tooth or toothplate.

Abundance and depth range

Frequent in sample GeoB 14704-1 from 246 m depth. Present in two samples from 450 m and 577 m depth.

Association with CWCH

Present in two samples from CWCH. Of no significance.

Trifarina angulosa (Williamson, 1858)

Fig. 24N

Diagnostic Features

Test free, elongate, triangular in section, length up to 610 µm, width up to 290 µm; triserial, test widest in the middle, becoming slender and irregularly uniserial towards the last chambers, angles carinate, sutures curved; wall calcareous, hyaline, densely perforate

with small pores, few longitudinal costae; aperture terminal, oval to round, at the end of a narrowing chamber, on a short, central neck.

Abundance and depth range

Present to occasional in three samples from 414 m to 577 m depth.

Association with CWCH

Associated as only found in CWCH.

Trifarina fornasinii (Selli, 1948)

Fig. 25A–C

Synonym

Trifarina fornasini (Selli, 1948) in Spezzaferri et al. (2015), p. 80, pl. 24, figs. 8a–b.

Diagnostic Features

Test free, stout, length up to 770 µm, width up to 450 µm; triserial; wall calcareous, hyaline, few scattered pores, surface smooth, with flat irregularly arranged elevations and ridges, three carinate margins on the last two to three chambers; aperture terminal, round, on a very short, central neck, surrounded by a thick and wide collar. The specimens found lack a tooth or toothplate.

Remarks

The species differs from *Trifarina reussii* (Cushman, 1913) by lacking carinate margins extending over the whole test and lacking initial spines.

Abundance and depth range

Rare in four samples from 246 m to 577 m depth.

Association with CWCH

Rare in three samples from CWCH. Also found above.

Genus *Uvigerina* d'Orbigny 1826

Uvigerina hispida Schwager, 1866

Fig. 25D–F

Synonym

Siphouvigerina hispida (Schwager, 1866) in Hayward et al. (2022).

Diagnostic Features

Test free, elongate, length up to 580 µm, width up to 230 µm; triserial, botryoid chamber arrangement, test widest below the middle, becoming slender and irregularly uniserial towards the last chambers; wall calcareous, hyaline, heavily hispid all over except for the last chamber which is less hispid, at least last chamber perforate; aperture terminal, round, at the end of the last chamber which becomes slender and extends into a neck, aperture surrounded by a thin lip.

Abundance and depth range

Occasional in sample GeoB 14910-2 from 535 m depth, rare in sample GeoB 14853-1 from 1252 m depth.

Association with CWCH

Occasional in one sample from CWCH, overall of no significance. Also found below.

Uvigerina mediterranea Hofker, 1932

Fig. 25G, H

Diagnostic Features	Test free, elongate, oval in outline, almost round in section, length up to 820 µm, width up to 410 µm; triserial, botryoid chamber arrangement, test widest in the middle, lower end round; sutures depressed; wall calcareous, hyaline, finely and densely perforate, chambers ornamented with widely separated costae; aperture terminal, round, on a neck surrounded by a lip.
Abundance and depth range	Rare to occasional in three samples from 505 m to 577 m depth and in two samples from 1119 m and 1196 m depth.
Association with CWCH	Rare to occasional in three samples from CWCH. Also found below.

Uvigerina peregrina Cushman 1923

Fig. 25I

Diagnostic Features	Test free, elongate, oval in outline, almost round in section, length up to 520 µm, width up to 310 µm; triserial, botryoid chamber arrangement, test widest in the middle, lower end round; sutures depressed; wall calcareous, hyaline, perforate, except for the last chamber ornamented with longitudinal serrated costae interrupted at the sutures, short spines or dots between the costae, frequent longer spines on the last chamber and neck; aperture terminal, round, on a short, central neck surrounded by a lip or without.
Remarks	The species identification is based upon Schönfeld (2006).
Abundance and depth range	Present to dominant in seven samples from 414 m to 590 m depth. Rare to occasional in three samples from 1119 m to 1310 m depth, rare in two samples from 91 m to 246 m depth.
Association with CWCH	Of importance in CWCH. Also found in lower numbers below and above.

Uvigerina pygmaea d'Orbigny 1826

Fig. 25J, K, Fig. 37C

Diagnostic Features	Test free, elongate, oval in outline, almost round in section, length up to 560 µm, width up to 320 µm; triserial, botryoid chamber arrangement, test widest below the last chamber, lower end round; wall calcareous, hyaline, perforate, ornamented with fine, longitudinal costae except for the initial part and last chamber which carry dots and short spines; aperture terminal, round, on a short, central neck. The specimens found lack a lip and toothplate, which may be due to bad preservation.
Remarks	The species identification is based upon Schönfeld (2006).
Abundance and depth range	Rare in one sample from GeoB 14910-2 from 535 m depth.
Association with CWCH	Rare in one sample from CWCH, overall of no significance.

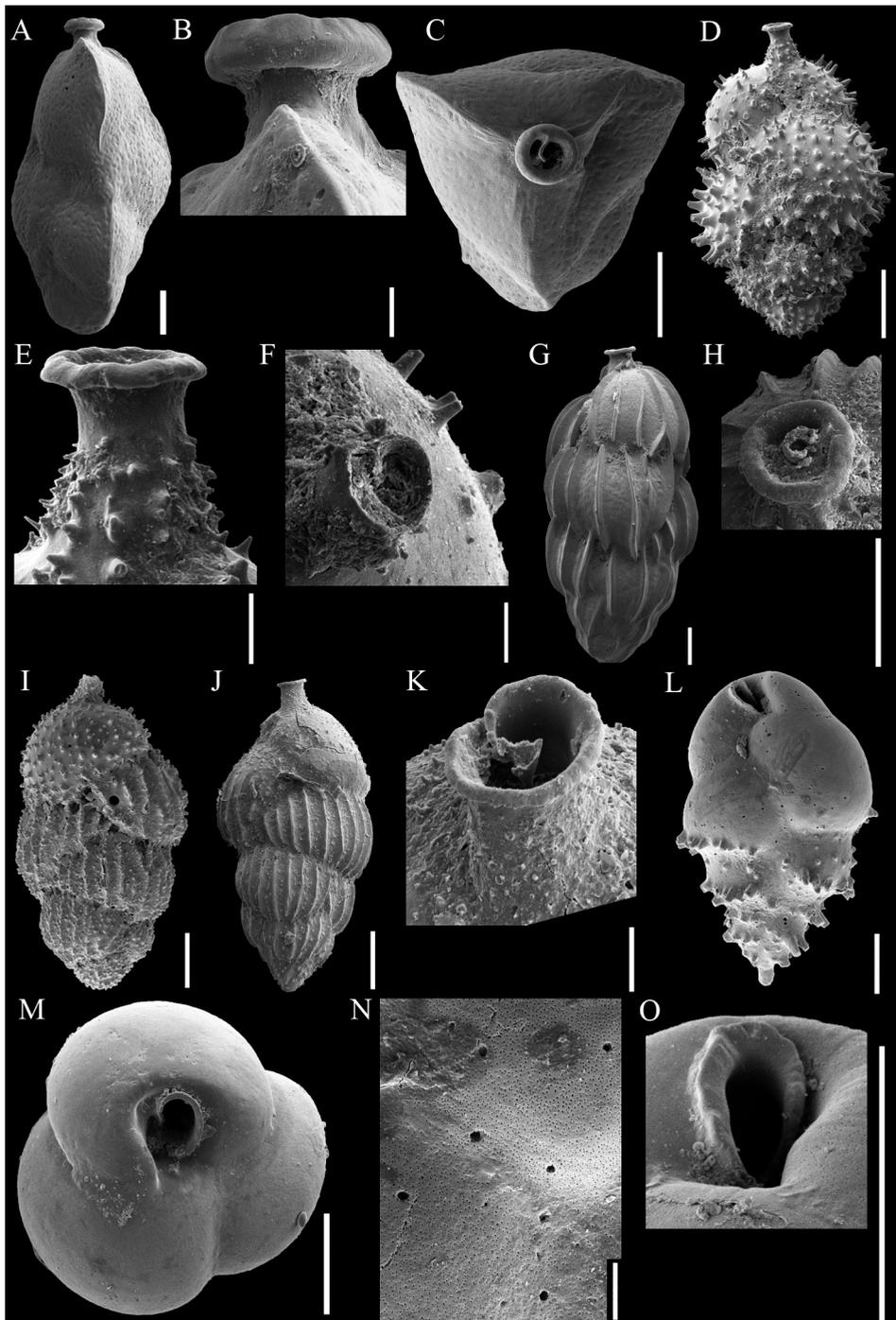


Fig. 25 A–C: *Trifarina fornasinii* A, B: GeoB 14898-1; C: GeoB 14898-1; D–F: *Uvigerina hispida* D, E: GeoB 14853-1; F: GeoB 14853-1; G, H: *Uvigerina mediterranea* G: GeoB 14898-1; H: GeoB 14898-1; I: *Uvigerina peregrina* GeoB 14898-1; J, K: *Uvigerina pygmaea* GeoB 14910-2; L–O: *Bulimina aculeata* L, N: GeoB 14898-1; M: GeoB 14898-1; O: GeoB 14910-2. Scale bars 100 μm except for B, E, F, K, N: 20 μm .

Superfamily BULIMINOIDEA Jones, 1875

Family BULIMINIDAE Jones, 1875

Genus *Bulimina* d'Orbigny 1826

Bulimina aculeata d'Orbigny 1826

Fig. 25L–O

Diagnostic Features Test free, elongate ovate, length up to 750 µm, width up to 380 µm; triserial, last chambers rapidly increasing in size, last 3 chambers inflated and globular, lowest part of the chambers ornamented with irregular rows of short tubercles and longer spines; sutures depressed; wall calcareous, hyaline, smooth and covered with minute perforations; aperture an oval opening extending from the base of the last chamber up the face, with a looped toothplate.

Abundance and depth range Present to rare in four samples from 1119 m to 1310 m depth. Present in two samples from 505 m and 535 m depth.

Association with CWCH Present in two samples from CWCH, overall of no significance.

Bulimina marginata d'Orbigny 1826

Fig. 26A, B

Diagnostic Features Test free, elongate ovate, length up to 530 µm, width up to 290 µm; triserial, last chambers rapidly increasing in size, last 3 chambers inflated, chambers sharply angled with spines in a row at the angle margin; sutures depressed; wall calcareous, hyaline, smooth and covered with minute perforations; aperture an oval opening extending from the base of the last chamber up the face, with a looped toothplate.

Abundance and depth range Present to rare in four samples from 486 m to 1252 m depth.

Association with CWCH Present in two samples from CWCH, overall of no significance.

Bulimina striata d'Orbigny in Guérin-Méneville, 1832

Fig. 26C, D

Diagnostic Features Test free, elongate ovate, length up to 650 µm, width up to 480 µm; triserial, last chambers rapidly increasing in size, last 3 chambers inflated, chambers overlapping; sutures depressed; wall calcareous, hyaline, covered with pores, last 3 chambers are ornamented with small ribs, running together into costae and ending in spines, first chambers obscured and ornamented with spines; aperture an oval opening extending from the base of the last chamber up the face, with a looped toothplate.

Abundance and depth range Present to rare in three samples from 505 m to 1196 m depth.

Association with CWCH Present in one sample from CWCH, of no significance.

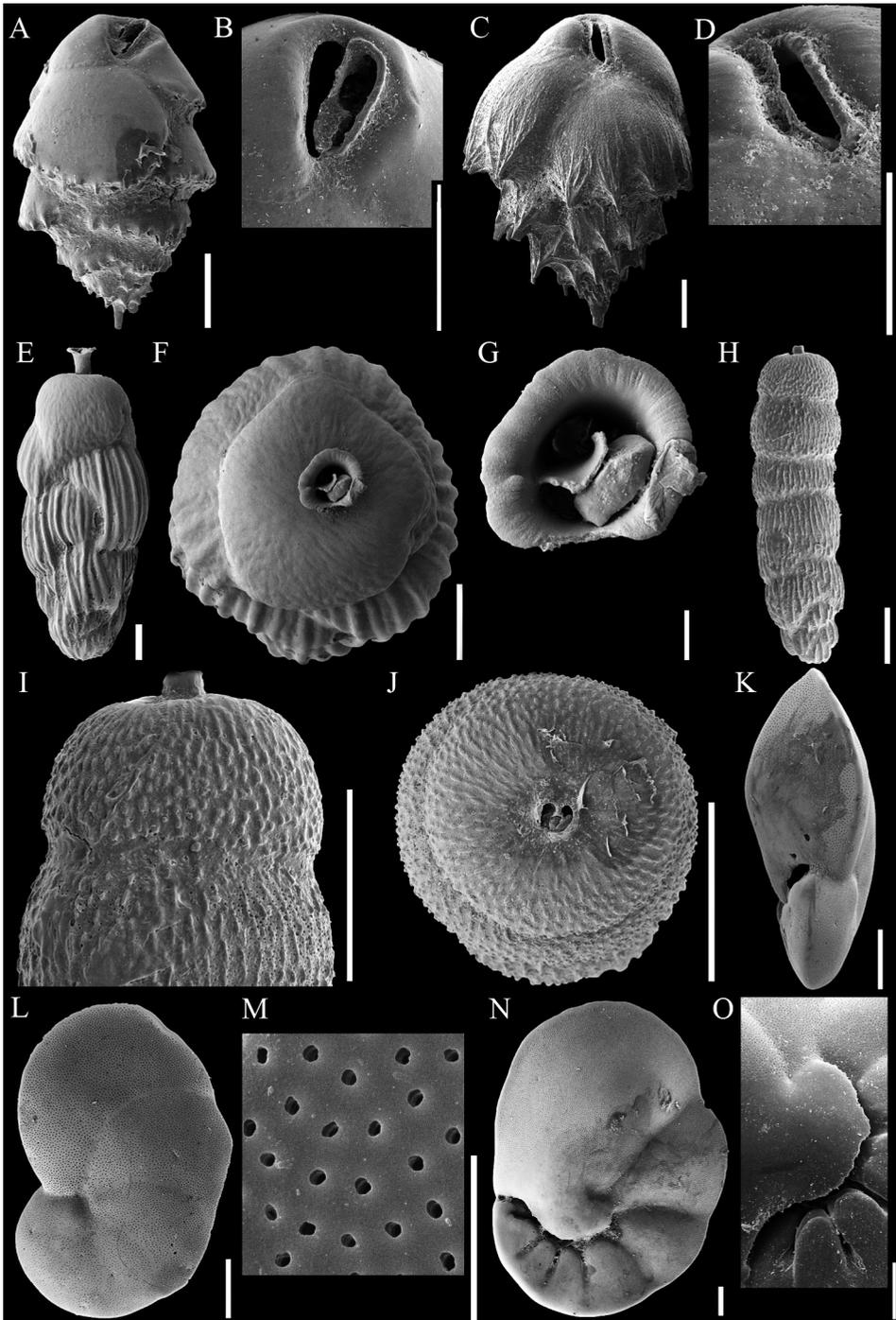


Fig. 26 A, B: *Bulimina marginata* GeoB 14854-1; C, D: *Bulimina striata* GeoB 14854-1; E-G: *Rectuvigerina elongatastriata* GeoB 14898-1; H-J: *Rectuvigerina nicoli* H, I: GeoB 14898-1; J: GeoB 14898-1; K-O: *Cancris auriculus* K, L: GeoB 14898-1; M: GeoB 14889-1; N: GeoB 14889-1; O: GeoB 14889-1. Scale bars 100 μ m except for G, M: 20 μ m.

Family SIPHOGENERINOIDIDAE Saidova, 1981

Genus *Rectuvigerina* Mathews, 1945

Rectuvigerina elongatastriata (Colom, 1952)

Fig. 26E–G

Diagnostic Features

Test free, elongate, cylindrical outline, round in section, length up to 980 µm, width up to 370 µm; triserial, chambers gradually increasing in size, at least last chambers wider than high; sutures depressed and curved, some chambers have a hook-shaped extension, which extends over a previous chamber; wall calcareous, hyaline, densely perforate, ornamented with longitudinal striae, most interrupted at the sutures and with short striae in between; aperture terminal, round, on a pronounced, central neck, surrounded by a lip.

