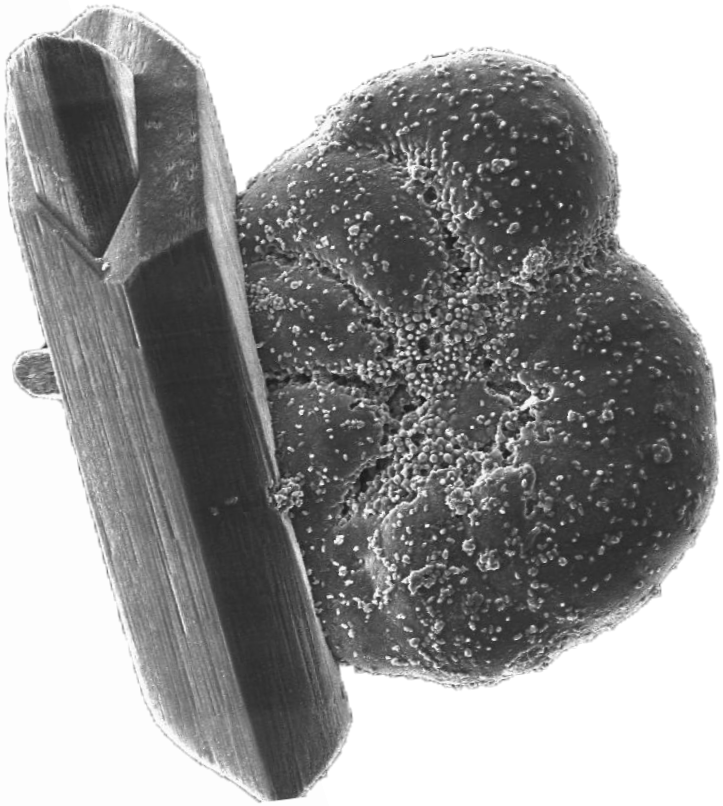
Universidade do Algarve

ECOLOGIC ZONATION MODEL OF THE BENTHIC FORAMINIFERA AND THECAMOEBIANS OF GUADIANA RIVER ESTUARY AND APPLICATION IN PALEOENVIRONMENTAL RECONSTRUCTION

VOLUME II

ATLAS OF BENTHIC FORAMINIFERA AND THECAMOEBIAN SPECIES FROM THE GUADIANA RIVER ESTUARY

Dionilde Sarita Graça Camacho da Encarnação



Trabalho efetuado sobre a orientação de: Doutora Delminda Maria de Jesus Moura
Doutor Tomasz Boski
Doutor David B. Scott

Dissertação de Doutoramento em Ciências do Mar

Especialidade em Processos de Ecossistemas Marinhos

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Atlas of benthic foraminifera and thecamoebian species from the Guadiana River Estuary

Chapter 9

9 - Atlas of benthic foraminifera and thecamoebian species from the Guadiana River Estuary

9. 1. Chapter objectives

This chapter was created to bring together all the methodologies and information resulting from the identification and classification of the foraminifera and thecamoebians of the Guadiana Estuary as they were the main subject proxies in this work. Each group of organisms was presented in a historical and biological context. All the identification methodologies, with special emphasis to genetic analysis, are here described. The Atlas gathers 304 SEM photographs which illustrate 78 species of foraminifera, 16 species of thecamoebians and, at least, 3 species of tintinnids. Each species of foraminifera is described in terms of their morphological characteristics and distribution within the estuary in individual reports. The thecamoebians, which in the beginning were to be a complementary information proxy, reveled to be a very fruitful data source group. Exceeding all expectations, enabled to compile a considerable amount of pictures of different formae which are being presented for the first time in Portugal. The tintinnids, which were initially misidentified and counted as thecamoebians, were also included and illustrated in the present work.

With the present Atlas is expected to provide to future works concerning the use of foraminifera and thecamoebians, a species catalogue in which the identification task can be based on. The inexistence of such helpful tool has been felt, not only by the author but by all those that work with these microrganims in the Algarvian estuarine systems, especially the beginners and high-school teachers, which not being experts are interested in explore and give to know to the class-room the usefulness of the foraminifera as bioindicators. Is also expected to bring new insights and to contribute to the worldwide systematic's long lived debate.

9. 2. Foraminifera

9. 2. 1. What are foraminifera?

Foraminifera are single celled eukaryote organisms which belong to Kingdom Chromista, Phylum Foraminifera (Hayward et al., 2012). Possess a hard shell often distinctively coiled to resemble that of a gastropod or cephalopod (Lowe and Walker, 1997) which after death remains in the sediment where it can fossilize.

The foraminifera were first described and illustrated in the sixteenth century, but were not studied systematically until the latter part of the nineteenth century following the remarkable voyage of HMS Challenger which began in 1872. The discovery during that expedition of living foraminifera in deep-sea waters, and fossil remains in sediments that were dredged from the sea floor, revolutionized marine micropaleontology (Lowe and Walker, 1997).

Stratigraphically, the foraminifers appear in the Early Cambrian (the first unambiguous ones are from the lowermost Cambrian of West Africa), at about the same time that the metazoans with skeletons (Pawlowski et al., 2003), differentiating in innumerous species which adapted to all marine environments, since the most superficial till the highest oceanic depths (Scott et al., 2001). Molecular studies indicate this appearance must have been preceded by a broad radiation of naked, practically unfossilizable unicellular species that diverged from a Cercozoarian ancestor several million years before the beginning of the Phanerozoic (Pawlowski et al., 2003). At the moment, is estimated to exist around 4000 species of foraminifera (Debenay et al., 2010) of which only 40 to 50 are planktic (Sen Gupta, 1999a).

The benthic species live in the bottoms where they can be free or sessile, epifaunal (attached to the substrate - sand, stones, rocks, animal shells, etc), epifaunal epiphyte (attached to algae or sea-grass) or infaunal, living in the interior of the sediment (Calonge et al., 2001). The planktic forms float passively in the water column, moved only by currents but capable of vertical migration (Debenay et al., 2010)

Whereas metazoans evolved organs and other specialized features through the multicellularity, he foraminifera as other eukaryotes specialized by diversifying subcellular components or organelles to perform their vital functions (Goldstein, 1999).

Two broad morphological features distinguish the foraminifera from the other chromists:

- They possess granuloreticulopodia which are fine, thread-like, pseudopodia that anastomose and have a granular texture when viewed with the light microscope (Goldstein, 1999). The granuloreticulopodia emerges from one or several orifices

existent in the test, foramina (a term from which the name of the group is derived), and are used in the captures of praise, in substrate fixation, in physiological residues elimination, in dislocations and test construction (Seyve, 1990).

- Nearly all foraminifera possess a test or shell that encompasses the organism and separates it from the surrounding milieu. The test may be organic (not mineralized), agglutinated (constructed of foreign particles cemented together by the foraminifer), composed of calcium carbonate or, in rare cases, silica (Goldstein, 1999).

There are considerable variations in the dimension, morphology, composition and microstructure of the foraminifera tests. Those features are of great taxonomic importance for being intimately related with physiological differences, habitat, ecological niche and several types of reproductive strategies, each with repercussions in their life cycles.

The organic-walled forms belong to the Order Allogromiida. They have a thin, non-rigid test of proteinaceous or pseudochitinous matter generally termed tectin (Armstrong and Brasier, 2005). It is not common to find fossil records of organic-walled forms because the test preservation only occurs in very favorable conditions (Sen Gupta, 1999b).

The agglutinated forms collect organic and mineral matter from the sea floor and bound it together by an organic, calcareous or ferric oxide cement. The grains are commonly selected for size, texture or composition (e.g. coccoliths, sponge spicules and heavy minerals) (Armstrong and Brasier, 2005). The determination of the cement and bounded particles composition provide information about the type of sediment and environmental conditions at the time of test construction (Commeau et al., 1985). Although, there are several genus which are not selective and use, indiscriminately, every type of material available in the sea bottom (Haynes, 1981).

The calcareous forms can be separated in porcelaneous and hyalines (also called glassy), according to their appearance to transmitted light. The porcelaneous are opaque, reflecting all the light and the glassy, as the name suggests, are translucent to the light passage (Haynes, 1981). Porcelaneous tests are imperforate with a milky or amber aspect and are characteristic of the Order Miliolida. These tests are constructed by the secretion of tiny needles of high magnesium calcite within tiny vesicles in the cytoplasm, which are then exported to the outer margin of the cell (Armstrong and Brasier, 2005). In the hyaline forms the test is build by a bio-mineralization process which have place exteriorly to the protoplasmatic body (Calonge et al., 2001). This type of wall shows numerous perforations (pores) of very small diameter so that is also termed "calcareous perforate". Together with the aperture the pores function as

passages for the cytoplasm carrying food or waste products between the interior and the exterior of the test (Albani et al., 2001).

The siliceous tests are very rare and their systematic position and phylogeny are badly known. It is hard to determine if the silica in the fossil tests is biogenic or results from diagenetic substitution processes (Debenay et al., 1996).

Most benthic foraminifers are opportunistic omnivores (Debenay et al., 2010). They adopted a broad range of feeding mechanisms and nutritional resources including herbivory, bacterivory, suspensivory, detritivory, carnivory and parasitism (see review by Murray, 2006). Some large calcareous and planktic forms can bear in the endoplasm naked photosybionts, especially diatoms and dinoflagellates that aid in supplying energy (Armstrong and Brasier, 2005) and some are able to sequester and house chloroplasts (chloroplast husbandry) but not the entire cell (Goldstein, 1999).

The life cycle of foraminifera is characterized by an alternation between two generations: the gamogony, the generation which reproduces sexually, and a schizogony, the generation which reproduces asexually (Boersma, 1998). The individuals generated present dimorphism in the form and size of the proloculus (first cell). Individuals resulting from schizogony produces megalosespheric forms (with a large proloculus but smaller test) and the individuals resulting from gamogony produces microespheric forms (with a small proloculus but larger test) (Haynes, 1981).

9. 2. 2. New insights in foraminifera classification

The test is the most studied element of foraminifera for it serves as the base of actual classification which rests, almost exclusively, in its morphological characteristics (Debenay et al., 1996). However, the taxonomic value of those characteristics is questionable due to the influence of environmental factors on the morphology of foraminiferal tests, which makes distinction between ecophenotypes and species difficult (Holzmann and Pawlowski, 1997). The identification difficulties are particularly inconvenient in the case of species of worldwide distribution and with high morphological variability, such as the genera *Ammonia* and *Elphidium* (Hayward et al., 2004). The high morphological variability of *Ammonia*, for instance, renders its status uncertain and controversial (Debenay et al., 1998a; Holzmann and Pawlowski, 1997; Holzmann et al., 1998; Langer and Leppig, 2000; Pawlowski et al., 1995), with more than 40 species and subspecies (or varieties) being described worldwide (Hayward et al., 2004). The recent application of molecular methods and techniques is bringing new

insights into foraminifera taxonomy. Pawlowski et al. (1994) demonstrate that the analysis of RNA ribosomal sequences can be applied in the identification of the foraminiferal species, providing a new taxonomic criterion, independent of the morphologic characteristics of the test. Molecular analysis also enables an evaluation of the ecological significance of the different morphologic characteristics and the determination of intraspecific morphological variability (Pawlowsky et al., 1994). In the future, it is expected that all the specific definitions related to modern foraminifera will include not only the traditional description of their morphology and distribution, but also the respective genetic information (Pawlowski et al., 1994).

9. 2. 3. Identification and classification

The most important foraminifera species were photographed using an scanning electron microscope (SEM), model JEOL JSM–5410, based at Huelva University. The photographs and plates were edited and compiled with Adobe Photoshop (Ps) CS5.

Several guides were used for identification, especially Loeblich and Tappan (1988), Colom (1974), Jones (1994) and the Ellis and Messina (1942–2012) online catalogue. The principal reference was the collection gathered during a study of Guadiana river paleoenvironments (Camacho, 2004) and the collection of modern assemblages from the Ria Formosa and Guadiana estuary for projects FORMOSE, PRAXIS XXI//2/22.1/MAR 1745/95 and MEGASIG SP5.P23/02- INTERREG IIIA.

Most of the foraminifera were classified accordingly to the generic classification proposed by Loeblich and Tappan (1988). For the higher levels of taxonomy, other than genus and species, the Worm's classification was followed (World Register of Marine Species – www.marinespecies.org), which adopted the recent modifications proposed by Cavalier-Smith (2010) (Hayward, personal communication, 2012). Cavalier-Smith (2010) discussed eukaryotic deep phylogeny and reclassified the basal eukaryotic kingdom Protozoa and derived kingdom Chromista in the light of multi-gene trees. The author transferred the formerly protozoan Heliozoa and infrakingdoms Alveolata and Rhizaria into Chromista, which is a sister to kingdom Plantae and arguably originated by synergistic double internal enslavement of green algal and red algal cells. He also established new subkingdoms for the expanded Chromista, being Harosa the subkingdom to which foraminifera belongs.

In collaboration with the project foramBARCODING, a molecular database of foraminifera, based at Geneva University and coordinated by Pawlowski and Holzmann (2010–2012), several species were identified at genetic level. To accomplish this, two extra field campaigns

were made with the aim of collecting live specimens, the first in November 2010 and the second in March 2011. During both campaigns the most fruitful sites in terms of foraminifera densities in the previous sampling campaigns were revisited and sampled. Samples of the top centimeter of sediment were collected by hand with a scraper. In the laboratory, two subsamples were taken and washed. One was stained with Rose Bengal to evaluate the quantity and quality of live specimens, and the other was left to settle for a couple of hours in sea water. With the use of a stereomicroscope, foraminifera suspected to be alive were isolated for better monitoring. When the evidence of life was strong the specimens were placed in plastic vials filled with extraction buffer guanidine. At least 4 live specimens of each species were separated and sent to Geneva for genetic analysis. In Geneva, every specimen was incubated at 60º C for 1 h, followed by a short centrifugation to remove insoluble material (Pawlowski, personal communication, 2010). Three forms of *Ammonia*, two species of *Elphidium* and the species *Discorinopsis aguayoi* were successfully analyzed. The specimens were photographed under a stereomicroscope prior to DNA extraction and the photographs are included in the Atlas.

The following methodology was adapted from the general procedure in Pawlowski and Holzmann (2010–2012), detailed in Pawlowski (2000). The analyzed barcoding region is situated at the 3' end of the SSU rRNA gene and is amplified using the primer pairs s14F3 (acgcamgtgtgaaacttg)-sB (tgatccttctgcaggttcacctac). It is usually necessary to perform a nested PCR, replacing primer 14F3 with primer 14F1 (aagggcaccacaagaacgc). The barcoding region spans six foraminifera-specific hypervariable expansion segments, 37f, 41f, 43f, 45e, 47f and 49e, which were shown to be sufficiently variable to differentiate between closely related species. The length of the barcoding region varies between 1000-1200 nucleotides depending on the species. Most amplifications are done on single-cell DNA extractions. Because of intra-individual polymorphism, the amplification products are cloned and 2-3 clones are sequenced. After sequencing the results were aligned, confirming the presence of several species. The sequence of each species analyzed is documented in the respective species report.

9. 2. 4. Results and discussion

There is a generalized tendency among taxonomists to raise varieties and subspecies to species rank and to distinguish new species on subtle morphologic differences. Likewise, the differences between genera are becoming smaller. Collectively these trends reduce the chances of consistent identification because the system depends on the judgment of each observer

rather than on unambiguously defined criteria (Murray, 2007). In order to avoid contributing to this general trend towards taxonomic entropy, several taxa identified by the author were left in open nomenclature or in *incertae sedis*. This was the case of the miliolids, which, in the absence of type material and similarities with other miliolids in the same geographical area (eg. Colom, 1974; Villanueva et al., 1999), were classified with code names. Nevertheless, a short list of possible nomenclature is presented in the Atlas for each taxon, based on comparisons with previous works. Whenever possible, the identification was based on molecular analysis. Priority was given to cosmopolitan but doubtful genera like *Ammonia* and *Elphidium*, as well as some potentially good environmental indicators with stenotopic behavior, such as *Discorinopsis aguayoi*. Unfortunately, analysis of the subunits of rRNA genes only yielded results for a limited number of species. Genetic codes deciphered successfully are presented in the Atlas in the respective species report. Among the species that gave somewhat controversial results is *Discorinopsis aguayoi*, which is considered an agglutinated species (Loeblich and Tappan, 1988) because it agglutinates calcareous particles during test construction. However, this epiphytic species has an obvious hyaline aspect (see Fig. 9.16) and is one of the species most susceptible to carbonate dissolution (Camacho, unpublished data). A preliminary analysis revealed that the *D. aguayoi* ribosomal RNA sequence branches at the base of a clade containing *Glabratella*, an epiphytic calcareous foraminifera. These findings clearly suggest that the taxonomic classification of this species should be revised, probably along with many other species in the future.

Ammonia genus includes species that are among the most common benthic foraminifera in the shallow waters of marginal marine environments globally (Langer and Leppig, 2000). With 35 taxa so far described, the genus *Ammonia* exhibits a significant range of morphological variants, making species identification particularly difficult (Holzmann et al., 1998; Langer and Leppig, 2000). Three morphological variants of *Ammonia* were sent for genetic analysis to avoid later criticism from taxonomists, some of whom sit in opposing camps when it comes to defining taxa, commonly termed ‘lumpers’ and ‘splitters’. ‘Lumpers’ defend that all morphotypes are included in a unique taxon. For example, *Ammonia beccarii*, when cultured, produced at least six morphological “species” from one clone (Schnitker, 1974), suggesting that this is a species of high morphological variability. On the other hand, the ‘splitters’ defend that the different morphological variants are separate species, each with a distinct ecological indicator value. Although the latter may be more attractive due to the extra information that the division in ecophenotypes brings, it can only be accurate when supported by genetic analysis, otherwise it will be only stand as one more opinion based on observation. Genetic analyses of

the three *Ammonia* variants were only successful in *Ammonia* sp2 and sp3. Both align with *Ammonia* T2 (in Hayward et al., 2004), thus corresponding to the species *Ammonia aberdoveyensis* in the foramBarcoding.unige.ch database. Further field collections and analysis of *Ammonia* sp1 proved fruitless. Based on morphological similarities, the lack of correlation of each variant to specific environmental conditions and the confirmation that *Ammonia* sp2 and sp3 are the same species, led us to believe that all the specimens of *Ammonia* found in Guadiana estuary belong to *A. aberdoveyensis* species and the morphological differences result from the existence of an intergradational morphological rank.

Another of the controversial species successfully submitted for genetic analysis was the species here considered as *Elphidium oceanensis* (d'Orbigny) based on strong morphological similarities with the specimens found at Portuguese and Spanish estuaries (Murray, 1971); Alday et al., 2006; Cearreta, 1988; Cearreta et al., 2002; Cearreta et al., 2007; Leorri and Cearreta, 2004. The *Elphidium* genus has dozens of species (Hayward et al., 2012), some with several varieties and formae (ecophenotypes), as is the case of *Elphidium excavatum* (Terquem) species (Feyling-Hanssen, 1972; Miller et al., 1982), which is one of the most difficult *taxon* to identify and classify. *Elphidium* species usually range from brackish lagoonal environments to the continental shelf (Li et al., 2000) and, when associated with the *Ammonia* group and *Haynesina germanica*, are indicative of estuarine and low intertidal environments (Edwards and Horton, 2000; Horton and Edwards, 2000). In the present study, several morphological varieties of living *Elphidium* were recorded, although only *E. oceanensis* was significantly abundant and even dominant in summer. This species is believed to belong to the same controversial plexus of elphidiid taxa abridged by Langer and Schmidt-Sinns (2006). The question is whether *Elphidium gunteri* (Cole), *Elphidium gunteri* (Cole) var. *waddensis* (Van Voorthuyen), *Elphidium oceanensis* (d'Orbigny), *Elphidium littoral* (LeCalvez and LeCalvez) are conspecific, being different phenotypes of the same species, or if they are different species being lumped together. Langer and Schmidt-Sinns (2006), based on series of ontogenetic growth and test morphological characteristics, propose the distinction of a new species, named *Cribroelphidium mirum*, endemic to the SE Atlantic (between Namibia and South Africa), from the plexus of species under discussion (see Langer and Schmidt-Sinns, 2006, for further details). In the present work, the genetic analysis sheds new light on this question, although it does not answer it definitively. According to the results, the species presented here as *E. oceanensis* is in fact *Elphidium excavatum* of the foramBarcoding.unige.ch database and is nearly identical to the sequence of the *E. excavatum* referenced with the code EF534073 in

GenBank (www.ncbi.nlm.nih.gov). These results suggest that *E. oceanensis* in this study is in fact one ecophenotype of the complex species *E. excavatum* and not a distinct species as Langer and Schmidt-Sinns (2006) claim. Only future molecular data will reveal whether the present species is the same as *C. mirum* of Langer and Schmidt-Sinns (2006), *E. oceanensis* (d'Orbigny) of Murray (1971) and Cearreta (1988), and *E. gunteri* (Cole) of Hayward et al. (1997).

9. 2. 5. Conclusions

The preliminary application of genetic techniques brought new insights into the classification of some of the most important species in Guadiana Estuary:

- The dominant *Ammonia* species was identified as *Ammonia aberdoveyensis* Haynes, 1973. This species presented a significant intergradation between forms which can misleading to the division in different species;
- *Elphidium oceanensis* (d'Orbigny) was identified as an ecophenotype of *Elphidium excavatum* (Terquem), calling into question previous authors classifications;
- *Discorinopsis aguayoi* (Bermúdez) was strongly related to the epiphytic calcareous *Glabratella* group, calling into question the previous classification as an agglutinated species;
- The information provided here by the genetic analysis is regarded as preliminary, dependent of more and more consistent analysis to proof effectiveness. Nevertheless, it raises a little the veil of how much the preconceived information will be refuted in the future and of how much is still to be done in what concerns foraminifera taxonomy.

9. 2. 6. Systematics and species reports

Kingdom CHROMISTA

Subkingdom HAROSA

Infrakingdom RHIZARIA

Phylum FORAMINIFERA

Class POLYTHALAMEA

Order ASTRORHIZIDA

Superfamily ASTROHIZOIDEA

Family POLYSACCAMMINIDAE Loeblich and Tappan, 1984

Genus *Polysaccammina* Scott, 1976

Polysaccammina ipohalina Scott, 1976

- *Polysaccammina ipohalina* Scott, 1976b, p. 318, pl. 2, figs. 1-4, text figs. 4a-c; Scott and Medioli, 1980, p. 38, pl. 2, figs. 8-11; Scott et al., 1990, p. 737, pl. 1, fig. 5; Scott et al., 1991, p. 389, pl. 2, fig. 3; Javaux and Scott, 2003, p. 24, fig. 6, subfig. 8; Barbosa et al., 2005, p. 35, pl. 1, fig. 12.



Figure 9.1. 1-3) three different exemplars of *Polysaccammina ipohalina* illustrating the differences in size and form. In all exemplars is possible to see organic matter attached.

Morphological description: Test free, finely arenaceous with pseudochitinous base; chambers globular, irregularly shaped, in uniserial arrangement but sometimes irregularly developed, with terminal aperture. Test is flexible at sutures; earlier chambers appear to collapse; sutures distinct and depressed; arenaceous outer layer is not continuous between chambers.

Distribution in Guadiana Estuary: Dominant species with narrow occurrence, only at site SCM – in the vegetated margin of a saltworks pond which feeds salt-pans reservoirs, during summer, at 1.96m above MSL. *P. ipohalina* occur as dominant species (20.8%) along with *Jadammina macrescens* (75%) and *Trochammina inflata* (4.17%). Not found in the fossil record.

Remarks: Its amorphous aspect and resemblances with organic matter debris could be promoting it's the non-recognition as it is a rarely mention in other works concerning marsh an estuarine foraminifera analysis. The species was originally described as no-attached. However, many of the species observed in Nova Scotia (Scott and Medioli, 1980) and at the present work were attached to organic debris (Fig. 9.1).

Relevant literature: Scott, 1976b; Scott and Medioli, 1980; Scott et al., 1990.

Polysaccammina hyperhalina Medioli, Scott and Petrucci, 1983

- *Protoschista findens*, Parker, 1870, Jones, 1994, p. 38, pl. 32, fig. 10 and 11.
- *Reophax moniliformis*, Siddal, 1886, Murray and Alve, 2011, p. 26, fig. 15.15.
- *Polysaccammina hyperhalina* Petrucci et al., 1983, p. 73 and 74, pl. 1 and 2; Barbosa et al., p. 35, pl. 1, figs. 10 and 11.

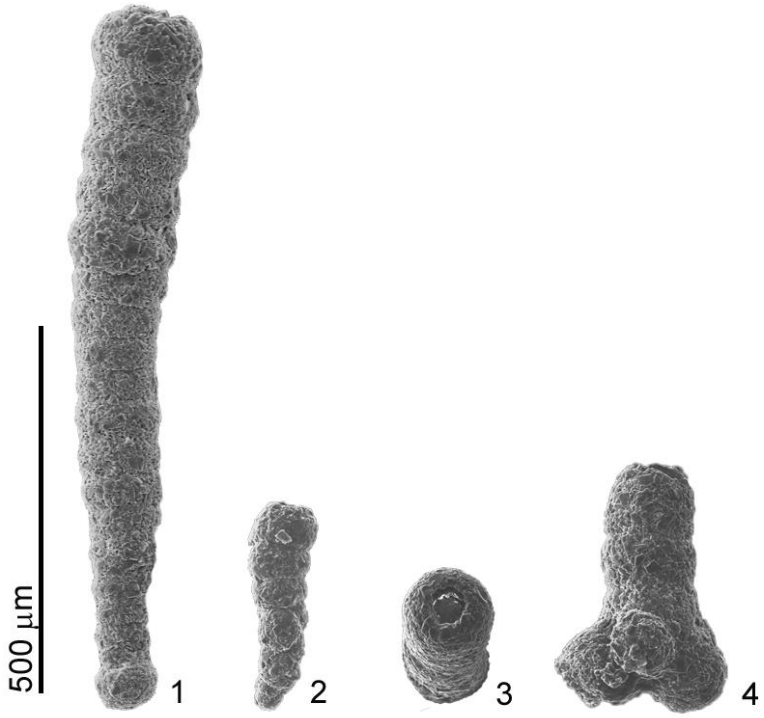

Figure 9.2. 1-2) two different size exemplars of *Polysaccammina hyperhalina*; 3) aperture view; 4) specimen with several side branches.

Morphological description: Test coarsely to fine agglutinated, usually uniserial but often irregular and sometimes branching (Fig. 9.2. 4); chambers of irregular shape, either regularly increasing in size or remaining of the same size throughout; test flexible due to an inner pseudochitinous lining which can be observed at broken chamber connections; aperture terminal, round and ivaginated to form a inner, backward pointing funnel (Fig. 9.2. 3).

Distribution in Guadiana Estuary: reported in Guadiana Estuary for the first time. It is a common and nearly constant agglutinated species; in winter, its distribution seems restricted to the lower elevation zones, whilst in summer it reaches higher abundances at both the middle and lower elevations of the marshes; not recorded in the fossil assemblages.

Remarks: after washing, most specimens were broken. Only fragments with 3 or more chambers were considered as one individual.

Relevant literature: Petrucci et al., 1993.

Family SACCAMINIDAE

Genus *Pseudothurammina* Scott, Medioli and Williamson, 1981

Pseudothurammina limnetis (Scott and Medioli, 1980)

- *Thurammina (?) limnetis*, Scott and Medioli, 1980, p. 43, pl. 1, figs. 1-3.
- *Pseudothurammina limnetis* (Scott and Medioli, 1980), Javaux and Scott, 2003, p. 24, fig. 6, subfig. 9.

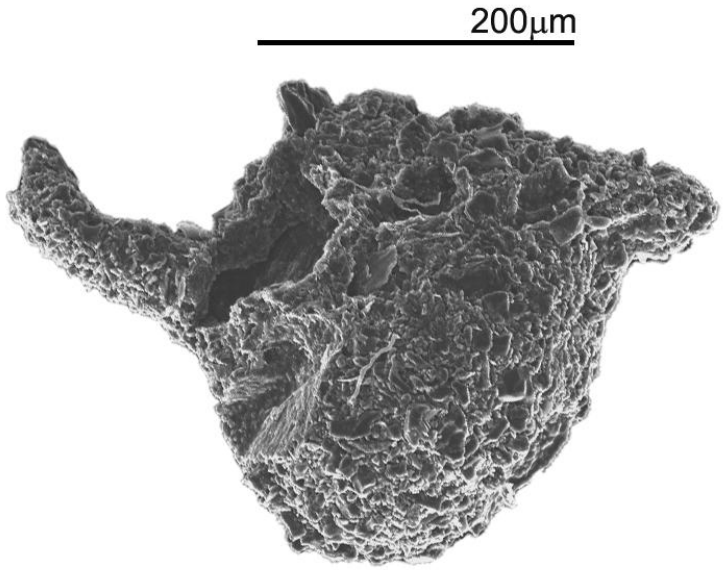

Figure 9.3. SEM photograph of a *Pseudothurammina limnetis;* view of a broken specimen with two projections; unique exemplar.

Morphological description: Test free or less commonly attached, subglobular, with up to five irregular mamillae or projections from the surface; agglutinated wall; do not preserve in sediments after death (Loeblich and Tappan, 1988).

Distribution in Guadiana Estuary: very rare species, with only one dead specimen counted in Aouro, in summer. Not found in the fossil record.

Remarks: Could be overlooked due to its test fragility and unusual morphology (Javaux and Scott, 2003).

Relevant literature: Javaux and Scott, 2003.

Order LITUOLIDA

Superfamily AMMODISCOIDEA

Family AMMODISCIDAE Reuss, 1862

Genus *Ammovertellina* Suleymanov, 1959

Ammovertellina sp.

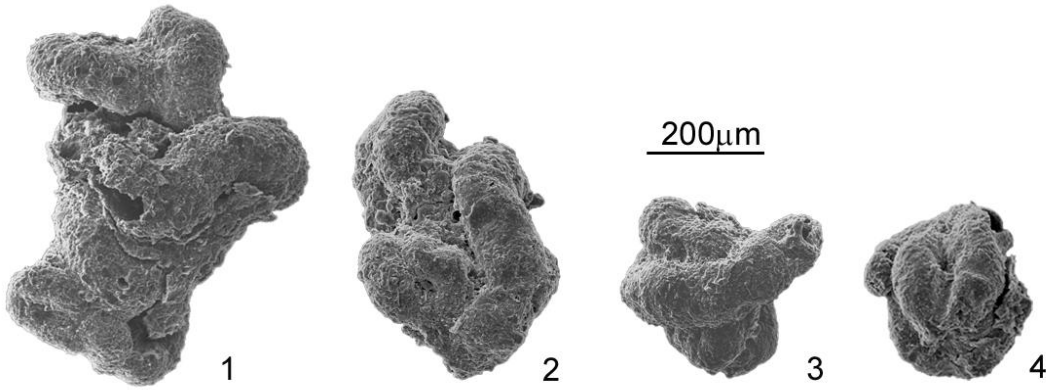

Figure 9.4. 1 – 4) different size specimens of *Ammovertellina* sp.

Morphological description: proloculus followed by streptospirally wound tubular second chamber, later becoming planispiral; final stage uncoiling and with zig-zag or irregular growth; wall agglutinated, of angular quartz grains in insoluble cement; aperture at the open end of the tube.

Distribution in Guadiana Estuary: rare occurrence; not recorded at the paleoassemblages.

Superfamily HAPLOPHRAGMOIDEA

Family HAPLOPHRAGMOIDIDAE Maync, 1952

Genus *Haplophragmoides* Cushman, 1910

Haplophragmoides manilaensis Andersen, 1952

- *Haplophragmoides manilaensis* Andersen, 1952, Andersen (1953), p. 22, pl. 4, fig. 8; Scott et al. (1991), p. 387, pl. 1, figs. 18, 19; Scott et al., 1995, p. 293, Fig. 6, subfigs. 3 and 4.

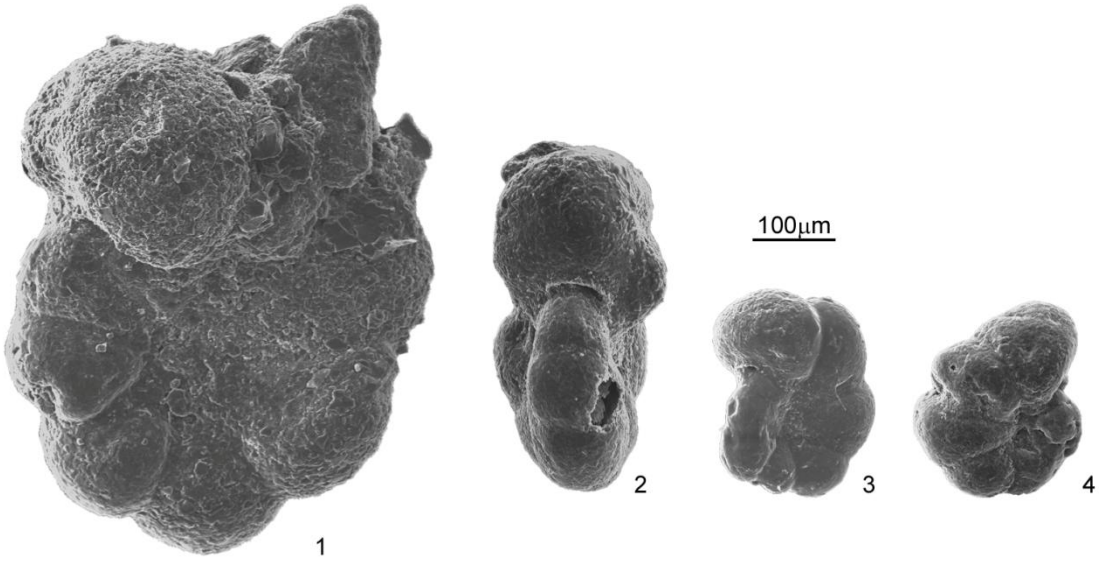

Figure 9.5. 1 – 4) different size specimens of *Haplophragmoides manialensis*; 1, 3-4) lateral view; 2) profile view with aperture detail.

Morphological description: test agglutinated, planispiral, coiled; aperture is an elongate equatorial slit at the base of the apertural face.

Distribution in Guadiana Estuary: indigenous species, dominant in upper reaches of the modern estuary; not found alive; not present in the paleorecord.

Remarks: the larger individuals agglutinate large clusters of sediment and coarse grains.

Genus *Trochamminita* Cushman and Brönnimann, 1948

Trochamminita cf. *irregularis* Cushman and Brönnimann, 1948

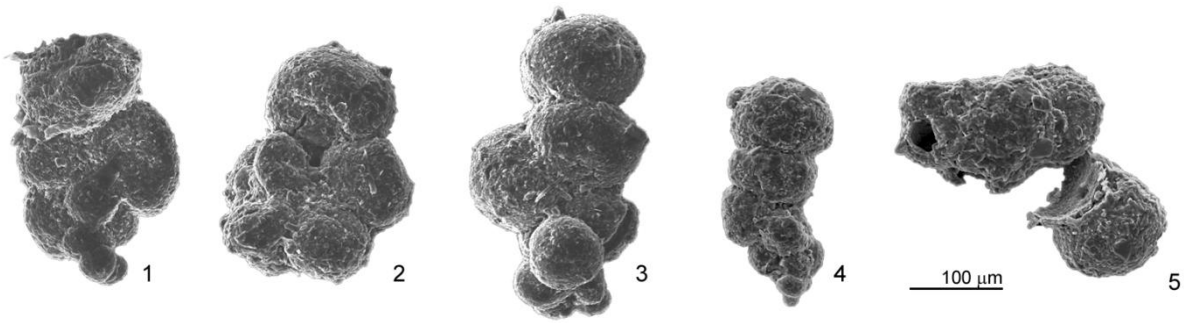

Figure 9.6. 1 – 5) different specimens of *Trochamminita* cf. *irregularis*; 5) broken individual.

Morphological description: Test planispirally enrolled at least in the early stage, later chambers irregular in form and arrangement; wall thin, brownish, with fine to course quartz grains on a proteinaceous base.

Distribution in Guadiana Estuary: species of narrow distribution, with dead occurrences only, at the northernmost locations (LAR and Aouro) where it reaches 13% in abundance;

Remarks: The highly diversified morphology raise strong doubts in the present classification.

Superfamily HORMOSINOIDEA Haeckel, 1894

Family HORMOSINIDAE Haeckel, 1894

Genus *Reophax* de Montfort, 1808

Reophax nana Rhumbler, 1913

- *Reophax nana* Rhubler, Scott and Medioli, 1980, p. 43, pl.2, fig. 6; Barbosa et al., 2005, p. 35, pl. 1, figs. 15-17;

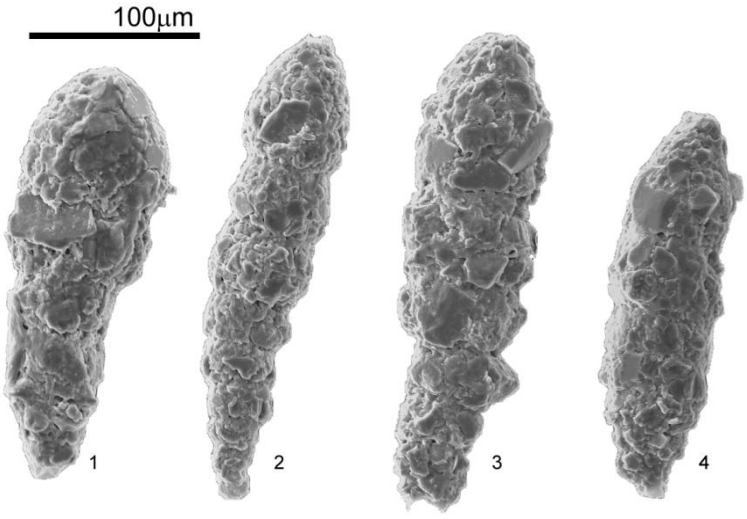

Figure 9.7. 1 – 4) different specimens of *Reophax nana*.

Morphological description: test agglutinated, uniserial, elongated; aperture simple on the top of the last chamber.

Distribution in Guadiana Estuary: indigenous species in the modern estuary, occurring as an accessory species, preferentially at the lower stands of the marsh, like *Ammotium salsum* and *Textularia earlandi.*

Genus *Leptohalysis* Loeblich and Tappan, 1984

Leptohalysis scottii (Chaster, 1892)

- *Reophax scottii* Chaster, 1892.
- *Reophax scottii* Chaster, Murray, 1971, p. 17, pl. 1, figs. 6-9; Levy et al., 1995, p. 18, pl. 1, fig. 15.
- *Leptohalysis scottii* (Chaster), Diz and Francés, 2008, p. 182, pl. 1, fig. 4; Murray and Alve, 2011, p. 31, fig. 18.5.

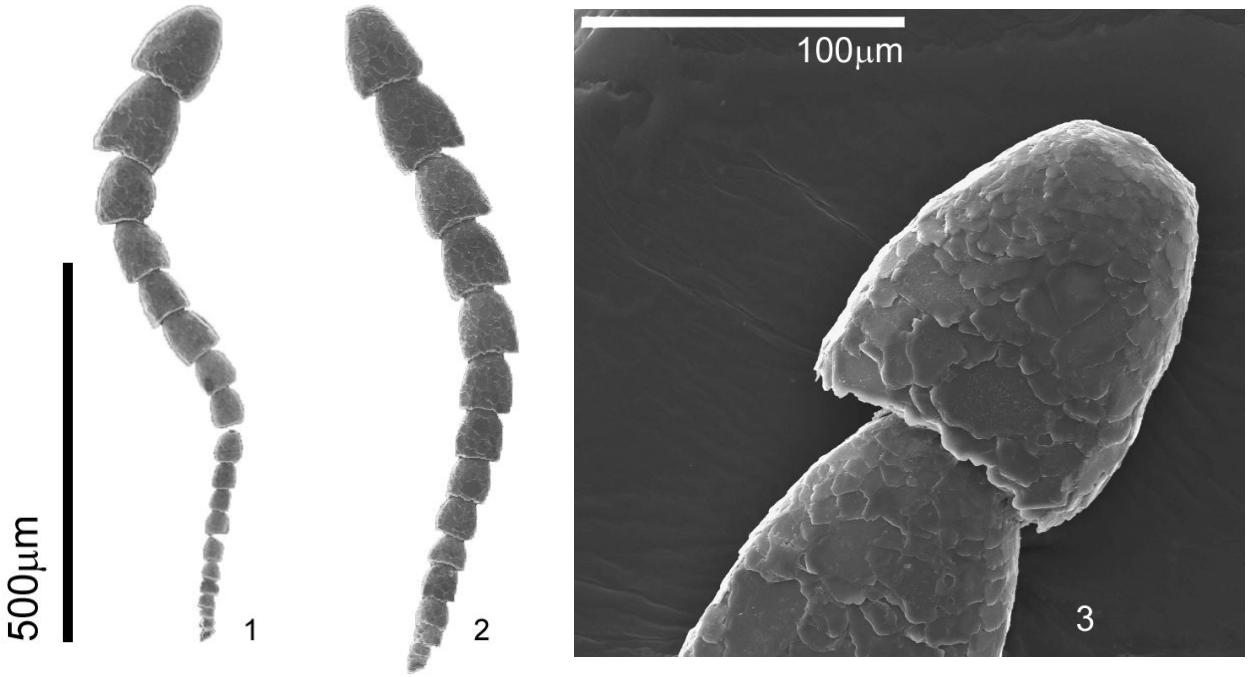

Figure 9.8. 1 – 3) *Leptohalysis scottii*; 1 and 2) side view of two complete specimens; 3) detail on the agglutination of the last chamber.

Morphological description: test agglutinated, uniserial, elongated; usually very thin and with somewhat angular chambers; a inner organic lining makes the test particularly flexible.

Distribution in Guadiana Estuary: exotic species, rare in the modern estuary; not found in the paleo-record.

Remarks: indicator of high organic matter contamination (Scott et al., 2001).

Superfamily LITUOLOIDEA

Family LITUOLIDAE de Blainville, 1827

Genus *Ammobaculites* Cushman, 1910

Ammobaculites cf. *exiguus* Cushman and Brönnimann, 1948 (Fig. 9.9. 4)

- *Ammobaculites* cf. *exiguus* Cushman and Brönnimann, Scott et al., 1991, p. 384; Scott et al., 1995, p. 292, fig. 6.1.

Morphological description: test elongate, agglutinated, initially planispirally coiled and latter with several uniserial chambers; aperture terminal, rounded.

Distribution in Guadiana Estuary: very rare in the modern estuary; uncertain occurrence in the paleoenvironments.

Remarks: when the uncoiled portion is broken, it can be confused with *Ammotium salsum*.

Ammobaculites sp. (Fig. 9.9. 1)

Morphological description: test elongate, agglutinated, initially planispirally coiled and latter with several uniserial chambers; chambers better differentiated than *Ammobaculites* sp. 2 and *Ammobaculites* cf. *exiguus*; aperture terminal, rounded.

Distribution in Guadiana Estuary: rare in the living assemblage; very resistant to *postmortem* degradation; it is one of the few dominant agglutinated species in the Holocene paleoenvironments.

Remarks: The species occurring in the modern estuary can be different from those occurring in the paleoassemblages.

Ammobaculites sp.2 (Fig. 9.9. 3 and 4)

Morphological description: generally identical to other *Ammobaculites* but more robust and with coarser agglutination (some heavy minerals).

Distribution in Guadiana Estuary: very rare in the modern estuary; uncertain occurrence in the paleoenvironments.

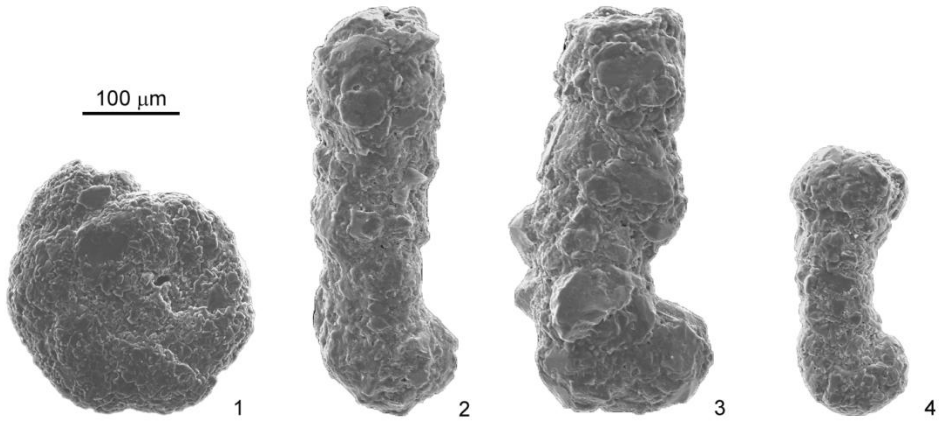

Figure 9.9. 1 – 4) different specimens of *Ammobaculites* genus; 1) *Ammobaculites* sp. with the uncoiled portion broken; 2 and 3) *Ammobaculites* sp.2; 4) *Ammobaculites* cf. *exigus*.

Genus *Ammotium* Loeblich and Tappan, 1953

Ammotim cf. *cassis* (Parker, 1870) (Fig. 9.10. 1)

- *Haplophragmium cassis*, (Parker, 1870)
- *Lituola cassis Dawson*, 1870
- *Ammobaculites cassis* (Parker, 1870),
- *Ammotium cassis* (Parker, 1870), Scott et al., 1977, p. 1578, pl. 2, figs. 1 and 2.

Morphological description: test agglutinated, initially planispirally coiled and latter chambers tend to uncoil, forming a wide uniserial pattern with slanting suture lines; aperture terminal and rounded.

Distribution in Guadiana Estuary: very rare species in the modern estuary; not found in the paleo-record.

Remarks: indicative of increased levels of suspended particulate matter (Scott et al., 2001).

Ammotium salsum (Cushman and Brönnimann, 1948) (Fig. 9.10. 2-5)

- *Ammobaculites salsum,* Cushman and Brönnimann, 1948.
- *Ammoscalaria pseudospiralis* (Williamson, 1858), Murray and Alve, 2011, p. 25, fig. 16. 12.
- *Ammotium salsum,* (Cushman and Brönnimann), Scott and Medioli, 1980, p. 35, pl. 1, figs. 11-13; Scott et al., 1991, p. 384, pl. 1, figs. 11-13.

Morphological description: similar to *Ammotium cassis* but with chambers not as broad.

Distribution in Guadiana Estuary: Accessory (> 10%) species in the modern estuary, preferring the lower stands of the marsh; not found in the paleo-record.

Ammotium sp. (Fig. 9.10. 6)

Morphological description: test agglutinated, initially planispirally coiled and latter chambers tend to uncoil, forming a wide uniserial pattern with last chambers tending to inflate.

Distribution in Guadiana Estuary: very rare in the modern estuary; not found in the paleo-record.

Remarks: strong uncertainties in the classification due to resemblance with *Ammobaculites*.

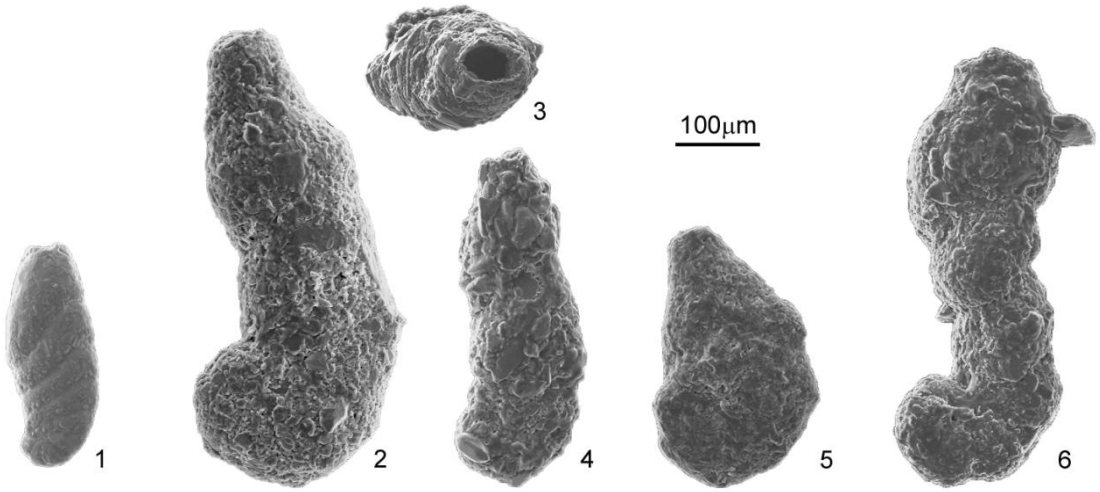

Figure 9.10. 1 – 6) several specimens of *Ammotium*; 1) *Ammotium* cf. *cassis*; 2 – 5) *Ammotium salsum*, 2) best exemplar, 3) detail on the aperture, 3 and 4) different size and shape *A. salsum*, resembling *Ammobaculites dilatatus*, Cushman and Brönnimann; 6) *Ammotium* sp.

