TAXONOMY AND DISTRIBUTION OF THE BENTHIC FORAMINIFERA IN THE GULF OF İSKENDERUN, EASTERN MEDITERRANEAN

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Approval of the Graduate School of Natural and Applied Sciences.

Prof. Dr. Canan Özgen
Director

I certify that this thesis satisfies all the requirements as a thesis for the degree of Master of Science.

Prof. Dr. Vedat Doyuran
Head of Department

This is to certify that we have read this thesis and that in our opinion it is fully adequate, in scope and quality, as a thesis for the degree of Master of Science.

Assist. Prof. Dr. Vedat Ediger
Co-Supervisor

Assoc. Prof. Dr. Sevinç Özkan Altıner
Supervisor

Examining Committee Members

Prof. Dr. Demir Altıner	(METU, GEOE)	________________
Assoc. Prof. Dr. Sevinç Özkan Altıner	(METU, GEOE)	________________
Assist. Prof. Dr. Vedat Ediger	(IMS-METU, GEOE)	________________
Assist. Prof. Dr. İ. Ömer Yılmaz	(METU, GEOE)	________________
Dr. Erkan Ekmekçi	(MTA)	________________

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Name, Last name: Sabire Aslı OFLAZ

Signature :

ABSTRACT

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EASTERN MEDITERRANEAN

Oflaz, Sabire Aslı
M. Sc., Department of Geological Engineering

Supervisor: Assoc. Prof. Dr. Sevinç Özkan Altıner
Co-Supervisor: Assist. Prof. Dr. Vedat Ediger

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The present study aims to investigate the foraminiferal assemblages of the recent samples in terms of abundance and diversity, to determine the bathymetrical and the geographical distributions of the foraminiferal assemblages. This study further intends to put forward the responses of foraminifers to environmental factors (e.g. bathymetry, salinity, substrate, pollution, water currents, etc.) on the distribution of foraminifers.

In this manner, foraminiferal fauna has been taxonomically identified and quantitatively analyzed in the 34 grab samples distributed at depths from 18 m. to 190 m. collected from the Gulf of İskenderun. Counting 300 individuals from each sample, the relative abundances of 151 benthic foraminiferal species belonging to suborders of Rotaliina, Miliolina, Textulariina, Spirillinina and Lagenina have been determined.

The relative abundances of samples are dominated by *Ammonia tepida*; *Adelosina cliarensis*, *Nonion* sp.A, *Textularia bocki, Reussella spinulosa*, *Cribroelphidium poeyanum*, *Adelosina pulchella*, *Buccella granulata*, *Elphidium advenum* and *Nonion depressulum* that are also common in the western Mediterranean. Furthermore, the Lessepsian migrants; *Peneroplis pertusus*, *Septoloculina angulata, Septloculina rotunda, Septoloculina tortuosa, Vertebralina striata* and *Amphistegina lobifera* are abundant in only southeastern part of the gulf.

Because of complex distribution scheme of benthic foraminifers, some statistical analysis (Cluster Analysis, DCA and CCA) have been applied to relative abundance (percentage) of the most abundant, ecologically important taxa in order to visualize assemblages and their representative species. Two main clusters, mainly controlled by $CaCO_3$ and substrate, have been obtained. It is recognized that the distribution of benthic foraminiferal assemblages are not strongly depend on depth as it expected.

Keywords: Benthic foraminifer, Environmental factors, Statistical analysis, the Gulf of İskenderun

ÖZ

İSKENDERUN KÖRFEZİNDEKİ BENTİK FORAMİNİFER DAĞILIMI VE TAKSONOMİSİ

Oflaz, Sabire Aslı
Yüksek Lisans, Jeoloji Mühendisliği Bölümü

Tez Yöneticisi: Assoc. Prof. Dr. Sevinç ÖZKAN ALTINER
Ortak Tez Yöneticisi: Assist. Prof. Dr. Vedat Ediger

Eylül 2006, 306 sayfa

Bu çalışmanın amacı güncel örneklerdeki foraminifer topluluklarının bolluk ve çeşitlilik açısından araştırıp, bu toplulukların coğrafik ve batimetrik dağılımlarını belirlemektir. Bu çalışmada ayrıca, foraminiferlerin dağılımlarının çevresel faktörlere (örneğin batimetri, tuzluluk, substrat, kirlilik, su akıntıları v.b.) tepkileri amaçlanmıştır.

Bu kapsamda, İskenderun Körfezi'nden toplanan yüzey sedimanlarından alınan örneklerdeki foraminifer faunası çalışılmıştır. 18 m.-190 m. arası derinlikten gelen 34 örnekten elde edilen bentik foraminifer toplulukları kantitatif olarak sayılıp taksonomik olarak tanımlanmıştır. Tüm örneklerden 300 birey sayılarak, Textulariina, Spirillinina, Miliolina, Lagenina ve Rotaliina'ya ait 151 bentik foraminifer türünün göreceli bollukları belirlenmiştir.

Ammonia tepida; *Adelosina cliarensis*, *Nonion* sp.A, *Textularia bocki, Reussella spinulosa*, *Cribroelphidium poeyanum*, *Adelosina pulchella*, *Buccella granulata*, *Elphidium advenum* ve *Nonion depressulum* bolluk açısından baskın türlerdir. Bunların yanısıra *Peneroplis pertusus*, *Septoloculina angulata, Septloculina rotunda, Septoloculina tortuosa, Vertebralina striata* ve *Amphistegina lobifera* gibi bazı Lessepsiyen göçmeleri sadece körfezin güneydoğu kısmında baskındır.

Bentik foraminiferler kompleks bir dağılım gösterdiği için bentik foraminifer toplulukları ve bunların baskın türlerini daha iyi görebilmek için bazı istatistiksel analizler (Kümeleme analizi, DCA and CCA) kullanılmıştır. Bu analizlerin sonucunda substrat ve $CaCO_3$ ile kontrol edilen iki ana cluster elde edilmiştir. Benthic foraminifer topluluklarının dağılımlarının çalışmanın başında beklenildiği gibi derinliğe bağlı bulunmadığı anlaşılmıştır.

Anahtar Kelimeler: Bentik foraminifer, Dağılım, Çevresel faktörler, İstatistiksel yöntemler, İskenderun Körfezi.

To My Family

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CHAPTER I

INTRODUCTION

1.1. Purpose and Scope

Foraminifera are perfectly suitable to environmental studies. They are recorders of environmental changes due to their wide distribution over all marine environments; high taxonomic diversity; hard exoskeleton; their small size and consequently high abundance in small samples, which provide an adequate statistical base and make them to be collected easily; and their short generation times that let them to respond quickly to environmental change.

For this study, samples from the Dardanelles, the Sea of Marmara, the coasts of Erdemli (Eastern Mediterranean Sea) and the Gulf of İskenderun have been examined. Having extremely high abundance and diversity of benthic species compared to other locations, Gulf of İskenderun was chosen for this study. Moreover, highly industrialized character of this region gives an opportunity to investigate effects of pollution on benthic foraminifera. In addition, Gulf of İskenderun is located between the East Anatolian / Kyrenia-Misis Ranges and Dead Sea Fault complexes, and basin is tectonically active and the shape and the structure of the bottom is controlled by the position and the direction of several faults. In this manner, it is provided that an ideal natural laboratory for studying the mixed effects of hydrography, benthogenic production, deltaic influences, and somewhat anthropogenic activities (Ergin *et al*., 1998).

Although there are only about 40-50 planktonic species, the great majority of modern foraminifera are benthic (Sen Gupta, 1999). In Gulf of İskenderun, diversity of planktonic species is extremely low and this study is only focused on benthic foraminifera, although the planktonic species are counted in each sample.

The main objective of the present study is to investigate the occurrences and distribution of the foraminiferal assemblages as a function of mainly bathymetry and other environmental parameters. This thesis further aims to discuss reasons of abrupt changes in the relative abundances and diversity of the species within each sample. Since modern foraminiferal distributions give clues for their analog ancient marine environments, it is important to document distribution patterns. For example, relation between depth and distribution of foraminifera may simplify paleodepth studies. It is well known that there is a debate in timing of connection of the Aegean Sea and the Marmara Sea. This study may be providing a calibration of the depth range of neritic benthic foraminifera in the Mediterranean Sea where is a little information about the depth distribution of modern benthic foraminifera. Many of the same species are already recorded in the Marmara Sea (Kaminski, 2002).

Most of the studies on recent foraminifera from Turkey rely on qualitative analysis of foraminifera. In this aspect, this study represents careful documentation of relative abundances of the species and their bathymetrical distributions.

In this study, 300 specimens from each sample are counted, contrary to most of the studies in this subject. To be statistically significant, counting of data up to 300 is extremely important to recognize almost real relative abundances of species. After counting 300 individuals, relative abundance of the species are almost same.

Recently, paleontology is a quantitative science and there has been a growing amount of interest to both statistical procedures and analytical methods for paleontological problems. For example, these analyses make easier to recognize distribution patterns of foraminifers and their relations to environmental factors. In this manner, some statistical analyses are applied to relative abundances (percentage) of the most abundant, ecologically important taxa in order to visualize assemblages and their representative species.

Second principal objective of this study is to produce an extensive systematic catalogue of recent benthic foraminiferal species from the Eastern Mediterranean Sea, focusing on mainly morphological features. Like Murray, 1971; Hayward, B. W., Buzas, M. A., 1979; Sgarrella and Moncharmont-Zei, 1993; Loeblich and Tappan, 1994; Sakinç, 2000; Javaux and Scott 2003; Murray, 2003; and Meriç *et al.*, 2004; most recent published studies in this subject are occasionally systematically inadequate due to very limited synonymies, without proper descriptions or any diagnosis to distinguish a given species from similar ones. In these studies, descriptions of the species usually consist of main features of the genera. It is unnecessary to put these features under the species description. In order to cope with this problem, genera descriptions are given in systematical paleontology chapter. Although the identification of species is mostly made under the light microscope, details that can be seen only under the Scanning Electron Microscope are given generally by mostly of authors. Therefore, it is given an attention to state distinguishing features of the species under the light microscope, if it is available.

Besides, distribution patterns of benthic foraminifera in the Gulf of İskenderun are compared with that of the Aegean Sea, Marmara Sea, Western Mediterranean and Red Sea.

1.2. Location

Geographical and physiographical setting

Gulf of İskenderun is nearly a rectangular shaped embayment (~ 65x35 km) with a surface area of about 2275 km^2 and located in easternmost part of the Mediterranean sea of southern Turkey. The study area is situated between the longitudes 35^0 23′ 00″-36^0 08′ 12″ E and latitudes 36^0 14′ 45″- 36^0 53′ 36″ N (Figure 1-1).

The gulf is enclosed by a narrow coastal plain that is flanked by the Amanos (Nur) Mountain (~ 2000 m) in the southeastern part and by a large fluvial and coastal plain that is flanked by the Misis Mountain in the northwest to the north part.

Ceyhan River, the most important fresh-water supply into The Gulf of İskenderun, discharges near to Yumurtalık Bay. Though there are several streams in the surrounding coastline of gulf, they are ephemeral nature and their discharge rates are low. Ceyhan River drains a basin of approximately 20.500 km^2 with an average annual discharge of 303m^3/sec and annual sediment yield of 5500x103 tones (compiled from EIE, 1982 and 1984). It has a delta complex comprising several typical lagoons, marshes, abandoned channels, delta mouths, etc. (Bal and Demirkol, 1987).

The land topography, having a very large coastal plain with low topographic relief along the northwestern part of the gulf and narrow coastal plain with high topographic relief in southern sector, is one of the important factors that control the supply of sediments in to the gulf.

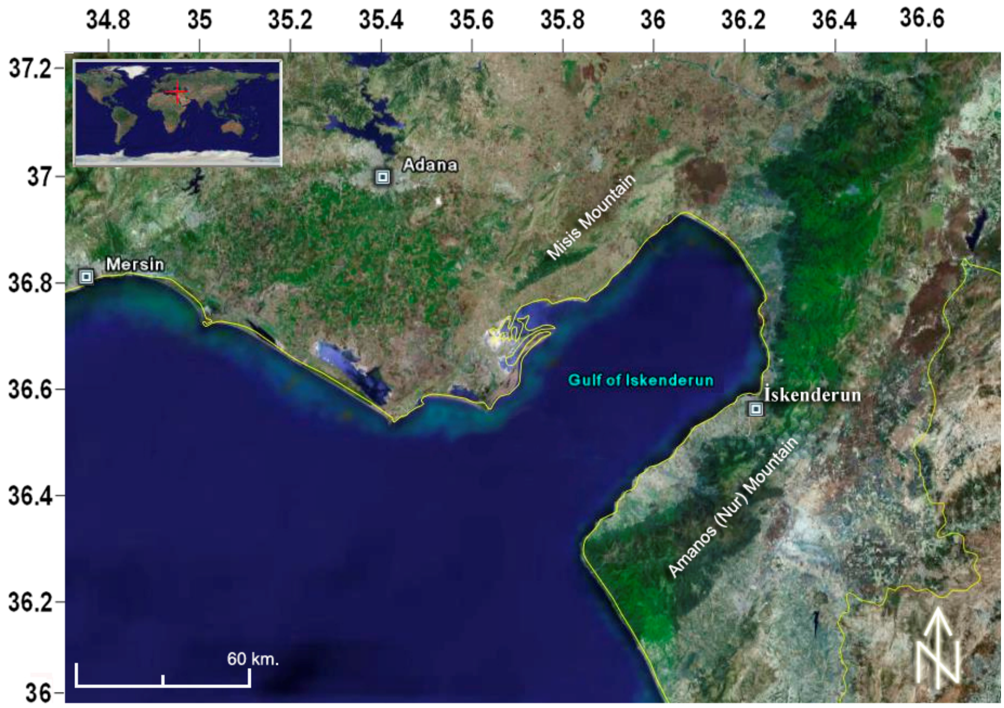


Figure 1-1. Satellite image of study area and surrounding regions (from Google Earth 2006).

The study area has a typically "Mediterranean Climate" that is hot and dry in summer and mild and wet in winter. Available data of 1939 -1980 shows that the air temperature varies between 11.4 ^{0}C in January and 30^{0}C in July with an annual mean temperature of 19.6 ^{0}C. The mean annual rainfall and mean humidity is 740 mm and 70 %, respectively (Meteorological Bulletin, 1984).

The general circulation current pattern is strongly influenced by the dominant wind direction at İskenderun, which is prevalently from the N-NW sector in summer (from April through to September) even as from the S-SE in winter (from October through to March) (İyiduvar, 1986).

Bathymetry

The Mediterranean Sea is composed of two distinct basins, the western and the eastern Mediterranean. The shallow Sicilian Channel (150 km wide, 400 m deep) separates them and prevent the water masses from the deep and bottom layers of the two basins from mixing (Malanotte-Rizzoli *et al*., 1996). The eastern Mediterranean consists of the Levantine, Ionian, Adriatic and Aegean Seas. In the northeastern Levantine Sea, the morphology of the seafloor is mostly constrained by large-scale tectonic elements of converging African and Anatolian plates and by the rivers flowing into the region (Aksu *et al*., 1992).

The Gulf of İskenderun, located in northeastern Levantine Sea, looks like a shallow marine basin. The bottom topography of the gulf is generally less than 100 m and it increases in east-west direction from 10 m in the inner part to approximately 100 m towards the mouth of the gulf (Figure 1-2). The depth variation in the north-south direction is irregular and much deeper in the southern part than in the northern part. The continental shelf is generally less than 5 km wide from the coasts of Mersin as well as the Gulf of İskenderun to the Syrian coasts, but it widens noticeably to 15-45 km off the mouth of the present-day deltas (Ceyhan and Seyhan). The shelf break occurs at 100-150 m, steeper slopes of 1:100 in the İskenderun Basin (Aksu *et al*., 1992).

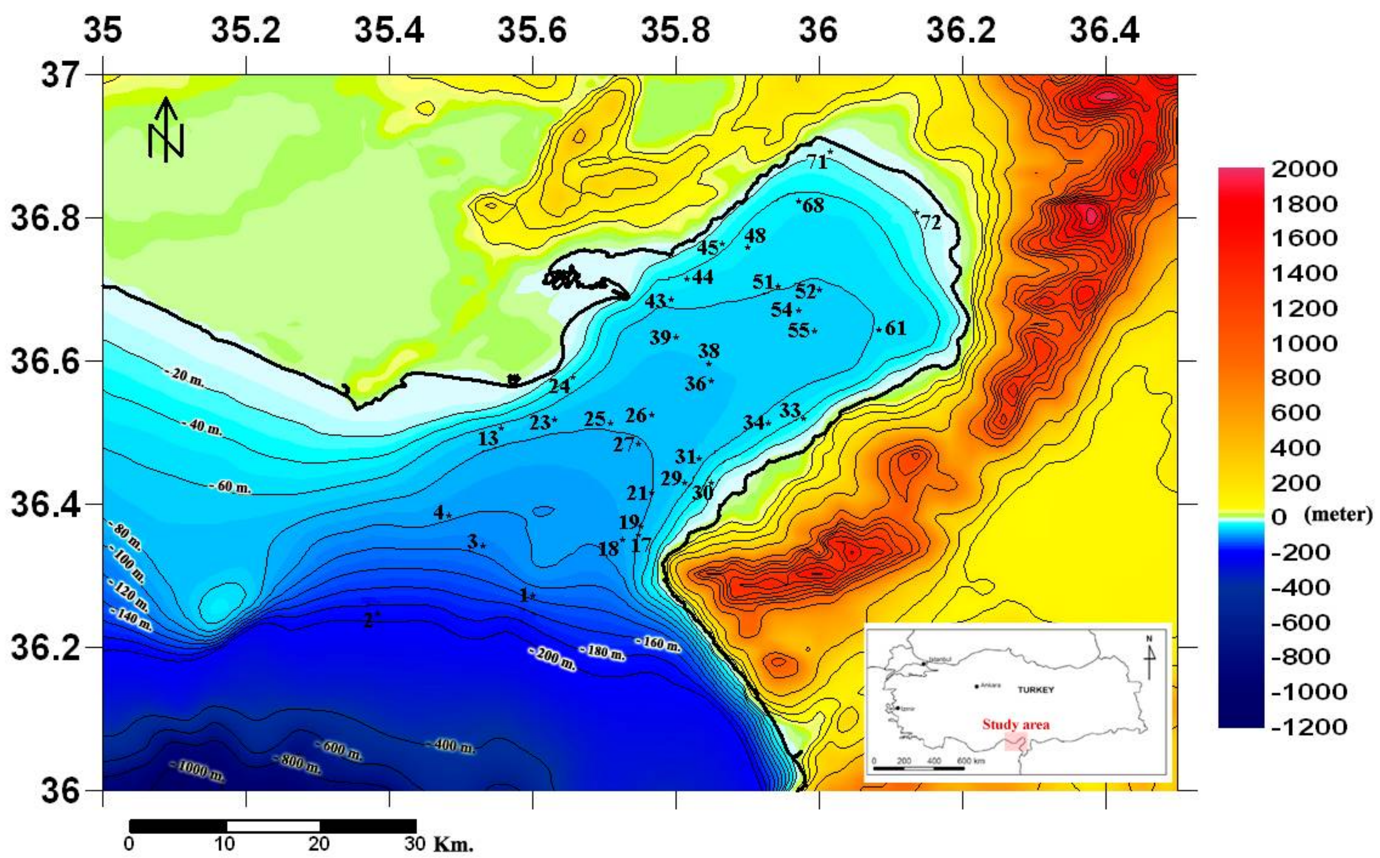


Figure 1-2. Batyhymetry of the Gulf of İskenderun and the locations of the stations of the samples in this study. Depth of the contour intervals are in meter.

1.3. General Oceanographic Characteristics

In this section, not only general oceanographic characteristics of the Gulf of İskenderun, but also that of the Mediterranean Sea emphasizing eastern part of it are given. To understand these features is important as a point of view of ecological environments of surrounding areas.

Water circulation

The Mediterranean Sea is a mid-latitude semi-enclosed sea or just about isolated oceanic system and characterized by evaporation exceeding precipitation and river runoff. The circulation in the Mediterranean Sea mainly relies on this water exchange and the geometry of the Strait of Gibraltar (Krijgsman, 2002). Although, circulation in Mediterranean is still debated, general scheme as follows. Eastern Mediterranean originated salty and warm water mass in the lower layer exits from Gibraltar, while less salty and cold Atlantic Water (AW) mass in the upper layer enters Gibraltar. Therefore, all waters are circulating in an anticlockwise direction (Figure 1-3). AW mass spreads eastward as it undergoes progressive modifications and becomes warmer and saltier (Mediterranean Waters- MWs). MWs are qualified as either intermediate or deep depending on the subbasin. For the western basin, Western Mediterranean Deep Water (WMDW) is produced in the Gulf of Lions and for the eastern basin, Eastern Mediterranean Deep water (EMDW) is produced in the southern Adriatic. In Eastern Levantine, intense evaporation in the wintertime and associated heat loss under surface winds change modified-AW into a different water mass that is saltier, denser and sinks to intermediate depths of 300 to 500 meters, called Levantine Intermediate Water (LIW) (Malanotte-Rizzoli *et al*., 1996, Figure 1-4).

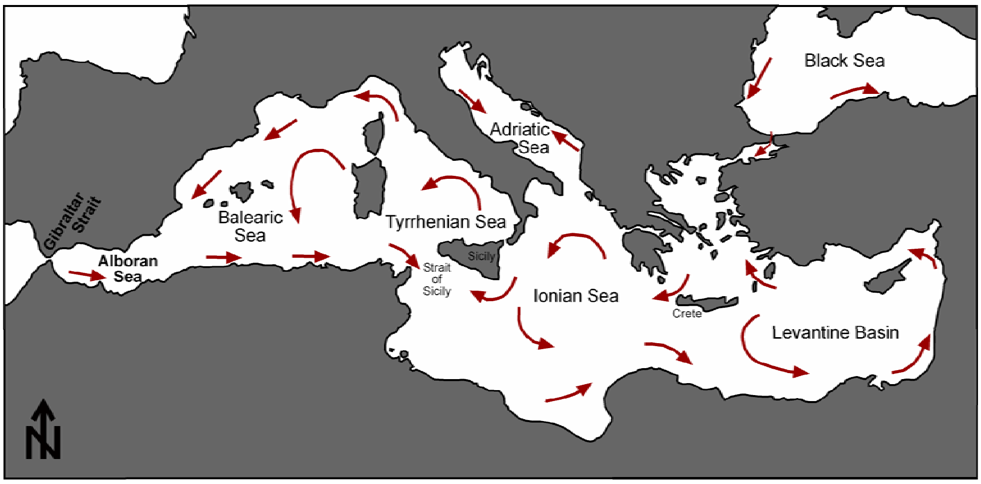


Figure 1-3. Generalized surface circulation pattern of Mediterranean Sea (Cimmerman and Langer, 1991).

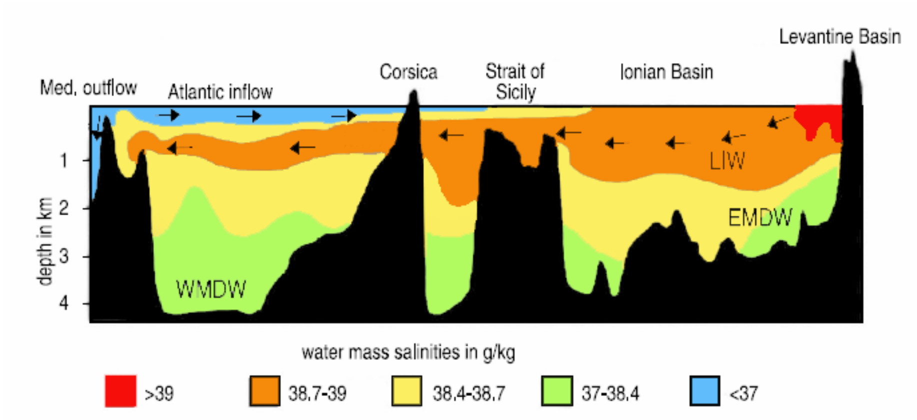


Figure 1-4. Schematic diagram of water-mass circulation for Mediterranean basin during summer. WMDM=Western Mediterranean Deep Water; EMDM=Eastern Mediterranean Deep water; and LIW=Levantine Intermediate Water (Krijgsman, 2002).

The general pattern of water movement in the Gulf of İskenderun is influenced by northwesterly flowing open-sea currents and local winds (Figure 1-5, İyiduvar, 1986). During summer, open-sea waters, creating clockwise gyres in the inner part and anticlockwise in the outer part, enter the gulf from the north-west and the water column is strongly stratified in consequence of insolation. During winter, open-sea waters enter into the gulf from the south-southwest and move towards the inner gulf along the coast. Gulf water becomes cooler because of northerly and northeasterly winds and wind-induced mixing results a homogeneous vertical structure in water column (Ergin *et al*., 1996). These gyres shown in the Figure 1-5 may produced by shearing of northwesterly flowing Mediterranean current along the coast. Whatever the case may be, it appears that the general flow pattern in the gulf comprises two main gyres (anti-cyclonic and cyclonic), whose extend and rotation are variable (Latif *et al*., 1989).

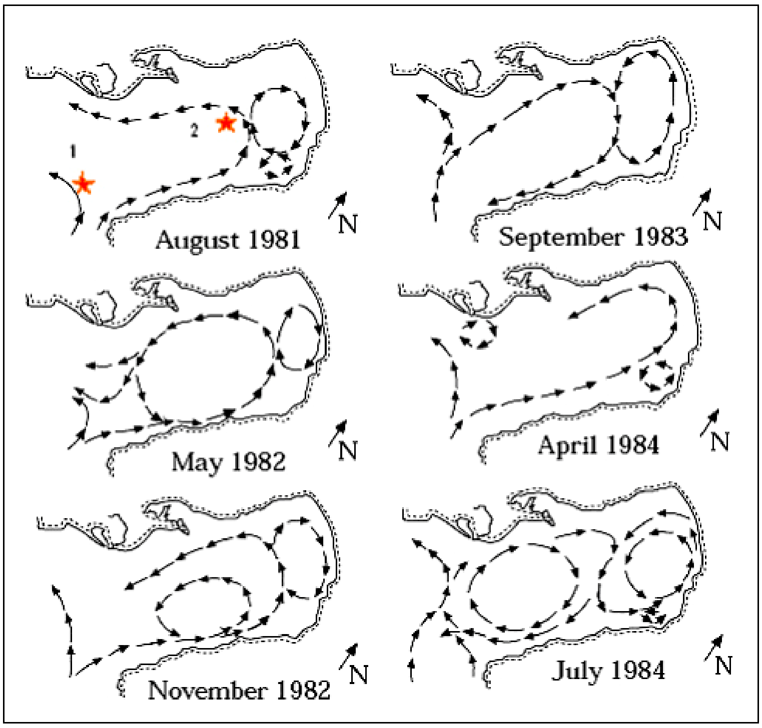


Figure 1-5. Prevailing surface circulation patterns in the Gulf of İskenderun. Stars with numbers 1 and 2 show the monitoring stations (after İyiduvar, 1986).

Temperature and salinity distribution

Mediterranean Sea is represented by high temperatures with annual minimum of 12 °C, reaching up to 25 °C during summer, inducing high metabolic rates. Besides, it is high saline environment with a freshwater deficiency of about 2 500 km^3/year (EEA, 1999).

In Gulf of İskenderun, the water column has an identical two-layer temperature structure as solar radiation heats the surface, during the summer. The sea surface temperature varies from 15 ^{0}C to about 29 ^{0}C in February-March and August, respectively. In the middle of the gulf that held relatively colder waters with temperature of 20 ^{0}C, thermocline is settled at about 50 m. In autumn, water column temperature begins to decrease because of land originated northerly and northeasterly winds and sea surface temperature is minumum in February. A distinctly homogeneous structure is formed owing to vertical wind-induced mixing (İyiduvar, 1986).

During November-February period, when evaporation is high, salinity of the gulf water increases and reaches 39.4 ppt. During March-June period, surface salinity decreases to 38.5 ppt as rainfall and local rivers discharges. Since more saline surface waters enter into the gulf during march-June periods, there are more saline waters at the surface than lower layer at the mouth of gulf. This is most remarkable characteristic of the gulf (İyiduvar, 1986).

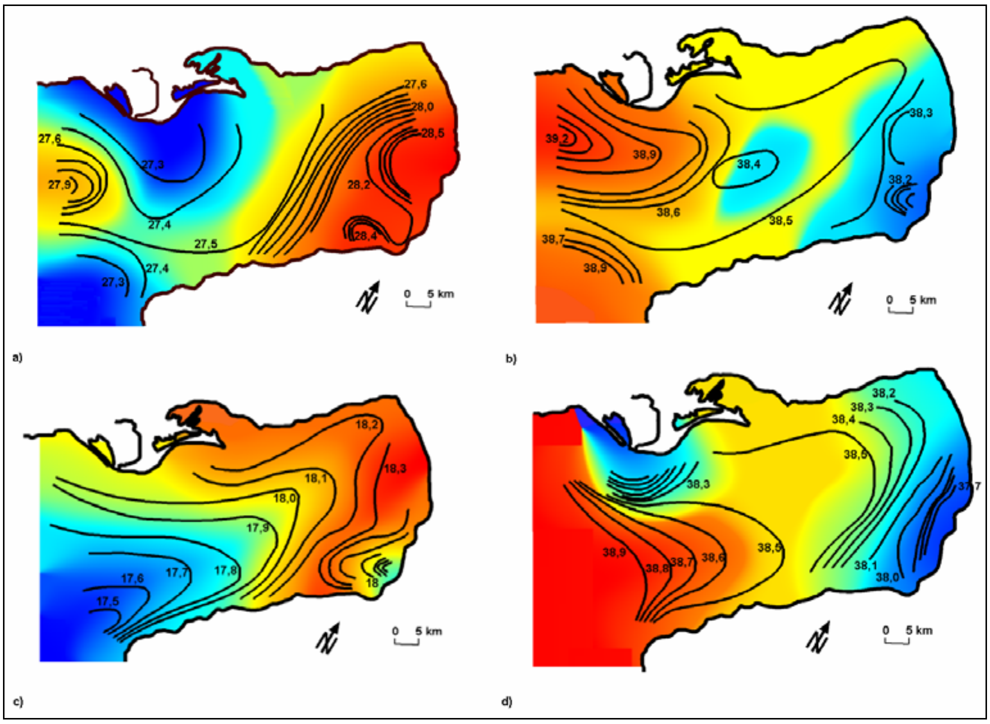


Figure 1-6. Summer surface temperature (a) and salinity (b) distribution 14–18 July, 1981; Winter surface temperature (c) and salinity (d) distribution 17–18 April, 1984 (İyiduvar, 1986)

Ecosystem productivity

Having relatively low concentrations of nutrients and low primary production and low phytoplankton biomass, Mediterranean waters are generally oligothropic that increases from west to east. However, river discharges bring nutrients to sea near the rivers mouths and wind mixing and upwelling allows for vertical transport of nutrients in some areas. Although primary production of most of the world's oceans is considered nitrogen limited, Mediterranean waters are phosphorus limited (EEA, 2006).