Abundance and depth range

Present to rare in three samples from 505 m to 1252 m depth.

Association with CWCH

Present in one sample and rare in another sample from CWCH, overall of no significance.

Rectuvigerina nicoli Mathews, 1945

Fig. 26H–J

Diagnostic Features

Test free, elongate, cylindrical outline, round in section, length up to 510 µm, width up to 140 µm; initial triserial part becoming biserial and for most of the test uniserial; sutures depressed, in the uniserial part horizontal, in the lower parts curved backwards; wall calcareous, hyaline, densely perforate, ornamented with longitudinal striae, most interrupted at the sutures and with short striae in between; aperture terminal, round, on a pronounced, central neck, surrounded by a lip.

Abundance and depth range

Rare in sample GeoB 14898-1 from 505 m depth, not in counts.

Association with CWCH

Rare in one sample from CWCH, of no significance.

Superfamily DISCORBOIDEA Ehrenberg, 1838

Family CANCRISIDAE Chapman, Parr & Collins, 1934

Genus *Cancris* Montfort, 1808

Cancris auriculus (Fichtel & Moll, 1798)

Fig. 26K–O, Fig. 37D

Synonym

Cancris auricula (Fichtel & Moll 1798) in Hayward et al. (2022).

Diagnostic Features

Test free, outline ovate to auriculate, length up to 1030 µm, width up to 620 µm; trochospiral, uncoiling in a flared spire, chambers increasing rapidly in width and to a lesser extent in length, chambers on the umbilical side inflated, periphery with a small carina; sutures on the spiral side arched, slightly depressed, curved backward towards the periphery, sutures on the umbilical side significantly depressed, radial, slightly curved; wall calcareous, hyaline, densely and finely perforate, except for an area on the umbilical side around

the coiling axis; aperture a slit on the umbilical side at the base of the last chamber, covered by a broad flap.

Abundance and depth range	Present to occasional in eleven samples from 414 m to 590 m depth, rare to occasional in three samples from 30 m to 246 m depth.
Association with CWCH	Closely associated as found in eleven samples from CWCH, also found in fewer numbers above.

Cancris carinatus (Millett, 1904)

Fig. 27A–C

Diagnostic Features Test free, outline ovate to round, length up to 850 µm, width up to 690 µm; trochospiral, uncoiling in a flared spire, chambers increasing rapidly in width and to a lesser extent in length, chambers on the umbilical side inflated, periphery with a well developed carina; sutures on the spiral side arched, slightly depressed, curved backward towards the periphery, sutures on the umbilical side significantly depressed, radial, slightly curved; wall calcareous, hyaline, densely and finely perforate, except for an area on the umbilical side around the coiling axis; aperture a slit on the umbilical side at the base of the last chamber, covered by a broad flap.

Remarks It differs from *Cancris auriculus* by being less elongate and almost as wide as high, carrying a pronounced carina and the last chamber being strongly inflated.

Abundance and depth range Present in two samples from 30 m and 111 m depth. Not in counts.

Association with CWCH Not associated as only found well above CWCH.

Family EPONIDIDAE Hofker, 1951

Genus *Eponides* Montfort, 1808

Eponides repandus (Fichtel & Moll, 1798)

Fig. 27D–F

Diagnostic Features Test free, biconvex, high convex on the umbilical side, outline ovate with the last chamber pointed, length up to 810 µm, width up to 640 µm; trochospiral, chambers on the spiral side crescentic, on the umbilical side triangular; sutures raised and curved, on the spiral side more thickened, periphery keeled; wall calcareous, hyaline, between the sutures densely and finely perforate; aperture a broad interiomarginal arch extending from the umbilicus to the periphery, apertural face with additional areal round openings.

Abundance and depth range Frequent in one sample from 14 m and rare in one sample from 30 m depth. Present in one sample from 111 m depth, not in counts.

Association with CWCH Not associated as only found well above CWCH.

Family MISSISSIPPINIDAE Saidova, 1981

Genus *Stomatorbina* Dorreen, 1948

Stomatorbina concentrica (Parker & Jones, 1864) in Brady (1864).

Fig. 27G–I, Fig. 37F

Diagnostic Features

Test free, outline oval, low biconvex, diameter up to 980 µm, width up to 860 µm; trochospiral, about five to nine chambers in the last whorl; sutures on the spiral side much thickened and raised, merging into a broad round keel, sutures on the umbilical side deeply depressed, umbilicus wide and broad, covered partly by triangular flaps; wall calcareous, hyaline; aperture a slit running from the umbilicus to the periphery along the lower margins of the last chambers, partly covered by flaps, at its end before the periphery bordered by lip which extends into a flap.

Abundance and depth range

Present to rare in three samples from 414 m to 493 m depth.

Association with CWCH

Associated as found in three samples from CWCH only, overall of no significance.

Family ROSALINIDAE Reiss, 1963

Genus *Hyrrokkin* Cedhagen, 1994

Hyrrokkin sarcophaga Cedhagen, 1994

Fig. 27J–L, Fig. 37H

Synonyms

Discanomalina coronata (Parker & Jones, 1865) in Reymond et al. (2014) p. 80, pl. 4, figs. 5–6.

Hyrrokkin sarcophaga Cedhagen, 1994 in Westphal et al. (2014) p. 46, pl. 6.6.3, fig. C.1.

Diagnostic Features

Test large, commonly attached, convex on the spiral side, concave or flat on the umbilical side, outline oval, lobulate, length up to 1350 µm, thickness up to 390 µm; shallow trochospiral, chambers elongated, curved and differing in form, sutures flush and later slightly depressed, irregularly curved; wall calcareous, hyaline, imperforate; primary aperture a slit extending from the umbilicus to the periphery along the margin of the last chamber, part at the periphery arched, several additional apertures around the umbilical area.

Remarks

The species differs from *Hyrrokkin carnivora* (Todd, 1965) by having U-shaped rather than V-shaped sutures on the umbilical side, by having a smoother surface around the umbilical area and by lacking ridges on the chambers around the umbilical area, perpendicular to the sutures. Furthermore the test is thicker than in *Hyrrokkin carnivora*. *H. sarcophaga* is reported to be a parasite which feeds on cold-water corals and other prey (Beuck et al., 2008).

Abundance and depth range

Present to frequent in 14 samples from 414 m to 590 m depth. Rare in one sample from 30 m depth.

Association with CWCH

Closely associated and a widespread, important species in CWCH. It is never dominant

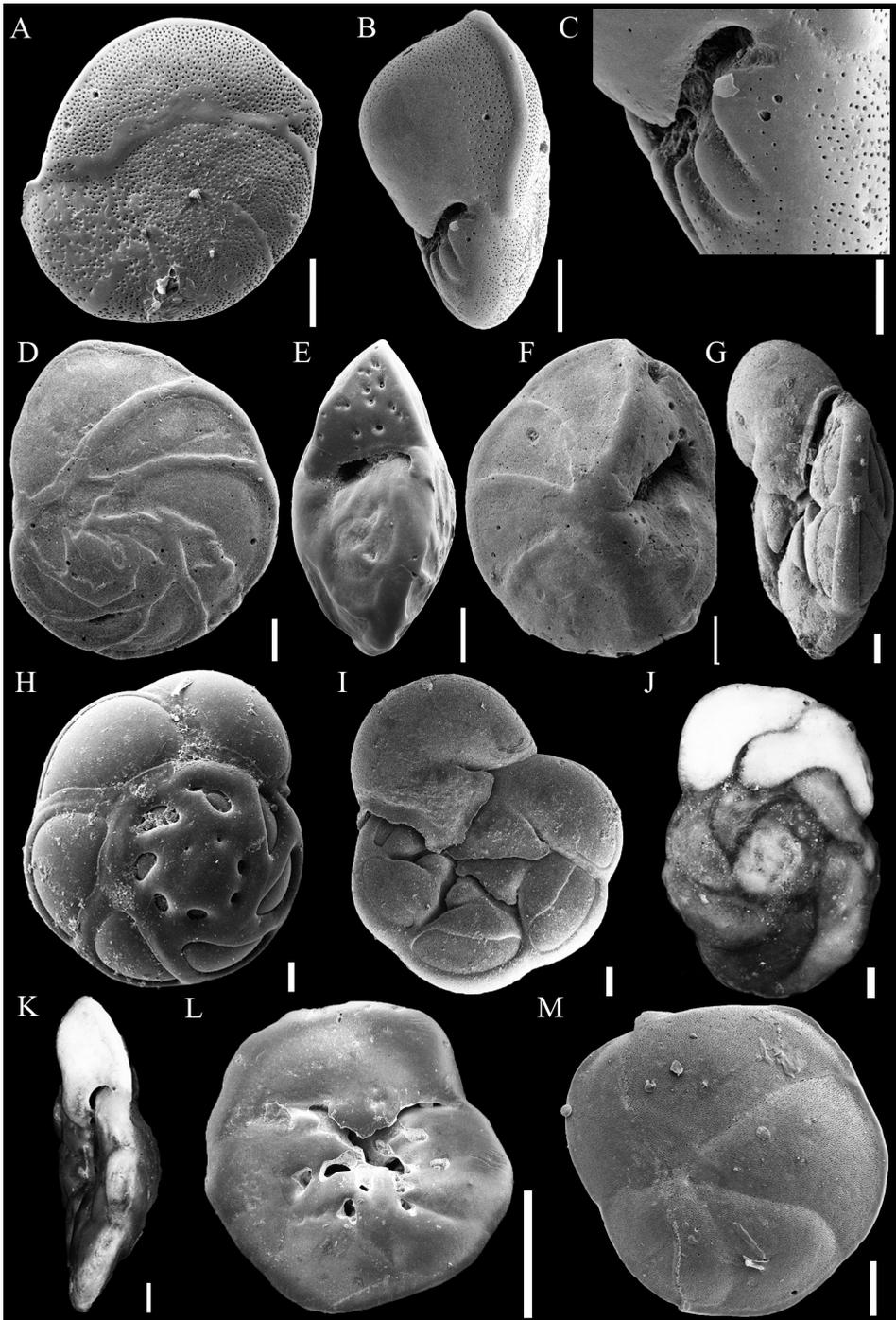


Fig. 27 A–C: *Cancris carinatus* A, B: GeoB 14703-1; C: GeoB 14788-1; D–F: *Eponides repandus* D: GeoB 14703-1; E: GeoB 14788-1; F: GeoB 14703-1; G–I: *Stomatorbina concentrica* G, H: GeoB 14905-1; I: GeoB 14905-1; J–L: *Hyrrokkin sarcophaga* J, K: GeoB 14903-1; L: GeoB 14903-1; M: *Planodiscorbis rarescens* GeoB 14704-1. Scale bars 100 μm except for C: 50 μm , L: 500 μm .

and its share does not exceed 8,5 %. Also found above.

Genus *Planodiscorbis* Bermúdez, 1952

Planodiscorbis rarescens (Brady, 1884)

Fig. 27M, Fig. 28A, B

Diagnostic Features

Test commonly attached, outline rectangular with widely rounded edges, planoconvex, flat on the spiral side, length up to 610 µm, width up to 540 µm, thickness up to 180 µm; low trochospiral, chamber arrangement on the spiral side evolute except for the last chambers overlapping previous ones by a broad plate, on the umbilical side involute, chambers increasing rapidly in size, on the spiral side crescentic, on the umbilical side triangular; sutures on the spiral side flush, on the umbilical side depressed, sutures thickened and merging at the periphery into a carina; wall calcareous, hyaline, finely perforate all over; aperture an interiomarginal arch on the spiral side.

Abundance and depth range

Rare in sample GeoB 14704-1 from 246 m depth.

Association with CWCH

Not associated as only found well above CWCH.

Genus *Rosalina* d'Orbigny, 1826

Rosalina semipunctata (Bailey, 1851)

Fig. 28C–F, Fig. 37E

Synonym

Discanomalina semipunctata (Bailey 1851) in Hayward et al. (2022).

Diagnostic Features

Test commonly attached and with imprint of substrate or more rarely free, length 700 µm to 1500 µm; trochospiral, outline oval, with one or more tubulospine-like structures, chambers inflated; wall calcareous, hyaline, with coarse pores on the spiral side, smooth on the umbilical side; aperture umbilical to extraumbilical, with a pronounced lip which may extend to flaps on the umbilical side.

Remarks

Hayward et al. (2022) show as a reference a drawing from Brady (1884). The figured specimens show a markedly different spiral and umbilical side, indicative of a trochospiral chamber arrangement. The specimens found also show a low trochospiral enrolment as illustrated on Fig. 28 C–F. As this species is trochospiral a placement under the genus *Discanomalina* which is described as planispiral by Asano (1951), is not followed.

Abundance and depth range

Present to occasional in eleven samples from 414 m to 590 m depth.

Association with CWCH

Closely associated and a wide spread species in CWCH. It is never dominant and its share does not exceed 4,5 %. Missing in three samples from CWCH. Not found elsewhere.

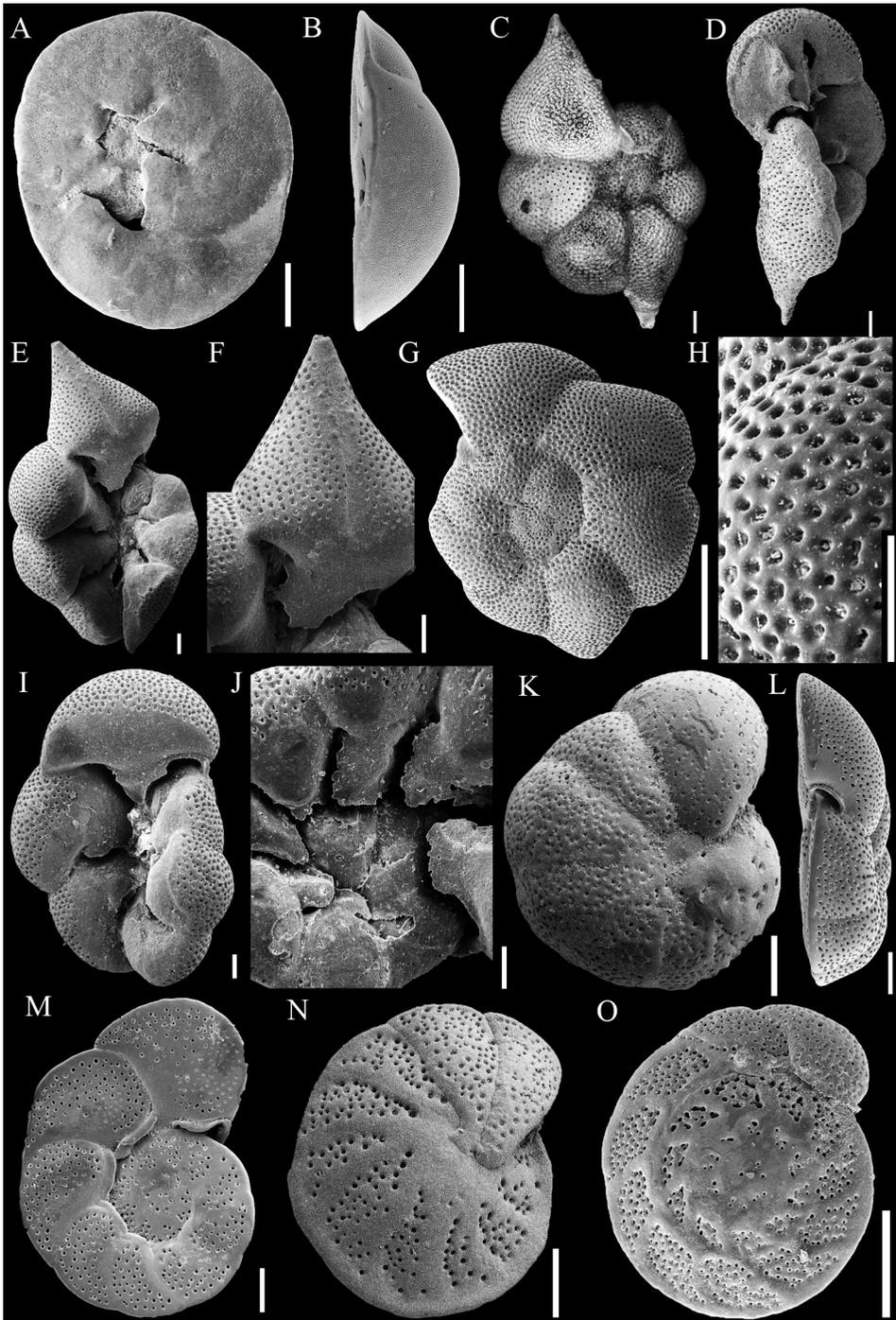


Fig. 28 A, B: *Planodiscorbis rarescens* A: GeoB 14704-1; B: GeoB 14704-1; C-F: *Rosalina semipunctata* C: GeoB 14903-1; D: GeoB 14903-1; E, F: GeoB 14903-1; G-J: *Rosalina vermiculata* G: GeoB 14903-1; H: GeoB 14910-2; I: GeoB 14903-1; J: GeoB 14903-1; K-M: *Cibicidoides lobatulus* K: GeoB 14905-1; L, M: GeoB 14788-1; N, O: *Cibicidoides mundulus* N: GeoB 14910-2; O: GeoB 14910-2. Scale bars 100 μ m except for G: 500 μ m.