Genus *Cribrostomoides* Cushman, 1910

Cribrostomoides crassimargo (Norman, 1892)

- *Haplophragmium crassimargo* Norman, 1892.
- *Alveolophragmium crassimargo* (Norman, 1892).
- *Labrospira crassimargo* (Norman, 1892).
- *Cribrostomoides crassimargo* (Norman), Murray and Alve, 2011, p. 27, fig. 16.16 and 16.17.

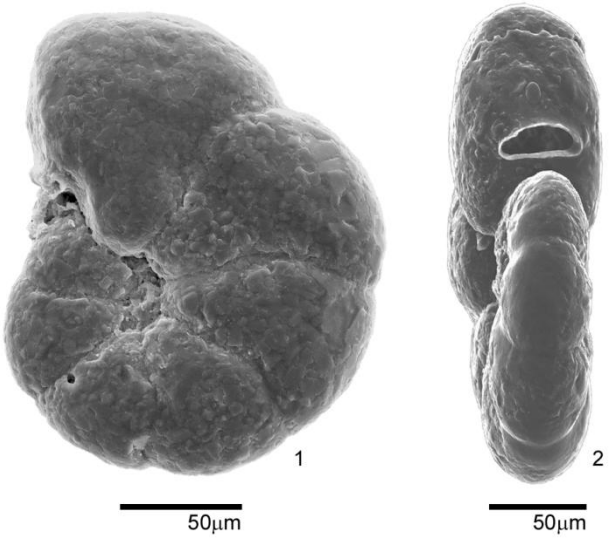

Figure 9.11. *Cribrostomoides crassimargo*; 1) side view; 2) profile view with aperture in detail.

Morphological description: test enrolled with few chambers per whorl; early stages slightly streptospiral in growth, later becoming planispiral and symmetrical; wall agglutinated, thin and simple in structure; surface smoothly finished; aperture equatorial, just above the base of the final chamber, with a narrow lip of finer sand.

Distribution in Guadiana Estuary: very rare in the modern estuary; not found in the paleo-record.

Superfamily RZEHAKINOIDEA

Family RZEHAKINIDAE Cushman, 1933

Genus *Miliammina* Heron-Allen and Earland, 1930

Miliammina fusca (Brady, 1870)

- *Quinqueloculina fusca* Brady, 1870.
- *Miliammina fusca* (Brady, 1870), Scott and Medioli, 1980, p. 38, pl. 2, figs. 1-3; Scott et al. (1991), p. 387, pl. 1, fig. 14; Javaux and Scott, 2003, p. 24, fig. 6, subfig. 7;

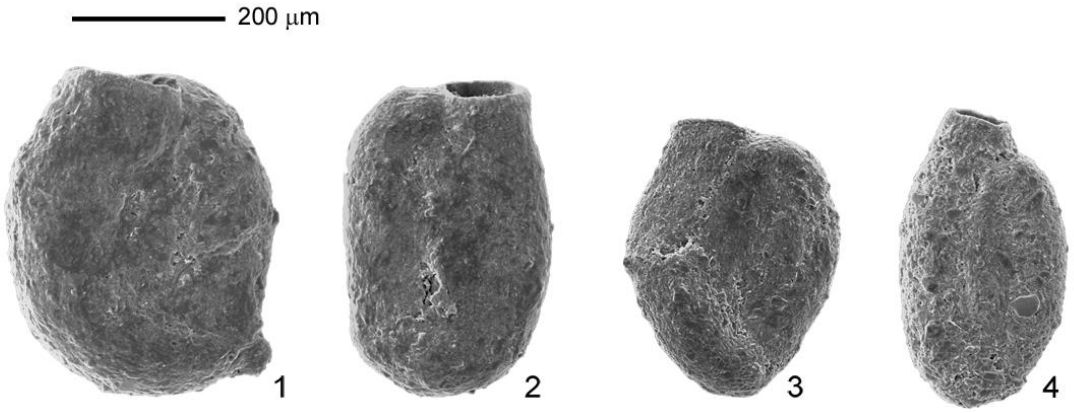

Figure 9.12. 1 – 4) several specimens of *Miliammina fusca*.

Morphological description: test agglutinated, elongated, ovate, of half coil in a quinqueloculine pattern; wall relatively thick, fine agglutinated on an organic base and insoluble in acid; aperture at the end of the chamber, rounded to semilunate, depend on the degree of compression against the previous whorl and may be produced on a short neck.

Distribution in Guadiana Estuary: it is one of the most ubiquitous agglutinated species in the modern estuary, dominating mid-low environments in the upper reaches of the estuary; not found in the paleorecord.

Miliammina obliqua Heron-Allen and Earland, 1930

- *Miliammina obliqua* Heron-Allen and Earland, Hayward and Hollis, 1994, pl. 3, fig. 9 and 10; Hayward et al., 1999, p. 405, fig. 9.

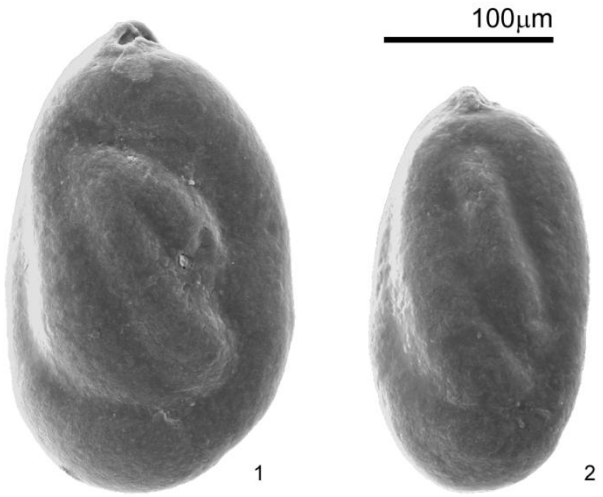

Figure 9.13. 1 and 2) two different size *Miliammina obliqua*; 1) view of the interio-marginal arch of the aperture.

Morphological description: Broadly ovate, quinqueloculine test with early chambers oblique to main axis; thin wall composed of well-cemented fine silt grains, with a smoothly finished, light brown shinning surface; aperture is an interio-marginal arch (Fig. 9.13. 2); smaller than *M. fusca*.

Distribution in Guadiana Estuary: reported for the first time in Guadiana where is common, with higher incidence in winter, at middle elevations of the northernmost positions and at upper elevations with a more confined position.

Remarks: strong morphological similarities with *M. fusca* may prevent accurate identification, not only in Portuguese estuarine systems, but also worldwide; rarely mentioned in the literature.

Relevant literature: Hayward and Hollis, 1994.

Order TEXTULARIIDA

Superfamily TEXTULARIOIDEA

Family EGGERELLIDAE Cushman, 1937

Genus *Eggereloides* Haynes, 1973

Eggereloides scaber (Williamnson, 1858)

- *Bulimina scabra*, Williamson, 1858
- *Eggerella scabra* (Williamson), Murray, 1971, p. 45, pl. 15, figs. 1-6 and Levy et al., 1995, p. 19, pl. 2, fig. 9.
- *Eggerelloides scabrus* (Williamson), Loeblich and Tappan, 1988, p. 170, pl. 189, figs. 5-7 and Milker and Schmiedl, 2012, p. 37, fig. 10.9.
- *Eggerelloides scaber* (Williamson), Jones, 1994, p. 52, pl. 47, figs. 15-17; Martins and Gomes, 2004, p. 36-39, fig. 2.17 and Mendes et al., 2012, p. 22, fig.2.3.

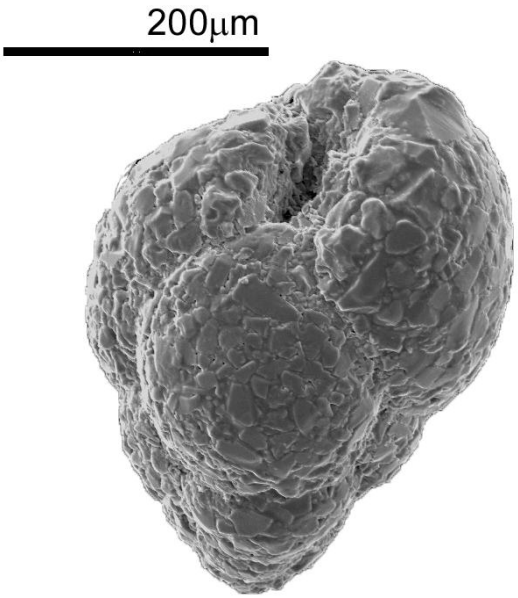

Figure 9.14. SEM photograph of *Eggerelloides scaber* with aperture view.

Morphological description: The test is oblong, the initial part is trochospirally arranged but is reduced to triserial in the adult part; chambers gradually increasing in size as added, so the last

whorl commonly forms half the length of the test; the aperture is an interiomarginal arch in the center of the apertural face; coarsely agglutinated wall.

Distribution in Guadiana Estuary: indigenous species in the modern estuary; rare in the living assemblage but abundant in the dead assemblage; occurs mainly at the lower reaches of the estuary, at the lower stands of the marsh; more abundant in the winter.

Remarks: The juvenile specimens can be easily confused with other *Eggerella* species.

Family TEXTULARIIDAE Ehrenberg, 1838

Genus *Textularia* Defrance, 1824

Textularia earlandi Parker, 1952

- *Textularia tenuissima* Earland, 1933.
- *Spiroplectinella earlandi* (Parker, 1952), Martins and Gomes, 2004, p. 21, fig. 2.7.
- *Textularia earlandi* Parker, 1952, Scott et al. (1991), p. 389, pl. 2, fig. 9; Levy et al., 1995, p. 20, pl. 3, fig. 4.

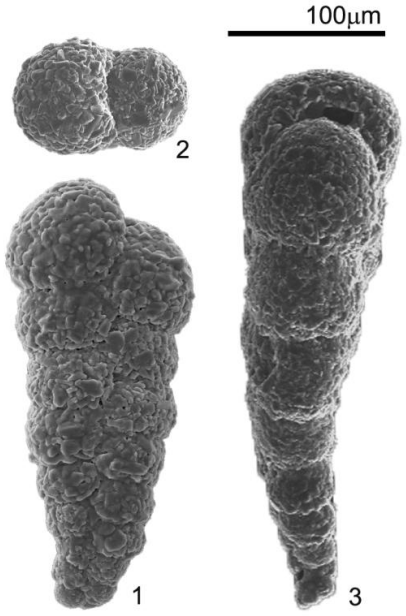

Figure 9.15. *Textularia earlandi*; 1) lateral view; 2) apertural view; 3) profile view with aperture in detail.

Morphological description: Test agglutinated, chambers biserially arranged, laterally compressed; aperture is a simple arch at the base of the last chamber (Fig. 9.15. 3);

Distribution in Guadiana Estuary: indigenous rare in the modern estuary; seems to prefer the lower stands of the marsh; not recorded in the paleo-sequences.

Family VALVULAMMINIDAE Loeblich and Tappan, 1986

Genus *Discorinopsis*

Discorinopsis aguayoi (Bermúdez, 1935)

- *Discorbis aguayoi* Bermúdez, 1935.
- *Discorinopsis aguayoi*, (Bermúdez,), Scott et al. (1990), p. 737, pl. 1, figs. 6 a, b.; Javaux and Scott, 2003, p. 24, fig. 6, subfigs. 1, 2; Scott et al. (1991), p. 389, pl. 2, figs. 17, 18.

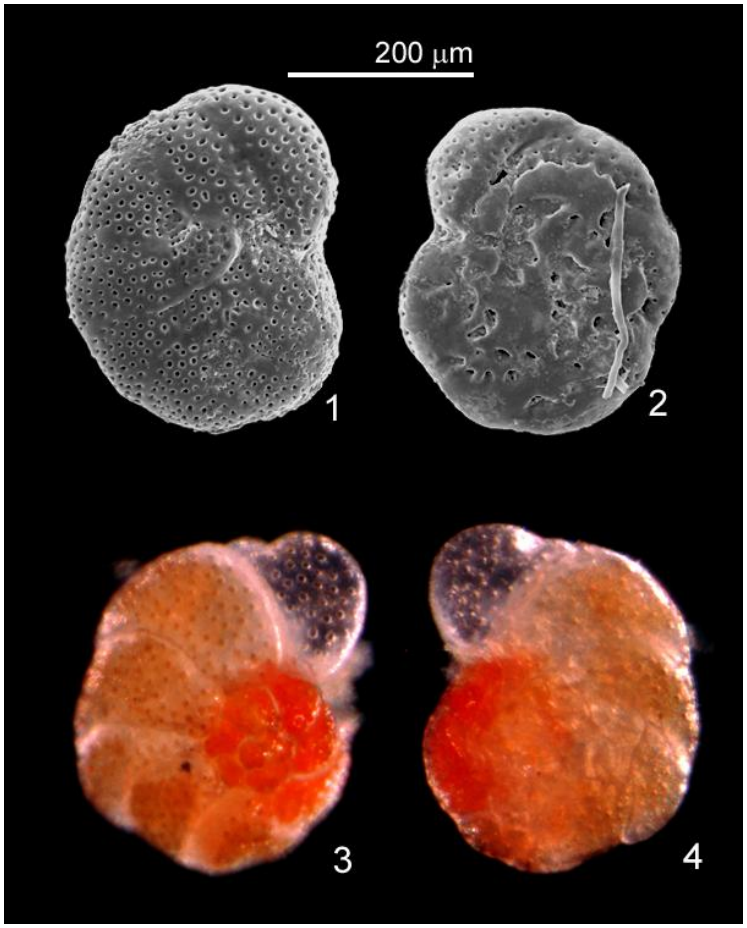

Figure 9.16. *Discorinopsis aguayoi*; 1) dorsal view; 2) ventral view, with organic matter attached; 3 and 4) light microscope photograph of a living specimen (natural colors); 3) dorsal view and 4) ventral view.

Morphological description: test with low trochospiral coil, with about five chambers in the first whorl; the increased height of the spire results in an auriculate test, spiral side strongly

convex, umbilical side flattened to concave with broad umbilicus; sutures strongly curved in spiral side, nearly radial on the umbilical side; wall agglutinated of calcareous particles.

Distribution in Guadiana Estuary: is a species of narrow distribution, occurring with *J. macrescens* and *T. inflata* in significant abundances (11.9%) during winter. In the living assemblage, its occurrence seems limited to confined sites of the lower estuary (LG and E1), at lower to middle elevations where low marsh vegetation occurs.

Remarks: in Guadiana environments, it is epiphytic, found highly attached to vegetal structures; very low preservation potential; preliminary analysis revealed that the *D. aguayoi* ribosomal RNA sequence branches at the base of a clade containing *Glabratella*, an epiphytic calcareous foraminifera. These findings clearly suggest that the taxonomic classification of this species should be revised,

Relevant literature: Scott et al. (1990); Javaux and Scott (2003).

Barcode sequence:

LSU rRNA partial - 13172.4_Discorinopsis

AAGGGCACCACAAGAACGCGTGGAGCATGTGGCTTAATTTGACTCAACGCGGGAAATCTTACCGGG
TCCGGACACACTGAGGATTGACAGGTTTCAATACCATTACTTNTTATGNTAATGTTATTATAAATATG
CTAGTCCTTTCATGATTATGTGATAGGTGGTGCATGGCCGTTCTTAGTTCGTGGAGTGATCTGTCTGC
TTAATTGCGTTTCACATAGAGTCTATATTATAATGTGTGTTGCGGCTTTTCTTAGACCCCTTCATTTCG
GTGAAGCGCGTGTCTTTGATTATTAGTTTAGCTCATACTTTTTAGACTCTGAAAGCAACGAACGTGAC
CGCAACCTCTTGTTGCCTTTATACCAAATGTATTCGTTGTCTCTATGGCAGTGATACATAAAAAGGCC
ATATGGCGCTTACTCTTTCAACAGAGCATGGTGTCAAAACTAGAGGGGCCGCTGTTACTTTCTTAAA
CCAGAGGAAGGTTGCGGCAATAACAGGTCTGTGATGCCCTTAGATGTTCCGGGCTGCACACGTGCTA
CAATGATTATTGCAGTGAGCATCTCATTTTTTTTACACACCGCATGCGTGAGTCTATTTGTGCACTTA
CCTATGGTATGTTTGCTACAAATATGTATCTCTACGCGCGGTAAAGCCTGCTTCGAAAGTAAGTGGG
TAATCAATTAGAAGTAATGATTTCCCTTTATTTTAGCACAAATATATACGGCGTCATTACCCGGCATA
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GACAGACCATTGTTAATTGTTGGTCTCGGTCTTAACTAGGAATGCCTTGTACTGGTCTTTGGTTCAAC
AAACCACCAGGAATACGTCCCTGCCCTTTGTACACACCGCCCGTCGCTCTTACCGATGGATTTCTCTG
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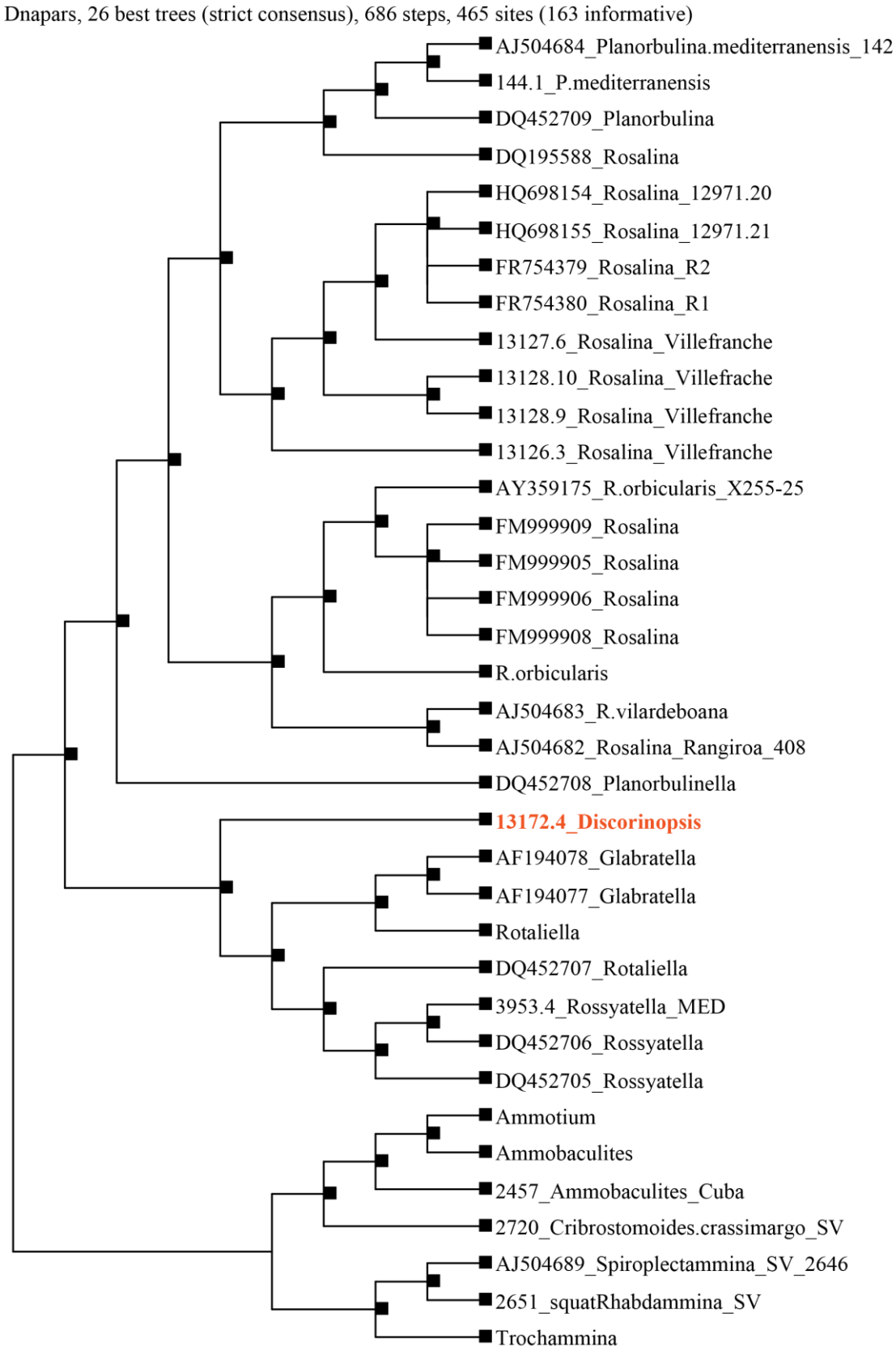

Figure 9.17. Phylogeneticc analysis of *D. aguayoi*; *D. aguayoi* ribosomal RNA sequence branches at the base of a clade containing *Glabratella;*

Order TROCHAMMINIDA

Superfamily TROCHAMMINOIDEA

Family TROCHAMMINIDAE Schwager, 1877

Genus *Arenoparrella* Andersen, 1951

Arenoparrella mexicana (Kornfeld, 1931)

- *Trochammina inflata* (Montagu) var. *mexicana* Kornefeld, 1931.
- *Arenoparrella mexicana* (Kornfeld), Scott et al., 1991, p. 387, pl. 1, figs. 16, 17; Debenay et al., 1998b, p. 75, pl. II, figs. 5, 10 and 12.

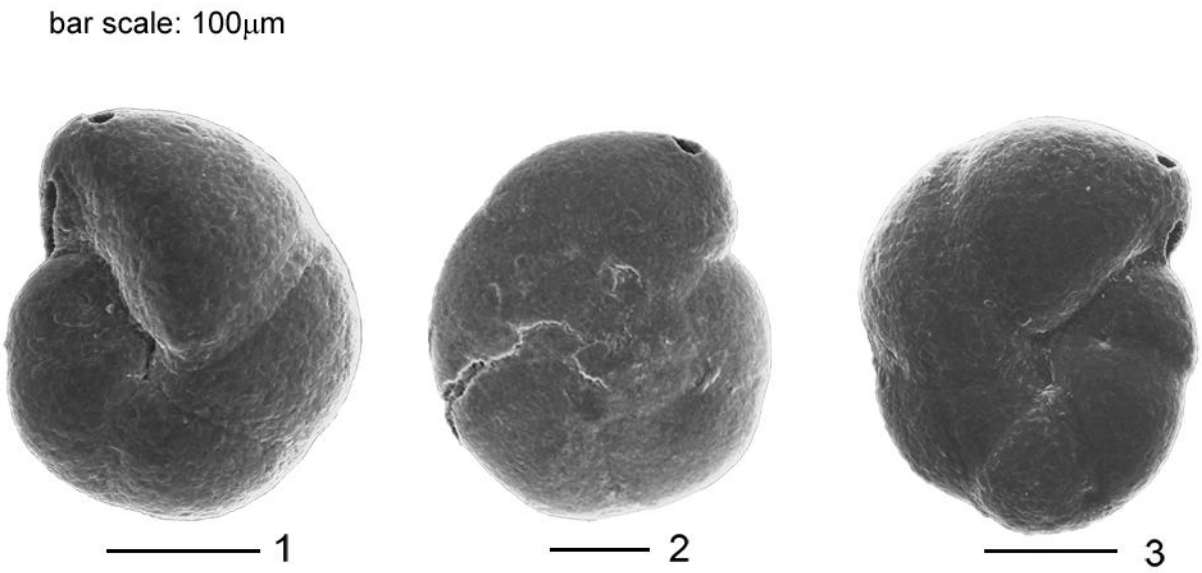

Figure 9.18. *Arenoparrella mexicana*; 1 and 3) two specimens on ventral side, in both cases is possible to see the main aperture and upper supplementary apertures; 2) dorsal side view of a broken specimen, supplementary aperture is also visible.

Morphological description: test agglutinated trochospiral with supplementary apertures in the apertural face which differentiate the genus from other trochospiral forms.

Distribution in Guadiana Estuary: Indigenous rare species in the modern estuary; not found in fossil record.

Genus *Deuterammina* Brönnimann, 1976

Deuterammina eddystonensis Brönnimann and Whittaker, 1990

- *Deuterammina eddystonensis* Brönnimann and Whittaker, Debenay et al., 2001, p. 86, pl. 1, figs. 17 and 18; Diz et al., 2004, p. 15, pl. 1, fig. 7.

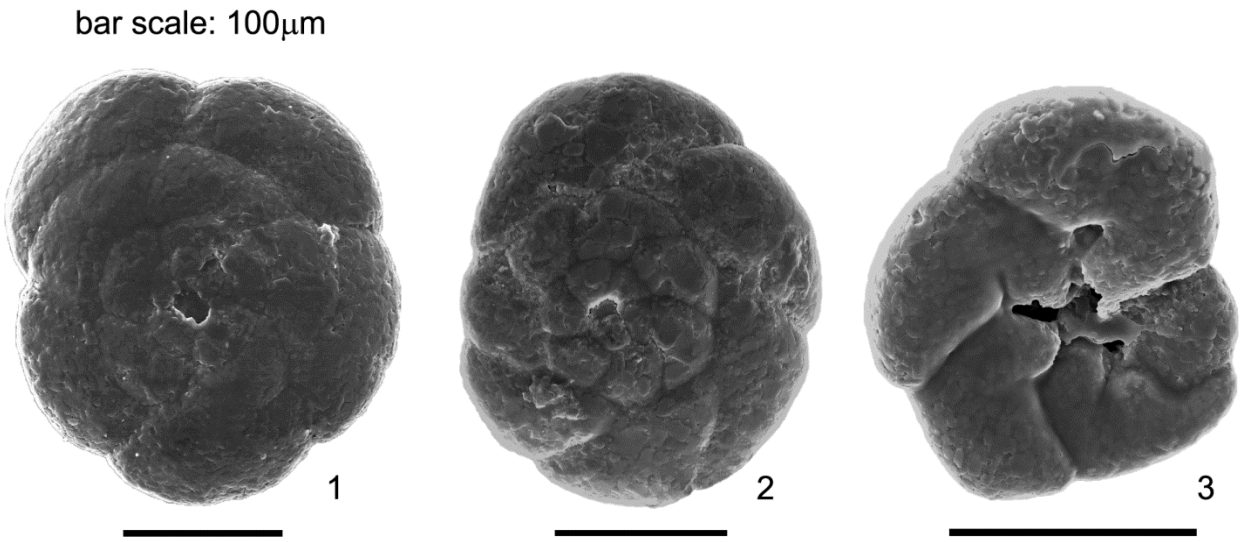

Figure 9.19. *Deuterammina eddystonensis*; 1 and 2) dorsal view of two different specimens; 3) ventral side view.

Morphological description: wall is thin and agglutinated; the test is low trochospirally enrolled and slightly concavo-convex; chambers increasing in size as added; sutures are radial and the periphery is rounded; wall thin, agglutinated, single layered.

Distribution in Guadiana Estuary: rare in the living assemblages of the modern estuary; not found in fossil record.

Genus *Jadammina* Bartenstein and Brand, 1938

Jadammina macrescens (Brady, 1870)

- *Trochammina inflata* (Montagu) var. *macrescens* Brady, 1870.
- *Trochammina macrescens* (Brady, 1870), Scott and Medioli (1980), p. 39, pl. 3, figs. 1-11; Javaux and Scott (2003), p. 24, fig. 6, subfigs. 14-19; Barbosa et al. (2005), p. 36, pl. 2, figs. 13-15.
- *Jadammina macrescens* (Brady, 1870), Debenay et al., 2001, p. 86, pl. 1, fig. 7;

Morphological description: test flattened trochospiral that tends to be nearly planispiral in the adult; chambers increasing gradually in size as added, sutures radial to slightly curved, periphery rounded; wall finely and sparsely agglutinated on a proteinaceous base; imperforate; the primary aperture is a low interiomarginal equatorial slit, with one or more supplementary areal openings in the lower portion of the apertural face, each bordered by a projecting lip (Fig. 9.20. 4 and 5).

Distribution in Guadiana Estuary: indigenous species in the modern estuary; was the most ubiquitous agglutinated species, occurring along the entire estuary, but with an optimum of occurrence at the marine estuary, in the most elevated positions of the marsh, where the assemblages are almost exclusively (and in some cases, exclusively) composed of *J. macrescens.* This species exhibits uncommonly high densities in some places, surpassing 75 000 individuals/20 cc in sample LG1 (confined environment) in winter; dominant in both winter and summer, seems to be better adapted to winter conditions.

Remarks: The presence of supplementary apertures observed in the specimens suggest that the taxon occurring in Guadiana is *Jadammina macrescen*s f. *polystoma*.

Important literature: Scott and Medioli, 1980.

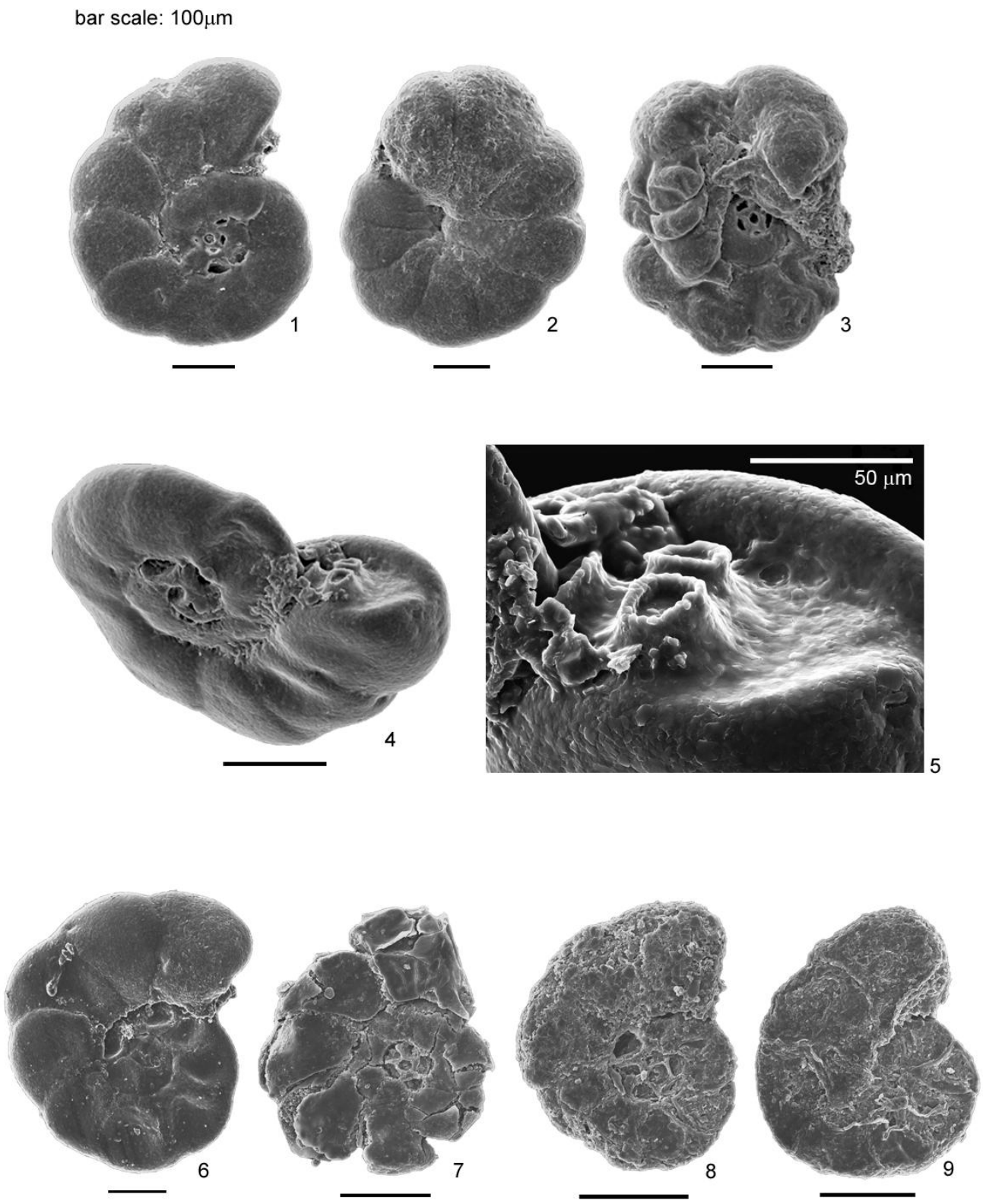

Figure 9.20. 1 – 6) *Jadammina macrescens*; 1) dorsal side view; 2) ventral side view; 3) dorsal view of a deformed specimen; 4) view of the supplementary apertures; 5) detail view of the supplementary apertures; 6) dorsal view of a fossil exemplar; 7 – 9) *Trochammina* spp. from the paleo-record, evolving to inner linings; tests presented in increasing order of degradation.

Genus *Lepidodeuterammina* Brönnimann and Whittaker, 1983

Lepidodeuterammina plymouthensis Brönnimann and Whittaker, 1989

- *Lepidodeuterammina plymouthensis* Brönnimann and Whittaker, Martins and Gomes, 2004, p. 31, fig. 2.13.

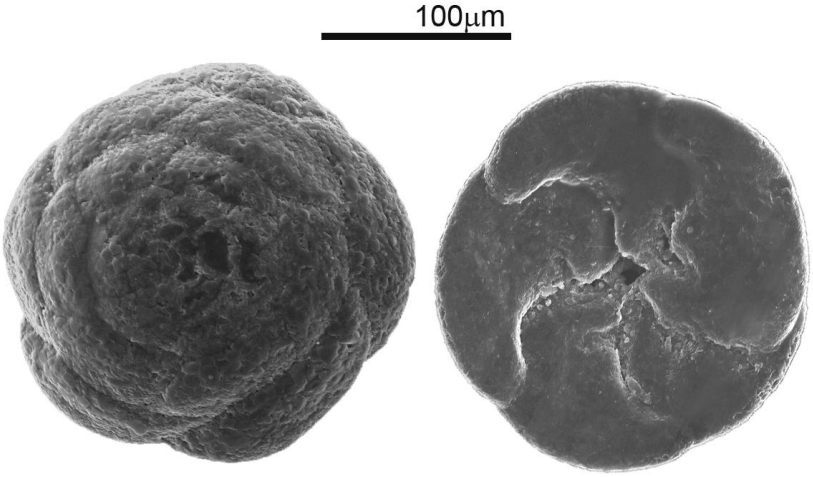

Figure 9.21. *Lepidodeuterammina plymouthensis*; 1) dorsal side view; 2) ventral side view.

Morphological description: the wall is thin and agglutinated; test is low trochospirally enrolled and concavo-convex; sutures are radial and the periphery is rounded; wall thin, agglutinated, single layered.

Distribution in Guadiana Estuary: exotic, rare in the living assemblages of the modern estuary; not found in fossil record.

Lepidodeuterammina ochracea (Williamson, 1858)

- *Rotalina ochracea* Williamson, 1858.
- *Trochammina ochracea* (Williamson, 1858), Murray, 1971, p. 37, pl. 11, figs. 1-5; Scott and Medioli, 1980, p. 41, pl. 4, figs. 4 and 5.
- *Lepidodeuterammina ochracea* (Williamson), Loeblich and Tappan, 1988, p. 127, pl. 135, figs. 10-14; Martins and Gomes, 2004, p. 29, fig. 2.12; Scott and Medioli, 1980, p. 41, pl. 4, figs. 4 and 5.

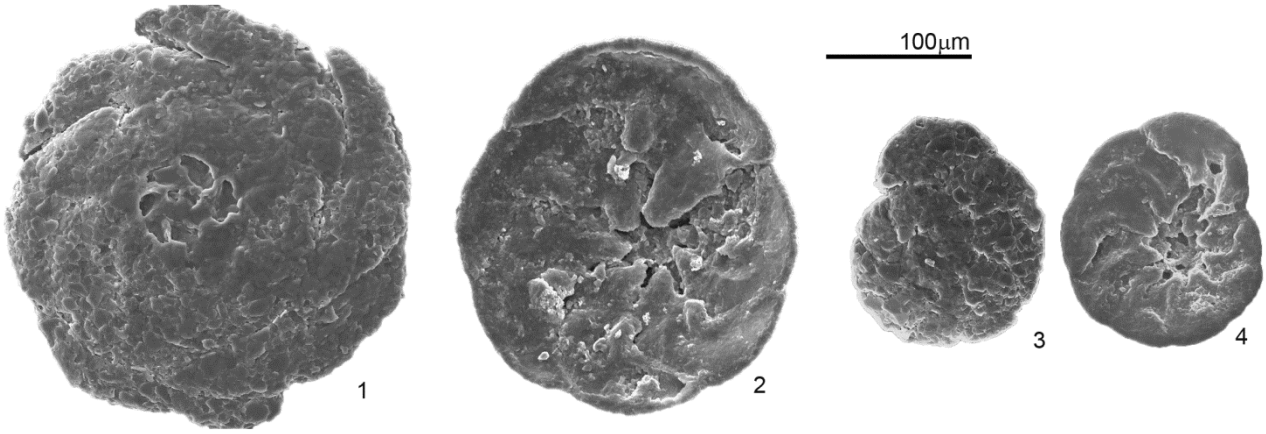

Figure 9.22. *Lepidodeuterammina ochracea*; 1 and 2) larger specimens, 1) dorsal view and 2) ventral view; 3 and 4) small specimens, 3) dorsal view and 4) ventral view.

Morphological description: the wall is thin and agglutinated; trochospirally enrolled, very flat and concave ventrally; sutures are radial and the periphery is rounded; wall thin, agglutinated, single layered.

Distribution in Guadiana Estuary: indigenous, rare in the living assemblages of the modern estuary; not found in fossil record.

Genus *Portatrochammina* Echols, 1971

Portatrochammina sp.

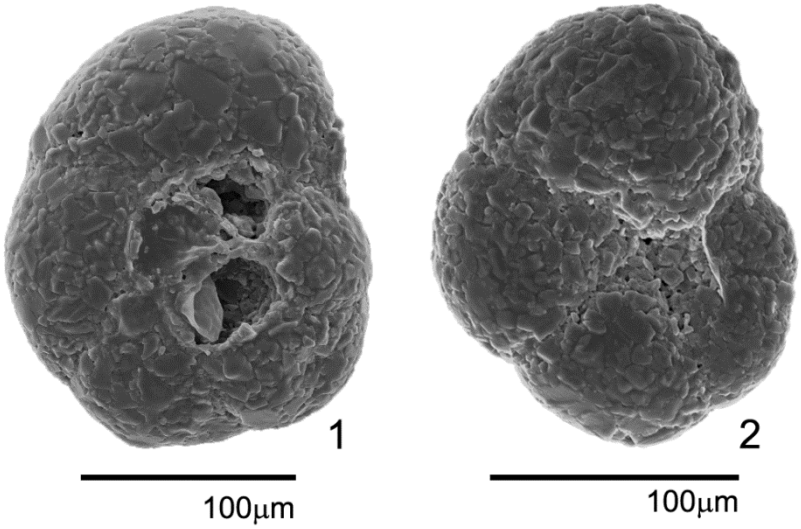

Figure 9.23. *Portatrochammina* sp.; 1) dorsal view; 2) ventral view.

Morphological description: trochospirally enrolled, with few gradually enlarging chambers per whorl; periphery is rounded; wall thin, agglutinated light mineralogical material (transparent).

Distribution in Guadiana Estuary: indigenous, rare in the living assemblages of the modern estuary; not found in fossil record.

Genus *Siphotrochammina* Saunders, 1957

Siphotrochammina sp.

- *Trochammnina inflata* Montagu 1808 'Sipho' type, Scott et al., 1995, p. 293, fig. 6, subfigs. 11, 13-17.

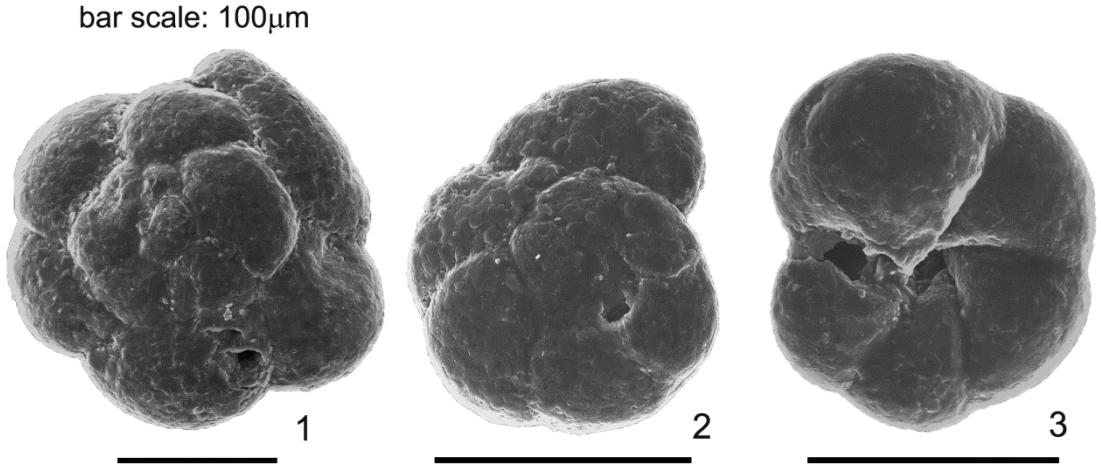

Figure 9.24. 1 – 3) SEM photographs of *Siphotrochammina* sp.; 1) dorsal view of a big specimen, with a inter-cameral foramen; 2) dorsal view of a smaller specimen, also with a inter-cameral foramen; 3) ventral view.

Morphological description: Test low trochospiral, chambers ovate, increasing gradually in size as added, sutures gently curved, periphery rounded; wall light brown in color, finely and sparsely agglutinated on a proteinaceous base, the early whorl darker brown and with very little agglutinated material; aperture interiomarginal, at the end of a siphonlike lobe projecting from the umbilical margin of the chamber and directed forward (Loeblich and Tappan, 1988). Although no recognizable through binocular microscope observation, the SEM images of the two photographed specimens (Fig. 9.24) permitted to see a well defined, dorsal, inter-cameral

foramen. As far as we know, this characteristic is not documented elsewhere and more photographs should be taken to confirm this morphological characteristic.

Distribution in Guadiana Estuary: it is an indigenous species, very common in the modern estuary, with a well individualized position in the north-south gradient, appearing (live and dead) only in the northernmost samples (from Aouro upstream) where it replaces *T. inflata*; not found in the paleo-record.

Remarks: According to Scott et al. (1995) the present *Siphotrochammin*a sp. is a type of the species *Trochammina inflata*. Based on the present data we believe that *Siphotrochammina* sp. is in fact a distinct species than *T. inflata* because, besides its smaller size and more rough texture, which resembles the microspheric *T. inflata* (Scott and Mediloi, 1980) (see also, for comparison, fig. 9.26.4 and 9.26.5) it has a very well defined position in the fluvial part of the estuary, contrary to *T. inflata* which is more sea dependent.

Genus *Tiphotrocha* Saunders, 1957

Tiphotrocha comprimata (Cushman and Brönnimann, 1948)

- *Trochammina comprimata* Cushman and Brönnimann, 1948.
- *Tiphotrocha comprimata* (Cushman and Brönnimann, 1948), Scott and Medioli, 1980, p. 42, pl. 5, figs. 1-3; Scott et al., 1991, p. 389, pl. 2, figs. 5, 6; Javaux and Scott, 2003, p. 24, fig. 6, subfig. 10, 11.

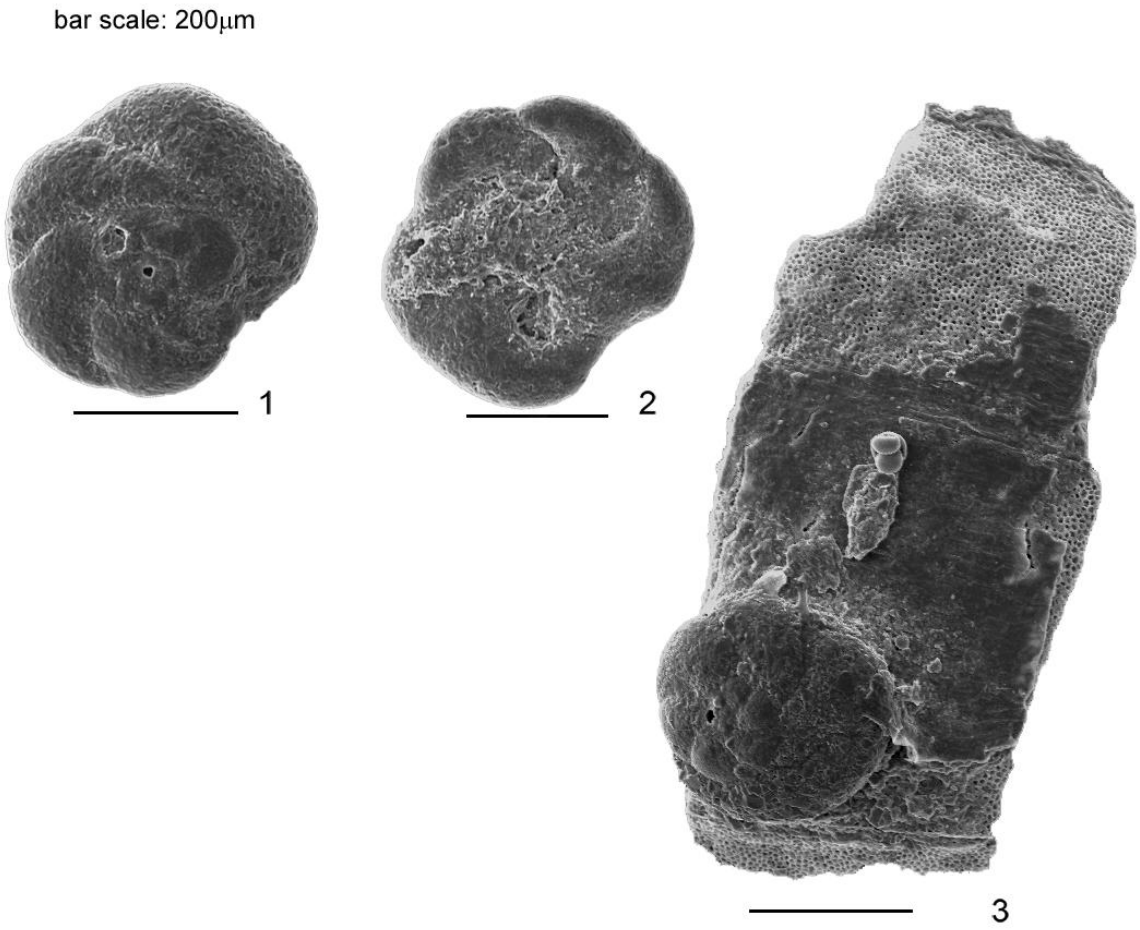

Figure 9.25. *Tiphotrocha comprimata*; 1) dorsal view; 2) ventral view; 3) individual strongly attached to a sea-grass leaf and detail of a *Pinus* pollen at the center of the leaf.

Morphological description: agglutinated, trochospirally enrolled, flattened, with ventral side slightly concave; with few gradually enlarging chambers per whorl; periphery is rounded; wall thin; siphon-like extension to the aperture in the umbilical area.

Distribution in Guadiana Estuary: indigenous, rare in the living assemblages of the modern estuary; not found in fossil record.

Genus *Trochammina* Parker and Jones, 1859

Trochammina inflata (Montagu, 1808)

- *Nautilus inflatus,* Montagu, 1808.
- *Rosalina inflata*, Williamsoni, 1858.

- *Trochammina inflata* (Montagu), Scott and Medioli, 1980, p. 39, pl. 3, figs. 12-14 and pl. 4, figs. 1-3; Jones, 1994, p. 46, pl. 41, fig. 4; Debenay et al., 1998b, p. 75, pl. II, figs. 16, 17 and 20.