Despite the plankton rich waters of the North Atlantic and Black Sea, The SeaWIFS satellite image shows the clear, pigment poor waters of the Mediterranean. Trough the eastward, there is a noticeable west–east gradient with increasing oligotrophy, even in the less productive month of September (Turley, 1999, Figure 1-7).

Figure (1-7) shows that present study area is nutrient rich as well as the Adriatic Sea, the coasts of Egypt, the Gulf of Lions and the Gulf of Cadiz. These areas will be discussed later in terms of the distributions of benthic foraminifers from selected studies.

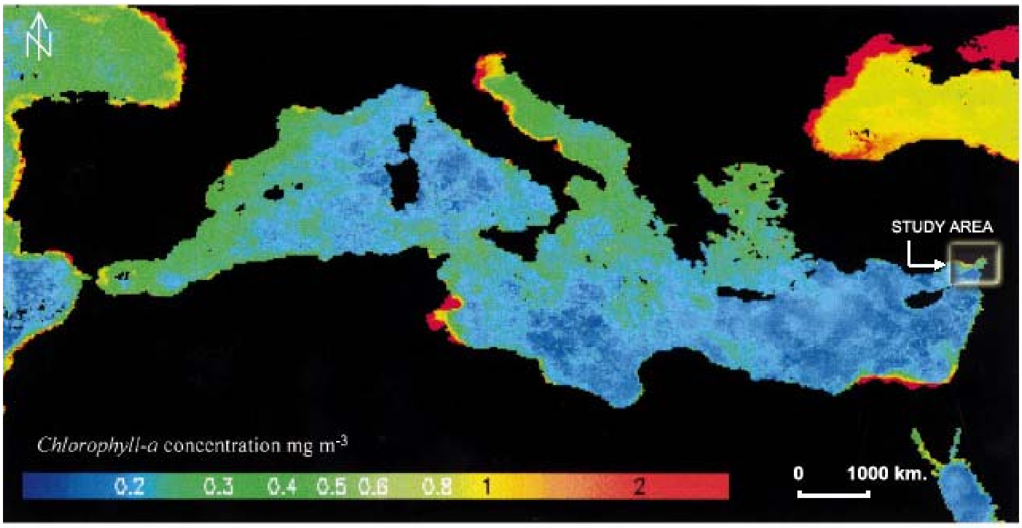


Figure 1-7 The Ocean colour Sea-viewing Wide Field-of-View Sensor (SeaWiFS) image from Orbital Sciences Coorporations' SeaStar satellite estimates of phytoplankton concentrations monthly composite during September 1997 (Turley, 1999).

According to Turley (1999), primary production in Mediterranean Sea is on average three times lower in the eastern basin than the western basin.

Except from riverine and oceanic inputs, inputs from the atmosphere as a dust deposition may also be important to the functioning of the Mediterranean ecosystem and it gradually increases from the western to the eastern Mediterranean. The majority of dust deposition carries many trace elements like Fe, Mn, Be and Al, episodically and they contributes the phytoplankton growth (Guerzoni *et al*, 1997).

According to Yılmaz *et al*. (1992), production in the Gulf of İskenderun is 2 to 4 times higher than offshore areas of eastern Mediterranean and the Gulf of İskenderun has higher chlorophyll-a values than remaining parts of eastern Mediterranean Sea coasts of Turkey. Main reason of these higher values is mainly Ceyhan River discharge. Consequently, Gulf of İskenderunis not oligotrophic as the eastern mediterranean and no eutrophication has been experienced (Polat, 2002).

Pollution

Because, Mediterranean Sea is a microtidal regime with a tidal range typically less than 50 cm, it reduces the potential for dilution and dispersion of dissolved and particulate wastes (EEA, 2006). 131 “pollution hot spots”, which consist of 26 % urban, 18 % industrial and 56 % mixed, have been identified along the Mediterranean coastline (UNEP/WHO, 2003). These hot spots are point pollution sources or polluted coastal areas that may affect ecosystems and biodiversity. Sources of pollution are land-based including sewage and urban run-off, urban solid wastes, persistent organic pollutants (POPs), heavy metals, radioactive substances, nutrients, suspended solids and hazardous wastes; and off shore and marine-based pollution that is petroleum hydrocarbons from shipping activities and marine litter.

Figure 1-8 shows that the Gulf of İskenderun is also a pollution hot spot as maritime traffic in the The Gulf of İskenderun is heavy due to industrial facilities, petrol pipelines and loading facilities and waste discharges of domestic and industrial origin are discharged into the gulf (Yılmaz *et al*., 1992). Effects of pollution on the benthic foraminifers of the Gulf of İskenderun will be discussed in the following chapters.

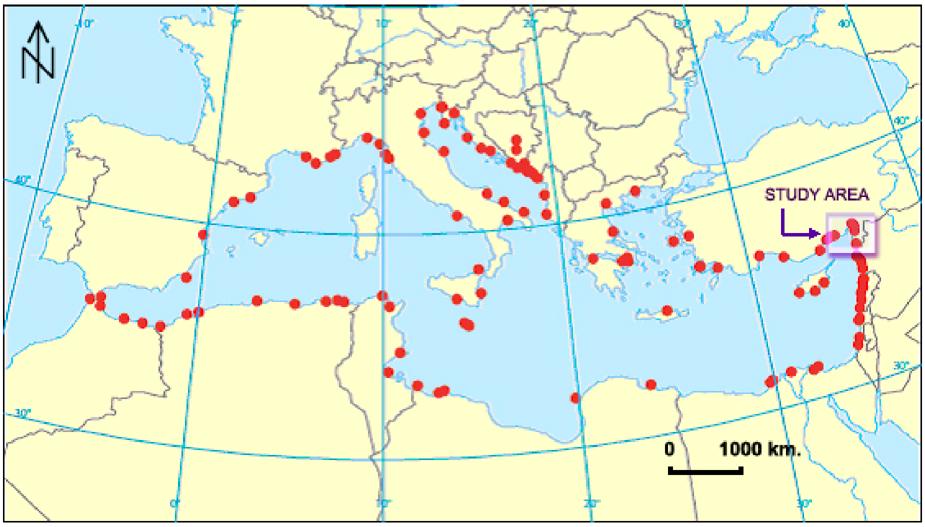


Figure 1-8 Pollution hot spots along the Mediterranean coast represented by dots. (UNEP/WHO, 2003)

1.4. Geology of the Gulf of İskenderun

In consequence of its latitudinal position and its semi-enclosed land-locked setting between Africa and Europe, the Mediterranean is excellent natural laboratory to study the fundamental paleoclimatic and geodynamic processes (Krijgsman, 2002). The last phase of collision between the Eurasia and African plate acts as the primary plate tectonic process on the Eastern Mediterranean and the displacements of the smaller Arabian, Syrian, Anatolian and Aegean microplates also control the present-day tectonic framework (Aksu *et al*., 1992a).

Jackson and Mc Kenzie (1984) and Kasapoğlu and Toksöz (1983) suggested that the motion of the East Anatolian Fault in the west of the junction of African and Arabian plates includes an extensional component, which may have been responsible for the opening of the Gulf of İskenderun. Sengör *et al*. (1985) support some geological evidence of the occurrence of recent rifting in the Gulf of İskenderun. They claim that the Cilician Basin may have been originated because of similar movements.

Between the north and west faulted margins of the Kızıldağ–Hatay ophiolite complex and the Aslantaş Fault Zone, the İskenderun Basin is situated at the edge of the Anatolian platform, immediately southwest of the Africa/Arabia/Anatolia triple junction (Dewey *et al*., 1986; Figures 1-9). The southeast margin of the Amanos Mountains is bordered by the sinistral Amanos Fault that converges with strands of the Dead Sea Transform Fault below the Amik Basin. The northeast onland extension of the İskenderun Basin, having extensive outcrops of Quaternary volcanics, is The Dörtyol Plain south of the Aslantaş Fault Zone (Kozlu, 1987). To the south, the İskenderun Basin is separated from the Inner Latakia Basin by a set of NW–SE-trending, SW-dipping faults that define the southwest termination of the Amanos Mountains. İskenderun Basin and the Adana Basin is separated by the Misis Mountains that linked by Misis–Kyrenia Fault Zone to the Kyrenia Range of northern Cyprus (Aksu *et al*., 2005a).

Kennett (1982) suggested that all mediterranean basins include a Pliocene-Quaternary clastic sequence, a late Miocene evaporite sequence (Messinean) and a deep-water pre-late Miocene sequence beneath the evaporates. Mulder (1973) stated that a major unconformity is present at the base of the Miocene. Based on seismic reflection data (Mulder *et al*., 1975; and Biju-Duval *et al*., 1978), the upper Cenozoic deposits reach 5-6 km in thickness including thick upper Miocene (Messinean) evaporates in the Adana and İskenderun basins.

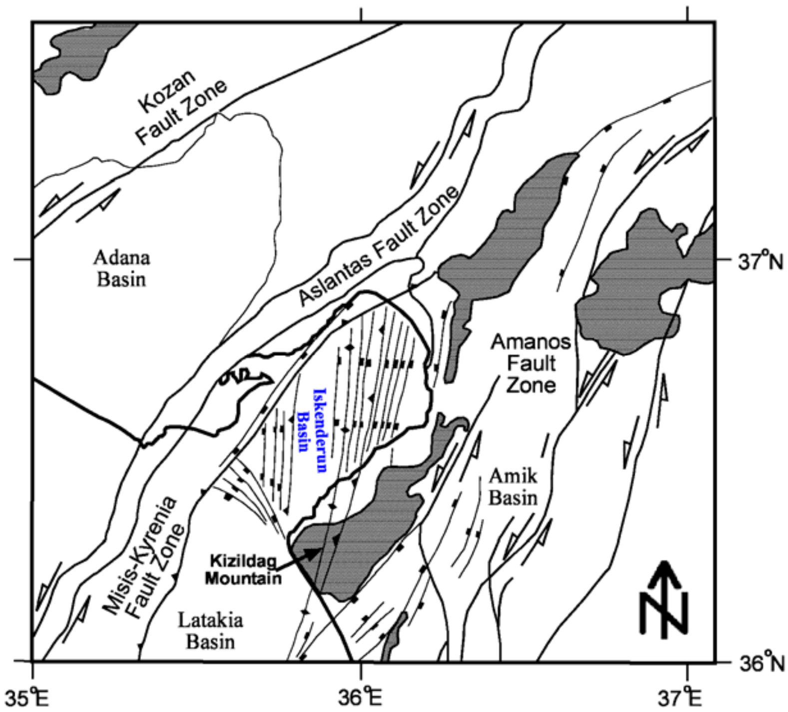


Figure 1-9 Tectonic map of the İskenderun Basin, showing major fault zones. Normal faults shown with (■) ticks at hanging wall, thrust/reverse faults with(▲) ticks at hanging wall, major ophiolites (shaded areas). Half arrows indicate transform/strike-slip faults (Aksu *et al*., 2005b).

The important geological formations outcropping in the coastal hinterland of the gulf are studied by Aslaner (1973) and Tolun and Pamir (1975) and summarized below (Figure 10). At the northern corner of the Gulf of İskenderun, NE-SW trending early Palaeozoic formations are represented by shale-slate-phyllites, micro-conglomerate-quartz sandstones, gray-black dolomitized limestones, clayey limestone-shale and quartzite. The Early Mesozoic formations comprise conglomeratic sandstone-quartzite, crystallized gray limestone, and brecciated dolomitic limestone. Tertiary is characterized by Paleocene limestone facies through Lutetian cherty, gray limestone and nodular limestone and Neogene, which is composed of Miocene conglomerate, sandstone, limestone and marl formations and Pliocene porous conglomerate, sandstone, clay and tuffaceous limestone beds. Quaternary, including ancient and recent alluvial, cemented, angular rubbish breccia, poor cemented conglomerate with angular and rounded pebbles, sands and clay is widespread in the area.

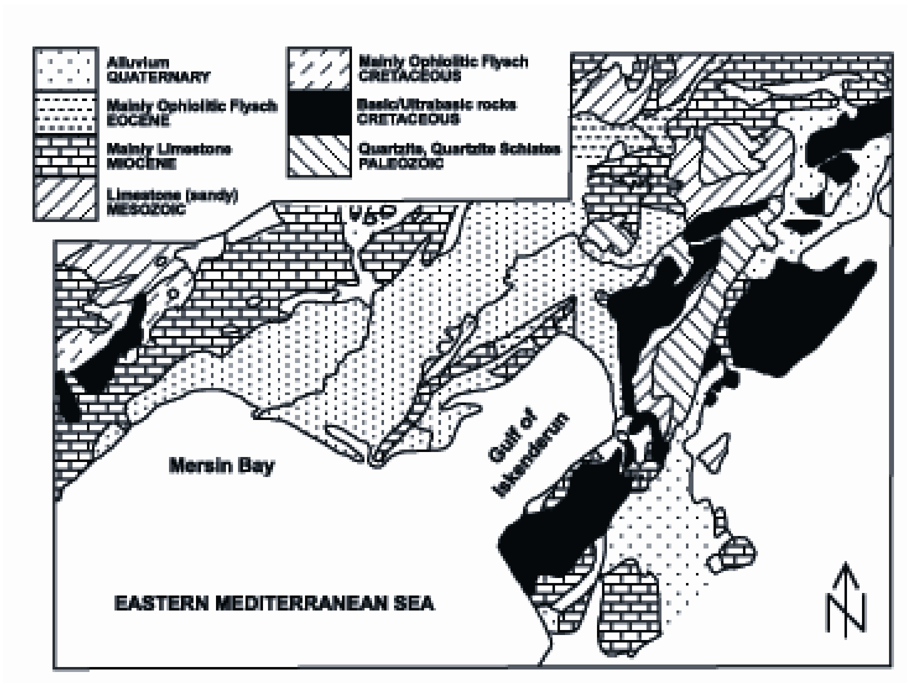


Figure 1-10 Surrounding-land geology of Gulf of İskenderun (slightly modified from the Geological Map of Turkey, 1989).

1.5. Materials and Methods

During the 1988-1991 cruises of R.V. Bilim and R.V. Çubuklu in the gulf of İskenderun, sediment samples were taken from 5 cm of the top layer using a Dietz Lafonde grab sampler and all sample material stored originally at room temperature was available dry in sealed plastic bags. All materials examined (34 samples from 18-190 m water depth) in this study were selected from these samples regarded as being mainly of recent age. Because average sedimentation rates are about 100–200 cm 1000 years^{-1} in study area that means the ages of 5 cm-surface sediment is between 25 and 50 years (Ergin *et al*., 1998).

The samples were processed in following manner. For each sample, 5 grams of dried sediment generally yield 300 specimens of foraminifera was immersed in water. Because the samples disaggregated readily as they were not cemented or consolidated, and resultant slurry washed through the sieves having a mesh opening of 250µm, the middle one 125 µm and the lower one 63µm. The residue was oven-dried at 50 °C. Subsequently, the samples were dry-sieved into the fractions >125 µm. In this study, the fraction greater than 125 µm of the benthic foraminiferal content was investigated for the quantitative analyses, not only in order to save time, but also to distinguish detailed morphological features in microscope. Moreover, most of the studies on recent distribution of benthic foraminifera in Turkey is based on greater than 63 µm fraction. There is a comparison between smaller (> 63 µm) and larger (> 125 µm) benthic foraminiferal faunas distributions with this study. Benthic foraminifera were identified at species level and counted under the stereo microscope.

The studied samples have been previously used for a study of geochemistry of surface sediments and the distribution of grain size (Kazan, 1994). All geochemical and sedimentological data used in this study is belonging to the study of Kazan (1994).

1.6. Previous works

Over the last century, various geological studies have been carried out for different purposes by many researchers in the Mediterranean Sea.Systematic investigations of the Quaternary paleoclimatic and paleoceanographic history of the Mediterranean Sea started with the Swedish Deep Sea Expedition in 1947-1948 (Kullenberg, 1952). Discovery of sapropels in cores from this expedition led to many studies. These studies focused on understanding the origin and the paleoceanographic evolution of the eastern Mediterranean Sea emphasizing neotectonics of eastern Anatolia (Dewey *et al*., 1973; Biju-Duval *et al*., 1977 and 1978; Ketin, 1977; Laubscher and Bernoulli, 1977; Sengör and Yılmaz, 1981; Smith and Woodcock, 1982; Kasapoğlu, 1984; Robertson and Dion, 1984; Sengör *et al*., 1985; Gealey, 1988; Aksu *et al*., 1992 a; Garfunkel, 1998; Robertson, 1998; Garfunkel, 2004; and Aksu *et al*., 2005a).

Dewey *et al*. (1973) is one of the earliest studies on the Eastern Mediterranean basins that described Paleozoic to Cenozoic evolution of the basin and its relation with Anatolia. In the study of Robertson *et al*. (1991), palaeogeographic and palaeotectonic evolution of the Eastern Mediterranean Neotethys is described from integrated basin-scale field and laboratory studies. In addition, Robertson *et al*. (1991) has been discussed the role of the tectonics versus global sea-level change in the neogene evolution of the Eastern Mediterranean. The plate tectonic reconstruction of Eastern Mediterranean has been explained at four stages by Robertson *et al*. (1991). Unlike the interpretations of other workers on Mediterranean evolution (Dewey *et al*., 1973; Biju-Duval *et al*., 1977), Gealey (1988) have interpreted that the Eastern Mediterranean and adjacent Middle East area are developed as two seaways with an intervening continental sliver derived from Africa that now comprises Central Turkey and West Iran. Miocene to recent tectonic evolution of the eastern Mediterranean is studied by Aksu *et al*. (2005b) according to detailed interpretation of multichannel seismic reflection profiles and biostratigraphic data from exploration wells.

There are many general studies on the recent sediments of the Cilician Basin. Shaw (1978) and Kapur *et al*. (1989) studied on the clay mineralogy of the recent surface sediments of the Cilician basin. The studies of Shaw and Bush (1978), and Ergin *et al*. (1988) are related to the geochemistry of the recent sediments of the Cilician basin. The nature, distribution and origin of sapropelic sediments of the Clician Basin are represented by Shaw and Evans (1984). Mange-Rajetzky (1983) established the heavy mineral distribution of the recent sediments of the Cilician Basin.

Vautrin (1933) is the first publication concerning the İskenderun basin, which includes the description of this basin and gives general picture of this area. In the report on the geology of Hatay (Ericson, 1940), a detailed survey of the İskenderun basin is given .The land geology of the surroundings of the Gulf of İskenderun has been studied in detail by Erickson (1940), Turkunal (1750), Erentoz and Tolun (1954), Atan (1969), Aslaner (1973), Talun and Pamir (1975), Beltrandi and Biro (1975), Ilhan (1976), Altinli (1988) and Yilmaz *et al*. (1988).

Geophysics of the İskenderun Basin and Quaternary seismic stratigraphy were implemented by Aksu *et al*. (1992b, 1993). Mean depths of the masses that cause magnetic anomalies in the Gulf of İskenderun is determined by Demirel (1993). Ediger *et al*. (1992) and Kizilkoca (1992) also has been studied some small-scale geological and geophysical studies. Geochemistry of surface sediments in İskenderun Basin was carried out by Kazan (1994); Avcı (1996); and Ediger *et al*., (1997). Ergin *et al*. (1996) emphasize the source and depositional controls on heavy metal distribution in marine sediments.

In the İskenderun Basin, although land geology, geophysics, oceanography and geochemistry of surface sediments have been studied extensively, knowledge on micropaleontology of recent marine sediments is very limited. Only, brief summary of the distribution of the benthic foraminifers of the Gulf of the İskenderun was given in Avşar (1997), and Avşar *et al*., 2001. Basso and Spezzaferri (2000) represents living benthic foraminifera of the Gulf of İskenderun with a statistical approach. Moreover, geochemical anomalies in the recent foraminifers of the Gulf of İskenderun have been carried out by Yalçın *et al.,* 2004. In their study, colored benthic foraminiferal tests collected from two different locations has been studied by using whole-rock and microprobe methods and their relation with hydrothermal springs related to faults have been investigated.

Meditrerranean coasts of Turkey are relatively less studied than other coasts in terms of the recent foraminifers. Micropaleontological studies in Turkey are mainly concentrated on taxonomy of the foraminifers to evaluate the distribution in the coasts of Turkey (Alavi, 1980; Alavi, 1988; Meriç, 1986; Avşar, 1997; Meriç and Avşar, 1997; Sakinç, 2000; Avşar and Meriç, 2001b; Avşar, 2002a; Meriç *et al*., 2002c; Meriç *et al*., 2003a; Meriç *et al*., 2004a). Many of the published studies on foraminifers from the coasts of Turkey are given in Table 1 and Figure 1-11. The most of the studies on recent foraminifera from Turkey do not rely on quantitative analysis of the Foraminifera.

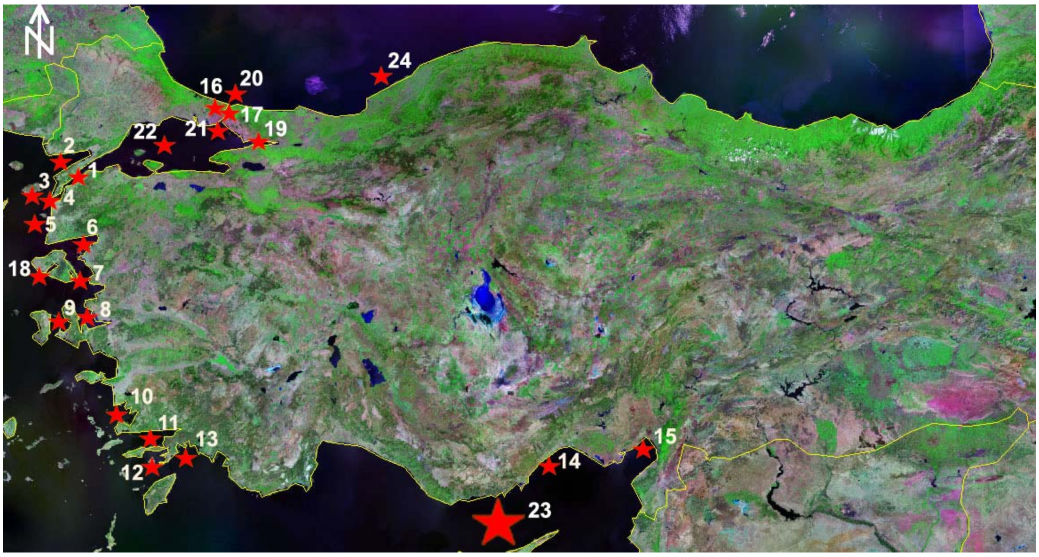


Figure 1-11. Selected references from Turkey for ecological remarks of the benthic foraminifers in the Turkish coast. Stars show locations of studies that given in table detailly.

Table 1-1. Selected studies on the benthic foraminifers from the Turkish coasts

star #	Location	Authors who have studied in that locality
1	Dardanelles	Avşar and Meriç, 2001b
2	Gulf of Saroz	Meriç *et al*., 2004; Altiner *et al*., 1999; Sakinç, 2000
3	Gökçeada	Meriç *et al*., 2004; Avşar and Meriç, 2001b
4	Gökçeada, Bozcaada and Çanakkale triangle	Meriç *et al*., 2004; Avşar, 2002a; Meriç *et al*., 2002c; Avşar and Meriç, 2001b
5	Bozcaada	Meriç *et al*., 2004; Meriç *et al*., 2002; Sakinç, 2000; Avşar and Meriç, 2001b
6	Gulf of Edremit	Meriç *et al*., 2004; Meriç *et al*., 2003a; Sakinç, 2000
7	Dikili and Çandarlı Bays	Meriç *et al*., 2004; Meriç *et al*., 2003b
8	Gulf of Izmir	Meriç *et al*., 2004
9	Karaburun Peninsula	Meriç *et al*., 2004; Avşar and Meriç, 2001a; Meriç,1986; Avşar and Meriç, 2001b
10	Güllük Bay	Meriç *et al*., 2004; Avşar and Meriç, 2001b
11	Gulf of Gökova	Meriç *et al*., 2004
12	Gulf of Datça	Meriç *et al*., 2004
13	Marmaris Bay	Meriç *et al*., 2004
14	Mersin Bay	Avşar, 1997; Avşar and Meriç, 2001b; Alavi, 1980
15	The Gulf of İskenderun	Avşar, 1997; Avşar *et al*., 2001; Avşar and Meriç, 2001b
16	Golden Horn	Meriç *et al*., 2003c; Meriç and Sakınç, 1990; Sakinç, 1998; Avşar and Meriç, 2001b; Şamlı, 1996
17	Bosporus	Meriç *et al*., 2001; Meriç and Sakınç, 1990; Sakinç, 1998, Alavi, 1988
18	Midilli (Lesbos) Island	Meriç *et al*., 2002a
19	Gulf of İzmit	Meriç *et al*., 1995; Meriç and Avşar, 1997
20	Northern end of the Bosphorus	Meriç *et al*., 2001; Avşar and Meriç, 2001b; Aksu *et al*., 2002
21	Northern Marmara Sea	Meriç *et al*., 2001; Meriç and Avşar, 1997; Kaminski *et al*., 2002; Avşar and Meriç, 2001b; Alavi, 1988; Aksu *et al*., 2002
22	Marmara Sea	Aksu *et al*., 2002; Kaminski *et al*., 2002
23	Cilician Basin	Alavi, 1980
24	Western Black Sea	Avşar and Meriç, 2001b

The Black Sea foraminifers have been documented by Yanko and Troitskaja (1987), and their ecology summarised by Yanko (1990). Only detailed taxonomical study, which is related to the microspheric and macrosferic individuals of *Amphicoryna scalaris* of the eastern Aegean Sea, is carried out by Meriç *et al.*, 2004b. There are also some taxonomical studies emphasizing on the benthic foraminifers in the areas under the thermal influence. The benthic foraminiferal content and change in abundance of benthic foraminifers of the sediment samples from the thermal regions in İzmir is taxonomically investigated by Avşar and Meriç, 2001b. In addition, there are some micropaleontological studies on the samples from the Marmara Sea and Aegean Sea to investigate the history of the marine connections between the Black Sea and Mediterranean (Meriç *et al*., 1995; Meriç and Avşar, 1997; Kaminski *et al*., 2002; Aksu *et al*., 2002). Kaminski *et al*., 2002 further aims to provide a taxonomic census of the benthic foraminifera and to trace the development of oxygen depletion beneath pycnocline by using the benthic foraminifers and quantitative analysis. The most detailed study based on quantitative analysis of the foraminifers of the Gulf of Saroz and bathymetrical distributrion of the foraminifers have been carried out by Altıner *et al.* (1999). According to their invstigations, the relative abundance of some foraminifers is related to depth of the samples and that may give information about tectonic events. Meriç *et al*., 2003b and Meriç *et al*., 2004c concentrated on the morphological abnormalities of benthic foraminiferal test in the Aegean Sea. Thay aimed to provide important data on relation between the morphological abnormalities and contempareneous environmental conditions. Hovewer, they did not give the portion of the deformed tests and types of the morphological deformities in detail.

Although there is a limited application on recent foraminifera in Turkey, other studies from surrounding of Turkey will give extensive documentation of the foraminifera. Jorissen (1988) studied the distribution and morphology of the benthic foraminifera and constructed a paleoecological model that is useful to interpret the faunal changes in the Adriatic Sea. Cimerman and Langer (1991) produced a workable taxonomic framework for the benthic foraminifers from the western Mediterranean Sea. Hottinger *et al*. (1993) focused on internal structures of species with well-illustrated X-ray photographs and exhibited a precisely defined terminology of most used terms. This framework has been expanded by the faunal studies given in Figure 1-12.