Rosalina vermiculata (Bailey, 1851)

Fig. 28G–J

Synonyms *Discoanomalina vermiculata* (d'Orbigny, 1839) in Jones (1994), p. 101, pl. 97, fig. 7.
Discanomalina vermiculata (d'Orbigny, 1839) in Reymond et al. (2014) p. 80, pl. 3, figs. 1–2.
Discanomalina vermiculata (d'Orbigny, 1839) in Hayward et al. (2022).

Diagnostic Features Test commonly attached and with imprint of substrate or more rarely free, length 500 to 800 µm; trochospiral, outline oval to round; wall calcareous, hyaline, with coarse pores on the spiral side, smooth on the umbilical side; chambers inflated; aperture umbilical to extraumbilical, with a pronounced lip which may extend to flaps on the umbilical side.

Remarks The identification is based upon Jones (1994), who identifies a similar specimen as *Discoanomalina vermiculata* (d'Orbigny, 1839). Jones (1994) and Hayward et al. (2022) show as a reference a drawing from Brady (1884). The figured specimen has markedly different spiral and umbilical sides, indicative of a trochospiral arrangement. The specimens found also show a low trochospiral enrolment as illustrated on Fig 28G–J. As this species is trochospiral a placement under the genus *Discanomalina*, which is described as planispiral by Asano (1951), is not followed. It differs from *Rosalina semipunctata* by lacking tubulospine-like structures.

Abundance and depth range Rare to dominant in fourteen samples from 414 m to 590 m depth.

Association with CWCH Closely associated, wide spread and the most important species in CWCH. It is dominant in eight samples and frequent in four samples. It is found in all samples of CWCH. Not found elsewhere.

Superfamily PLANORBULINOIDEA Schwager, 1877

Family CIBICIDIDAE Cushman, 1927 in Cushman (1927b)

Genus *Cibicidoides* Thalmann, 1939

Cibicidoides lobatulus (Walker & Jacob, 1798)

Fig. 28K–M

Synonyms *Lobatula lobatula* (Walker & Jacob, 1798) in Spezzaferrri et al. (2015), p. 86, pl. 30, fig. 1.
Cibicides refulgens (Montfort, 1808) in Reymond et al. (2014) p. 80, pl. 4, figs. 14–15.
Lobatula lobatula (Walker & Jacob, 1798) in Reymond et al. (2014) p. 80, pl. 4, figs. 16–17.
Lobatula lobatula (Walker & Jacob, 1798) in Westphal et al. (2014) p. 45, pl. 6.6.2, fig. 10.

Diagnostic Features Test attached, planoconvex, variable morphology, outline lobulate, in spiral view length up to 720 µm, width up to 610 µm, thickness up to 240 µm; trochospiral, spiral side flat, chambers variable from trapezoid to crescentic and kidney shaped; sutures flush to slightly depressed, curved backward, umbilical side convex, chambers inflated, triangular, sutures depressed and radiate, periphery rounded and in some specimens keeled; wall calcareous,

hyaline, surface densely, coarsely perforate on both sides; aperture an interiomarginal slit, which extends around the periphery onto the spiral side and then along the inner margin of the last two chambers, some specimens have flaps over the slit on the spiral side, lip along the part of the aperture around the periphery.

Abundance and depth range

Present to dominant in thirteen samples from 30 m to 1310 m depth.

Association with CWCH

Present to rare in five samples from CWCH, overall of no significance. More frequent in samples from above, dominant with 25 % in sample GeoB 14788-1 from 30 m depth. Also found below.

Cibicidoides mundulus (Brady, Parker & Jones, 1888)

Fig. 28N, O, Fig. 29A

Diagnostic Features

Test free, biconvex, outline almost round, diameter up to 770 µm, thickness up to 390 µm; trochospiral, about 11 trapezoid chambers in the last coil; sutures and margins raised and thickened, sutures curved backwards, periphery keeled; wall calcareous, hyaline, surface between the sutures smooth and coarsely perforate on both sides; aperture a slit, which extends around the periphery onto the spiral side and then along the inner margin of the last three chambers, lip along the part of the aperture around the periphery.

Remarks

This species differs from *Cibicidoides pachyderma* (Rzehak, 1886) by having visible pores on the umbilical side rather than lacking them as described by Rzehak (1886).

Abundance and depth range

Dominant in one sample from 246 m depth. Present to frequent in fifteen more samples from 91 m to 1310 m depth.

Association with CWCH

Present to frequent in ten samples from CWCH. Rare to dominant above and below. Significant in CWCH and not limited to it.

Cibicidoides wuellerstorfi (Schwager, 1866)

Fig. 29B–D

Synonym

Planulina wuellerstorfi (Schwager 1866) in Westphal et al. (2014) p. 46, pl. 6.6.3, fig. A.4.

Diagnostic Features

Test free, compressed, spiral side convex, umbilical side slightly convex, length up to 690 µm, width up to 570 µm, thickness up to 220 µm; trochospiral, about 9–11 narrow, almost crescentic chambers in the last coil, umbilicus on the spiral side slightly depressed; sutures on the spiral side depressed, curved backwards, on the umbilical side flush and between last three to four chambers depressed, sutures curved backwards, periphery rounded; wall calcareous, hyaline, surface between the sutures smooth and coarsely perforate on both sides; aperture a slit, which extends at the periphery from the spiral side onto the umbilical side along the inner margin of the last three chambers, lip along the peripheral part of the aperture.

Abundance and depth range

Rare to frequent in four samples from 1119 m to 1310 m depth and rare to occasional in four samples from 414 m to 535 m depth.

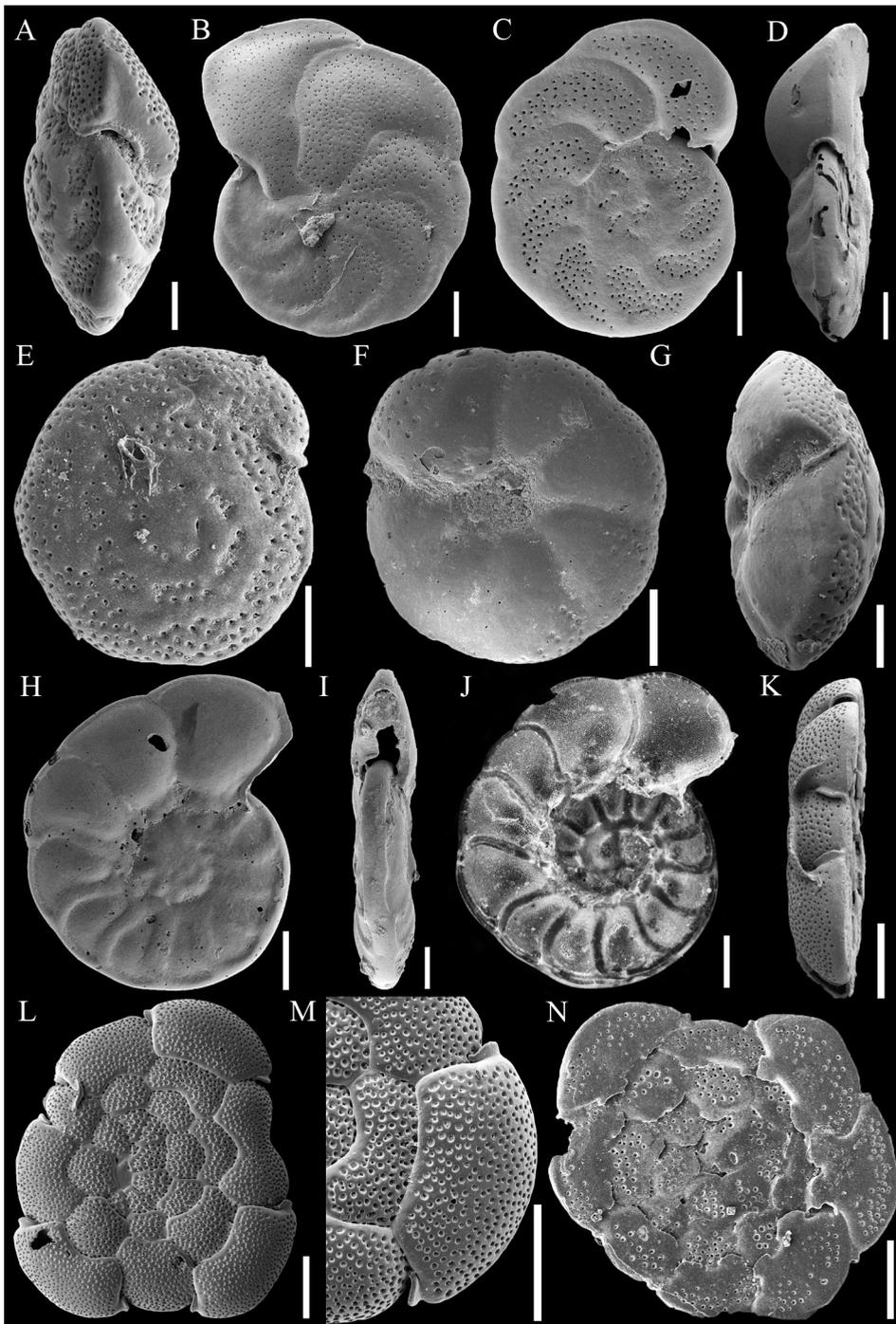


Fig. 29 A: *Cibicoides mundulus* GeoB 14910-2; B–D: *Cibicoides wuellerstorfi* B: GeoB 14852-1; C: GeoB 14852-1; D: GeoB 14898-1; E–G: *Heterolepa bradyi* E: GeoB 14853-1; F: GeoB 14853-1; G: GeoB 14853-1; H–J: *Hyalinea balthica* H: GeoB 14903-1; I: GeoB 14903-1; J: GeoB 14903-1; K–N: *Planorbulina mediterraneensis* K, L: GeoB 14788-1; M, N: GeoB 14703-1. Scale bars 100 μ m.

Association with CWCH Rare to occasional in four samples from CWCH, overall of little significance. Also found below.
Genus *Heterolepa* Franzenau, 1884

Heterolepa bradyi (Trauth, 1918)

Fig. 29E–G

Diagnostic Features

Test free, round in outline, biconvex, diameter up to 390 µm, thickness up to 160 µm; trochospiral, spiral side evolute, umbilical side involute, about 7 chambers in the last coil, on the spiral side chambers trapezoid; sutures flush to slightly raised and thickened, on the umbilical side chambers triangular, sutures depressed, central umbilical depression; wall calcareous, hyaline, on the spiral side coarsely perforate, scattered in the first whorls, densely in the last whorl and over the periphery reaching on to the umbilical side, rest of the umbilical side scarcely perforate; aperture a slit running from the spiral side over the periphery to the umbilical side with a thick upper lip.

Abundance and depth range

Present in sample GeoB 14853-1 from 1252 m depth only.

Association with CWCH

Not associated as only found well below CWCH.

Family PLANORBULINIDAE Schwager, 1877

Genus *Hyalinea* Hofker, 1951

Hyalinea balthica (Schröter, 1783)

Fig. 29H–J, Fig. 37I

Diagnostic Features

Test attached, round in outline, coin-like much compressed, diameter up to 540 µm, width up to 160 µm; planispiral, about 10–13 chambers in the last coil, previous coils visible, umbilical depression; sutures raised and thickened, curved backwards, periphery keeled; wall calcareous, hyaline, surface between the sutures smooth and perforate; aperture extraumbilical, equatorial slit.

Abundance and depth range

Present in three samples from 414 m to 1119 m depth.

Association with CWCH

Present in two samples from CWCH, overall of no significance.

Genus *Planorbulina* d'Orbigny, 1826

Planorbulina mediterraneensis d'Orbigny, 1826

Fig. 29K–N

Diagnostic Features

Test irregularly discoidal, planoconvex, diameter varies widely, thickness about 110 µm; annular coiling, attached side flat, controlled by the substrate, free side convex; wall calcareous, hyaline, coarsely perforate; on the free side each chamber has two arched apertures bordered by a rim, on the attached side multiple apertures covered by flaps, periph-

ery rounded and thickened on each outer chamber.

Abundance and
depth range

Present to rare in five samples from 30 m to 483 m depth.

Association
with CWCH

Occasional in one sample from CWCH, overall of no significance.

Family PLANULINIDAE Bermúdez, 1952

Genus *Planulina* d'Orbigny, 1826

Planulina ariminensis d'Orbigny, 1826

Fig. 30A–D

Diagnostic
Features

Test free, globular in outline, big, coin-like much compressed, diameter up to 1220 µm, thickness up to 160 µm; low trochospiral, about 9–11 crescentic chambers in the last coil, previous coils visible, sutures curved backwards, strongly at the periphery; sutures on the spiral side raised, on the umbilical side ranging from slightly raised to slightly depressed between the last chambers, periphery with a thick rounded keel; wall calcareous, hyaline, surface between the sutures smooth and coarsely perforate, sutures imperforate; aperture a slit, which extends at the periphery from the spiral side onto the umbilical side along the inner margin of the last six to seven chambers, lip at the peripheral part of the aperture.

Abundance and
depth range

Rare to dominant in thirteen samples from 414 m to 590 m depth. Occasional in one sample from 246 m and rare in two samples from 1119 m and 1252 m depth.

Association
with CWCH

Closely associated, wide spread and important species in CWCH. Found in low numbers above and below.

Superfamily DISCORBINELLOIDEA Sigal, 1952

Family DISCORBINELLIDAE Sigal, 1952

Genus *Hanzawaia* Asano, 1944

Hanzawaia boueana (d'Orbigny, 1846)

Fig. 30E–G

Diagnostic
Features

Test semicircular in outline, planoconvex, length up to 680 µm, width up to 510 µm, thickness up to 210 µm; trochospiral, about 10 chambers in the last whorl, last chambers increasing rapidly in size, spiral side involute with central boss, umbilical side partially evolute, wide umbilicus slightly depressed and covered partially by flaps; sutures thickened and curved backwards towards the periphery, where they merge to a keel; wall calcareous, hyaline, surface between the sutures on both sides smooth and finely perforate all over; aperture interiomarginal slit, extending from under the flaps of the umbilical side over the periphery and a bit onto the spiral side, bordered by a lip at the periphery.

Abundance and
depth range

Present to occasional in two samples from 246 m and 91 m depth. Occasional to frequent in two samples from 505 m and 566 m depth.

Association
with CWCH

Associated as found occasional to frequent in two samples of CWCH. Also found above.