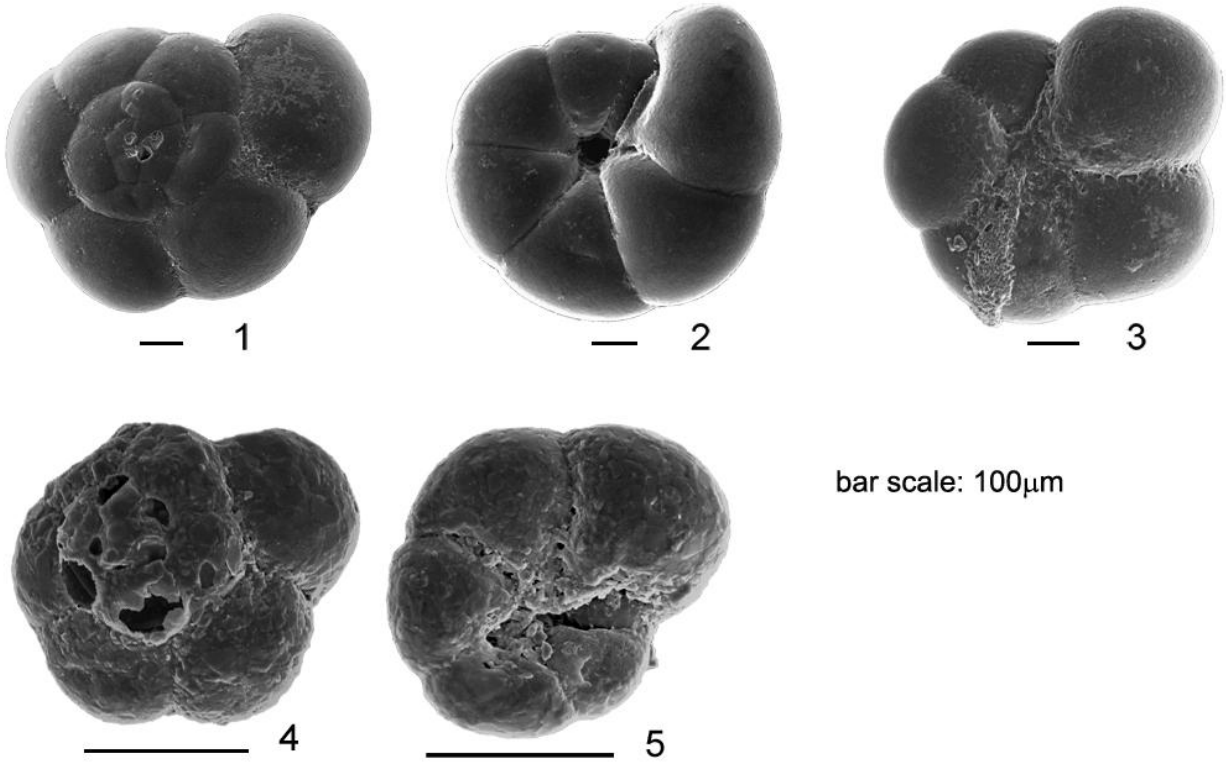

Figure 9.26. *Trochammina inflata*; 1) dorsal view; 2) ventral view; 3) ventral view with umbilical tube detail; 4 and 5) two specimens of microspheric form of *T. inflata*, 4) dorsal view and 5) ventral view.

Morphological description: agglutinated, trochospirally enrolled, chambers rather inflated, increasing in size gradually; aperture a low arch with a bordering lip;

Distribution in Guadiana Estuary: indigenous, dominant in the living assemblages of the modern estuary; closely related to *J. macrescens*, occurring together in almost all the samples, although it have higher abundances in middle elevations (0.2 to 0.8 m above MSL at samples E1, LG2 and FB2) where *J. macrescens* abundance starts to decrease and species diversity starts to increase; like *J. macrescens*, seems to be better adapted to winter conditions; dominant species in the paleo-record, being the earliest species occurring in the estuary formation.

Remarks: is the type species of the genus *Trochammina*; perhaps the best known and most distinctive of all the endemic marsh species, as well as being one of the earliest species ever

described (Scott et al., 2001); the specimens found in Guadiana often present a proteinaceous umbilical tube (Fig. 9.26. 3), covered with fine sediment, which purpose is unknown.

Important literature: Scott and Medioli, 1980; Scott et al., 2001.

Superfamily REMANEICOIDEA Loeblich and Tappan 1964

Family REMANEICIDAE Loeblich and Tappan 1964

Genus *Remaneica* Rhumbler, 1938

Remaneica helgolandica Rhumbler, 1938

- *Remaneica helgolandica* Rhumbler, 1938, Levy et al., 1974, p. 128, pl. 2, fig. 1 and 2; Loeblich and Tappan, 1988, p. 129, pl. 137, figs. 9-11; Martins and Gomes, 2004, p. 32, fig. 2.14.

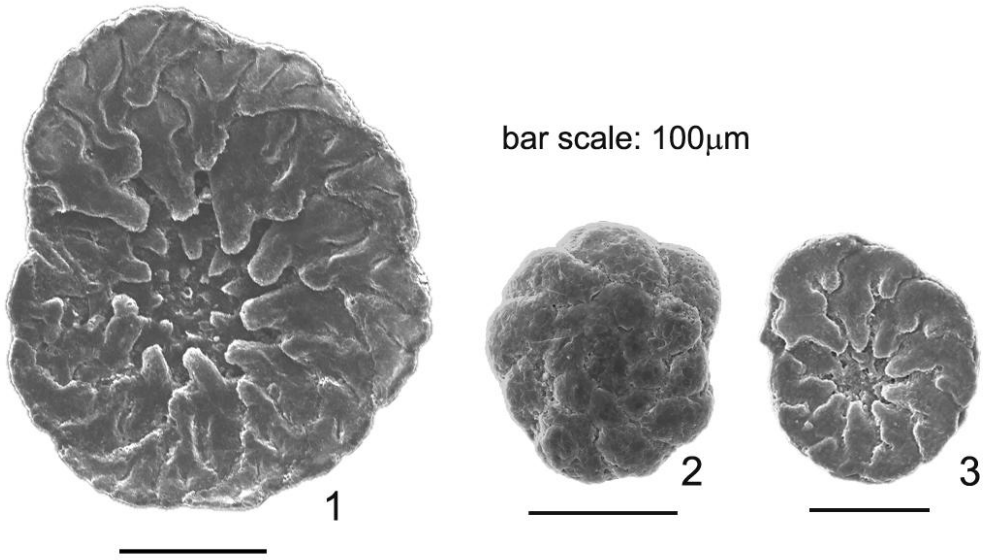

Figure 9.27. *Remaneica helgolandica*; 1) ventral view of a spectacular specimen; 2 and 3) common size specimens, 1) dorsal view and 2) ventral view.

Morphological description: agglutinated, trochospirally enrolled, flattened, with ventral side slightly concave; wall brownish, finely agglutinated on proteinaceous base, thin, imperforate and flexible; primary septa single layered, secondary septula double walled as they result from invagination of the outer wall.

Distribution in Guadiana Estuary: exotic, rare in the modern estuary; not found in fossil record.

Genus *Septotrochammina* Zheng, 1979

Septotrochammina gonzalezi (Seiglie, 1964)



Figure 9.28. *Septotrochammina gonzalezi;* ventral view of a unique exemplar.

Morphological description: depressed, trochospiral, chambers numerous, umbilicus open, numerous radial secondary septa of four to five orders produced by invaginations from the peripheral wall; wall thin, flexible, proteinaceous, incorporating a very small amount of agglutinated silt.

Distribution in Guadiana Estuary: exotic, very rare in the modern estuary; not found in fossil record.

Septotrochammina plicata (Terquem, 1876)

- *Patellina plicata* Terquem, 1876.
- *Trochammina plicata* (Terquem, 1876).
- *Remaneica plicata* (Terquem), Levy et al., 1974, p. 128, pl. 1, figs. 2, 6 and 7.
- *Septotrochammina plicata* (Terquem), Loeblich and Tappan, 1988, p. 129, pl. 138, figs. 1-8; Martins and Gomes, 2004, p. 33, fig. 2.15.

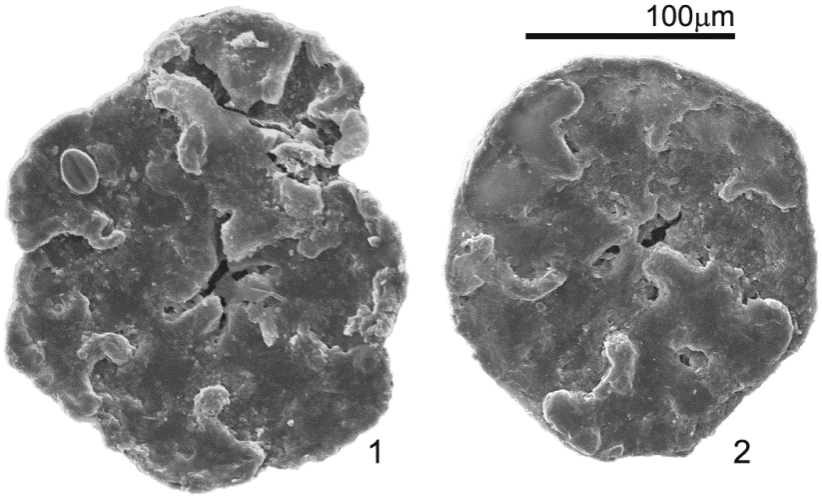

Figure 9.29. *Septotrochammina plicata*; 1 and 2) ventral view of two different specimens.

Morphological description: similar to *S. gonzalezi*.

Distribution in Guadiana Estuary: exotic, rare in the modern estuary; not found in fossil record.

Order BULIMINIDA

Superfamily BULIMINOIDEA

Family SIPHOGENERINOIDIDAE

Genus *Hopkinsina* Howe and Wallace, 1933

Hopkinsina sp.



Figure 9.30. SEM photograph of a *Hopkinsina* sp.

Morphological description: test elongate, narrow, chambers slightly inflated, increasing in size as added; triserially arranged in the early stage, with later biserial arrangement; sutures depressed, oblique; wall calcareous hyaline.

Distribution in Guadiana Estuary: rare exotic species in the modern estuary; not reported for the studied Holocene sedimentary sequences.

Superfamily BOLIVINOIDEA

Family BOLIVINIDAE

Genus *Bolivina* d'Orbigny, 1839

Bolivina ordinaria Phleger and Parker, 1952, new name

- *Bolivina ordinaria* Pheleger and Parker, 1952.
- *Bolivina variabilis* (Williamson 1858), Debenay et al., 2001, pl. 4, figs 3 and 4; Duchemin et al., 2005, pl. 1, fig. 12.
- *Bolivina ex. gr. dilatata*; Duchemin et al., 2007, pl. 1, figs. 14-16.
- *Bolivina ordinaria* Pheleger and Parker; Boltovskoy et al., 1980, p. 18, pl. 3, figs. 1-3; Martins and Gomes, 2004, p. 90-91, fig. 2.53 and Mendes et al., 2012, p. 22, fig. 2.8.



Figure 9.31. 1 – 4) different specimens of *Bolivina ordinaria*

Morphological description: The wall is calcareous; test small, compressed, tapering regularly throughout to subacute initial end, slightly ovate at apertural end; chambers increasing gradually as added, narrow, seven to ten pairs in adult; sutures depressed, broad and curved; wall smooth, distinctly perforate; aperture a narrow loop at the base of the apertural face, bordered on one margin by a thickened and imperforated rim.

Distribution in Guadiana Estuary: occurs as a dominant species in winter, associated to *A. aberdoveyensis* and *H. germanica,* at low-middle heights of the marshlands. In summer it is less frequent and less abundant.

Remarks: There is no consensus on its identification, due to insufficient taxonomic documentation. For further information see Mendes et al., 2012.

Relevant literature: Martins and Gomes, 2004; Mendes et al., 2012.

Bolivina cf. *variabilis* (Williamson, 1858)

- *Textularia variabilis* Williamson, 1858.
- *Brizalina variabilis* (Williamson), Murray, 1971, p. 113, pl. 46, figs. 1-3.
- *Bolivina variabilis* (Williamson), Martins and Gomes, 2004, p. 102, fig. 2.58; Milker and Schmiedl, 2012, p. 81, fig. 19, subfigs. 25 and 26.

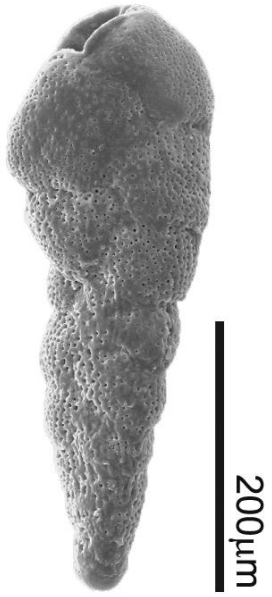

Figure 9.32. SEM photograph of a slightly deformed *Bolivina* cf. *variabilis*.

Morphological description: The wall is calcareous; test small, compressed, tapering regularly throughout to subacute initial end, slightly ovate at apertural end; chambers increasing gradually as added, narrow, seven to ten pairs in adult; sutures depressed, broad and curved; wall smooth, distinctly perforate; aperture a narrow loop at the base of the apertural face, bordered on one margin by a thickened and imperforated rim.

Distribution in Guadiana Estuary: accessory species, occurring only at LG site, a tidal lagoon at the estuary mouth.

Remarks: the occurrence of few individuals with good morphological characteristics causes strong doubts in the present identification.

Family BULIMINELLIDAE

Genus *Buliminella* Cushman, 1911

Buliminella elegantissima (d'Orbigny, 1839)

- *Bulimina elegantissima* d'Orbigny, 1839.
- *Buliminella elegatissima* (d' Orbigny), Murray, 1971, p. 105, pl. 42, figs. 1-4; Jones, 1994, p. 55, pl. 50, figs. 20-22; Martins and Gomes, 2004, p. 157 and 158, fig. 2.89.



Figure 9.33. SEM photograph of a specimen of *Buliminella elegantissima*.

Morphological description: the test is coiled in a high trochospiral of many chambers; only two to three whorls oblongs are developed, well separated by depressed sutures; chambers are numerous, very narrow and very oblique; the radial calcite wall is perforate except around the aperture.

Distribution in Guadiana Estuary: exotic species, very rare in both the modern estuary and paleoenvironments.

Family BULIMINIDAE

Genus *Stainforthia* Hofker, 1956

***Stainforthia* sp.**



Figure 9.34. SEM photograph of *Stainforthia* sp.

Morphological description: test narrow, fusiform, rounded in section, inflated to globular to ovate chambers increasing in height as added; triserially arranged in the early stage at least in the microspheric generation, later in a twisted biserial arrangement; test calcareous hyaline.

Distribution in Guadiana Estuary: rare exotic species in the modern estuary; not reported for the studied Holocene sedimentary sequences.

Order MILIOLIDA

Superfamily CORNUSPIROIDEA

Family CORNUSPIRIDAE

Genus *Cornuspira* Schultze, 1854

Cornuspira involvens, (Reuss 1850)

- *Operculina involvens* Reuss, 1950.
- *Cornuspira involvens* (Reuss); Jones, 1994, p. 26, pl. 11, figs. 1-3; Murray, 2003, p.16, fig. 4, no. 5; Milker and Schmiedl, 2012, p. 44, fig. 12, subfig. 1.

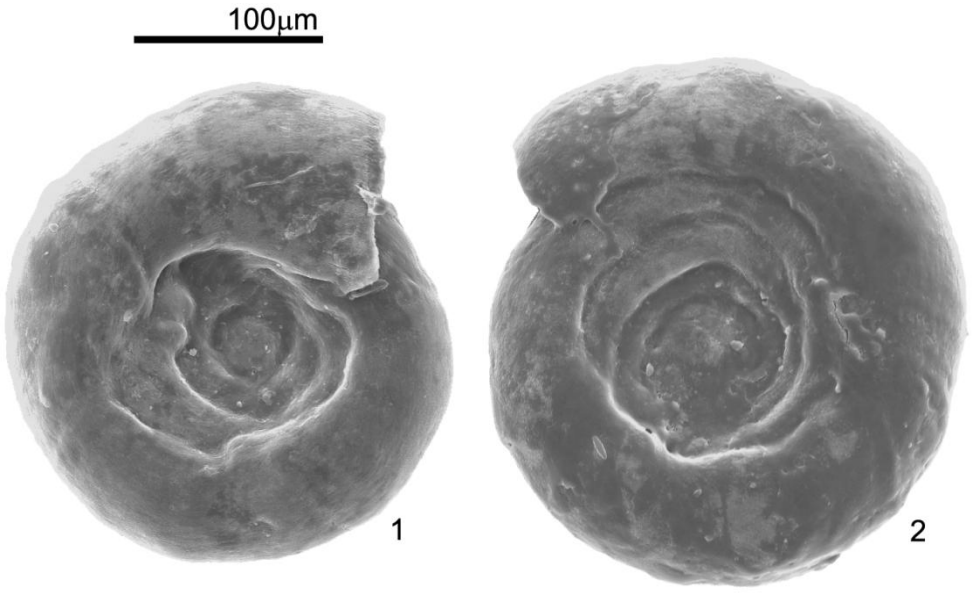

Figure 9.35. 1 and 2 – planispiral view of two specimens of *Cornuspira involvens*.

Morphological description: The wall is porcelaneous and imperforate; the test is discoidal, circular in outline and flattened; the proloculus is followed by a second enrolled and undivided tubular chamber that gradually increases in size; the periphery is subrounded; the aperture is rounded at the end of the tubular chamber. The test surface is smooth.

Distribution in Guadiana Estuary: indigenous species, rare in both the modern estuary and in the paleoenvironments.

Incertae sedis (Fig. 9.36 and 9.37)

Miliolid sp1 – *Triloculina williamsoni* (?) in Debenay et al., 2001;

Miliolid sp2 – *Pseudotriloculina laevigata* (?) in Debenay et al., 2005;

Miliolid sp3 – *Quinqueloculina seminulum* (?) in Cearreta, 1988 ;

Miliolid sp4 – *Miliolinella* sp. (?) in Milker and Schmiedl, 2012;

Miliolid sp5 – *Quinqueloculina seminulum* (Linné) (?) in Milker and Schmiedl, 2012;

Miliolid sp6 – *Triloculina akneriana rotunda* (Gerke) (?) Debenay and Luan, 2006 ;

Miliolid sp7 – *Affinetrina* sp. (?) in Milker and Schmiedl, 2012; *Triloculina bermudezi* (Acosta), in Villanueva et al., 1999.

Miliolid sp8 –

Miliolid sp9 –

Miliolid sp10 -

Miliolid sp11 - ?

Miliolid sp12 – *Wiesnerella* sp. (?) in Milker and Schmiedl, 2012;

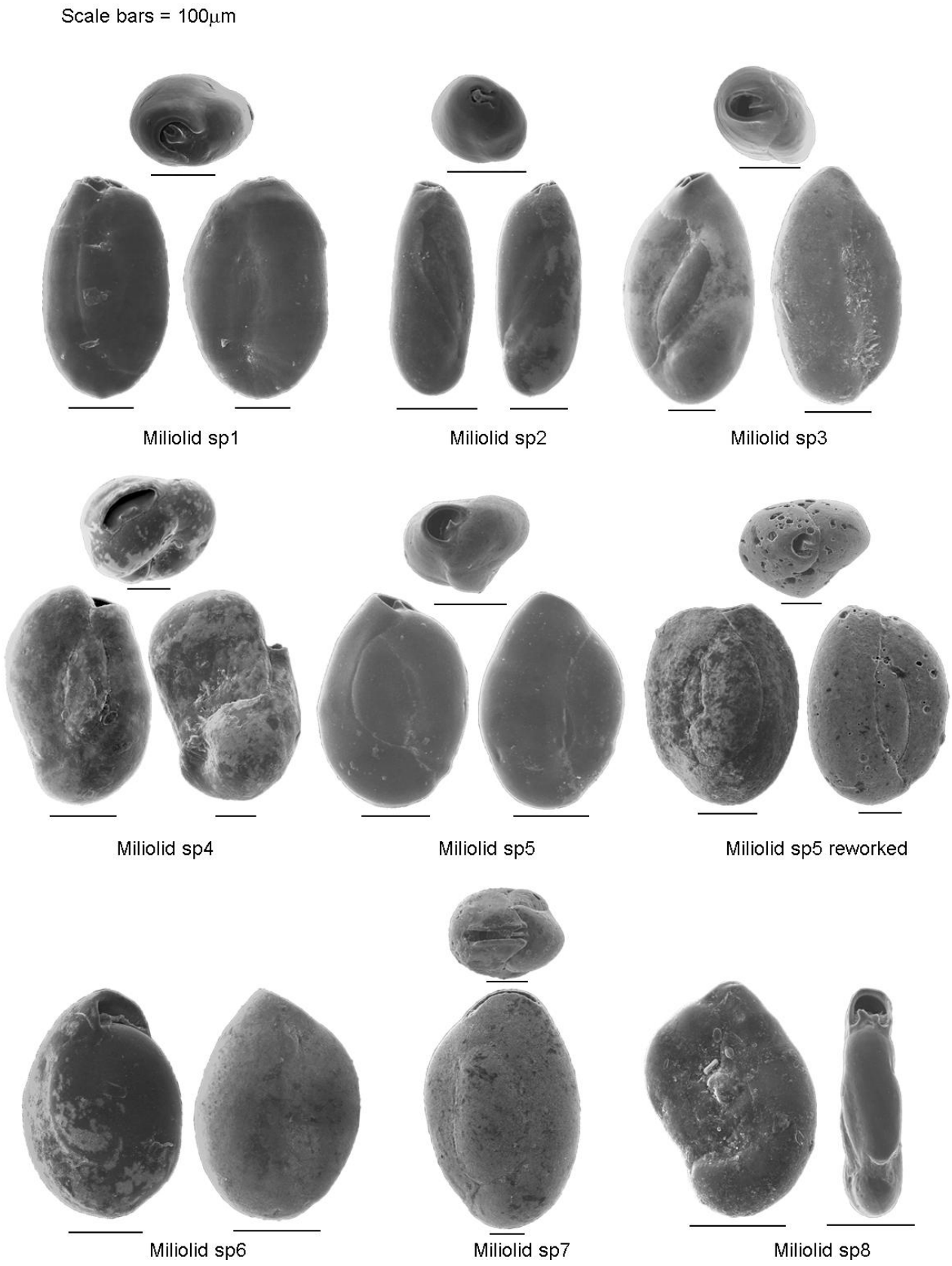

Figure 9.36. SEM photographs of 8 species of miliolids (sp1 to sp8) gathered in *Incertae sedis*.

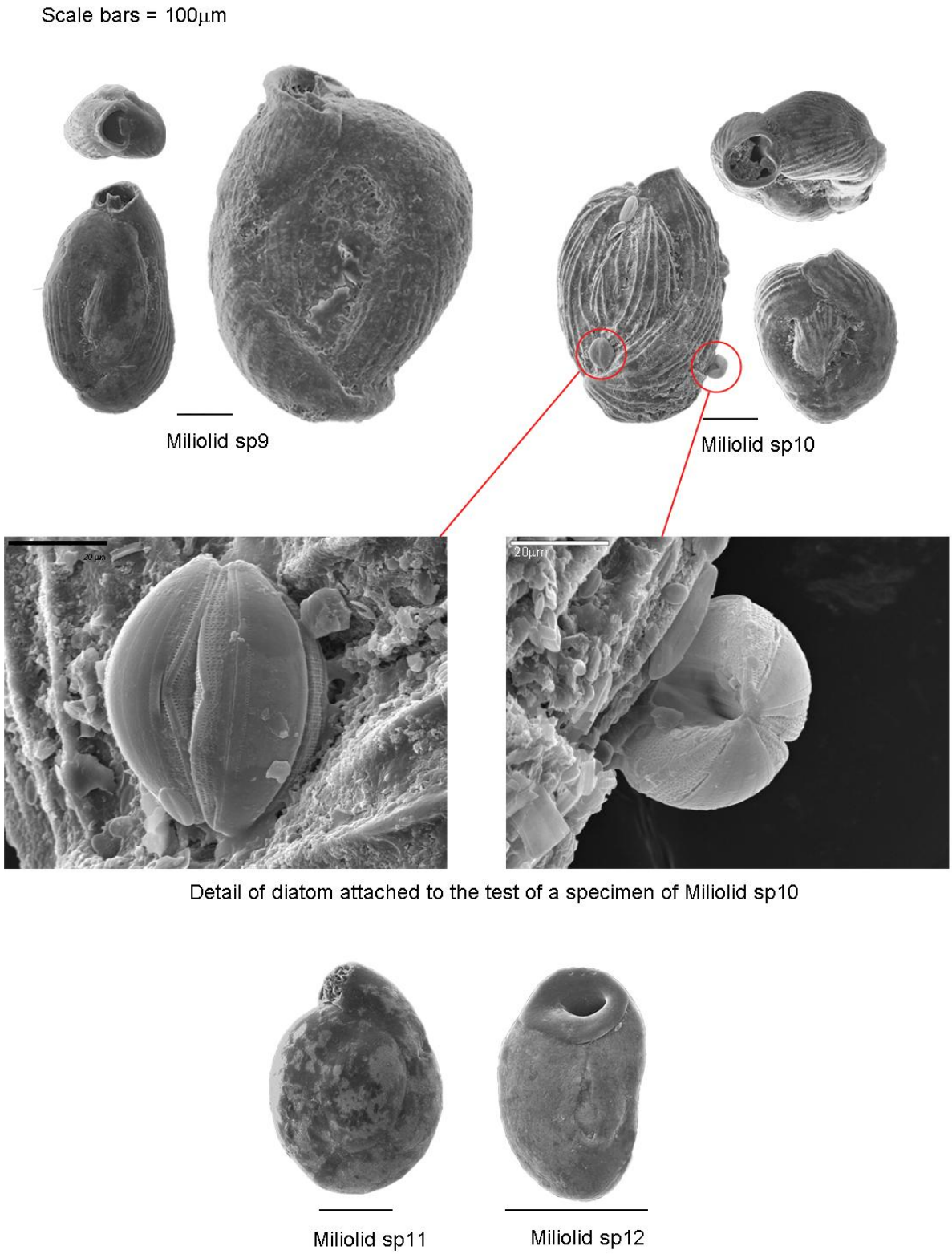

Figure 9.37. SEM photographs of 4 species of miliolids (sp9 to sp12) gathered in *Incertae sedis*.

Order ROBERTINIDA

Superfamily CERATOBULIMINOIDEA

Family CERATOBULIMINIDAE

Genus *Lamarckina* Berthelin, 1881

Lamarckina haliotidea (Heron-Allen and Earland, 1911)

- *Pulvinulina haliotidea* Heron-Allen and Earland, 1911.
- *Lamarckina haliotidea* (Heron-Allen and Earland), Murray, 1971, p. 205, pl. 86, figs. 1-6; Martins and Gomes, 2004, p. 81, fig. 2.47.

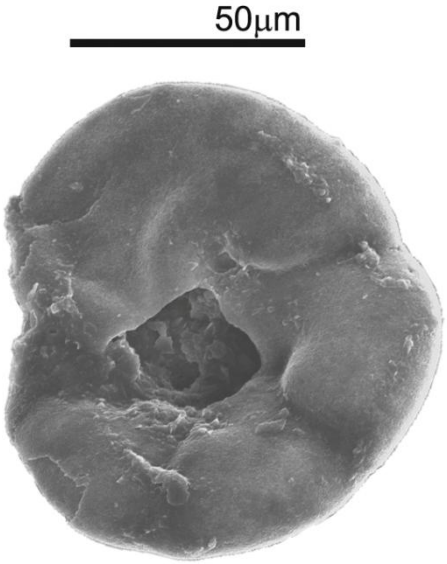

Figure 9.38. SEM photograph of a specimen of *Lamarckina haliotidea*; ventral view.

Morphological description: Test planoconvex or inequally biconvex, trochospiral, coiling dextral, chambers enlarging rapidly and becoming progressively broader and lower; final chamber strongly overlapping; periphery subacute to carinate; wall calcareous, aragonitic, finely perforate; surface smooth and polished on the umbilical side.

Distribution in Guadiana Estuary: very rare in Guadiana Estuary; not found in the paleo-record.

Relevant literature: Martins and Gomes, 2004.

Order ROTALIIDA Delage and Herouard, 1896

Superfamily ASTERIGERINOIDEA

Family ASTERIGERINATIDAE Reiss, 1963

Genus *Asterigerinata* Bermúdez, 1949

Asterigerinata mamilla (Williamson, 1848)

- *Rotalia mamilla* Williamson, 1848.
- *Asterigerinata mamilla* (Williamson), Murray, 1971, p. 141, pl. 59, figs. 1-6; Levy et al., 1995, p. 46, pl. 10, fig. 10; Martins and Gomes, p. 218-219, fig. 2.129 and Milker and Schmiedl, 2012, p. 111, fig. 24, subfigs. 21-24.

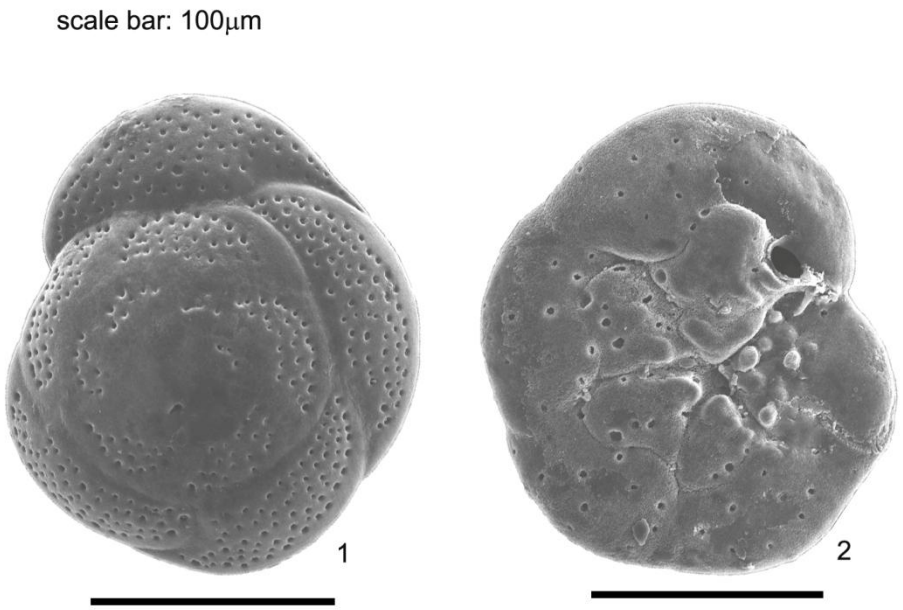

Figure 9.39. *Asterigerinata mamilla*; 1) dorsal view and 2) ventral view.

Morphological description: The wall is calcareous; test is low trochospiral and conical in peripheral view; spiral side is convex and evolute; umbilical side is involute; chambers rapidly increase in breadth as added on the spiral side; sutures are curved, oblique, thickened, imperforate and flush with the surface on the spiral side; on the umbilical side, sutures are curved, oblique and slightly depressed; periphery is subangular; both sides are perforate with larger pores on the chamber margins of the spiral side and more loosely larger and irregularly arranged pores on the umbilical side. The aperture is a low interiomarginal, umbilical arch at the base of the final chamber.

Distribution in Guadiana Estuary: abundant species in the biocenosis and tanathocenosis; more abundant at the lower estuary; higher densities during winter.

Relevant literature: Martins and Gomes, 2004; Milker and Schmiedl, 2012; Murray, 1971.

Superfamily DISCORBOIDEA

Family DISCORBIDAE Ehrenberg, 1838

Genus *Discorbis* Lamarck, 1804

Discorbis sp.

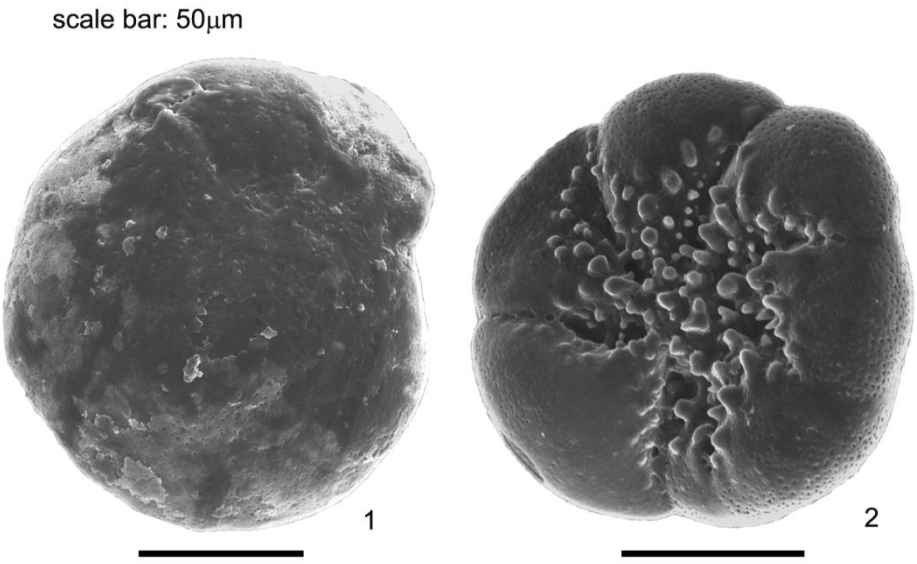

Figure 9.40. *Discorbis* sp.; 1) dorsal view; 2) ventral view.

Distribution in Guadiana Estuary: rare in the modern estuary; uncertain in the paleo-record.

Remarks: Probably wrongly identified. It could be *Bucella frigida* (Cushman) in Hayward and Hollis, 1994, p. 207, pl. 3, figs. 11-13.

Family EPONIDIDAE

Genus *Poroeponides* Cushman, 1944

Poroeponides cf. *lateralis* (Terquem, 1878)

- *Rosalina lateralis* Terquem, 1878.
- *Poroeponides lateralis* (Terquem), Hottinger et al., 1991b, p. 73, pl. 4, figs. 1-10; Jones, 1994, p. 105, pl. 106, figs. 2 and 3.

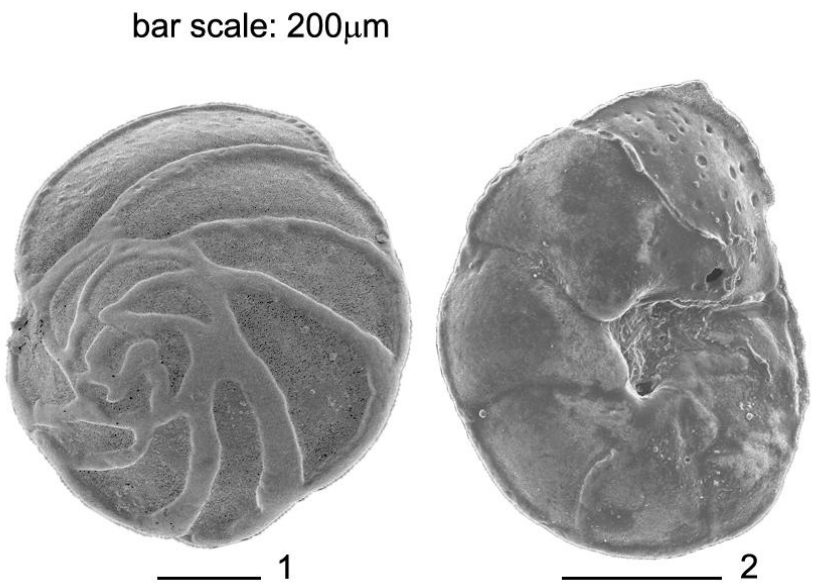

Figure 9.41. fossil *Poroeponides* cf. *lateralis*; 1) dorsal view; 2) ventral view.

Morphological description: Test trochospiral, evolute on dorsal side and involute in ventral side, unequally and variably biconvex, usually more convex on the ventral side; crescent shape on dorsal side and subtriangular on ventral side; prominent marginal prolongation; no umbilicus present

Distribution in Guadiana Estuary: exotic, rare in the modern estuary; rare species in the paleoenvironments (CM3 borehole).

Relevant literature: Hottinger et al., 1991b.

Family HELENINIDAE

Genus *Helenina* Saunders, 1961

Helenina anderseni (Warren, 1957)

- *Pseudoeponides anderseni* Warren, 1957.
- *Helenina anderseni* (Warren), Scott and Medioli (1980), p. 42, pl. 5, figs. 10, 11; Scott et al. (1991), p. 389, pl. 2, figs. 19, 20; Hayward and Hollis, 1994, p. 207, pl. 3, figs. 14-16; Javaux and Scott (2003), p. 24, fig. 6, subfigs. 3, 4.

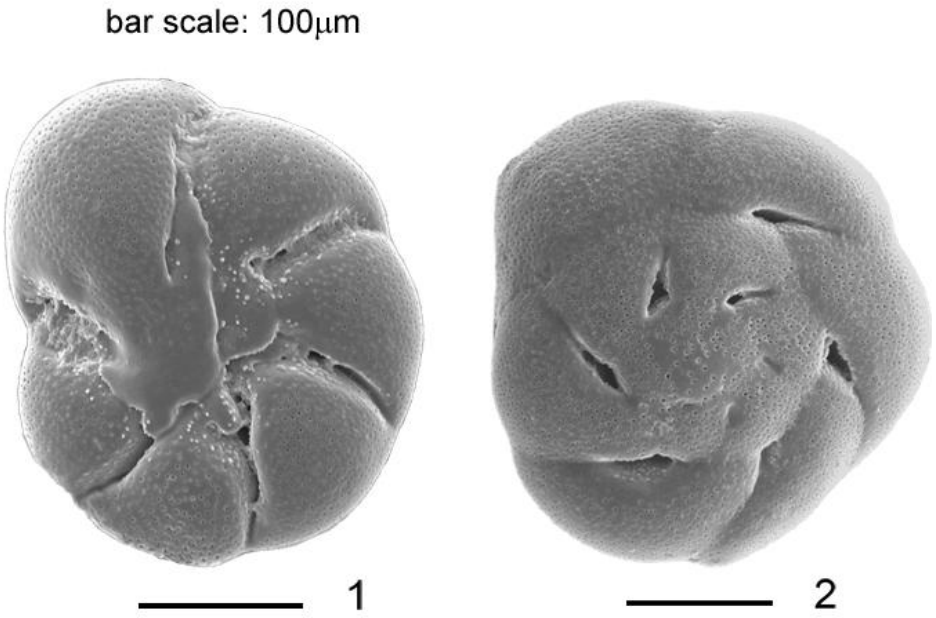

Figure 9.42. *Helenina anderseni*; 1) ventral side view and 2) dorsal side view.

Morphological description: Test low trochospiral, both sides flattened, all chambers of the two whorls visible on the flattened spiral side; chambers enlarging gradually, of greater breadth than height, six in the final whorl; sutures curved, oblique, depressed, on the opposite side the somewhat produced umbilical flaps of successive chambers overlap to close the umbilicus; wall calcareous, finely perforate; surface smooth.

Distribution in Guadiana Estuary: indigenous rare species, with a narrow distribution restricted to the estuary lower reaches. Not recorded in the paleoenvironments.

Remarks: usually associated with *D. aguayoi*; can be easily misidentified as *Ammonia* by beginners.

Family ROSALINIDAE

Genus *Neoconorbina* Hofker, 1951

Neoconorbina sp.



Figure 9.43. SEM photograph of the ventral view of a *Neoconorbina* sp.

Morphological description: test circular in outline, low conical trochospiral; spiral side convex with all of the three whorls visible; chambers increasing rapidly and the final chambers occupies most of the periphery; umbilical side flat to concave, exposing only the three to four of the final whorl around the open umbilicus.

Distribution in Guadiana Estuary: exotic, rare in the modern estuary; not reported at the studied Holocene sedimentary sequences.

Genus *Rosalina* d'Orbingny, 1826

Rosalina bradyi, (Cushman, 1915) (Fig. 9.44. 5 and 6)

- *Discorbis globularis* (d'Orbigny) var. *bradyi* Cushman, 1915.

- *Rosalina bradyi* (Cushman), Jones, 1994, p. 93, pl. 86, fig. 8; Debenay et al., 2005, p. 336 pl. 3, figs. 2 and 22; Milker and Schmiedl, 2012, p. 96, fig. 22, subfigs. 11-14.

Rosalina macropora, (Hofker, 1951) (Fig. 9.44. 1-4)

- *Discopulvinulina macropora* Hofker, 1951.
- *Rosalina macropora* (Hofker), Milker and Schmiedl, 2012, p. 96, fig. 22, subfigs. 17 and 18.

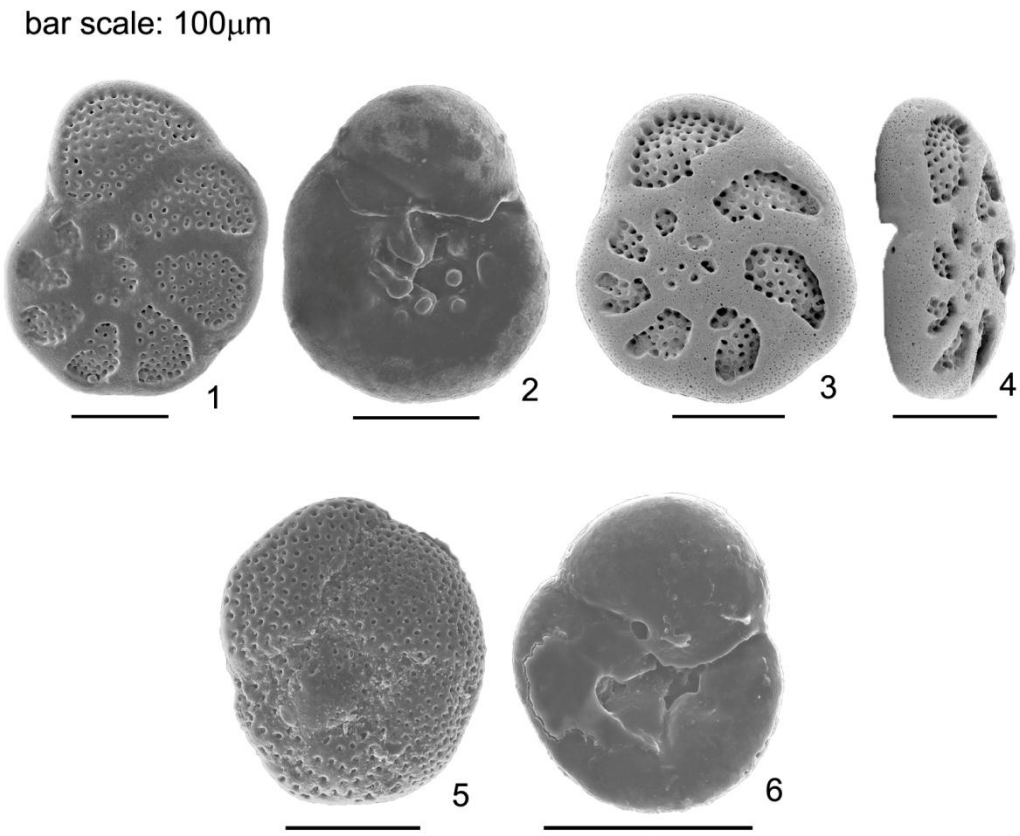

Figure 9.44. 1 and 2) modern specimens of *Rosalina macropora*, 1) dorsal view and 2) ventral view; 3 and 4) fossil specimen of *R. macropora*, 3) dorsal view and 4) lateral view; 5 and 6) modern specimens of *Rosalina* bradyi, 5) dorsal view and 6) ventral view.

Morphological description (*Rosalina* genus): Test trochoespiral, planoconvex to concavoconvex, with rapidly enlarging chambers visible on the convex spiral side where the depressed sutures are oblique and curved back at the periphery; on the umbilical side chambers are subtriangular and strongly overlapping; the final chamber occupy about one-third of the circumference; sutures strongly curved.

Distribution in Guadiana Estuary: rare exotic genus in the modern estuary; rare in the fossil record.

Superfamily GLABRATELLOIDEA

Family GLABRATELLIDAE

Genus *Glabratella* Dorreen, 1948

Glabratella sp.

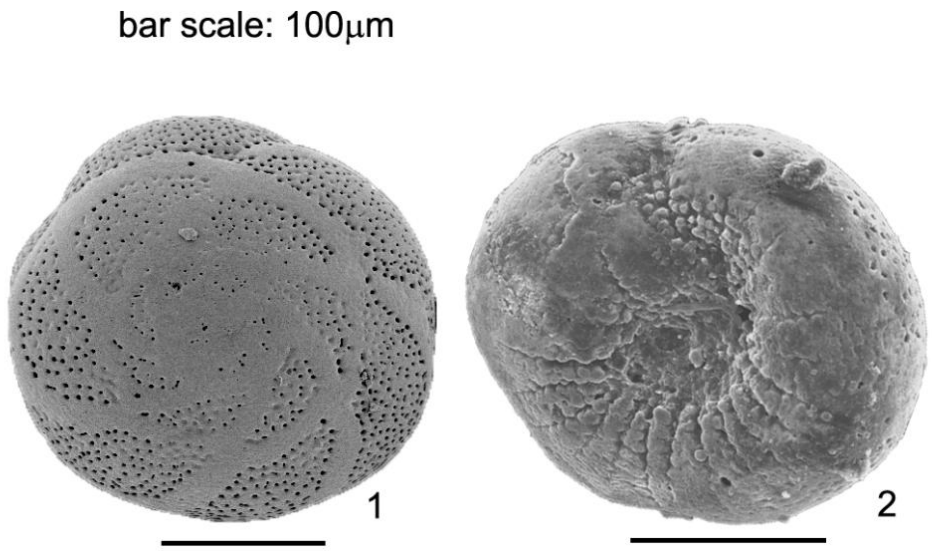

Figure 9.45. fossil specimens of *Glabratella* sp.; 1) dorsal view; 2) ventral view.

Morphological description: test enrolled in a low trochospiral coil; chambers inflated and globular; sutures curved, depressed, periphery rounded; wall calcareous, finely perforate but may be more coarsely perforate on the spiral side; surface smooth except for radial striae and rows of pustules leading to the umbilicus.

Distribution in Guadiana Estuary: rare exotic species in both, the modern estuary and fossil record.

Superfamily NONIONOIDEA

Family NONIONIDAE

Genus *Haynesina* Banner and Culver, 1978

Haynesina depressula (Walker and Jacob, 1798) (Fig. 9.46. 1)

- *Nautilus depressulus* Walker and Jacob, 1798, p. 641, pl. 14, fig. 33.
- *Haynesina depressula* (Walker and Jacob), Hayward and Hollis, 1994, p. 211, pl. 5, figs. 13-16; Milker and Schmiedl, 2012, p. 109, fig. 25, subfigs. 17 and 18.

Morphological description: The wall is calcareous, planispiral, circular in outline, and biumbilicate with narrow and depressed umbilici in peripheral view; the sutures are radial, backward curved; about eight to ten chambers per whorl, enlarging gradually as added; the umbilical region is filled with pustules; the periphery is subrounded and the test surface is smooth.

Distribution in Guadiana Estuary: indigenous species, rare in both modern estuary and paleoenvironments.

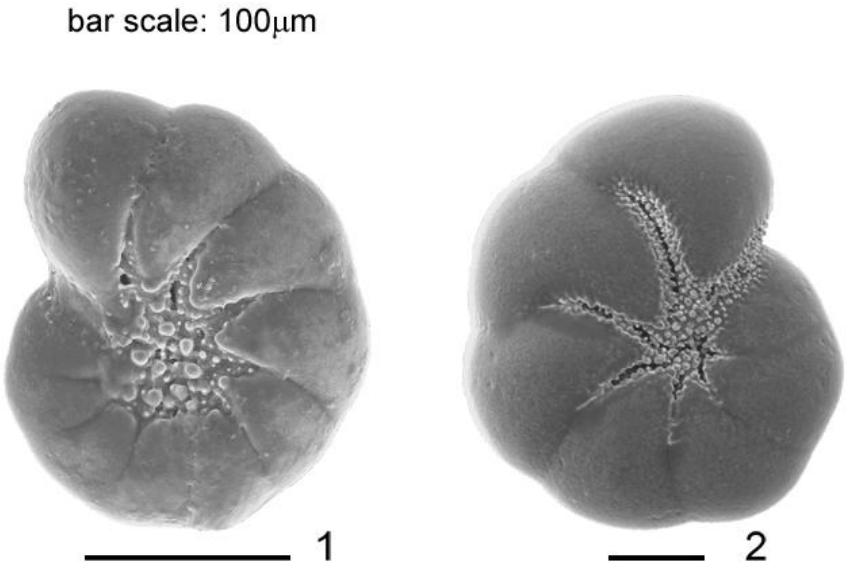

Figure 9.46. 1) *Haynesina depressula*; 2) *Haynesina germanica*.

Haynesina germanica (Ehrenberg) (Fig. 9.46. 2)

- *Nonionina germanica* Ehrenberg, 1840.
- *Nonion germanica* (Ehrenberg, 1840).
- *Protelphidium orbiculare* (Brady, 1881), Scott and Medioli, 1980, p.42, pl. 5 fig. 7.