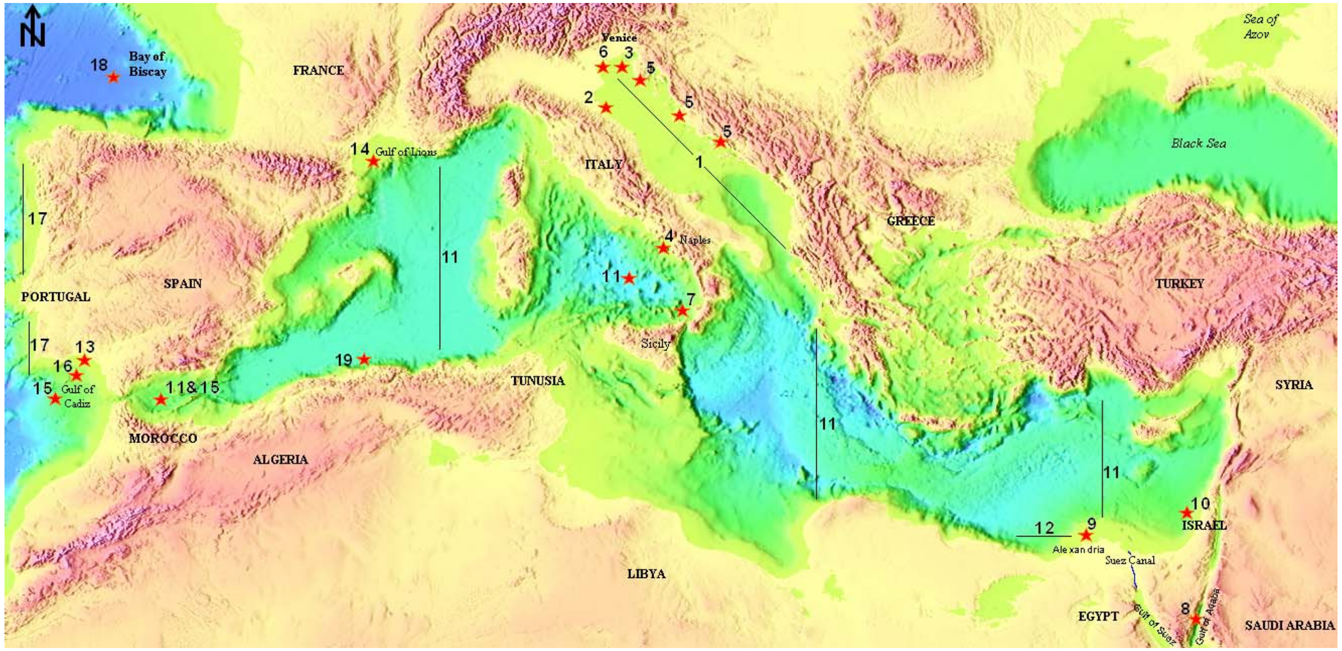


Figure 1-12 Selected references (except from Turkey) for ecological remarks of the benthic foraminifers in the Mediterranean Sea and surrounding areas. 1) Jorissen., 1987; and Jorissen,1988; 2) Fiorini and Vaiani, 2001; 3) Jorissen,1992; and Donnici *et al*., 2002; 4) Sgarrella and Moncharmont-Zei, 1993; 5) Cimerman, and Langer, 1991; and Vanicek *et al*., 2000; 6) Barbero *et al*., 1999 and Donnici *et al*., 1997; 7) Langer., 1993; and Panieri *et al*., 2005; 8) Hottinger *et al*., 1993; 9) Samir and El-Din, 2001; 10) Hyams *et al*., 2002; and Yanko *et al*, 1998; 11) Cita and Zocchi, 1978; 12) Samir *et al*., 2003; 13) Mendes *et al*., 2004; 14) Schmiedl *et al*., 2000 and Schmiedl *et al*., 2004; 15) Caralp, 1988; 16) Schönfeld, 2002a and Schönfeld, 2002b; 17) Schönfeld, 1997; Levy *et al*., 1993 and Schönfeld and Zahn, 2000; 18) Fontanier *et al*., 2002; 19) Moulfi-El-Houari *et al*., 1999.

Bandy and Chierici (1966) evaluated the influence of depth and temperature variations on the foraminifers of the Mediterranean Sea and made a comparison between the bathyal foraminifers of southern California coasts and the Mediterranean Sea. The different basins of the Mediterranean Sea has ben investigated quantitatively and qualitatively in terms of their benthic foraminiferal content by Cita and Zocchi (1978) and abundance and diversity of these species are related to depth of the samples. Langer (1993) studied the morphology of the epiphytic foraminifera in the Island of Vulcano (Tyrrhenian Sea) and classified their assemblages with multivariate analyses. Jorissen *et al.* (1992) evaluated the relationship between the input of organic matter and the distribution of benthic foraminifera in the northern Adriatic Sea by using some statistical methods. Donnici *et al.* (1997) aimed to understand the mechanisms that control the dynamics of populations and growth factors and to verify the capability of biocenosis as an indicator of environmental change in the Venice Lagoon. Barbero *et al.* (1999) also studied in the Venice Lagoon and defined both the zonal environmental similarities (biotopes) and the faunal similarities (biofacies).

Donnici and Barbero (2002) described the benthic foraminiferal associations, correlated the foraminiferal populations with environmental parameters in the northern Adriatic Sea. Caralp (1988) studied the distribution of late glacial to recent deep-sea benthic foraminifers from the northeastern Atlantic (the Gulf of Cadiz) and western Mediterranean (the Alboran Sea) and investigated the relation between bottom waters and the deep-sea benthic foraminifers. Schimedl *et al.* (2004) evaluated the influence of microhabitat, organic matter flux and metabolism on stable oxygen and carbon isotope composition of foraminifera of the western Mediterranean Sea. Holzmann *et al.* (1998) studied the molecular variability in *Ammonia* spp. from the Lagoon of Venice. Danovaro *et al.* (1999) evaluated the response of the benthic foraminifera to particulate fluxes in different tropic environments of the Catalan Sea and Creten Sea. Schimedl *et al* (2004) described the complex network between physical, biological and biogeochemical parameters and the resulting stable isotope composition of benthic foraminifera in a mesotrophic continental slope environment of the western Mediterranean Sea. Moufi-El-Houari *et al.* (1999) studied the distribution and associations of benthic foraminifera in the Algeria coasts by using cluster Analysis.

Samir *et al,* 2003 studied in the Alexandra, Gulf of Kanayis, Abu Hashafa Bay and aimed to determine the distribution of benthic foraminiferal assemblages and to relate the faunal assemblages to environmental factors. In the El Max and Miami Bays (Egypt), the distribution and abundance of benthic foraminiferal species, the relationship between foraminiferal assemblage and marine pollution have been investigated using cluster analysis by Samir and El-Din (2001). Hyams *et al.* (2002) reported the distribution patterns of the larger foraminifera in the Israel coasts. Yanko *et al.* (1994 and 1998) studied the morphological deformities of the benthic foraminiferal tests and its relation to pollution in the Israel coasts.

Guimerans and Currado (1999) reviewed the available taxonomic information and described the distrubution pattern of the uvigerinids in the Gulf of Cadiz. Levy *et al*. (1993) evaluated the quantitative distribution and biogeography of benthic and planktonic foraminifera in the Continental Margin of Portugal by using the correspondence analysis and principal component analysis. Schönfeld (1997) and Schönfeld (2002) described the response of the bathyal benthic foraminifera of the coasts of the Portugal to a set of well-known environmental factors, which is provided by a near-bottom current, called as the Mediterranean Outflow Water (MOW), and he used some statistical methods including the multivariate statistical analysis, R-mode cluster analysis. Mendes *et al.* (2004) analyzed the population of the benthic foraminifers on the Guadiana Shelf influenced by rivers, geomorphological and hydrodynamic setting of shelf. He also identified the possible influences of environmental parameters on the distribution of the benthic foraminifers by using Q and R-mode cluster analysis.

CHAPTER II

QUANTITATIVE ANALYSIS OF BENTHIC FORAMINIFERA IN THE GULF OF İSKENDERUN

2.1. Introduction

The studied samples have been collected from the Gulf of İskenderun. Foraminifers have been picked up from 34 samples distributed between 18-190 meters depths. For each sample, individuals have been counted up to the statistically significant number 300, excluding the sample-23. Although whole material (10 gr.) of the sample-23 has been washed, only 87 individuals been have counted. Possible reasons for relatively low number of total individuals in this sample will be discussed later. It should be noted that relative abundance term is used here to define relative percentage of species.

Bathymetrical and geographical distributions of the sampling locations are given in Table 2.1.Bathymetrical subdivision of Sgarrella and Moncharmont-Zei (1993) given in Table 2.2 is used to simplify the demonstration of depth of the samples. Herein, this study mainly deals with the neritic zone including infralittoral, upper circalittoral and lower circalittoral zones. It should be noted that the depths of majority of the samples have been limited in the upper circalittoral zone. Effects of this depth restriction on the distribution of the benthic foraminifers will be discussed in the following chapters.

Table 2.1. Bathymetrical and geographical distribution of sampling locations.

Station No:	Sediment texture	Longitude (º " ')	Latitude (º " ')	Depth (m)	Bathymetrical zones
71	(g)sM	36 00 54	36 53 36	18	Infralittoral Zone
72	msG	36 08 12	36 48 30	18	
30	msG	35 51 54	36 26 00	35	
45	M	35 52 00	36 45 54	35	
33	gM	35 58 42	36 31 15	38	
24	Z	35 39 23	36 34 45	41	
68	M	35 58 12	36 50 00	44	
44	M	35 47 18	36 43 00	45	
48	M	35 53 24	36 45 33	49	
34	mG	35 57 06	36 30 51	50	Upper circalittoral Zone
43	M	35 47 36	36 41 30	55	
51	(g)mS	35 56 30	36 42 09	58	
61	(g)M	36 08 12	36 38 48	58	
13	M	35 33 30	36 29 00	64	
29	gM	35 50 02	36 25 56	65	
31	(g)sM	35 53 00	36 28 00	65	
39	(g)M	35 48 00	36 38 00	65	
54	(g)sM	35 58 15	36 40 18	65	
52	(g)mS	36 00 00	36 42 00	70	
55	(g)M	35 59 38	36 38 36	70	
23	M	35 37 48	36 30 30	71	
38	M	35 50 48	36 38 00	71	
18	(g)sM	35 43 30	36 21 03	76	
26	M	35 46 00	36 31 30	77	
36	(g)M	35 53 12	36 36 09	77	
25	(g)M	35 42 30	36 32 05	78	
17	(g)M	35 40 24	36 21 30	80	
19	(g)M	35 45 00	36 22 12	80	
21	(g)sM	35 42 36	36 25 00	80	
27	(g)M	35 46 12	36 29 03	83	
4	(g)M	35 29 00	36 21 00	94	
3	(g)M	35 31 48	36 20 36	117	**Lower circalittoral Zone**
1	(g)sM	35 36 00	36 14 45	137	
2	M	35 23 00	36 15 30	190	

Table 2.2. Bathymetrical subdivision of the neritic and epibathyal Mediteranean zones (Sgarrella and Moncharmont Zei, 1993).

Zone	Upper Limit (m)	Lower Limit (m)
Infralittoral	0	40-50
Upper Circalittoral	40-50	80-100
Lower Circalittoral	80-100	150-200
Upper Epibathyal	150-200	400-500
Lower Epibathyal	400-500	1, 000

2.2. Distribution of the Foraminifers

The benthic foraminiferal assemblages of the studied samples have been identified and quantitatively analyzed. The results are documented in the Appendix A. It should be remembered that the data comprise counts of the number of individuals belonging to a total of the planktonic and benthic foraminiferal species in 34 samples. Total individuals in each sample are equal to 300, except sample-23. In this study, 151 benthic foraminiferal species belonging to 81 genera of the Suborders Rotaliina, Miliolina, Textulariina, Lagenina and Spirillinina have been determined. Taxonomical hierarchy of species will be given in Chapter 4.

Benthic foraminifers in the studied samples show high diversification (Appendix-A) and complex distribution patterns. Generally, the distribution patterns do not show a distinct tendency with the change of the bathymetrical zones. In other words, it is difficult to describe any relation between bathymetry and distribution of each species recorded in this study. Although species are not generally confined to distinct depth range, relative abundance of some species show increasing or decreasing trend in distinct depth zones. As mentioned previously, the benthic foraminiferal fauna in the study area is highly diversified; many species have been recorded with only one individual. As a result, it is rather difficult to reach any conclusion either on a possible depth preference of these species or on effects of other parameters. Considering this, any discussion regarding these rare species is avoided in this study.

2.3. Distribution of the suborders

The relative abundance of foraminifers based on their suborders is given in Figure 2-1. Distribution pattern of planktonic foraminifers which are classified as the Suborder Globigerinina, will be explained separately in following section.

Among all suborders, the Suborder Rotaliina has the greatest relative abundance value of 47.3 %. Moreover, diversity of this suborder is extremely high and represented by 36 genera including 60 species. The variations in the abundance of the Suborder Rotaliina in the samples are easily recognized. According to their Suborder Rotaliina content, the samples can be listed in descending order; the samples 31, 26, 52, 4, 39, 54, 17, 36, 19, 38, 45, 27, 25 and 68. These samples are generally located in the inner part of the gulf except the samples 19 and 45.

Based on the relative abundances, the Suborder Miliolina is the second most important component of the total assemblages with 36.9 %. Besides, diversity of the Suborder Miliolina is lower than that of the Suborder Rotaliina and it comprises of 27 genera. Relative abundance of the Suborder Miliolina is high in samples 1, 18, 72, 3, 33, 30, 71, 13 and 24. These samples are generally located near the coastline of the Gulf of İskenderun (infralittoral zone) except the samples situated at the entrance of the gulf (the samples 1 and 3 from the lower circalittoral zone). Most of the miliolids are considered as shallow water forms except few genera from the deep sea (Sen Gupta, 1999).

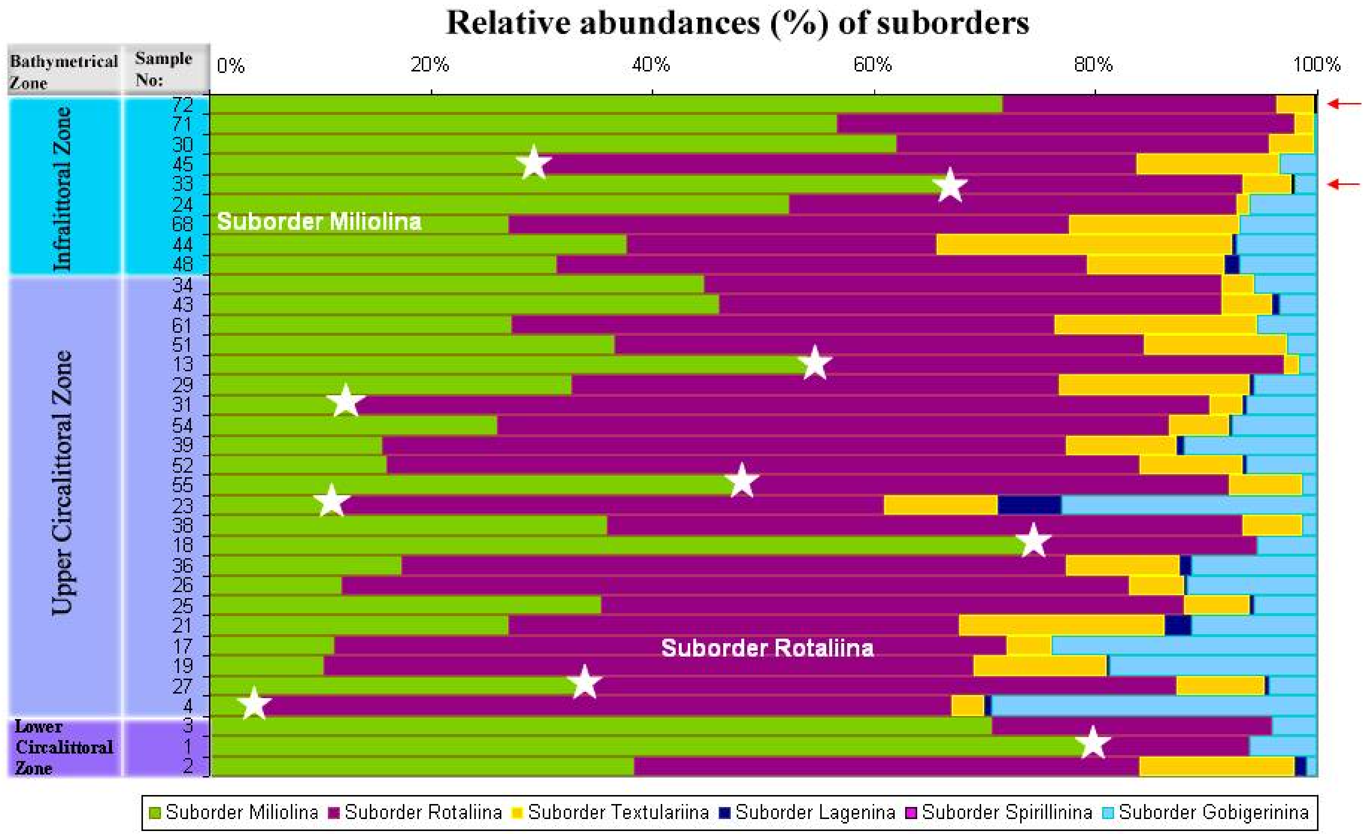


Figure 2-1 Bathymetrical distribution of relative abundance (%) of the suborders of foraminifers recorded in the studied samples. Arrows show the suborder Spirillinina and stars show abrupt increase or decrease in relative abundances of the Suborder Milioliina and the Suborder Rotaliina.

There is an inverse relationship between relative abundances of the Suborder Miliolina and the Suborder Rotaliina in the studied samples. This relationship is easily recognized especially in the samples 72, 33, 18, 3 and 1 with higher relative abundance of the Suborder Miliolina; and samples 31, 39, 52, 36, 26, 17, 19 and 4 with higher relative abundance of the Suborder Rotaliina (Figure 2-1). Median values of vertical distribution of these suborders also show this inverse relationship (Figure 2-2). Relative abundance of the Suborder Rotaliina is lower, higher and lower than that of the Suborder Miliolina with increasing bathymetrical zones, respectively. Conversely, there are anomalous samples, which is contrary to this pattern illustrated in Figure 2-2. Against the samples in the same bathymetrical zone, relative abundance of this suborders increases or decreases abruptly in the samples 45, 13, 55, 18, 27, and 1.

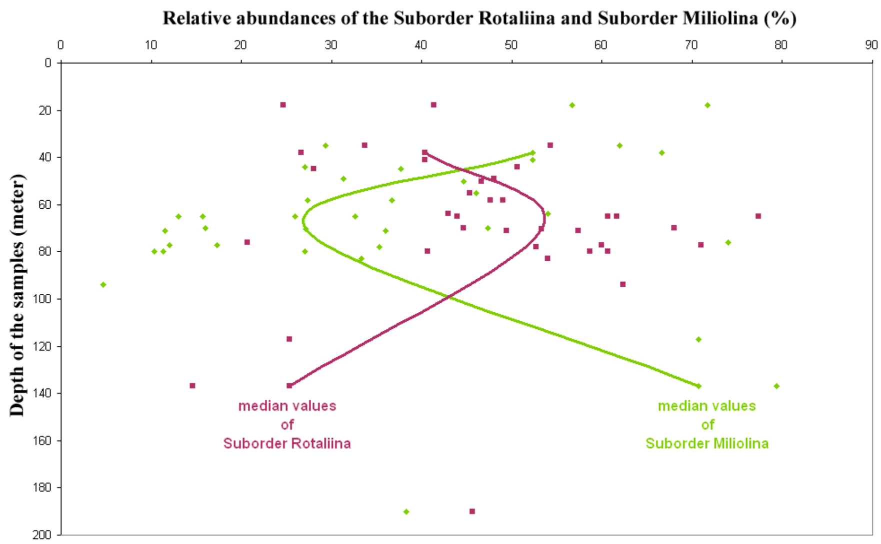


Figure 2-2. Bathymetrical distribution of relative abundances (%) of the Suborder Miliolina and the Suborder Rotaliina recorded in the studied samples.

In western Mediterranean Sea, like the Gulf of İskenderun, the Suborder Rotaliina is the most diverse and abundant component of the assemblages.

Instead of the Suborder Miliolina as in this study, the Suborder Textulariina is the second high abundant and diverse groups. In the Egypt coasts, the most abundant component of fauna (60-85 % of the total assemblages) is the Suborder Miliolina, and it is followed by the Suborder Rotaliina with lower relative abundance (15–40%) (Samir and El-Din, 2001; Samir *et al*., 2003).

The relative abundance (%) of the Suborder Textulariina is lower than the other suborders. The highest relative abundance of this suborder (28.8 %) is recorded in the sample 44, which is located in the entrance of the Yumurtalık Lagoon. The Suborder Textulariina is absent in the samples (18, 1 and 3) located at the entrance of the gulf, while relative abundance of this suborder is lower than 5% in some samples (43, 33, 4, 30, 72, 31, 34, 71, 24 and 13) located near the mouth of the rivers. Diversity of this suborder is very low. This suborder is only represented by 8 genera including 11 species (*Textularia bocki, Textularia truncata, Textularia agglutinans, Sahulia conica, Spiroplectinella sagittula, Siphotextularia concava, Lagenammina diffusiformis, Eggerelloides advenus, Eggerelloides scabrus, Reophax scorpiurus* and *Bigenerina nodosaria*). Relative abundances of these species are lower than 1 % within total faunas of the gulf. However, there is one species belonging to Suborder Textulariina, *Textularia bocki* (4.7%) among the most abundant species in this study.

A special attention is given to the Suborder Textulariina, since the diversity and relative abundance of this suborder have been expected much more higher than the results as in western Mediterranean Sea. It is very difficult to compare the relative abundance of this suborder with studies from Turkey since there is a limited knowledge about relative abundances and bathymetrical distributions of foraminifers, as mentioned earlier. However, it can be concluded that there are very low numbers of agglutinated species among the mostly abundant species in these studies. In previous studies from coasts of Turkey, the most dominant agglutinated species are *Textularia agglutinans* and *Bigenerina nodosaria,* while relative abundance of these species is lower than 1 % in the present study.

Although there is limited information on the relative abundance and bathymetric distribution of the Suborder Textulariina, the diversity in the suborder Textulariina has been presented in the previous studies. The diversity of this suborder is varying from the Black Sea to Mediterranean coasts of Turkey. Agglutinated species are absent at the Bozcaada and Çeşme-Ilıca Bay and there is much lower amount of textularids species in Gökçeada, İzmir and Marmaris Bay (Sakinç, 2000; Avşar and Meriç, 2001b; Meriç *et al*., 2002; Meriç *et al*., 2004a). The diversity of the suborder Textulariina in the Marmara Sea (Alavi, 1988; Meriç and Sakınç, 1990; Şamlı, 1996; Sakinç, 1998; Avşar and Meriç, 2001b; Meriç *et al*., 2001; Meriç *et al*., 2003c), in the Gulf of Edremit, Dikili Bay, Çandarlı Bay, the Kuşadası and Güllük Bay (Sakinç, 2000; Avşar and Meriç, 2001b; Meriç *et al*., 2003a; Meriç *et al*., 2003b; Meriç *et al*., 2004a) are more or less similar to that of the present study. However, the Bosporus, like Black Sea, is represented by exceptionally low diversity (Alavi, 1988; Meriç and Sakınç, 1990; Sakinç, 1998; Meriç *et al*., 2001). Diversity of this suborder is high (14 genera including 19 species) in the Gökçeada, Bozcaada and Çanakkale triangle and 10 species of them are the same species which are recorded in this study (Avşar and Meriç, 2001b; Avşar, 2002a; Meriç *et al*., 2002c; Meriç *et al*., 2004a). In the Gulf of Saroz, unlike present study area, diversity of the Suborder Textulariina is the highest diversity with 15 genera including 38 species with comparison to other coasts from Turkey (Altıner *et al*., 1999). Although the relative abundance of *Bigenerina nodosaria*, *Siphotextularia concava* and *Textularia foliacea* is higher in the Gulf of Saroz, the relative abundance of *Bigenerina nodosaria* and *Siphotextularia concava* is much lower and *Textularia foliacea* is not recorded in the studied samples. These species are frequent from the infralittoral zone to the upper epibathyal zone in the Gulf of Saroz. Because of the limit of depth of samples (infralittoral to lower circalittoral zone) they are infrequent in the present study. Especially, the relative abundance of *Bigenerina nodosaria* is recorded almost up to 15 %, while only one individual of *Bigenerina nodosaria* is recognized in the studied samples. In addition, 11 genera including 11 species different from previously mentioned ones are also recorded from the other studies in the Gulf of Saroz (Sakinç, 2000; Meriç *et al*., 2004a). As a conclusion, the eastern Aegean Sea seems to be more diversified in contrast to the Gulf of İskenderun. It is known that bathymetrical distributions of the Suborder Textulariina in previous studies from the eastern Aegean Sea are within the infralittoral zone and circalittoral zone. In other words, the reason of higher diversity of this suborder in these studies is not depth.

Between Aegean Sea and Mediterranean Sea, the Gulf of Datça and Gökova are highly diversified in terms of agglutinated species with 11 genera including 15 species (Meriç *et al*., 2004a). In the Cilician Basin, the relative abundance of agglutinated taxa seems depth dependent as it is generally low (about 5 %) from Anamur to the Akyatan Lagoon along the coastline and increases up to 40 %, after upper epibathyal zone (Alavi, 1980). Furthermore, the diversity of the Suborder Textulariina in the Cilician Basin is extremely high with 62 species belonging to 9 families and 35 genera. On the shelf of the Cilician Basin, like the Gulf of İskenderun, the agglutinated taxa are mostly represented by *Textularia agglutinans*, while the deeper waters are dominated by other agglutinated taxa, which are not recorded in the preset study. In the Gulf of İskenderun, although *Pseudoclavulina crustata* and *Clavulina angularis* are recorded in other studies (Avşar, 1997; and Avşar *et al*., 2001) they are not recognized in this study. Although the differences in the diversity of this suborder from these localities could be explained by the bathymetrical differences between the Cilician Basin and the Gulf of İskenderun, it is not enough to explain the lower diversity in the study area. According to Bizon and Bizon (1985) rapid decomposition of tests may be caused to absence of some agglutinated taxa.

The eastern Mediterranean sea is represented by mostly agglutinated forms at depths greater than 1800 meter (bathyal zones). From the Gulf of Antalya to Nile cone delta (the Egypt coasts), a reworked Pleistocene agglutinated species dominate to clay (kaolinite) rich sediments, related with low ph and 5 agglutinated species, which are not recognized in the present study, are recorded dominantly (Cita and Zocchi, 1978). In the Egypt coasts (Samir and El-Din, 2001; and Samir *et al*., 2003), and relative abundance of the Suborder Textulariina is lower (lower than 0.5 %) than the Gulf of İskenderun and diversity of agglutinated species is also lower and represented by textulariids. In the coasts of Israel (Yanko *et al*, 1994; and Yanko *et al*, 1998), there is limited number of agglutinated species; *Eggerelloides scabrus* and *Textularia bocki* are common. In contrast to the Gulf of İskenderun, Egypt and Israel, the Gulf of Aqaba (Red Sea) is represented by high diversity of the Suborder Textulariina with 39 species belonging to 14 families and 20 genera; it should be noted that the majority of samples are belonging to neritic zone (Hottinger *et al*., 1993).

The diversity and relative abundance of the Suborder Textulariina is also higher in the western Mediterranean Sea compared to the present study. In the Bou-İsmail Bay (continental margin of Algeria), 17 agglutinated species belonging to12 genera are recorded, 6 of them are recorded in the present study, remaining ones are common in Aegean Sea and other parts of western Mediterranean Sea (Moulfi-El-Houari *et al*., 1999). Adriatic Sea is enormously diversified (44 species) with agglutinated species, which are also reported in the Aegean Sea and eastern Mediterranean Sea, and the most frequent agglutinated species are *Textularia agglutinans*, *Bigenerina nodosaria, Eggerelloides scabrus,* and *Spiroplectinella sagittula* (Jorissen, 1988; and Jorissen, 1987; Donnici *et al*., 2002 and Jorissen, 1992; Cimerman, and Langer, 1991; Vanicek *et al*., 2000; and Fiorini and Vaiani, 2001). These dominant species are also recorded near the volcanic island of Vulcano in Tyrrhenian Sea (Cimerman, and Langer, 1991; Panieri *et al*. (2005); and Langer., 1993). In the Gulf of Naples (Sgarrella and Moncharmont-Zei, 1993), diversity of agglutinated species is also extremely high with 64 species belonging to 14 families, 38genera. *Textularia agglutinans* is also common up to upper epibathyal zone in the coasts of Greece islands (Blanc-Vernet, 1969). The Alboran Sea (1200-1300 m depth), where the majority of sediments are considered to be reworked, is lack of agglutinated species (Caralp, 1988; and Cita and Zocchi, 1978). The Balearic basin (mesobathyal zone) is dominated by few agglutinated taxa (Cita and Zocchi, 1978). In the Gulf of Lions, more than 22 agglutinated species belonging to 18 genera are recorded and 4 of them (*Reophax* spp. and *Bigenerina* spp.) are dominant (Schmiedl *et al*., 2000; and Schmiedl *et al*., 2004). As a conclusion, agglutinated taxa in western Mediterranean Sea are similar to that of Turkish coasts and only small number of these species is recorded in the Gulf of İskenderun. Highly diversified agglutinated species of western Mediterranean Sea is partly related to bathymetry, some of these species are recorded in bathyal zone.

Near the Gibraltar, The Gulf of Cadiz (the eastern North Atlantic) is influenced by waters of Mediterranean Sea. In contrast to present study, the Gulf of Cadiz is represented by highly diversified (74 species being 39 % of total fauna) in terms of agglutinated species, which is characteristics of bathyal zone (Schönfeld, 2002a; and Schönfeld, 2002b). Guadiana shelf of the Gulf of Cadiz is dominated by *Eggerelloides scabrus* (Mendes *et al*., 2004). The Portuguese continental margin that is also affected by outflow waters of Mediterranean Sea is largely dominated by 67 Textulariina species, almost 40 % of the total species (Schönfeld, 1997; Levy *et al*., 1993; and Schönfeld and Zahn, 2000). It can be concluded that the eastern North Atlantic Sea at the entrance of Mediterranean Sea is represented by more diversified agglutinated species than the present study and species are similar to that of the Mediterranean Sea.