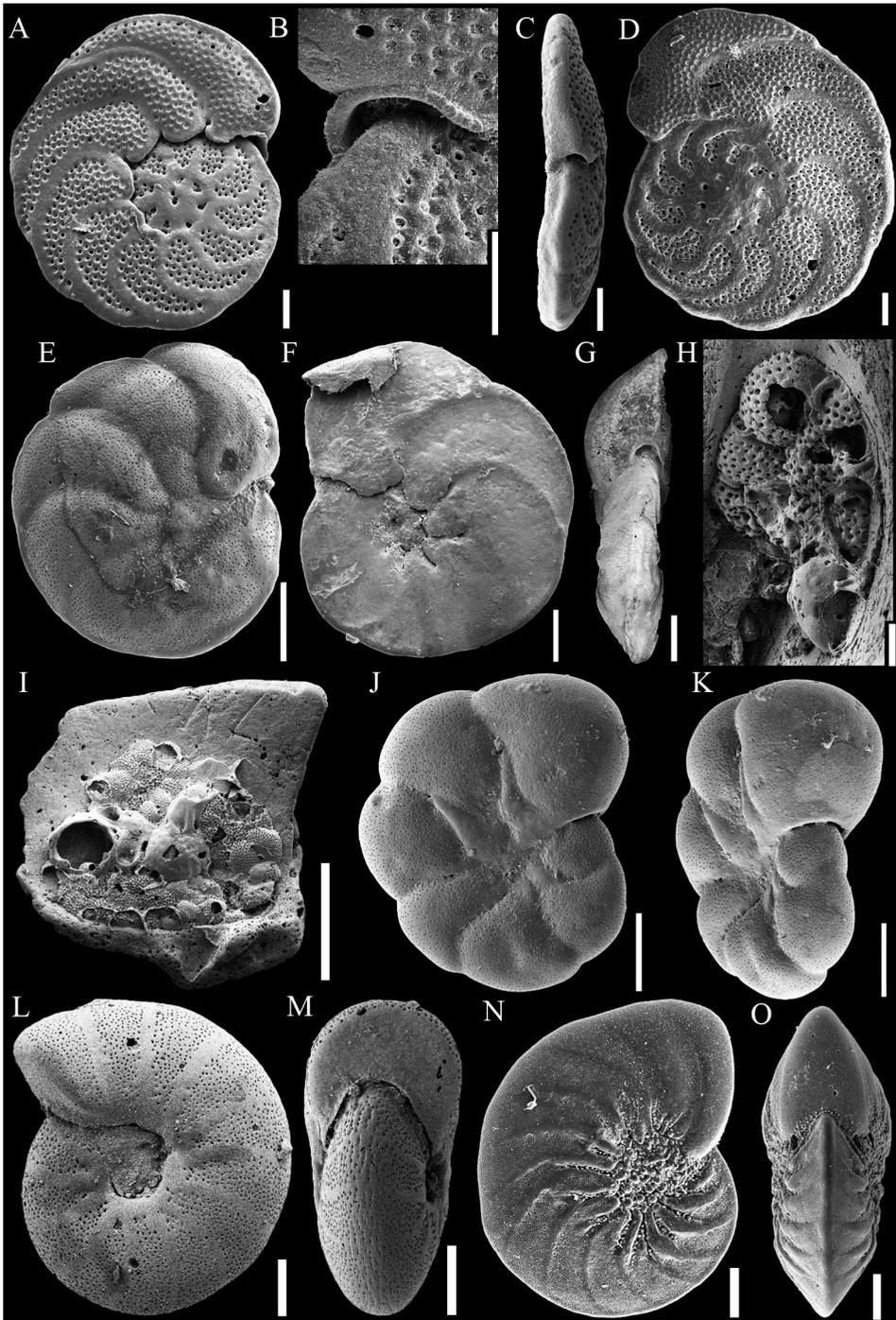


Fig. 30 A–D: *Planulina ariminensis* A, B: GeoB 14910-2; C: GeoB 14910-2; D: GeoB 14898-1; E–G: *Hanzawaia boueana* E: GeoB 14704-1; F: GeoB 14704-1; G: GeoB 14704-1; H, I: *Acervulina inhaerens* H: GeoB 14788-1; I: GeoB 14788-1; J, K: *Astrononion stelligerum* GeoB 14898-1; L, M: *Melonis zaandamae* L: GeoB 14910-2; M: GeoB 14910-2; N, O: *Nonion fabum* N: GeoB 14705-1; O: GeoB 14705-1. Scale bars 100µm.

Genus *Laticarinina* Galloway & Wissler, 1927
Laticarinina pauperata (Parker & Jones, 1865)
 Fig. 33J–M

Diagnostic Features Test free, small, outline crescentic, length up to 490 µm, width up to 450 µm, thickness up to 110 µm; trochospiral, planoconvex; sutures depressed; wall calcareous, hyaline; aperture at the base of the last chamber; very broad keel wrapped around the trochospiral chambers, flat, crescentic and transparent.

Abundance and depth range Present in sample GeoB 14853-1 from 1252 m depth only. Not in counts.

Association with CWCH Not associated as only found well below CWCH.

Superfamily ACERVULINOIDEA (Schultze, 1854)
 Family ACERVULINIDAE Schultze, 1854
 Genus *Acervulina* Schultze, 1854

Acervulina inhaerens Schultze, 1854
 Fig. 30H, I

Diagnostic Features Test attached to encrusting and with imprint of substrate on one side, discoidal irregular, outline irregular oval to round, diameter up to 2100 µm; early chambers coiled, later chambers irregularly added according to the substrate; wall calcareous, hyaline, with coarse pores; multiple oval apertures on sutures, bordered by a rim.

Abundance and depth range Occasional in a sample from 14 m and dominant in another sample from 30 m depth.

Association with CWCH Not associated as only found well above CWCH.

Superfamily NONIONOIDEA Schultze, 1854
 Family ASTRONONIONIDAE Cushman & Edwards, 1937
 Genus *Astrononion* Cushman & Edwards, 1937

Astrononion stelligerum (d'Orbigny, 1839) in d'Orbigny (1839c)
 Fig. 30J, K

Diagnostic Features Test free, round lobulate in outline, laterally compressed, concave on both sides, length up to 430 µm, width up to 350 µm, thickness up to 170 µm; planispiral, involute, about seven chambers which increase gradually in size, triangular in side view; sutures depressed, radiate, umbilici covered by a plate which extends over the inner parts of the chambers along the sutures with pointed ends, giving it a star like appearance; wall calcareous, hyaline, surface smooth, finely perforate all over, except for the plate; aperture an interiomarginal and equatorial low slit which extends towards the umbilici, bordered by a thin lip.

Abundance and depth range Present in sample GeoB 14898-1 from 505 m depth. Not in counts.

Association with CWCH Present in one sample from CWCH, of no significance.

Family MELONIDAE Holzmann & Pawlowski, 2017

Genus *Melonis* Montfort, 1808

Melonis zaandamae (van Voorthuysen, 1950)

Fig. 30L, M

Synonym *Melonis zaandami* (van Voorthuysen 1952) in Hayward et al. (2022).

Diagnostic Features Test free, circular in outline, diameter up to 620 µm; planispiral, involute, about 12–14 chambers, each like a slice of cake; sutures flush and thickened; wall calcareous, hyaline, coarsely perforate except for the thickened sutures, both umbilici deepening into a hole; aperture terminal, low arch extending from one umbilicus to the other, with an upper lip.

Remarks The species differs from *Melonis barleeianum* (Williamson, 1858) and *Melonis affinis* (Reuss, 1851) by having a broad apertural face rather than an elongated pointed one. The aperture extends all along the lower margin of the apertural face rather than being short and limited to the central part of the lower margin of the apertural face.

Abundance and depth range Rare to frequent in four samples from 505 m to 566 m depth, present to occasional in three samples from 1196 m to 1310 m depth.

Association with CWCH Associated with CWCH, as found in four samples with a share of up to 11,5 %. Found to a much lesser extent below.

Family NONIONIDAE Schultze, 1854

Genus *Nonion* Montfort, 1808

Nonion fabum (Fichtel & Moll, 1798)

Fig. 30N, O

Synonym *Nonion faba* (Fichtel & Moll, 1798) in Hayward et al. (2022).

Diagnostic Features Test free, outline in side view a broad bean shape, in apertural view ovate with pointed ends, length up to 710 µm, width up to 540 µm, thickness up to 320 µm; planispiral, involute, about 16 chambers, increasing in length, curved backwards towards the periphery; sutures of the last whorl thickened and raised and becoming flush towards the last chambers, both umbilici wide and covered with numerous, partly amalgamated pustules and granules which extend in smaller sizes into the sutures; wall calcareous, hyaline, densely, finely perforate except for the sutures; aperture an equatorial slit at the base of the last chamber, ornamented and covered by granules.

Abundance and depth range Rare to frequent in four samples from 91 m to 246 m depth. Present to rare in samples from 414 m to 1196 m depth.

Association with CWCH Present in CWCH, overall of no significance.

Family PULLENIIDAE Schwager, 1877

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

Pullenia bulloides (d'Orbigny, 1846)

Fig. 31A

Diagnostic Features

Test free, almost globose with one half slightly larger than the other, outline in all views globular, diameter up to 420 µm; planispiral, involute, four chambers in the last whorl, sutures radial; wall calcareous, hyaline, imperforate, umbilicus covered by the chambers; aperture a broader interiomarginal slit at the base of the last chamber.

Abundance and depth range

The species is present in samples 14858-1 from a depth of 493 m and 14910-2 from a depth of 535 m only.

Association with CWCH

Present in CWCH, overall of no significance.

Pullenia subcarinata (d'Orbigny, 1839) in d'Orbigny (1839b)

Fig. 31B, C

Diagnostic Features

Test free, outline rectangular with broadly rounded edges and ovoid in apertural view, length up to 360 µm, width up to 410 µm; planispiral, about seven chambers increasing in size, both umbilici deepening into a small hole; wall calcareous, hyaline, imperforate; aperture terminal, low arch extending from one umbilicus to the other, with a lip on both sides.

Abundance and depth range

Rare in sample GeoB 14853-1 from 1252 m depth.

Association with CWCH

Not associated as only found well below CWCH.

Superfamily CHILOSTOMELLOIDEA Brady 1881

Family ALABAMINIDAE Hofker, 1951

Genus *Oridorsalis* Andersen, 1961

Oridorsalis umbonatus (Reuss, 1851)

Fig. 31D–F

Diagnostic Features

Test free, outline round and lobulate, biconvex, in spiral view diameter up to 520 µm, thickness up to 220 µm; trochospiral, three visible whorls on the spiral side with 5–7 chambers; sutures flush on the spiral side and depressed on the umbilical side; wall calcareous, hyaline; aperture an interiomarginal slit bordered by a lip, additional apertures may occur on the last chambers of the spiral side.

Abundance and depth range

Present to rare in four samples from to 505 m to 1196 m depth.

Association with CWCH

Present to rare in CWCH, overall of no significance.

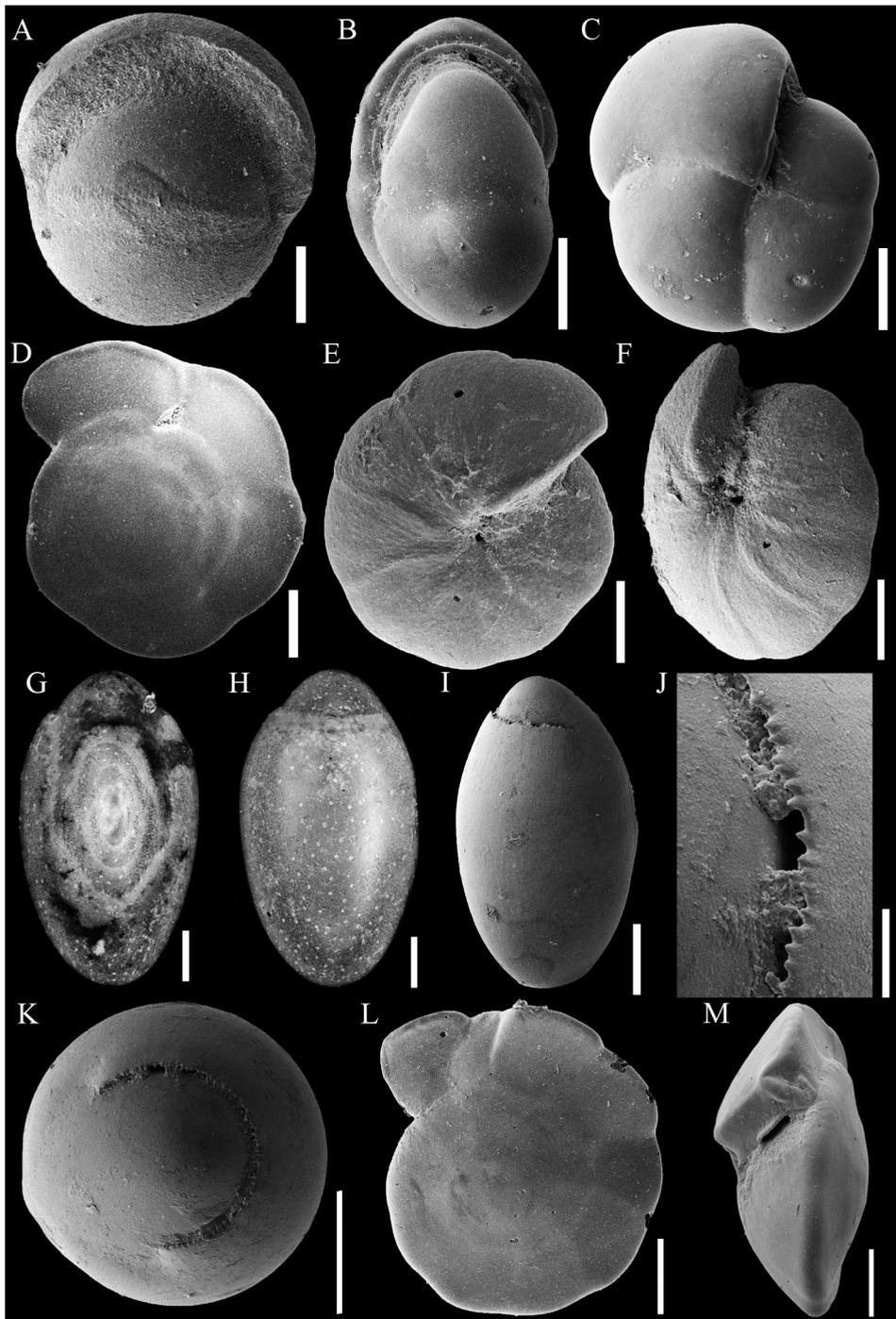


Fig. 31 A: *Pullenia bulloides* GeoB 14858-1; B, C: *Pullenia subcarinata* B: GeoB 14853-1; C: GeoB 14853-1; D-F: *Oridorsalis umbonatus* D: GeoB 14854-1; E, F: GeoB 14898-1; G, H: *Chilostomella oolina* GeoB 14910-2; I-K: *Chilostomella* sp. GeoB 14898-1; L, M: *Gyroidina orbicularis* L: GeoB 14898-1; M: GeoB 14898-1. Scale bars 100µm except for J: 20µm.

Family CHILOSTOMELLIDAE Brady 1881

Genus *Chilostomella* Reuss in Čížek, 1849

Chilostomella oolina Schwager, 1878

Fig. 31G, H, Fig. 37G, J

Diagnostic Features

Test free, elongate, ovoid, circular in section, length 620 µm, width up to 340 µm; planispiral, outline oval, two chambers embracing each other per whorl, on one side previous chambers stick out and show through; wall calcareous, hyaline, with scattered pores; aperture an interiomarginal slit running more than half around the test.

Abundance and depth range

Rare to dominant in three samples from 1119 m to 1310 m depth. Present in two samples from 535 m and 577 m depth.

Association with CWCH

Present in CWCH, overall of no significance.

Chilostomella sp.

Fig. 31I–K

Diagnostic Features

Test free, elongate, ovoid, circular in section, length 440 µm, width up to 260 µm; planispiral, outline oval, two chambers embracing each other per whorl, on one side previous chambers stick out and show through; wall calcareous, hyaline, with scattered pores; aperture an interiomarginal, serrated slit running more than halfway around the test.

Abundance and depth range

Present in sample GeoB 14898-1 from 505 m depth. Not in counts.