- *Haynesina germanica* (Ehrenberg), Langer, 2000, p. 643, Fig. 1, subfigs. A, B and C; Leorri and Cearreta, 2004, p. 78, pl. 1, fig. 3; Austin et al., 2005, p. 70, fig. 1A, B and D.

Morphological description: The wall is calcareous, planispiral, circular in outline, and biumbilicate with narrow and depressed umbilici in peripheral view; the sutures are radial, backward curved; about eight to ten chambers per whorl, enlarging gradually as added; the umbilical region is filled with pustules; test surface is smooth.

Distribution in Guadiana Estuary: indigenous species, very constant and dominant at the middle and lower elevations of the modern estuary; strongly associated with *A. aberdoveyensis*; dominant species in the paleo-record.

Superfamily PLANORBULINOIDEA

Family CIBICIDIDAE Cushman, 1927

Genus *Lobatula* Fleming, 1822

Lobatula lobatula (Walker and Jacob, 1798)

- *Nautilus lobatulus* Walker and Jacob, 1798.
- *Cibicides lobatulus* (Walker and Jacob), Scott et al., (1980c), p. 226, pl. 4, figs. 8 and 9; Murray, 1971, p. 175, pl. 73, figs. 1-7; Levy et al., 1995, p. 44, pl. 10, fig. 4.
- *Lobatula lobatula* (Walker and Jacob), Martins and Gomes, 2004, p. 211-213, fig. 2.126; Loeblich and Tappan, 1988, p. 583, pl. 637, figs. 10-13; Milker and Schmiedl, 2012, p. 107-108, fig. 24, subfigs. 17-20.

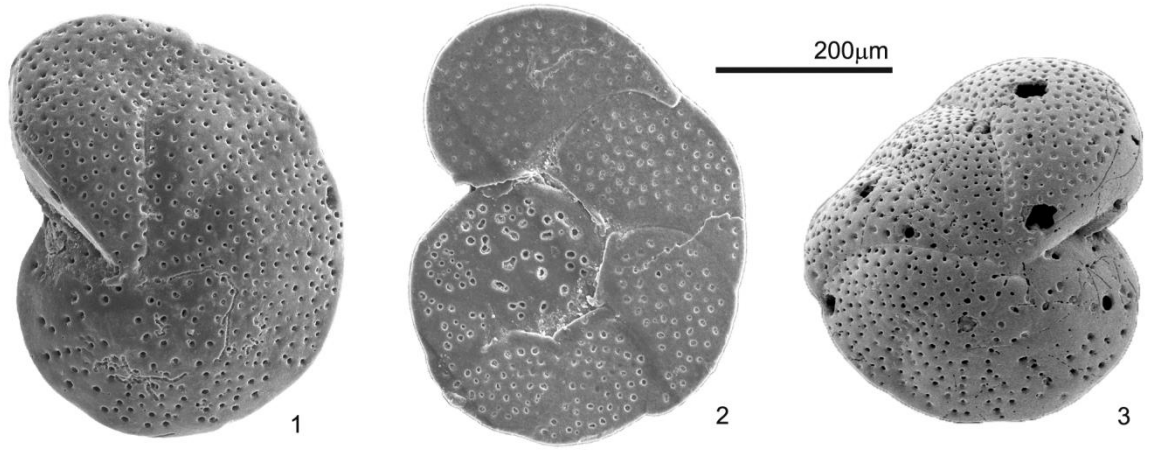

Figure 9.47. *Lobatula lobatula*; 1 and 2) modern specimens, 1) unattached side view and 2) attached side view; 3) fossil specimen unattached side view.

Morphological description: The wall is calcareous with a coarsely and uniformly perforation on both sides; test is trochospiral and planoconvex with an evolute spiral side and an involute umbilical side and can be irregularly arranged; chambers increasing in size as added; sutures are raised and backward curved on the spiral side and radial, curved and depressed on the umbilical side; periphery is acute and carinate; aperture is a low interiomarginal and equatorial opening, bordered by a rim.

Distribution in Guadiana Estuary: common exotic species at the modern estuary, especially at the lower reaches; is present in the paleo-record, at the southernmost borehole.

Family PLANORBULINIDAE

Genus *Planorbulina* d'Orbigny, 1826

Planorbulina mediterranensis d'Orbigny, 1826

- *Planorbulina mediterranensis* d'Orbigny, 1826.

- *Planorbulina mediterranensis* d'Orbigny, Murray, 1971, p. 179, pl. 75, figs. 1-6; Jones, 1994, p. 96, pl. 92, fig. 1, Levy et al., 1995, p. 44-45, pl. 10, fig. 6; Martins and Gomes, 2004, p. 214 and 215, fig. 2.127; Milker and Schmiedl, 2012, p. 108, fig. 24, subfigs. 21-24.

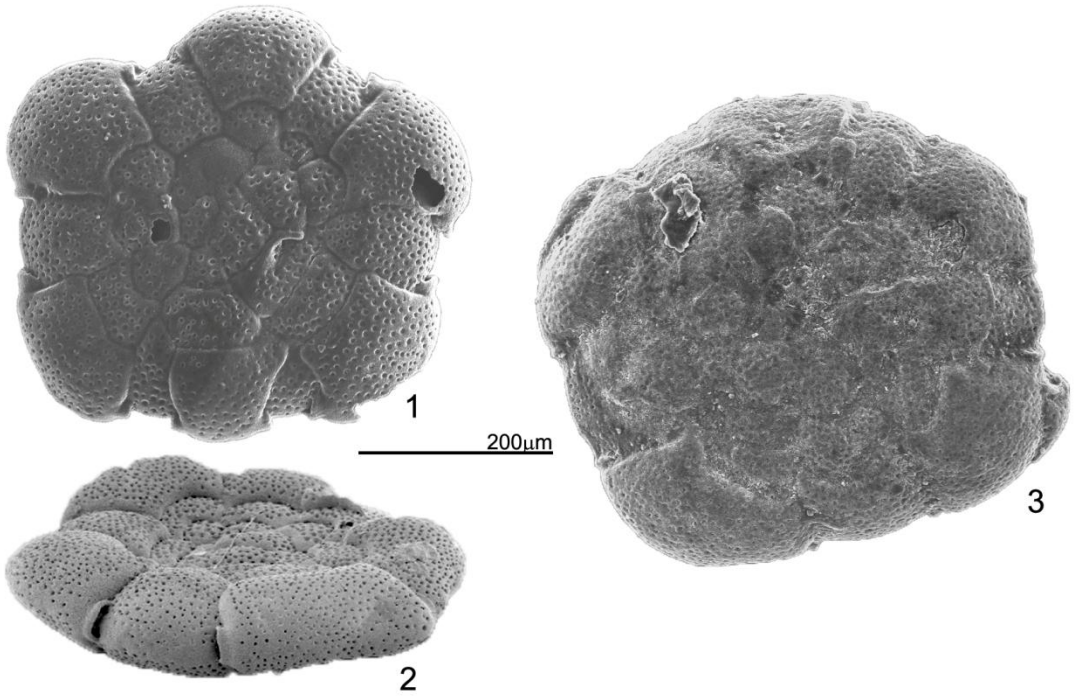

Figure 9.48. *Planorbulina mediterranensis*; 1 and 2) modern specimens, 1) unattached side view and 2) lateral view of two extraumbilical apertures; 3) unattached side view of a fossil specimen.

Morphological description: The wall is calcareous, coarsely and densely perforate on both sides; test is planoconvex; early stage is trochospiral and later stage chambers are added in a cyclical pattern; typically the test is quadrate in outline; sutures are depressed on the unattached, umbilical side and thickened, limbate and imperforate on the attached spiral side; in the adult stage, each chamber has two interiomarginal and extraumbilical apertures, bordered by a lip.

Distribution in Guadiana Estuary: exotic, rare in the modern estuary; accessory species in the paleoenvironments (CM3 borehole).

Remarks: Associated to *Posidonia oceanica* meadows in the Mediterranean (Colom, 1974).

Relevant literature: Colom, 1974; Martins and Gomes, 2004; Murray, 1971

Superfamily ROTALIOIDEA

Family ELPHIDIIDAE Galloway, 1933

Genus *Elphidium* de Montfort, 1808

Elphidium advenum (Cushman, 1922) (PLATE 1, fig. 7)

- *Polystomella advena* Cushman, 1922.
- *Cribrononion advenum* (Cushman, 1922).
- *Elphidium advenum* (Cushman), Jones, 1994, p. 108, pl. 110, fig. 1; Debenay and Luan, 2006, p. 80, pl. 2, fig. 46.

Distribution in Guadiana Estuary: exotic, rare in the modern estuary; rare species in the paleoenvironments.

Elphidium advenum var. *margaritaceum* Cushman, 1930 (PLATE 1, fig. 15)

- *Elphidium advenum* var. *margaritaceum* Cushman,
- *Elphidium margaritaceum* (Cushman), Pawlowski and Holzmann, 2012, http://forambarcoding.unige.ch/specs/106-elphidium-margaritaceum

Morphological description: Test planispiral, bilaterally symmetrical; sutural canal system opens into a single row of pores; septal bridges usually hollow and contain a retral process; aperture a series of large circular pores at base of aperture face.

Distribution in Guadiana Estuary: exotic, rare in the modern estuary; common species in the paleoenvironments.

Elphidium cf. *discoidale* (d'Orbigny, 1839) (PLATE 1, fig. 6)

- *Polystomella discoidale* d'Orbigny, 1839.
- *Elphidium discoidale* (d'Orbigny, 1839), Martins and Gomes, 2004, p. 263, fig. 2.155.

Distribution in Guadiana Estuary: exotic, rare in the modern estuary; rare species in the paleoenvironments.

Elphidium crispum (Linnaeus, 1758) (PLATE 1, fig. 1)

- *Nautilus crispus* Linnaeus, 1758.
- *Elphidium crispum* (Linnaeus), Murray, 1971, p. 155, pl. 64, figs. 1-6; Jones, 1994, p. 109, pl. 110, figs. 6-7; Levy et al., 1995, p. 51, pl. 12, fig. 5; Martins and Gomes, 2004, p. 261-262, fig. 2.154; Milker and Schmiedl, 2012, p. 120, fig. 27.13-14.

Morphological description: The wall is calcareous; test is biconvex, planispiral enrolled and involute; chambers are numerous and narrow in the outer whorl; peripheral margin is keeled; long retral processes span the depressed sutures and occupy about two thirds of the chamber width; the umbilical region are ornamented with more massive calcite bosses which in large specimens fuse to form a large boss with coarse perforations; primary aperture consists of a row of interiomarginal openings that are bordered by a rim; test surface is ornamented with small pustules only in the apertural region.

Distribution in Guadiana Estuary: exotic species, relatively abundant (< 10%) in the modern estuary, mainly at the lower reaches of the marine estuary; rare in the paleo-record.

Relevant literature: Colom, 1974.

Elphidium excavatum (Terquem, 1875) (PLATE 1, fig. 11)

- *Polystomella excavata* Terquem, 1875.
- *Cribroelphidium excavatum* (Terquem, 1875).
- *Elphidium excavatum* f. *excavatum* (Terquem, 1875), Hayward and Hollis, 1994, p. 211, pl. 5, figs. 1-5;
- *Elphidium excavatum* (Terquem), Debenay et al., 1998c, p. 80, pl. IV, figs. 9 and 10.

Morphological description: The wall is calcareous, planispiral enrolled; peripheral outline slightly lobate, rounded in edge view. 8-10 chambers in outer whorl; sutures straight to moderately curved backwards, narrow, extending into umbilical area; umbilicus depressed, covered by numerous papillae.

Distribution in Guadiana Estuary: exotic species, rare in modern estuary; relatively abundant in the paleo-record.

Relevant literature: Feyling-Hanssen, 1972; Miller et al., 1982; Hayward and Hollis, 1994.

Elphidium williamnsoni Haynes, 1973 (PLATE 1, figs. 2-5)

- *Elphidium articulatum multicameratum* Collins, 1974.
- *Elphidium gunteri carioense* Collins, 1974.
- *Elphidium williamnsoni* Haynes, 1973, Hayward and Hollis, 1994, p. 211, pl. 5, figs. 9-12; Leorri and Cearreta, 2004, p. 78, pl. 1, fig. 4; Cearreta et al., 2007, p. 128, pl. 1, fig. 13; Pawlowski and Holzmann, 2012, http://forambarcoding.unige.ch/specs/105-elphidium-williamsoni

Morphological description: Test with evenly rounded outline, becoming lobulate in later part; periphery broadly rounded to sub-acute; septal bridges long, evenly spaced and numerous.

Distribution in Guadiana Estuary: indigenous species, relatively abundant (< 10%) in the modern estuary; rare in the paleo-record.

Elphidium gerthi Van Voorthuysen, 1957 (PLATE 1, figs. 12-14)

- *Elphidium gerthi* Van Voorthuysen, 1957.
- *Cribrononion gerthi* (Van Voorthuysen); Levy et al., 1995, p. 51, pl. 12, fig. 2; Martins and Gomes (2004), p. 257-258, fig. 2.152.
- *Elphidium gerthi Van Voorthuysen,* Mendes et al., 2012, p. 24, fig. 4.8.

Morphological description: The wall is calcareous; test is planispiral, compressed and slightly evolute; the umbilical area is large and slightly depressed; nine to eleven chambers in the final whorl; sutures depressed, curved close to the periphery, crossed by sutural bridges or retral processes, with several fossettes; the aperture is multiple with several interomarginal arches.

Distribution in Guadiana Estuary: indigenous species, relatively abundant (< 10%) in the modern estuary; not recorded in the studied Holocene sedimentary sequences.

Relevant literature: Martins and Gomes, 2004; Mendes et al., 2012.

Elphidium oceanensis (d'Orbigny, 1826) (PLATE 1, figs. 16-21)

- *Polystomella oceanensis* d'Orbigny, 1826.
- *Cribroelphidium vadescens* Cushman snd Bronnimann, 1948.
- *Elphidium littorale* Le Calvez and Le Calvez, 1951.
- *Elphidium gunteri* Cole, 1931, Debenay et al., 1998c, p. 80, pl. IV, fig. 17; Hayward and Hollis, 1994, p. 209, pl. 4, figs. 10-12.
- *Cribroelphidium mirum* n. sp., Langer and Schmidt-Sinns, 2006, p. 671, Fig. 1, subfigs. 1-23.
- *Elphidium oceanensis* (d'Orbigny), Murray, 1971, p. 165, pl. 69, figs. 1-7; Cearreta, 1988, p. 36, pl. I, fig. 8; Leorri and Cearreta, 2004, p. 78, pl. 1, fig. 5; Cearreta et al., 2007, p. 128, pl. I, fig. 3.

Morphological description: Planispiral, involute, inflated test with 8-15 chambers in outer whorl; periphery broadly rounded, slightly to irregularly lobate; sutures depressed, straight to gently curved; septal bridges irregular in number and degree of development; umbilicus may be slightly depressed or raised due to growth of irregular bosses; tubercular development in sutural pits, umbilical depression and base of apertural face; aperture is an interiomarginal row of arches; wall is coarsely perforate and usually golden brown.

Distribution in Guadiana Estuary: has its optimum during summer, being a dominant species at middle and lower elevations (-0.7 to 1.1 m in relation to MSL); in terms of distribution range it is almost as eurytopic as *A. aberdoveyensis*, occupying the entire study range of elevation and latitude.

Relevant literature: Murray, 1971; Hayward and Hollis, 1994; Langer and Schmidt-Sinns, 2006.

GenBank code: *Elphidium excavatum* (EF534073)

Barcode sequences:

LSU rRNA partial - 13171.2_E.excavatum

AAGGGCACCACAAGAACGCNNNNNNCATGTGGCTTAATTTGACTCAACGCGGGAAATCTTACCGGG
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AATTGCGTTTCACTAAAGGCGTCATATCTGTTTTGTTGCGTGTTTGACCCCTCTTCGGAGCGCGTGTC
TTCACGCACAATTACTTTGGCGTCTGAAAGCAACGAACGTGACCGTAACCTCTTGTTGCCTTCTCTTC
TCCTCGGAGAATGCTGTTTGTTTTTGCAGGCAGTATATGGAGGCTTTTTTACTCAACAACTAGAGGG
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TTCCGGGCTGCACACGTGATACATTGATTACTTCAGTGAGTATCTACGTTTTACTGCGTGGCATTGCA
ATGCATATTTCTTCGGAAGTGTGTTTTTGCTTGCCGCCTCAACCTGCTTCGAAAGCATGCGGGTAACC
AATTAGAAGTAGTGATTTCCTTTTTTTATAACCACACTAATACGGGGCATCATCACCCGGCATGCCCT
GTTGTATGTTTTGTGTGTGGTGTTTGCTTTTCCATGTGCTTTTGTCAATTCATAGTGGGGACAGACCAT
TGTTAATTGTTGGTCTCGGTCTTAACTAGGAATGCCTTGTACGAGTTTTTGGCTCAACAAACCACTCG
GAACACGTCCCTGCCCTTTGTACACACTGCCCGTCGCTCTTACCGATGGATTATATTATGAGTCGGCA
GGACCGTTTAGGAAATGCCCGCGAATNNNNNGATCTAAAGGAAAGAGAAGTCGAACAAGGCA

LSU rRNA partial - 13171.3_E.excavatum

AAGGGCACCACAAGAACGCGTGGATCATGTGGCTTAATTTGACTCAACGCGGGAAATCTTACCGGG
TCCGGACACACTGAGGATTGACAGGTTCCGAGAGTTTTTGCTTCGGCAATGCTCTCTTAAATATGCT
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ATGCATATTTCTTCGGAAGTGTGTTTTTGCTTGCCGCCTCAACCTGCTTCGAAAGCATGCGGGTAACC
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TTGTATGTTTTGTGTGTGGTGTTTGCTTTTCCATGTGCTTTTGTCAGTTCATAGTGGGGACAGACCATT
GTTAATTGTTGGTCTCGGTCTTAACTAGGAATGCCTTGTACGAGTTTTTGGTTCAACAAACCACTCGG
AATACGTCCCTGCCCTTTGTACACACCGCCCGTCGCTCTTACCGATGGATTATATTATGAGTCGGCAG
GACCGTTTAGGAAATGCCCGCGAATAATGTGATCTAAAGGAAAGAGAAGTCGAACAAGGCA

Elphidium poeyanum (d'Orbigny, 1826) (PLATE 1, fig. 8)

- *Polystomella poyana* d'Orbigny, 1826.
- *Elphidium poeyanum* (d'Orbigny, 1826), Debenay et al., 1998c, p. 80, pl. IV, fig. 11.
- *Cribroelphidium cuvillieri* (Lévy, 1966), Debenay et al., 2001, p. 96, pl. 6, fig. 18.

Morphological description: similar to other *Elphidium* but with a test more ovate, smoother and finely perforated.

Distribution in Guadiana Estuary: indigenous, rare in the modern estuary; slightly more abundant in the Holocene sequences.

Porosononion granosum (d'Orbigny, 1826) (PLATE 1, fig. 10)

- *Nonionina granosa* d'Orbigny, 1846.
- *Elphidium granosum* (d'Orbigny), Jorissen, 1987, p. 47, pl. 2, figs. 1-2 and Milker and Schmiedl, 2012, p. 121, fig. 27.17-18.
- *Porosononion granosum* (d'Orbigny), Poignant et al., 2000, p. 400, pl. 1, figs. 13-15.

Morphological description: calcareous hyaline test, planispiral, with coarse perforation; the umbilical region and sutures are filled with pustules; the periphery is subrounded.

Distribution in Guadiana Estuary: exotic species, rare in the modern estuary; not reported in the studied paleo-sequences.

PLATE 1 - 8 different species of the family Elphidiidae; 1) fossil exemplar of *Elphidium crispum*; 2-5) *Elphidium excavatum williamsoni*, 2) stereomicroscope photograph of a living exemplar subject to molecular analysis, 3) SEM photograph of lateral view; 4) profile view and 5) lateral view of a small individual; 6) *Elphidium* cf. *discoidale*; 7) *Elphidium advenum*; 8 and 9) *Cribroelphidium poeyanum*; 10) *Pseudononion granosum*; 11) *Elphidium excavatum*; 12 – 14) *Elphidium gerthi*; 15) *Elphidium advenum* var. *margaritaceum*; 16 – 21) *Elphidium oceanensis*, 16) fossil adult specimen, 21) stereomicroscope photograph of living exemplar subject to molecular analysis.

PLATE 1



Family ROTALIIDAE Ehrenberg, 1839

Genus *Ammonia* Brünnich, 1772

Ammonia aberdoveyensis Haynes, 1973

- *Ammonia beccarii* (Linnaeus, 1758).
- *Ammonia tepida* (Cushman, 1926).
- *Ammonia aberdoveyensis*, Haynes, Hayward et al., 2004, p. 253, pl. II, fig. T2, p. 256, pl. III, fig, T2, p. 258, pl. IV, fig. T2; Pawlowski and Holzmann, 2012, http://forambarcoding.unige.ch/specs/72-ammonia-aberdoveyensis-t2

Morphological description: small proloculus, test medium-size (0.3 – 0.5 mm); whorls medium width on spiral side; moderate inflation, a broadly rounded periphery, 6-9 chambers per whorl; small pores and longer radial sutural furrows on the umbilical side, than the other 'Ammonias'; little to no secondary calcite, usually with no umbilical boss.

Distribution in Guadiana Estuary: indigenous, is the most ubiquitous calcareous species in the modern estuary, being absent only from the most elevated stands of the marsh; its optimum occurrence is in the lower to middle elevations of the lower and middle estuary; its peak of occurrence is observed in summer, especially in the lower elevations where it is always the dominant species; in summer, is able to migrate farther up the marsh, occupying higher elevation stands; *A. aberdoveyensis* is a dominant element in two of the main assemblages found for Guadiana: in the middle elevations north assemblage, where it is subdominant to *M. fusca*, and in the lower elevations of the lower estuary assemblage, where is co-dominant with *B. ordinaria* in winter.

Remarks: found in Mediterranean coasts, France and Italy (Hayward et al., 2004).

Important literature: Hayward et al., 2004;

Barcode sequences:
LSU rRNA partial - 13162.1_Ammonia
AAGGGCACCACAAGAACGCNNNNNNNNNNGCTTAATTTGACTCAACGCGGGAAATCTTACCGGGTC
CGGACACACTGAGGATTGACAGATATACGCTCATTGCGTGTGCTTCGGCGCTGCTTTGAGCTGAAAG
ATGCTAGTTCTTTCATGATTATGTGATAGGTGGTGCATGGCCGTTCTTAGTTCGTGGAGTGATCTGTC
TGCTTAATTGCGTATCAATAATAGAGACCTAGTATACGCGTGGATTTCGCGTGGTAGTGACCCCCTG

TTCACGCAGGCGTGTGTCGCACACGCGTGGCCACGCACTGGTCTCAGATAGCAACGAACGTGACCGT
ATTCTATTGTTGCAGTGAAATTGTACTTTCGGGAGTACGACCCACTGCTTAGTGTATGTACGGCCTCG
GTGCGAGCAATACACATTAAACTATAGAGACCGCTGTTTCTTCTTTAAACCAGAGGAAGGATACGGC
AATAACAGGTCTGTGATGCCCTCAGATGTTCCGGGCTGCACACGTGCTACAATGATCATTGCACTGT
GCATCTAACCCAATGTGCGTGGACGCCGCATGCATGTACTCCTTGTGGGTACACGCATTGCTGAGCG
ACCACGCCGAACCTACTTCGAAAGTAAAATTTCTCTGTGGGTAATCCATTAGAAGTAATGACTCGCA
TAGACCATGGCACACCAAATGTACGCGCAGGTCTACCCGGCTCGCCTTTGTGTGAGTGCAGTGCGTA
GCTTGTTGTTTCGTACGTGCCACTCCGTATTAATTCGTACGTGGGGATAGATCATTGTTTAATTGTTG
GTCTCGGTCTTAACTAGGAATGCCTTGTACGGGTCTCTGGTTCAACATACCACCCGGAATACGTCCCT
GCCCTTTGTACACACCGCCCGTCGCTCTTACCGATGGATTATGCTATGAATCTATAGGACTGCCAAA
GTTGCTTCGGCTGCTTAGTGGAAATATATATGAATAGCGTGATCTAAAGGAAAGAGAAGTCGAACA
AGGCAA

LSU rRNA partial - 13162.2_Ammonia
AAGGGCACCACAAGAACGCNNNNNNNNNNGCTTAATTTGACTCAACGCGGGAAATCTTACCGGGTC
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TTCACGCAGGCGTGTGTCGCACACGCGTGGCCACGCACTGGTCTCAGATAGCAACGAACGTGACCGT
ATTCTATTGTTGCAGTGAATATGTGTGCCTTCGGGCGTACGACCCACTGCTTAGTATATGCACGCCTC
GGCGAGCAATATACATTAAACTATAGAGACCGCTGTTTCTTCTTTAAACCAGAGGAAGGATACGGCA
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CTTGTTGTTTCGTACGTGCCACTCCGTATTAATTCGTACGTGGGGATAGATCATTGTTTAATTGTTGG
TCTCGGTCTTAACTAGGAATGCCTTGTACGGGTCTCTGGTTCAACATACCACCCGGAATACGTCCCTG
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AGGCAA

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CCTGTTTCAACGCAGGCGTGTGTCGCACACGCGTGCGGCGCACTGGTCTCAGATAGCAACGAACGTG
ACCGTATTCTATTGTTGCAGTGAAATGTACTTTCGAGTACGACCCACTGCTTAGTATATGCACCGCCT
CGGCGAGCAATATACATTAAACTATAGAGACCGCTGTTTCTTCTTTAAACCAGAGGAAGGATACGGC
AATAACAGGTCTGTGATGCCCTCAGATGTTCCGGGGCTGCACACGTGCTACAATGATCATTGCACTG
TGCATCTAACCCAATGTGCGTGGACGCCGCATGCATGTACTCCTTGTGGGTACACGCATTGCTGAGC
GACCACGCCGAACCTACTTCGAAAGTAAAATTTCTCTGTGGGTAATCCATTAGAAGTAATGACTCGC
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LSU rRNA partial - 13166.10_Ammonia
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AAAGATGCTAGTTCTTTCATGATTATGTGATAGGTGGTGCATGGCCGTTCTTAGTTCGTGGAGTGATC
TGTCTGCTTAATTGCGTATCAATAATAGAGACCTAGTATACGCGTGGATTTCGCGTGGTAGTGACCC
CCTGTTTCAACGCAGGCGTGTGTCGCACACGCGTGCGGCGCACTGGTCTCAGATAGCAACGAACGTG
ACCGTATTCTATTGTTGCAGTGAAATGTACTTTCGAGTACCGACCCACTGCTTTAGTGTATGTACGGC
TTCGGTGCGAGCAATACACATTAAACTATAGAGACCGCTGTTTCTTCTTTAAACCAGAGGAAGGATA
CGGCAATAACAGGTCTGTGATGCCCTCAGATGTTCCGGGGCTGCACACGTGCTACAATGATCATTGC
ACTGTGNATCTAACCCAATGTGCGTGGACGCCGCATGTATGTACTCCTTGTGGGTACACGCATTGCT
GAGCGACCACGCCGAACCTACTTCGAAAGTAAAATTTCTCTGTGGGTAATCCATTAGAAGTAATGAC

TCGCATAGACCATGGCACACCAAATGTACGCGCAGGTCTACCCGGCTCGCCTTTGTGTGAGTGCAGT
GCGTAGCTTGTTGTTTCGTACGTGCCACTCCGTATTAATTCGTACGTGGGGATAGATCATTGTTTAAT
TGTTGGTCTCGGTCTTAACTAGGAATGCCTTGTACGGGTCTCTGGTTCAACATACCACCCGGAATAC
GTCCCTGCCCTTTGTACACACCGCCCGTCGCTCTTACCGATGGATTATGCTATGAATCTATAGGACTG
CCAAAGTTGCTTCGGCTGCTTAGTGGAAATATATATGAATAGCGTGATCTAAAGGAAAGAGAAGTC
GAACAAGGCA

PLATE 2

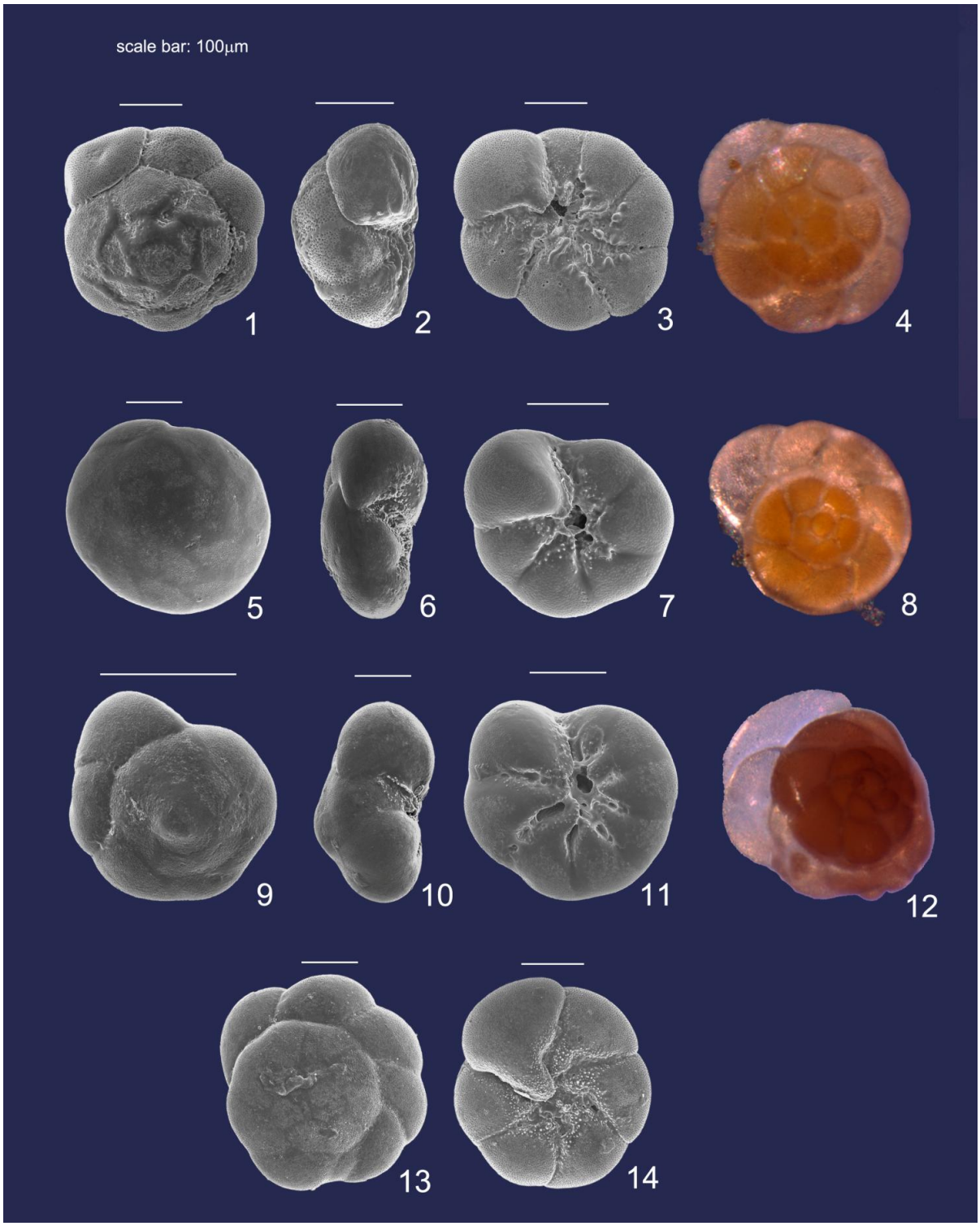

PLATE 2 – 1 – 14) *Ammonia aberdoveyensis*; 1 – 4) sp1, 1) dorsal view, 2) profile view, 3) ventral view, 4) stereomicroscope photograph, dorsal view; 5 – 8) sp2, 5) dorsal view, 6) profile view, 7) ventral view, 8) stereomicroscope photograph, dorsal view; 9 – 12) sp3, 9) dorsal view, 10) profile view, 11) ventral view, 12) stereomicroscope photograph, dorsal view; 13 and 14) fossil specimens, 13) dorsal view and 14) ventral view.

Ammonia beccarii (Linnaeus, 1758)

- *Nautilus beccarii* Linnaeus, 1758.
- *Nautilus beccarii* var. *perversus* Walker, 1784.
- *Rotalia beccarii* (Linnaeus, 1758).
- *Streblus beccarii* (Linnaeus, 1758).
- *Ammonia beccarii* (Linnaeus), Colom, 1974, p. 132, fig. 24. a-e; Martins and Gomes, 2004, p. 254, fig. 2.150D and p. 256, fig. 2.151.

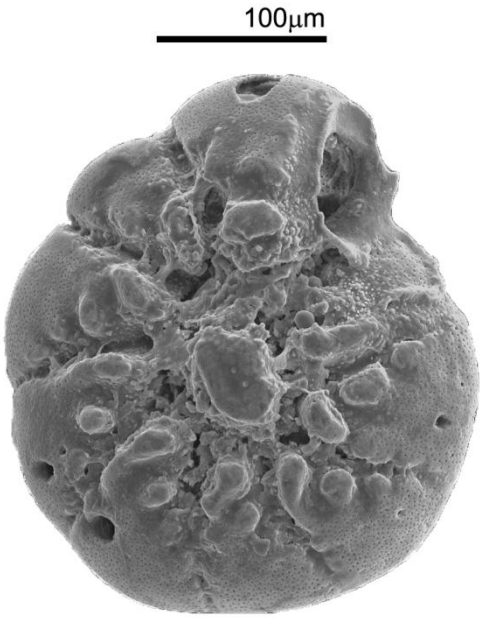

Figure 9.49. *Ammonia beccarii*, ventral view.

Ammonia beccarii (Lineaus) var. *punctatogranosa* (Seguenza, 1880)

- *Rotalia punctatogranosa* Seguenza, 1880.
- *Ammonia beccarii punctatogranosa* (Seguenza), Colom, 1974, p. 133, fig. 25, a-k.

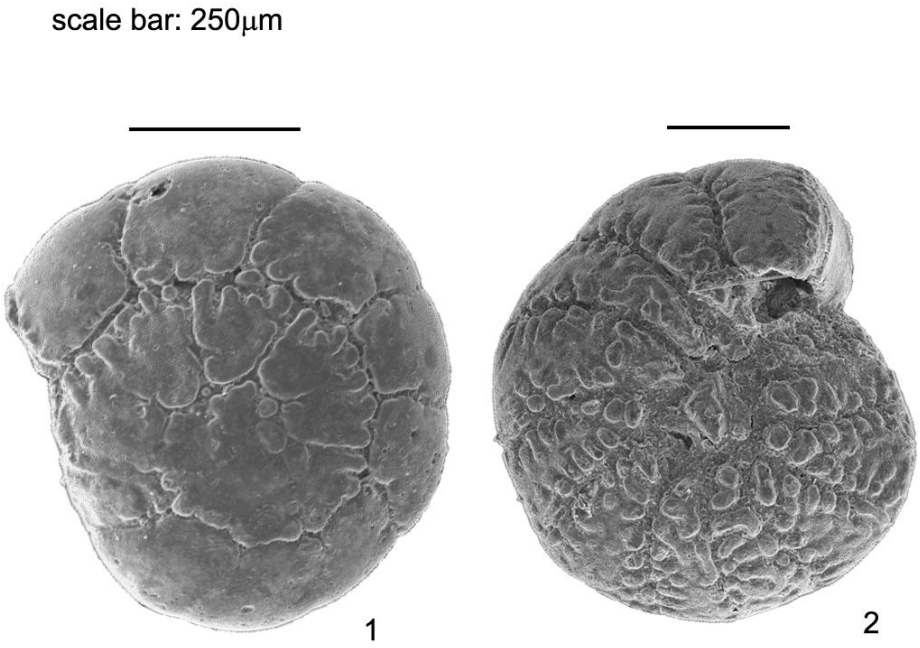

Figure 9.50. *Ammonia beccarii punctatogranosa*, 1) dorsal view and 2) ventral view.

Morphological description (*Ammonia beccarii* species): calcareous hyaline test, trochospiral biconvex, rounded periphery; sutures of spiral side limbate, flush or slightly raised; sutures of umbilical deeply depressed; inner tips of final whorl of chambers project into broad umbilicus; inner parts of sutures and umbilicus ornamented with tubercles, which may coalesce to form a central boss or pillar; aperture is an ovate slit at the base of final chamber.

Distribution in Guadiana Estuary: exotic species, relatively abundant (< 10%) in the modern estuary, usually at the lower reaches; rare species in the studied paleo-sequences.

Genus *Pararotalia* (Le Calvez, 1949)

Pararotalia cf. *spinigera* (Le Calvez, 1949)

- *Globorotalia spinigera* (Terquem), Le Calvez, 1949.
- *Pararotalia spinigera* (Le Calvez, 1949), Hottinger et al., 1991, p. 20, fig. 1, subfig. 2, 5-8.

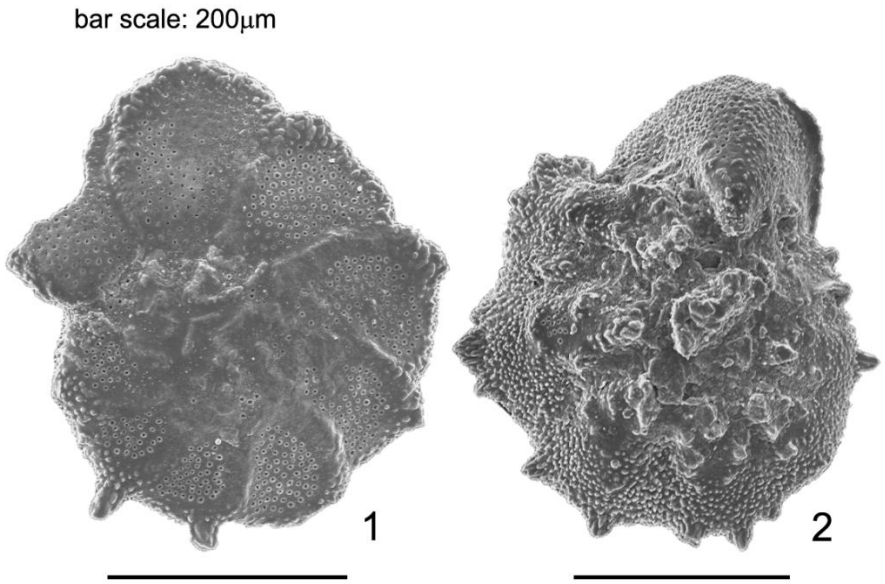

Figure 9.51. 1 and 2) SEM photographs of *Pararotalia* cf. *spinigera*; 1) dorsal view with broken last chamber and 2) ventral view.

Morphological description: calcareous heavily ornamented, trochospiral test with single interiomarginal main aperture into which a toothplate protrudes with a free edge; chambers convex on the ventral side with a pronounced umbilical shoulder and deeply depressed intercameral sutures; a single umbilical plug, and the short blunt, peripheral spines arising from each chamber.

Distribution in Guadiana Estuary: Exotic species, not found in the modern sediments. Found only in the paleorecord, at CM3 borehole at 1643 cm depth, representing 10% of the paleoassemblage.

Remarks: All species from *Pararotalia* genus are typical of marine, warm conditions (Hayward et al., 2012).

9. 3. Thecamoebians

9. 3. 1. What are thecamoebians?

Thecamoebian is the informal name given to the shelled/testate amoebae. Like foraminifera, thecamoebians are single-celled eukaryotes and possess a hard test that, after death, can fossilize in the sediment (Scott et al., 2001). Thecamoebians live in a wide range of terrestrial and aquatic habitats, including wet soils, lakes and even the supratidal and upper intertidal sediments of saltmarshes (Charman, 2001; Gehrels, 2001). The organism consists of a test with an aperture and a cytoplasmic amoeboid body with nucleus, inclusions, and pseudopods which branch out from the aperture like those of foraminifera (Medioli and Scott, 1983; Medioli et al., 1994). Their tests are usually sack-shaped (generally similar to that of the foraminifera *Saccamina*) (Medioli and Scott, 1983) and are composed either from proteinaceous, agglutinated, calcareous, or siliceous material (Ogden and Hedley, 1980). Like foraminifera, thecamoebians' building units can either be secreted (autogenous test) or agglutinated from the surrounding environment (xenogenous test) by, gluing together organic or mineral particles (e.g. sand grains, diatom shells). The tests range from 10 μm up to 800 μm in size with high morphological diversity, allowing identification to species level, and are usually well preserved in peat and lake sediments (Siemensma, 2012). A few taxa (Hyalospheniadae) can build either type of test, depending on circumstances and availability of foreign material (Scott et al., 2001). Three basic groups are recognized, based on pseudopod morphology: Arcellinida, with lobose pseudopodia; Euglyphida, with filose pseudopodia; and Granuloreticulosa, with anastomosing networks of reticulopodia (Siemensma, 2012). All species found in the present study belong to the order Arcellinida, with representatives in 2 of its 3 suborders: Arcellina, which includes the membranous or chitinoid, flexible or rigid tests, without any scales or plates; and Difflugina, which includes rigid, sometimes completely chitinoid tests, but usually composed of xenosomes (collected particles) or idiosomes (secreted particles), embedded in organic cement or attached to the surface; both groups have digitate lobopodia.

Thecamoebians, reproduce once every two to eleven days by simple asexual binary fission to form an identical daughter cell (Ogden and Hedley, 1980). The test, which is built at the time of reproduction, does not grow after the original division (Penard, 1902). Sexuality appears to be rare but not absent (Valkanov, 1962; 1966 in Medioli and Scott., 1983).

Thecamoebians are omnivorous, preying a series of other microorganisms, the size of which depends on the size of the predator test aperture. Bacteria, algae, fungi, other protozoa, including other testate amoebae and small naked amoebae, and rotifers are described among

the dietary preferences of thecamoebians. Some of the large forms may project pseudopodia inside of larger prey and absorb their cytoplasm (Ogden and Hedley, 1980).

Thecamoebians have the capacity of encyst at certain times, usually as protection against adverse environmental conditions, such as desiccation, exhaustion of food supplies or anaerobiosis (Ogden and Hedley, 1980). This feature promotes the transportation of living thecamoebians by wind and birds, facilitating dispersal and quick colonization of new habitats around the world (Medioli and Scott, 1983; Scott et al., 2001).

9. 3. 2. Identification and classification

The most important thecamoebians species encountered in the Guadiana Estuary were photographed using a scanning electron microscope. The photographs were edited and compiled in six plates.

Several guides were used for identifying thecamoebians, with special emphasis on Ogden and Hedley (1980), Medioli and Scott (1983), Medioli et al. (1994), Kumar and Dalby (1998) and Siemensma (2012), MICROWORLD – World of Amoeboid organisms (www.arcella.nl). For higher taxonomy (above family rank) the Worm's classification was used (WoRMS, 2012, World Register of Marine Species – www.marinespecies.org).

9. 3. 3. Taxonomic remarks

Two different taxonomy perspectives are presented in the literature: the 'splitter' perspective, in which a series of species are individualized based on small morphological differences (Ogden and Hedley, 1980) and a 'lumper' perspective, in which the so-called species identified by splitters are treated as gradational morphological variants of a limited number of stock species (Medioli and Scott, 1983 and other works of the same authors). In the perspective of Reinhardt et al. (1998), which lies in between the two extremes, a small number of species is divided into infraespecific strains distinguished on the basis of relatively small variations in morphology. Although, the strain names are not considered valid under the International Code of Zoological Nomenclature (ICZN) and thus, are used in informal sense.

Although fine taxonomic divisions can be ecologically important, the present taxonomic methodology follows on from Medioli and Scott's (1983) perspective, as it seems more appropriate for beginners. Nevertheless, for some species several strains are presented in the following systematic description.

9. 3. 4. Systematics

Kingdom PROTOZOA

Subkingdom SARCOMASTIGOTA

Phylum AMOEBOZOA

Subphylum LOBOSA

Class TUBULINEA

Order ARCELLINIDA

Suborder ARCELLINA

Family ARCELLIDAE

Genus *Arcella* Ehrenberg, 1832

***Arcella* cf. *arenaria* Greeff, 1866**

Plate 1, figs. 1 and 2

Genus *Pyxidicula* Ehrenberg, 1833

***Pyxidicula* sp.**

Suborder DIFFLUGINA

Family DIFFLUGIDAE

Genus *Difflugia* Lamarck, 1816

***Difflugia bidens* Penard, 1902**

Plate 3, figs. 10 and 11

***Difflugia corona* Wallich, 1864**

Plate 3, figs. 5 - 9

***Difflugia protaeiformis* Lamarck, 1816**

Plate 5, figs. 1 – 16

Recognizable strains:

D. protaeiformis "acuminata"

D. protaeiformis "amphoralis"

D. protaeiformis "elegans"

D. protaeiformis "claviformis"

D. protaeiformis "lanceolata"

***Difflugia oblonga* Ehrenberg, 1832**

Plate 6, figs. 1 – 11

Recognizable strains:

D. oblonga "bryophila"

D. oblonga "glans"

D. oblonga "lacustris"

D. oblonga "nodosa"

D. oblonga "oblonga"

D. oblonga "tenuis"

***Difflugia urceolata* Carter, 1864**

Plate 4, 1 – 15

Recognizable strains:

D. urceolata "amphora"

D. urceolata "lebes"

Genus *Pontigulasia* Rhumbler, 1896

***Pontigulasia compressa* (Carter, 1864)**

Plate 3, fig. 14

Family CENTROPYXIDAE

Genus *Centropyxis* Stein, 1857

***Centropyxis aculeata* (Ehrenberg, 1832)**

Plate 1, figs. 5 – 20; Plate 2, figs. 1 – 5

***Centropyxis arcula* (Leidy, 1879)**

Plate 2, figs. 14 and 15

***Centropyxis constricta* (Ehrenberg, 1832)**

Plate 2, figs. 6 - 13

***Centropyxis orbicularis* Deflandre, 1929**

Plate 2, figs. 16 - 18

Family TRIGONOPYXIDAE

Genus *Cyclopyxis* (Deflandre, 1929)

***Cyclopyxis* sp.**

Plate 3, fig. 12

Family PLAGIOPYXIDAE

Genus *Bullinularia*

***Bullinularia* cf. *indica* (Penard, 1907)**

Plate 3, figs. 1 - 4

Family LESQUEREUSIIDAE

Genus *Lesquereusia* Schlumberger (1845)

***Lesquereusia* sp.**

Family NEBELIDAE

Genus *Nebela* Leidy, 1874

Nebela cf. *penardiana* Deflandre, 1936

Plate 3, fig. 13

9. 4. Tintinnids

Tintinnids are planktonic ciliate chromists, characterized by the possession of a shell or lorica, the architecture and size of which ranges widely and classically distinguishes over 1000 species (Dolan, 2010; Dolan et al., 2012). Among the lorica characteristics used to distinguish species and form groups, the diameter of the oral end appears to be the most reliable and conservative characteristic distinguishing species of otherwise similar lorica architecture (Dolan et al., 2012).

Tintinnids are a ubiquitous component of the microzooplankton, and like most other planktonic ciliates, tintinnids are grazers on pico- and nano-planktonic organisms, both heterotrophic and autotrophic, ranging from 0.2–20 μm in size (Gavriola and Dolan, 2003). While representing a minor part of the ciliate plankton (5‑10% of total cell numbers of the ciliate microzooplankton) (Dolan and Gallegos, 2001; Gavriola and Dolan, 2003), they are nonetheless much more abundant than foraminifera or radiolarians (Dolan et al., 2002).

In the Ria Formosa lagoon system of Southern Portugal, Barbosa (2006) found positive and significant relationships between the abundance and biomass of tintinnids and nanoplankton, in particular cryptophytes, suggesting that tintinnid variability is conditioned by food availability. Other parameters, such day length, temperature and predation are also identified as important factors in controlling tintinnid populations (Sanders, 1987). Copepods are typically identified as the dominant predators of tintinnids (e.g. Dolan and Gallegos 2001; Sanders, 1987). The trophic position of tintinnids, as grazers on pico- and nanoplankton and the prey of copepods, may render them especially sensitive to changes in the planktonic food web (Gavriola and Dolan, 2003).