The Suborder Lagenina has relatively lower relative abundance (generally <1 %) within the suborders in the studied samples. It is represented by 16 species belonging to11 genera including *Dentalina, Laevidentalina, Favulina, Fissurina, Amphicoryna, Lagena, Glandulina, Globulina, Robertinoides*, *Lamarkiana* and *Nodosaria*. These low relative abundance and low diversity are possibly resulted from selected sediment size fraction (>125 μm). This suborder is mainly recorded in the upper circalittoral zone. The Suborder Lagenina demonstrates highest relative abundance (5, 7%) in the sample 23 that is already exceptional sample from many other points of view and will be explained in following sections.

In the other parts of Turkey seas, diversity and relative abundance of the Suborder Lagenina is generally higher than the present study. In the Marmara Sea (Alavi, 1988; Meriç and Sakınç, 1990; Şamlı, 1996; Sakinç, 1998; Avşar and Meriç, 2001b; Meriç *et al*., 2001; Meriç *et al*., 2003c), diversity of the Suborder Lagenina is lower than eastern Aegean Sea but it is higher than the present study. In the eastern Aegean Sea, diversity of the Suborder Lagenina is higher and characterized by 44 species belonging to 5 families and 24 genera (Meriç *et al*., 2004aa; and Sakinç, 2000). Partially, different coasts of the eastern Aegean Sea are represented by low diversity of the Suborder Lagenina. For instance, diversity of the Suborder Lagenina in the Gulf of Saroz (Altıner *et al*., 1999), which is the most diversified region of eastern Aegean Sea, is slightly lower than the present study with 12 species belonging to 9 genera, while relative abundance of these species is slightly higher than the present study. Frequency and relative abundance of these species in the Gulf of Saroz increases at depths greater than 70 meter.

In the Egypt coasts (Samir and El-Din, 2001; and Samir *et al*., 2003), although sediment size fraction is greater than 63 µm, diversity and relative abundance of the Suborder Lagenina is low as is present study. This suborder is only characterized by the Family Polymorphinidae and relative abundance of this suborder is lower than 0.5 % in the Egypt coasts. In the present study, Family Polymorphinidae is only represented by *Globulina minuta* and *Glandulina* sp. A. In the Gulf of Aqaba (Hottinger *et al*., 1993), there are 37 species belonging to 6 families and 20 genera; most of these species is different from other Lagenina species in the western Mediterranean Sea. Only 3 (*Oolina hexagona*, *Fissurina lucida* and *Lagena strumosa*) of these species are recorded in the present study.

In contrast to the present study, the western Mediterranean Sea is extremely diverse with the Suborder Lagenina (Jorissen,1988; Jorissen., 1987; Donnici *et al*., 2002; Jorissen,1992; Sgarrella and Moncharmont-Zei, 1993; Cimerman, and

Langer, 1991; Vanicek *et al*., 2000; Barbero *et al*., 1999; Donnici *et al*., 1997; Langer., 1993; Schmiedl *et al*., 2000 ;Schmiedl *et al*., 2004; Caralp, 1988; Fontanier *et al*., 2002; Moulfi-El-Houari *et al*., 1999; Fiorini and Vaiani, 2001). Especially, in the Gulf of Naples, there are 83 species of the Suborder Lagenina belonging to 4 families and 19 genera in the Gulf of Naples (Sgarrella and Moncharmont-Zei, 1993). Most of them are rare, infrequent. 46 of them are recorded deeper than lower circalittoral zone. All species recorded in the present study are also reported from western Mediterranean Sea but only one individual of these species is generally recorded, even *Amphicoryna scalaris,* relative abundance of that is generally higher than 5 %. Depth and sediment size fraction (>63 μm) in previous studies seems to play important role in this high species number. However, it can be concluded that diversity of the Suborder Lagenina in the studied samples from the Gulf of İskenderun is noticeably lower than western Mediterranean Sea.

The Suborder Spirillinina is only represented by *Spirillina vivipara* and has extremely low abundance. Only two individuals are found in different locations (in sample 72 and 33) near the northeastern part of coastline and their depths are corresponding to the infralittoral zone.

The Suborder Spirillinina is very rare in other parts of the Turkey seas, similarly in the Gulf of İskenderun. In the eastern Aegean Sea, The Suborder Spirillinina is only characterized by 3 species including *Spirillina vivipara, Spirillina limbata* and *Patellina corrugata*; while *Spirillina limbata* is not recorded in the Marmara Sea. In western Mediterranean Sea, the Suborder Spirillinina is characterized by at most 7 species belonging to 3 genera and diversity and relative abundance of this suborder are very low.

Based on the basic wall structure, tests of the benthic species are grouped as 3 categories with porcelaneous tests, agglutinated test and hyaline tests. There are 75 species having hyaline tests, 65 porcelaneous and 11 agglutinants.

Bathymetrical distribution of wall composition of assemblages in each sample is plotted in a ternary diagram (Figure 2-3). This diagram shows that the lower circalittoral zone represented by mostly porcelaneous species, while porcelaneous species replaced by hyaline species in the upper circalittoral zone. As explained earlier, it is simply noticed that the study area lack of agglutinated species. The infralittoral zone is also represented by mostly porcelaneous species, except in the samples (45, 48 and 68) located between Botaş and the Yumurtalık Lagoon. In the samples 45, 48 and 68, porcelaneous/hyaline ratio is almost 3/5. It may be concluded that infralittoral zone and lower circalittoral zone are the favorable place for the distribution of porcelaneous forms. Relative abundances of porcelaneous species in upper circalittoral zone is significantly lower than the other two zones.

Hyaline species is mostly distributed at the center part and the northwestern entrance of the gulf, while coastline of the gulf is deficient in terms of hyaline species (Figure 2-4). Inverse relationship between porcelaneous and hyaline species is also well represented in geographical distribution maps (Figure 2-4 and Figure 2-5). In contrast to hyaline species, porcelaneous species is mostly distributed in the coastline and southwestern entrance of the gulf. Geographical distribution of agglutinated species is not homogeneous. İskenderun, the Yumurtalık Lagoon and southeastern entrance of the gulf are characterized by agglutinated species (Figure 2-6).

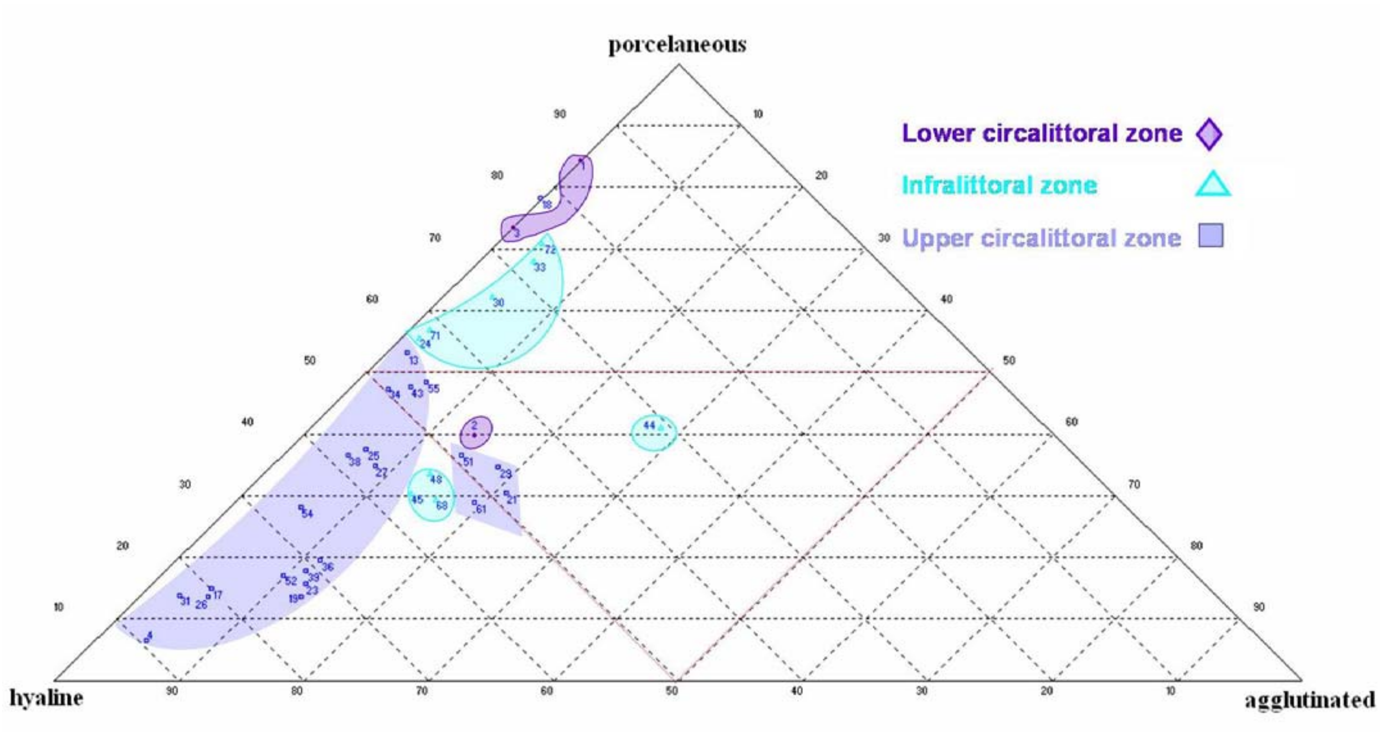


Figure 2-3. Ternary diagram of bathymetrical distribution of the benthic foraminiferal species in terms of wall structure. Numbers show samples number

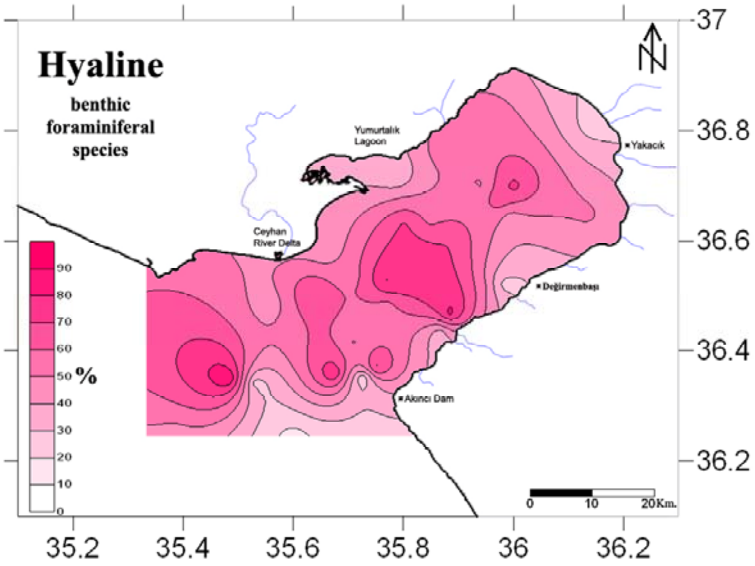


Figure 2-4. Geographical distribution of relative abundance (%) of hyaline foraminiferal species recorded in the studied samples. Color scheme shows percentage of relative abundance.

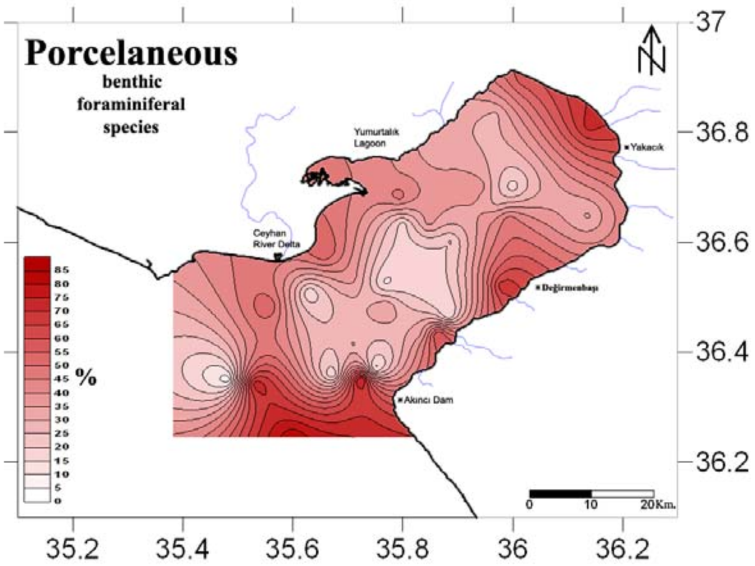


Figure 2-5. Geographical distribution of relative abundance (%) of porcelaneous foraminiferal species recorded in the studied samples. Color scheme shows percentage of relative abundance.

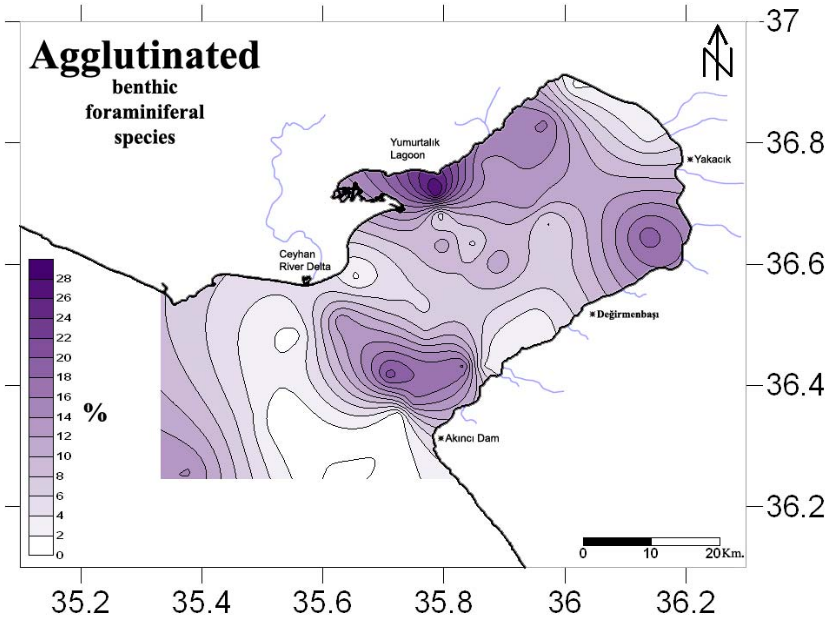


Figure 2-6. Geographical distribution of relative abundance (%) of agglutinated foraminiferal species recorded in the studied samples. Color scheme shows percentage of relative abundance.

As a conclusion, the relative abundances of the Foraminifera are variable from site to site in the present study. Figure 2-1 and appendix A show that there are not any regular distribution patterns of the suborders according to bathymetrical zones. In other words, distribution of species as well as the distribution of the suborders is not homogeneous in terms of bathymetrical zones and this patchiness seems to be related different environmental conditions in different parts of the gulf. Therefore, vertical (bathymetrical) and horizontal (geographical) distributions of ecologically most important species will be discussed separately in following sections.

2.4. Distribution of Planktonic Species

In the samples from the Gulf of İskenderun, diversity of planktonic species is extremely low thus this study is only focused on benthic foraminifera. Planktonic foraminifera constitute almost 7.3 % of total faunas found in the studied samples. Planktonic species have not been identified specifically, although they have been counted as a planktonic form from each sample.

Relative abundance of planktonic foraminifera in the samples is given in Figure 2-7 a. The relative abundance of planktonic foraminifera increases towards to lower circalittoral zone. Infralittoral zone is poor in planktonic species, as it is undoubtedly expected owing to shallower depths. In the sample 72 (18 meter), planktonic species are absent and only one individual is encountered from the samples 71 (18 meter) and 30 (35 meter).
The relative abundance of planktonic foraminifera is high at the outer parts of the gulf, whereas the northeastern part of the gulf is barren in terms of planktonic foraminifera (Figure 2-7 b).

The relative abundance of planktonic foraminifera in the samples 1 and 18 (137 m and 76 m, respectively) has been expected much higher than the results (<2 %). To find possible reason for low relative abundance, the samples have been checked again through the fractions between 63 and 125 micron. However, planktonic species was absent. It may be concluded that the planktic/benthic foraminiferal ratio may be unreliable environmental indicator for determining depth in areas controlled by a combination of various environmental parameters.

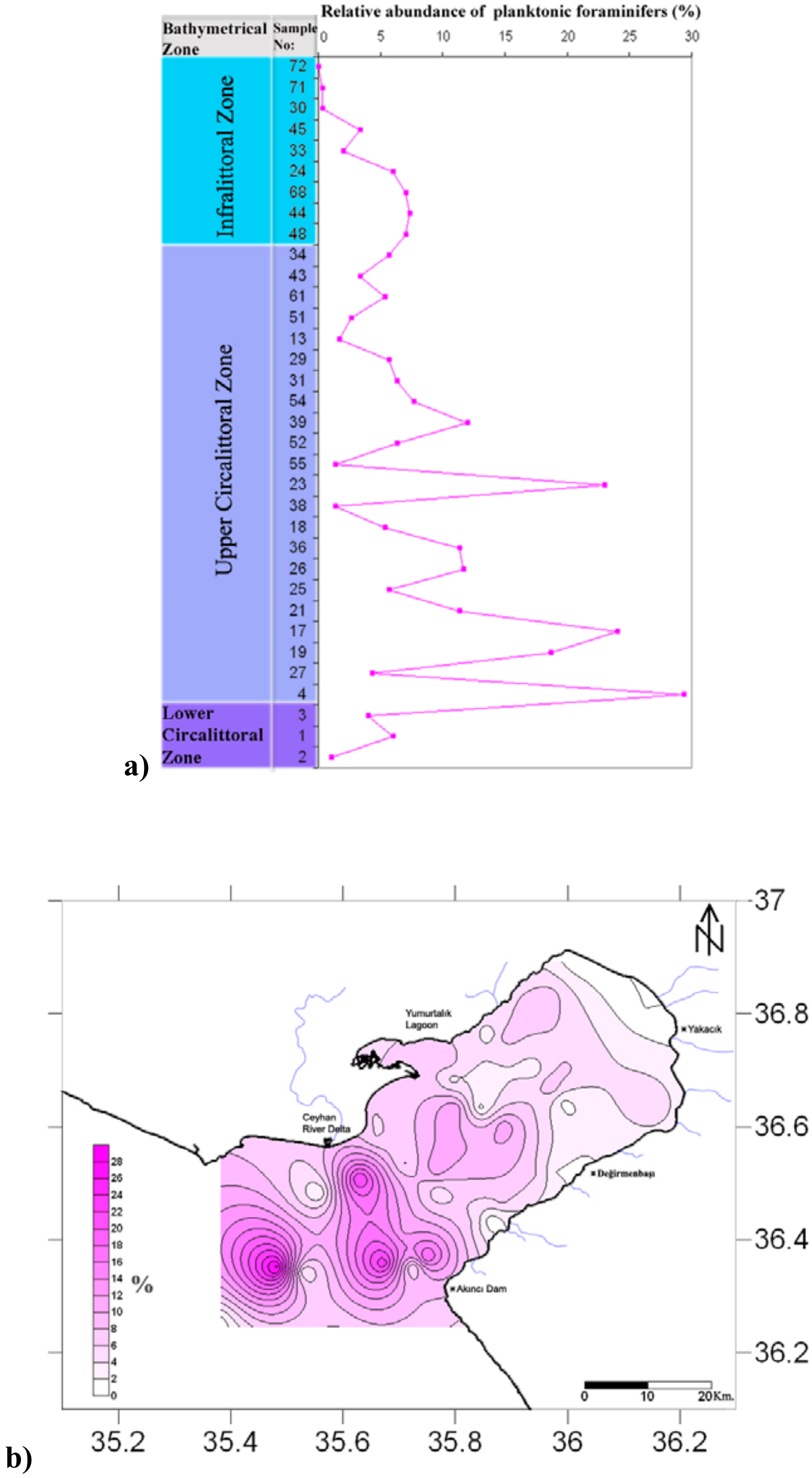


Figure 2-7. Relative abundance (%) of planktonic foraminiferal species recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

2.5. Distribution of the most abundant benthic foraminiferal species

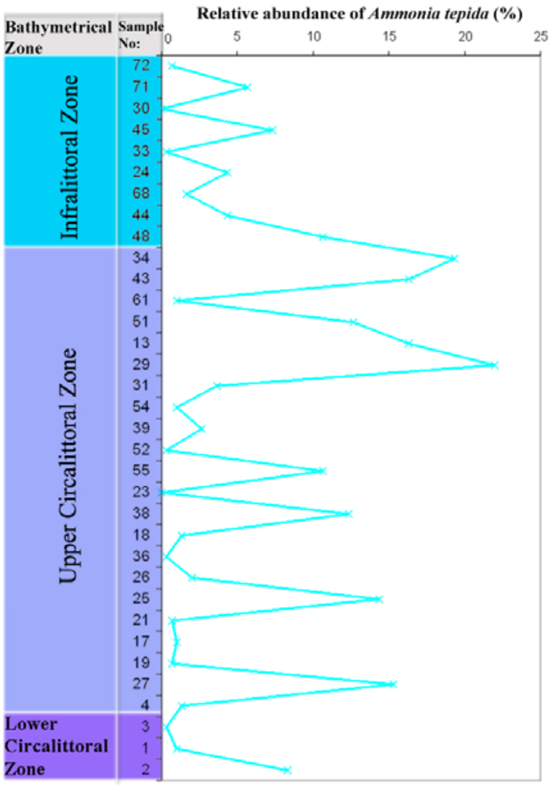
In the study area, some species are frequent and very abundant all over the gulf. These species are generally recorded continuously in all samples. The relative abundances of these 11 species are greater than or equal to 2%. These species are *Ammonia tepida, Adelosina cliarensis*, *Nonion* sp., *Textularia bocki, Reussella spinulosa, Cribroelphidium poeyanum, Adelosina pulchella, Buccella granulata, Elphidium advenum,* and *Nonion depressulum* in descending order of the relative abundance.

Ammonia tepida (Cushman, 1926)

Ammonia tepida (Cushman, 1926) is the most abundant benthic foraminifer in the study samples and its relative abundance is 5.9 % in all of faunas. Its relative distribution according to depth is given in Figure 2-8 (a).

Figure 2-8 (a) shows that *Ammonia tepida* is one of the most frequent species recorded in almost all samples except the samples 30 and 23. In addition, the relative abundance of this form is lower than 1% in the samples 33, 52, 3, 36, 19, 21, and 72. Highest relative abundance (22 %) of this species is recognized in the sample 29 and the sample 34 follows it with 19.3 % of relative abundance. Both the samples 29 and 34 are located near the coastline of the gulf and the mouth of the rivers (Figure 2-8 b). These two samples are belonging to the uppermost circalittoral zone. Although the relative abundance does not show homogeneous distribution within the same bathymetrical zones, it can be concluded that the upper circalittoral zone is represented by the higher amount of *Ammonia tepida*.

a)



b)

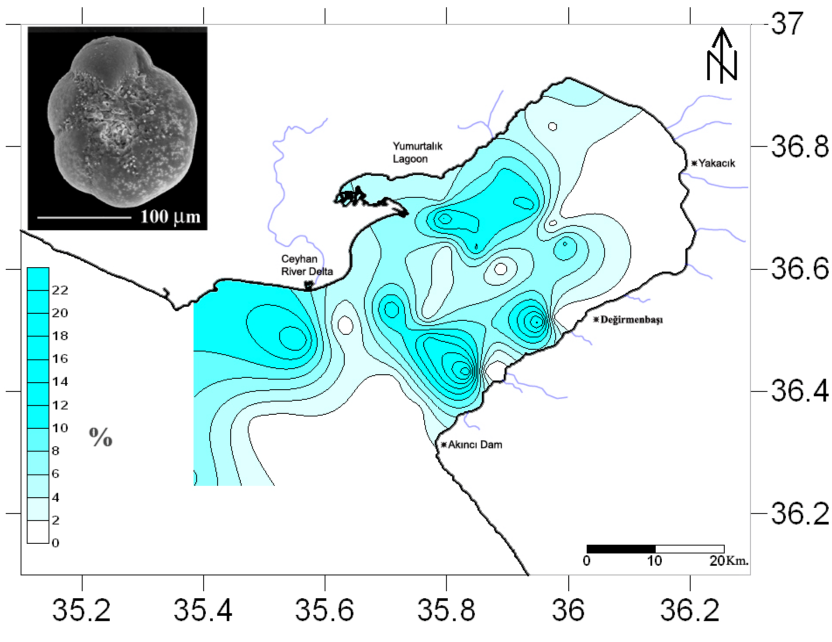


Figure 2-8. Relative abundance (%) of *Ammonia tepida* (Cushman, 1926) recorded in the studied samples, a) bathymetrical distribution, b) Geographical distribution. Color bar shows the percentage of relative abundance.

In the Marmara Sea, *Ammonia tepida* is widespread in the infralittoral zone (Alavi, 1988; Meriç and Sakınç, 1990; Sakinç, 1998; Meriç *et al*., 2001; Aksu *et al*., 2002; Kaminski *et al*., 2002). According to Sakinç (2000) and Meriç *et al*., (2004a), it occurs frequently in the infralittoral zone and the upper circalittoral zones of different localities in the Eastern Aegean Sea, similarly in the Cilician Basin (Alavi, 1980) and the western Mediterranean Sea (Jorissen, 1988; Sgarrella and Moncharmont-Zei, 1993; Fiorini and Vaiani, 2001). Vanicek *et al*. (2000) concluded that it is also recorded in the Lake Mljet (Adriatic Sea). In the Israel coasts, the relative abundance of this species is greater than 5 % and living specimens dominates the infralittoral and the upper circalittoral zones (Yanko *et al*., 1998).

Ammonia tepida is distributed globally. Notwithstanding it is an opportunistic species, it flourishes mainly in shallow, saline to brackish environments (Almogi-Labin *et al*., 1995). Living specimens have been recognized from the hypohaline-brackish environments (salinity less than 1 ppt) to the hyperhaline environments (more than 90 ppt) and it prefers generally brackish waters (Walton and Sloan, 1990).

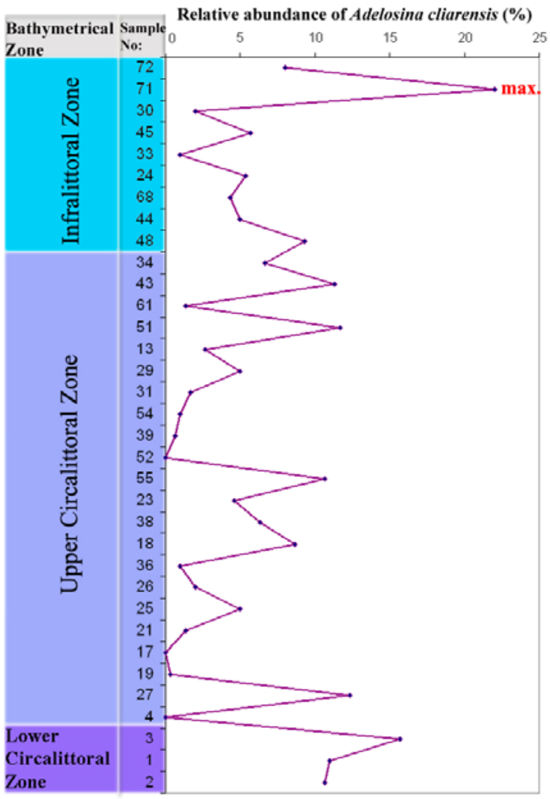
In the present study, the relative abundance of *Ammonia tepida* is generally higher in vicinity of the mouth of the rivers in the southern coastline of the gulf; the Yumurtalık Lagoon and the Ceyhan River Delta that are the brackish water environment (Figure 2-8 b). In the Turkish coasts, the relative abundance of it increases towards to the Black Sea. Genus *Ammonia* dominates throughout the Black Sea and 89 % of them are Mediterranean originated species. Today, *Ammonia tepida* is widespread, while A*mmonia beccarii* and *Ammonia parkinsoniana,* which are other *Ammonia* species recorded in the present study, does not live in the Black Sea (Yanko, 2004). This species is also reported in the river mouths, especially in the Gulf of Naples and the Bay of Mersin.

In Egypt coasts, *Ammonia tepida* is dominant in the El-Mex Bay, which is characterized by low salinity, while it is absent in euhaline waters of the Miami Bay (Samir and El-Din, 2001). In contrast to Mediterranean Sea, *Ammonia tepida* is absent in hypersaline waters of Red Sea (Hottinger *et al*., 1993; Gupta, 1994). As a conclusion, the geographical and bathymetrical distributions of *Ammonia tepida* is similar to the present study throughout the Mediterranean Sea and other Turkish coasts, in contrast to the Red Sea.