Association with CWCH

Present in one sample from CWCH, of no significance.

Family GAVELINELLIDAE Hofker, 1956

Genus *Gyroidina* d'Orbigny, 1826

Gyroidina orbicularis d'Orbigny in Parker, Jones & Brady, 1865

Fig. 31L, M

Diagnostic Features

Test free, outline round, umbilical side highly convex, spiral side low convex, diameter up to 410 µm, thickness up to 280 µm; trochospiral, 10–12 chambers in the last whorl, coiling on the spiral side evolute and on the umbilical side involute, chambers on the spiral side trapezoid, on the umbilical side triangular; sutures flush on the spiral side and depressed on the umbilical side; wall calcareous, hyaline, finely perforate; aperture an interiomarginal slit running from the umbilicus onto the apertural face, covered on the umbilical side partly by an elongated flap and partly bordered by a small lip.

Abundance and depth range

Rare to occasional in five samples from 493 m to 577 m depth, rare to occasional in four samples from 1119 m to 1310 m depth.

Association with CWCH

Associated with CWCH with shares of up to 5,5 %. Also found below.

Superfamily CALCARINOIDEA Schwager, 1876

Family CALCARINIDAE d'Orbigny, 1826

Genus *Pararotalia* Le Calvez, 1949

***Pararotalia* sp.**

Fig. 32A–C

Synonym *Ammonia beccarii* (Linnaeus, 1758) in Reymond et al. (2014) p. 80, pl. 4, fig. 4.

Diagnostic Features Test free, small, outline almost round, lobulate, profile biconvex to rhomboidal, diameter up to 450 µm, thickness up to 310 µm; trochospiral, about eight chambers in the last coil; sutures on the spiral side flush to slightly raised, on the umbilical side much depressed, umbilicus deeply excavated with a central plug; wall calcareous, hyaline, surface perforated, on the umbilical side towards the periphery much pustulose; aperture a slit on the umbilical side at the base of the last chamber.

Remarks The species resembles *Pararotalia calcariformata* McCulloch, 1977 but lacks the ornamentation on the spiral side and a connection of the umbilical plug to the chambers. *Pararotalia calcariformata* is not reported from the open Atlantic. *Pararotalia capetownensis* (McCulloch, 1977) is reported from the Atlantic off Capetown, but lacks the umbilical grooves of the specimens found.

Abundance and depth range Present in three samples from 30 m, 246 m and 493 m depth.

Association with CWCH Too rare to draw conclusions.

Superfamily ROTALIOIDEA Ehrenberg, 1839

Family AMMONIIDAE Saidova, 1981

Genus *Ammonia* Brünnich, 1771

***Ammonia neobeccarii* Shchedrina & Mayer, 1975**

Fig. 32D–G

Synonym *Ammonia beccarii* (Linnaeus, 1758) in Westphal et al. (2014) p. 45, pl. 6.6.1, fig. C.4., pl. 6.6.2, fig. A.4, C.4 and D.8 and p. 46, pl. 6.6.3, fig. A.8.

Diagnostic Features Test free, outline almost round, profile biconvex, diameter up to 720 µm, thickness up to 510 µm; trochospiral, adult specimens with about 10–12 trapezoid chambers in the last whorl, chambers triangular pointed with sharp borders, ornamented with granules and tubercles, which are orientated perpendicular to the sutures, umbilicus deeply incised, with a small pointed boss; sutures on the spiral side deeply incised in the last whorl, sutures of previous whorls covered by tubercles, which conglomerate in the central part, sutures on the umbilical side deeply incised and widening towards the umbilicus; wall calcareous, hyaline, surface finely perforate; aperture a slit at the base of the apertural face

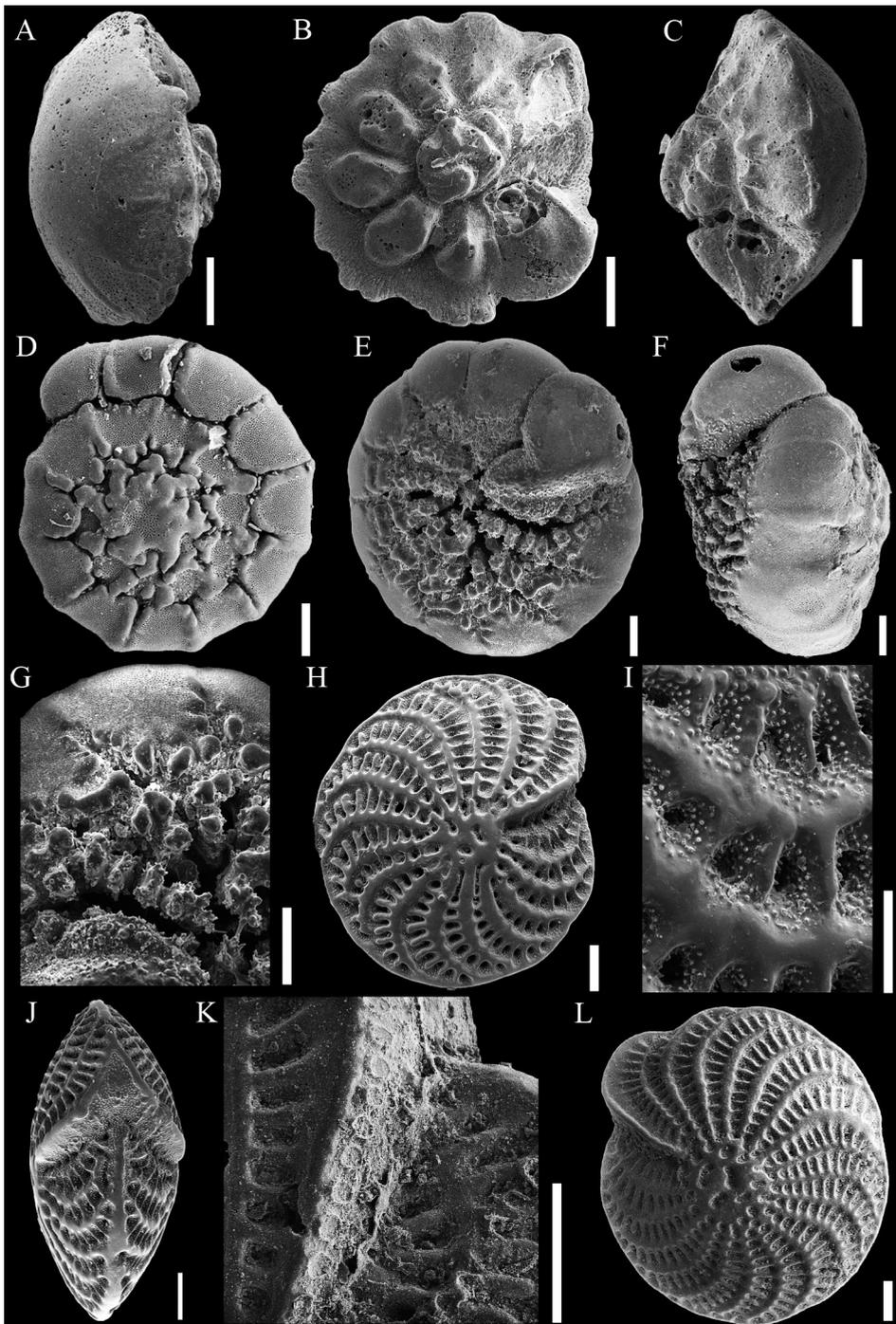


Fig. 32 A–C: *Pararotalia* sp. GeoB 14704-1; D–G: *Ammonia neobeccarii* D: GeoB 14865-1; E, G: GeoB 14865-1; F: GeoB 14865-1; H–L: *Elphidium crispum* H–J: GeoB 14788-1; K, L: GeoB 14858-1. Scale bars 100 µm except for I: 50 µm.

extending from the umbilicus over the periphery onto the spiral side, covered partly by a flap on the umbilical side.

Abundance and depth range

Rare to dominant in nine samples from 52 m to 369 m depth, present to dominant in 10 samples from 414 m to 590 m depth, occasional in one sample from 1252 m depth, interpreted as caused by downslope transport.

Association with CWCH

Associated with CWCH, also found above and below.

Family ELPHIDIIDAE Galloway, 1933

Genus *Elphidium* Montfort, 1808

Elphidium crispum (Linnaeus, 1758)

Fig. 32H–L

Diagnostic Features

Test free, large, outline almost round, profile biconvex to rhomboidal, diameter up to 810 µm, thickness up to 380 µm; planispiral, numerous (20 and more) slender, crescentic chambers in the last coil, strongly curved; sutures depressed with numerous sutural bridges extending over the whole suture, umbilicus covered by a broad plug with 10 or more pits; wall calcareous, hyaline, surface finely perforate; aperture a row of pores at the base of the apertural face.

Remarks

This species differs from *Elphidium macellum* (Fichtel & Moll, 1798) by its inflated, rhomboidal profile.

Abundance and depth range

Occasional to dominant in six samples from 14 m to 246 m depth, rare to frequent in four samples from 483 m to 516 m depth. Present to rare in three samples from 1119 m to 1310 m depth.

Association with CWCH

Associated with CWCH, found in greater numbers above and in fewer numbers below.

Elphidium fichtelianum (d'Orbigny, 1846)

Fig. 33A–C

Diagnostic Features

Test free, outline almost round, profile much compressed with flat sides, diameter up to 650 µm, thickness up to 220 µm; planispiral, numerous (14 or more) slender, crescentic chambers in the last coil, sutures slightly depressed, strongly curved backwards both towards the periphery and umbilicus; reticulate ornamentation throughout, built by numerous sutural bridges rectangular to the sutures, bridges leave a small gap to the next suture, umbilicus wide and flat ornamented with several tubercles, small keel; wall calcareous, hyaline, surface finely perforate; aperture/s obscured, apertural face with about five to six large and numerous small papillae.

Remarks

In Spezzaferri et al. (2015) specimens with a similar morphology are identified as *Elphidium hanzawai* Asano, 1939, which in this paper is viewed as a subjective synonym of *Elphidium fichtelianum*.

Abundance and depth range Present to rare in six samples from 30 m to 1252 m depth.

Association with CWCH Not associated as only found above and below CWCH.

Elphidium maorium Hayward, 1997

Fig. 33D–F

Diagnostic Features Test free, small, outline almost round, slightly lobulate, biconvex, diameter up to 200 µm; planispiral, about 10 or more slender, crescentic chambers in the last coil; sutures depressed with up to five sutural bridges, sutures slightly curved backwards towards the periphery, periphery with a small keel, umbilicus a small plug partially surrounded by a depression; wall calcareous, hyaline, surface finely perforate, numerous fine papillae in the umbilical depression, sutures and around the base of the apertural face; aperture at the base of the apertural face, obscured by amalgamated papillae with some irregularly placed holes.

Remarks The species differs from *Elphidium advenum* (Cushman, 1922) in Cushman (1922b) and *Elphidium charlottense* (Vella, 1957) by its weaker keel.

Abundance and depth range Present in three samples from 91 m, 111 m and 1310 m depth.

Association with CWCH Not associated as only found above and below CWCH.

Elphidium williamsoni Haynes, 1973

Fig. 33G–I

Synonym *Criboelphidium williamsoni* (Haynes, 1973) in Hayward et al. (2022).

Diagnostic Features Test free, small, outline almost round, biconvex, diameter up to 310 µm, thickness up to 100 µm; planispiral, about 10 or more slender, crescentic chambers in the last coil, last chamber a bit inflated; sutures depressed with numerous sutural bridges, on the first chambers bridges very broadened, leaving just some holes, sutures curved backwards, umbilicus a small plug partially surrounded by a depression, may also be irregular; wall calcareous, hyaline, surface finely perforate, sutures and bridges on the last chambers with small spikes; aperture an elongated slit at the base of the last chamber, covered partially by ornamentation.

Abundance and depth range Present in sample GeoB 14865-1 from 52 m depth. Not in counts.

Association with CWCH Not associated as only found above CWCH.

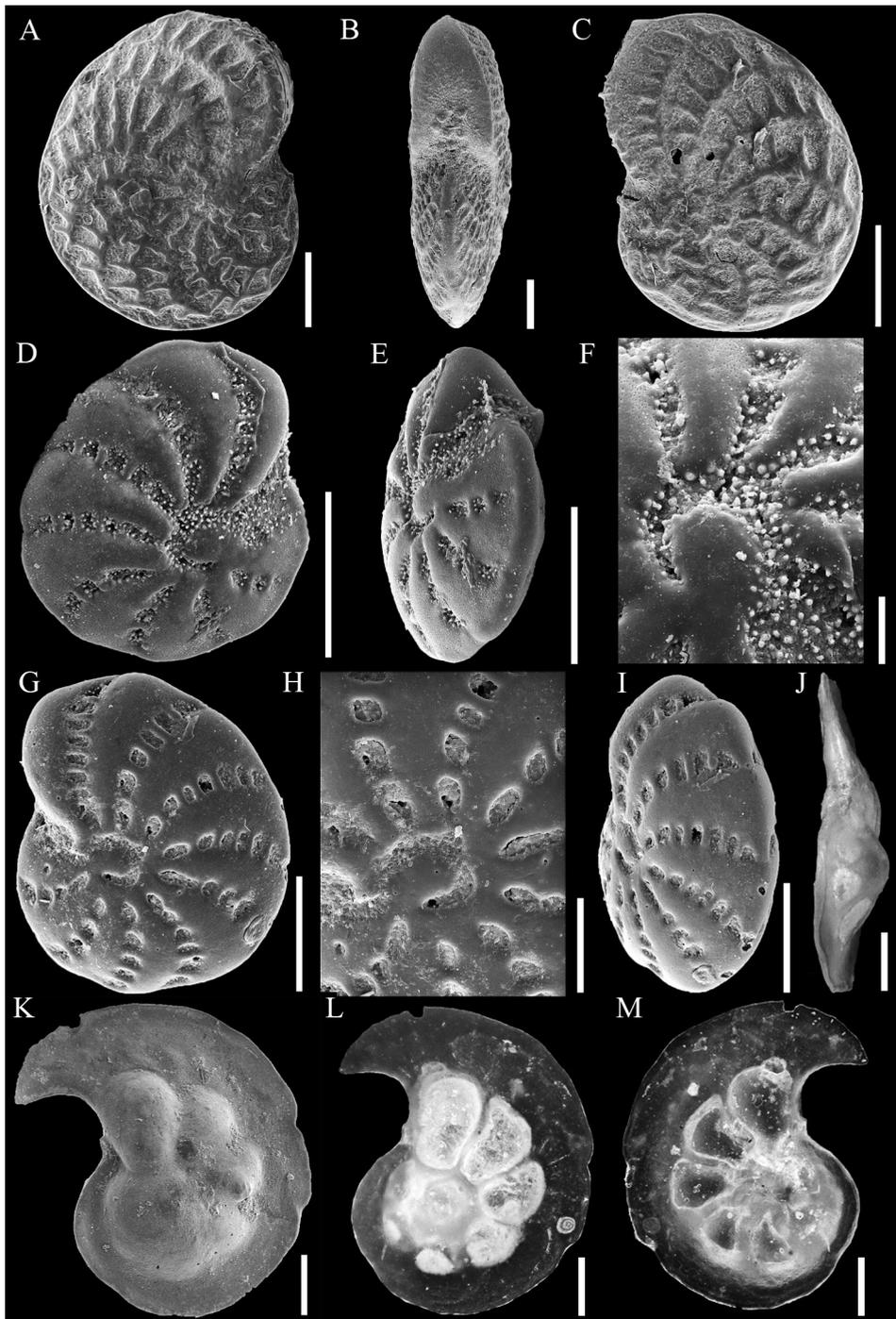


Fig. 33 A–C: *Elphidium fichtelianum* A: GeoB 14704-1; B: GeoB 14853-1; C: GeoB 14704-1; D–F: *Elphidium maorium* GeoB 14705-1; G–I: *Elphidium williamsoni* GeoB 14865-1; J–M: *Laticarinina pauperata* GeoB 14853-1. Scale bars 100 μm except for F: 20 μm , H: 50 μm .