Some species are cosmopolitan (occurring in all oceans) and other have geographical ranges restricted to cold and or warm water masses, with the majority of genera occurring in tropical and temperate waters of the world's oceans (Pierce and Turner, 1990). Few genera have been found to be neritic, or restricted to relatively shallow waters. These include the genera *Tintinnopsis* and *Stenosemella* (Pierce and Turner, 1990), the two genera found in the intertidal

sediments of the Guadiana Estuary. Neritic genera, like *Tintinnopsis* and *Stenosemella*, are noted for their capacity to incorporate mineral flakes into loricae, characteristics that may limit their distribution. Another characteristic of neritic tintinnids is the production of resting cysts which, in shallow water, sink into the sediment, excysting only when conditions are favorable (Pierce and Turner, 1990).

Little is known about transport of empty loricae and how long they remain intact in the water column and sediment (Pierce and Turner, 1990). Nevertheless, it is known that tintinnid with agglutinated loricae preserve in fossil sediment, with several fossil records dating back to Ordovician (Tappan and Loeblich, 1973).

9. 4. 1. Identification and classification

Species identification was based on the Plankton sheets (117 and 119) provided by the International Council for the Exploration of the Sea (ICES) 1939-2001 (http://www.ices.dk/products/idleaflets.asp), which are, in turn, based on the work of Kofoid and Campbell (1929, 1939 and 1942). For higher taxonomy (above family rank) the Worm's classification was used: Warren (2012 - World Register of Marine Species www.marinespecies.org).

9. 4. 2. Systematics

Kingdom CHROMISTA

Subkingdom HAROSA

Phylum CILIOPHORA

Subphylum INTRAMACRONUCLEATA

Class SPIROTRICHEA

Order TINTINNIDA

Family CODONELLOPSIDAE

Genus *Stenosemella* Jörgensen, 1924

***Stenosemella ventricosa* (Claparède and Lachmann, 1858)**

Plate 6, figs. 14-17

Family CODONELLIDAE

Genus *Tintinnopsis* Stein, 1867

***Tintinnopsis campanula* Ehrenberg, 1840**

Plate 6, fig. 12

***Tintinnopsis* cf. *lata* Meunier, 1910**

Plate 6, fig. 13

Plate 1

(scale bar = 100 µm)

1 – *Arcella* cf. *arenaria* Greeff, 1866, apertural view

2 – *Arcella* cf. *arenaria* Greeff, 1866, aboral view

3 – Indeterminate form

4 – *Arcella* sp.

5 – 20 – *Centropyxis aculeata* (Ehrenberg, 1830) formae

5 – 8 - ventral view of flat specimens with no spines;

9 – lateral view of flat specimen with no spines;

10 – 12 – ventral view of different formae with spines

13 – lateral view of flat specimen with spines

14 – ventral view of thick specimen with no spines

15 – ventral view of a good exemplar of *C. aculeata*

16 – dorsal view with diatom frustules agglutinated

17 – ventral view of a large and coarse agglutinated specimen

18 – dorsal view of a large and coarse agglutinated specimen

19 – ventral view of a diatom agglutinated specimen

20 – dorsal view of a diatom agglutinated specimen

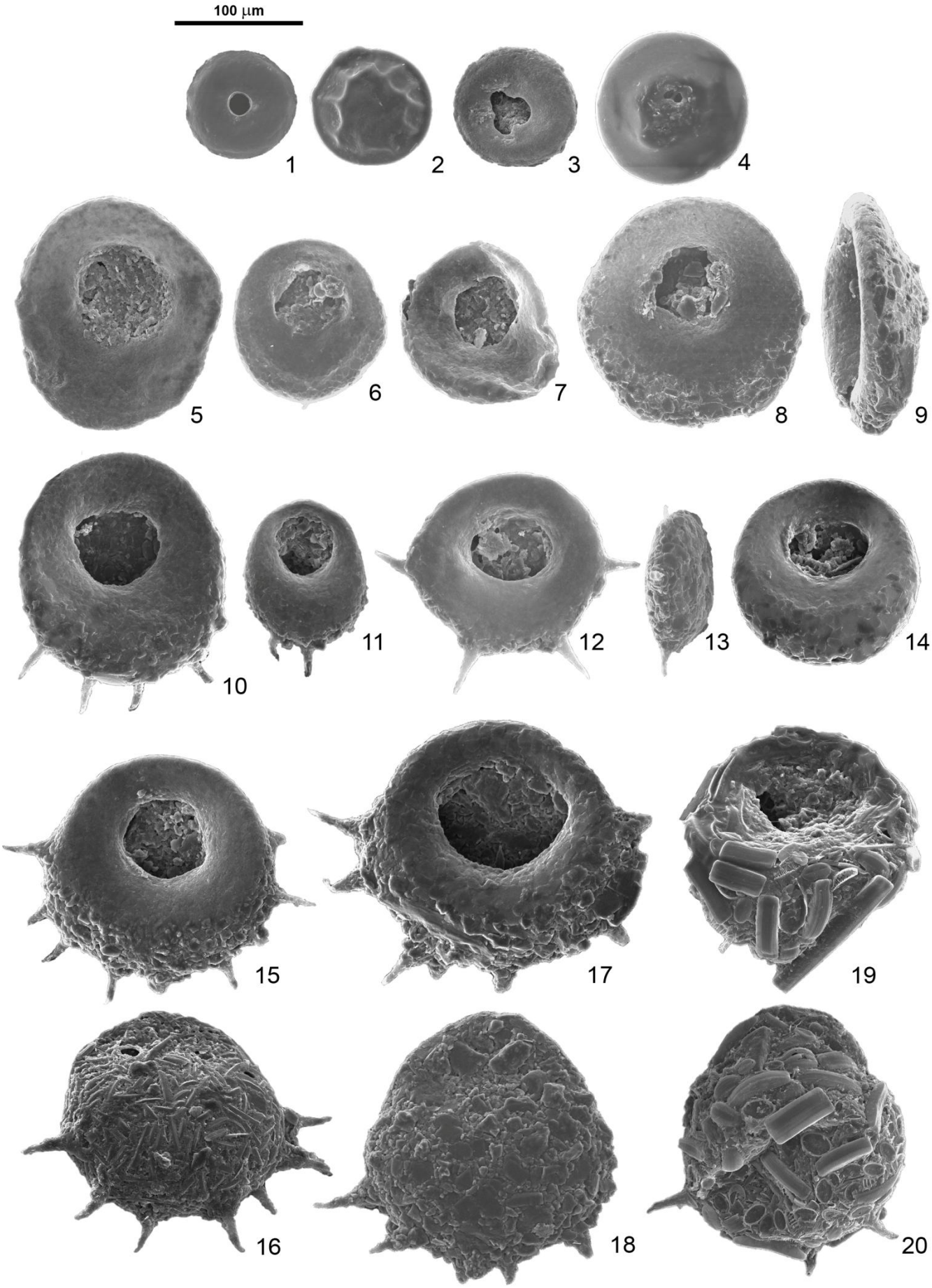
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Plate 2

(scale bar = 100 μm)

1 – 5 – *C. aculeata*, different formae;

6 – 13 – *Centropyxis constricta* (Ehrenberg, 1843) different formae;

6 – ventral view of a small formae with spines;

7 – ventral view of a small formae with no spines;

8 – ventral view of an inflate formae;

9; 11 – 13 – ventral view of *C. constricta* (Ehrenberg, 1843) “aerophila”?;

10 - ventral view of *C. constricta* (Ehrenberg, 1843) “aerophila”;

14 – *Centropyxis arcula* (Leidy, 1879), ventral view;

15 – dorsal view with aboral thick spines of *C. arcula*;

16 – 17 – ventral view and eccentric aperture view of *Centropyxis orbicularis* Deflandre, 1929;

18 – dorsal view of *C. orbicularis*.

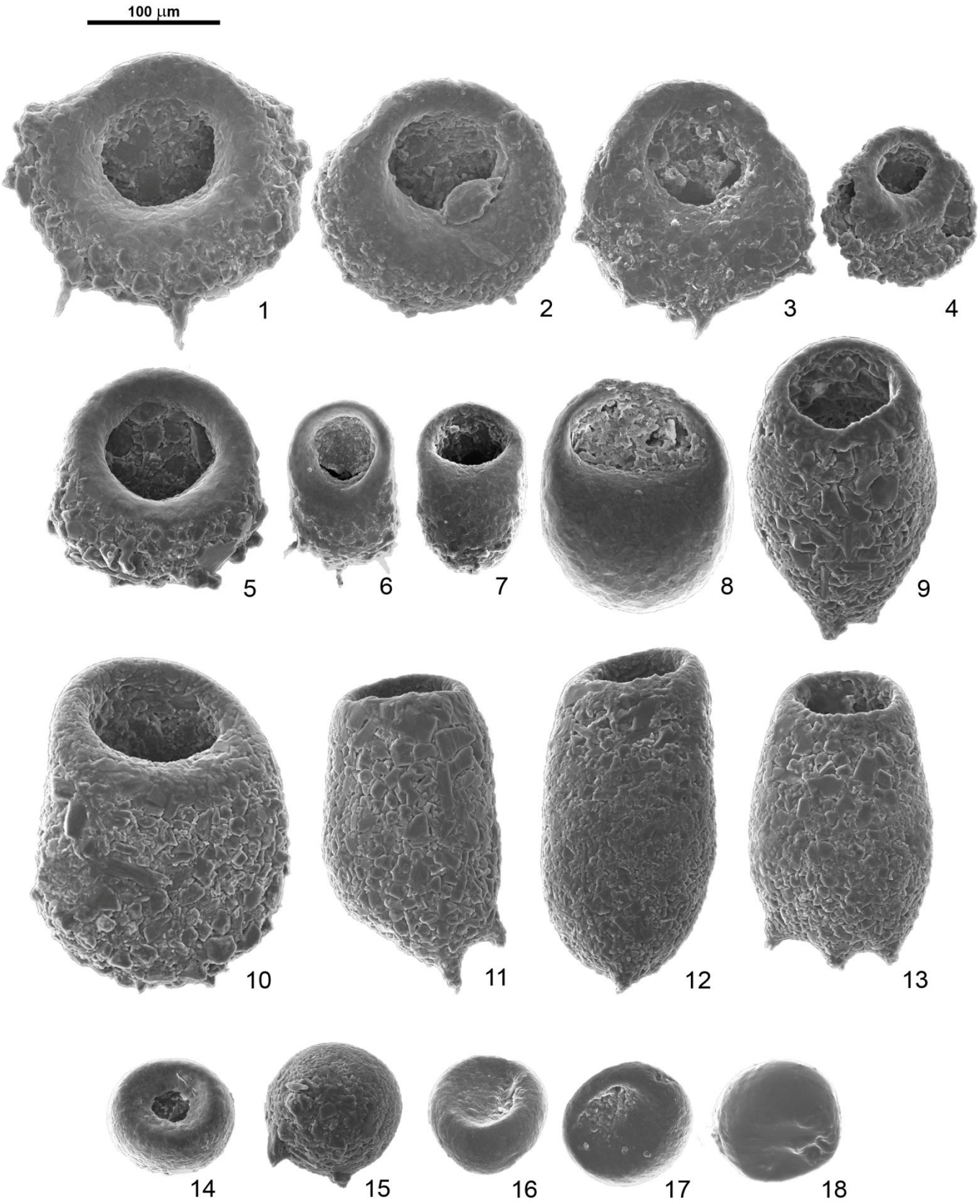
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Plate 3

(scale bar = 100 µm)

1 – 4 – ***Bullinularia* cf. *indica*** (Penard, 1907);

1, 3 – ventral views, with eccentrical aperture with inner lip depressed; pores on the apical margin;

2 – hemispherical lateral view;

4 – lateral/dorsal of a smaller specimen;

5 – 9 – ***Difflugia corona*** Wallich, 1864, different formae;

5, 7 – aperture views;

6 – ovate specimen with one spine;

8 – round specimen with 4 spines (2 broken);

9 – elongated specimen with 4 visible spines at fundus;

10 – ***Difflugia bidens*** Penard, 1902, broad lateral view;

11 – ***D. bidens***, aperture view;

12 – ***Cyclopyxis*** ?, aperture view;

13 – ***Nebela penardiana*** Deflandre, 1936, broad lateral view;

14 – ***Pontigulasia compressa*** (Carter, 1864), broad lateral view.

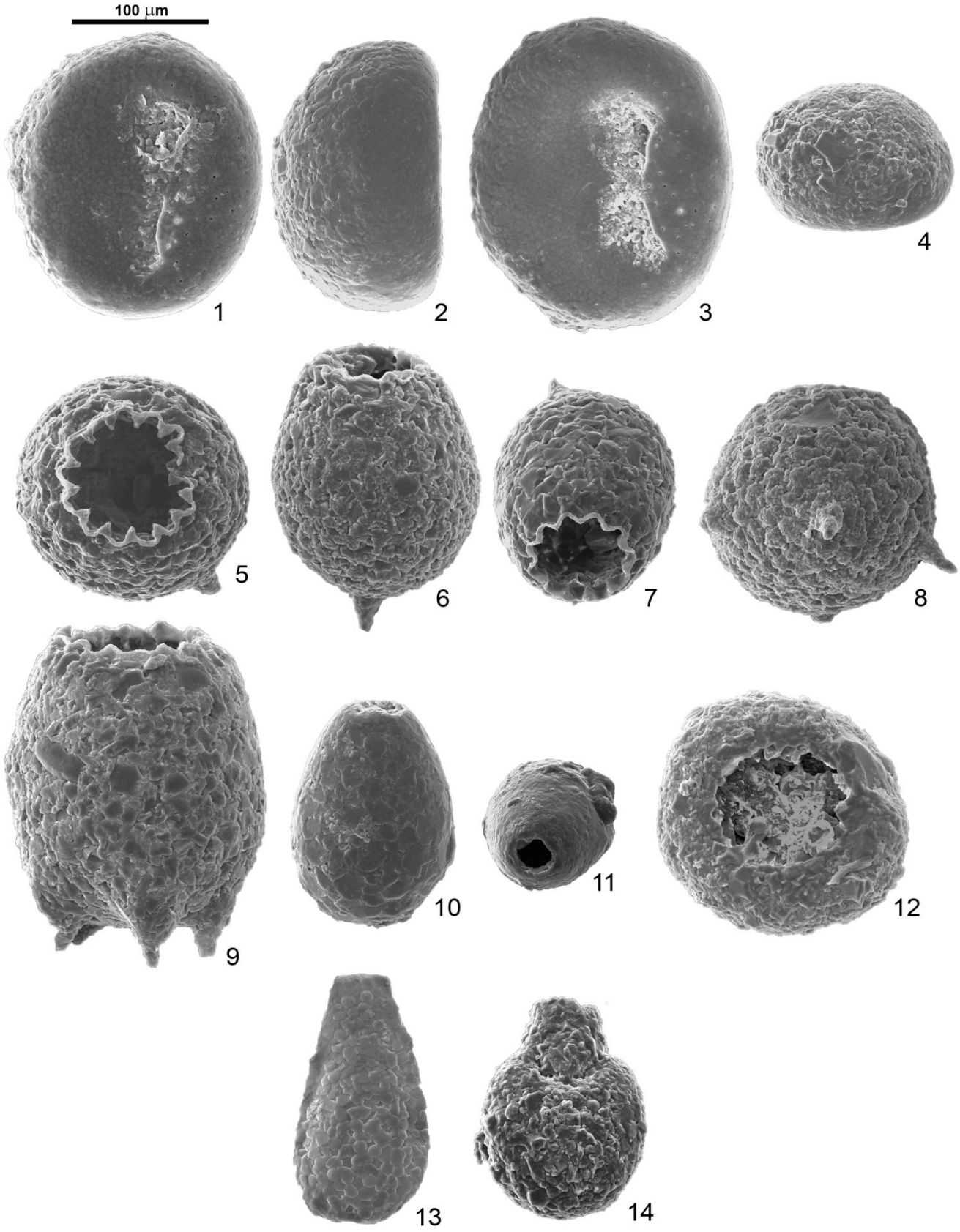
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Plate 4

(scale bar = 100 μm)

1 – 15 – ***Difflugia urceolata*** Carter, 1864, different formae;

1 – ***D. urceolata*** Carter, 1864, “amphora”; aperture view of a specimen with thickened lip;

2, 4 – typical specimens of ***D. urceolata*** form “amphora”; 4 – with well developed spine;

3 - ***D. urceolata*** Carter, 1864, “lebes”; side view of a specimen with asymmetric thickened lip;

5 – acuminate form of ***D. urceolata*** form “amphora”; specimen with long neck;

6 – 11 – different formae of ***D. urceolata*** “lebes”, from round to olive shape;

12 – aperture view of a ***D. urceolata*** “lebes” form;

13 – 15 – side view of oblong and large ***D. urceolata*** “lebes” formae.

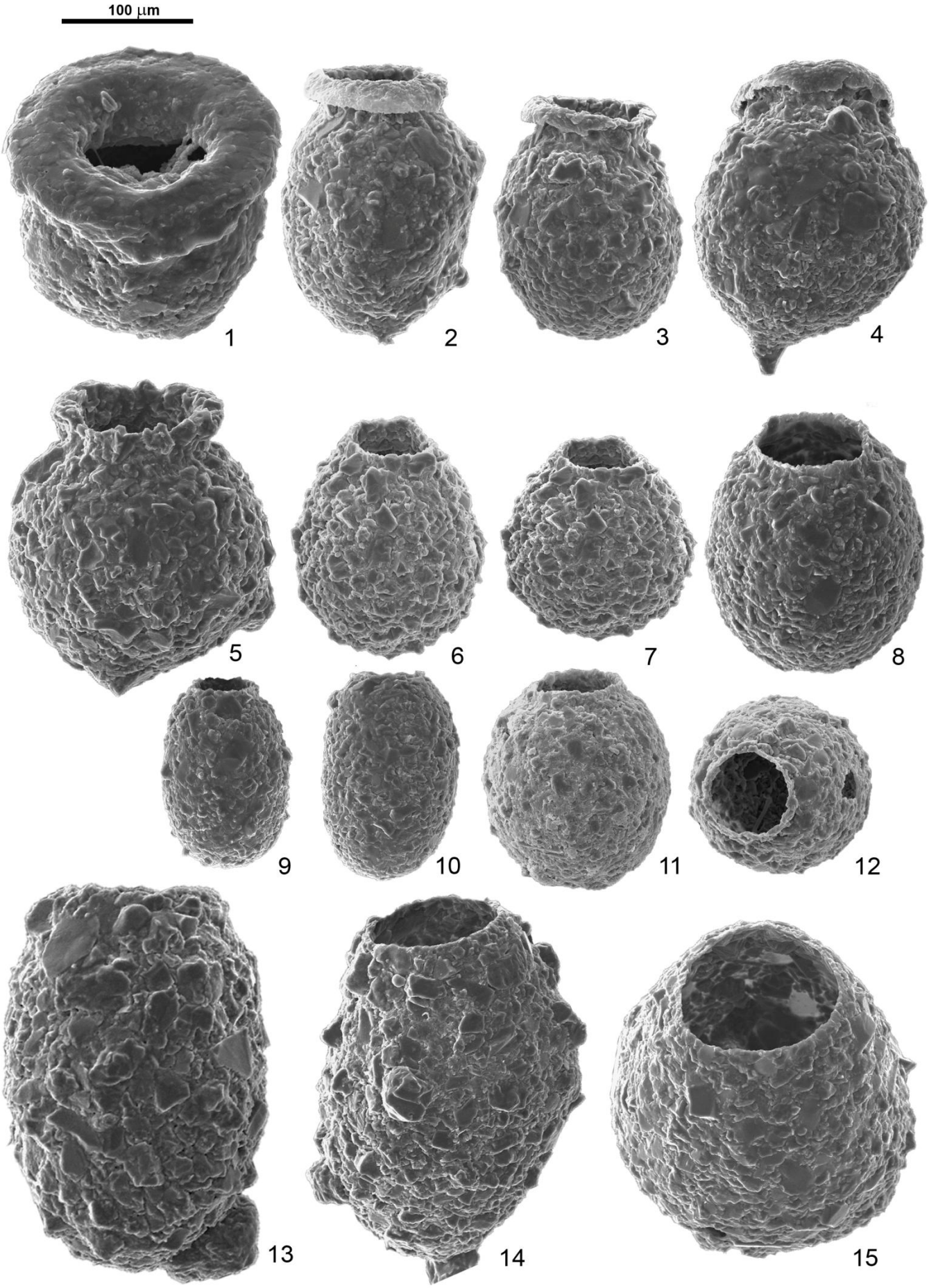
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Plate 5

(scale bar = 100 µm)

1 – 16 – ***Difflugia protaeiformis*** Lamarck, 1816, different formae;

1 – 2 – ***D. protaeiformis*** Lamarck, 1816, “lanceolata” (polished and smooth walls);

3 – 4 – ***D. protaeiformis***, Lamarck, 1816, “claviformis”;

5 – ***D. protaeiformis*** Lamarck, 1816, “acuminata”;

6 – 7 – ***D. protaeiformis*** Lamarck, 1816, “elegans”;

8 – 12, 16 – ***D. protaeiformis*** Lamarck, 1816, “amphoralis”;

13 – 15 – ***D. protaeiformis***?

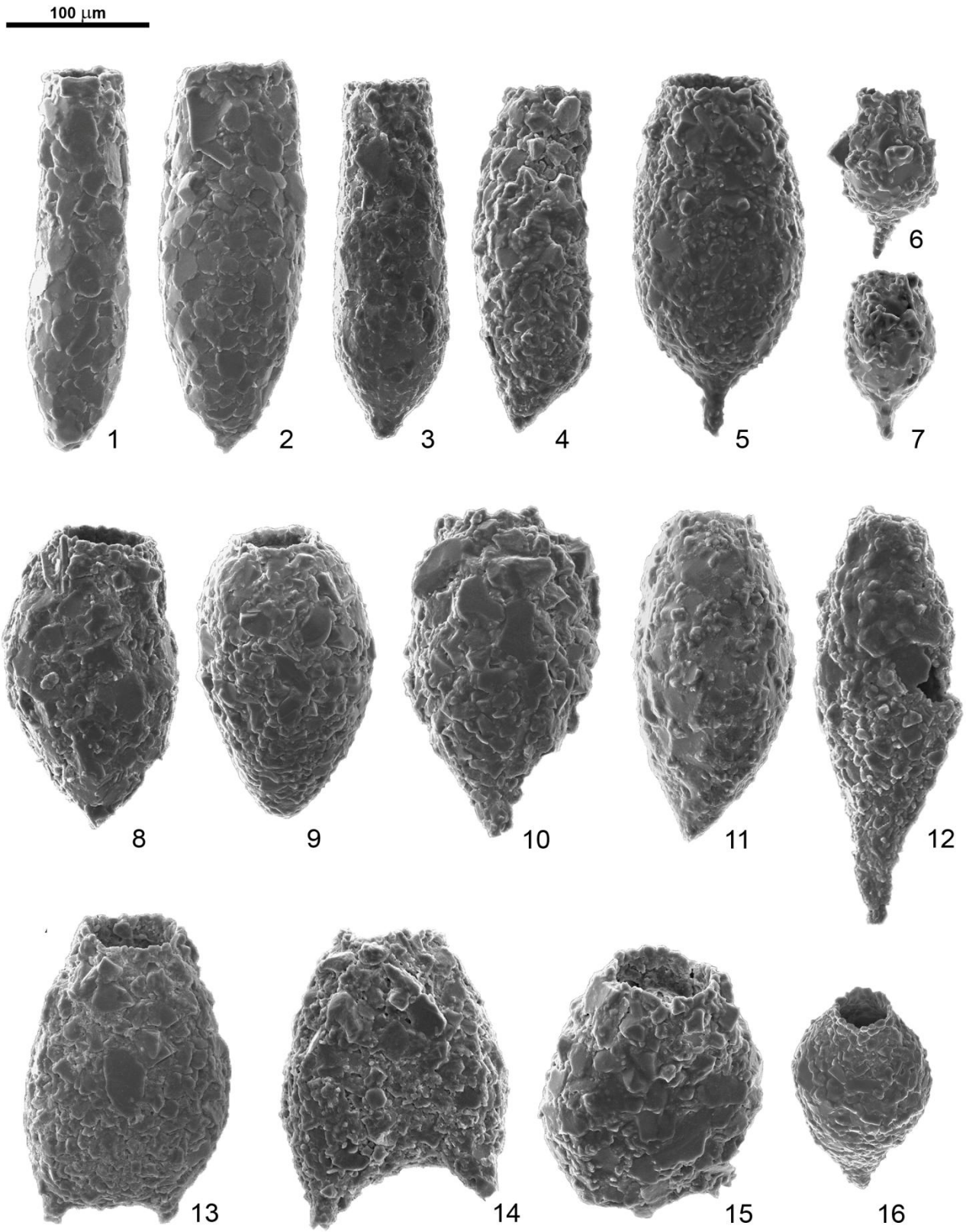
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Plate 6

(scale bar = 100 µm)

1 – 11 – ***Difflugia oblonga*** Ehrenberg, 1832, different formae;

1 – ***D. oblonga*** Ehrenberg, 1832, “glans”, aperture view;

2 - ***D. oblonga*** form “glans”, side view;

3, 7 – 8 - ***D. oblonga*** Ehrenberg, 1832, “tenuis”, different sizes;

4 - ***D. oblonga*** Ehrenberg, 1832, “oblonga”;

5 - ***D. oblonga*** Ehrenberg, 1832, “lacustris”;

6, 9 – 10 - ***D. oblonga*** Ehrenberg, 1832, “bryophila”, different sizes;

11 – ***D. oblonga*** Ehrenberg, 1832, “nodosa”;

12 – 17 – Tintinnids;

12 – ***Tintinnopsis campanula*** (Ehrenber, 1840);

13 - ***Tintinnopsis* cf. *lata*** Meunier, 1910;

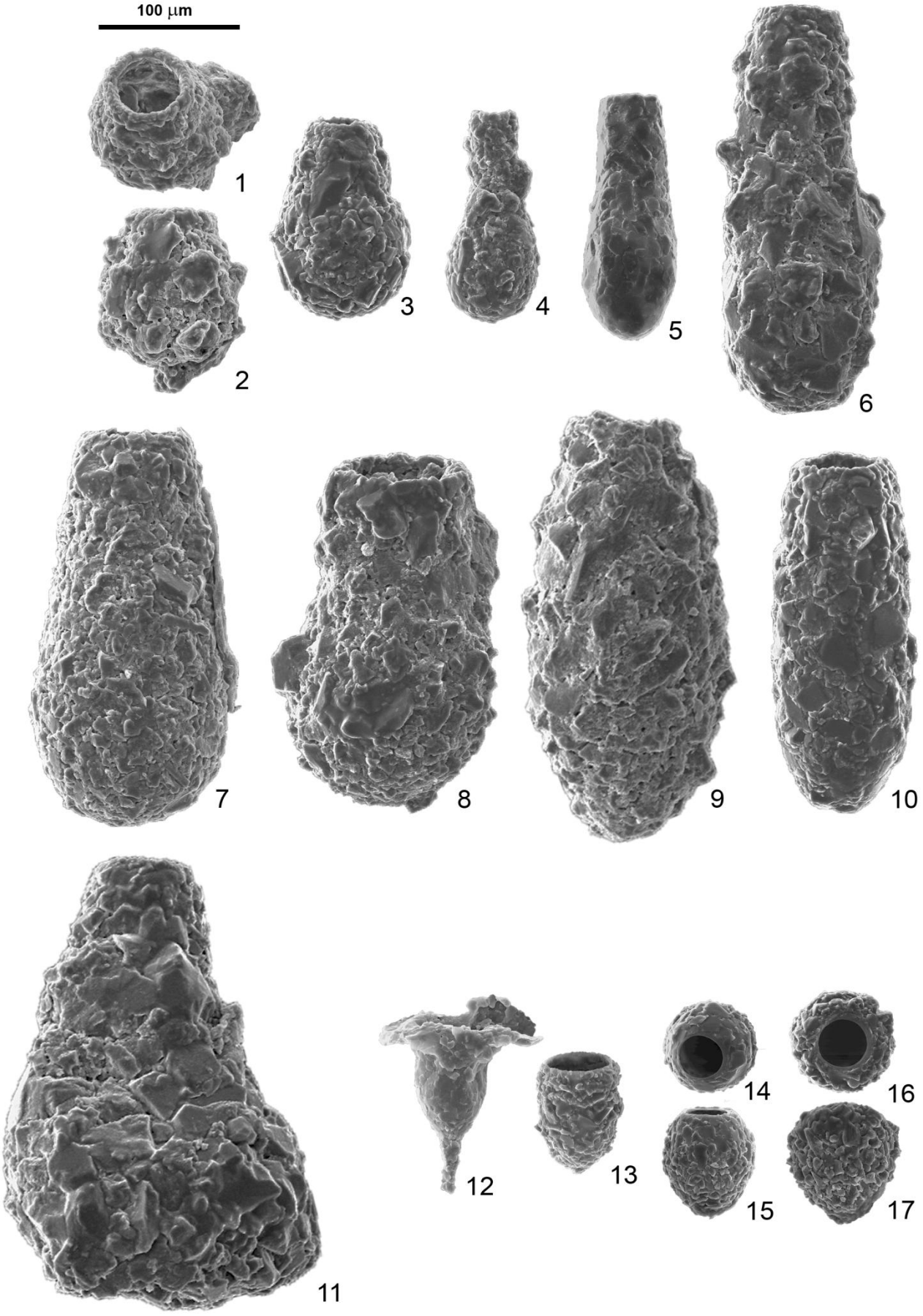
14 – 17 – ***Stenosemella ventricosa*** (Claparède and Lachmann, 1858), two forms;

14 – ***Stenosemella ventricosa*** (Claparède and Lachmann, 1858) fine form, aperture view;

15 – ***Stenosemella ventricosa*** (Claparède and Lachmann, 1858) fine form, lateral view;

16 – ***Stenosemella ventricosa*** (Claparède and Lachmann, 1858) coarser form, aperture view;

17 – ***Stenosemella ventricosa*** (Claparède and Lachmann, 1858) coarser form, lateral view.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Appendix 1

VRSA Lagoa (LG)















Espanha (E)









1 - VRSA Lagoa site (LG) site; 2 - d-GPS survey and lagoon surroundings; 3 - measurment of lagoon water physico-chemical parameters; 4 - ‘barbas’ mat inside the lagoon indicating eutrophicated conditions; 5 - first middle elevation sampling point LG1; 6 - second middle elevation sampling point LG2; 7 - lower elevation sampling point LG3; 8 - Espanha site (E); 9 - middle elevation sampling point E1; 10 - first lower elevation sampling point E2; 11 - second lower elevation sampling point E3.





















12 - Espanha ETAR site (EE) and sampling point location; 13 - Ayamonte STP outfall; 14 - bivalve shells around the STP outfall; 15 - Vila Real de Santo António site (VRSA)*;* 16 - sampling point VRSA1 in the eutrophicated margin of the tidal pond; 17 - VRSA *S. densiflora* meadows view; 18 - second upper elevation sampling point VRSA2 at *S. densiflora* meadows; 19 - middle elevation sampling point VRSA3 at *S. maritima* meadows; 20 - VRSA *S. maritima* meadows and *R. maritima* view; 21 - lower elevation sampling point VRSA4.

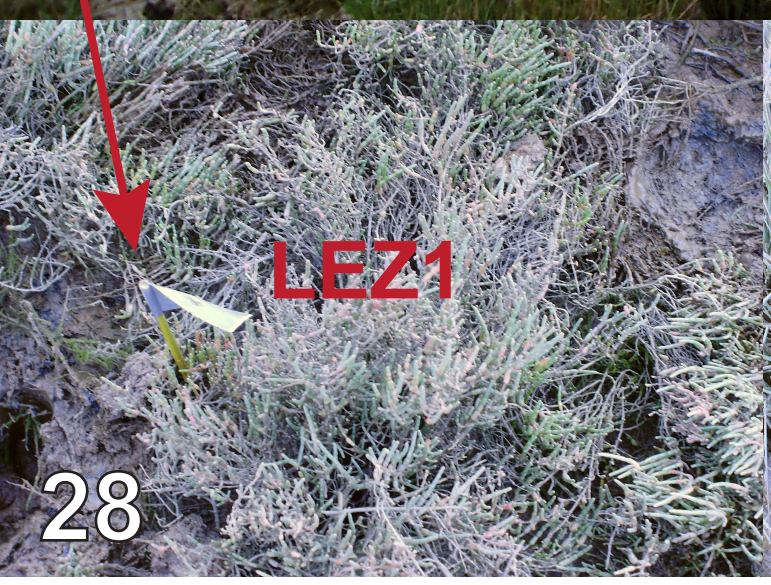












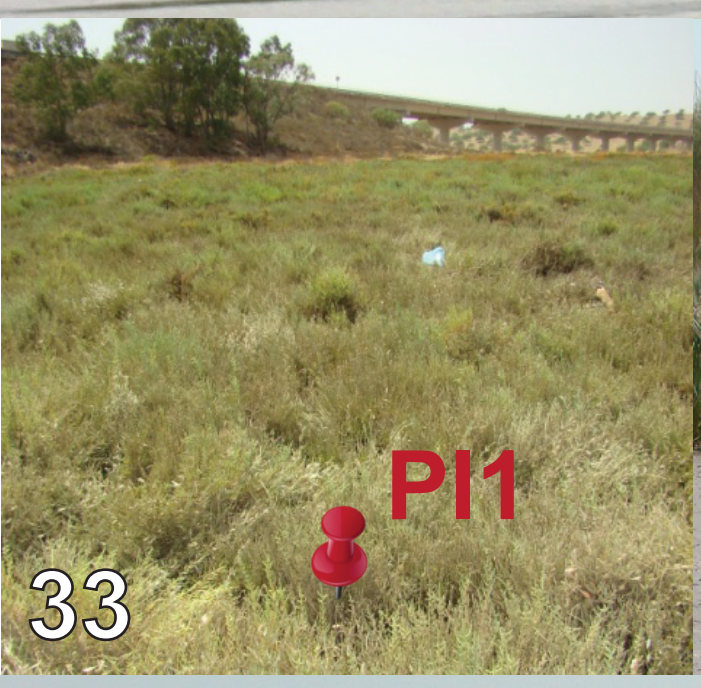




22 - transversal view of VRSA lower elevations; 23 - marsh erosion detail in VRSA site ; 24 - Sapal de Castro Marim site (SCM); 25 - SCM saltwork pond view and sampling collection; 26 - SCM sampling point; 27 - Esteiro da Lezíria site (LZ); 28 - first upper elevation sampling point LEZ1; 29 - second upper elevation sampling point LEZ2; 30 - middle elevation sampling point LEZ3;













31 - Ponte Internacional site (PI); 32 - halophytic zonation along the transect and samples location; 33 - upper elevations sampling point PI1; 34 - marsh view from the river with PI2, PI3 and PI4 location; 35 - middle elevations sampling points PI3 and PI4; 36 - Foz do Beliche site (FB).



















37 - Beliche rivulet at low tide; 38 - Beliche rivulet mouth; 39 - sediment plume at the rivulet mouth during high tide; 40 - salt crust at FB upper elevations; 41 - d-GPS survey; 42 - upper elevations sampling point FB1; 43 - middle elevations sampling point FB2; 44 - lower elevations sampling point FB3; 45 - Almada d’Ouro site (Aouro) and sampling point location.















46 - Foz de Odeleite site (FO); 47 and 48 - FO sampling point location in *Elymus* cf. *repens* meadows; 49 - Laranjeiras site (LAR); 50 and 51 - LAR sampling point location; 52 - Alcoutim site and sampling point location.

Appendix 2

1 - Barbas; 2 and 3 - *Ruppia maritima;* 4 and 5 - *Spartina maritima;*
6 and 7 - *Spartina densiflora;* 8 - *Halimione portucaloides;*
9 - *Arthroctemum macrostachyum.*









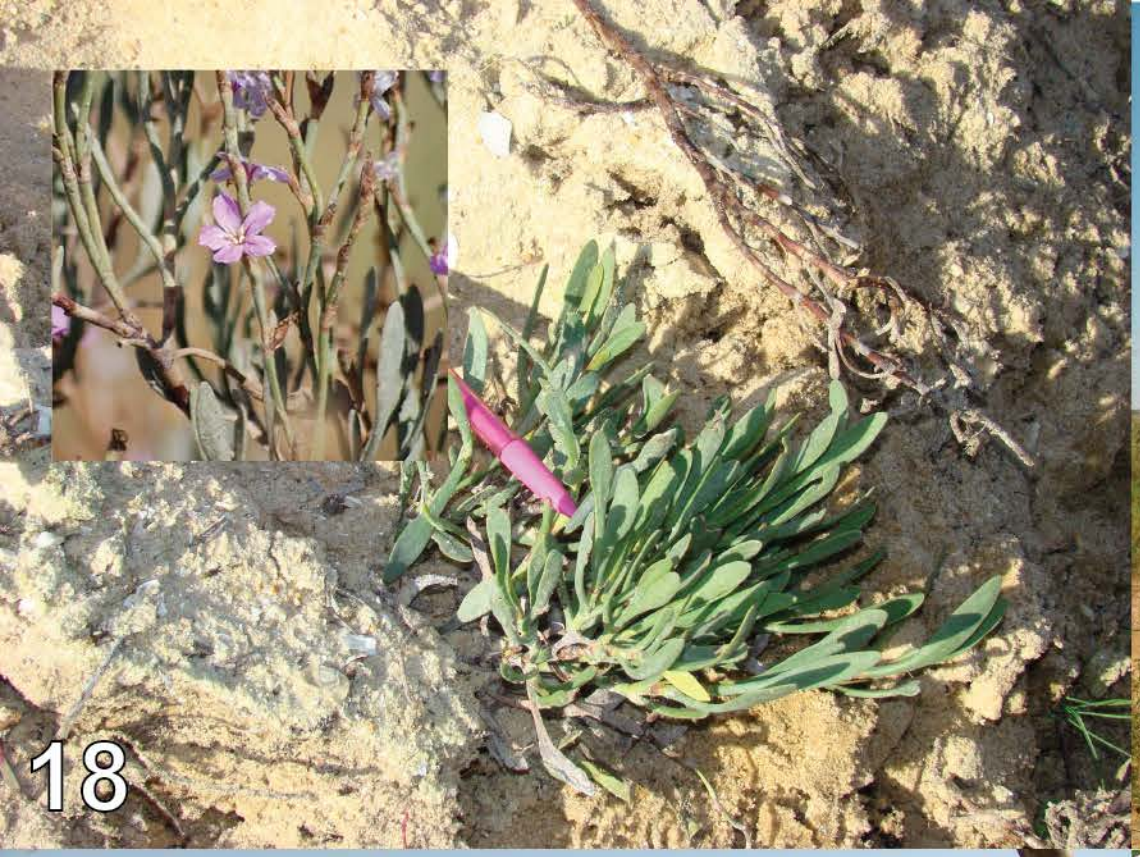








10 and 11 - *Sarcocornia perennis* ssp. *alpini;* 12 - *Sarcocornia perennis* ssp. *perennis;* 13 - *Salicornia ramosissima;* 14 and 15 - *Sarcocornia fruticosa;* 16 - *Suaeda maritima;* 17 - *Suaeda vera.*













18 - *Limoniastrum monopetalum;* 19 - *Juncus acutus;* 20 - *Juncus* and *Arundo donax;* 21 - Bermuda buttercups, clovers and other grasses; 22 - *Elymus* cf. *repens*; 23 - *Elymus* and *Juncus*.

Appendix 3

Table I – Geographical and topographic data resulting from d-GPS and total station survey.

				Datum 73								WGS 84	
Place	**Sample**	**Description**	**d-GPS point name**	**Eastings**	**Northings**	**Elev HZ**	**Elev MSL**	**Hz_Prec (m)**	**Vt_Prec (m)**	**PDOP**	**Sats**	**Latitude**	**Longitude**
Portela Alta		Land mark	VG_PORTELA_ALTA	57742.253	-245049.4	147.24	145.240	0.008	0.011	1.1	7		
Alcoutim	AL	sampling point	ALCOUTIM	58599.626	-243261.976	2.209	0.013	0.016		1.7	7	37°28'29.91"N	7°28'14.31"W
Corte das Donas		Land mark	VG_CORTEDONAS	58512.456	-253097.593	170.88	168.880	0.009	0.015	2.1	6		
Laranjeiras	LAR	sampling point	LARANJEIRAS_ML	59841.474	-251196.821	2.311	0.311	0.009	0.017	8.5	9	37°24'12.28"N	7°27'26.09"W
Eira Velha		Land mark	VG_EIRAVELHA	59934.173	-258953.794	131.31	129.310	0.008	0.011	2.7	5		
Foz Odeleite	FO	sampling point	FOZODELEITE	60808.447	-256955.96	2.334	0.334	0.012	0.018	1.6	8	37°21'5.26"N	7°26'48.47"W
Vicente		Land mark	VG_VICENTE	60692.532	-262549.502	85.5	83.500	0.008	0.013	1.7	6		
Almada Ouro	Aouro	sampling point	ALMADA_DOURO	61149.393	-261793.396	2.532	0.532	0.009	0.013	1.5	7	37°18'28.28"N	7°26'36.06"W
Espigão		Land mark	VG_ESPIGAO	61021.128	-267839.871	49.43	47.430	0.008	0.016	3	6		
Foz Beliche	FB	profile point	FozBEL_01	61919.802	-267067	3.365	1.365	0.007	0.01	1.8	8		
	FB	profile point	FozBEL_02	61920.63	-267066	3.406	1.406	0.007	0.011	1.3	9		
	FB	profile point	FozBEL_03	61921.37	-267064	3.389	1.389	0.007	0.011	1.6	9		
	FB	profile point	FozBEL_04	61921.9	-267063	3.453	1.453	0.006	0.01	1.6	9		
	FB	sampling point	FozBEL_05 Sal	61922.506	-267062	3.432	1.432	0.007	0.011	1.3	10	37°15'37.21"N	7°26'6.24"W
	FB	profile point	FozBEL_06	61922.573	-267061	3.349	1.349	0.007	0.011	2.2	10		
	FB	profile point	FozBEL_07	61922.806	-267061	3.354	1.354	0.007	0.012	1.6	10		
	FB	profile point	FozBEL_08	61922.909	-267061	3.175	1.175	0.007	0.011	1.6	10		
	FB	profile point	FozBEL_09	61923.007	-267060	2.965	0.965	0.006	0.009	0.8	10		
	FB	profile point	FozBEL_10	61923.421	-267059	2.844	0.844	0.007	0.01	1.6	10		
	FB	profile point	FozBEL_11	61923.755	-267058	2.871	0.871	0.007	0.011	1.6	10		
	FB	profile point	FozBEL_12	61924.126	-267057	2.768	0.768	0.006	0.01	1.6	10		
	FB	sampling point	FozBEL_13 Sp	61924.614	-267057	2.752	0.752	0.012	0.019	1.6	10	37°15'37.38"N	7°26'6.15"W
	FB	profile point	FozBEL_14	61924.904	-267056	2.7	0.7	0.007	0.01	1.6	10		
	FB	profile point	FozBEL_15	61925.736	-267055	2.764	0.764	0.008	0.013	1.7	10		
	FB	profile point	FozBEL_16	61926.564	-267053	2.808	0.808	0.008	0.012	1.7	10		
	FB	profile point	FozBEL_17	61926.914	-267052	2.582	0.582	0.011	0.017	2.4	10		
	FB	profile point	FozBEL_18	61927.065	-267051	2.599	0.599	0.008	0.013	1.7	10		
	FB	sampling point	FozBEL_19	61927.302	-267051	2.471	0.471	0.009	0.014	1.7	10	37°15'37.57"N	7°26'6.04"W
	FB	profile point	FozBEL_20	61927.818	-267050	2.269	0.269	0.008	0.012	1.8	9		
	FB	profile point	FozBEL_21	61928.028	-267049	2.205	0.205	0.008	0.012	1.8	9		
	FB	profile point	FozBEL_22	61928.235	-267048	2.044	0.044	0.009	0.014	1.5	9		
	FB	profile point	FozBEL_23	61928.417	-267048	1.914	-0.086	0.007	0.011	1.8	9		
	FB	profile point	FozBEL_24	61928.656	-267047	1.788	-0.212	0.013	0.02	1.8	9		
	FB	profile point	FozBEL_25	61928.918	-267046	1.686	-0.314	0.008	0.012	2.6	9		
	FB	profile point	FozBEL_26	61929.192	-267046	1.478	-0.522	0.009	0.013	2.6	9		
	FB	profile point	FozBEL_27	61929.346	-267045	1.328	-0.672	0.007	0.011	1.8	9		
	FB	profile point	FozBEL_28	61929.388	-267045	1.081	-0.919	0.008	0.012	1.8	9		
	FB	profile point	FozBEL_29	61929.503	-267044	0.938	-1.062	0.013	0.02	2.6	9		

Table I, continuation.

	FB	profile point	FozBEL_30	61929.647	-267044	0.807	-1.193	0.009	0.014	1.3	9		
	FB	profile point	FozBEL_31	61929.671	-267043	0.669	-1.331	0.008	0.013	1.8	9		
	FB	profile point	FozBEL_32	61929.797	-267043	0.508	-1.492	0.009	0.014	1.8	9		
Castro Marim Castelo		Land mark	VG_CASTROMAR	61389.115	-271702.764	46.810	44.810	0.005	0.009	1.9	6		
Ponte Internacional	PI	sampling point	CMponte_27	62974.271	-269471.977	3.188	1.188					37°14'18.79"N	7°25'24.29"W
	PI	profile point	CMponte_26	62983.051	-269465.611	3.167	1.167						
	PI	profile point	CMponte_25	62983.875	-269465.018	2.553	0.553						
	PI	profile point	CMponte_24	62984.23	-269464.793	2.358	0.358						
	PI	profile point	CMponte_23	62984.37	-269464.513	2.536	0.536						
	PI	profile point	CMponte_22	62984.91	-269464.141	3.169	1.169						
	PI	profile point	CMponte_21	62986.365	-269462.688	3.494	1.494						
	PI	profile point	CMponte_20	62987.319	-269461.775	4.16	2.160						
	PI	profile point	CMponte_19	62988.726	-269460.376	4.198	2.198						
	PI	profile point	CMponte_18	62989.36	-269459.85	4.055	2.055						
	PI	profile point	CMPontep2_17	62989.4	-269459.96	3.935	1.935	0.01	0.018	1.8	7		
	PI	profile point	CMPontep2_16	62990.123	-269459.247	3.405	1.405	0.007	0.013	1.8	7		
	PI	profile point	CMPontep2_15	62990.658	-269458.702	3.266	1.266	0.01	0.018	2.5	7		
	PI	profile point	CMPontep2_14	62992.208	-269457.515	3.225	1.225	0.009	0.016	1.5	7		
	PI	profile point	CMPontep2_13	62993.362	-269456.427	3.166	1.166	0.01	0.018	1.5	7		
	PI	profile point	CMPontep2_12	62994.63	-269455.159	3.116	1.116	0.008	0.016	2.6	7		
	PI	profile point	CMPontep2_11	62995.916	-269453.917	3.16	1.160	0.008	0.015	1.8	7		
	PI	sampling point	CMPI_sdensi	62997.536	-269452.581	3.198	1.198	0.006	0.011	1.8	7	37°14'19.42"N	7°25'23.34"W
	PI	profile point	CMPontep2_10	62998.47	-269451.035	3.124	1.124	0.007	0.014	1.8	7		
	PI	profile point	CMPontep2_09	63000.453	-269448.847	3.064	1.064	0.007	0.015	1.9	7		
	PI	profile point	CMPontep2_08	63002.004	-269447.066	2.883	0.883	0.007	0.014	1.2	7		
	PI	profile point	CMPontep2_07	63003.472	-269445.643	2.844	0.844	0.01	0.019	1.9	7		
	PI	profile point	CMPontep2_06	63005.101	-269443.943	2.785	0.785	0.005	0.01	1.9	7		
	PI	sampling point	CMPI_Smar	63006.818	-269442.632	2.614	0.614	0.01	0.02	1.9	7	37°14'19.74"N	7°25'22.97"W
	PI	profile point	CMPontep2_05	63007.948	-269441.656	2.506	0.506	0.006	0.012	1.9	7		
	PI	profile point	CMPontep2_04	63009.204	-269440.551	2.374	0.374	0.008	0.015	1.9	7		
	PI	profile point	CMPontep2_03	63010.829	-269439.759	2.129	0.129	0.008	0.016	2.7	7		
	PI	sampling point	CMPImargem	63012.253	-269438.821	2.011	0.011	0.007	0.015	1.9	7	37°14'19.86"N	7°25'22.74"W
	PI	profile point	CMPontep2_02	63013.083	-269437.748	1.841	-0.159	0.009	0.019	2.2	7		
	PI	profile point	CMPontep2_01	63013.879	-269437.478	1.716	-0.284	0.007	0.015	2.2	7		
Castro Marim	SCM	sampling point	CMarimSapal	59401.402	-272673.316	3.96	1.960	0.007	0.013	1.8	7	37°12'35.80"N	7°27'50.15"W
Esteiro da Lezíria	LEZ	profile point	CMLez_p3_13	61399.252	-272410.426	3.444	1.444	0.01	0.016	2.4	6		
	LEZ	profile point	CMLez_p3_12	61397.85	-272408.257	3.263	1.263	0.008	0.013	1.6	7		
	LEZ	profile point	CMLez_p3_11	61397.84	-272405.271	3.321	1.321	0.01	0.015	2.3	7		
	LEZ	profile point	CMLez_p3_10	61396.063	-272403.031	3.257	1.257	0.007	0.012	1.3	7		
	LEZ	profile point	CMLez_p3_09	61394.471	-272400.622	3.241	1.241	0.006	0.01	1.6	7		
	LEZ	sampling point	CMLezalto	61394.114	-272397.855	3.317	1.317	0.006	0.01	1.6	7	37°12'44.28"N	7°26'29.26"W
	LEZ	profile point	CMLez_p3_08	61393.673	-272395.108	3.331	1.331	0.01	0.015	2.3	7		
	LEZ	profile point	CMLez_p3_07	61393.469	-272392.269	3.385	1.385	0.009	0.014	1.3	8		
	LEZ	profile point	CMLez_p3_06	61392.962	-272390.614	3.432	1.432	0.009	0.014	0.8	8		

Table I, continuation.