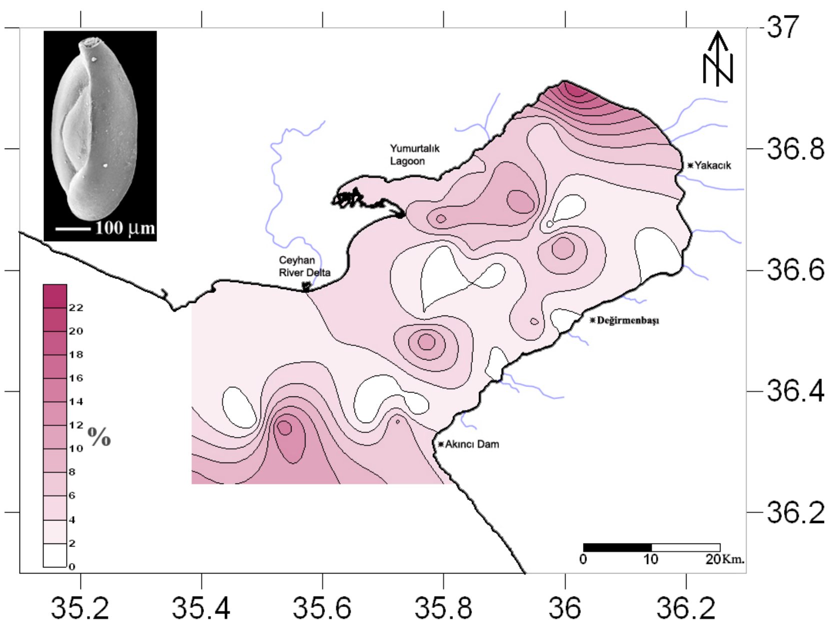
Adelosina cliarensis (Heron-Allen and Earland, 1930)

Adelosina cliarensis (Heron-Allen and Earland, 1930) is the most frequent and abundant (5.7 %) porcelaneous benthic foraminifer in the studied samples. It is also more frequent species than *Ammonia tepida* (Figure 2-9 a). It is absent only in the samples (52, 17 and 4) belonging to the upper circalittoral zone. It exhibits the highest percentage (22 %) in the sample 71 situated at the uppermost infralittoral zone. It is difficult to conclude that relative abundance of this species is related to the bathymetrical zones, since the relative abundance of this species is remarkably variable within the same zone. *Adelosina cliarensis* is highly abundant near the northern coastline and the southeastern entrance of the gulf (Figure 2-9 b). Furthermore, there are some locations, where the relative abundance of this species is high, scattered in the center of the gulf.

In Turkey, *Adelosina cliarensis* is very widespread and highly abundant (>5%); it is generally recorded in the infralittoral and the upper circalittoral zones of the Black Sea, the Marmara Sea, the eastern Aegean Sea and the Mediterranean Sea (Yanko and Troitskaja, 1987; Alavi, 1988; Meriç and Sakınç, 1990; Sakinç, 1998; Sakinç, 2000; Meriç *et al*., 2001; Avşar and Meriç, 2001b; Aksu *et al*., 2002; Kaminski *et al*., 2002; Meriç *et al*., 2004a). In the western Mediterranean, unlike the present study, *Adelosina cliarensis* is generally absent, especially in the Gulf of Naples (Sgarrella and Moncharmont-Zei, 1993), the continental



a)



b)

Figure 2-9. Relative abundance (%) of *Adelosina cliarensis* (Heron-Allen and Earland, 1930) recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

margin of Algeria (Bou-Ismail Bay), the Alboran Sea (Cita and Zocchi, 1978; Caralp, 1988) and the Gulf of Lions (Schmiedl *et al*., 2000, 2004). Indeed, the diversity and the abundance of the Genus *Adelosina* is extremely low in the western Mediterranean Sea. However, *Adelosina cliarensis* is recorded in the circalittoral zones of the Adriatic Sea (Cimerman, and Langer, 1991; Fiorini and Vaiani, 2001). Although, it is extremely abundant in the circalittoral zones of Israel coasts (Yanko *et al.*, 1994, 1998), the relative abundance of this species is lower than 1% in the Egypt coasts (Samir and El-Din, 2001).

According to Hottinger *et al*. (1993) and Gupta (1994), this species is also absent in the Red Sea, similar to the western Mediterranean Sea.

In this manner, it can be concluded that geographical distribution of *Adelosina cliarensis* is restricted to Turkey coasts up to Egypt in eastern Mediterranean Sea and the Adriatic Sea in the western Mediterranean Sea.

Adelosina pulchella **d' Orbigny, 1846**

Adelosina pulchella d' Orbigny, 1846 has the highest relative abundance (10 %) in the samples (45 and 68) from the infralittoral zone. These two samples are very close to each other and located in the northern coastline of the gulf. *Adelosina pulchella* is absent near the Ceyhan Delta (in the samples 23, 24 and 13) and at the southeastern entrance of the gulf (in the samples 1, 18, and 3).

It is recognized that the relative abundance of *Adelosina pulchella* is generally inversely proportional to that of *Adelosina cliarensis* (Figure 2-10). For example, the relative abundance of *Adelosina cliarensis* is exceptionally high (22 %), while only one individual of *Adelosina pulchella* is recorded in the sample 71. Furthermore, the relative abundance of *Adelosina cliarensis* is extremely high (> 15 %), while *Adelosina pulchella* is absent in the sample 3. In the all samples where *Adelosina pulchella* is absent, the relative abundance of *Adelosina cliarensis* is generally higher than 5 %. On the contrary, the relative abundance of *Adelosina pulchella* is very high (10 %), while the relative abundance of *Adelosina cliarensis* is approximately 4 % in the sample 68.

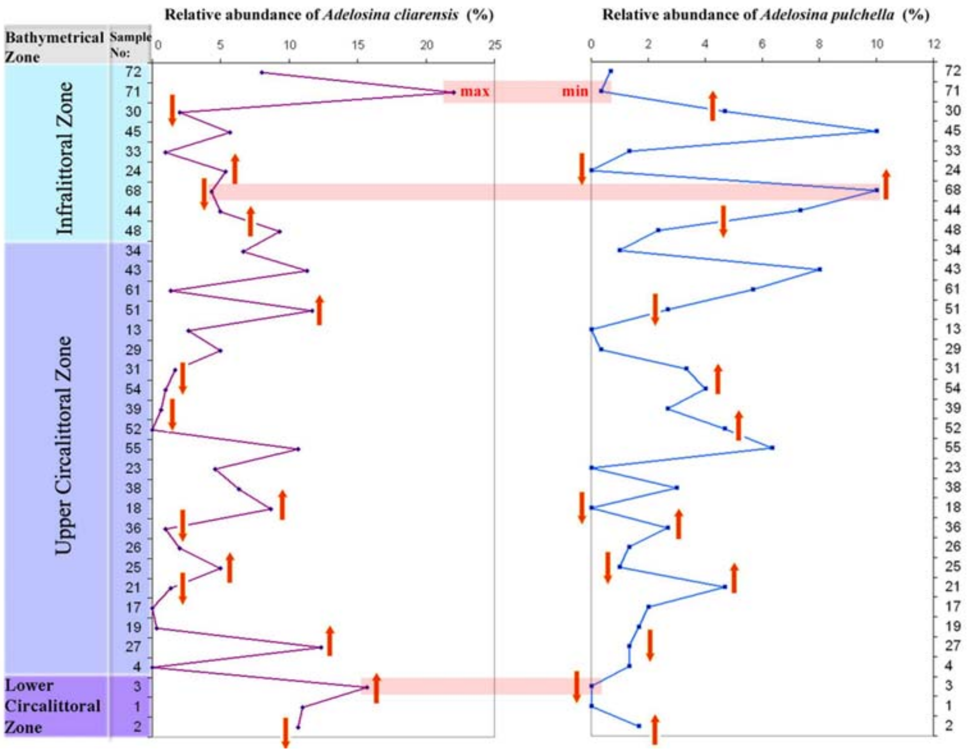


Figure 2-10. Comparison of relative abundances of *Adelosina cliarensis* (Heron-Allen and Earland, 1930) and *Adelosina pulchella* d' Orbigny, 1846. Arrows shows increasing or decreasing trend in relative abundance.

In Turkey, the geographical distribution of *Adelosina pulchella,* like that of *Adelosina cliarensis,* is widespread in the infralittoral and the circalittoral zones (Yanko and Troitskaja, 1987; Alavi, 1988; Meriç and Sakınç, 1990; Sakinç, 1998; Sakinç, 2000; Meriç *et al*., 2001; Avşar and Meriç, 2001b; Aksu *et al*., 2002; Kaminski *et al*., 2002; Meriç *et al*., 2004a). Especially, its relative abundance is high in the infralittoral zones of the Dikili and Çandarlı Bays

(Sakinç, 2000). In the coasts of Israel (Yanko *et al*., 1998), the relative abundance of *Adelosina pulchella* is higher than the present study. This species is absent in the Egypt coasts and the Red Sea (Hottinger *et al*., 1993; Samir and El-Din, 2001).

In the western Mediterranean, this species is also absent in the Alboran Sea and the Balearic Sea (Cita and Zocchi, 1978; Caralp, 1988), while it is recorded from the infralittoral and the circalittoral zones of the Tyrrhenian, Ionian and Adriatic seas with low relative abundance (Blanc-Vernet, 1969; Sgarrella and Moncharmont-Zei, 1993; Fiorini and Vaiani, 2001). Although *Adelosina cliarensis* is absent, *Adelosina pulchella* is reported on the circalittoral sediments of the Gulf of Naples.

As a conclusion, the geographical distribution of *Adelosina pulchella* is differentiated from that of *Adelosina cliarensis* by the occurrence of this species in the Tyrrhenian Sea and absence in the Egypt coasts. Furthermore, the bathymetrical distribution of *Adelosina pulchella* is more regular than that of *Adelosina cliarensis* with decreasing relative abundance from the infralittoral zone to the lower circalittoral zone.

***Nonion* sp. A**

Although, the frequency of *Nonion* sp.A is very high in the studied samples, it is absent in the samples (18, 1, 23) from the upper circalittoral zone and the sample 30 (35 meter depth). Figure 2-11a shows that the bathymetrical distribution of this species is very irregular. Its relative abundance decreases in the vicinity of the Ceyhan Delta and increases in the northwestern, western and the outer parts of the gulf (Figure 2-11b). It has the highest relative abundance (19%) at the center of the gulf (the sample 39).

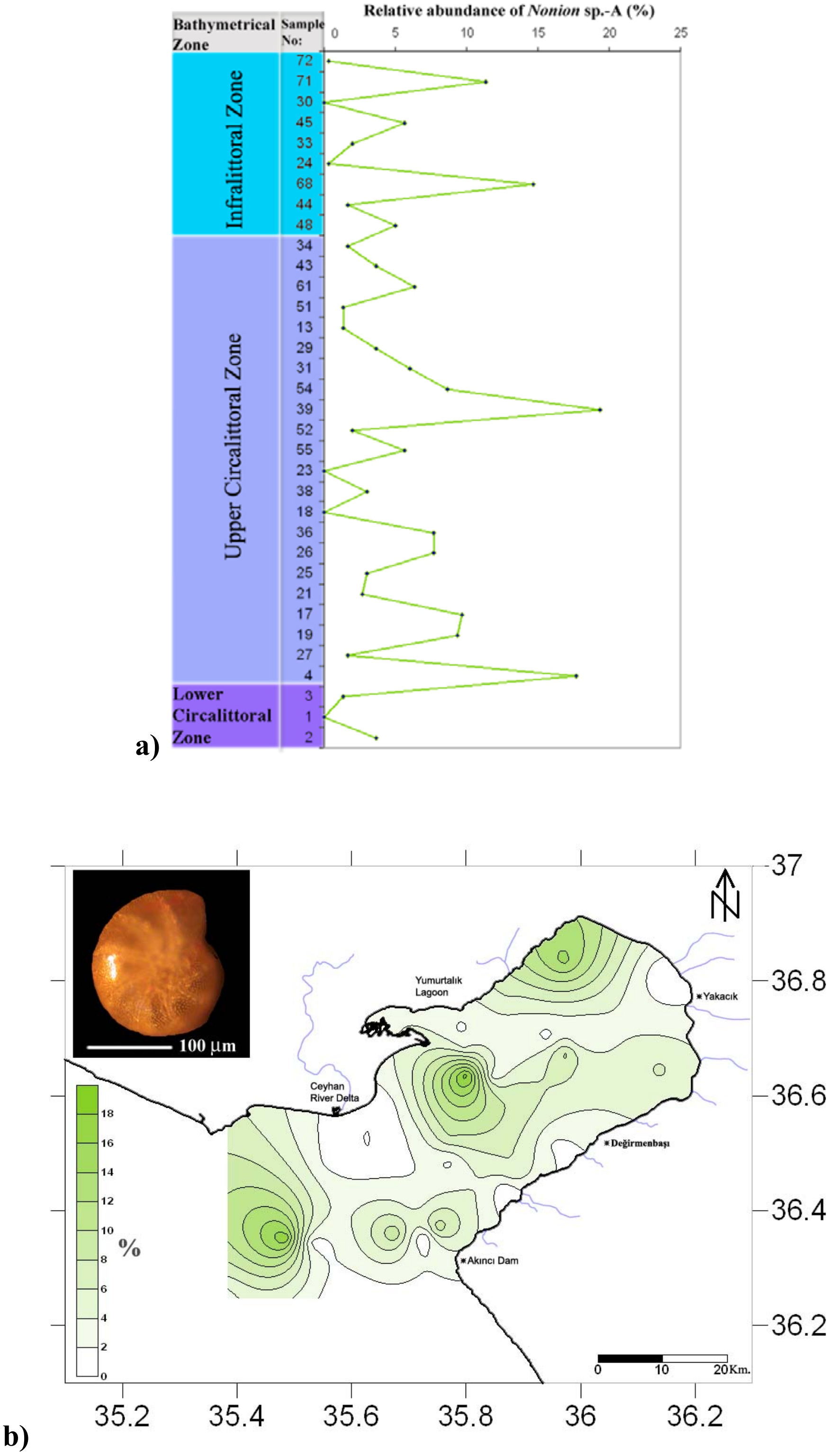


Figure 2-11. Relative abundance (%) of *Nonion* sp.-A. recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

Textularia bocki Höglund, 1947

Textularia bocki Höglund, 1947 is commonly occurred and the most abundant agglutinated species in the studied samples. Figure 2-12a demonstrates that its relative abundance decreases with the increasing depth. The highest relative abundance (21 %) of *Textularia bocki* is recorded in the infralittoral zone (the sample 44). Its relative abundance is greater than 10 % in the samples (61, 68 and 29) from the infralittoral and the uppermost circalittoral zone. Figure 2-12b shows that this species is the most abundant near the Yumurtalık Lagoon. It is absent in the samples 18, 1, 3, and 24 located at the eastern entrance of the gulf and near the Ceyhan River Delta. Furthermore, it has relatively lower abundance near Yakacık and Değirmenbaşı.

As noted before, *Textularia bocki* is widespread in the infralittoral and the circalittoral zones of the Turkish coast from the Black Sea to the eastern Mediterranean Sea (Yanko and Troitskaja, 1987; Alavi, 1988; Meriç and Sakınç, 1990; Sakinç, 1998; Sakinç, 2000; Meriç *et al*., 2001; Avşar and Meriç, 2001b; Aksu *et al*., 2002; Kaminski *et al*., 2002; Meriç *et al*., 2004a). In the western Mediterranean Sea, it is not reported in the Alboran, Tyrrhenian and Balearic seas, except the Gulf of Lions (Vénec and Peyré, 1984). In the Adriatic Sea, this species commonly occur in the infralittoral and the circalittoral zones; and the relative abundance of this species is lower than 5 % (Cimerman, and Langer, 1991; Jorissen, 1992; Langer, 1993; Fiorini and Vaiani, 2001). In the western Mediterranean Sea, one of the most abundant agglutinated species is *Textularia agglutinants*, while the relative abundance of this species is extremely lower than *Textularia bocki* as explained earlier. In the Israel coasts (Yanko *et al,* 1994), this species is recorded in the infralittoral and the circalittoral zones with the low relative abundance (<5 %). Although, it is not reported from the Egypt coasts, this species is widespread in the Gulf of Aqaba (Hottinger *et al*., 1993).

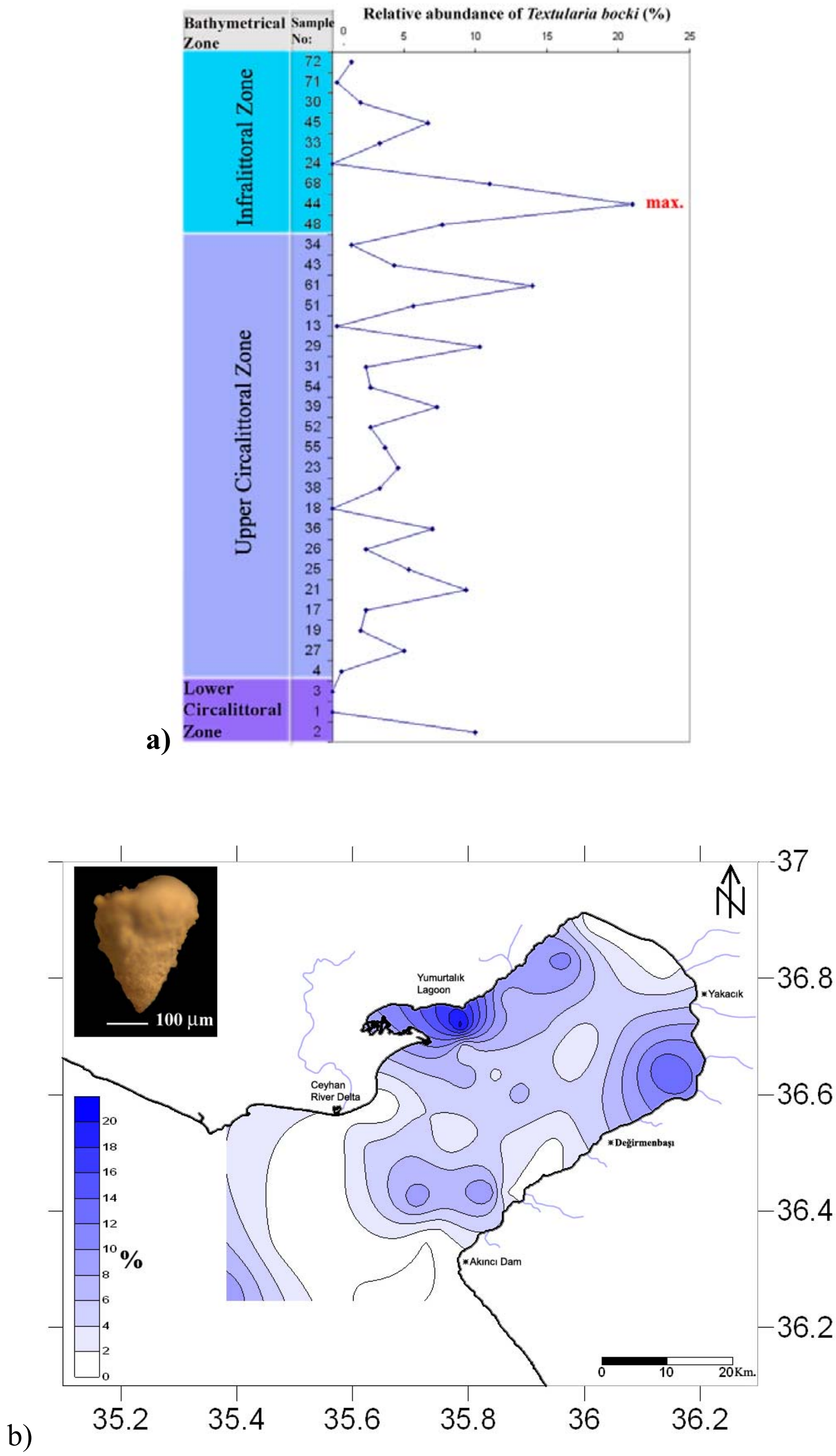


Figure 2-12. Relative abundance (%) of *Textularia bocki* Höglund, 1947 recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

According to Langer (1993), *Textularia bocki* is permanently motile and grazing epiphytic. This feature may effects the distribution of this species.

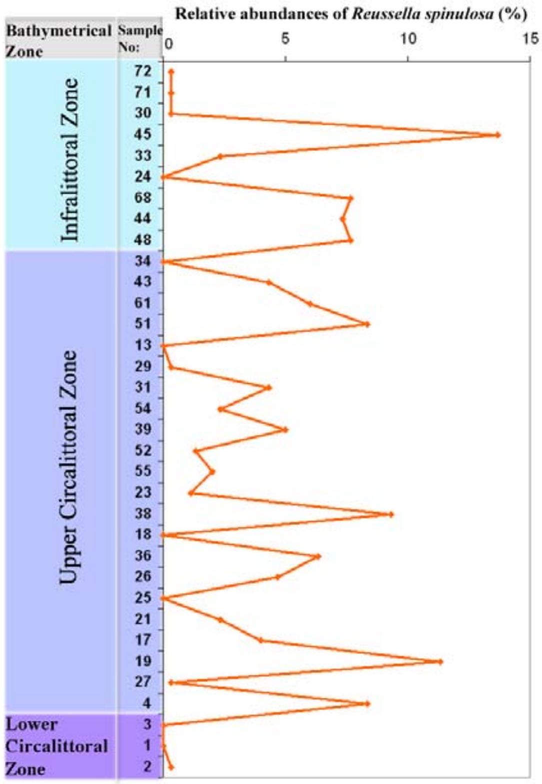
As a conclusion, the geographical distribution of this species is limited; this species is replaced by *Textularia agglutinants* in the western Mediterranean Sea. However, the relative abundance of this species noticeably increases towards the eastern Mediterranean Sea and coasts of Turkey. Especially, this species is recorded in the Black Sea in contrast to *Textularia agglutinants.* Moreover, its bathymetrical distribution in the present study is well correlated with surrounding environment.

Reussella spinulosa (Reuss, 1850)

Reussella spinulosa (Reuss, 1850) is frequently distributed species in all studied samples excluding the samples 24, 34, 13, 18, 25, 3 and 1. It is concentrated within the lowermost part of infralittoral zone and the upper circalittoral zone (Figure 2-13 a). Relative abundance of this species is the highest (>13 %) in the infralittoral zone (in the sample 45). The second sample, which is rich (11% of total fauna) in terms of *Reussella spinulosa*, is the sample 19 in the upper circalittoral zone.

Figure 2-13 b shows that higher amount of *Reussella spinulosa* is found as patches near the Yumurtalik Lagoon and southeastern entrance of the gulf. It is obvious that the ecological conditions near the Ceyhan River do not favor the distribution of *Reussella spinulosa*. This is most probably is due to high amount of terrigeneous input and entrance of fresh water resulting a decrease in salinity. According to Basso and Spezzaferri (2000), median salinity of the stations where *Reussella spinulosa* is found is relatively high (approximately 39.1 ppt.).

a)



b)

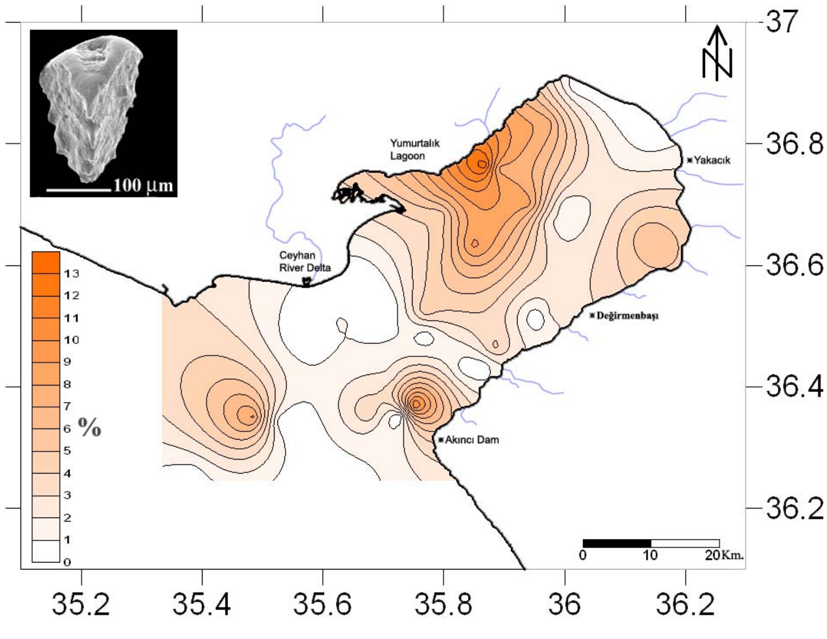


Figure 2-13. Relative abundance (%) of *Reussella spinulosa* (Reuss, 1850) recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

Reussella spinulosa is very widespread throughout the Mediterranean Sea (Cita and Zocchi, 1978; Jorissen., 1987; Jorissen,1988; Caralp, 1988; Cimerman, and Langer, 1991; Jorissen,1992; Langer., 1993; Moulfi-El-Houari *et al*., 1999; Schmiedl *et al*., 2000; Schmiedl *et al*., 2004; Panieri *et al*., 2005) and the Turkey coasts (Alavi, 1988; Meriç and Sakınç, 1990; Sakinç, 1998; Sakinç, 2000; Meriç *et al*., 2001; Avşar and Meriç, 2001b; Aksu *et al*., 2002; Kaminski *et al*., 2002; Meriç *et al*., 2004aa). This species is absent in brackish waters of the Black Sea (Yanko and Troitskaja, 1987), as it expected. This species is rare in the bathyal zones, while it is generally found abundantly (>5 %) in the infralittoral and circalittoral zones of the Adriatic Sea and the Gulf of Naples (Jorissen, 1992; Sgarrella and Moncharmont-Zei, 1993). This species is also widely distributed with low relative abundance in the Cilician Basin (Alavi, 1980). In the Israel coasts (Yanko *et al.* 1994; Yanko *et al.*1998; Hyams *et al*., 2002), this species is not reported, as it is not pollution tolerant species. Similarly, this species is also absent in the most polluted coast of Egypt (El-Mex Bay), while it dominates the Miami Bay of Egypt (Samir and El-Din, 2001). It is absent in the Red Sea (Hottinger *et al*., 1993; Gupta, 1994).

As a conclusion, this species is widespread up to bathyal zones in the surrounding areas, excluding highly polluted and low-salinity areas.

***Cribroelphidium poeyanum* (d'Orbigny, 1839)**

Cribroelphidium poeyanum (d'Orbigny, 1839) is one of the species that has the regular bathymetrical distribution pattern (Figure 2-14 a). Under the infralittoral zone, it is found in all samples, except in the sample 1. It may be concluded that this species has continuous distribution with respect to increasing depth and mainly concentrated to the upper circalittoral zone. It shows the highest relative abundance in the sample 27 with 10.3 %. Besides, the relative abundance of this species has a peak in the sample 48 (49 meter) with 9.3 %.

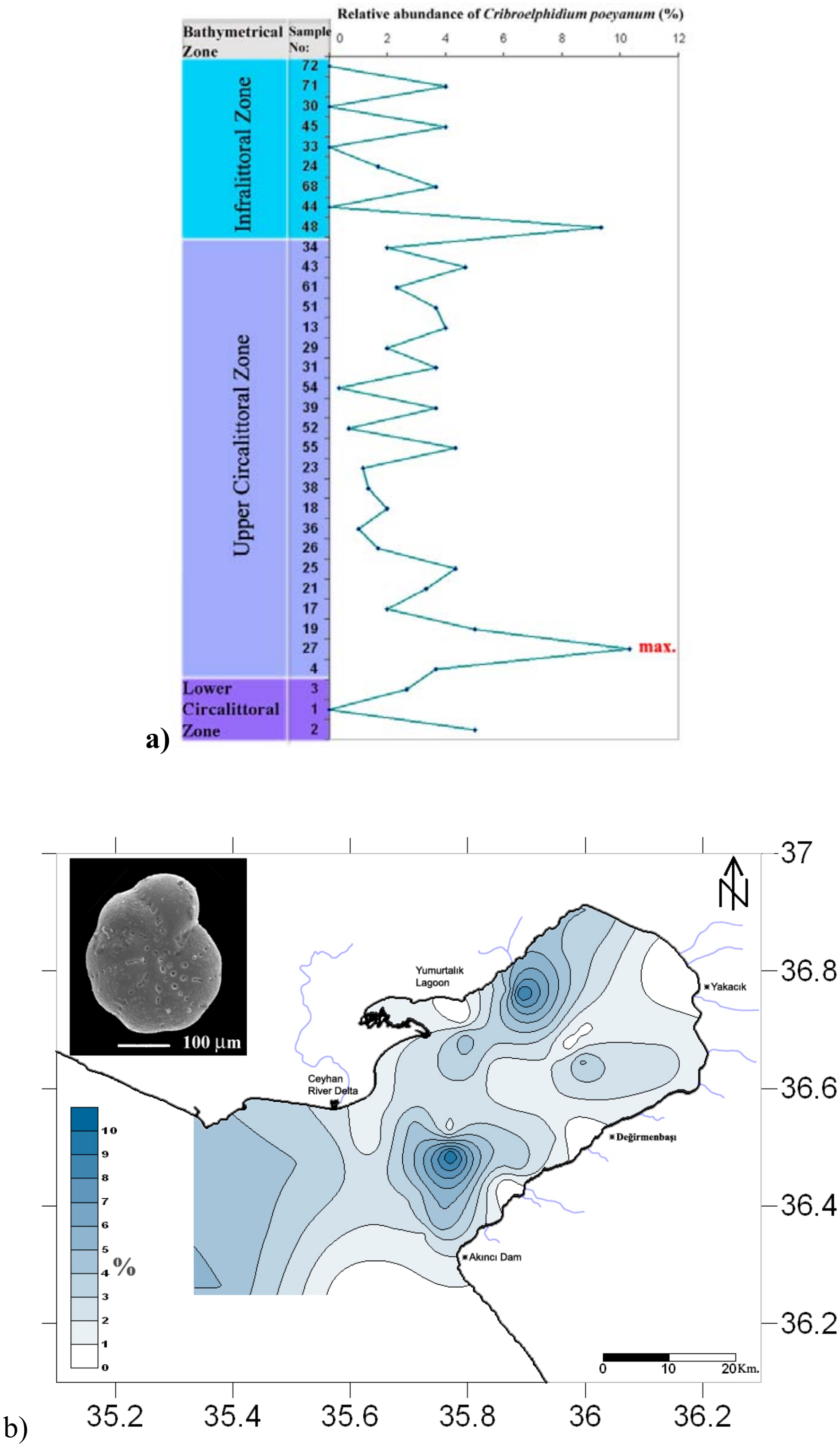


Figure 2-14. Relative abundance (%) of *Cribroelphidium poeyanum* (d'Orbigny, 1839) recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

The geographical distribution of this species is very limited and concentrated near the Akıncı Dam and the northeastern side of the Yumurtalık Lagoon (Figure 2-14 b). In the infralittoral zone, this species is generally absent near the mouth of the rivers in the southern part of the gulf (the sample 30 and 33) and the Yumurtalık Lagoon (the sample 44). From the Figure 2-13 b and Figure 2-14 b, it is easily noticed that the geographical distribution patterns of *Cribroelphidium poeyanum* and *Reussella spinulosa* are more or less similar.