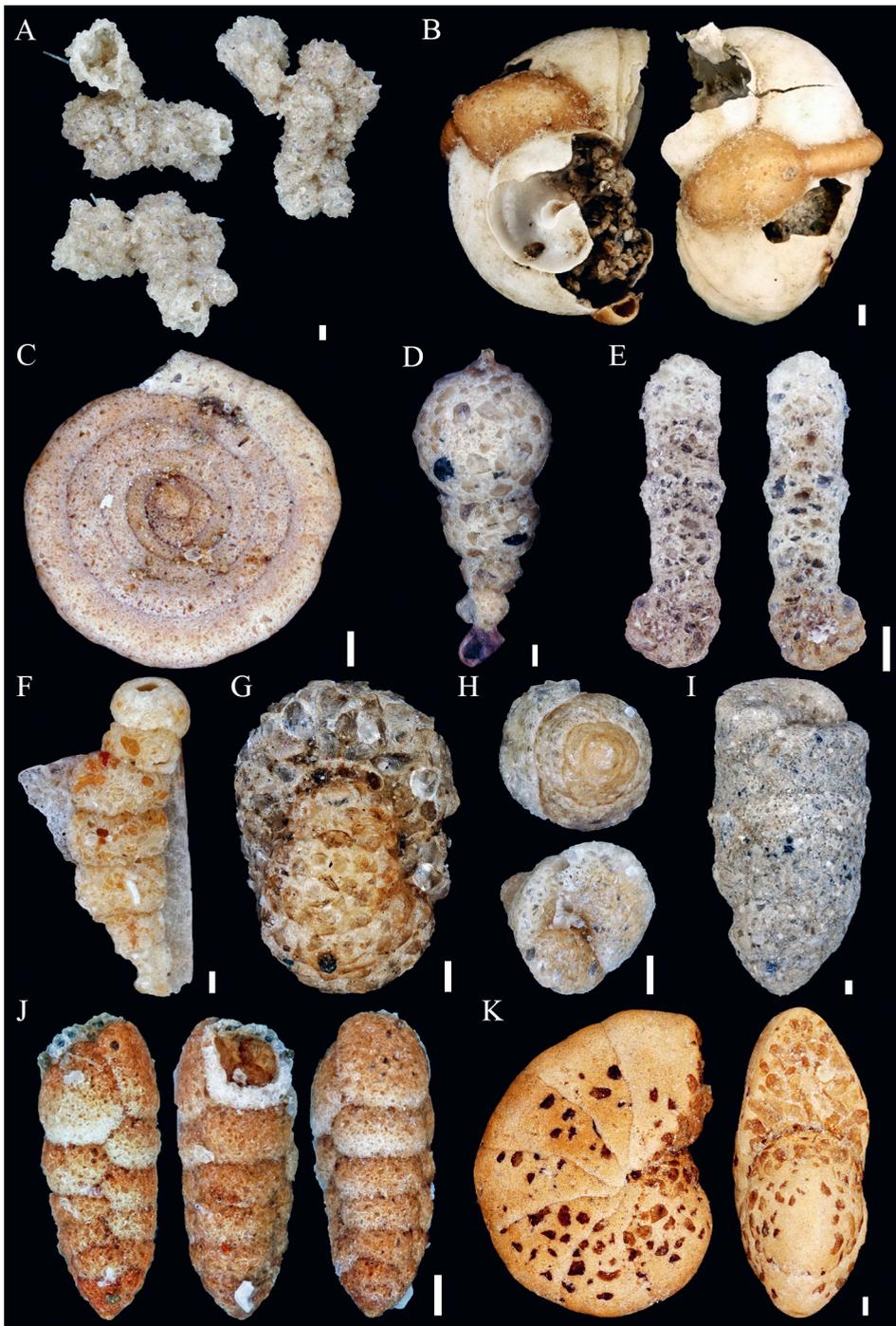


Fig. 34 A: *Dendrophyra radiata* GeoB 14910-2, three views GeoB 14910-2; B: *Ammolagena clavata* GeoB 14852-1, two views; C: *Ammodiscus tenuis* GeoB 14910-2; D: *Hormosina globulifera* GeoB 14910-2; E: *Ammobaculites filiformis* GeoB 14911-1, two views; F: *Placopsilina bradyi* GeoB 14706-1; G: *Cribrostomoides subglobosus* GeoB 14848-1; H: *Tritaxis conica* GeoB 14856-1, two views; I: *Dorothis pseudoturris* GeoB 14903-1; J: *Eggerelloides advenus* GeoB 14903-1, three views; K: *Cyclamina cancellata* GeoB 14903-1, two views. Scale bars 100 μm .

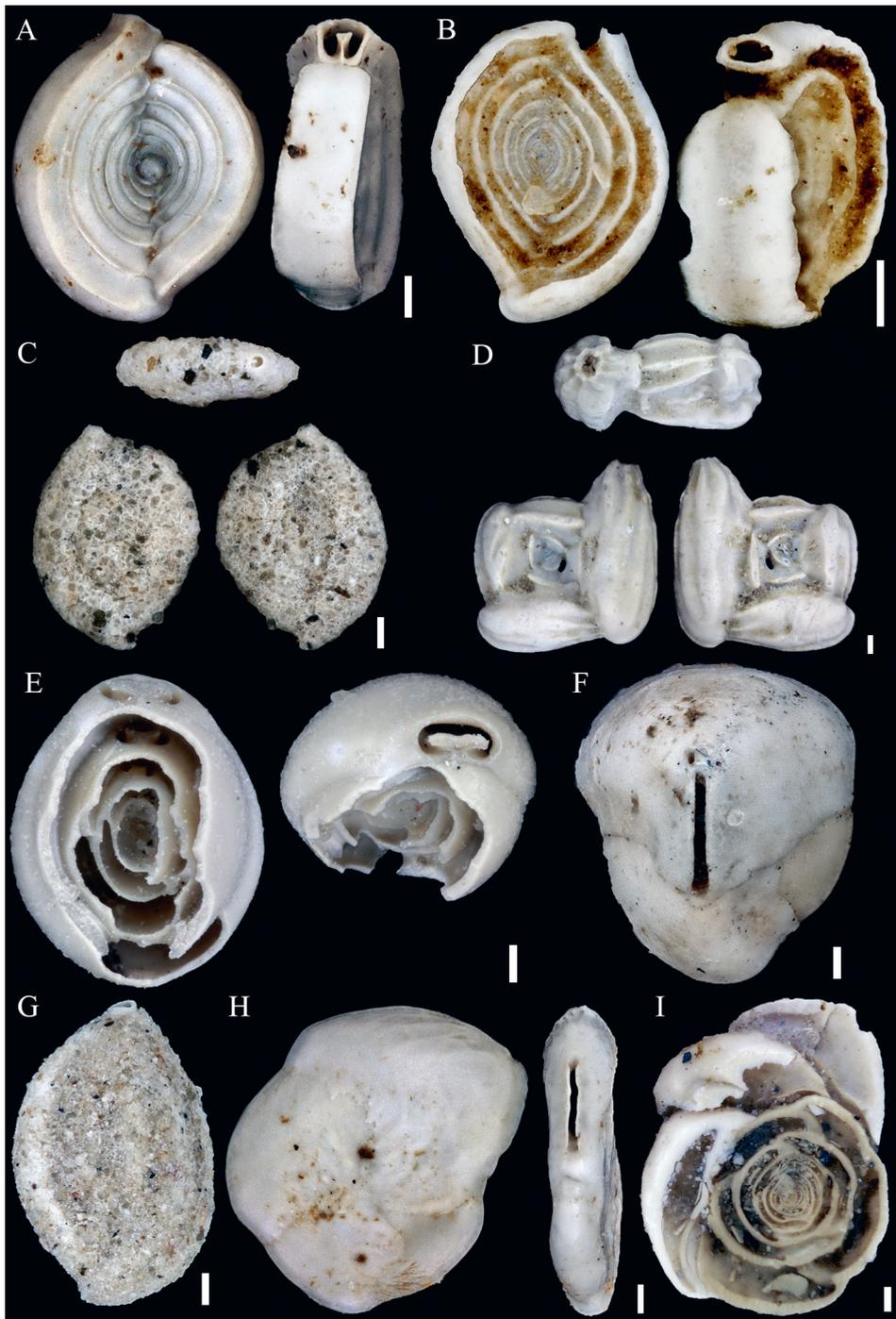


Fig. 35 A: *Spiroloculina excavata* GeoB 14903-1, two views; B: *Spiroloculina tenuiseptata* GeoB 14903-1, two views; C: *Proemassilina arenaria* GeoB 14856-1, three views; D: *Ptychomiliola separans* GeoB 14865-1, three views; E: *Pyrgo depressa* Forma A GeoB 14858-1, two views; F: *Triloculina angusteoralis* GeoB 14903-1; G: *Sigmoilopsis schlumbergeri* GeoB 14910-2; H, I: *Planispirinella exigua* H: GeoB 14903-1; I: GeoB 14799-1. Scale bars 100 μ m.

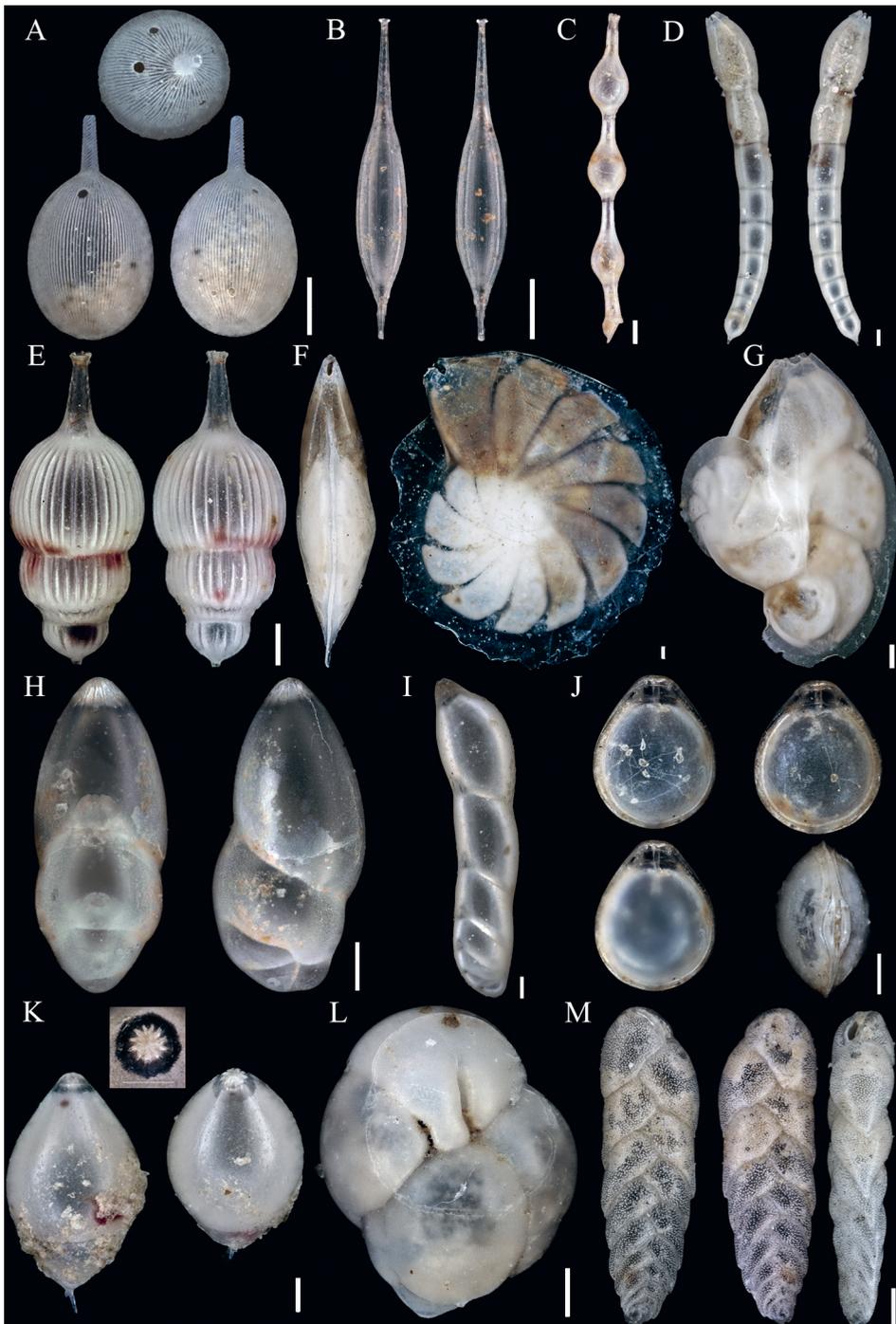


Fig. 36 A: *Lagena striata* GeoB 14878-1, three views; B: *Procerolagena gracilis* GeoB 14856-1, two views; C: *Grigelis orectus* GeoB 14898-1; D: *Laevidentalina communis* GeoB 14910-2, two views; E: *Amphicoryna scalaris* GeoB 14910-2, two views; F: *Lenticulina iota* GeoB 14910-2, two views; G: *Lenticulina* sp. GeoB 14910-2; H: *Marginulina glabra* GeoB 14904-1, two views; I: *Vaginulinopsis sublegumen* GeoB 14910-2; J: *Fissurina* sp. GeoB 14856-1, four views; K: *Glandulina ovula* GeoB 14856-1, three views; L: *Robertinoides bradyi* GeoB 14903-1; M: *Bolivina beyrichi* GeoB 14856-1, three views. Scale bars 100 μ m.

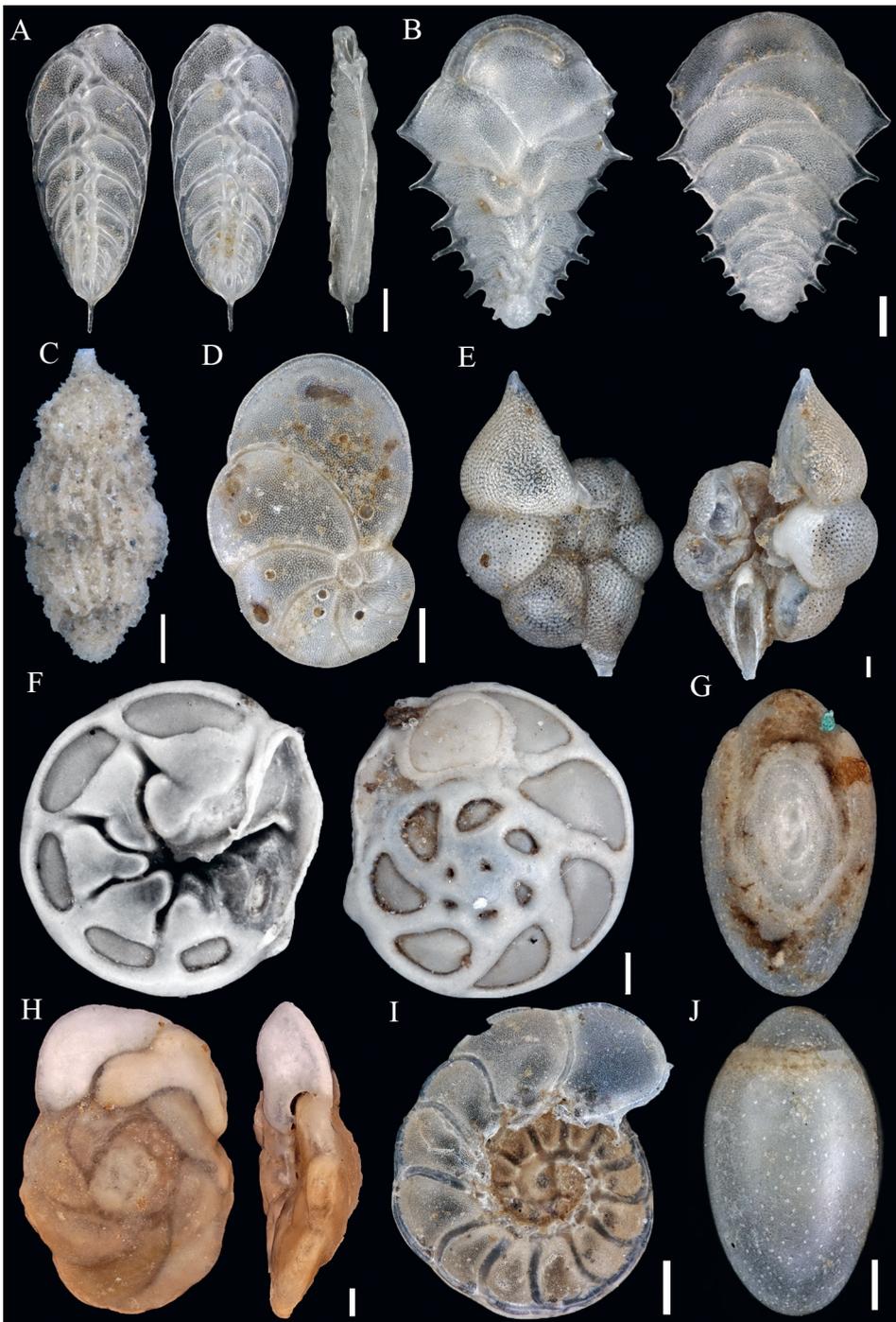


Fig. 37 A: *Bolivina subaenariensis* GeoB 14910-2, three views; B: *Ehrenbergina serrata* GeoB 14910-2, two views; C: *Uvigerina pygmaea* GeoB 14910-2; D: *Cancris auriculus* GeoB 14910-2; E: *Rosalina semipunctata* GeoB 14903-1, two views; F: *Stomatorbina concentrica* GeoB 14903-1, two views; G, J: *Chilostomella oolina* GeoB 14910-2, two views; H: *Hyrrokkin sarcophaga* GeoB 14903-1, two views; I: *Hyalinea balthica* GeoB 14903-1. Scale bars 100 μm .