	LEZ	profile point	CMLez_p3_05	61392.416	-272389.156	3.448	1.448	0.012	0.019	2.4	6		
	LEZ	profile point	CMLez_p3_04	61392.229	-272388.611	3.031	1.031	0.007	0.011	1.7	8		
	LEZ	sampling point	CMLezmed	61390.198	-272388.367	3.062	1.062	0.007	0.012	1.3	8	37°12'44.58"N	7°26'29.41"W
	LEZ	profile point	CMLez_p3_03	61392.052	-272388.25	2.496	0.496	0.007	0.011	1.3	8		
	LEZ	profile point	CMLez_p3_02	61391.773	-272387.974	2.261	0.261	0.011	0.018	1.6	8		
	LEZ	sampling point	CMLez_bxo	61391.183	-272387.306	2.202	0.202	0.012	0.018	2.1	6	37°12'44.62"N	7°26'29.37"W
Vila Real da Santo António	VRSA	Total station origin	CASTELO	63558.838	-272824.746	3.786	1.786						
	VRSA	profile point	ETAR007	63507.40	-272711.46	3.88	1.880						
	VRSA	profile point	ETAR006	63509.02	-272715.06	3.33	1.330						
	VRSA	profile point	ETAR005	63509.61	-272716.52	3.16	1.160						
	VRSA	profile point	ETAR004	63510.01	-272717.87	3.13	1.130						
	VRSA	profile point	ETAR003	63542.95	-272794	3.14	1.140						
	VRSA	profile point	ETAR002	63549.04	-272808.49	3.12	1.120						
	VRSA	profile point	ETAR001	63551.96	-272814.47	2.97	0.970						
	VRSA	sampling point	ETAR1	63557.17	-272825.6	3.21	1.210					37°12'29.88"N	7°25'1.68"W
	VRSA	profile point	ETAR2	63557.25	-272826.48	3.23	1.230						
	VRSA	profile point	ETAR3	63557.42	-272826.95	3.24	1.240						
	VRSA	profile point	ETAR4	63557.87	-272827.7	3.34	1.340						
	VRSA	profile point	ETAR5	63558.31	-272828.9	3.63	1.630						
	VRSA	profile point	ETAR6	63558.4	-272829.57	3.89	1.890						
	VRSA	profile point	ETAR7	63558.57	-272830.43	4.12	2.120						
	VRSA	profile point	ETAR8	63558.91	-272831.28	4.08	2.080						
	VRSA	profile point	ETAR9	63559.11	-272832.22	4.07	2.070						
	VRSA	profile point	ETAR10	63559.24	-272832.56	3.69	1.690						
	VRSA	profile point	ETAR11	63559.71	-272834.16	3.42	1.420						
	VRSA	sampling point	ETAR12	63560.61	-272836.35	3.03	1.030					37°12'29.95"N	7°25'1.23"W
	VRSA	profile point	ETAR13	63562.01	-272839.66	2.97	0.970						
	VRSA	profile point	ETAR14	63562.82	-272842.08	2.92	0.920						
	VRSA	profile point	ETAR15	63564.4	-272845.36	2.92	0.920						
	VRSA	profile point	ETAR16	63565.44	-272846.94	2.89	0.890						
	VRSA	profile point	ETAR17	63565.74	-272847.6	2.93	0.930						
	VRSA	profile point	ETAR18	63566.41	-272849.12	2.84	0.840						
	VRSA	profile point	ETAR19	63566.7	-272849.85	2.93	0.930						
	VRSA	profile point	ETAR20	63566.96	-272850.51	2.84	0.840						
	VRSA	profile point	ETAR21	63567.51	-272851.9	2.82	0.820						
	VRSA	profile point	ETAR22	63568.22	-272853.6	2.82	0.820						
	VRSA	profile point	ETAR23	63568.8	-272854.53	2.79	0.790						
	VRSA	profile point	ETAR24	63569.37	-272855.81	2.77	0.770						
	VRSA	profile point	ETAR25	63569.55	-272857.13	2.75	0.750						
	VRSA	profile point	ETAR26	63570.26	-272857.83	2.72	0.720						
	VRSA	profile point	ETAR27	63570.27	-272857.96	2.41	0.410						
	VRSA	profile point	ETAR28	63570.68	-272859.93	2.33	0.330						
	VRSA	profile point	ETAR29	63570.93	-272860.64	2.34	0.340						
	VRSA	profile point	ETAR30	63571.13	-272861.42	2.33	0.330						

Table I, continuation.

	VRSA	sampling point	ETAR31	63571.94	-272863.74	2.29	0.290					37°12'30.22"N	7°25'0.07"W
	VRSA	profile point	ETAR32	63572.78	-272866.14	2.26	0.260						
	VRSA	profile point	ETAR33	63573.96	-272869.27	2.11	0.110						
	VRSA	profile point	ETAR34	63575.16	-272873.63	2.05	0.050						
	VRSA	profile point	ETAR35	63579.1	-272883.45	1.86	-0.140						
	VRSA	profile point	ETAR36	63583.14	-272891.76	1.73	-0.270						
	VRSA	sampling point	ETAR37	63589.81	-272904.11	1.53	-0.470					37°12'30.65"N	7°24'58.37"W
	VRSA	profile point	ETAR38	63592.8	-272911.73	1.49	-0.510						
	VRSA	profile point	ETAR39	63598.56	-272923.97	1.15	-0.850						
	VRSA	profile point	ETAR40	63601.64	-272931.12	1	-1.000						
	VRSA	profile point	ETAR41	63605.7	-272939.74	0.87	-1.130						
	VRSA	profile point	ETAR42	63610.27	-272949.57	0.74	-1.260						
Espanha ETAR	EE	sampling point	Esp_esgo2010	64604.906	-274266.784	1.257	-0.743	0.007	0.012	3.3	7	37°11'42.88"N	7°24'19.63"W
Espanha	E	profile point	Espanha31	64847.539	-274462.736	2.933	0.933	0.012	0.019	2.1	8		
	E	profile point	Espanha30	64816.866	-274471.755	2.738	0.738	0.01	0.016	1.6	8		
	E	profile point	Espanha29	64777.874	-274484.01	2.757	0.757	0.008	0.017	2.7	5		
	E	profile point	Espanha28	64735.202	-274499.83	2.823	0.823	0.007	0.011	2.2	8		
	E	profile point	Espanha27	64703.246	-274516.39	2.768	0.768	0.007	0.015	2.3	6		
	E	profile point	Espanha26	64691.041	-274519.607	2.747	0.747	0.012	0.019	2.6	7		
	E	profile point	Espanha25	64690.348	-274523.434	2.567	0.567	0.006	0.013	2.3	6		
	E	sampling point	Espanha24	64684.93	-274521.467	2.574	0.574	0.009	0.019	2.3	6	37°11'34.60"N	7°24'16.47"W
	E	profile point	Espanha23	64683.375	-274520.565	2.707	0.707	0.007	0.015	3.2	6		
	E	profile point	Espanha22	64680.523	-274521.042	2.597	0.597	0.01	0.02	1.8	6		
	E	profile point	Espanha21	64680.153	-274521.107	2.104	0.104	0.005	0.01	2.2	6		
	E	sampling point	Espanha20	64677.255	-274521.922	1.934	-0.066	0.007	0.013	1.8	7	37°11'34.58"N	7°24'16.78"W
	E	profile point	Espanha19	64674.395	-274522.674	1.808	-0.192	0.006	0.01	2.6	7		
	E	profile point	Espanha18	64673.08	-274523.068	1.822	-0.178	0.006	0.01	1.8	7		
	E	profile point	Espanha17	64670.792	-274523.601	1.908	-0.092	0.006	0.01	1.8	7		
	E	profile point	Espanha16	64663.95	-274525.311	1.827	-0.173	0.007	0.013	1.9	7		
	E	profile point	Espanha15	64660.354	-274526.247	1.756	-0.244	0.007	0.013	1.9	7		
	E	profile point	Espanha14	64653.487	-274528.043	1.618	-0.382	0.006	0.011	1.9	7		
	E	profile point	Espanha13	64648.619	-274529.359	1.469	-0.531	0.007	0.011	1.2	7		
	E	profile point	Espanha12	64643.576	-274530.705	1.379	-0.621	0.011	0.016	1.9	7		
	E	sampling point	Espanha11	64637.258	-274532.308	1.257	-0.743	0.006	0.01	1.9	7	37°11'34.26"N	7°24'18.41"W
	E	profile point	Espanha10	64631.168	-274533.865	1.183	-0.817	0.005	0.01	2	7		
	E	profile point	Espanha09	64625.89	-274535.222	1.128	-0.872	0.006	0.011	2	7		
	E	profile point	Espanha08	64621.644	-274536.377	1.11	-0.890	0.007	0.011	2.8	8		
	E	profile point	Espanha07	64618.857	-274537.096	1.186	-0.814	0.008	0.015	2	7		
	E	profile point	Espanha06	64612.336	-274538.803	1.062	-0.938	0.012	0.018	2.3	8		
	E	profile point	Espanha33	64613.36	-274538.542	1.059	-0.941	0.01	0.016	1.7	8		
	E	profile point	Espanha05	64605.877	-274540.443	0.969	-1.031	0.007	0.011	1.2	8		
	E	profile point	Espanha04	64599.808	-274541.66	0.889	-1.111	0.012	0.019	1.7	7		
	E	profile point	Espanha03	64593.113	-274543.76	0.809	-1.191	0.007	0.012	2	7		
	E	profile point	Espanha02	64586.075	-274545.656	0.741	-1.259	0.007	0.011	1.2	8		

Table I, continuation.

	E	profile point	Espanha01	64579.838	-274547.301	0.667	-1.333	0.006	0.01	1.2	8		
Lagoa VRSA	LG	profile point	VRSAp1_01	64517.385	-276687.931	2.445	0.445	0.014	0.017	1.6	7		
	LG	profile point	VRSAp1_02	64515.016	-276690.52	2.396	0.396	0.013	0.016	3.1	6		
	LG	sampling point	VRSA_veget	64513.526	-276692.511	2.397	0.397	0.008	0.01	1.6	7	37°10'24.26"N	7°24'24.06"W
	LG	profile point	VRSAp1_03	64511.634	-276693.632	2.354	0.354	0.008	0.01	0.9	7		
	LG	profile point	VRSAp1_04	64509.854	-276695.299	2.308	0.308	0.012	0.015	1.1	6		
	LG	sampling point	VRSA_mlagoa	64509.007	-276696.394	2.167	0.167	0.013	0.017	0.7	7	37°10'24.14"N	7°24'24.24"W
	LG	profile point	VRSAp1_05	64507.755	-276697.618	2.024	0.024	0.012	0.015	0.9	7		
	LG	sampling point	VRSA_lagoa	64506.052	-276699.545	1.91	-0.090	0.012	0.016	1.3	7	37°10'24.03"N	7°24'24.36"W

Eastings - point East metric coordinate
Northings - point West metric coordinate
Elev HZ - point height in relation to hidrographic zero
Elev MSL - point height in relation to mean sea level
Hz Prec (m) - point horizontal precision in meters (the error is normaly in the order of 1 to 2 cm)
Vt Prec (m) - point vertical precision in meters (the error is normaly in the order of 1 cm)
PDOP - Precision dilution (Measure of the quality of satelites distribution)
Sats - number of common satelites between the base unit and the mobile unit used to calculate the point coordinates

Appendix 4

Table I - Absolute and relative frequencies of living foraminifera in winter samples.

Sample 20 cc	LAR		FO		Aouro		FB1		FB2		FB3		PI2		PI3		PI4		LEZ1		LEZ2		LEZ3		SCM		VRSA1		VRSA2		VRSA3		VRSA4		EE		E1		E2		E3		LG1		LG2		LG3		
Method (Division - D; Flotation - F)	F/D		D/F		D/F		D		D		D		D		D		D/F		D		D		D		D		F		D		D		F		F		F		D		D		D		D		D		
Total counted nº of foraminifera	34		282		24		2678		233		96		206		59		62		137		158		9		713		17		594		165		51		50		169		15		123		1191		344		275			
Estimation of the total nº/20 cc	61		313		24		21424		621		384		1648		135		113		8768		249		72		5704		17		4747		375		204		50		169		15		488		76224		2752		2200			
taxa	6		14		8		2		17		20		7		7		11		2		7		6		4		5		11		19		8		16		9		6		16		5		14		21			
live %	3.49		40.06		8.6		59.22		41.39		25.07		23.52		18.44		13.05		14.09		32.05		2		25.56		9.29		51.83		26.66		10.2		9.17		46.94		11.9		21.75		49.83		52.2		18.35			
frequency (relative - R; absolut - A)	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	C%
Ammobaculites sp.									2	0.86																			10	1.68	3	1.82	2	3.92							2	1.63					3	1.09	31.6
Ammonia aberdoveyensis			52	18.44					77	33	8	8.33	11	5.34	21	35.6	7	11.3			5	3.16					1	5.88	41	6.9	59	35.8	12	23.5	3	6			2	13.3	11	8.94			10	2.91	101	36.7	73.7
Ammotium cf. *cassis*											1	1.04											1	11.1																									5.2
Ammotium salsum			5	1.77	2	8.33					3	3.13																			1	0.61									1	0.81					7	2.55	26.3
Ammovertellina sp.																													3	0.51																			5.2
Arenoparrella mexicana			2	0.71					2	0.86	4	4.17																																					15.8
Asterigerinata mamilla											6	6.25																							3	6			2	13.3	18	14.6							15.8
Bolivina cf. *variabilis*																																															14	5.09	5.2
Bolivina ordinaria											7	7.29			6	10.2	15	24.2													15	9.09	8	15.7	14	28			8	53.3	56	45.5			1	0.29			42.1
Buliminella elegantissima																																														1	0.36	5.2
Cornuspira involvens									11	4.72																									1	2	2	1.18			1	0.81			2	0.58			26.3
Elphidium poeyamn									2	0.86	1	1.04																					1	1.96	1	2													21.1
Discorinopsis aguayoi																																			1	2											41	11.9	1	0.36	15.2
Elphidium excavatum																															1	0.61																			5.2
Elphidium williamsoni									1	0.43			11	5.34																	1	0.61					5	2.96			1	0.81							26.3
Elphidium gerthi											1	1.04																							1	2											1	0.36	15.2
Elphidium oceanensis									18	7.73	19	19.8			2	3.39															4	2.42	3	5.88	1	2					4	3.25							36.8
Fisssurina sp.									1	0.43																					1	0.61																	10.5
M. obliqua	7	20.6	3	1.06					3	1.29	1	1.04									1	0.63	1	11.1	83	11.6																									26.3
Haplophragmoides spp.	2	5.88									1	1.04																																							5.2
Haynesina depressula																																							1	6.67											0
Haynesina germanica			9	3.19					12	5.15	1	1.04	5	2.43	26	44.1	3	4.84											7	1.18	50	30.3	15	29.4	4	8					8	6.5			3	0.87	12	4.36	68.4
Helenina anderseni																																										1	0.81			4	1.16			10.5
Jadammina macrescens			6	2.13	1	4.17	2515	93.91	44	18.9	4	4.17	159	77.2	2	3.39	2	3.23	136	99.27	19	12	3	33.3	503	70.5	5	29.4	313	52.7	11	6.67			8	16	71	42			4	3.25	1067	89.6	103	29.9	1	0.36	94.7
Lepidodeuterammina ochracea																	2	3.23																		1	0.59													10.5
Lepidodeuterammina plymouthensis					1	4.17																																											0
Leptohalysis scottii			1	0.35																																														5.2
Miliammina fusca	6	17.6	162	57.45	15	62.50			14	6.01	29	30.2			1	1.69	19	30.6			1	0.63							21	3.54	1	0.61											10	0.84	6	1.74	1	0.36	58
Miliolid sp1													12	5.83																					3	6					3	2.44	2	0.17					21.1
Miliolid sp2									16	6.87																																							5.2
Miliolid sp3																											7	41.2	171	28.8															34	9.88	28	10.2	15.8
Miliolid sp4																											2	11.8			1	0.61													13	3.78	8	2.91	15.8
Miliolid sp6																																															10	3.64	5.2
Miliolid sp8																											2	11.8																					0
Miliolid sp9																																															2	0.73	5.2
Miliolid sp10																																															2	0.73	5.2
Miliolids	2	5.88									1	1.04									130	82.3			7	0.98											1	0.59			1	0.81					40	14.5	31.6
Polysaccammina hyperhalina			1	0.35											1	1.69	2	3.23					1	11.1					7	1.18	4	2.42	7	13.7			4	2.37	1	6.67	10	8.13			2	0.58	31	11.3	52.6
Portatrochammina sp.					1	4.17											1	1.61																															5.2
Reophax nana					2	8.33			1	0.43	1	1.04					5	8.06													1	0.61																	21.1
Siphotrochammina sp.	16	47.1	5	1.77	1	4.17																																											15.8
Textularia earlandi			1	0.35							1	1.04																	2	0.34	3	1.82			1	2	1	0.59					2	0.17					36.8
Tiphotrocha comprimata																																			1	2													5.2
Trochammina inflata							163	6.09	24	10.3	1	1.04	5	2.43			2	3.23	1	0.73	1	0.63	2	22.2	120	16.8			12	2.02	2	1.21			5	10	83	49.1					110	9.24	119	34.6	2	0.73	84.2
Agglutinated indeterminate			1	0.35					2	0.86	2	2.08																			2	1.21			2	4					1	0.81			3	0.87	1	0.36	58
Calcareous indeterminate	1	2.94	6	2.13	1	4.17			3	1.29	4	4.17					4	6.45			1	0.63									2	1.21	3	5.88	1	2	1	0.59	1	6.67	1	0.81			3	0.87	5	1.82	42.1
Linings of calcareous forms			28	9.93									3	1.46									1	11.1					7	1.18	3	1.82															4	1.45	26.3
Total calcareous	3	8.82	95	33.69	1	4.17			141	60.5	48	50	42	20.4	55	93.2	29	46.8			136	86.1	1	11.1	7	0.98	12	70.6	226	38	137	83	42	82.4	33	66	9	5.33	14	93.3	105	86.1	2	0.17	111	32.3	229	83.3	
Total agglutinated	31	91.2	187	66.31	23	95.83	2678	100	92	39.5	48	50	164	79.6	4	6.78	33	53.2	137	100	22	13.9	8	88.9	706	99	5	29.4	368	62	28	17	9	17.6	17	34	160	94.7	1	6.67	18	14.7	1189	99.8	233	67.7	46	16.7	
Total porcelaneous	2	5.88							27	11.6	1	1.04	12	5.83							130	82.3			7	0.98	11	64.7	171	28.8	1	0.61			4	8	3	1.77			5	4.06	2	0.17	49	14.2	90	32.7	

Table II – Absolute and relative frequencies of living foraminifera in summer samples.

Sample 20 cc	LAR		FO		Aouro		FB1		FB2		FB3		PI1		PI2		PI3		PI4		LEZ1		LEZ2		LEZ3		SCM		VRSA1		VRSA2		VRSA3		VRSA4		EE		E1		E2		E3		LG1		LG2		LG3		
Method (Division - D; Flotation - F)	D		D		D/F		D		D		D		D		D		D		D/F		D		D		D		D		D/F		D		D/F		D/F		F		F/D		F		F		D		D		F		
Total counted nº of foraminifera	6		52		75		148		238		653		1036		223		207		197		181		264		293		48		1		352		355		1036		352		143		332		159		846		447		166		
Estimation of the total nº/20 cc	31		83		75		4736		634		5224		16576		892		550		788		11584		2112		2344		3072		2		2816		710		2072		1407		286		332		636		6768		3576		332		
taxa	4		9		14		1		19		12		3		2		12		15		2		13		10		3		1		9		18		16		14		13		13		14		8		14		15		
live %	6.90		28.89		12.61		15.18		50.32		80.02		60.69		43.55		60.35		34.99		39.43		59.33		47.56		9.09		0.69		49.65		44.77		62.41		66.42		27.29		56.46		46.49		29.79		66.32		17.01		
frequency (relative - R; absolut - A)	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	C%
Ammobaculites exigus																																					1	0.28															4.3
Ammobaculites sp.									1	0.42																							5	1.41	3	0.29													2	1.20	17.4
Ammonia aberdoveyensis	1	16.67	9	17.31	9	12			29	12.18	107	16.39					37	17.87	29	14.72			40	15.15	42	14.33			1	100	89	25.28	84	23.66	418	40.35	215	61.08	7	4.90	193	58.13	86	54.09	57	6.74	260	58.17	76	45.78	78.3
Ammotium cassis									1	0.42													1	0.38																													8.7
Ammotium salsum									3	1.26	8	1.23					20	9.66					1	0.38	4	1.37							5	1.41	35	3.38			5	3.50					3	0.35	1	0.22			43.5
Ammovertellina sp.											1	0.15																																	6	0.71					8.7
Arenoparrella mexicana									2	0.84																							2	0.56																	8.7
Asterigerinata mamilla					1	1.33													7	3.55															6	0.58	3	0.85	2	1.40	3	0.90	5	3.14					2	1.20	34.8
Bolivina cf. *variabilis*	1	16.67																																																6	3.61	4.3
Bolivina ordinaria			2	3.85	2	2.67					1	0.15							3	1.52			1	0.38											1	0.10					2	0.60	6	3.77			1	0.22	4	2.41	43.5
Cornuspira involvens																							1	0.38																													4.3
Deuterammina eddystonensis									1	0.42																																										4.3
Discorbis sp.																																					3	0.85							1	0.63							8.7
Discorinopsis aguayoi																																																3	0.67	1	0.60	8.7
Eggerelloides scaber																																			4	0.39	1	0.28	1	0.70													13
Elphidium advenum																																							3	2.10			1	0.63									8.7
Elphidium excavatum																																					1	0.28															4.3
Elphidium excavatum williamsoni																																			1	0.10			3	2.10													8.7
Elphidium gerthi			3	5.77																																																4.3
Elphidium oceanensis			7	13.46	8	10.67			3	1.26	76	11.64					3	1.45	18	9.14			54	20.45	68	23.21							19	5.35	77	7.43	60	17.05			24	7.23	18	11.32			1	0.22			65.2
Glomospira sp.			1	1.92	2	2.67			2	0.84													1	0.38	9	3.07							1	0.28																	26.1
Haplophragmoides spp.									1	0.42																																									4.3
Haynesina depressula											1	0.15							1	0.51																	1	0.28			1	0.30	2	1.26							26.1
Haynesina germanica					2	2.67			1	0.42	8	1.23					28	13.53	8	4.06			1	0.38	4	1.37							145	40.85	260	25.10	33	9.38	3	2.10	76	22.89	23	14.47			7	1.57	9	5.42	69.5
Helenina anderseni																																	1	0.28																	4.3
Jadammina macrescens	1	16.67			5	6.67	148	100	36	15.13	1	0.15	1011	97.59	214	95.96	6	2.90	1	0.51	180	99.45	115	43.56	16	5.46	36	75			161	45.74	18	5.07			5	1.42	77	53.85	6	1.81			711	84.04	58	12.98			82.6
Lamarckina haliotidea																																					1	0.28															4.3
Lepideuterammina ochracea									1	0.42																																									4.3
Leptohalysis scottii																	2	0.97	1	0.51																																	8.7
Miliammina fusca			24	46.15	25	33.33			136	57.14	416	63.71	1	0.10			21	10.14	107	54.31			43	16.29	120	40.96					10	2.84	3	0.85	12	1.16			2	1.40					16	1.89	30	6.71	9	5.42	69.5
Miliolid sp1					2	2.67																																					5	3.15	5	0.59	33	7.38			17.4
Miliolid sp3																															5	1.42	17	4.79															8.7
Miliolid sp4																																	20	5.63													11	2.46	12	7.23	13
Miliolid sp5											24	3.68																									19	5.40											9	5.42	13
Miliolids			2	3.85																			3	1.14											24	2.32					14	4.22							2	1.20	21.7
Nonion sp.																																									1	0.30									4.3
Polysaccammina hyperhalina									3	1.26							75	36.23	3	1.52					1	0.34					66	18.75	24	6.76	116	11.20					3	0.90	4	2.52			3	0.67	29	17.47	47.8
Polysaccammina ipohalina																											10	20.83																							4.3
Reophax nana																	1	0.48	3	1.52													2	0.56	2	0.19															17.4
Rosalina sp.																																																		2	1.20	4.3
Siphotrochammina inflata	3	50.00			9	12.00																																													4.3
Textularia earlandi					2	2.67			1	0.42	3	0.46					7	3.38	7	3.55											2	0.57	1	0.28	9	0.87			3	2.10	2	0.60	1	0.63	1	0.12			1	0.60	56.5
Tiphotrocha comprimata					3	4.00																																	2	1.40													8.7
Trochammina inflata									8	3.36			24	2.32	9	4.04	2	0.97	2	1.02	1	0.55			9	3.07	2	4.17			6	1.70	1	0.28			7	1.99	34	23.78	1	0.30	1	0.63	47	5.56	37	8.28			69.5
Agglutinated indeterminate			2	3.85	3	4.00			5	2.10							5	2.42	4	2.03			2	0.76							1	0.28	3	0.85	1	0.10			1	0.70			2	1.26			1	0.22			52.2
Calcareous indeterminate			2	3.85	2	2.67			3	1.26	7	1.07							3	1.52			1	0.38									4	1.13	67	6.47	2	0.57			6	1.81	4	2.52			1	0.22	2	1.20	56.5
Linings of calcareous forms									1	0.42															20	6.83					12	3.41																			13
Total calcareous	2	33.33	25	48.08	26	34.67			36	15.55	224	34.30					68	32.85	69	35.03			101	38.26	114	45.73			1	100	94	30.11	290	81.69	854	82.43	338	96.02	18	12.59	320	96.39	151	94.97	62	7.33	317	70.92	125	75.30	
Total agglutinated	4	66.67	27	51.92	49	65.33	148	100	201	84.45	429	65.70	1036	100	223	100	139	67.15	128	64.97	181	100	163	61.74	159	54.27	48	100			246	69.89	65	18.31	182	17.57	14	3.98	125	87.41	12	3.61	8	5.03	784	92.67	130	29.08	41	24.70	
Total porcelaneous			2	3.85	2	2.67					24	3.68											4	1.52							5	1.42	37	10.42	24	2.32	19	5.40			14	4.22	5	3.15	5	0.59	44	9.84	23	13.86	

Table III – Absolute and relative frequencies of total foraminifera (living + dead) in winter samples

Sample 20 cc	**LAR**		**FO**		**Aouro**		**FB1**		**FB2**		**FB3**		**PI2**		**PI3**		**PI4**		**LEZ1**		**LEZ2**		**LEZ3**		**SCM**		**VRSA1**		**VRSA2**		**VRSA3**		**VRSA4**		**EE**		**E1**		**E2**		**E3**		**LG1**		**LG2**		**LG3**	
Method (Division - D; Flotation - F)	F/D		D/F		D/F		D		D		D		D		D		D/F		D		D		D		D		F		D		D		F		F		F		D		D		D		D	
Total counted nº of foraminifera	974		704		279		4522		552		383		876		320		475		972		493		449		2790		183		1146		619		500		545		360		126		562		2390		659		1499	
Estimation of the total nº/20 cc	1875		802		279		10448		1472		1532		7008		732		844		48880		635		3592		22320		183		9160		2476		2000		545		360		126		2248		152960		5272		11992	
taxa	16		20		21		5		32		37		13		28		32		5		34		22		9		33		13		34		36		46		17		27		45		9		17		32	
live %	3.49		40.06		8.60		59.22		41.39		25.07		23.52		18.44		13.05		14.09		32.05		2.00		25.56		9.29		51.83		26.66		10.20		9.17		46.94		11.90		21.75		49.83		52.20		18.35	
frequency (relative - R; absolut - A)	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
Asterigerinata mamilla	1	0.10							1	0.18	26	6.79			10	3.13	5	1.05			2	0.41					3	1.64			9	1.45	1	0.20	26	4.77			10	7.94	68	12.10						
Ammobaculites cf. *exigus*																	1	0.21																	1	0.18												
Ammobaculites sp.									2	0.36													3	0.67					43	3.75	32	5.17	34	6.80	45	8.26	2	0.56	6	4.76	38	6.76					12	0.80
Ammobaculites sp2																																	18	3.60							1	0.18						
Ammonia aberdoveyensis	2	0.21	55	7.81	6	2.15			92	16.67	19	4.96	12	1.37	42	13.13	24	5.05			33	6.69	6	1.34	1	0.04	31	16.94	67	5.85	87	14.05	68	13.60	55	10.09			17	13.49	52	9.25			15	2.28	551	36.76
Ammonia beccarii																																			5	0.92			8	6.35								
Ammotium cassis											2	0.52					1	0.21					1	0.22									1	0.20														
Ammotium salsum			5	0.71	2	0.72			1	0.18	5	1.31					6	1.26					1	0.22							5	0.81	10	2.00	7	1.28	2	0.56			2	0.36					27	1.80
Ammovertellina sp.																								0.00					7	0.61													7	0.29				
Arenoparrella mexicana			5	0.71					10	1.81	6	1.57					2	0.42			5	1.01	2	0.45							1	0.16	1	0.20	2	0.37	3	0.83			4	0.71						
Bolivina cf. *variabilis*																																																27	1.80
Bolivina ordinaria											16	4.18			14	4.38	15	3.16			6	1.22									25	4.04	14	2.80	17	3.12			10	7.94	66	11.74			1	0.15		
Bolivina pseudoplicata																																							1	0.79								
Bolivina striatula											1	0.26																																				
Bulimina sp.											1	0.26			1	0.31	3	0.63															1	0.20	1	0.18			1	0.79	3	0.53						
Buliminella elegantissima																																			2	0.37											1	0.07
Cassidulina sp.															2	0.63											1	0.55																			1	0.07
Cornuspira involvens									17	3.08											1	0.20													1	0.18	2	0.56			1	0.18			13	1.97		
Cribrostomoides crassimargo			9	1.28	2	0.72									2	0.63	2	0.42			1	0.20									1	0.16			1	0.18					2	0.36						
Deuterammina eddystonensis					16	5.73			4	0.72			1	0.11	1	0.31	3	0.63			5	1.01	1	0.22							6	0.97	4	0.80	3	0.55					4	0.71						
Discorinopsis aguayoi																											2	1.09							1	0.18									46	6.98	1	0.07
Eggerelloides scaber															1	0.31	30	6.32															1	0.20	23	4.22			7	5.56	2	0.36						
Elphidium cf. *discoidale*																											21	11.48					2	0.40	2	0.37												
Elphidium complanatum																																			1	0.18												
Elphidium crispum																											6	3.28							1	0.18			2	1.59								
Elphidium excavatum																											3	1.64			3	0.48			1	0.18					3	0.53						
Elphidium gerthi											9	2.35															2	1.09							5	0.91			1	0.79	33	5.87					17	1.13
Elphidium macelum var. *aculcatum*																											1	0.55																				
Elphidium oceanensis	4	0.41							30	5.43	59	15.40			23	7.19	4	0.84			9	1.83									4	0.65	14	2.80	7	1.28					8	1.42						
Elphidium poeyamn									2	0.36	2	0.52																					3	0.60	3	0.55			1	0.79	3	0.53						
Elphidium spp.															2	0.63	1	0.21			2	0.41									3	0.48			1	0.18			3	2.38	3	0.53					4	0.27
Elphidium williamsoni									1	0.18			41	4.68													2	1.09			9	1.45			3	0.55	6	1.67			2	0.36					14	0.93
reworked *Elphidium*																																			14	2.57			9	7.14	1	0.18						
Epistominella sp.											3	0.78																																				
Eponides lateralis																											1	0.55																				
Eponides sp.																																	1	0.20					1	0.79								
Fissurina sp.									2	0.36											2	0.41									7	1.13	4	0.80							5	0.89						
Glabratella sp.																											1	0.55																				
Globulina *sp.*																											1	0.55																				
M. obliqua	64	6.57	4	0.57	3	1.08	1	0.02	11	1.99	2	0.52					3	0.63			13	2.64	31	6.90	175	6.27					1	0.16	2	0.40	1	0.18			1	0.79	1	0.18						

Table III continuation

| | | |

Table IV – Absolute and relative frequencies of total foraminifera (living + dead) in summer samples

Sample 20 cc	LAR		FO		Aouro		FB1		FB2		FB3		PI1		PI2		PI3		PI4		LEZ1		LEZ2		LEZ3		SCM		VRSA1		VRSA2		VRSA3		VRSA4		EE		E1		E2		E3		LG1		LG2		LG3	
Method (Division - D; Flotation - F)	D		D		D/F		D		D		D		D		D		D		D/F		D		D		D		D		D/F		D		D/F		D/F		F		F/D		F		F		D		D		F	
Total counted nº of foraminifera	111		180		595		975		473		816		1707		512		343		564		459		445		616		528		144		709		793		1660		555		524		588		342		2840		674		976	
Estimation of the total nº/20 cc	444		288		595		31200		1261		6528		27312		2048		912		2256		29376		3560		4928		33792		288		5672		1586		3320		2220		1048		588		1368		22720		5392		1952	
taxa	17		26		25		2		25		22		6		4		19		39		4		25		18		6		27		17		42		36		33		19		36		29		15		17		47	
live %	6.9		28.89		12.61		15.18		50.32		80.02		60.69		43.55		60.35		34.99		39.43		59.33		47.56		9.09		0.69		49.65		44.77		62.41		63.42		27.29		56.46		46.49		29.79		66.32		17.01	
frequency (relative - R; absolut - A)	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R
Asterigerinata mamilla			2	1.11	5	0.84			1	0.21	7	0.86							31	5.50			1	0.22					4	2.78			5	0.63	13	0.78	5	0.90	2	0.38	11	1.87	13	3.80					10	1.02
Ammobaculites cf. *exigus*											1	0.12																					1	0.06	2	0.36														
Ammobaculites sp.					1	0.17			1	0.21									3	0.53			2	0.45	2	0.32					4	0.56	17	2.14	11	0.66	10	1.80	2	0.38	11	1.87	6	1.75	7	0.25			34	3.48
Ammonia aberdoveyensis	6	5.41	19	10.56	17	2.86			31	6.55	131	16.05					41	11.95	68	12.06			49	11.01	45	7.31	7	1.33	19	13.19	106	14.95	139	17.53	544	32.77	250	45.05	23	4.39	238	40.48	132	38.60	57	2.01	306	45.40	383	39.24
Ammonia beccarii																																	1	0.13															1	0.10
Ammotium cf. *cassis*									1	0.21													1	0.22																										
Ammotium salsum									4	0.85	8	0.98					30	8.75					1	0.22	10	1.62							11	1.39	47	2.83			13	2.48							2	0.30		
Ammotium spp																			2	0.35											1	0.14									5	0.85	3	0.88	4	0.14			10	1.02
Ammovertellina sp.											1	0.12																			2	0.28													60	2.11				
Amphicoryna sp.																													1	0.69					1	0.06														
Arenoparrella mexicana	2	1.80	1	0.56	12	2.02			2	0.42									2	0.35													4	0.50	3	0.18			1	0.19	2	0.34								
Bolivina cf. *variabilis*	1	0.90																																														16	1.64
Bolivina ordinaria			3	1.67	2	0.34					4	0.49							5	0.89			1	0.22											3	0.18	1	0.18			3	0.51	7	2.05			1	0.15	6	0.61
Bolivina spp.	1	0.90																	1	0.18													1	0.13	1	0.06	1	0.18											1	0.10
Bolivina striatula																																										1	0.29					1	0.10
Bulimina sp.			1	0.56															4	0.71															1	0.06	1	0.18			1	0.17	2	0.58					1	0.10
Buliminella elegantissima																			1	0.18													1	0.13															1	0.10
Cassidulina sp.																			2	0.35																														
Cornuspira involvens																			1	0.18			1	0.22																										
Elphidium poeyamn			1	0.56							1	0.12							4	0.71															3	0.18	1	0.18			2	0.34	4	1.17					1	0.10
Deuterammina eddystonensis	1	0.90	5	2.78	2	0.34			8	1.69							2	0.58	4	0.71											1	0.14	2	0.25											1	0.15	2	0.20
Discorbis cf. *williamsoni*																																			1	0.18														
Discorbis sp.																																			6	1.08					1	0.17	1	0.29				
Discorinopsis aguayoi																																													6	0.89	1	0.10
Eggerelloides scaber																																	6	0.36	7	1.26	3	0.57	18	3.06	5	1.46					1	0.10
Elphidium advenum																																	2	0.25					4	0.76			2	0.58					5	0.51
Elphidium advenum var. *margaritaceum*																																																2	0.20
Elphidium cf. *discoidale*																													27	18.75			1	0.13	1	0.06	3	0.54										
Elphidium complanatum																																			1	0.06													1	0.10
Elphidium crispum																													10	6.94											4	0.68	2	0.58					2	0.20
Elphidium excavatum																																					5	0.90					2	0.34					1	0.10
Elphidium williamsoni																					1	0.22											3	0.38	4	0.24			3	0.57							11	1.13
Elphidium gerthi			9	5							2	0.25							17	3.01									2	1.39			10	1.26	1	0.06	1	0.18			1	0.17					17	1.74
Elphidium macelum var. *aculcatum*																																	1	0.13														
Elphidium oceanensis	8	7.21	15	8.33	20	3.36			3	0.63	85	10.42					3	0.87	54	9.57			86	19.33	70	11.36							25	3.15	106	6.39	82	14.77			38	6.46	24	7.02			1	0.15		
Elphidium spp.					2	0.34													4	0.71													1	0.13			1	0.18			1	0.17								
reworked *Elphidium*																													10	6.94			1	0.13	1	0.06					2	0.34	3	0.88						
Epistominella sp.																							3	0.67																										
Eponides sp.																													3	2.08											1	0.17								
Fissurina sp.			1	0.56															1	0.18			1	0.22									2	0.25															1	0.10
Glabratella sp.																													2	1.39																		
Globulina sp.																													1	0.69																		
M. obliqua	4	3.60	2	1.11	142	23.87			4	0.85	1	0.12					2	0.58	1	0.18			3	0.67	23	3.73					2	0.28	2	0.25											2	0.07				
Haplophragmoides maniliensis	9	8.11	2	1.11	10	1.68													1	0.18																														
Haplophragmoides wilberti					3	0.50																																												
Haynesina depressula					3	0.50					8	0.98							9	1.60									1	0.69					4	0.24	7	1.26			15	2.55	11	3.22						
Haynesina germanica					7	1.18			2	0.42	17	2.08					28	8.16	18	3.19			8	1.80	4	0.65			9	6.25			215	27.11	351	21.14	53	9.55	3	0.57	110	18.71	54	15.79			13	1.93	117	11.99
Helenina anderseni																																	2	0.25							1	0.17					1	0.15	1	0.10
Hopkinsina sp.																			3	0.53																													1	0.10

Table IV continuation

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Table V – Base data set of the foraminifera total assemblages representing the winter sampling period.

Taxa/Sample 20 cc	LAR	FO	Aouro	FB1	FB2	FB3	PI2	PI3	PI4	LEZ1	LEZ2	LEZ3	SCM	VRSA1	VRSA2	VRSA3	VRSA4	EE	E1	E2	E3	LG1	LG2	LG3
Ammobaculites sp.					0.36							0.67			3.75	5.17	6.80	8.26	0.56	4.76	6.76			0.80
Ammonia aberdoveyensis	0.21	7.81	2.15		16.67	4.96	1.37	13.13	5.05		6.69	1.34	0.04	16.94	5.85	14.05	13.60	10.09		13.49	9.25		2.28	36.76
Ammotium salsum		0.71	0.72		0.18	1.31			1.26			0.22				0.81	2.00	1.28	0.56		0.36			1.80
Asterigerinata mamilla	0.10				0.18	6.79		3.13	1.05		0.41			1.64		1.45	0.20	4.77		7.94	12.10			
Bolivina ordinaria						4.18		4.38	3.16		1.22					4.04	2.80	3.12		7.94	11.74		0.15	
Discorinopsis aguayoi														1.09				0.18					6.98	0.07
Elphidium cf. *discoidale*														11.48			0.40	0.37						
Elphidium gerthi						2.35								1.09				0.91		0.79	5.87			1.13
Elphidium oceanensis	0.41				5.43	15.40		7.19	0.84		1.83					0.65	2.80	1.28			1.42			
M. obliqua	6.57	0.57	1.08	0.02	1.99	0.52			0.63		2.64	6.90	6.27			0.16	0.40	0.18		0.79	0.18			
Haplophragmoides manilaensis	30.80		0.72		0.54	0.26		0.63	0.63		0.20	0.22									0.53			
Haynesina germanica	0.21	1.28	1.43		4.17	1.83	1.48	17.50	2.11		1.22			5.46	0.61	21.00	14.00	6.61	0.28	4.76	6.58		0.46	2.87
Jadammina macrescens	0.72	5.11	9.32	95.40	25.36	4.18	83.11	3.75	8.42	96.40	30.43	57.91	82.94	6.56	56.02	14.22	5.00	12.84	49.17	1.59	3.74	89.96	27.31	0.60
Lobatula lobatula						0.78								12.57		0.16	0.40	4.22		0.79	0.71			0.13
Miliammina fusca	4.62	65.63	45.16		7.97	25.85	0.80	15.31	26.95	0.21	2.84	3.12			3.58	2.10	0.80			0.79	1.07	0.75	3.79	1.40
Polysaccammina hyperhalina		0.28			0.36	0.52		4.38	2.53		0.61	1.11	0.04		4.80	8.89	13.20	5.32	6.94	15.08	3.91	0.04	4.25	4.67
Reophax nana		0.14	1.43		1.09	1.31		1.56	4.42		1.42	0.89				2.58	7.40	0.37	0.56	0.79	2.67		0.15	0.07
Siphotrochammina sp.	44.76	5.26	4.30																					
Trochammina inflata				4.51	12.32	3.13	1.60	1.25	2.74	3.19	5.48	18.26	9.61	2.19	2.71	1.78	0.40	7.16	33.89	0.79	1.25	8.12	27.62	0.13
Miliolids	0.21		0.72		5.62	6.53	1.60	1.25	0.21		27.18		0.36	20.22	17.98	0.97	1.60	0.92	0.28	0.79	1.78	0.08	18.06	42.09
Planktic														0.55		0.32	0.20				1.25			
Σ Exotic agglutinated <10%		0.14			0.36	0.52	0.23	1.56	0.21		0.61	0.22				2.75	0.60		0.28		0.18			
Σ Exotic calcareous <10%	0.21		0.36		0.36	1.31		1.56	0.84		1.01			11.48		2.10	1.20	6.97		20.63	4.62			2.20
Σ Indigenous agglutinated <10%	1.85	5.40	25.45	0.04	6.88	6.53	1.03	9.06	26.95		9.13	4.90			2.27	8.89	10.20	8.44	1.67	5.56	5.34	0.42		0.27
Σ Indigenous calcareous <10%					4.17	2.87	4.68	0.94			0.41			1.09		1.62	0.80	3.12	2.22	3.17	2.49		3.49	2.74

Table VI– Base data set of the foraminifera total assemblages representing the summer sampling period.