Cribroelphidium poeyanum is widespread from the Black Sea to the Mediterranean coasts of Turkey (Yanko and Troitskaja, 1987; Avşar and Meriç, 2001b; Meriç *et al*., 2004a). It occurs more frequently in the infralittoral and the upper circalittoral zones, while it is rare in the bathyal zones of the eastern Aegean Sea. In contrast to the Turkey's coasts, the geographical distribution of *Cribroelphidium poeyanum* is restricted to Adriatic Sea in the western Mediterranean Sea. In the Adriatic Sea, it is abundant (>5 %) in the infralittoral and the circalittoral zones (Jorissen., 1987, 1988, 1992; Cimerman, and Langer, 1991; Fiorini and Vaiani, 2001), while it is absent in the Tyrrhenian Sea, the Balearic Sea and the Alboran Sea (Cita and Zocchi, 1978; Caralp, 1988; Sgarrella and Moncharmont-Zei, 1993; Moulfi-El-Houari *et al*., 1999). This species present in the infralittoral and the circalittoral zones of the Israel's coasts (Yanko *et al*. 1994,1998), whereas it is absent the coasts of the Egypt (Samir and El-Din, 2001; Samir *et al*., 2003). It is not recorded in the Red Sea (Hottinger *et al*., 1993).

As a conclusion, the bathymetrical distribution of *Cribroelphidium poeyanum* in the studied samples is similar to surrounding areas though geographical distribution is very limited between the Adriatic Sea in the west and the Israel coasts in the east.

Buccella granulata (di Napoli Allita, 1952)

Buccella granulata (di Napoli Allita, 1952) is the most abundant in the samples 68 and 52 with high relative abundance that is greater than 10 % (Figure 2-15 a). The bathymetrical distribution of this species is very irregular. In other words, any relationship between the relative abundance of this species and the bathymetrical zones has not been recognized. The geographical distribution pattern of this species is concentrated on mainly in vicinity of highly industrialized part of the gulf where the Industry of Fertilizers and Botaş are situated. This species is not observed over a line from the Yumurtalık Lagoon to Değirmenbaşı in the samples 23, 25, 27, 29 and 30 (Figure 2-15 b). It is also absent in the sample 2 situated the farthest point of the gulf. The samples, in which *Buccella granulata* is not recognized, belong to both the infralittoral and the circalittoral zones.

It is important to emphasize that *Buccella granulata* has been recorded for the first time in the Turkish coasts in this study. Although it is not recorded in Turkey's coasts, this species is widely distributed in the infralittoral and circalittoral zones of the western Mediterranean Sea, especially in the Adriatic Sea (Jorissen, 1988; Sgarrella and Moncharmont-Zei, 1993; Donnici *et al*., 1997 Fiorini and Vaiani, 2001). Similar to other coasts from Turkey, this species is also absent in the Israel coasts, the Cilician Basin, the Egypt coasts and the Red Sea (Alavi, 1980; Hottinger *et al*., 1993; Yanko *et al*., 1998; Samir and El-Din, 2001; Samir *et al*., 2003).

As a conclusion, this species has extremely limited geographical distribution and the bathymetrical distribution of this species recorded in this study is similar to the distribution in the western Mediterranean Sea.

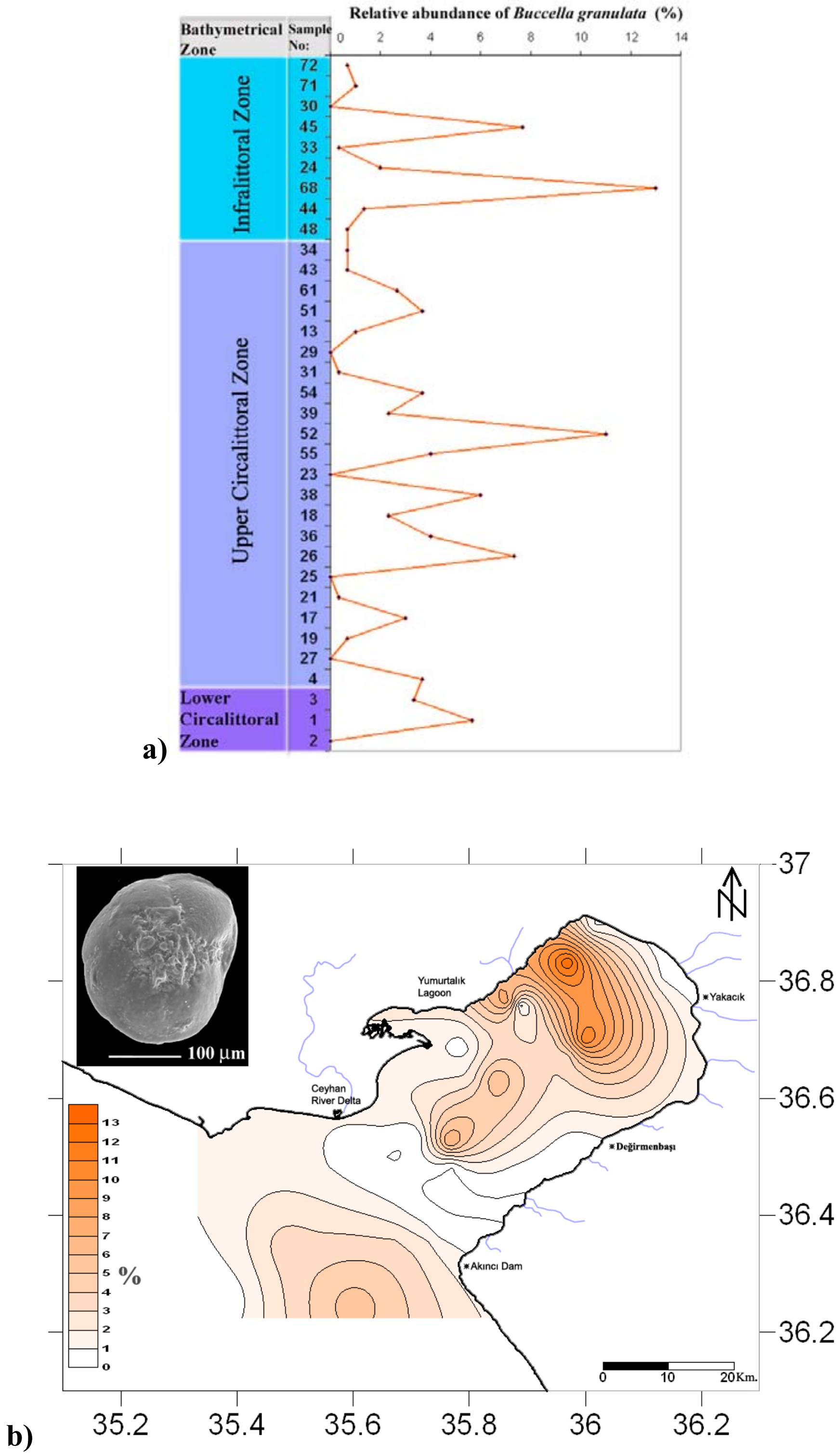


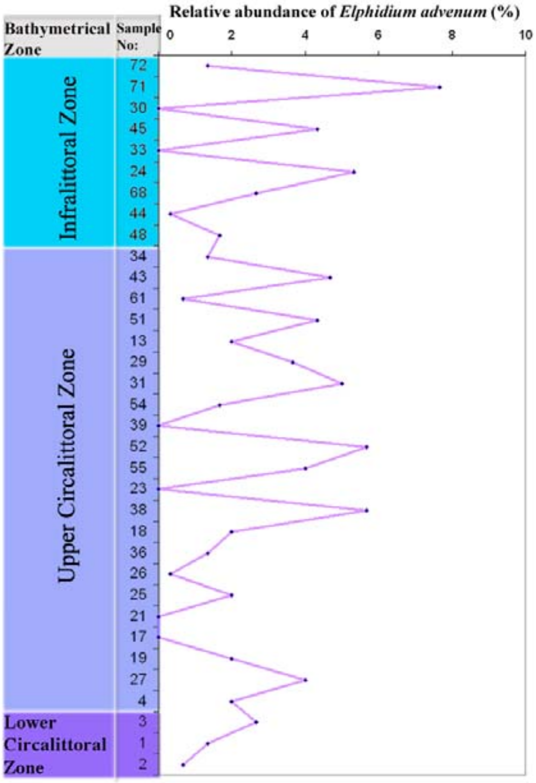
Figure 2-15. Relative abundance (%) of *Buccella granulata* (di Napoli Allita, 1952) recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

***Elphidium advenum* (Cushman, 1922)**

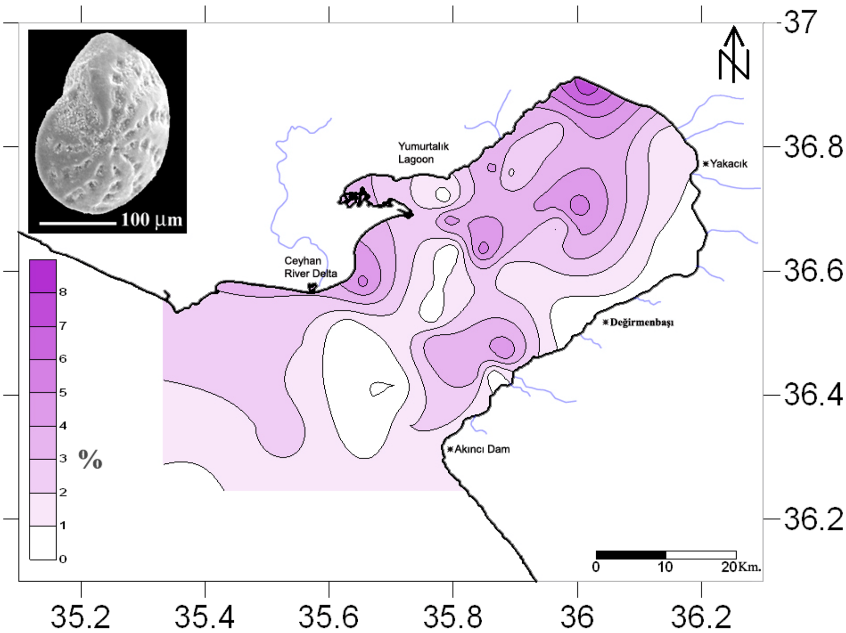
Elphidium advenum (Cushman, 1922) is generally recognized in all samples excluding the samples 39, 23, 17, 21, 33 and 30 (Figure 2-16 a). It is the most abundant (7.7 %) in the infralittoral zone (the sample 71), while its relative abundance is almost 1.3 % in the sample having same depth (sample 72). Although the bathymetrical distribution of this species is not regular between the infralittoral zone and the uppermost circalittoral zone, its relative abundance is decreasing from the lowermost part of the upper circalittoral zone to the lower circalittoral zone.

The geographical distribution of this species is very sporadic in the present study. In other words, this species is distributed as patches throughout the gulf (Figure 2-16 b). According to Jorissen (1988), *Elphidium advenum* is considered as a low-salinity tolerant species. Interestingly, despite higher abundance in the vicinity of the northern coastline of the gulf (in the sample 71), this species is not recognized in the other areas situated near the coastline of the gulf. Therefore, there will be other environmental factors in the northern coastline of the gulf that affect the relative abundance of this species. The southern coasts of the gulf are generally barren in *Elphidium advenum*. Furthermore, it is absent or has extremely low abundance in the middle part of the entrance of the gulf.

This species is widespread in all Turkish seas, excluding the Black Sea (Meriç and Sakınç, 1990; Sakinç, 1998; Sakinç, 2000; Meriç *et al*., 2001; Avşar and Meriç, 2001b; Meriç *et al*., 2004aa). It is recorded mostly in the infralittoral and upper circalittoral zones, while it is rare in the bathyal zones of the eastern Aegean Sea. Likewise, it frequently occurs in the infralittoral and upper circalittoral zones of the western Mediterranean Sea including the Balearic Sea, the Alboran Sea, the Tyrrhenian Sea, the Ionian Sea and the Adriatic Sea (Blanc-Vernet, 1969; Di Napoli Alliata and Ornesi, 1970; Jorissen, 1988; Jorissen, 1992; Usera and Blazquez, 1997; Donnici *et al*., 1997; Barbero *et al*., 1999; Fiorini and



a)



b)

Figure 2-16. Relative abundance (%) of *Elphidium advenum* (Cushman, 1922) recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

Vaiani, 2001). It is not recorded in the Gulf of Naples (Sgarrella and Moncharmont-Zei, 1993). This species is abundant in the infralittoral zones of the Cilician Basin (Alavi, 1980), the coasts of Egypt (Samir and El-Din, 2001; Samir *et al*., 2003) and the Israel coasts (Yanko *et al*., 1994). It also occurs in the Red Sea (Gupta, 1994).

Elphidium advenum is widely distributed throughout adjacent basins of the present study and the bathymetrical distribution is similar to the present study.

Nonion depressulum (Walker and Jacob, 1798)

The relative abundance of *Nonion depressulum* (Walker and Jacob, 1798) is lower (almost 2 %) in all species compared to other species that is mentioned before in this section. Figure 2-17 (a) shows that its distribution is concentrated to the circalittoral zone and the relative abundance of this species is higher in the upper circalittoral zone. It is relatively less abundant in the infralittoral zone. Indeed, it is absent in the infralittoral zone (the samples 30, 33, 44 and 68). In addition, it is not recognized in the samples (43, 51, 21 and 1) belonging to the circalittoral zone. It is the most abundant with 8 % of relative abundancy in the sample 27 (83 meter depth). *Nonion depressulum* has relatively less abundance in the innermost part of the gulf and the vicinity of the Yumurtalık Lagoon (Figure 2-17 b). Moreover, the southern part of the gulf is represented by relatively low abundance of *Nonion depressulum*.

Except the Black Sea, *Nonion depressulum* is widespread in all Turkish seas, (Meriç and Sakınç, 1990; Meriç *et al*., 1995; Meriç and Avşar, 1997 Sakinç, 1998; Sakinç, 2000; Meriç *et al*., 2001; Avşar and Meriç, 2001b; Meriç *et al*., 2004aa). It is recorded mainly from the infralittoral and upper circalittoral zones of the Marmara Sea and eastern Aegean Sea. Likewise, this species is also generally recorded in the infralittoral and upper circalittoral zones of the western

Mediterranean Sea (Jorissen., 1987; and Jorissen, 1988; Cimerman, and Langer, 1991; Jorissen, 1992; Donnici *et al*., 1997; Barbero *et al*., 1999; Fiorini and Vaiani, 2001). Relative abundance of this species is greater than 5 % in the Adriatic Sea (Jorissen, 1992). According to Sgarrella and Moncharmont-Zei (1993), the relative abundance of this species increases in the areas in front of the river mouths, this species is frequent in marsh environments of the Ionian Sea (Scott *et al*., 1979). This species is absent in the continental margin of Algeria (Moulfi-El-Houari *et al*., 1999), the Alboran Sea (Cita and Zocchi, 1978; Caralp, 1988) and the bathyal Gulf of Lions (Schmiedl *et al*., 2000; Schmiedl *et al*., 2004). This species is recorded in the infralittoral zones of polluted areas of the Egypt coasts (Samir and El-Din, 2001). The infralittoral and circalittoral zones of the Israel coasts are significantly rich in terms of *Nonion depressulum* (Yanko *et al.,* 1998).

In short, frequency of *Nonion depressulum* increases from the western Mediterranean Sea to the Turkish Seas and the eastern Mediterranean Sea. Like the present study, the bathymetrical distribution of this species is restricted to neritic zones of surrounding areas.

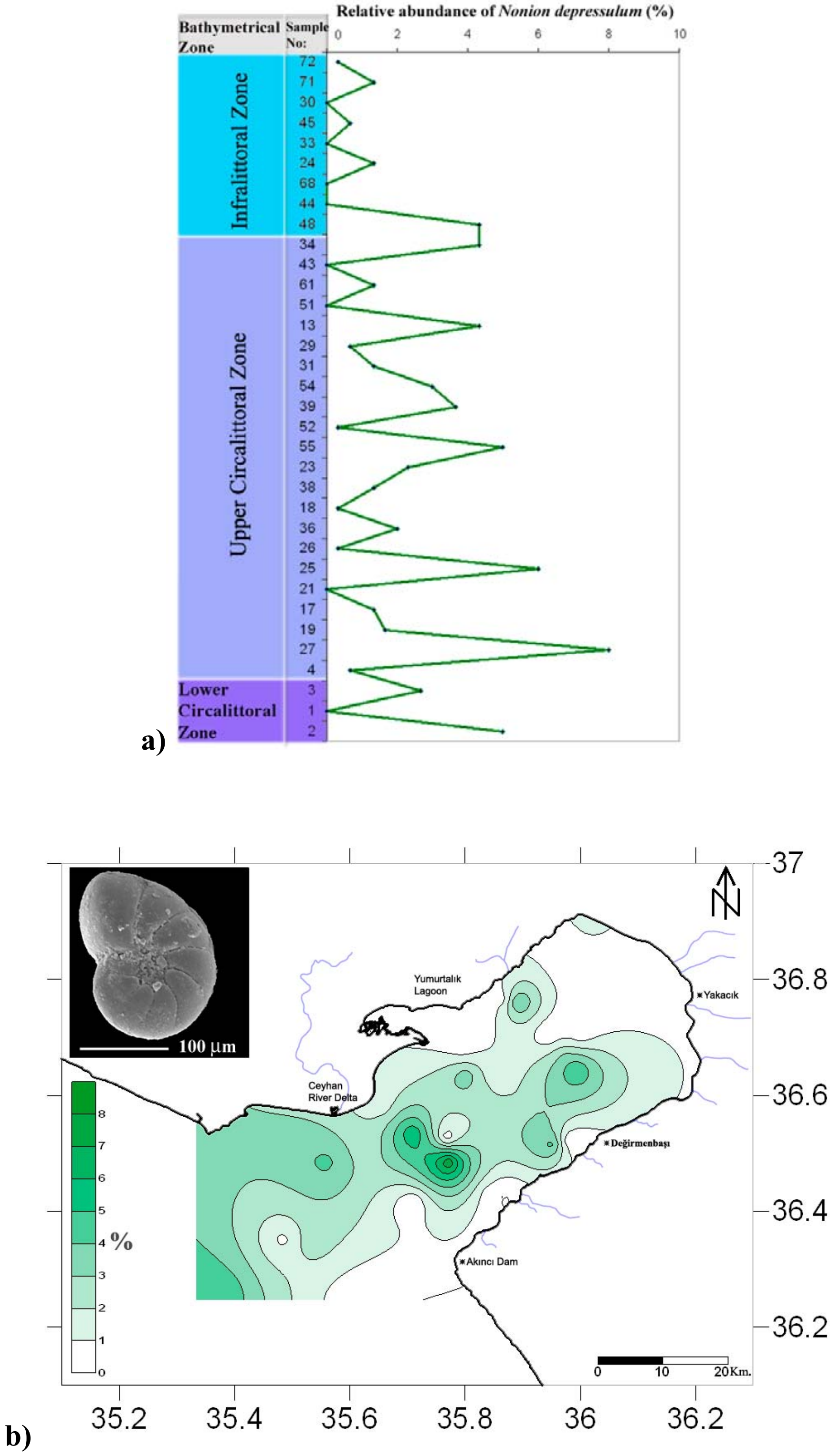


Figure 2-17. Relative abundance (%) of *Nonion depressulum* (Walker and Jacob, 1798) recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

2.6. Distribution of the benthic foraminiferal species which are abundant in specific areas

In the study area, some species are abundant in only specific areas but not frequently recognized in all samples. These species are *Peneroplis pertusus*, *Septoloculina angulata, Septloculina rotunda, Septoloculina tortuosa, Vertebralina striata, Amphistegina lobifera* and *Valvularina bradyana.*

All these species are "Lessepsian migrants" (Langer and Hottinger, 2000; Hyams *et al*., 2002; Meriç *et al*., 2006), except *Valvularina bradyana*. Lessepsian migrants are some alien species that may be transported via ballast waters on the body of the vessels or may have been carried to the Mediterranean for aquaculture purposes or mistakenly introduced from public aquariums. Nevertheless, the most important reason of transportation of the species between ecosystems is the man made canals, especially the Suez Canal (Por, 1978). From the Red Sea into the Levantine Basin, many Indo-Pacific originated foraminifer species is introduced to Eastern Mediterranean via Suez Canal. This phenemenon was named as the "Lessepsian Migration", after Ferdinand de Lesseps who is builder of the canal. The consequent penetration of tropical Indo-Pacific organisms into the subtropical Eastern Mediterranean is still going on. The impact of the lessepsian migration on the ecosystem of the Mediterranean, especially in the Levant basin, is immense and this migration is modified the Mediterranean ecosystem. According to Hyams *et al.* (2002), survival of these lessepsian migrant populations in recent sediments of Mediterranean may be a sign of global warming. Migration in the opposite direction is minor and known as "Anti-Lessepsian migration."

It the present study, there are many other lessepsian migrants. These species are *Edentostomina cultrata, Edentostomina milletti, Nodopthalmidium antillarum*, *Sigmohauerina bradyi, Pseudomassilina australis, Triloculina asymetrica,* *Articulina alticostata, Articulina mayori, Articulina carinata, Peneroplis planatus, Peneroplis arietinus, Amphisorus hemprichii, Sorites orbiculus, Planispirinella exigua* and *Elphidium striatopunctatum.* They are not mentioned in this section because only one individual from each species is generally recorded in the study area. In other words, their relative abundances are not high as much as *Peneroplis pertusus*, *Septoloculina angulata, Septloculina rotunda, Septoloculina tortuosa, Vertebralina striata,* or *Amphistegina lobifera*.

The majority of the lessepsian migrants are larger and porcelaneous foraminifers, excluding *Elphidium striatopunctatum,* and *Amphistegina lobifera that are hyaline forms.*

The abundant species in only specific areas will be discussed in detail in the following section. It should be noted that the geographical distribution patterns of the lessepsian migrants are quite similar to each other and mainly restricted to southeastern part of the gulf.

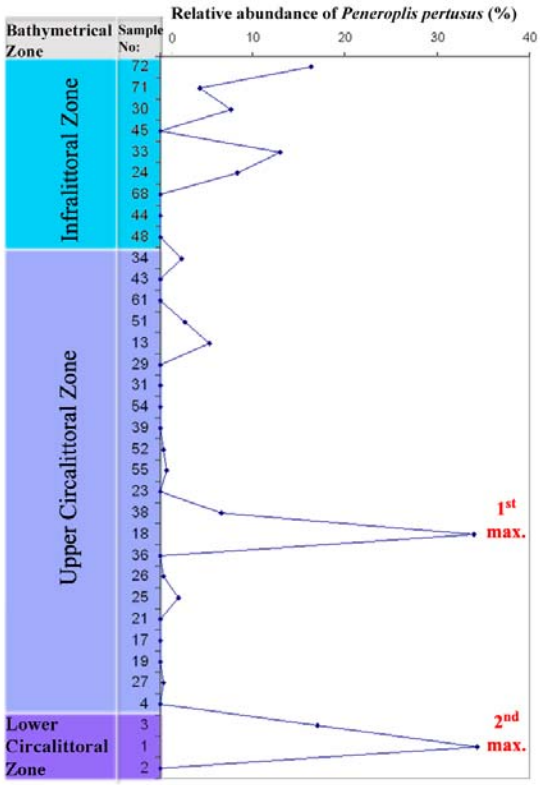
***Peneroplis pertusus* (Forskal, 1775)**

The relative abundance of *Peneroplis pertusus* (Forskal, 1775) in total foraminiferal fauna of the Gulf of İskenderun is 4.6 %.

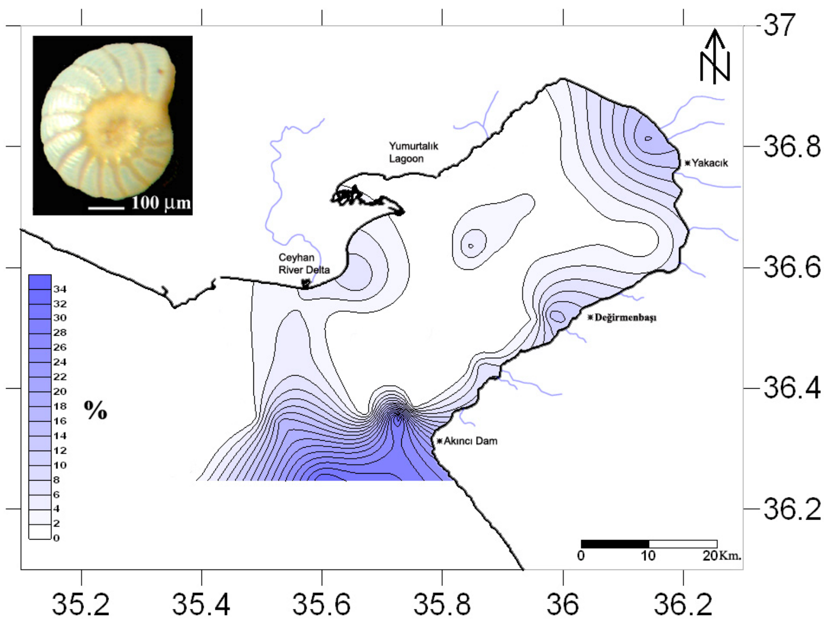
According to Langer (1993), *Peneroplis pertusus* shows preferences for specific plants. It is most frequently recorded on *Dasycladus, Halopteris, Pseudolitophyllum* and *Posidonia* leaves, but it is lacking in rhizomal microhabitats. In contrast, *Peneroplis planatus* is recognized in rhizomal habitats but it is lacking on *Posidonia* leaves. Leutenegger (1984) concluded that owing to light requirement of these specific plants, *Peneroplis pertusus* is found mostly between 0 - 20 m, while *Peneroplis planatus* is found mostly between 0 - 50 m. In the Mersin Bay situated near the Gulf of İskenderun, sea grasses, like

Posidonia, occur generally in between 15-25 meter depth (Ediger, personal communication, 2006). Contrarily, there are two unexpected abrupt increase in relative abundance of *Peneroplis pertusus* in the samples 18 (76 m.) and 1 (137 m.) (Figure 2-18 a). Furthermore, *Peneroplis pertusus* is the most abundant (34 %) in these samples. Avcı (1996) stated that there is strong sediment transportation from southeastern coasts to inner parts of the gulf due to surface currents. Possible reason of this extremely abundance of these species in sample 18 might be transportation of these species from infralittoral zone of the southernmost coast of the gulf. Indeed, this species may be interpreted as displaced and reworked. Although sample 1 is enormously far from the coast, there is an intense accumulation of sands (% 57). Furthermore, it should be noted that the shape and structure of the bottom is mainly controlled by active fault system in the gulf (Basso and Spezzaferri, 2000). This fault system might be responsible of this irregularity in the abundance of *Peneroplis pertusus* and *Peneroplis planatus* likewise in the Gulf of Saroz (Altıner, 1999). In Figure (2-18 b and Figure 2-19), *Peneroplis pertusus* rich areas with deficiency of *Peneroplis planatus* may be show *Posidonia* rich environments, especially in samples 51, 25 and 34. Figure 2-18 shows that infralittoral zone is rich in terms of *Peneroplis* species. Increase in relative abundance towards to lower circalittoral zone, especially in the southeastern entrance of the gulf may be explained by proximity to Suez Canal of these samples (Figure 2-18 b).