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Appendix

Appendix I Analysis of Foraminifera in 28 samples from the Mauritanian shelf and slope of expedition MSM16/3 of RV Maria S. Merian. List of species

<i>Abditodentrix pseudothalmanni</i>	<i>Bilocolinella globula</i>	<i>Cassidulina laevigata</i>
<i>Ehrenbergina serrata</i>	<i>Glandulina ovula</i>	<i>Homalohedra borealis</i>
<i>Lenticulina submamilligera</i>	<i>Nonion fabum</i>	<i>Proemassilina arenaria</i>
<i>Reophax bradyi</i>	<i>Siphouvigerina proboscidea</i>	<i>Textularia</i>
<i>Acerulina inhaerens</i>	<i>Bolivina beyrichi</i>	<i>Chilostomella oolina</i>
<i>Elphidium crispum</i>	<i>Globobulimina doliolum</i>	<i>Homalohedra williamsoni</i>
<i>Lenticulina</i>	<i>Oolina laevigata</i>	<i>Psammospaera fusca</i>
<i>Reussoolina strangeri</i>	<i>Sphaeroidina bulloides</i>	<i>Textularia truncata</i>
<i>Ammobaculites agglutinans</i>	<i>Bolivina earlandi</i>	<i>Chilostomella</i>
<i>Elphidium fichtelianum</i>	<i>Globobulimina turgida</i>	<i>Homalohedra globulifera</i>
<i>Marginulina glabra</i>	<i>Oridorsalis umbonatus</i>	<i>Pseudonodosaria brevis</i>
<i>Rhabdammina abyssorum</i>	<i>Spiroloculina dilatata</i>	<i>Trifarina albatrossi</i>
<i>Ammobaculites crassaformis</i>	<i>Bolivina pseudoplicata</i>	<i>Cibicidoides lobatulus</i>
<i>Elphidium maorium</i>	<i>Globulina gibba</i>	<i>Hyalinea balthica</i>
<i>Marginulina striatula</i>	<i>Pararotalia</i>	<i>Ptychomiliola separans</i>
<i>Rhabdammina scabra</i>	<i>Spiroloculina excavata</i>	<i>Trifarina angulosa</i>
<i>Ammobaculites filiformis</i>	<i>Bolivina spathulata</i>	<i>Cibicidoides mundulus</i>
<i>Elphidium williamsoni</i>	<i>Goesella cylindrica</i>	<i>Hyrokkin sarcophaga</i>
<i>Marginulina</i>	<i>Placopsilina bradyi</i>	<i>Pullenia bulloides</i>
<i>Robertinoides bradyi</i>	<i>Spiroloculina tenuiseptata</i>	<i>Trifarina fornasinii</i>
<i>Ammodiscus tenuis</i>	<i>Bolivina subaenariensis</i>	<i>Cibicidoides wuellerstorfi</i>
<i>Eponides repandus</i>	<i>Grigelis orectus</i>	<i>Karrerella bradyi</i>
<i>Marsipella elongata</i>	<i>Planispirinella exigua</i>	<i>Pullenia subcarinata</i>
<i>Rosalina semipunctata</i>	<i>Spiroplectinella wrighti</i>	<i>Triloculina angusteoralis</i>
<i>Ammolagena clavata</i>	<i>Bulimina aculeata</i>	<i>Clavulina multicamerata</i>
<i>Evolvocassidulina bradyi</i>	<i>Gyroidina orbicularis</i>	<i>Lachlanella barnardi</i>
<i>Martinottiella communis</i>	<i>Planodiscorbis rarescens</i>	<i>Pyrgo depressa A</i>
<i>Rosalina vermiculata</i>	<i>Spirorutilus carinatus</i>	<i>Triloculina fichteliana</i>
<i>Ammonia neobeccarii</i>	<i>Bulimina marginata</i>	<i>Connemarella rudis</i>
<i>Fissurina spinosiformis</i>	<i>Hanzawaia boueana</i>	<i>Lachlanella bicornis</i>
<i>Melonis zaandamae</i>	<i>Planorbulina mediterraneensis</i>	<i>Pyrgo depressa B</i>
<i>Rutherfordoides rotundiformis</i>	<i>Stomatorbina concentrica</i>	<i>Triloculina trigonula</i>
<i>Amphicoryna scalaris</i>	<i>Bulimina striata</i>	<i>Cribromiliolinella subvalvularis</i>
<i>Fissurina variocarinata</i>	<i>Haplophragmoides tenuis</i>	<i>Laevidentalina communis</i>
<i>Miliolina oblonga</i>	<i>Planularia cassis</i>	<i>Pyrgo williamsoni</i>
<i>Rutherfordoides</i>	<i>Subreophax</i>	<i>Tritaxis conica</i>
<i>Amphicoryna separans</i>	<i>Cancris auriculus</i>	<i>Cribrostomoides subglobosus</i>
<i>Fissurina</i>	<i>Heterolepa bradyi</i>	<i>Laevidentalina subsoluta</i>
<i>Miliolinella</i>	<i>Planulina ariminensis</i>	<i>Pyrgoella sphaera</i>
<i>Sahulia barkeri</i>	<i>Tetragonostomina rhombiformis</i>	<i>Trochammina inflata</i>
<i>Astrononion stelligerum</i>	<i>Cancris carinatus</i>	<i>Cyclammina cancellata</i>
<i>Fursenkoina complanata</i>	<i>Hoeglundina elegans</i>	<i>Lagena aspera</i>
<i>Neolenticulina peregrina</i>	<i>Procerolagena gracilis</i>	<i>Quinqueloculina lamarckiana</i>
<i>Sigmoilopsis schlumbergeri</i>	<i>Textularia pseudotrochus</i>	<i>Uvigerina hispida</i>

Dendrophya radiata
Lagena gibbera
Quinqueloculina viennensis
Uvigerina mediterranea
Dentalina vertebralis
Lagena striata
Quinqueloculina
Uvigerina peregrina
Discammina compressa

Lagenammina arenatula
Rectuvigerina elongatastriata
Uvigerina pygmaea
Dorothia pseudoturris
Lagenammina testacea
Rectuvigerina nicoli
Vaginulinopsis sublegumen
Eggerella
Laticarinina pauperata

Recurvoides contortus
Eggerelloides advenus
Lenticulina iota
Reophax agglutinatus
Eggerelloides scaber
Lenticulina rotulata
Reophax bilocularis

Appendix II Analysis of Foraminifera in 28 samples from the Mauritanian shelf and slope of expedition MSM16/3 of RV Maria S. Merian. Quantitative abundances of benthic foraminifera. The data are derived from counts of 200 specimens in 27 samples and of all 53 specimens found in one sample.

Species/GeoB-	14703-1	14704-1	14705-1	14706-1	14714-1	14785-4	14788-1	14799-1	14847-1	14848-1	14852-1	14853-1	14854-1
Counted Specimens	200	200	200	200	200	53	200	200	200	200	200	200	200
<i>Acervulina inhaerens</i>						6	91						
<i>Ammobaculites filiformis</i>												1	3
<i>Ammodiscus tenuis</i>													
<i>Ammolagena clavata</i>											8	6	
<i>Ammonia neobeccarii</i>	134	5	32	6	2		2	23	12	32		13	
<i>Amphicoryna scalaris</i>													
<i>Bolivina beyrichi</i>											2	3	8
<i>Bolivina earlandi</i>	1												
<i>Bolivina spathulata</i>	3	1	1										
<i>Bolivina subaenariensis</i>													1
<i>Bulimina aculeata</i>											4	4	1
<i>Bulimina marginata</i>												2	1
<i>Bulimina striata</i>													1
<i>Cancris auriculus</i>		7		5			4	2					
<i>Cassidulina laevigata</i>	10		18	5									2
<i>Chilostomella oolina</i>											5		74

	14856-1	14858-1	14860-1	14865-1	14867-1	14878-1	14889-1	14895-1	14896-1	14898-1	14903-1	14904-1	14905-1	14910-2	14911-1	Total
	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	5453
																97
																4
														1	1	2
						1	2								1	18
		35	50	3	4	1	1		6		2	10	1	2		376
								1	2					2		5
	23											2				38
										1						2
										2						7
								2	10	4		14	34	5		70
	4									1				1		15
													1	3		7
										2				1		4
		1	1				11	9	13	5	3	6	2	6		75
	2									1				2		40
	9							1						1		90

Species/GeoB-	14703-1	14704-1	14705-1	14706-1	14714-1	14785-4	14788-1	14799-1	14847-1	14848-1	14852-1	14853-1	14854-1
<i>Cibicoides lobatulus</i>	3	25	15	13			49				2	2	3
<i>Cibicoides mundulus</i>		44	3	17							29	13	
<i>Cibicoides wuellerstorfi</i>											2	14	5
<i>Connemarella rudis</i>		3	2	55									
<i>Cribromiliolinella subvalvularis</i>													
<i>Cribrostomoides subglobosus</i>								1		10	8	3	
<i>Cyclammina cancellata</i>													
<i>Discammina compressa</i>		5		3					63	56	11	3	27
<i>Dorothia pseudoturris</i>								7					
<i>Eggerella</i>								2					1
<i>Eggerelloides advenus</i>													
<i>Eggerelloides scaber</i>												2	8
<i>Ehrenbergina serrata</i>													
<i>Elphidium crispum</i>	7	9	45	37		2	15	3		21	1	7	
<i>Elphidium fichtelianum</i>		1	2	3			2					2	
<i>Elphidium maorium</i>	1		1								1		
<i>Eponides repandus</i>						25	5						
<i>Fissurina</i>												4	
<i>Fursenkoina complanata</i>												2	
<i>Globobulimina doliolum</i>													4
<i>Globobulimina turgida</i>		1						4			6	4	5
<i>Globulina gibba</i>			1				7	1					
<i>Goesella cylindrica</i>		2								8			
<i>Gyroidina orbicularis</i>											4	6	3

	14856-1	14858-1	14860-1	14865-1	14867-1	14878-1	14889-1	14895-1	14896-1	14898-1	14903-1	14904-1	14905-1	14910-2	14911-1	Total
	14					2		1	1		1		1			132
	11	4	3			3	1	26	26	8		1		28	2	219
	3									6	3		5	3		41
																60
		2				2										4
		2					1								3	28
		1					1									2
	14		6													188
		55	19								7	4	8		11	111
			5								1	1	3		1	14
	1									1						2
	2													2		14
							1	13	3	23					12	52
	6	13	5													171
	1															11
																3
																30
	2									1						7
																2
	11												1			16
		2				19	28		10	2	11	11	8	3	5	119
																9
							1				1	3				15
	4					5		6	5	10				11		54

14856-1	14858-1	14860-1	14865-1	14867-1	14878-1	14889-1	14895-1	14896-1	14898-1	14903-1	14904-1	14905-1	14910-2	14911-1	Total
								19	7						34
															1
					1	1	3		7						12
								4		3					7
									2	1					3
															8
1									1	1					3
	1	5			12	17	6	7	1	7	17	5	5	13	105
															6
															4
							1								1
1															1
					2				1						3
8						2								1	43
															1
								3							3
2	2					7	7	3	5	1	7		6	1	67
						11	1				4				17
											1				1
											2				3
					2										2
14							3		2				1		28
							23	5	11				10		60
					7					1					8

Species/GeoB-	14703-1	14704-1	14705-1	14706-1	14714-1	14785-4	14788-1	14799-1	14847-1	14848-1	14852-1	14853-1	14854-1
<i>Miliolinella</i>													
<i>Neolenticulina peregrina</i>													
<i>Nonion fabum</i>	20	5	25	9								1	
<i>Oridorsalis umbonatus</i>													1
<i>Pararotalia</i>		1					1						
<i>Placopsilina bradyi</i>				7			12						
<i>Planispirinella exigua</i>								1					
<i>Planodiscorbis rarescens</i>		3											
<i>Planorbulina mediterraneensis</i>	1	1	3				2						
<i>Planulina ariminensis</i>		6						7		2		4	
<i>Procerolagena gracilis</i>													
<i>Proemassilina arenaria</i>											1		
<i>Psammosphaera fusca</i>								2			4		1
<i>Pullenia subcarinata</i>												3	
<i>Pyrgo depressa A</i>		1						1					1
<i>Pyrgo depressa B</i>		1											
<i>Pyrgo williamsoni</i>								4			5	1	
<i>Pyrgoella sphaera</i>													
<i>Quinqueloculina lamarckiana</i>			2		3	7		6	124	61	6	6	
<i>Quinqueloculina viennensis</i>	14									3			
<i>Quinqueloculina</i>		4		2	2	5	1	2					
<i>Rectuvigerina elongatastriata</i>												2	
<i>Recurvoides contortus</i>													4
<i>Reophax agglutinatus</i>								1				4	

	14856-1	14858-1	14860-1	14865-1	14867-1	14878-1	14889-1	14895-1	14896-1	14898-1	14903-1	14904-1	14905-1	14910-2	14911-1	Total
		2									3		8			13
								4	7	3			1	5		20
		1				2					1			1		65
								2	1	1						5
			1													3
																19
		5									1				1	8
																3
		7														14
	4		46			37	10	11	7	12	25	23	4	23	9	230
	1															1
													1			2
	10															17
																3
		2														5
							2					3	2		4	12
		10				9					15	8	4			56
											6		1		2	9
		5	8	37	186	8	1		6		4	3			5	478
		2														19
	4	3		8	1						3	1	2			38
										1				5		8
																4
	2						6					3			3	19

	14856-1	14858-1	14860-1	14865-1	14867-1	14878-1	14889-1	14895-1	14896-1	14898-1	14903-1	14904-1	14905-1	14910-2	14911-1	Total
															1	5
									2		2					14
						13								2	1	19
	1															3
		1				1	7	4	1	1	4	4	9	3	7	49
		25	48			48	84	23	31	25	83	72	93	11	122	770
	2															11
																1
			1													1
	12						3	14	2					2		124
										1						1
						3			3	2				1		17
																11
		5				8					3				5	37
						11				1						12
		1	1			3										71
														1		4
			1								2		3			6
				152	9											352
		6														19
	1	1														6
	6															32
								1							1	16
								3			1			11		15

14856-1	14858-1	14860-1	14865-1	14867-1	14878-1	14889-1	14895-1	14896-1	14898-1	14903-1	14904-1	14905-1	14910-2	14911-1	Total
							3		2				5		15
	3									3		3			9
															8
9															24
															1
													6		10
3							7	3	2						17
12	3					2	25	20	45	1			17		145
													2		2

Appendix III Analysis of Foraminifera in 28 samples from the Mauritanian shelf and slope of expedition MSM16/3 of RV Maria S. Merian. Quantitative abundances of important species with a share of at least 10% in one sample.