Taxa/Sample 20 cc	LAR	FO	Aouro	FB1	FB2	FB3	PI1	PI2	PI3	PI4	LEZ1	LEZ2	LEZ3	SCM	VRSA1	VRSA2	VRSA3	VRSA4	EE	E1	E2	E3	LG1	LG2	LG3
Ammobaculites sp.			0.17		0.21					0.53		0.45	0.32			0.56	2.14	0.66	1.80	0.38	1.87	1.75	0.25		3.48
Ammonia aberdoveyensis	5.41	10.56	2.86		6.55	16.05			11.95	12.06		11.01	7.31	1.33	13.19	14.95	17.53	32.77	45.05	4.39	40.48	38.60	2.01	45.40	39.24
Ammotium salsum					0.85	0.98			8.75			0.22	1.62				1.39	2.83		2.48				0.30	
Asterigerinata mamilla		1.11	0.84		0.21	0.86				5.50		0.22			2.78		0.63	0.78	0.90	0.38	1.87	3.80			1.02
Bolivina ordinaria		1.67	0.34			0.49				0.89		0.22						0.18	0.18		0.51	2.05		0.15	0.61
Discorinopsis aguayoi																								0.89	0.10
Elphidium cf. *discoidale*															18.75		0.13	0.06	0.54						
Elphidium gerthi		5.00				0.25				3.01					1.39		1.26	0.06	0.18		0.17				1.74
Elphidium oceanensis	7.21	8.33	3.36		0.63	10.42			0.87	9.57		19.33	11.36				3.15	6.39	14.77		6.46	7.02		0.15	
M. obliqua	3.60	1.11	23.87		0.85	0.12			0.58	0.18		0.67	3.73			0.28	0.25						0.07		
Haplophragmoides manilaensis	8.11	1.11	1.68							0.18															
Haynesina germanica			1.18		0.42	2.08			8.16	3.19		1.80	0.65		6.25		27.11	21.14	9.55	0.57	18.71	15.79		1.93	11.99
Jadammina macrescens	15.32	4.44	17.82	97.33	28.12	1.96	95.78	95.12	7.29	4.26	96.51	40.90	28.08	93.94		58.67	9.33	1.81	3.96	62.60	3.57	2.34	83.20	17.36	1.54
Lobatula lobatula										0.35					11.81		0.63	0.12			0.17	0.29			0.51
Miliammina fusca	9.01	32.78	11.43		36.79	55.51	0.41	0.20	10.20	30.50		12.81	28.73			3.53	1.26	1.63	0.18	1.34	0.17		3.84	11.28	2.46
Polysaccammina hyperhalina					0.85				35.57	1.24		0.22	0.97			13.40	16.02	11.45	3.06	2.48	5.61	4.39	0.11	1.04	13.52
Polysaccammina ipohalina														3.03											
Reophax nana	0.90		0.17		0.21				1.75	2.48			0.16				0.50	0.84	0.54		1.02	0.29			0.31
Siphotrochammina sp.	25.23	4.44	14.29																						
Trochammina inflata				2.67	6.98	0.49	2.87	4.49	0.87	1.60	2.61	2.92	8.60	0.95		1.55	0.88	0.06	2.88	18.70	1.87	2.34	7.43	9.35	0.31
Trochamminita irregularis	12.61		4.37																						
Miliolids	0.90	2.22	0.50		0.21	4.53	0.06			1.06	0.65	2.92	0.16	0.57	13.19	1.13	5.67	2.05	7.75		2.55	2.63	0.21	11.13	10.86
Planktic		1.67				0.49				1.06					2.08				0.18		0.68	0.58			
Σ Exotic agglutinated <10%		0.56							0.29							0.14	0.13	0.06							
Σ Exotic calcareous <10%	1.80	1.11	0.34		0.21					3.72		1.35			24.31		1.64	0.30	3.24	0.95	2.72	3.80			4.20
Σ Indigenous agglutinated <10%	3.60	10.00	4.03		9.09	1.10	0.06	0.20	8.45	6.03		2.02	1.62			1.55	3.66	4.46	1.98	2.86	5.27	4.09	2.54	0.15	2.87
Σ Indigenous calcareous <10%		0.56	0.50			1.10				2.48	0.22	0.22			0.69		0.63	0.66	1.44	0.57	3.06	4.39		0.15	1.33

Table VII – Absolute frequencies of the foraminifera taxa found in CM3 borehole

Depth (cm)	190	380	480	625	690	866	972	1120	1351	1527	1643	1815	2100	2240	2300	2450	2600	2892	3063	3270
Total counted nº of foraminifera	306	61	101	416	104	8	20	23	112	15	323	398	370	318	5	4	1	346	312	0
Estimation of the total nº/20 cc	1224	326	202	6656	208	16	40	46	224	30	646	6368	5920	1744	80	64	16	2768	4992	0
Taxa	4	4	11	33	19	4	8	11	26	10	20	11	1	1	1	1	1	1	1	0
Ammobaculites sp.	81	27																		
Ammonia aberdoveyensis			50	41	18			4	20		93	98								
Ammonia beccarii							1		1											
Asterigerinata mamilla				121	6	1	2	4	17	1	28	5								
Bolivina ordinaria				13							11	22								
Bolivina pseudoplicata				1																
Bolivina striatula				2																
Bulimina sp.				10	1		1													
Cornuspira involvens				3							5									
Elphidium poeyamn			4								4									
Discorbinella sp.				1																
Discorbis sp.				16					4	1	5									
Elphidium advenum				1	5															
E .advenum var. *margaritaceum*			9	3					3		6									
Elphidium complanatum				1																
Elphidium crispum			1				5		5	1	2									
Elphidium discoidale					8		1	3	5	2										
Elphidium excavatum			1	31	7				3		5									
Elphidium incertum									3			9								
Elphidium oceanensis												9								
Elphidium sp.				3					2											
Elphidium williamsoni			2	1																
Eponides cf. *lateralis*										2	11									
Eponides sp.									1											
Fissurina sp.				1																
Glabratella sp.				1	2			2	1											
Globulina gibba					2															
Haynesina germanica			19	42	12			1	2		84	149								
Jadammina macrescens	33	2																		
Lagena gracilima												1								
Lobatula lobatula			1	5	7		2	1	2		3									
Miliolid sp1					2			1												
Miliolid sp2								1												
Miliolid sp3				1	5		5	2	9	2										
Miliolid sp4				6	1		3		3	3	3									
Miliolid sp5				40					7		5									
Miliolid sp6											3									
Miliolid sp7					10				1		7									
Miliolid sp8				1					1											
Nonion boueanum					2															
Nonion sp.				4					2											
Nonionella sp.				2								2								
Pararotalia cf. spinigera											32									
Planorbulina mediterranensis				31	8				10	1	2									
Rosalina globularis			2	1					1											
Rosalina vilardeboana				7																
Textularia sp.				1	2			2	2	1										
Trochammina inflata	43	9				4														
Trochammina spp. (linings)	149	23		1								5	370	318	5	4	1	346	312	
Uvigerina sp.				3					1											
Planktic			1	9	2	2			1		2	4								
Indeterminate			11	12	4	1		2	5	1	12	94								
calcareous			101	414	102	4	20	21	110	14	323	393								
Agglutinated	306	61		2	2	4		2	2	1		5	370	318	5	4	1	346	312	
Porcelaneous				51	18		8	4	21	5	23									

samples without statistical meaning

Table VIII – Relative frequencies of the foraminifera taxa found in CM3 borehole

Depth (cm)	190	380	480	625	690	866	972	1120	1351	1527	1643	1815	2100	2240	2300	2450	2600	2892	3063	3270
Total counted nº of foraminifera	306	61	101	416	104	8	20	23	112	15	323	398	370	318	5	4	1	346	312	0
Estimation of the total nº/20 cc	1224	326	202	6656	208	16	40	46	224	30	646	6368	5920	1744	80	64	16	2768	4992	0
Taxa	4	4	11	33	19	4	8	11	26	10	20	11	1	1	1	1	1	1	1	0
Ammobaculites sp.	26.47	44.26																		
Ammonia aberdoveyensis			49.5	9.85	17.3			17.4	17.85		28.8	24.6								
Ammonia beccarii							5		0.9											
Asterigerinata mamilla				29.1	5.8	12.5	10	17.4	15.18	6.67	8.67	1.25								
Bolivina ordinaria				3.1							3.4	5.52								
Bolivina pseudoplicata				0.24																
Bolivina striatula				0.5																
Bulimina sp.				2.4	1		5													
Cornospira involvens				0.72							1.54									
Elphidium poeyamn			3.96								1.24									
Discorbinella sp.				0.24																
Discorbis sp.				3.84					3.57	6.67	1.54									
Elphidium advenum				0.24	4.8															
E. advenum var. *margaritaceum*			8.91	0.72					2.68		1.85									
Elphidium complanatum				0.24																
Elphidium crispum			0.99				25		4.46	6.67	0.62									
Elphidium discoidale					7.7		5	13.04	4.46	13.33										
Elphidium excavatum			0.99	7.45	6.7				2.68		1.54									
Elphidium incertum									2.68			2.3								
Elphidium oceanensis												2.3								
Elphidium sp.				0.72					1.78											
Elphidium williamsoni			1.98	0.24																
Eponides cf. *lateralis*										13.33	3.4									
Eponides sp.									0.9											
Fissurina sp.				0.24																
Glabratella sp.				0.24	1.92			8.7	0.9											
Globulina gibba					1.92															
Haynesina germanica			18.8	10.1	11.5			4.34	1.78		26	37.43								
Jadammina macrescens	10.78	3.28																		
Lagena gracilima												0.25								
Lobatula lobatula			0.99	1.2	6.7		10	4.34	1.78		0.93									
Miliolid sp1					1.92			4.34												
Miliolid sp2								4.34												
Miliolid sp3				0.24	4.8		25	8.7	8	13.33										
Miliolid sp4				1.44	1		15		2.68	20	0.93									
Miliolid sp5				9.61					6.25		1.54									
Miliolid sp6											0.93									
Miliolid sp7					9.6				0.9		2.16									
Miliolid sp8				0.24					0.9											
Nonion boueanum					1.92															
Nonion sp.				0.96					1.78											
Nonionella sp.				0.5								0.5								
Pararotalia cf. *spinigera*											10									
Planorbulina mediterranensis				7.45	7.7				9	6.67	0.62									
Rosalina globularis			1.98	0.24					0.9											
Rosalina vilardeboana				1.7																
Textularia sp.				0.24	1.92			8.7	1.78	6.67										
Trochammina inflata	14.05	14.75				50														
Trochammina spp. (linings)	48.7	37.7		0.24								1.25	100	100	100	100	100	100	100	
Uvigerina sp.				0.72					0.9											
Planktic			0.99	2.16	1.92	25			0.9		0.62	1								
Indeterminate			10.9	2.88	3.84	12.5		8.7	4.46	6.67	3.71	23.6								
calcareous			100	99.52	98.08	50	100	91.30	98.21	93.33	100	98.74								
Agglutinated	100	100		0.48	1.92	50		8.70	1.79	6.67		1.26	100	100	100	100	100	100	100	
Porcelaneous				12.26	17.31		40	17.39	18.75	33.33	7.12									

samples without statistical meaning

Table IX - Absolute frequencies of the foraminifera taxa found in CM5 borehole. Cells in grey represent samples without statistical meaning

Depth (cm)	111	190	295	333	425	455	553	578	605	670	710	853	890	977	997	1076	1317	1345	1400	1585	1610	1675	1705	1795	1865	1905	1970	2010	2065	2095	2135	2157	2210	2270	2318	2338	2408	2425	2790	2845	3060
Total counted nº of foraminifera	0	45	70	206	166	67	459	444	356	13	111	51	2337	689	328	752	994	1405	634	330	94	107	927	633	33	92	300	74	162	109	39	395	207	555	59	48	33	30	57	46	270
Estimation of the total nº/20 cc		360	374	1098	886	358	7344	3552	2848	208	888	816	37392	11024	5248	12032	15904	22480	10144	2640	752	856	14832	10128	528	736	2400	592	1296	582	312	3160	1656	4440	472	384	1056	320	456	368	2160
Taxa		4	3	3	6	4	8	11	4	3	3	3	18	14	13	13	18	16	11	6	5	3	11	12	3	2	4	1	1	4	1	1	3	3	1	2	1	1	1	1	1
Ammobaculites sp.		6			5	2	1		25		2	5	30	7	2	20	28	4	16	99	46	28	23	9	1																
Ammonia aberdoveyensis							265	273	61				996	202	97	344	477	661	369	47			285	187			124			29											
Asterigerinata mamilla								2					28	9			9	7						4																
Bolivina ordinaria								1					44	6	2	6	43	73	1				14	10																
Bolivina striatula													11	3		6	12	39	1				2																	
Bulimina sp.								1											1																					
Buliminella elegantissima													1			2	15	20						1																
Discorbis sp.								1					3		3		4																							
Elphidium oceanensis													45	20	9		19	1					7																	
Elphidium poeyamn													32	18	1	35	45	39	48				50	20																
Elphidium sp.							34	20										3		2																				
Elphidium williamsoni													34	8	5	14	10	4	1																				
Fissurina sp.													110	23	15	6	26	35	3				18	22																
Haynesina depressula																	1																							
Haynesina germanica					2		40	63		4			654	318	136	248	161	184	119	11			442	264			134			50										
Jadammina macrescens		4	25	110	48	35	11	2								1					1												5	25		2					
Miliammina fusca													1																											
Nonion sp.													5				18	15																						
Quinqueloculina seminulum																	1																							
Rosalina spp.																								8																
Trochammina inflata		8	17	41	14	13	11	6						1	1	2					1												3	2							
Trochammina spp. (linings)		27	28	55	96	17	7	23	143	5	62	19	11	12	9	20	19		5	132	45	74	13	17	24	83	12	74	162	20	39	395	199	528	59	46	33	30	57	46	270
calcareous tests in dissolution							90	52	127	4	47	27								39					8	9	30			10										
Calcareous indeterminate					1								328	61	47	48	104	304	70		1	5	71	85																
Agglutinated indeterminate													2				2																							
Miliolids													2	1	1			9																						
Planktic																		7					2	6																
calcareous					3		429	413	188	8	47	27	2293	669	316	79	945	141	613	99	1	5	891	67	8	9	288			89											
Agglutinated		45	7	26	163	67	3	31	168	5	64	24	44	2	12	43	49	4	21	231	93	12	36	26	25	83	12	74	162	2	39	395	27	555	59	48	33	3	57	46	27
Porcelaneous													2	1	1		1	9																						

Depth (cm)	3120	3140	3235	3260	3318	3340	3383	3420	3467	3535	3555	3625	3655	3710	3754	3810	3912	3934	3965	4030	4095	4105	4120	4182	4244	4265	4280	4390	4470	4490	4513	4606	4675	4685	4700	4730	4750	4780	4810	4831-4836	4850
Total counted nº of foraminifera	291	214	193	76	75	151	408	237	251	0	0	0	22	0	0	509	136	0	289	637	0	0	0	273	0	90	2800	0	416	0	0	0	0	0	0	0	0	0	0	0	0
Estimation of the total nº/20 cc	2328	1712	1544	1216	600	1208	3264	1896	2008	0	0	0	44	0	0	8144	1088	0	2312	10192	0	0	0	4368	0	720	44800	0	3328	0	0	0	0	0	0	0	0	0	0	0	0
Taxa	2	2	1	1	1	1	1	1	2				3			1	1		1	2				1		1	2		2												
Ammobaculites sp.																																									
Ammonia aberdoveyensis																																									
Asterigerinata mamilla																																									
Bolivina ordinaria																																									
Bolivina striatula																																									
Bulimina sp.																																									
Buliminella elegantissima																																									
Discorbis sp.																																									
Elphidium oceanensis																																									
Elphidium poeyamn																																									
Elphidium sp.																																									
Elphidium williamsoni																																									
Fissurina sp.																																									
Haynesina depressula																																									
Haynesina germanica																																									
Jadammina macrescens	11	7							2				2																												
Miliammina fusca																																									
Nonion sp.																																									
Quinqueloculina seminulum																																									
Rosalina spp.																																									
Trochammina inflata													2							1							7		4												
Trochammina spp. (linings)	280	207	193	76	4	151	408	237	249				18			509	136		289	636				273		90	2793		412												
calcareous tests in dissolution																																									
Calcareous indeterminate																																									
Agglutinated indeterminate																																									
Miliolids																																									
Planktic																																									
calcareous																																									
Agglutinated	291	214	193	76	75	151	48	237	251				22			59	136		289	637				273		9	28		416												
Porcelaneous																																									

Table X - Relative frequencies of the foraminifera taxa found in CM5 borehole. Cells in grey represent samples without statistical meaning.

Depth (cm)	111	190	295	333	425	455	553	578	605	670	710	853	890	977	997	1076	1317	1345	1400	1585	1610	1675	1705	1795	1865	1905	1970	2010	2065	2095	2135	2157	2210	2270	2318	2338	2408	2425	2790	2845	3060
Total counted nº of foraminifera	0	45	70	206	166	67	459	444	356	13	111	51	2337	689	328	752	994	1405	634	330	94	107	927	633	33	92	300	74	162	109	39	395	207	555	59	48	33	30	57	46	270
Estimation of the total nº/20 cc		360	374	1098	886	358	7344	3552	2848	208	888	816	37392	11024	5248	12032	15904	22480	10144	2640	752	856	14832	10128	528	736	2400	592	1296	582	312	3160	1656	4440	472	384	1056	320	456	368	2160
Taxa		4	3	3	6	4	8	11	4	3	3	3	18	14	13	13	18	16	11	6	5	3	11	12	3	2	4	1	1	4	1	1	3	3	1	2	1	1	1	1	1
Ammobaculites sp.		13.3			3	3	0.22		7.02		1.8	10	1.28	1.01	0.61	2.66	2.81	0.3	2.52	30	49	26.17	2.5	1.42	3.03																
Ammonia aberdoveyensis							57.73	61.5	17.13				42.6	29.31	29.6	45.74	48	47.04	58.2	14.24			30.74	29.54			41.33			26.6												
Asterigerinata mamilla								0.44					1.2	1.3			0.9	0.5						0.63																	
Bolivina ordinaria								0.22					2	0.87	0.61	0.8	4.32	5.2	0.15				1.51	1.58																	
Bolivina striatula													0.47	0.43		0.8	1.2	2.77	0.15				0.21																	
Bulimina sp.								0.22											0.15																						
Buliminella elegantissima													0.04			0.26	1.5	1.42						0.16																
Discorbis sp.								0.22					0.13		0.91		0.4																								
Elphidium oceanensis													1.92	3	2.74		1.91	0.07					0.75																	
Elphidium poeyamn													1.37	2.6	0.3	4.65	4.52	2.77	7.57				5.4	3.16																	
Elphidium sp.							7.4	4.5										0.21		0.6																					
Elphidium williamsoni													1.45	1.16	1.52	1.86	1	0.3	0.15																						
Fissurina sp.													4.7	3.34	4.6	0.8	2.61	2.5	0.47				1.94	3.47																	
Haynesina depressula																	0.1																								
Haynesina germanica					1.2		8.71	14.2		30.77			28	46.15	41.46	33	16.3	13.1	18.8	3.33			47.7	41.7			44.7			46											
Jadammina macrescens		8.9	35.7	53.4	29	52.24	2.4	0.44								0.13					1.06												2.41	4.5		4.2				
Miliammina fusca													0.04																												
Nonion sp.													0.21				1.81	1.06																						
Quinqueloculina seminulum																	0.1																								
Rosalina spp.																								1.26																	
Trochammina inflata		17.8	24.3	20	8.43	19.4	2.4	1.35						0.14	0.3	0.26					1.06												1.45	0.36							
Trochammina spp. (linings)		60.02	40	26.6	57.8	25.37	1.52	5.2	40.16		55.85		0.47	1.74	2.74	2.66	1.91		0.8	40	48	69.16	1.4	2.7		90.23	4	100	100	18.3	100	100	96.16	95.13	100	95.8	100	100	100	100	100
calcareous tests in dissolution							19.6	11.7	35.7	30.77	42.34	53								11.81					24.24	9.78	10			9.17											
Calcareous indeterminate					0.6								14.03	8.85	14.33	6.4	10.46	21.63	11.04		1.06	4.67	7.66	13.43																	
Agglutinated indeterminate													0.08				0.2																								
Miliolids													0.08	0.14	0.3			0.64																							
Planktic																		0.5					0.21	0.95																	
calcareous					1.87		93.46	93.18	52.89	61.54	42.34	52.00	98.1	98.0	96.3	94.3	95.7	99.7	96.7	3	1.64	4.67	96.1	95.9	24.24	9.78	96			81.65											
Agglutinated		100	100	100	98.19	100	6.54	6.98	47.19	38.46	57.66	47.59	1.9	2.9	3.7	5.7	4.9	0.3	3.3	7	98.94	95.33	3.9	4.2	75.76	9.22	4	100	100	18.35	100	100	100	100	100	100	100	100	100	100	100
Porcelaneous													0.9	0.1	0.3		0.2	0.6																							

Depth (cm)	3120	3140	3235	3260	3318	3340	3383	3420	3467	3535	3555	3625	3655	3710	3754	3810	3912	3934	3965	4030	4095	4105	4120	4182	4244	4265	4280	4390	4470	4490	4513	4606	4675	4685	4700	4730	4750	4780	4810	4831-4836	4850
Total counted nº of foraminifera	291	214	193	76	75	151	408	237	251	0	0	0	22	0	0	509	136	0	289	637	0	0	0	273	0	90	2800	0	416	0	0	0	0	0	0	0	0	0	0	0	0
Estimation of the total nº/20 cc	2328	1712	1544	1216	600	1208	3264	1896	2008	0	0	0	44	0	0	8144	1088	0	2312	10192	0	0	0	4368	0	720	44800	0	3328	0	0	0	0	0	0	0	0	0	0	0	0
Taxa	2	2	1	1	1	1	1	1	2				3			1	1		1	2				1		1	2		2												
Ammobaculites sp.																																									
Ammonia aberdoveyensis																																									
Asterigerinata mamilla																																									
Bolivina ordinaria																																									
Bolivina striatula																																									
Bulimina sp.																																									
Buliminella elegantissima																																									
Discorbis sp.																																									
Elphidium oceanensis																																									
Elphidium poeyamn																																									
Elphidium sp.																																									
Elphidium williamsoni																																									
Fissurina sp.																																									
Haynesina depressula																																									
Haynesina germanica																																									
Jadammina macrescens	3.8	3.3							0.8				9.1																													
Miliammina fusca																																									
Nonion sp.																																									
Quinqueloculina seminulum																																									
Rosalina spp.																																									
Trochammina inflata													9.1							0.2							0.3		1												
Trochammina spp. (linings)	96.2	96.7	100	100	100	100	100	100	99.2							100	100		100	99.8				100	0	100	99.7		99											
calcareous tests in dissolution																																									
Calcareous indeterminate																																									
Agglutinated indeterminate																																									
Miliolids																																									
Planktic																																									
calcareous																																									
Agglutinated	100	100	100	100	100	100	100	100	100				100			100	100		100	100				100		100	100		100												
Porcelaneous																																									

Table XI - Base data set of the foraminifera fossil assemblages in CM3 borehole.

Depth (cm)	190	380	480	625	690	1351	1643	1815	2100	2240	2892	3063
Ammobaculites sp.	26.47	44.26										
Ammonia aberdoveyensis			49	9.85	17.3	17.85	28.8	24.6				
Asterigerinata mamilla				29.1	5.8	15.18	8.67	1.25				
Bolivina ordinaria				3.1			3.4	5.52				
E. discoidale					7.7	4.46						
E. oceanensis								2.3				
Haynesina germanica			18.6	10.1	11.5	1.78	26	37.43				
Jadammina macrescens	10.78	3.28										
Lobatula lobatula			0.9	1.2	6.7	1.78	0.93					
Pararotalia cf. spinigera							10					
Trochammina inflata	14.05	14.75										
Trochammina sp. (linings)	48.7	37.7		0.24				1.25	100	100	100	100
Miliolids				11.53	17.32	18.73	5.56					
Planktic			0.9	2.16	1.92	0.9	0.62	1				
Σ exotic agglutinated <10%				0.24	1.92	1.78						
Σ exotic calcareous <10%			13.8	28.64	25.96	33.13	9.57	3.05				
Σ indigenous calcareous <10%			6	0.96			2.78					

Table XII - Base data set of the foraminifera fossil assemblages in CM5 borehole.

Depth (cm)	**190**	**295**	**333**	**425**	**455**	**553**	**578**	**605**	**710**	**890**	**977**	**997**	**1076**	**1317**	**1345**	**1400**	**1585**	**1610**	**1675**	**1705**	**1795**	**1905**	**1970**	**2010**	**2065**	**2095**	**2135**
Ammobaculites sp.	13.3			3	3	0.22		7.02	1.8	1.28	1.01	0.61	2.66	2.81	0.3	2.52	30	49	26.17	2.5	1.42						
Ammonia aberdoveyensis						57.73	61.5	17.13		42.6	29.31	29.6	45.74	48	47.04	58.2	14.24			30.74	29.54		41.33			26.6	
Bolivina ordinaria							0.22			2	0.87	0.61	0.8	4.32	5.2	0.15				1.51	1.58						
Asterigerinata mamilla							0.44			1.2	1.3			0.9	0.5						0.63						
E. oceanensis										1.92	3	2.74		1.91	0.07					0.75							
Haynesina germanica				1.2		8.71	14.2			28	46.15	41.46	33	16.3	13.1	18.8	3.33			47.7	41.7		44.7			46	
Miliammina fusca										0.04																	
Trochammina inflata	17.8	24.3	20	8.43	19.4	2.4	1.35				0.14	0.3	0.26					1.06									
Jadammina macrescens	8.9	35.7	53.4	29	52.24	2.4	0.44						0.13					1.06									
Trochammina sp. (linings)	60.02	40	26.6	57.8	25.37	1.52	5.2	40.16	55.85	0.47	1.74	2.74	2.66	1.91		0.8	40	48	69.16	1.4	2.7	90.23	4	100	100	18.3	100
Miliolids										0.08	0.14	0.3		0.1	0.64												
Planktic															0.5					0.21	0.95						
Σ exotic calcareous <10%						7.4	4.94			5.55	3.77	5.51	1.86	7.52	7.96	0.77	0.6			2.15	4.89						
Σ indigenous calcareous <10%										2.82	3.76	1.82	6.51	5.62	3.07	7.72				5.4	3.16						
Depth (cm)	**2157**	**2210**	**2270**	**2318**	**2338**	**2408**	**2425**	**2790**	**2845**	**3060**	**3120**	**3140**	**3235**	**3260**	**3318**	**3340**	**3383**	**3420**	**3467**	**3810**	**3912**	**3965**	**4030**	**4182**	**4265**	**4280**	**4470**
Ammobaculites sp.																											
Ammonia aberdoveyensis																											
Bolivina ordinaria																											
Asterigerinata mamilla																											
E. oceanensis																											
Haynesina germanica																											
Miliammina fusca																											
Trochammina inflata		1.45	0.36																				0.2			0.3	1
Jadammina macrescens		2.41	4.5		4.2						3.8	3.3							0.8								
Trochammina sp. (linings)	100	96.16	95.13	100	95.8	100	100	100	100	100	96.2	96.7	100	100	100	100	100	100	99.2	100	100	100	99.8	100	100	99.7	99
Miliolids																											
Planktic																											
Σ exotic calcareous <10%																											
Σ indigenous calcareous <10%																											

Table XIII – Foraminifera species with less than 10% representation in the living, total and fossil assemblages, organized in 4 artificial groups.

Σ Indigenous agglutinated <10%
Ammobaculites cf. *exigus*
Ammobaculites sp2
Ammotium cassis
Ammotium sp.
Ammovertellina sp.
Arenoparrella mexicana
Cribrostomoides crassimargo
Deuterammina eddystonensis
Eggerelloides scaber
Lepidodeuterammina ochracea
Portatrochammina sp.
Textularia earlandi
Tiphotrocha comprimata
Trochamminita cf. *irregularis*

Σ Indigenous calcareous <10%
Cornuspira involvens
Elphidium poeyamn
Elphidium williamsoni
Haynesina depressula
Helenina anderseni

Σ Exotic agglutinated <10%
Lepidodeuterammina plymouthensis
Leptohalysis scottii
Remaneica helgolandica
Septotrochammina gonzalezi
Septotrochammina plicata
Textularia sp.

Σ Exotic calcareous <10%
Ammonia beccarii
Amphicoryna sp.
Bolivina cf. *variabilis*
Bolivina pseudoplicata
Bolivina spp.
Bolivina striatula
Bulimina sp.
Buliminella elegantissima
Cassidulina sp.
Discorbinella sp.
Discorbis cf. *williamsoni*
Discorbis sp.
Elphidium advenum
Elphidium complanatum
Elphidium crispum
Elphidium excavatum
Elphidium incertum
Elphidium macelum var. *aculcatum*
Elphidium spp.
Epistominella sp.
Eponides cf. *lateralis*
Eponides sp.
Fissurina sp.
Glabratella sp.
Globulina gibba
Globulina sp.
Hopkinsina sp.
Lagena gracilima
Lamarckina haliotidea
Neoconorbina sp.
Nodosaria sp.
Nonion boueanum
Nonion fabum
Nonion sp.
Nonionella sp.
Oolina sp.
Parafissurina cf. *inaequalabiata*
Planorbulina mediterranensis
Porosononion granosum
Pulleria bulloides
reworked Elphidium
Rosalina globularis
Rosalina sp.
Rosalina vilardeboana
Rotalia sp.
Stainforthia sp.
Trifarina sp.
Uvigerina sp.
Valvulineria sp.

Table XIV – Faunistic density (Ni), number of species (S) and absolute and relative frequencies of thecamoebian and tintinnids total assemblage (living + dead) in winter samples. C% - species constancy.

Sample 20 cc	LAR		FO		Aouro		FB1		FB2		FB3		PI2		PI3		PI4		LEZ1		LEZ2		LEZ3		SCM		VRSA1		VRSA2		VRSA3		VRSA4		EE		E1		E2		E3		LG1		LG2		LG3		
Method (Division - D; Flotation - F)	D		D		D/F		D		D		D		D		D		D/F		D		D		D		D		D/F		D		D/F		D/F		F		F/D		F		F		D		D		F			
Total counted nº of individuals	680		246		467		38		264		431		124		582		1403				218		198		65				45		1090		527		167		36		27		279		1		10		11			
Estimation of the total nº/20 cc	10880		1968		7472		608		4224		6896		1984		4656		4196				3488		3168		1040				360		5814		2108		334		72		54		2232		64		80		88			
species	15		13		13		10		11		12		10		11		15				13		9		5				9		14		14		12		6		5		13		1		2		2			
live individuals (absolut/relative)	3	0.4							1	0.4	6	1.4					4	0.3																																		
frequency (A - absolut; relative - R)	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	C%
Arcella cf. *arenaria*	13	1.9	5	2.0	9	1.9			5	1.9											13	6.0	2	1.0					1	2.2	5	0.5	6	1.1																	53
Arcella sp.																															2	0.2																	6.6
Bullinularia cf. *Indica/Centropyxis orbicularis*	14	2.1	34	13.8	27	5.8			30	11.4	45	10.4	4	3.2	50	8.6	138	9.8			18	8.3	11	5.6					1	2.2	17	1.6	6	1.1	9	5.4	2	5.6	2	7.4	15	5.4							93.3
Centropyxis aculeata	115	16.9	32	13.0	99	21.2	13	34.2	40	15.2	116	26.9	19	15.3	143	24.6	313	22.3			42	19.3	11	5.6	11	16.9			2	4.4	149	13.7	55	10.4	44	26.3					61	21.9	1	100					100
Centropyxis arcula	233	34.3	82	33.3	147	31.5	7	18.4	61	23.1	123	28.5	36	29.0	159	27.3	467	33.3			45	20.6	34	17.2	16	24.6			6	13.3	292	26.8	124	23.5	45	26.9	7	19.4	8	29.6	62	22.2			4	40			100
Centropyxis constricta	108	15.9	19	7.7	39	8.4	2	5.3	23	8.7	18	4.2	13	10.5	21	3.6	68	4.8			29	13.3	5	5.1	1	1.5			1	2.2	87	8.0	21	4.0	9	5.4	2	5.6			7	2.5							100
Cyclopyxis sp.	1	0.1																																														6.6
Difflugia bidens																	3	0.2																																6.6
Difflugia corona	11	1.6	2	0.8							5	1.2					5	0.4			2	0.9											1	0.2	1	0.6					1	0.4							53
Difflugia oblonga	30	4.4	4	1.6	7	1.5	1	2.6	6	2.3	28	6.5	5	4.0	6	1.0	85	6.1			3	1.4									12	1.1	13	2.5	3	1.8			1	3.7	3	1.1							86.6
Difflugia protaeiformis	24	3.5	7	2.8	5	1.1					2	0.5			2	0.3	24	1.7			2	0.9									14	1.3	8	1.5	2	1.2					2	0.7							73.3
Difflugia urceolata	36	5.3	4	1.6	19	4.1	2	5.3	5	1.9	18	4.2	3	2.4	14	2.4	50	3.6			5	2.3	1	0.5							24	2.2	11	2.1	4	2.4					7	2.5							93.3
Lesquereusia sp.																	4	0.3																																6.6
Nebela penardiana					2	0.4	1	2.6									1	0.1																																20
Pontigulasia compressa	9	1.3																													2	0.2	1	0.2							2	0.7							26.6
Pyxidicula sp.	45	6.6	11	4.5	15	3.2	2	5.3	6	2.3	4	0.9	7	5.6	14	2.4	18	1.3			14	6.4							1	2.2	27	2.5	13	2.5	4	2.4					4	1.4							86.6
Indeterminate	23	3.4	9	3.7	30	6.4	1	2.6	7	2.7	8	1.9	5	4.0	9	1.5	41	2.9			2	0.9	6	3.0	36	55.4			6	13.3	38	3.5	13	2.5	1	0.6	1	2.8			2	0.7					1	9.1	100
Stenosemella ventricosa	11	1.6	21	8.5	54	11.6	7	18.4	70	26.5	56	13.0	28	22.6	139	23.9	143	10.2			42	19.3	115	58.1					25	55.6	395	36.2	243	46.1	42	25.2	19	52.8	15	55.6	110	39.4			6	60	10	90.9	93.3
Tintinnopsis cf. *lata*	7	1.0	16	6.5	14	3.0	2	5.3	11	4.2	8	1.9	4	3.2	25	4.3	43	3.1			1	0.5	8	4.0	1	1.5			2	4.4	26	2.4	12	2.3	3	1.8	5	13.9	1	3.7	3	1.1							100
total counted thecamoebians	662	97.4	209	84.9	399	85.5	29	76.3	183	69.3	431	85.1	92	74.2	418	71.8	1217	86.7			175	80.3	70	37.9	64	98.5			18	40.0	669	61.4	272	51.6	122	73.1	12	33.3	11	40.7	166	59.5	1	100	4	40	1	9.1	
total counted tintinnids	18	2.7	37	15.1	68	14.6	9	23.7	81	30.7	64	14.9	32	25.8	164	28.2	186	13.3			43	19.7	123	62.1	1	1.5			27	60.0	421	38.6	255	48.4	45	26.9	24	66.7	16	59.3	113	40.5			6	60	10	90.9	
thecamoebians/20cc	10592		1672		6385		464		2928		5871		1472		3343		3640		0		2800		1200		1024		0		144		3568		1088		244		24		22		1328		64		32		8		
tintinnids/20cc	288		296		1087		144		1296		1024		512		1312		556		0		688		1969		16		0		216		2245		1020		90		48		32		904		0		48		80		

Table XV – Faunistic density (Ni), number of species (S) and absolute and relative frequencies of thecamoebian and tintinnids total assemblage (living + dead) in summer samples. C% - species constancy.

Sample 20 cc	AL		LAR		FO		Aouro		FB1		FB2		FB3		PI1		PI2		PI3		PI4		LEZ1		LEZ2		LEZ3		SCM		VRSA1		VRSA2		VRSA3		VRSA4		EE		E1		E2		E3		LG1		LG2		LG3		
Method (Division - D; Flotation - F)	D		D		D		D/F		D		D		D		D		D		D		D/F		D		D		D		D		D/F		D		D/F		D/F		F		F/D		F		F		D		D		F		
Total counted nº of individuals	924		112		344		310		2		705		442		32		48		466		1007		6		203		374		0		0		61		494		408		51		36		66		45		4		11		17		
Estimation of the total nº/20 cc	7392		448		2752		827		64		5640		3536		512		1536		3728		7336		384		1624		2992		0		0		411		988		2610		204		198		66		180		32		88		34		
species	14		11		12		11		2		13		13		5		6		14		12		3		10		11						8		12		15		8		5		7		6		1		2		7		
live individuals (absolut/relative)	47	5.09	7	6.3	35	10.2	3	1.0	1	50	402	57.0	5	1.1					70	15.0	12	1.2			9	4.4	77	20.6					1	1.6	209	42.3	61	15.0	13	25.5	2	5.6	3	4.5	1	2.2	0	0	0	0	0	0	
frequency (A - absolut; relative - R)	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	A	R	C%
Arcella cf. *arenaria*	29	3.1	3	2.7	10	2.9	7	2.3			13	1.8	2	0.5					6	1.3	3	0.3			2	1	2	0.5					3	4.9	3	0.6	6	1.5															81.3
Arcella sp.			1	0.9	1	0.3													1	0.2																	2	0.5															25.0
Bullinularia cf. *Indica* /*Centropyxis orbicularis*	35	3.8	12	10.7	22	6.4	47	15.2			39	5.5	24	5.4	1	3.1	3	6.3	23	4.9	43	4.3			10	4.9	16	4.3					1	1.6	28	5.7	29	7.1	4	7.8	6	16.7	5	7.6	4	8.9					1	5.9	100
Centropyxis aculeata	209	22.6	12	10.7	25	7.3	76	24.5			44	6.2	46	10.4	6	18.8	1	2.1	36	7.7	68	6.8	3	50	11	5.4	12	3.2					7	11.5	14	2.8	22	5.4			1	2.8			1	2.2					3	17.6	87.5
Centropyxis arcula	114	12.3	31	27.7	54	15.7	83	26.8			78	11.1	62	14.0	1	3.1	13	27.1	72	15.5	137	13.6			24	11.8	46	12.3					8	13.1	83	16.8	57	14.0	16	31.4	9	25.0	27	40.9	10	22.2					4	23.5	100
Centropyxis constricta	403	43.6	9	8.0	36	10.5	14	4.5	1	50	35	5.0	17	3.8					30	6.4	18	1.8			3	1.5	11	2.9					2	3.3	26	5.3	17	4.2	4	7.8			3	4.6	1	2.2			1	9.1	1	5.9	93.8
Difflugia bidens																					2	0.2															2	0.5															6.3
Difflugia corona	2	0.2					1	0.3													2	0.2																															18.8
Difflugia oblonga	6	0.7	2	1.8							5	0.7	7	1.6					11	2.4	30	3.0			1	0.5									1	0.2	9	2.2	1	2.0			1	1.5									68.8
Difflugia protaeiformis	24	2.6			6	1.7					2	0.3	4	0.9					1	0.2	10	1.0			1	0.5	2	0.5							2	0.4	1	0.3													1	5.9	62.5
Difflugia urceolata	61	6.6	2	1.8	17	4.9	2	0.6			2	0.3	7	1.6					3	0.6	7	0.7					4	1.1					1	1.6	2	0.4	1	0.2	1	2.0			1	1.5									87.5
Pontigulasia compressa	2	0.2					1	0.3			1	0.1	1	0.2					2	0.4	1	0.1															1	0.2															43.8
Pyxidicula sp.	4	0.4			2	0.6					8	1.1	6	1.4					2	0.4					3	1.5	3	0.8							12	2.4	3	0.7															56.3
Indeterminate	20	2.2	2	1.8	8	2.3	5	1.6			13	1.8	4	0.9	1	3.1	2	4.2	4	0.9	16	1.6	1	16.7	3	1.5	10	2.7					12	19.7	4	0.8	6	1.5	1	2.0					1	2.2					2	11.8	93.8
Stenosemella ventricosa	10	1.1	31	27.7	147	42.7	67	21.6	1	50	390	55.3	254	57.5	23	71.9	23	47.9	241	51.7	640	63.6	2	33.3	144	70.9	255	68.2					27	44.3	308	62.4	243	59.6	21	41.2	19	52.8	28	42.4	28	62.2	4	100	10	90.9	5	29.4	100
Tintinnopsis cf. *lata*	5	0.5	7	6.3	16	4.7	7	2.3			75	10.6	8	1.8			6	12.5	34	7.3	32	3.2			1	0.5	13	3.5							11	2.2	9	2.2	3	5.9	1	2.8	1	1.5									93.8
total counted thecamoebians	909	98.4	74	66.1	181	52.6	236	76.1	1	50	240	34.0	180	40.7	9	28.1	19	39.6	191	41.0	335	33.3	4	66.7	58	28.6	106	28.3					34	55.7	175	35.4	156	38.2	27	53	16	44.4	37	56.1	17	37.8			1	9.1	12	70.6	
total counted tintinnids	15	1.6	38	33.9	163	47.4	74	23.9	1	50	465	66.0	262	59.3	23	71.9	29	60.4	275	59.0	672	66.7	2	33.3	145	71.4	268	71.7					27	44.3	319	64.6	252	61.8	24	47	20	55.6	29	43.9	28	62.2	4	100	10	90.9	5	29.4	
thecamoebians/20cc	7272		296		1448		630		32		1919		1441		144		608		1528		2443		256		465		848		0		0		229		350		998		108		88		37		68		0		8		24		
tintinnids/20cc	120		152		1304		197		32		3720		2096		368		928		2200		4893		128		1160		2144		0		0		182		638		1613		96		110		29		112		32		80		10		

Appendix 5

Table I – Ecological data calculated on foraminifera living assemblages of samples collected in winter and summer.

Winter					Summer				
Sample	**Hs**	**J'**	**c**	**A/C(%)**	**Sample**	**Hs**	**J'**	**c**	**A/C(%)**
LAR	1.423	0.794	0.303	91.176	**LAR**	1.242	0.896	0.330	66.667
FO	1.440	0.546	0.380	66.312	**FO**	1.672	0.761	0.270	51.923
Aouro	1.370	0.659	0.410	95.833	**Aouro**	2.189	0.830	0.160	65.333
FB1	0.229	0.331	0.880	100.000	**FB1**	0.000	0.000	1.000	100.000
FB2	2.108	0.744	0.170	39.485	**FB2**	1.542	0.524	0.370	84.454
FB3	2.315	0.773	0.150	50.000	**FB3**	1.176	0.473	0.450	65.697
					PI1	0.118	0.107	0.950	100.000
PI2	0.921	0.473	0.610	79.612	**PI2**	0.169	0.244	0.920	100.000
PI3	1.329	0.683	0.330	6.780	**PI3**	1.888	0.760	0.200	67.150
PI4	1.988	0.829	0.180	53.226	**PI4**	1.672	0.603	0.330	64.975
LEZ1	0.043	0.062	0.980	100.000	**LEZ1**	0.034	0.049	0.990	100.000
LEZ2	0.653	0.335	0.690	13.924	**LEZ2**	1.504	0.586	0.280	61.742
LEZ3	1.677	0.936	0.210	88.889	**LEZ3**	1.676	0.728	0.250	54.266
SCM	0.842	0.607	0.540	99.018	**SCM**	0.675	0.614	0.610	100.000
VRSA1	1.395	0.867	0.290	29.412	**VRSA1**	0.000	0.000	0.000	0.000
VRSA2	1.349	0.563	0.370	61.953	**VRSA2**	1.412	0.642	0.310	69.886
VRSA3	1.904	0.647	0.230	16.970	**VRSA3**	1.880	0.650	0.240	18.310
VRSA4	1.801	0.866	0.190	17.647	**VRSA4**	1.724	0.622	0.250	17.568
EE	2.343	0.845	0.140	34.000	**EE**	1.314	0.498	0.410	3.977
E1	1.080	0.492	0.420	94.675	**E1**	1.513	0.590	0.350	87.413
E2	1.414	0.789	0.440	6.667	**E2**	1.320	0.515	0.400	3.614
E3	1.891	0.682	0.250	14.634	**E3**	1.632	0.602	0.330	5.031
LG1	0.380	0.236	0.810	99.832	**LG1**	0.657	0.316	0.710	92.671
LG2	1.760	0.667	0.240	67.733	**LG2**	1.452	0.550	0.370	29.083
LG3	2.146	0.705	0.190	16.727	**LG3**	1.872	0.675	0.260	24.699

	samples without statistical meaning
Hs	Shannon diversity
J'	Pielou's Evenness
c	dominance index
A/C(%)	agglutinated/calcareous ratio (%)

Table II – Ecological data calculated on foraminifera modern total assemblages in winter and summer and on fossil foraminifera in CM3 and CM5 boreholes.

	Winter		Summer		CM3				CM5	
Sample	**Hs**	**A/C(%)**	**Hs**	**A/C(%)**	**Depth**	**Hs**	**A/C(%)**	**Depth**	**Hs**	**A/C(%)**
LAR	1.482	98.25	2.277	88.51	**190**	1.218	100	**190**	1.462	100
FO	1.454	84.80	2.505	59.44	**380**	1.123	100	**295**	1.078	100
Aouro	2.127	93.19	2.344	87.23	**480**	1.593	0	**333**	1.033	100
FB1	0.192	99.98	0.123	100.00	**625**	2.535	0.5	**425**	1.254	99.4
FB2	2.522	59.96	1.983	88.16	**690**	2.663	2	**455**	1.110	100
FB3	2.766	46.48	1.607	60.42	**1351**	2.805	0	**553**	1.304	3.92
PI1			0.214	99.12	**1643**	2.197	1.64	**578**	1.268	6.99
PI2	0.817	86.76	0.211	100.00	**1815**	1.583	100	**605**	1.481	47.18
PI3	2.683	40.31	2.182	77.26	**2100**	0.000	100	**710**	0.762	57.65
PI4	2.715	81.26	2.665	52.13	**2240**	0.000	100	**890**	1.610	1.87
LEZ1	0.172	99.79	0.176	99.13	**2892**	0.000	100	**977**	1.552	5.5
LEZ2	2.331	55.78	1.887	60.90	**3063**	0.000	100	**997**	1.564	3.65
LEZ3	1.552	96.88	1.971	75.32				**1076**	1.465	6.62
SCM	0.619	98.89	0.307	97.92				**1317**	1.879	4.92
VRSA1	2.859	8.74	2.751	0.00				**1345**	1.643	0.3
VRSA2	1.518	73.39	1.397	80.25				**1400**	1.265	3.32
VRSA3	2.733	48.63	2.483	38.34				**1585**	1.420	70
VRSA4	2.812	55.40	2.224	25.30				**1610**	0.847	99.12
EE	3.053	45.87	2.046	14.95				**1675**	0.749	95.33
E1	1.364	96.67	1.369	93.13				**1705**	1.425	3.9
E2	2.826	33.33	2.232	20.75				**1795**	1.585	4.12
E3	3.034	30.07	2.347	17.84				**1905**	0.526	90.23
LG1	0.407	99.54	0.721	97.46				**1970**	1.084	4
LG2	2.046	64.04	1.723	40.06				**2010**	0.281	100
LG3	2.204	10.01	2.400	25.31				**2065**	0.279	100
								2095	1.240	18.3
								2135	0.000	100
								2157	0.000	100
								2210	0.351	100
								2270	0.207	100
								2318	0.000	100
								2338	0.173	100
								2408	0.425	100
								2425	0.000	100
								2790	0.000	100
								2845	0.000	100
								3060	0.000	100
								3120	0.161	100
								3140	0.144	100
								3235	0.156	100
								3260	0.243	100
								3318	0.208	100
								3340	0.207	100
								3383	0.000	100
								3420	0.049	100
								3467	0.144	100
								3810	0.000	100
								3912	0.347	100
								3965	0.000	100
								4030	0.012	100
								4182	0.000	100
								4265	0.000	100
								4280	0.017	100
								4470	0.054	100

Hs - Shannon diversity
A/C(%) - Agglutinated/calcareous ratio (%)

Appendix 6

Table I - Main sedimentological parameters calculated on winter samples

Sample	Elev MSL (m)	gravel	sand	mud	Granulometric mean (μm)	Sorting	Skewness	Kurtosis
LAR	0.311	0.000	0.247	0.753	16.232	5.403	-0.039	0.854
FO	0.334	0.000	0.318	0.682	20.374	5.630	-0.194	0.817
Aouro	0.532	0.000	0.158	0.842	11.008	5.187	0.054	0.991
FB1	1.432	0.000	0.104	0.896	9.710	4.319	-0.009	1.044
FB2	0.752	0.000	0.095	0.905	8.764	4.443	0.000	0.973
FB3	0.471	0.000	0.165	0.835	10.781	5.328	0.032	0.889
PI2	1.198	0.000	0.053	0.947	7.164	4.000	-0.063	1.005
PI3	0.614	0.000	0.224	0.776	13.582	5.472	-0.041	0.811
PI4	0.011	0.000	0.359	0.641	21.725	5.940	-0.227	0.782
LEZ1	1.317	0.000	0.054	0.946	7.343	3.795	-0.070	1.090
LEZ2	1.062	0.000	0.055	0.945	7.053	4.024	-0.042	1.010
LEZ3	0.202	0.000	0.070	0.930	7.907	4.245	-0.039	0.964
SCM	1.960	0.000	0.039	0.961	6.628	3.735	-0.090	1.015
VRSA1	1.210	0.007	0.924	0.068	278.161	1.895	-0.110	1.613
VRSA2	1.030	0.000	0.063	0.937	7.531	3.952	-0.050	1.101
VRSA3	0.290	0.000	0.672	0.328	78.116	5.627	-0.618	1.216
VRSA4	-0.470	0.000	0.825	0.175	149.035	3.216	-0.539	2.185
EE	-0.743	0.043	0.766	0.192	114.281	3.848	-0.130	2.885
E1	0.574	0.005	0.904	0.091	287.967	1.975	-0.177	1.867
E2	-0.066	0.073	0.874	0.053	219.969	2.312	0.160	2.259
E3	-0.743	0.000	0.680	0.320	66.657	4.501	-0.588	1.303
LG1	0.397	0.000	0.054	0.946	5.677	3.522	0.065	1.392
LG2	0.167	0.000	0.390	0.610	25.520	9.324	0.191	0.678
LG3	-0.090	0.000	0.596	0.404	77.102	8.930	-0.641	0.742

Table II - Main sedimentological parameters calculated on summer samples

Sample	Elev MSL (m)	gravel	sand	mud	Granulometric mean (μm)	Sorting	Skewness	Kurtosis
AL	0.209	0.0000	0.0890	0.9110	10.103	4.192	-0.095	1.091
LAR	0.311	0.0000	0.8476	0.1524	141.829	2.542	-0.526	2.424
FO	0.334	0.0000	0.3238	0.6762	20.060	6.524	0.012	0.749
Aouro	0.532	0.0000	0.1512	0.8488	10.816	5.089	-0.026	0.902
FB1	1.432	0.0000	0.0862	0.9138	8.857	4.271	-0.061	1.011
FB2	0.752	0.0000	0.0947	0.9053	8.261	4.546	0.003	0.956
FB3	0.471	0.0000	0.1929	0.8071	12.656	5.233	-0.028	0.850
PI1	1.188	0.0000	0.0396	0.9604	6.552	3.686	-0.091	1.036
PI2	1.198	0.0000	0.0673	0.9327	8.177	4.011	-0.031	1.016
PI3	0.614	0.0000	0.1861	0.8139	11.898	5.281	-0.054	0.818
PI4	0.011	0.0000	0.6012	0.3988	41.391	5.245	-0.611	1.009
LEZ1	1.317	0.0000	0.0337	0.9663	6.527	3.459	-0.119	1.053
LEZ2	1.062	0.0000	0.0724	0.9276	8.423	4.208	-0.068	0.961
LEZ3	0.202	0.0000	0.3067	0.6933	20.632	5.183	-0.322	0.828
SCM	1.96	0.0000	0.0378	0.9622	6.444	3.860	-0.115	0.978
VRSA1	1.21	0.0053	0.9401	0.0546	201.996	1.698	-0.101	1.528
VRSA2	1.03	0.0000	0.0219	0.9781	6.451	3.534	-0.137	0.978
VRSA3	0.29	0.0000	0.4218	0.5782	32.625	4.590	-0.480	1.158
VRSA4	-0.47	0.0000	0.7747	0.2253	101.939	3.432	-0.609	1.848
EE	-0.743	0.0542	0.8592	0.0866	248.502	4.374	-0.013	1.343
E1	0.574	0.0013	0.5490	0.4497	47.248	7.269	-0.346	0.854
E2	-0.066	0.0190	0.8620	0.1191	176.132	3.118	-0.448	3.234
E3	-0.743	0.0000	0.8246	0.1754	125.182	2.575	-0.483	1.834
LG1	0.397	0.0000	0.0236	0.9764	5.806	3.334	-0.140	1.021
LG2	0.167	0.0000	0.2374	0.7626	15.832	5.224	-0.110	0.836
LG3	-0.09	0.0000	0.5094	0.4906	41.500	6.820	-0.581	0.689

Table III – GRADISTAT data from winter samples.