Peneroplis planatus is recorded constantly together with *Peneroplis pertusus* but its relative abundance is always less than that of *Peneroplis pertusus* in the infralittoral zone and the lower circalittoral zone (in the samples .72, 71, 30, 33, 24, 13, 55, 38, 18, 3 and 1), while *Peneroplis planatus* is absent in the upper circalittoral zone (in the samples 34, 51, 52, 26, 25 and 27) where relative abundance of *Peneroplis pertusus* is lower than 2 % (Figure 2-19). Similarly, this relationship is also seen in the coasts of Egypt (Samir and El-Din, 2001) and Israel (Hyams *et al*., 2002).



a)



b)

Figure 2-18. Relative abundance (%) of *Peneroplis pertusus* (Forskal, 1775) recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

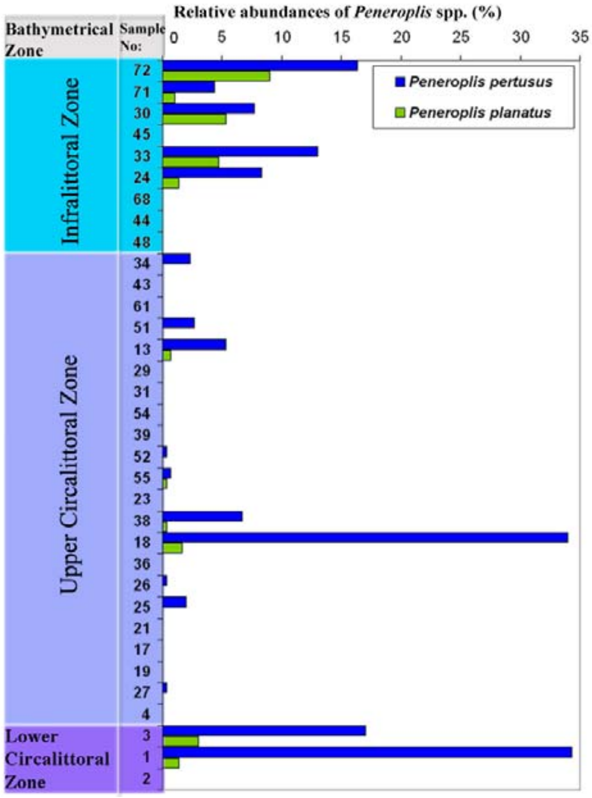


Figure 2-19. Comparison chart of the bathymetrical distributions of the relative abundances of *Peneroplis pertusus* and *Peneroplis planatus*

In the Turkish seas, frequency of *Peneroplis pertusus* increases from the Black Sea to Mediterranean Sea (Sakinç, 2000; Meriç *et al*., 2001; Avşar and Meriç, 2001b; Aksu *et al*., 2002; Kaminski *et al*., 2002; Meriç *et al*., 2004aa.Undoubtedly, the Black sea is deficient in terms of genus *Peneroplis* (Yanko and Troitskaja, 1987). It is also absent in the Marmara Sea where salinity and temperature of the waters is noticeably lower than the present study (Alavi, 1988; Meriç and Sakınç, 1990; Sakinç, 1998). Geographical distribution of this species is restricted to small area including Gökçeada, Bozcaada, the Gulf of Edremit, the Dikili and Çandarlı Bays, Dikili, İzmir, the Gulf of Gökova, Datça, and Marmaris Bay in mostly the infralittoral zone and very rarely in the circalittoral zone. This species is absent in the Gulf of Saroz, while *Peneroplis* *planatus* is recorded rarely in the lowermost part of the upper circalittoral zone (Meriç *et al*., 2004aa). This species is frequent in the Mersin Bay (Avşar, 1997). *Peneroplis pertusus* is also abundant in the infralittoral zones of Cilician basin (Alavi, 1980). In Miami Bay of Egypt (Samir and El-Din, 2001), the majority of the living population consisted of *Peneroplis pertusus*. In the Israel coasts, *Peneroplis pertusus* is the most abundant peneroplid, with highest numbers in the infralittoral zone (Yanko *et al*., 1998; Hyams *et al*., 2002). The western Mediterranean Sea is generally deficient in terms of genus *Peneroplis*. Colder and low-salinity waters of western Mediterranean, mentioned in the Chapter 1, may play important role in absence of it. Sgarrella and Moncharmont-Zei (1993) concluded that specimens of *Peneroplis pertusus* recorded at depths deeper than infralittoral zone is displaced, *Peneroplis pertusus* is recorded very rarely in the infralittoral zones of the Gulf of Naples. In the Tyrrhenian Sea, this species is widespread in the infralittoral zones of the volcanic island of Vulcano (Langer, 1993). It is also recognized with low abundance in the infralittoral zones of the Adriatic Sea (Cimerman, and Langer, 1991). This species is absent in the western most parts of the Mediterranean including Alboran Sea, Gulf of Lions and Balearic Sea (Cita and Zocchi, 1978; Caralp, 1988; Moulfi-El-Houari *et al*., 1999; Schmiedl *et al*., 2000)

In this manner, the geographical distribution of *Peneroplis pertusus* is very limited. Frequency of *Peneroplis pertusus* increases from the western Mediterranean Sea to Eastern Mediterranean Sea and the Red Sea.

***Septloculina* spp.**

Septloculina angulata El-Nakhal, 1990, *Septloculina rotunda* El-Nakhal, 1990 and *Septoloculina tortuosa* El-Nakhal, 1990 are important species by being the first recorded species in the Turkey coasts. They show remarkable distribution in the Gulf of İskenderun.

There is no uniform distribution of *Septloculina* species with respect to increasing depth (Figure 2-20). *Septloculina* spp. are highly abundant (>9 %) in the samples 18, 33, 1 and 30. Their distributions are similar but *Septloculina angulata* is the most abundant species with respect to *Septloculina rotunda* and *Septoloculina tortuosa*. *Septoloculina tortuosa* is the least abundant as in other part of the southeastern Mediterranean Sea including the coasts of Syria, Lebannon and Egypt. In the western Mediterranean sea, this species is absent except in the coasts of Libya where is the southernmost part of the western Mediterranean. *Septloculina* species is recorded in the Red Sea, while they are absent in the Gulf of Aqaba (El-Nakhal, 1990).

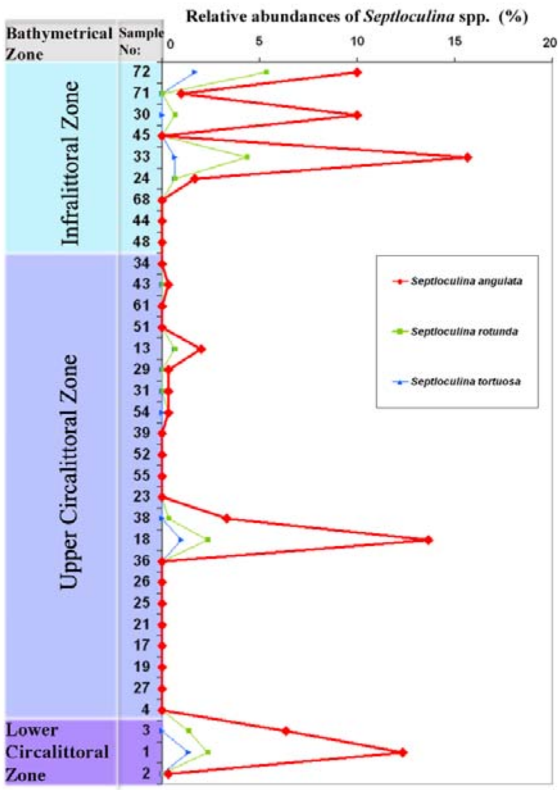


Figure 2-20. Bathymetrical distribution of relative abundance (%) of *Septloculina* spp.recorded in the studied samples.

Figure 2-21 perfectly shows that *Septloculina angulata* is highly abundant near southern coast and the southeastern entrance of the gulf that is the adjacent to Syria coasts. This restricted distribution is the indication of changes in the ecological factors. This species is recorded in the innermost part of the gulf and the center of the gulf. This distribution may be related to water circulation pattern, previously mentioned in the Chapter 1. The northern part of the gulf is deficient with *Septloculina* species. The possible reason is that *Septloculina* species may not adapted to the environmental conditions in the western part of the gulf, and the competition between indigenous benthic foraminiferal species and these exotic species.

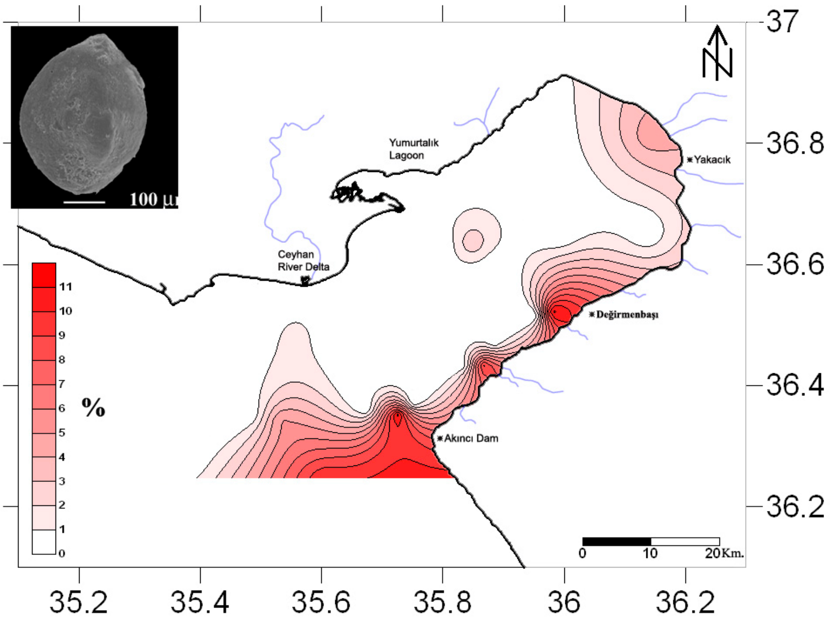


Figure 2-21. Geographical distribution of relative abundance (%) of *Septloculina angulata* recorded in the studied samples.

Amphistegina lobifera (Larsen, 1880)

Amphistegina lobifera (Larsen, 1880) is only recorded only in the infralittoral zone (samples 30, 33 and 72) and its relative abundance within total fauna in the gulf is less than 1 %. It is recorded with high relative abundance (14 %) in the sample-30 that is the only sample closest to southeastern Mediterranean Sea coasts (Figure 2-22). Only one individual is recorded in the samples 33 and 72 situated inner parts of the gulf. This species has been already recorded with high abundance in Red Sea, Egypt and Israel coasts (Hottinger *et al*., 1993; Yanko *et al*., 1994; Yanko *et al*., 1998; Samir *et al.*, 2003). Thus, the existence of this species in only southern part of the gulf can be explained by the connection from the Red Sea to the Gulf of İskenderun. This species is absent in the samples 29 and 31, which are belonging to upper circalittoral zone. According to Hyams *et al*. (2002), this species is only recorded between 9 and 25 meters depth with maximum abundance at 15 m (40 individuals/g) Although both samples are very close to sample 30, reason of absence of this species may be the higher depths of these samples.

This species is also recorded in the eastern Aegean Sea and Cilician Basin, while It is absent in the Black Sea, the Marmara Sea and the western Mediterranean Sea (Yanko and Troitskaja, 1987; Alavi, 1988; Meriç and Sakınç, 1990; Sakinç, 1998; Sakinç, 2000; Meriç *et al*., 2001; Avşar and Meriç, 2001b; Aksu *et al*., 2002; Kaminski *et al*., 2002; Meriç *et al*., 2004aa; Alavi, 1980; Cita and Zocchi, 1978; Jorissen., 1987; Jorissen,1988; Caralp, 1988; Cimerman, and Langer, 1991; Jorissen,1992; Langer., 1993; Moulfi-El-Houari *et al*., 1999; Schmiedl *et al*., 2000; Fiorini and Vaiani, 2001; Schmiedl *et al*., 2004; Panieri *et al*., 2005; Sgarrella and Moncharmont-Zei, 1993). According to Zmiri *et al*. (1974), living specimens of *Amphistegina lobifera* does not survive below 12°C, so temperature is one of the important limiting factors for this species.

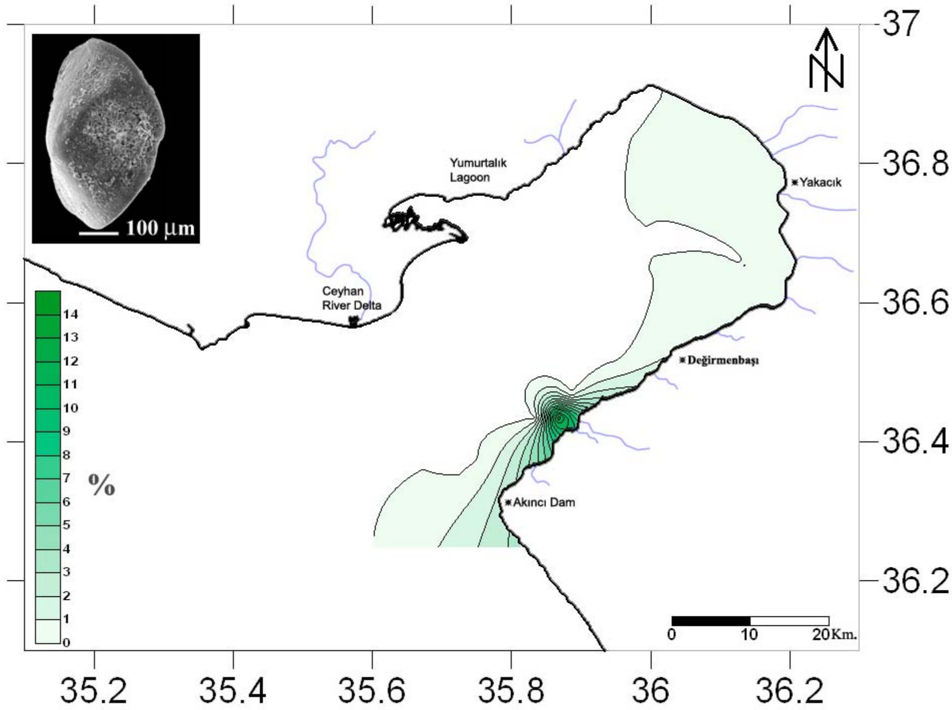


Figure 2-22. Geographical distribution of relative abundance (%) of *Amphistegina lobifera* (Larsen, 1880) recorded in the studied samples. Color scheme shows percentage of relative abundance.

Vertebralina striata d'Orbigny, 1826

Relative abundance of *Vertebralina striata* d'Orbigny, 1826, like that of *Amphistegina lobifera*, within total fauna in the gulf is less than 1 %. Figure 2-23 (a) shows that its relative abundance is the highest (8.3 %) in the infralittoral zone (the sample 30). It is generally absent in the circalittoral zone. Like the present study, *Vertebralina striata* is dominant (430 individuals/g) at 40 m in the Israel coasts (Hyams *et al*., 2002). Figure 2-23 (b) shows the geographical distribution of *Vertebralina striata* along the eastern coastline (near the Israel coasts), the Ceyhan River Delta and innermost part of the gulf. It is also recorded with relatively low percentage in middle part of the gulf. The geographical distribution of this species is similar to *Peneroplis Pertusus*.

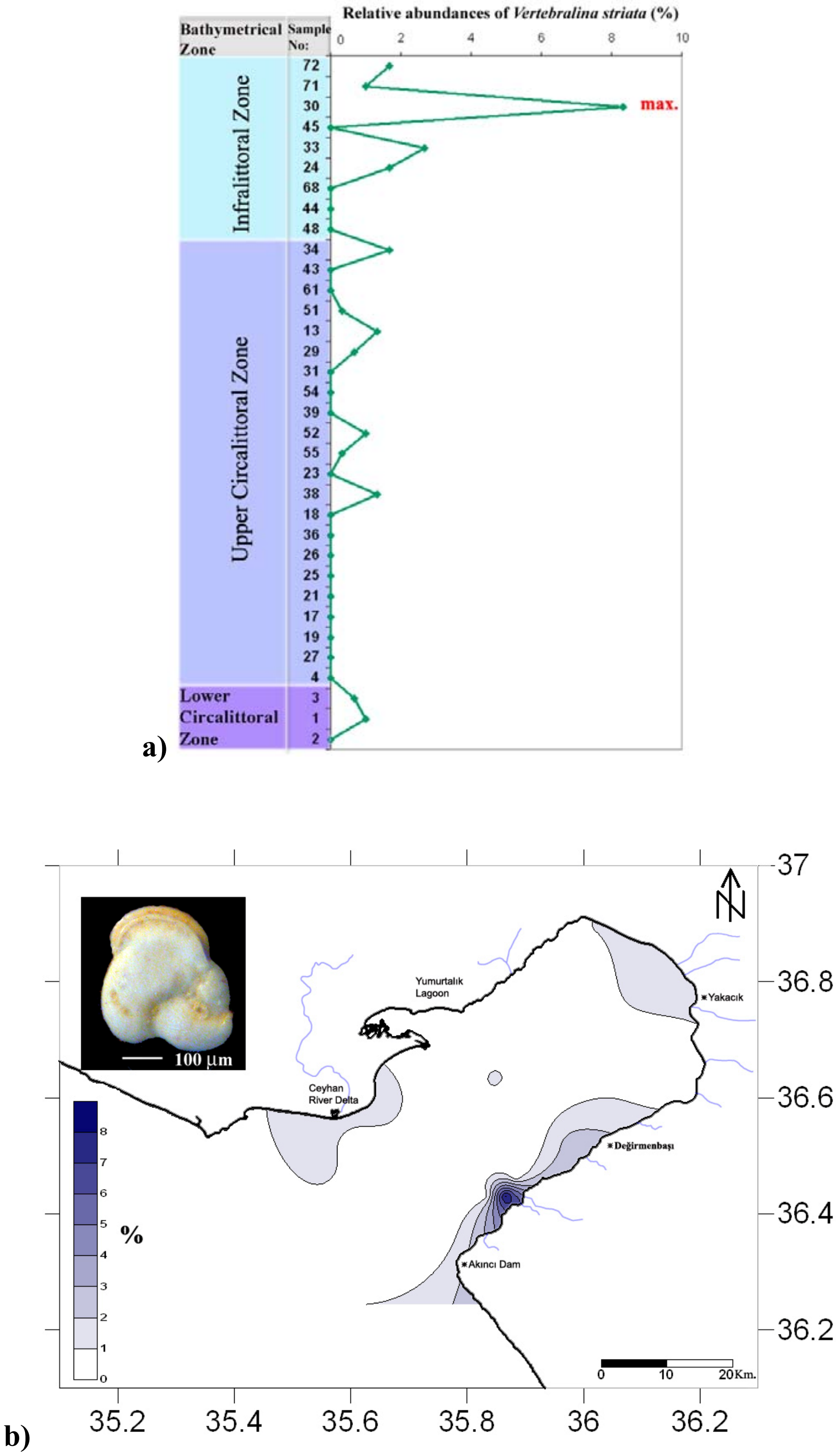


Figure 2-23. Relative abundance (%) of *Vertebralina striata* d'Orbigny, 1826 recorded in the studied samples, a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of relative abundance.

Valvularina bradyana (Fornasini, 1900)

Valvularina bradyana (Fornasini, 1900) is only recorded in the sample 23 (71 meter) and dominant with extremely high percentage (33.4 %). It is not recognized in the adjacent samples 13 and 24. As noted before, sample 23 is located near the Ceyhan River Delta (Figure 2-24). Possible reason of the high abundance of this species in the sample 23 is that this species may be adapted to high terrigeneous input from the Ceyhan River. According to Jorissen (1987), *Valvularina bradyana* is oxygen deficiency tolerant species. Therefore, the sample 23 may be poorly oxygenated microenvironment. In the Mljet Lakes, semienclosed basin in Croatia (Adriatic Sea), which is also oxygen deficient environment, *V. bradyana* is the second most dominant species (15 % of total assemblage at each station) and it is absent in the adjacent open sea (Vanicek, 2000).

Excluding the Black Sea, *Valvulineria bradyana* occurs mostly in the infralittoral and circalittoral zones of Turkey coasts, while it recorded rarely in the bathyal zones (Yanko and Troitskaja, 1987; Alavi, 1988; Meriç and Sakınç, 1990; Sakinç, 1998; Sakinç, 2000; Meriç *et al*., 2001; Avşar and Meriç, 2001b; Aksu *et al*., 2002; Kaminski *et al*., 2002; Meriç *et al*., 2004aa). It is also recorded in argillaceous sediments of the Cilician basin, similar to the present study (Alavi, 1980). This species is widespread in the Mediterranean and typical of circalittoral pelitic bottom with vegetation cover (Blanc-Vernet, 1969).in the Gulf of Naples, it is frequent in the circalittoral zone and relative abundance of this species is higher in 90-120 meter depth (Sgarrella and Moncharmont-Zei, 1993). In the Adriatic Sea, it is recorded mostly in the upper circalittoral zones (Jorissen., 1987; and Jorissen, 1988; Cimerman, and Langer, 1991; Jorissen, 1992). This species is not recorded in the southeastern Mediterranean Sea and the Red Sea (Hottinger *et al*., 1993; Gupta, 1994; Yanko *et al*., 1998; Samir and El-Din, 2001; Hyams *et al*., 2002). The absence of this species in the southeastern part of the

Mediterranean may explain the absence of this species in the southern part of the gulf where environmental conditions is different from the western part.

The geographical distribution of *Valvulineria bradyana* is restricted to the western Mediterranean and the Marmara Sea, Aegean Sea and the Mediterranean coasts of Turkey including the gulf of İskenderun. It is generally recorded from neritic zones.

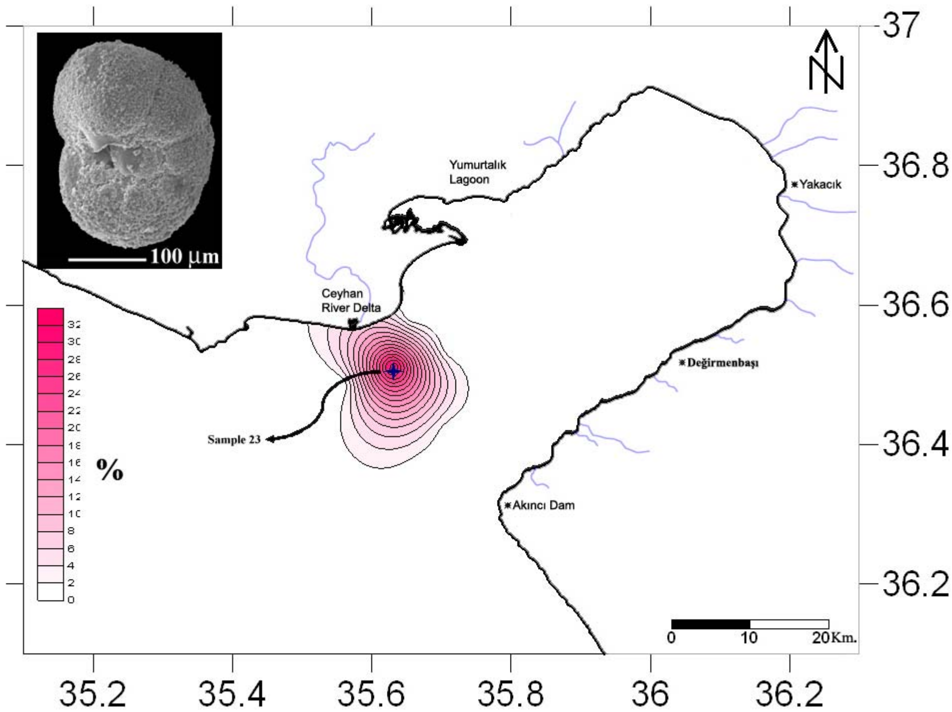


Figure 2-24. Geographical distribution of relative abundance (%) of *Valvularina bradyana* (Fornasini, 1900) recorded in the studied samples. Color scheme shows percentage of relative abundance.

2.7. Distribution of some depth-controlled benthic foraminiferal species

As a review of all information on distribution of benthic foraminifera according to depth, it is concluded that the most abundant species are generally found in all range of the depth, while extremely rare species is found sporadically. Therefore, it is difficult to generalize depth distribution of the species. In the literature, most abundant species are commonly used to give generalized distribution pattern of the foraminiferal fauna. On the contrary, some species, whose relative abundances are less than 1 %, are commonly found in distinct depth zones or their relative abundance exhibit variations with changing depth. In other words, their presences or relative abundances are uniformly distributed according to the distinct depth zones. Although relative abundances of these species are not statistically significant, it should be noted that most important reason of this lower abundance is related to restricted depth of the samples.

To generalize distribution of the species with respect to depth, mean depth of the rare benthic species having bathymetrical importance and the most abundant species, which are previously mentioned, are plotted in Figure 2-25. The geographical distributions of these depth-controlled species are not related well with the occurrences of them.

In the present study, the larger sized species like *Amphistegina lobifera, Amphisorus hemrichii, Challengerella bradyi, Parahauerinoides bradyi,* and *Sphaerogypsina globulus* are generally recorded in the infralittoral zones of the southeastern part of the gulf. The relative abundance of these species within total benthic foraminiferal fauna of the Gulf of İskenderun is very low, because the majority of the studied samples are belonging to the upper circalittoral zone. In addition, the other larger sized benthic foraminifer, *Elphidium crispum*, is recorded up to the lower circalittoral zone but its relative abundance is distinctly high in the infralittoral zone.

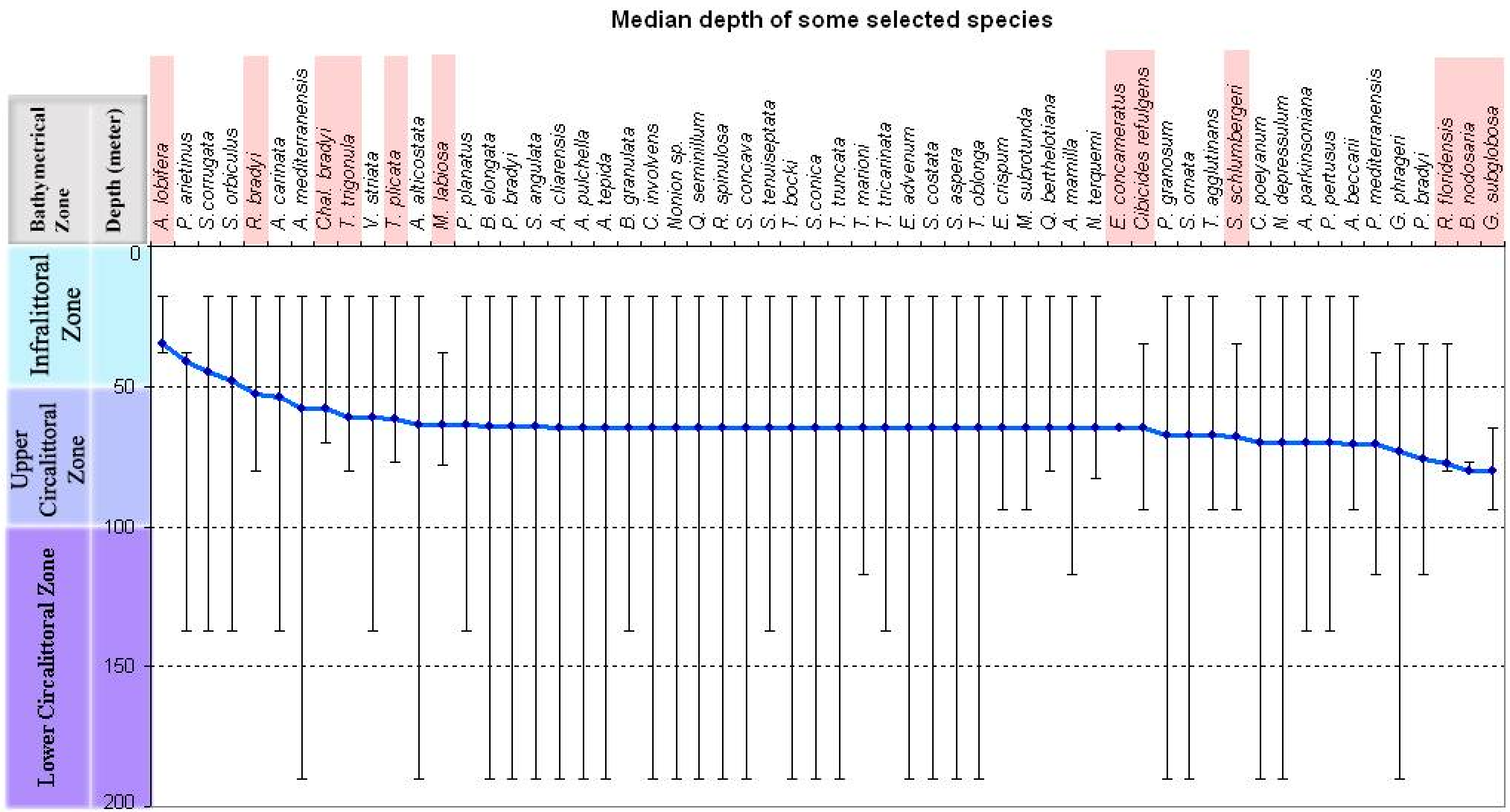


Figure 2-25. Bathymetrical distribution of selected benthic foraminifera in the Gulf of İskenderun. Bars show minimum and maximum depth of the species. Shaded areas show species having restricted depth distributions.

Bigeneria nodosaria is recorded from the middle part of the upper circalittoral zone to the lower circalittoral zone. Its relative abundance is less than 1 % in the total fauna of the gulf. According to Altıner *et al*. (1999), it is found with very high abundance in the circalittoral zone of the Gulf of Saroz. Therefore, it may be possible to conclude that this species is generally found in the circalittoral zone.

Like some cibicid species from the Gulf of Saroz (Altıner *et al*., 1999), *Cibicides refulgens, Cibicides* sp. and *Lobatula lobatula* are generally found in the upper circalittoral zone.

Rosalina floridensis, Rosalina sp. and especially *Rosalina bradyi* are also recognized with relatively high abundance in the infralittoral zone.

Globocassidulina subglobosa is only recorded from the upper circalittoral zone. It may be important to indicate the bathymetry with relatively high abundance in the lowermost part of the upper circalittoral zone. It is absent in the infralittoral zone and the lower circalittoral zone.

Lachlanella undulata is very rare but it is only recorded in the upper circalittoral zone.

Quinqueloculina berthelotiana is also one of the rare species and it is recognized up to the lower circalittoral zone (80 meter).

It might be concluded that infralittoral zone is represented by *Amphistegina lobifera*; and upper circalittoral zone is represented by *Bigeneria nodosaria, Globocassidulina subglobosa* and *Eponides concameratus,* which is only found in 65 meter (sample 54). Although only one individual of *Nodosaria subpervesa* and *Trifarina bradyi* are found respectively in 190 meter (sample 2) and 137 meter (sample 1), lower circalittoral zone might be represented by these species.

2.8. Species recorded only in the Gulf of İskenderun compared to the Turkish coasts

Some species have been recorded for the first time in the Turkish coasts. Indeed, these species are extremely rare, infrequent and generally restricted to extremely limited locations, except *Septloculina* spp. The relative abundance of these species are less than 1% in total benthic foraminiferal fauna of the Gulf of İskenderun including *Articulina mayori, Dentalina subsoluta, Spiroloculina ornata tricarinata, Fursenkoina schreibersiana, Nodosaria subpervesa, Sigmohauerina bradyi, Planisipirinella exigua, Nubeculoculina divaricata, Siphonina pulchra, Triloculina asymetrica, Planorbulina acervalis, Trifarina bradyi, Pseudomassilina austrailis* and as mentioned earlier, *Septloculina angulata, Septloculina rotunda* and *Septoloculina tortuosa*.