Species/GeoB-	14703-1	14704-1	14705-1	14706-1	14714-1	14785-4	14788-1	14799-1	14847-1	14848-1	14852-1	14853-1	14854-1
Counted Specimens	167	132	150	153	195	40	163	154	200	175	137	94	119
<i>Acervulina inhaerens</i>						6	91						
<i>Ammonia neobeccarii</i>	134	5	32	6	2		2	23	12	32		13	
<i>Bolivina beyrichi</i>											2	3	8
<i>Bolivina subaenariensis</i>													1
<i>Chilostomella oolina</i>											5		74
<i>Cibicoides lobatulus</i>	3	25	15	13			49				2	2	3
<i>Cibicoides mundulus</i>		44	3	17							29	13	
<i>Connemarella rudis</i>		3	2	55									
<i>Discammina compressa</i>		5		3					63	56	11	3	27
<i>Dorothia pseudoturris</i>								7					
<i>Ehrenbergina serrata</i>													
<i>Elphidium crispum</i>	7	9	45	37		2	15	3		21	1	7	
<i>Eponides repandus</i>						25	5						
<i>Globobulimina turgida</i>		1						4			6	4	5
<i>Melonis zaandamae</i>											1	9	1
<i>Nonion fabum</i>	20	5	25	9								1	
<i>Planulina ariminensis</i>		6						7		2		4	
<i>Quinqueloculina lamarckiana</i>			2		3	7		6	124	61	6	6	
<i>Rosalina vermiculata</i>								102		3			
<i>Sigmoilopsis schlumbergeri</i>											72	19	
<i>Spiroplectinella wrighti</i>	3	25	22	13			1	2					
<i>Tetragonostomina rhombiformis</i>					190				1				
<i>Uvigerina peregrina</i>		4	4								2	10	

	14856-1	14858-1	14860-1	14865-1	14867-1	14878-1	14889-1	14895-1	14896-1	14898-1	14903-1	14904-1	14905-1	14910-2	14911-1	Total
	105	144	186	192	199	123	131	139	127	130	135	140	149	115	154	4048
																97
		35	50	3	4	1	1		6		2	10	1	2		376
	23											2				38
								2	10	4		14	34	5		70
	9							1						1		90
	14					2		1	1		1		1			132
	11	4	3			3	1	26	26	8		1		28	2	219
																60
	14		6													188
		55	19								7	4	8		11	111
							1	13	3	23				12		52
	6	13	5													171
																30
		2				19	28		10	2	11	11	8	3	5	119
								23	5	11				10		60
		1				2					1			1		65
	4		46			37	10	11	7	12	25	23	4	23	9	230
		5	8	37	186	8	1		6		4	3			5	478
		25	48			48	84	23	31	25	83	72	93	11	122	770
	12						3	14	2					2		124
		1	1			3										71
				152	9											352
	12	3					2	25	20	45	1			17		145

Appendix IV Analysis of Foraminifera in 28 samples from the Mauritanian shelf and slope of expedition MSM16/3 of RV Maria S. Merian. Quantitative abundances of species with an overall count of at least 35 specimens grouped by life strategy.

Total	Species/Sample GeoB-	14703-1	14704-1	14705-1	14706-1	14714-1	14785-4	14788-1	14799-1	14847-1	14848-1	14852-1	14853-1
Infaunal													
376	<i>Ammonia neobeccarii</i>	134	5	32	6	2	0	2	23	12	32	0	13
38	<i>Bolivina beyrichii</i>	0	0	0	0	0	0	0	0	0	0	2	3
70	<i>Bolivina subaenariensis</i>	0	0	0	0	0	0	0	0	0	0	0	0
40	<i>Cassidulina laevigata</i>	10	0	18	5	0	0	0	0	0	0	0	0
90	<i>Chilostomella oolina</i>	0	0	0	0	0	0	0	0	0	0	5	0
219	<i>Cibicoides mundulus</i>	0	44	3	17	0	0	0	0	0	0	29	13
119	<i>Globobulimina turgida</i>	0	1	0	0	0	0	0	4	0	0	6	4
43	<i>Lagenammina arenatula</i>	0	0	0	0	0	0	0	0	0	0	9	11
60	<i>Melonis zaandamae</i>	0	0	0	0	0	0	0	0	0	0	1	9
65	<i>Nonion fabum</i>	20	5	25	9	0	0	0	0	0	0	0	1
145	<i>Uvigerina peregrina</i>	0	4	4	0	0	0	0	0	0	0	2	10
1265	Total Infaunal	164	59	82	37	2	0	2	27	12	32	54	64
Epifaunal attached													
97	<i>Acervulina inhaerens</i>	0	0	0	0	0	6	91	0	0	0	0	0
132	<i>Cibicoides lobatulus</i>	3	25	15	13	0	0	49	0	0	0	2	2
60	<i>Connemarella rudis</i>	0	3	2	55	0	0	0	0	0	0	0	0
105	<i>Hyrrokkin sarcophaga</i>	0	0	0	0	0	5	0	3	0	1	0	0
230	<i>Planulina ariminensis</i>	0	6	0	0	0	0	0	7	0	2	0	4
49	<i>Rosalina semipunctata</i>	0	0	0	0	0	0	0	7	0	0	0	0
770	<i>Rosalina vermiculata</i>	0	0	0	0	0	0	0	102	0	3	0	0
71	<i>Spiroplectinella wrighti</i>	3	25	22	13	0	0	1	2	0	0	0	0
1514	Total Epifaunal attached	6	59	39	81	0	11	141	121	0	6	2	6

	14854-1	14856-1	14858-1	14860-1	14865-1	14867-1	14878-1	14889-1	14895-1	14896-1	14898-1	14903-1	14904-1	14905-1	14910-2	14911-1
	0	0	35	50	3	4	1	1	0	6	0	2	10	1	2	0
	8	23	0	0	0	0	0	0	0	0	0	0	2	0	0	0
	1	0	0	0	0	0	0	0	2	10	4	0	14	34	5	0
	2	2	0	0	0	0	0	0	0	0	1	0	0	0	2	0
	74	9	0	0	0	0	0	0	1	0	0	0	0	0	1	0
	0	11	4	3	0	0	3	1	26	26	8	0	1	0	28	2
	5	0	2	0	0	0	19	28	0	10	2	11	11	8	3	5
	12	8	0	0	0	0	0	2	0	0	0	0	0	0	0	1
	1	0	0	0	0	0	0	0	23	5	11	0	0	0	10	0
	0	0	1	0	0	0	2	0	0	0	0	1	0	0	1	0
	0	12	3	0	0	0	0	2	25	20	45	1	0	0	17	0
	103	65	45	53	3	4	25	34	77	77	71	15	38	43	69	8
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	14	0	0	0	0	2	0	1	1	0	1	0	1	0	0
	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	1	5	0	0	12	17	6	7	1	7	17	5	5	13
	0	4	0	46	0	0	37	10	11	7	12	25	23	4	23	9
	0	0	1	0	0	0	1	7	4	1	1	4	4	9	3	7
	0	0	25	48	0	0	48	84	23	31	25	83	72	93	11	122
	0	0	1	1	0	0	3	0	0	0	0	0	0	0	0	0
	3	18	28	100	0	0	103	118	45	47	39	120	116	112	42	151

Total	Species/Sample GeoB-	14703-1	14704-1	14705-1	14706-1	14714-1	14785-4	14788-1	14799-1	14847-1	14848-1	14852-1	14853-1
Epifaunal free													
75	<i>Cancris auricula</i>	0	7	0	5	0	0	4	2	0	0	0	0
41	<i>Cibicoides wuellerstorfi</i>	0	0	0	0	0	0	0	0	0	0	2	14
52	<i>Ehrenbergina serrata</i>	0	0	0	0	0	0	0	0	0	0	0	0
171	<i>Elphidium crispum</i>	7	9	45	37	0	2	15	3	0	21	1	7
54	<i>Gyroidina orbicularis</i>	0	0	0	0	0	0	0	0	0	0	4	6
67	<i>Lenticulina rotulata</i>	0	8	0	11	0	0	0	6	0	0	1	0
124	<i>Sigmoilopsis schlumbergeri</i>	0	0	0	0	0	0	0	0	0	0	72	19
584	Total Epifaunal free	7	24	45	53	0	2	19	11	0	21	80	46
Epifaunal indistinct													
188	<i>Discammina compressa</i>	0	5	0	3	0	0	0	0	63	56	11	3
111	<i>Dorothia pseudoturris</i>	0	0	0	0	0	0	0	7	0	0	0	0
56	<i>Pyrgo williamsoni</i>	0	0	0	0	0	0	0	4	0	0	5	1
478	<i>Quinqueloculina lamarckiana</i>	0	0	2	0	3	7	0	6	124	61	6	6
37	<i>Spiroloculina excavata</i>	0	2	0	7	0	0	1	6	0	0	0	0
352	<i>Tetragonostomina rhombiformis</i>	0	0	0	0	190	0	0	0	1	0	0	0
1222	Total Epifaunal indistinct	0	7	2	10	193	7	1	23	188	117	22	10
4585	Total	177	149	168	181	195	20	163	182	200	176	158	126

14854-1	14856-1	14858-1	14860-1	14865-1	14867-1	14878-1	14889-1	14895-1	14896-1	14898-1	14903-1	14904-1	14905-1	14910-2	14911-1
0	0	1	1	0	0	0	11	9	13	5	3	6	2	6	0
5	3	0	0	0	0	0	0	0	0	6	3	0	5	3	0
0	0	0	0	0	0	0	1	13	3	23	0	0	0	12	0
0	6	13	5	0	0	0	0	0	0	0	0	0	0	0	0
3	4	0	0	0	0	5	0	6	5	10	0	0	0	11	0
0	2	2	0	0	0	0	7	7	3	5	1	7	0	6	1
0	12	0	0	0	0	0	3	14	2	0	0	0	0	2	0
8	27	16	6	0	0	5	22	49	26	49	7	13	7	40	1
27	14	0	6	0	0	0	0	0	0	0	0	0	0	0	0
0	0	55	19	0	0	0	0	0	0	0	7	4	8	0	11
0	0	10	0	0	0	9	0	0	0	0	15	8	4	0	0
0	0	5	8	37	186	8	1	0	6	0	4	3	0	0	5
0	0	5	0	0	0	8	0	0	0	0	3	0	0	0	5
0	0	0	0	152	9	0	0	0	0	0	0	0	0	0	0
27	14	75	33	189	195	25	1	0	6	0	29	15	12	0	21
141	124	164	192	192	199	158	175	171	156	159	171	182	174	151	181

Appendix V Analysis of Foraminifera in 28 samples from the Mauritanian shelf and slope of expedition MSM16/3 of RV Maria S. Merian. Faunal parameters per sample for species with an overall count of at least 35 specimens. For the life strategy (in- and epifaunal) the cumulative counts from Appendix IV are used.

Station GeoB-/ Faunal Parameter	Infaunal	Epifaunal attached	Epifaunal free	Epifaunal indistinct	Fisher's alpha α	Shannon H	Pielou's Equitability J
14703-1	164	6	7	0	3,1110	1,2930	0,5040
14704-1	59	59	24	7	10,7600	2,8080	0,8103
14705-1	82	39	45	2	5,5330	2,3880	0,7972
14706-1	37	81	53	10	4,7940	2,3780	0,8228
14714-1	2	0	0	193	0,9302	0,2668	0,1658
14785-4	0	11	2	7	2,1610	1,6000	0,8223
14788-1	2	141	19	1	4,4390	1,7430	0,6152
14799-1	27	121	11	23	7,1210	2,0430	0,6429
14847-1	12	0	0	188	0,7084	0,8556	0,6172
14848-1	32	6	21	117	3,1110	1,8050	0,7037
14852-1	54	2	80	22	8,4110	2,4650	0,7480
14853-1	64	6	46	10	14,4600	3,3940	0,9264
14854-1	103	3	8	27	10,7600	2,5070	0,7233
14856-1	65	18	27	14	11,2500	3,1330	0,8959
14858-1	45	28	16	75	8,8610	2,5220	0,7568
14860-1	53	100	6	33	3,7560	1,9570	0,7226
14865-1	3	0	0	189	0,7084	0,7125	0,5140
14867-1	4	0	0	195	0,7084	0,3118	0,2249
14878-1	25	103	5	25	6,7100	2,5160	0,8025
14889-1	34	118	22	1	6,3080	2,1170	0,6849
14895-1	77	45	49	0	7,9720	2,7900	0,8564
14896-1	77	47	26	6	7,9720	2,8430	0,8726
14898-1	71	39	49	0	12,2800	2,8290	0,7958
14903-1	15	120	7	29	9,7880	2,3460	0,6896
14904-1	38	116	13	15	6,3080	2,3580	0,7627
14905-1	43	112	7	12	6,7100	2,0370	0,6495
14910-2	69	42	40	0	12,2800	3,0940	0,8701
14911-1	8	151	1	21	6,3080	1,7070	0,5522
Total	1265	1514	584	1222			
	4585						

Appendix VI Analysis of Foraminifera in 28 samples from the Mauritanian shelf and slope of expedition MSM16/3 of RV Maria S. Merian. Quantitative and relative abundances of species in the living coral and non-living subcluster A with an overall share in the cluster of 5 % or more. The clusters are based on counts given in appendix II and calculated with the multivariate, classical hierarchical cluster analysis in Q-mode with Ward's method algorithm.

Living Coral Cluster										
Species/Sample	GeoB 14799-1	GeoB 14878-1	GeoB 14889-1	GeoB 14903-1	GeoB 14904-1	GeoB 14905-1	GeoB 14911-1	Total		
<i>Rosalina vermiculata</i>	102 51,0%	48 24,0%	84 42,0%	83 41,5%	72 36,0%	93 46,5%	122 61,0%	604 43,1%		
<i>Planulina ariminensis</i>	7 3,5%	37 18,5%	10 5,0%	25 12,5%	23 11,5%	4 2,0%	9 4,5%	115 8,2%		
<i>Globobulimina turgida</i>	4 2,0%	19 9,5%	28 14,0%	11 5,5%	11 5,5%	8 4,0%	5 2,5%	86 6,1%		
<i>Hyrrokkhin sarcophaga</i>	3 1,5%	12 6,0%	17 8,5%	7 3,5%	17 8,5%	5 2,5%	13 6,5%	74 5,3%		
Subtotal	116 58,0%	116 58,0%	139 69,5%	126 63,0%	123 61,5%	110 55,0%	149 74,5%	879 62,8%		
Total counted specimens	200	200	200	200	200	200	200	1400		

Non Living Coral Subcluster A					
Species/Sample	GeoB 14895-1	GeoB 14896-1	GeoB 14898-1	GeoB 14910-2	Total
<i>Uvigerina peregrina</i>	25 12,5%	20 10,0%	45 22,5%	17 8,5%	107 13,4%
<i>Rosalina vermiculata</i>	23 11,5%	31 15,5%	25 12,5%	11 5,5%	90 11,3%
<i>Cibicides mundulus</i>	26 13,0%	26 13,0%	8 4,0%	28 14,0%	88 11,0%
<i>Planulina ariminensis</i>	11 5,5%	7 3,5%	12 6,0%	23 11,5%	53 6,6%
<i>Ehrenbergina serrata</i>	13 6,5%	3 1,5%	23 11,5%	12 6,0%	51 6,4%
<i>Melonis zaandamae</i>	23 11,5%	5 2,5%	11 5,5%	10 5,0%	49 6,1%
Subtotal	121 60,5%	92 46,0%	124 62,0%	101 50,5%	438 54,8%
Total counted specimens	200	200	200	200	800