	SAMPLE NAME	LG1	LG2	LG3	VRSA1	VRSA2	VRSA3	VRSA4	SCM
	SAMPLE TYPE:	Unimodal, Poorly Sorted	Bimodal, Very Poorly Sorted	Unimodal, Very Poorly Sorted	Bimodal, Moderately Sorted	Bimodal, Poorly Sorted	Bimodal, Very Poorly Sorted	Unimodal, Poorly Sorted	Bimodal, Poorly Sorted
	TEXTURAL GROUP:	Fine Silt	Medium Sandy Fine Silt	Fine Silty Medium Sand	Slightly Very Fine Gravelly Medium Sand	Medium Silt	Very Coarse Silty Fine Sand	Very Coarse Silty Fine Sand	Medium Silt
	SEDIMENT NAME:	Mud	Sandy Mud	Muddy Sand	Slightly Gravelly Sand	Mud	Muddy Sand	Muddy Sand	Mud
FOLK AND WARD METHOD (μm)	MEAN	5.677	25.520	77.102	278.161	7.531	78.116	149.035	6.628
	SORTING	3.522	9.324	8.930	1.895	3.952	5.627	3.216	3.735
	SKEWNESS	0.065	0.191	-0.641	-0.110	-0.050	-0.618	-0.539	-0.090
	KURTOSIS	1.392	0.678	0.742	1.613	1.101	1.216	2.185	1.015
FOLK AND WARD METHOD (ϕ)	MEAN	7.461	5.292	3.697	1.846	7.053	3.678	2.746	7.237
	SORTING	1.816	3.221	3.159	0.922	1.983	2.492	1.685	1.901
	SKEWNESS	-0.065	-0.191	0.641	0.110	0.050	0.618	0.539	0.090
	KURTOSIS	1.392	0.678	0.742	1.613	1.101	1.216	2.185	1.015
FOLK AND WARD METHOD (Description)	MEAN:	Fine Silt	Coarse Silt	Very Fine Sand	Medium Sand	Fine Silt	Very Fine Sand	Fine Sand	Fine Silt
	SORTING:	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Moderately Sorted	Poorly Sorted	Very Poorly Sorted	Poorly Sorted	Poorly Sorted
	SKEWNESS:	Symmetrical	Coarse Skewed	Very Fine Skewed	Fine Skewed	Symmetrical	Very Fine Skewed	Very Fine Skewed	Symmetrical
	KURTOSIS:	Leptokurtic	Platykurtic	Platykurtic	Very Leptokurtic	Mesokurtic	Leptokurtic	Very Leptokurtic	Mesokurtic
	MODE 1 (μm):	6.159	280.317	280.317	302.500	9.738	280.317	280.317	8.359
	MODE 2 (μm):		7.175		53.500	0.985	52.247		0.985
	MODE 3 (μm):								
	MODE 1 (ϕ):	7.347	1.839	1.839	1.747	6.686	1.839	1.839	6.907
	MODE 2 (ϕ):		7.127		4.247	9.992	4.263		9.992
	MODE 3 (ϕ):								
	D10 (μm):	1.276	1.632	2.338	132.979	1.153	4.498	25.050	1.048
	D50 (μm):	5.845	16.735	222.431	275.611	8.059	166.627	204.391	7.239
	D90 (μm):	23.825	583.577	1184.833	545.778	40.988	337.560	378.987	33.371
	(D90 / D10) (μm):	18.672	357.615	506.805	4.104	35.562	75.043	15.129	31.833
	(D90 - D10) (μm):	22.549	581.946	1182.495	412.798	39.836	333.062	353.937	32.323
	(D75 / D25) (μm):	4.074	58.088	38.439	1.928	5.696	7.182	2.510	5.739
	(D75 - D25) (μm):	8.730	269.628	318.172	184.974	15.230	223.809	164.443	13.575
	D10 (ϕ):	5.391	0.777	-0.245	0.874	4.609	1.567	1.400	4.905
	D50 (ϕ):	7.419	5.901	2.169	1.859	6.955	2.585	2.291	7.110
	D90 (ϕ):	9.614	9.259	8.741	2.911	9.761	7.796	5.319	9.898
	(D90 / D10) (ϕ):	1.783	11.917	-35.722	3.332	2.118	4.976	3.800	2.018
	(D90 - D10) (ϕ):	4.223	8.482	8.985	2.037	5.152	6.230	3.919	4.992
	(D75 / D25) (ϕ):	1.315	4.141	4.262	1.686	1.436	2.464	1.710	1.425
	(D75 - D25) (ϕ):	2.027	5.860	5.265	0.947	2.510	2.844	1.328	2.521
	% GRAVEL:	0.00%	0.00%	0.00%	0.73%	0.00%	0.00%	0.00%	0.00%
	% SAND:	5.39%	39.05%	59.62%	92.43%	6.30%	67.22%	82.50%	3.89%
	% MUD:	94.61%	60.95%	40.38%	6.84%	93.70%	32.78%	17.50%	96.11%
	% V COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% FINE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V FINE GRAVEL:	0.00%	0.00%	0.00%	0.73%	0.00%	0.00%	0.00%	0.00%
	% V COARSE SAND:	0.00%	0.00%	0.00%	1.80%	0.00%	0.00%	0.00%	0.00%
	% COARSE SAND:	0.00%	0.00%	0.00%	9.07%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM SAND:	1.35%	29.95%	44.17%	46.47%	0.69%	27.95%	33.88%	0.13%
	% FINE SAND:	3.22%	8.77%	14.88%	33.43%	2.43%	29.61%	37.88%	1.03%
	% V FINE SAND:	0.83%	0.33%	0.57%	1.66%	3.18%	9.65%	10.75%	2.72%
	% V COARSE SILT:	2.18%	3.62%	2.80%	5.18%	7.49%	9.33%	6.40%	7.09%
	% COARSE SILT:	9.45%	8.44%	5.55%	0.23%	15.76%	4.54%	2.43%	15.45%
	% MEDIUM SILT:	21.64%	13.43%	8.13%	0.11%	21.44%	4.75%	2.04%	21.18%
	% FINE SILT:	26.39%	14.00%	8.78%	0.16%	19.78%	5.12%	2.33%	20.19%
	% V FINE SILT:	18.61%	9.80%	6.52%	0.09%	13.02%	3.62%	1.64%	14.09%
	% CLAY:	16.33%	11.67%	8.60%	1.07%	16.21%	5.43%	2.65%	18.10%

	SAMPLE NAME	EE	E1	E2	E3	LEZ1	LEZ2	LEZ3	PI1
	SAMPLE TYPE:	Bimodal, Poorly Sorted	Unimodal, Moderately Sorted	Bimodal, Poorly Sorted	Unimodal, Very Poorly Sorted	Bimodal, Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Poorly Sorted
	TEXTURAL GROUP:	Slightly Very Fine Gravelly Very Coarse Silty Very Fine Sand	Slightly Very Fine Gravelly Medium Sand	Very Fine Gravelly Fine Sand	Very Coarse Silty Fine Sand	Medium Silt	Fine Silt	Medium Silt	Medium Silt
	SEDIMENT NAME:	Slightly Gravelly Muddy Sand	Slightly Gravelly Sand	Gravelly Sand	Muddy Sand	Mud	Mud	Mud	Mud
FOLK AND WARD METHOD (μm)	MEAN	114.281	287.967	219.969	66.657	7.343	7.053	7.907	7.164
	SORTING	3.848	1.975	2.312	4.501	3.795	4.024	4.245	4.000
	SKEWNESS	-0.130	-0.177	0.160	-0.588	-0.070	-0.042	-0.039	-0.063
	KURTOSIS	2.885	1.867	2.259	1.303	1.090	1.010	0.964	1.005
FOLK AND WARD METHOD (ϕ)	MEAN	3.129	1.796	2.185	3.907	7.090	7.148	6.983	7.125
	SORTING	1.944	0.982	1.209	2.170	1.924	2.009	2.086	2.000
	SKEWNESS	0.130	0.177	-0.160	0.588	0.070	0.042	0.039	0.063
	KURTOSIS	2.885	1.867	2.259	1.303	1.090	1.010	0.964	1.005
FOLK AND WARD METHOD (Description)	MEAN:	Very Fine Sand	Medium Sand	Fine Sand	Very Fine Sand	Fine Silt	Fine Silt	Medium Silt	Fine Silt
	SORTING:	Poorly Sorted	Moderately Sorted	Poorly Sorted	Very Poorly Sorted	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Poorly Sorted
	SKEWNESS:	Fine Skewed	Fine Skewed	Coarse Skewed	Very Fine Skewed	Symmetrical	Symmetrical	Symmetrical	Symmetrical
	KURTOSIS:	Very Leptokurtic	Very Leptokurtic	Very Leptokurtic	Leptokurtic	Mesokurtic	Mesokurtic	Mesokurtic	Mesokurtic
	MODE 1 (μm):	152.500	302.500	215.000	177.285	9.738	7.175	8.359	8.359
	MODE 2 (μm):	2400.000		2400.000		0.985	0.846	0.985	0.846
	MODE 3 (μm):								
	MODE 1 (ϕ):	2.737	1.747	2.237	2.500	6.686	7.127	6.907	6.907
	MODE 2 (ϕ):	-1.243		-1.243		9.992	10.212	9.992	10.212
	MODE 3 (ϕ):								
	D10 (μm):	20.362	72.953	95.422	4.873	1.155	1.044	1.085	1.046
	D50 (μm):	120.363	285.749	214.789	114.481	7.927	7.379	8.140	7.641
	D90 (μm):	599.791	547.190	683.947	254.426	37.540	40.840	49.743	40.338
	(D90 / D10) (μm):	29.457	7.501	7.168	52.214	32.492	39.112	45.856	38.572
	(D90 - D10) (μm):	579.429	474.237	588.526	249.553	36.384	39.796	48.658	39.292
	(D75 / D25) (μm):	2.450	1.906	1.966	4.847	5.471	6.353	7.210	6.334
	(D75 - D25) (μm):	103.868	186.865	149.664	151.165	14.482	15.425	18.817	15.731
	D10 (ϕ):	0.737	0.870	0.548	1.975	4.735	4.614	4.329	4.632
	D50 (ϕ):	3.055	1.807	2.219	3.127	6.979	7.082	6.941	7.032
	D90 (ϕ):	5.618	3.777	3.390	7.681	9.757	9.903	9.848	9.901
	(D90 / D10) (ϕ):	7.618	4.342	6.185	3.890	2.061	2.146	2.275	2.138
	(D90 - D10) (ϕ):	4.881	2.907	2.841	5.706	5.022	5.290	5.519	5.270
	(D75 / D25) (ϕ):	1.515	1.691	1.569	1.952	1.421	1.462	1.517	1.464
	(D75 - D25) (ϕ):	1.293	0.931	0.975	2.277	2.452	2.667	2.850	2.663
	% GRAVEL:	4.26%	0.48%	7.34%	0.00%	0.00%	0.00%	0.00%	0.00%
	% SAND:	76.57%	90.45%	87.38%	68.03%	5.45%	5.47%	6.95%	5.26%
	% MUD:	19.17%	9.07%	5.28%	31.97%	94.55%	94.53%	93.05%	94.74%
	% V COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% FINE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V FINE GRAVEL:	4.26%	0.48%	7.34%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V COARSE SAND:	3.60%	1.63%	1.50%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE SAND:	2.82%	9.61%	2.60%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM SAND:	4.73%	50.21%	23.38%	10.86%	0.54%	0.50%	0.01%	0.39%
	% FINE SAND:	32.66%	25.72%	50.67%	35.43%	1.94%	1.61%	1.19%	1.47%
	% V FINE SAND:	32.77%	3.27%	9.23%	21.73%	2.97%	3.37%	5.75%	3.40%
	% V COARSE SILT:	6.06%	5.11%	1.29%	9.15%	7.16%	8.61%	10.78%	8.79%
	% COARSE SILT:	4.20%	2.00%	0.06%	4.78%	15.91%	14.79%	15.04%	15.50%
	% MEDIUM SILT:	1.40%	0.02%	1.30%	4.74%	21.95%	19.43%	18.36%	19.80%
	% FINE SILT:	2.04%	0.63%	0.64%	4.73%	20.20%	19.62%	18.24%	19.30%
	% V FINE SILT:	1.47%	0.04%	0.07%	3.50%	13.17%	14.06%	13.26%	13.55%
	% CLAY:	3.99%	1.26%	1.92%	5.08%	16.16%	18.01%	17.37%	17.81%

	SAMPLE NAME	PI3	PI4	FB1	FB2	FB3	Aouro	FO	LAR
	SAMPLE TYPE:	Trimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted
	TEXTURAL GROUP:	Very Fine Sandy Fine Silt	Very Fine Sandy Very Coarse Silt	Very Fine Sandy Medium Silt	Fine Silt	Very Fine Sandy Fine Silt	Very Fine Sandy Medium Silt	Very Fine Sandy Very Coarse Silt	Very Fine Sandy Medium Silt
	SEDIMENT NAME:	Sandy Mud	Sandy Mud	Sandy Mud	Mud	Sandy Mud	Sandy Mud	Sandy Mud	Sandy Mud
FOLK AND WARD METHOD (μm)	MEAN	13.582	21.725	9.710	8.764	10.781	11.008	20.374	16.232
	SORTING	5.472	5.940	4.319	4.443	5.328	5.187	5.630	5.403
	SKEWNESS	-0.041	-0.227	-0.009	0.000	0.032	0.054	-0.194	-0.039
	KURTOSIS	0.811	0.782	1.044	0.973	0.889	0.991	0.817	0.854
FOLK AND WARD METHOD (ϕ)	MEAN	6.202	5.525	6.686	6.834	6.535	6.505	5.617	5.945
	SORTING	2.452	2.570	2.111	2.152	2.414	2.375	2.493	2.434
	SKEWNESS	0.041	0.227	0.009	0.000	-0.032	-0.054	0.194	0.039
	KURTOSIS	0.811	0.782	1.044	0.973	0.889	0.991	0.817	0.854
FOLK AND WARD METHOD (Description)	MEAN:	Medium Silt	Coarse Silt	Medium Silt	Medium Silt	Medium Silt	Medium Silt	Coarse Silt	Coarse Silt
	SORTING:	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted
	SKEWNESS:	Symmetrical	Fine Skewed	Symmetrical	Symmetrical	Symmetrical	Symmetrical	Fine Skewed	Symmetrical
	KURTOSIS:	Platykurtic	Platykurtic	Mesokurtic	Mesokurtic	Platykurtic	Mesokurtic	Platykurtic	Platykurtic
	MODE 1 (μm):	70.912	96.243	9.738	7.175	7.175	8.359	82.612	8.359
	MODE 2 (μm):	6.159	7.175	0.985	0.985	52.247	0.846	7.175	82.612
	MODE 3 (μm):	0.985	0.985			0.846		0.846	0.985
	MODE 1 (ϕ):	3.822	3.381	6.686	7.127	7.127	6.907	3.602	6.907
	MODE 2 (ϕ):	7.347	7.127	9.992	9.992	4.263	10.212	7.127	3.602
	MODE 3 (ϕ):	9.992	9.992			10.212		10.212	9.992
	D10 (μm):	1.294	1.613	1.335	1.159	1.140	1.257	1.690	1.629
	D50 (μm):	13.524	27.732	9.610	8.604	10.023	10.111	24.632	15.982
	D90 (μm):	110.310	162.847	64.392	60.048	93.777	99.664	148.285	129.913
	(D90 / D10) (μm):	85.268	100.948	48.220	51.799	82.253	79.298	87.754	79.763
	(D90 - D10) (μm):	109.016	161.234	63.057	58.889	92.637	98.408	146.595	128.284
	(D75 / D25) (μm):	14.281	17.750	6.723	7.636	11.281	9.085	15.005	12.819
	(D75 - D25) (μm):	51.701	88.395	21.565	21.536	34.594	29.409	75.800	56.851
	D10 (ϕ):	3.180	2.618	3.957	4.058	3.415	3.327	2.754	2.944
	D50 (ϕ):	6.208	5.172	6.701	6.861	6.641	6.628	5.343	5.967
	D90 (ϕ):	9.594	9.276	9.549	9.753	9.777	9.636	9.209	9.262
	(D90 / D10) (ϕ):	3.017	3.543	2.413	2.403	2.863	2.896	3.344	3.146
	(D90 - D10) (ϕ):	6.414	6.657	5.592	5.695	6.362	6.309	6.455	6.318
	(D75 / D25) (ϕ):	1.920	2.215	1.518	1.550	1.741	1.647	2.079	1.916
	(D75 - D25) (ϕ):	3.836	4.150	2.749	2.933	3.496	3.183	3.907	3.680
	% GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% SAND:	22.37%	35.86%	10.38%	9.45%	16.54%	15.76%	31.83%	24.73%
	% MUD:	77.63%	64.14%	89.62%	90.55%	83.46%	84.24%	68.17%	75.27%
	% V COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% FINE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V FINE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V COARSE SAND:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE SAND:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM SAND:	0.72%	2.53%	0.36%	0.24%	0.95%	1.32%	2.03%	1.57%
	% FINE SAND:	7.02%	14.23%	2.95%	2.31%	5.27%	6.14%	11.77%	9.11%
	% V FINE SAND:	14.64%	19.10%	7.07%	6.90%	10.33%	8.29%	18.03%	14.04%
	% V COARSE SILT:	13.78%	12.53%	10.52%	11.08%	11.70%	10.16%	14.33%	12.88%
	% COARSE SILT:	11.30%	9.35%	15.47%	14.41%	12.34%	13.64%	10.88%	12.84%
	% MEDIUM SILT:	13.31%	10.77%	19.67%	17.67%	15.22%	17.04%	11.59%	14.54%
	% FINE SILT:	14.17%	11.23%	18.16%	18.22%	16.13%	16.87%	11.64%	13.82%
	% V FINE SILT:	10.77%	8.58%	11.80%	13.04%	11.97%	11.81%	8.48%	9.51%
	% CLAY:	14.29%	11.69%	14.00%	16.13%	16.10%	14.73%	11.24%	11.68%

Table IV – GRADISTAT data from summer samples.

	SAMPLE NAME	LG1	LG2	LG3	VRSA1	VRSA2	VRSA3	VRSA4	SCM
	SAMPLE TYPE:	Bimodal, Poorly Sorted	Trimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Unimodal, Moderately Sorted	Bimodal, Poorly Sorted	Bimodal, Very Poorly Sorted	Unimodal, Poorly Sorted	Bimodal, Poorly Sorted
	TEXTURAL GROUP:	Mud	Sandy Mud	Muddy Sand	Slightly Gravelly Sand	Mud	Sandy Mud	Muddy Sand	Mud
	SEDIMENT NAME:	Medium Silt	Very Fine Sandy Very Coarse Silt	Medium Silty Fine Sand	Slightly Very Fine Gravelly Fine Sand	Medium Silt	Very Fine Sandy Very Coarse Silt	Very Coarse Silty Fine Sand	Medium Silt
FOLK AND WARD METHOD (μm)	MEAN	5.806	15.832	41.500	201.996	6.451	32.625	101.939	6.444
	SORTING	3.334	5.224	6.820	1.698	3.534	4.590	3.432	3.860
	SKEWNESS	-0.140	-0.110	-0.581	-0.101	-0.137	-0.480	-0.609	-0.115
	KURTOSIS	1.021	0.836	0.689	1.528	0.978	1.158	1.848	0.978
FOLK AND WARD METHOD (ϕ)	MEAN	7.428	5.981	4.591	2.308	7.276	4.938	3.294	7.278
	SORTING	1.737	2.385	2.770	0.764	1.821	2.198	1.779	1.949
	SKEWNESS	0.140	0.110	0.581	0.101	0.137	0.480	0.609	0.115
	KURTOSIS	1.021	0.836	0.689	1.528	0.978	1.158	1.848	0.978
FOLK AND WARD METHOD (Description)	MEAN:	Fine Silt	Coarse Silt	Very Coarse Silt	Fine Sand	Fine Silt	Very Coarse Silt	Very Fine Sand	Fine Silt
	SORTING:	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Moderately Sorted	Poorly Sorted	Very Poorly Sorted	Poorly Sorted	Poorly Sorted
	SKEWNESS:	Fine Skewed	Fine Skewed	Very Fine Skewed	Fine Skewed	Fine Skewed	Very Fine Skewed	Very Fine Skewed	Fine Skewed
	KURTOSIS:	Mesokurtic	Platykurtic	Platykurtic	Very Leptokurtic	Mesokurtic	Leptokurtic	Very Leptokurtic	Mesokurtic
	MODE 1 (μm):	8.359	60.868	206.537	215.000	9.738	70.912	206.537	9.738
	MODE 2 (μm):	0.985	7.175	8.359		0.985	6.159		0.985
	MODE 3 (μm):		0.846						
	MODE 1 (ϕ):	6.907	4.042	2.280	2.237	6.686	3.822	2.280	6.686
	MODE 2 (ϕ):	9.992	7.127	6.907		9.992	7.347		9.992
	MODE 3 (ϕ):		10.212						
	D10 (μm):	1.031	1.547	1.860	107.377	1.048	2.831	8.345	0.973
	D50 (μm):	6.540	17.074	91.284	201.627	7.237	51.828	145.342	7.309
	D90 (μm):	24.324	113.693	255.617	347.052	29.271	144.175	264.879	33.529
	(D90 / D10) (μm):	23.602	73.481	137.424	3.232	27.937	50.924	31.743	34.447
	(D90 - D10) (μm):	23.293	112.146	253.757	239.675	28.223	141.344	256.535	32.556
	(D75 / D25) (μm):	4.887	12.872	30.249	1.750	5.544	5.982	2.855	6.200
	(D75 - D25) (μm):	10.675	54.846	189.614	112.191	13.043	77.343	136.265	14.075
	D10 (ϕ):	5.361	3.137	1.968	1.527	5.094	2.794	1.917	4.898
	D50 (ϕ):	7.257	5.872	3.453	2.310	7.110	4.270	2.782	7.096
	D90 (ϕ):	9.922	9.336	9.070	3.219	9.899	8.464	6.905	10.005
	(D90 / D10) (ϕ):	1.851	2.976	4.609	2.109	1.943	3.029	3.603	2.042
	(D90 - D10) (ϕ):	4.561	6.199	7.102	1.692	4.804	5.670	4.988	5.106
	(D75 / D25) (ϕ):	1.368	1.905	3.093	1.417	1.414	1.753	1.672	1.446
	(D75 - D25) (ϕ):	2.289	3.686	4.919	0.807	2.471	2.581	1.514	2.632
	% GRAVEL:	0.00%	0.00%	0.00%	0.53%	0.00%	0.00%	0.00%	0.00%
	% SAND:	2.36%	23.74%	50.94%	94.01%	2.19%	42.18%	77.47%	3.78%
	% MUD:	97.64%	76.26%	49.06%	5.46%	97.81%	57.82%	22.53%	96.22%
	% V COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% FINE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V FINE GRAVEL:	0.00%	0.00%	0.00%	0.53%	0.00%	0.00%	0.00%	0.00%
	% V COARSE SAND:	0.00%	0.00%	0.00%	0.84%	0.00%	0.00%	0.00%	0.00%
	% COARSE SAND:	0.00%	0.00%	0.00%	2.40%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM SAND:	0.00%	0.86%	11.21%	23.69%	0.00%	1.31%	13.33%	0.00%
	% FINE SAND:	0.40%	7.39%	33.79%	60.32%	0.21%	12.81%	44.92%	0.89%
	% V FINE SAND:	1.96%	15.49%	5.94%	6.76%	1.98%	28.06%	19.22%	2.85%
	% V COARSE SILT:	4.07%	16.10%	3.16%	1.79%	6.68%	23.55%	6.34%	7.29%
	% COARSE SILT:	13.94%	11.59%	7.70%	0.92%	16.69%	9.21%	3.52%	15.97%
	% MEDIUM SILT:	23.36%	12.80%	10.27%	0.00%	22.03%	6.06%	2.96%	20.97%
	% FINE SILT:	22.55%	13.92%	10.24%	0.03%	20.27%	6.42%	3.14%	19.06%
	% V FINE SILT:	15.12%	9.74%	7.30%	0.95%	14.11%	4.97%	2.44%	13.51%
	% CLAY:	18.60%	12.11%	10.38%	1.77%	18.04%	7.61%	4.12%	19.42%

	SAMPLE NAME	EE	E1	E2	E3	LEZ1	LEZ2	LEZ3	PI1
	SAMPLE TYPE:	Polymodal, Very Poorly Sorted	Polymodal, Very Poorly Sorted	Unimodal, Poorly Sorted	Unimodal, Poorly Sorted	Unimodal, Poorly Sorted	Bimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Bimodal, Poorly Sorted
	TEXTURAL GROUP:	Gravelly Sand	Slightly Gravelly Muddy Sand	Slightly Gravelly Muddy Sand	Muddy Sand	Mud	Mud	Sandy Mud	Mud
	SEDIMENT NAME:	Very Fine Gravelly Very Fine Sand	Slightly Very Fine Gravelly Very Coarse Silty Medium Sand	Slightly Very Fine Gravelly Muddy Fine Sand	Very Coarse Silty Fine Sand	Medium Silt	Medium Silt	Very Fine Sandy Very Coarse Silt	Medium Silt
FOLK AND WARD METHOD (μm)	MEAN	248.502	47.248	176.132	125.182	6.527	8.423	20.632	6.552
	SORTING	4.374	7.269	3.118	2.575	3.459	4.208	5.183	3.686
	SKEWNESS	-0.013	-0.346	-0.448	-0.483	-0.119	-0.068	-0.322	-0.091
	KURTOSIS	1.343	0.854	3.234	1.834	1.053	0.961	0.828	1.036
FOLK AND WARD METHOD (ϕ)	MEAN	2.009	4.404	2.505	2.998	7.259	6.891	5.599	7.254
	SORTING	2.129	2.862	1.641	1.365	1.791	2.073	2.374	1.882
	SKEWNESS	0.013	0.346	0.448	0.483	0.119	0.068	0.322	0.091
	KURTOSIS	1.343	0.854	3.234	1.834	1.053	0.961	0.828	1.036
FOLK AND WARD METHOD (Description)	MEAN:	Fine Sand	Very Coarse Silt	Fine Sand	Fine Sand	Fine Silt	Medium Silt	Coarse Silt	Fine Silt
	SORTING:	Very Poorly Sorted	Very Poorly Sorted	Poorly Sorted	Poorly Sorted	Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Poorly Sorted
	SKEWNESS:	Symmetrical	Very Fine Skewed	Very Fine Skewed	Very Fine Skewed	Fine Skewed	Symmetrical	Very Fine Skewed	Symmetrical
	KURTOSIS:	Leptokurtic	Platykurtic	Extremely Leptokurtic	Very Leptokurtic	Mesokurtic	Mesokurtic	Platykurtic	Mesokurtic
	MODE 1 (μm):	76.500	302.500	215.000	177.285	9.738	11.345	82.612	8.359
	MODE 2 (μm):	152.500	76.500				0.985	7.175	0.985
	MODE 3 (μm):	302.500	1.500					0.846	
	MODE 1 (ϕ):	3.731	1.747	2.237	2.500	6.686	6.466	3.602	6.907
	MODE 2 (ϕ):	2.737	3.731				9.992	7.127	9.992
	MODE 3 (ϕ):	1.747	9.466					10.212	
	D10 (μm):	65.277	1.623	25.071	29.794	1.121	1.143	1.689	1.056
	D50 (μm):	216.699	75.119	195.648	146.459	7.263	8.934	28.683	7.199
	D90 (μm):	1346.448	394.232	368.833	263.248	28.655	51.013	120.508	32.348
	(D90 / D10) (μm):	20.627	242.963	14.712	8.836	25.572	44.616	71.353	30.629
	(D90 - D10) (μm):	1281.171	392.610	343.762	233.454	27.535	49.870	118.819	31.292
	(D75 / D25) (μm):	5.575	17.384	1.983	2.371	5.018	7.223	12.883	5.517
	(D75 - D25) (μm):	451.495	248.641	129.163	120.362	12.181	20.038	68.754	13.117
	D10 (ϕ):	-0.429	1.343	1.439	1.926	5.125	4.293	3.053	4.950
	D50 (ϕ):	2.206	3.735	2.354	2.771	7.105	6.807	5.124	7.118
	D90 (ϕ):	3.937	9.267	5.318	5.069	9.802	9.772	9.210	9.887
	(D90 / D10) (ϕ):	-9.174	6.901	3.696	2.632	1.912	2.276	3.017	1.997
	(D90 - D10) (ϕ):	4.366	7.925	3.879	3.143	4.676	5.479	6.157	4.937
	(D75 / D25) (ϕ):	3.876	3.143	1.509	1.550	1.385	1.526	1.984	1.413
	(D75 - D25) (ϕ):	2.479	4.120	0.988	1.245	2.327	2.853	3.687	2.464
	% GRAVEL:	5.42%	0.13%	1.90%	0.00%	0.00%	0.00%	0.00%	0.00%
	% SAND:	85.92%	54.90%	86.20%	82.46%	3.37%	7.24%	30.67%	3.96%
	% MUD:	8.66%	44.97%	11.91%	17.54%	96.63%	92.76%	69.33%	96.04%
	% V COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% FINE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V FINE GRAVEL:	5.42%	0.13%	1.90%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V COARSE SAND:	9.40%	0.53%	0.29%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE SAND:	12.09%	3.79%	2.89%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM SAND:	19.07%	22.82%	21.86%	12.96%	0.00%	0.00%	0.17%	0.00%
	% FINE SAND:	21.31%	14.78%	50.81%	46.76%	0.81%	1.32%	8.95%	0.91%
	% V FINE SAND:	24.06%	12.97%	10.36%	22.74%	2.56%	5.92%	21.56%	3.04%
	% V COARSE SILT:	1.41%	14.00%	1.17%	7.20%	5.35%	11.29%	17.72%	6.51%
	% COARSE SILT:	0.79%	5.78%	1.83%	3.41%	15.46%	16.48%	11.29%	15.25%
	% MEDIUM SILT:	1.42%	4.44%	1.21%	1.41%	23.34%	18.58%	10.53%	21.66%
	% FINE SILT:	0.72%	5.36%	1.77%	1.59%	21.39%	17.29%	10.74%	20.65%
	% V FINE SILT:	0.82%	1.55%	1.32%	1.27%	14.09%	12.63%	7.90%	14.11%
	% CLAY:	3.49%	13.83%	4.61%	2.66%	17.00%	16.49%	11.15%	17.86%

	SAMPLE NAME	PI S. densiflora	PI S. maritima	PI margem lodosa	Foz Beliche Salicornia	Foz Beliche S. dens	Foz Beliche M. lodosa	Alcoutim	Al d'ouro	Foz Odeleite	Laranjeiras
	SAMPLE TYPE:	Unimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Bimodal, Very Poorly Sorted	Trimodal, Very Poorly Sorted	Unimodal, Poorly Sorted
	TEXTURAL GROUP:	Mud	Sandy Mud	Muddy Sand	Mud	Mud	Sandy Mud	Mud	Sandy Mud	Sandy Mud	Muddy Sand
	SEDIMENT NAME:	Medium Silt	Very Fine Sandy Fine Silt	Very Coarse Silty Very Fine Sand	Medium Silt	Fine Silt	Very Fine Sandy Medium Silt	Medium Silt	Very Fine Sandy Medium Silt	Fine Sandy Medium Silt	Coarse Silty Fine Sand
FOLK AND WARD METHOD (μm)	MEAN	8.177	11.898	41.391	8.857	8.261	12.656	10.103	10.816	20.060	141.829
	SORTING	4.011	5.281	5.245	4.271	4.546	5.233	4.192	5.089	6.524	2.542
	SKEWNESS	-0.031	-0.054	-0.611	-0.061	0.003	-0.028	-0.095	-0.026	0.012	-0.526
	KURTOSIS	1.016	0.818	1.009	1.011	0.956	0.850	1.091	0.902	0.749	2.424
FOLK AND WARD METHOD (ϕ)	MEAN	6.934	6.393	4.595	6.819	6.920	6.304	6.629	6.531	5.640	2.818
	SORTING	2.004	2.401	2.391	2.095	2.184	2.388	2.068	2.347	2.706	1.346
	SKEWNESS	0.031	0.054	0.611	0.061	-0.003	0.028	0.095	0.026	-0.012	0.526
	KURTOSIS	1.016	0.818	1.009	1.011	0.956	0.850	1.091	0.902	0.749	2.424
FOLK AND WARD METHOD (Description)	MEAN:	Medium Silt	Medium Silt	Very Coarse Silt	Medium Silt	Medium Silt	Medium Silt	Medium Silt	Medium Silt	Coarse Silt	Fine Sand
	SORTING:	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Very Poorly Sorted	Poorly Sorted
	SKEWNESS:	Symmetrical	Symmetrical	Very Fine Skewed	Symmetrical	Symmetrical	Symmetrical	Symmetrical	Symmetrical	Symmetrical	Very Fine Skewed
	KURTOSIS:	Mesokurtic	Platykurtic	Mesokurtic	Mesokurtic	Mesokurtic	Platykurtic	Mesokurtic	Mesokurtic	Platykurtic	Very Leptokurtic
	MODE 1 (μm):	8.359	70.912	112.123	11.345	7.175	8.359	15.398	9.738	177.285	206.5365
	MODE 2 (μm):		7.175	5.287	0.985	0.985	70.912	0.846	0.846	13.217	
	MODE 3 (μm):		0.846				0.846			0.846	
	MODE 1 (ϕ):	6.907	3.822	3.161	6.466	7.127	6.907	6.025	6.686	2.500	2.280
	MODE 2 (ϕ):		7.127	7.568	9.992	9.992	3.822	10.212	10.212	6.246	
	MODE 3 (ϕ):		10.212				10.212			10.212	
	D10 (μm):	1.216	1.139	2.593	1.177	1.077	1.279	1.385	1.152	1.570	20.748
	D50 (μm):	8.305	12.014	82.007	9.351	8.136	12.356	11.182	10.818	17.675	163.265
	D90 (μm):	48.068	91.828	188.532	55.994	60.091	99.001	56.211	85.391	202.398	269.019
	(D90 / D10) (μm):	39.541	80.592	72.700	47.582	55.812	77.421	40.583	74.095	128.916	12.966
	(D90 - D10) (μm):	46.852	90.689	185.938	54.817	59.014	97.722	54.826	84.239	200.828	248.271
	(D75 / D25) (μm):	6.307	12.976	8.674	6.874	7.950	12.052	6.304	10.256	22.372	2.005
	(D75 - D25) (μm):	17.551	43.134	118.454	20.174	20.648	42.725	21.845	31.990	106.264	109.422
	D10 (ϕ):	4.379	3.445	2.407	4.159	4.057	3.336	4.153	3.550	2.305	1.894
	D50 (ϕ):	6.912	6.379	3.608	6.741	6.942	6.339	6.483	6.530	5.822	2.615
	D90 (ϕ):	9.684	9.777	8.591	9.731	9.859	9.611	9.496	9.761	9.315	5.591
	(D90 / D10) (ϕ):	2.212	2.838	3.569	2.340	2.430	2.881	2.286	2.750	4.042	2.952
	(D90 - D10) (ϕ):	5.305	6.333	6.184	5.572	5.803	6.275	5.343	6.211	7.010	3.697
	(D75 / D25) (ϕ):	1.476	1.837	2.074	1.515	1.553	1.812	1.504	1.697	2.415	1.457
	(D75 - D25) (ϕ):	2.657	3.698	3.117	2.781	2.991	3.591	2.656	3.358	4.484	1.004
	% GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% SAND:	6.73%	18.61%	60.12%	8.62%	9.47%	19.29%	8.90%	15.12%	32.38%	84.76%
	% MUD:	93.27%	81.39%	39.88%	91.38%	90.53%	80.71%	91.10%	84.88%	67.62%	15.24%
	% V COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% FINE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V FINE GRAVEL:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% V COARSE SAND:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% COARSE SAND:	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	% MEDIUM SAND:	0.00%	0.00%	3.03%	0.00%	0.00%	0.35%	0.71%	0.36%	4.75%	14.66%
	% FINE SAND:	1.21%	4.46%	25.54%	1.89%	1.95%	5.67%	3.38%	4.41%	17.87%	53.83%
	% V FINE SAND:	5.52%	14.11%	31.54%	6.72%	7.52%	13.27%	4.81%	10.35%	9.77%	16.28%
	% V COARSE SILT:	10.06%	14.01%	10.28%	10.48%	10.42%	12.73%	11.40%	12.20%	7.54%	2.85%
	% COARSE SILT:	15.28%	12.24%	4.50%	16.45%	13.90%	13.03%	19.69%	14.35%	12.53%	3.64%
	% MEDIUM SILT:	19.75%	14.15%	5.79%	19.45%	17.27%	15.00%	19.96%	15.75%	13.97%	2.13%
	% FINE SILT:	19.31%	14.44%	6.05%	17.30%	17.84%	14.75%	16.07%	15.16%	12.70%	2.32%
	% V FINE SILT:	13.32%	10.86%	5.12%	11.99%	13.52%	10.88%	10.59%	11.53%	8.97%	1.70%
	% CLAY:	15.55%	15.69%	8.14%	15.71%	17.58%	14.32%	13.37%	15.88%	11.91%	2.61%

Appendix 7

Table I – Spatial location and elemental parameters of the samples collected during winter and summer

				Winter					Summer				
Sample	Elev (MSL)	East	North	TC	TOC	TIC	TN	C/N	TC	TOC	TIC	TN	C/N
AL	0.209	58599.63	-243262						2.10	2.10	0.01	0.20	10.70
LAR	0.311	59841.47	-251197	2.18	1.98	0.21	0.17	11.55	0.62	0.57	0.04	0.06	10.02
FO	0.334	60808.45	-256956	1.50	1.42	0.08	0.16	8.65	9.59	8.95	0.64	0.69	12.99
Aouro	0.532	61149.39	-261793	2.06	2.00	0.06	0.16	12.58	1.35	1.16	0.19	0.13	9.17
FB1	1.432	61922.51	-267062	6.53	6.25	0.28	0.41	15.31	2.79	2.36	0.42	0.30	7.85
FB2	0.752	61924.61	-267057	2.62	2.32	0.30	0.22	10.47	2.30	2.21	0.09	0.27	8.31
FB3	0.471	61927.3	-267051	3.33	3.12	0.21	0.27	11.38	3.47	3.24	0.22	0.30	10.81
PI1	1.188	62974.27	-269472						4.16	4.16	0.00	0.57	7.40
PI2	1.198	62997.54	-269453	3.24	3.09	0.15	0.36	8.67	3.56	3.47	0.09	0.37	9.47
PI3	0.614	63006.82	-269443	2.28	2.10	0.18	0.27	7.87	2.63	2.35	0.29	0.23	10.03
PI4	0.011	63012.25	-269439	1.84	1.83	0.01	0.21	8.93	1.61	1.58	0.03	0.18	8.91
LEZ1	1.317	61394.11	-272398	7.77	7.16	0.61	0.74	9.63	6.45	5.94	0.51	0.58	10.26
LEZ2	1.062	61390.2	-272388	2.49	2.17	0.32	0.26	8.28	2.92	2.63	0.29	0.29	9.04
LEZ3	0.202	61391.18	-272387	1.68	1.65	0.03	0.23	7.15	2.10	1.90	0.20	0.22	8.63
SCM	1.96	59401.4	-272673	3.88	3.40	0.48	0.31	11.06	5.49	5.12	0.38	0.44	11.60
VRSA1	1.21	63557.2	-272826	1.53	0.96	0.57	0.15	6.58	1.10	0.30	0.80	0.03	9.06
VRSA2	1.03	63568.3	-272824	6.08	5.64	0.43	0.56	10.04	0.88	0.70	0.18	0.08	8.65
VRSA3	0.29	63597.08	-272817	1.20	1.17	0.02	0.14	8.37	0.67	0.63	0.03	0.10	6.60
VRSA4	-0.47	63639.63	-272805	0.49	0.18	0.31	0.02	8.32	4.77	4.75	0.02	0.62	7.73
EE	-0.743	64604.91	-274267	1.41	0.54	0.87	0.07	7.62	0.80	0.48	0.33	0.04	12.55
E1	0.574	64684.93	-274521	0.28	0.30	0.01	0.04	7.80	0.89	0.81	0.09	0.07	12.38
E2	-0.066	64677.26	-274522	1.05	0.22	0.83	0.04	5.89	1.08	0.31	0.77	0.03	10.52
E3	-0.743	64637.26	-274532	0.99	0.79	0.20	0.09	8.44	0.82	0.67	0.14	0.06	12.00
LG1	0.397	64513.53	-276693	10.17	8.17	2.00	1.05	7.78	7.88	6.66	1.21	0.90	7.37
LG2	0.167	64509.01	-276696	6.74	6.03	0.71	0.83	7.27	6.52	5.66	0.87	0.77	7.33
LG3	-0.09	64506.05	-276700	2.93	2.33	0.60	0.34	6.86	3.87	3.27	0.60	0.39	8.35

in red - values of TOC lower than 0.3 % and respective C/N ratio values.

Appendix 8

Table I – Physico-chemical parameters of winter and summer samples.

Winter					Summer				
Sample	**pHsed**	**Sal**	**DO(%)**	**T°C**	**Sample**	**pHsed**	**Sal**	**DO(%)**	**T°C**
					AL	6.63	0.18	92.1	24.8
LAR	7.19	0.25	104.50	12.62	**LAR**	7.30	0.18	85.30	25.66
FO	7.39	0.13	89.10	14.31	**FO**	6.77	0.22	78.80	26.46
Aouro	7.38	0.23	106.60	13.11	**Aouro**	7.69	0.43	73.40	26.79
FB1	6.96				**FB1**	6.58			
FB2	6.95				**FB2**	6.42			
FB3	6.84	0.24	85.30	12.87	**FB3**	6.73	2.81	76.40	26.35
					PI1	6.38			
PI2	7.28				**PI2**	6.00			
PI3	7.73				**PI3**	6.77			
PI4	7.37	0.24	111.30	12.46	**PI4**	6.48	9.33	59.90	28.75
LEZ1	7.69				**LEZ1**	6.57			
LEZ2	7.34				**LEZ2**	7.02			
LEZ3	6.22	1.21	98.10	12.36	**LEZ3**	6.43	24.13	57.20	26.97
SCM	7.01	14.30	115.00	12.43	**SCM**	6.98	26.10	35.20	20.18
VRSA1	7.81	1.16	94.50	13.06	**VRSA1**	7.98	35.48	65.30	27.35
VRSA2	6.95				**VRSA2**	6.50			
VRSA3	6.86				**VRSA3**	6.67			
VRSA4	7.43	3.01	99.50	15.67	**VRSA4**	6.63	28.04	60.40	26.38
EE	7.62	1.42	78.20	14.32	**EE**	7.44	4.03	65.00	26.84
E1	7.70	0.48	106.30	14.87	**E1**	7.00	35.61	68.60	28.23
E2	7.53				**E2**	7.02			
E3	7.76	1.61	91.30	14.72	**E3**	6.98	22.34	83.70	29.57
LG1	6.44				**LG1**	6.50			
LG2	6.86				**LG2**	6.74			
LG3	7.42	27.79	69.00	13.93	**LG3**	7.64	35.97	44.40	25.20

pHsed	sediment pH
Sal	salinity
DO(%)	dissolved oxygen
T°C	temperature

Appendix 9

Table I - Results of normality tests on all environmental and ecological variables.

Environmental variable	*p* value	Shapiro-Wilks W	Normality?
Elev_MSL (all points)	**0.81**	**0.97**	**yes**
Elev_MSL (margin points)	**0.26**	**0.91**	**yes**
Longitude	0.04	0.92	no
Latitude (all points)	0.00	0.76	no
Latitude (margin points)	**0.23**	**0.9**	**yes**
Gravel_w	0.00	0.36	no
Gravel_s	0.00	0.31	no
Sand_w	0.00	0.83	no
Sand_s	0.00	0.84	no
Mud_w	0.00	0.83	no
Mud_s	0.00	0.84	no
TOC_w	0.00	0.86	no
TOC_s	0.01	0.89	no
TIC_w	0.00	0.76	no
TIC_s	0.00	0.87	no
TN_w	0.00	0.82	no
TN_s	0.01	0.9	no
C/N_w	0.04	0.91	no
C/N_s	0.04	0.96	no
Sal_w	0	0.54	no
Sal_s	0.01	0.83	no
DO_w	**0.86**	**0.97**	**yes**
DO_s	**0.9**	**0.97**	**yes**
T_w	**0.16**	**0.9**	**yes**
T_s	0.03	0.86	no
pHsed_w	**0.14**	**0.94**	**yes**
pHsed_s	**0.06**	**0.93**	**yes**
Foraminifera ecological variables	***p* value**	**Shapiro-Wilks W**	**Normality?**
Hs_w	**0.38**	**0.95**	**yes**
Hs_s	0.00	0.86	no
c_w	0.01	0.86	no
c_s	0.00	0.80	no
A/C%_w	0.03	0.89	no
A/C%_s	0.01	0.89	no
Ni_w	0.00	0.42	no
Ni_s	0.00	0.70	no
S_w	**0.38**	**0.95**	**yes**
S_s	0.03	0.90	no
Thecamoebian and tintinnids ecological variables	***p* value**	**Shapiro-Wilks W**	**Normality?**
Ni thecas_w (margin points)	**0.35**	**0.91**	**yes**
Ni thecas_s (margin points)	0.00	0.66	no
Ni tintinnids_w (margin points)	**0.16**	**0.88**	**yes**
Ni tintinnids_s (margin points)	0.00	0.68	no
Ni thecas_w (all points)	0.00	0.77	no
Ni thecas_s (all points)	0.00	0.56	no
Ni tintinnids_w (all points)	0.00	0.83	no
Ni tintinnids_s (all points)	0.00	0.71	no

Elev_MSL - elevation in relation to mean sea level
TOC - Total organic carbon
TIC - total inorganic carbon
TN - total nitrogen
C/N - carbon/nitrogen ratio
Sal - salinity
DO - dissolved oxygen
T - temperature ºC
pHsed - sediment pH
HS - Shannon diversity
c - dominance index
A/C% - Agglutinated/calcareous ratio
Ni - faunistic density
S - number of species

_w - winter
_s - summer

Appendix 10

Table I – Information on datings and boreholes geographic location.

Sample Depth/cm	Laboratory code	Method	Material	^{14}C age [yrs]	Cal BP [yrs]
CM3 - Guadiana main channel - 37º 12' 06'' N; 007º 25' 10'' W					
459	GX-25421	Rad	*C. angulata*	3300 ± 160	3598
960	GX-25452	Rad	*C. angulata*	6710 ± 120	7594
1452	GX-25453	Rad	*C. angulata*	7080 ± 200	7936
2690	GX-25454	Rad	wood	9470 ± 250	10738
CM5 - Beliche Marsh - 37º 15' 56'' N; 007º 27' 08'' W					
333[a]	WK-16012	AMS	*S. plana*	3375±39	3220
579[b]	IRPA-15211	AMS	*Venerupis*	4295±35	4408
890[a]	WK-16013	AMS	*C. glaucum*	6764±45	7600
1345	IRPA-15212	AMS	*Venerupis*	7585±35	8017
1775[b]	IRPA-15210	AMS	*Cardium*	7725±45	8169
2095[a]	WK-16014	AMS	wood	8256±55	9310
4270[a]	WK-16015	AMS	wood	10273±66	11448
4767[b]	β-137110	AMS	wood	10990±40	12991

Laboratory codes: β – Beta Analytical, USA; IRPA – Institut Royal du Patrimoine Artistique, Belgium. WK – University of Waikato, New Zealand

Method: Rad – β radiometric counting; AMS – accelerator mass spectrometry.

[a] - data from Fletcher et al., (2007);

[b] - data from Gonzalez-Vila et al., (2003);