Like *Septloculina angulata, Septloculina rotunda* and *Septoloculina tortuosa; Articulina mayori, Sigmohauerina bradyi, Planisipirinella exigua, Triloculina asymetrica, Planorbulina acervalis, Pseudomassilina austrailis* are also the lessepsian migrants and their geographical distribution is restricted to the eastern Mediterranean Sea. *Articulina mayori* is recorded in the upper circalittoral zone (in the samples 34, 13, 25) and the lower circalittoral zone (in the sample 2) of the Gulf of İskenderun. Although different species of the genus *Articulina*, which is interpreted as the lessepsian migrant (Meriç *et al*., 2006), are recorded in the Turkish coasts excluding the Black Sea, this species is not recognized (Alavi, 1980, Meriç and Sakınç, 1990; Sakinç, 1998; Avşar and Meriç, 2001b; Meriç *et al*., 2004aa). It can be concluded that *Articulina mayori* does not adapted the environmental conditions of the other coasts of Turkey as well as *Articulina alticostata. Planisipirinella exigua* is recorded in the circalittoral zone (in the samples 3 and 13). *Sigmohauerina bradyi* is recorded in the infralittoral zone (in the sample 30) and lower circalittoral zone (in the sample 3). *Triloculina asymetrica* is recorded in the upper circalittoral zone (in the samples 27 and 34).

Pseudomassilina austrailis is recorded in the infralittoral zone (in the sample 33). *Planorbulina acervalis* is recognized in the infralittoral (sample 45) and upper circalittoral zone (25, 29 and 13). Although bathymetrical distributions of these species have very wide range, geographical distribution patterns of *Articulina mayori, Sigmohauerina bradyi, Planisipirinella exigua, Triloculina asymetrica, Pseudomassilina austrailis* and *Planorbulina acervalis* are restricted to southeastern part of the gulf (Figure 2-26).

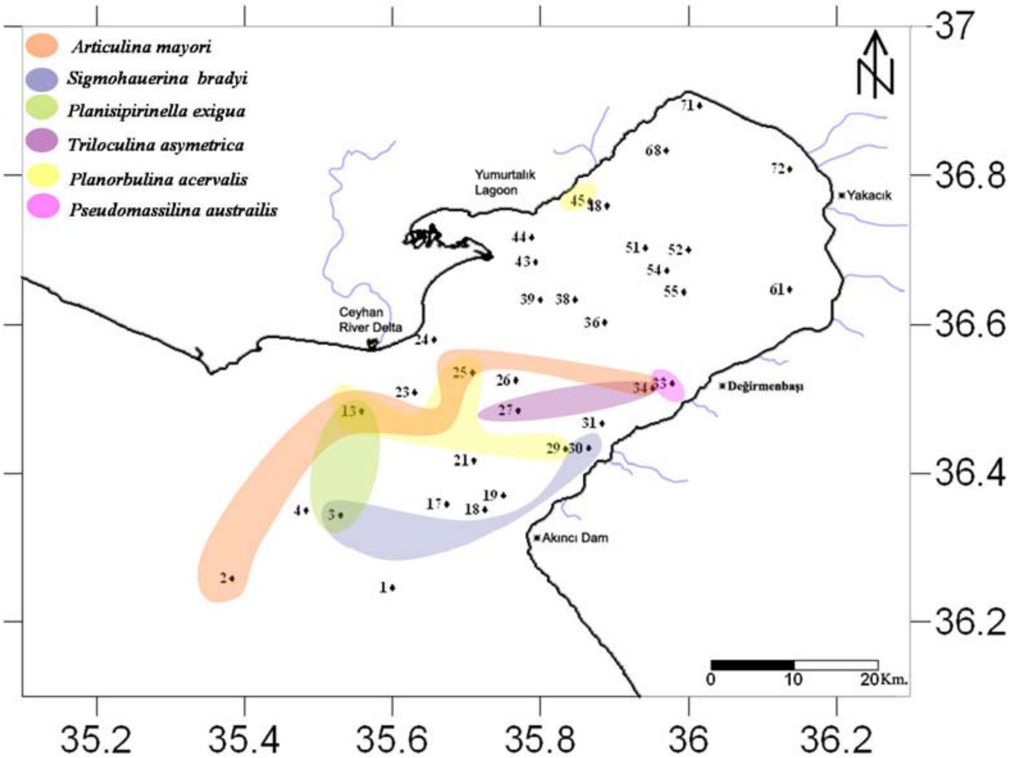


Figure 2-26. Geographical distribution of occurrences of some lessepsian migrant foraminiferal species recorded only in the studied samples. Color scheme shows percentage of relative abundance.

Rest of species, including *Dentalina subsoluta, Fursenkoina scheibosciana, Nodosaria subpervesa, Nubeculoculina divaricata, Siphonina pulchra, Trifarina bradyi* are generally recognized in the circalittoral zones of the gulf, except

Fursenkoina scheibosciana (Figure 2-27). They are distributed sporadically in the gulf. In other words, any relationship between geographical distribution pattern and occurrences of these species is not recognized (Figure 2-28). These species are generally distributed to the circalittoral zones of the western Mediterranean Sea and the Atlantic Sea (Cimerman, and Langer, 1991; Sgarrella and Moncharmont-Zei, 1993; Jones, 1994) and they are absent in the southeastern Mediterranean Sea (Hottinger *et al*., 1993; Yanko *et al*, 1998; Samir *et al*., 2003).

Spiroloculina ornata tricarinata is widely distributed to the gulf and it is recorded generally infralittoral zones of the gulf. It is also recognized in the infralittoral zones of western Mediterranean Sea (Fiorini and Vaiani, 2001).

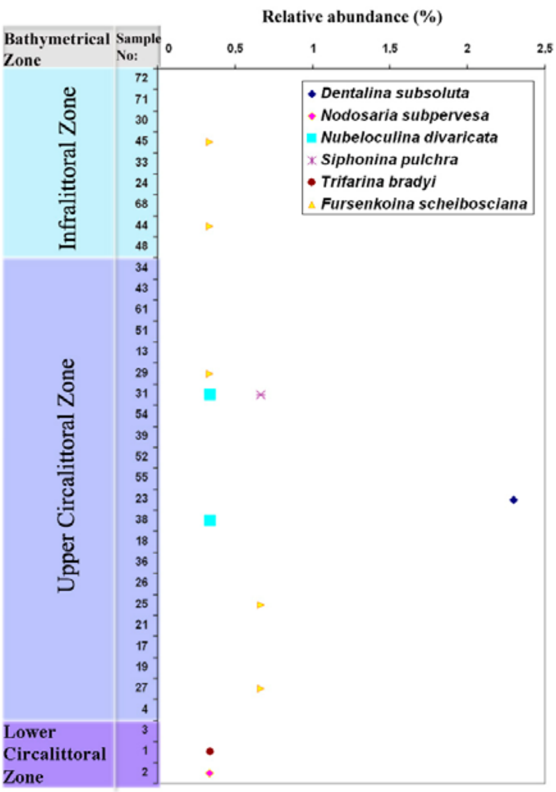


Figure 2-27. Bathymetrical distribution of some foraminiferal species recorded only in the Gulf of İskenderun of the Turkish coasts.

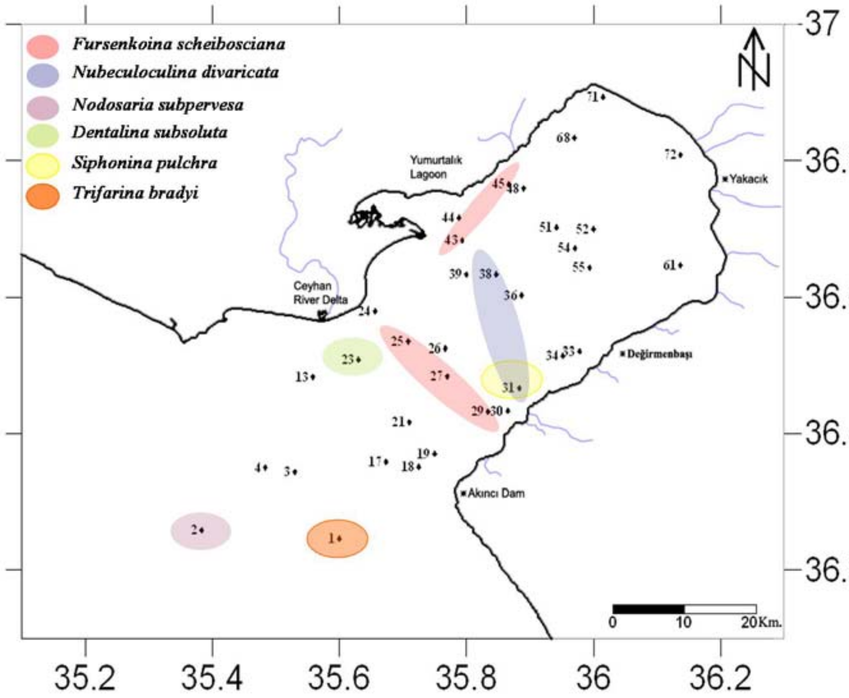


Figure 2-28. Geographical distribution of some foraminiferal species recorded only in the Gulf of İskenderun of the Turkish coasts. Color scheme shows percentage of relative abundance.

CHAPTER III

INTERPRETATION OF THE DISTRIBUTION OF BENTHIC FORAMINIFERA IN THE GULF OF İSKENDERUN

3.1. Environmental Controls on Biotic Distribution

A specific volume occupied by species is called niche. The niche includes effects of all ecological factors, both biotic and abiotic. There are so many environmental variables interacting together that affect the niche. For instance, a species may be able to tolerate low salinity as long as temperature is close to the optimum. However, if both variables are close to the limits of tolerance, their combined effects might cause death before the true limit of tolerance is reached. Therefore, it should be noted that the niche of any given species differs from one place to another. In other words, different combinations of factors may be limiting the distributions in different areas (Doyle, 1999). Some parameters have more intense effect on determining range of species than others and they are termed limiting factors including light, nutrients, oxygen, temperature, salinity, substrate, substrate mobility and turbidity, and depth. Some of these limiting factors are discussed previously in terms of both the Mediterranean Sea and the Gulf of İskenderun. Knowing these parameters will give a background of the environmental character of the study area and related areas.

Temperature

Despite some contradictory evidence, as temperature decreases, size of the species generally increases (Boltovskoy *et al.*, 1991). This is particularly true for species that do not need large amounts of calcium carbonate to construct their test. As mentioned earlier, the sea surface temperature in the Gulf of İskenderun varies from 15^0C to about 29^0C within a year. The effect of temporal variation in temperature on the distribution of foraminifers and the size of the specimens have not been recorded. Yalçın *et al*. (2004) claimed that a thermal region shows high abundance in some peneroplids, like in the Çeşme-Ilıca Bay (Avşar and Meriç, 2002). High abundance of peneroplids has been also recorded in the studied samples. *Peneroplis planatus* is the most abundant in the sample 72, which is followed by the sample 30.

According to Yalçın *et al*. (2004), abnormal contamination of foraminiferal tests with high Cu, Zn, and Pb in different locations, which are close to the samples 72 and 30 is resulted from enrichment in sea water with hot waters coming from active faults. Although green, pink, gray or yellow colored benthic foraminiferal tests have not been observed in the studied samples, some tests in the samples 72 and 30 are black colored. These black colored foraminifers (*Peneroplis pertusus, Peneroplis planatus, Lachlanella variolata* and *Triloculina marioni)* have not been counted, because they have been assumed as reworked or displaced specimens.

Although there may be slight decrease in temperature in vicinity of mouth of the rivers, any anomalies in size and abundance of benthic foraminifers have not been recognized. Therefore, the temperature variation cannot be considered as a main controlling factor in this region.

Salinity and $CaCO_3$ Solubility

It is suggested that there is a relationship between salinity and $CaCO_3$ solubility (Boltovskoy *et al.*, 1991). As previously described, the Gulf of İskenderun is euhaline environment. $CaCO_3$ is rich in the infralittoral zone with the most abundance (71.9 %) in the sample 30 (Figure 3-1 a). In addition, the sample 30 is followed by the sample 1 (in the lower circalittoral zone) with 59.5 % $CaCO_3$. The $CaCO_3$ content of the surface sediments in the gulf is high in the southeastern coastline and the northernmost part of the gulf (Ergin *et al*., 1996). (Figure 3-1 b).

If the salinity is low in environments, many foraminiferal species become smaller, thin walled, and their ornamentations decrease or even disappear completely. Tappan (1951) recorded that the test became thinner and transparent when the distilled water was added, in cultures of benthic foraminifers. In this study, *Biloculinella* species, which has been recognized in the sample 39 ($CaCO_3$ percentage is relatively low with 23.8 %), has relatively thinner test than the specimens in the samples 21 and 19 ($CaCO_3$ percentage is relatively high with >31 %). For that reason, the tests become fragile; the multilocular arrangement part of *Biloculinella* is easily broken apart. Therefore, it is easily confused with Genus *Fissurina*.

According to Boltovskoy *et al*. (1991), colder and less saline waters, like the vicinity of the mouth of the rivers, are characterized mostly by the agglutinated fauna, whereas the temperate areas contain regular calcareous hyaline forms and low to high salinity areas contain abundant miliolids. The salinity may be relatively low in the samples (30, 33, 34, and 72) close to the mouths of the rivers but the effect of low salinity on the abundance of the agglutinated species has not been observed. There is no increasing in the abundance of the agglutinated species in the studied samples. In contrast, the most abundant agglutinated species has been recorded near the Yumurtalık Lagoon.

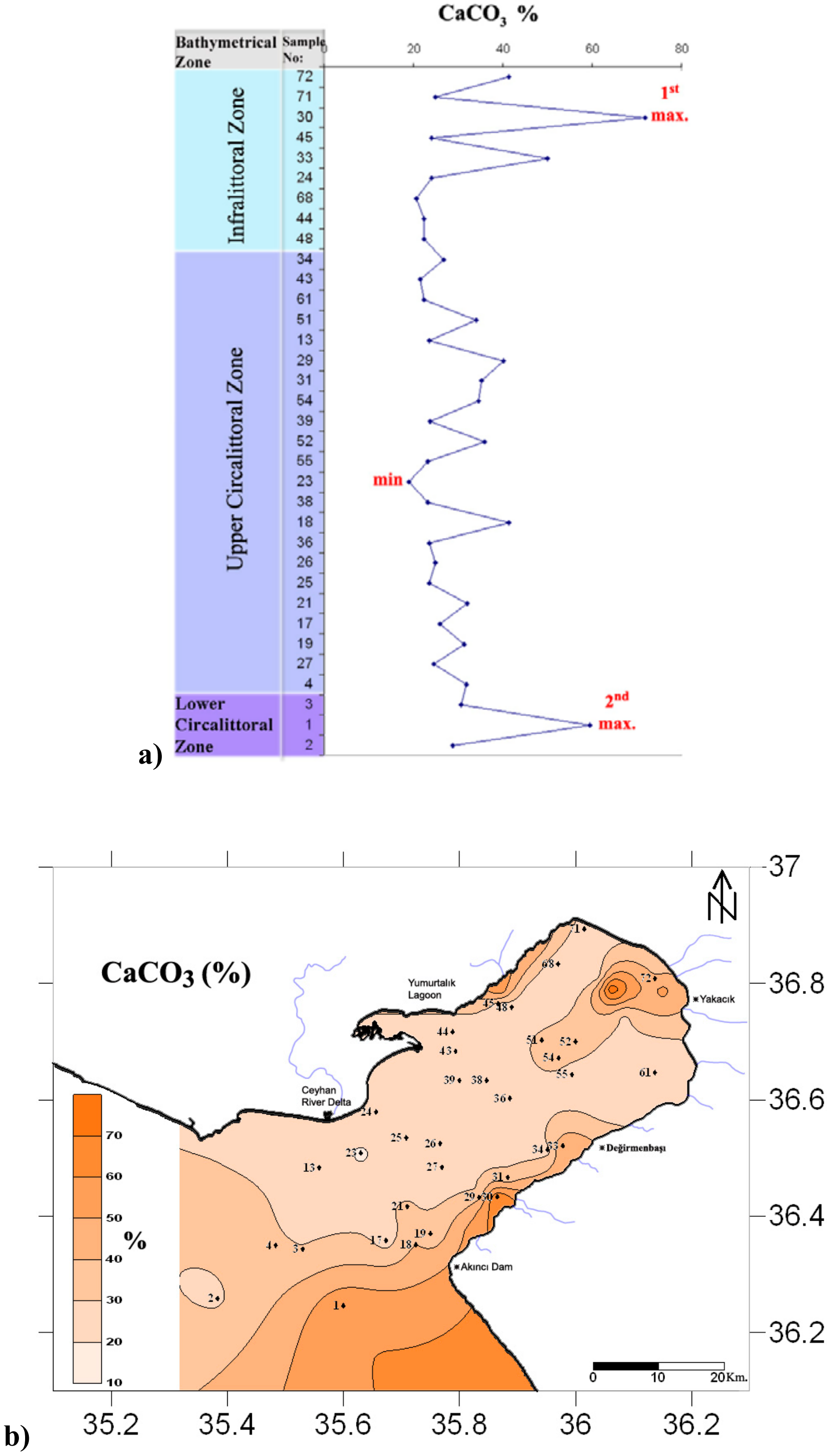


Figure 3-1. Distribution of $CaCO_3$ in the surface sediments of the Gulf of İskenderun; a) bathymetrical distribution, b) geographical distribution. Color scheme shows percentage of $CaCO_3$ content (modified from Ergin *et al*., 1996).

Pollution

Benthic foraminiferal distributions in polluted marine environments are considered to be one of the most sensitive biomarkers (Sen Gupta, 1999; Murray, 2000). Studies about marine pollution effects on the foraminifers (Yanko *et al.*, 1994; Alve, 1995; Culver and Buzas, 1995; Geslin *et al.*, 1998; Yanko *et al.*, 1998; Geslin *et al.*, 2003; Alve, 2003; Châtelet *et al.*, 2004) include changes in assemblage compositions such as disappearance, replacement, or appearance of specific species, increased abundance of certain species, and morphological abnormalities such as abnormal additional chamber, reduced chamber size, over-developed chamber, abnormally protruding chamber, aberrant chamber shape, distorted chamber arrangement or change in coiling direction, siamese twins, double aperture, development of high spiral face in relation to different types of pollutant.

Understanding foraminiferal ecological dynamics in polluted marine environments is difficult. Because, the most severely polluted areas are often naturally stressed, marginal marine environments where natural environmental conditions change over small distances. Proportion of observed local variation in assemblage composition, abundance and diversity patterns could be changed by either natural or anthropogenically causes. In addition, many different kinds of pollutants are being discharged into various marine environments, and it is reasonable to assume that foraminiferal response varies with different mixtures of pollutants. Moreover, same kind of pollution can affect various environments differently (Murray, 2000).

As noted before, although the Gulf of İskenderun is a pollution hot spot, any abrupt variation in the assemblage has not been recognized in the studied samples (the samples 44, 45, 71, 72 and 61), which is located near the highly industrialized areas (Botaş, the Industry of Fertilizers, petrol pipelines, waste discharges of domestic and industrial origin). However, the relative abundance of a Lessepsian migrant, *Peneroplis pertusus,* is extremely high (9 %) in the sample 72 (18 meter depth), although this sample is located far from the Suez Canal. In the sample 30 (35 meter depth), only 6 individuals of *Peneroplis pertusus* show morphological abnormalities like change in coiling direction, additional chambers and protuberances (plate 4, fig. 10 and plate 5, figs. 1-2). Moreover, aberrant chamber shape and abnormal protruding last chamber have been recognized in only one specimen from each of *Asterigerinata mamilla* and *Ammonia tepida* in the sample 13, which is situated near the entrance of the Ceyhan River. The proportion of abnormal tests recorded in this study is extremely low in contrast to that in the coasts of Israel (Yanko *et al.*, 1994; Yanko *et al.*, 1998). In the present study, the presence of these abnormal specimens is not enough to relate effects of pollution. According to Yanko *et al.* (1998), the morphological deformities can occur within the range of natural variability of a given species up to 1 % of total living population. Abnormalities in the test shapes are not necessarily caused by pollution, but also it may be resulted from abnormal salinity, reduced nutrition levels and rapidly changing environmental conditions.

Other factors

As mentioned previously in the Chapter 3, there is a complex distribution scheme of benthic foraminifers. In the beginning of this study, it was expected that **depth** is one of the main controlling factor on benthic foraminiferal distribution, as in many other studies (Altıner *et al.*, 1999; Sgarrella and Moncharmont-Zei, 1993; Cita and Zocchi, 1978; Jorissen, 1988). The influence of depth can not be recorded practically, it is not possible to separate this factor from effects of other ecological parameters. There is also a little relation between the depth and the distribution patterns of the benthic foraminifers in the present study. Some species exhibit decreasing or increasing trend of relative abundance according to the depth. In the study area, there are many samples having same depth and some of them show different distribution patterns of benthic foraminifers in contrast to the estimated patterns. Although one of the important benthic species is abundant in one sample, this species is absent in other sample having same depth. Some of these samples and their relations with the relative abundance and depth are summarized in Table 3-1. Especially, the sample 30 and 45 (having 35 meter depth) are inversely related in terms of occurrences of some benthic foraminifers. The sample 30 is deficient in terms of the most abundant species, while the Lessepsian migrants are absent in the sample 45. This inverse relationship will be emphasized in the statistical analyses section.

Table 3-1. Comparison of the relative abundances of some benthic foraminiferal species in the studied samples having same depth

Benthic foraminiferal species		Sample number (species is absent)	Sample Number / relative abundance of the species	Depth (meter)
Lessepsian migrants	*Peneroplis pertusus*	sample 45	sample 30 / 7.7 %	35
	Septloculina angulata	sample 45	sample 30 / 9.4 %	35
	Vertebralina striata	sample 45	sample 30 / max. abundance (8.3 %)	35
The most abundant species	*Adelosina cliarensis*	sample 52	sample 55 / 10.7 %	70
	Adelosina pulchella	sample 23	sample 38 / 3 %	71
	Ammonia tepida	sample 30	sample 45 / 7.4 %	35
		sample 52	sample 55 / 10.6 %	70
		sample 23	sample 38 / 12,4 %	71
	Buccella granulata	sample 30	sample 45 / 7.7 %	35
		sample 29	sample 54 / 3.7 %	65
	Cribroelphidium poeyanum	sample 30	sample 45 / 4 %	35
		sample 44	sample 48 / 9.4 %	45-49
		sample 72	sample 71 / 4 %	18
	Elphidium advenum	sample 30	sample 45 / 4.4 %	35
		sample 39	sample 31 / 1.7 %	65

In this manner, there will be another parameter, which affects the distribution patterns of benthic foraminifers. Fiorini and Vaiani (2001) stated that variation in foraminiferal associations provides a highly sensitive record for monitoring environmental parameters, especially in the shallower marine environments. Therefore, there are many controlling factors, which affect the distribution patterns, in addition to depth. One of the important parameter is **substrate**. Generally, distribution of the foraminifera shows strong correlation with the sedimentary characteristics of the samples (Avşar, 1997; Jorissen, 1988; Basso and Spezzaferri, 2000; Fiorini and Vaiani, 2001). Grain size distribution according to samples is given in Figure 3-2. Figure 3-3 and Figure 3-4 show that the southeastern and northern coastline of the gulf are represented by the highest gravel percentages (5-36 %) and the highest sand percentages (50-80 %). Moreover, the high sand percentages (10-48 %) are found in the west of the Ceyhan River.

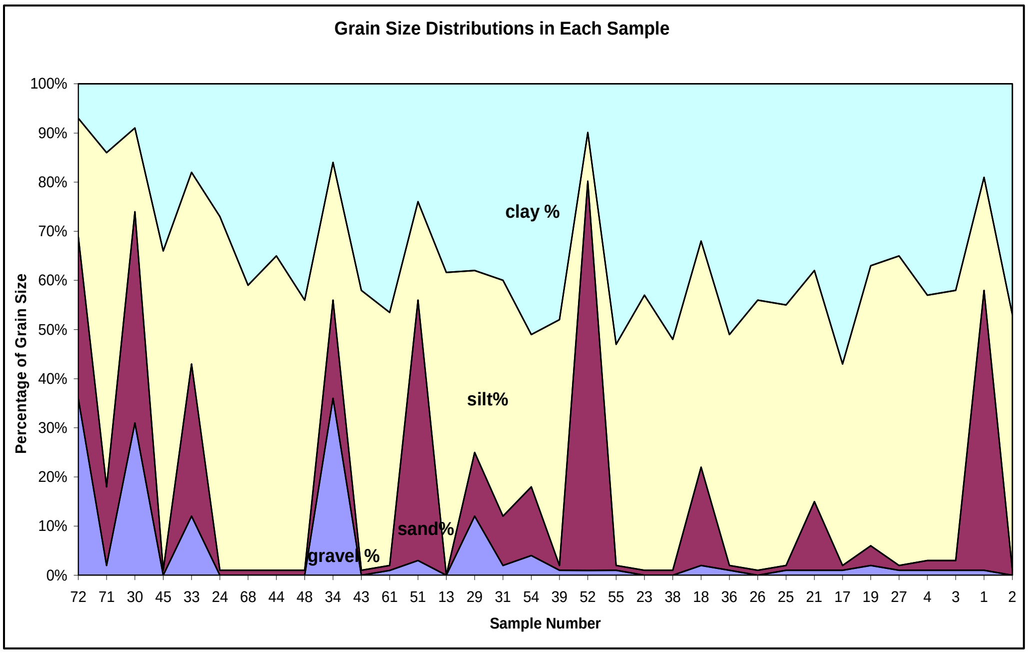


Figure 3-2. Grain size distribution of surface sediments in the studied samples (Kazan, 1994)

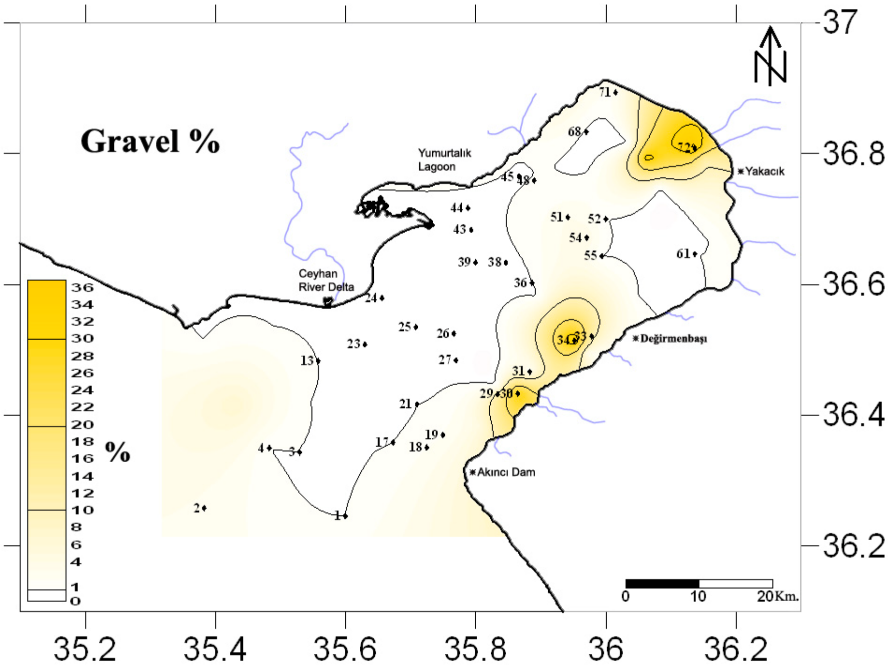


Figure 3-3. Geographical distribution of the gravel percentages in the Gulf of İskenderun sediments (Kazan, 1994).

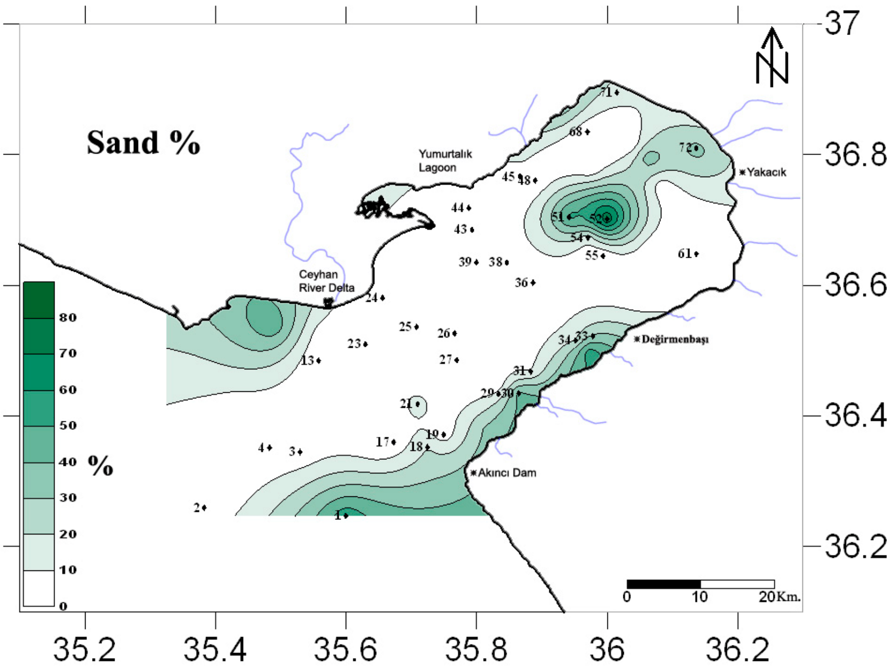


Figure 3-4. Geographical distribution of the sand percentages in the Gulf of İskenderun sediments (Kazan, 1994).

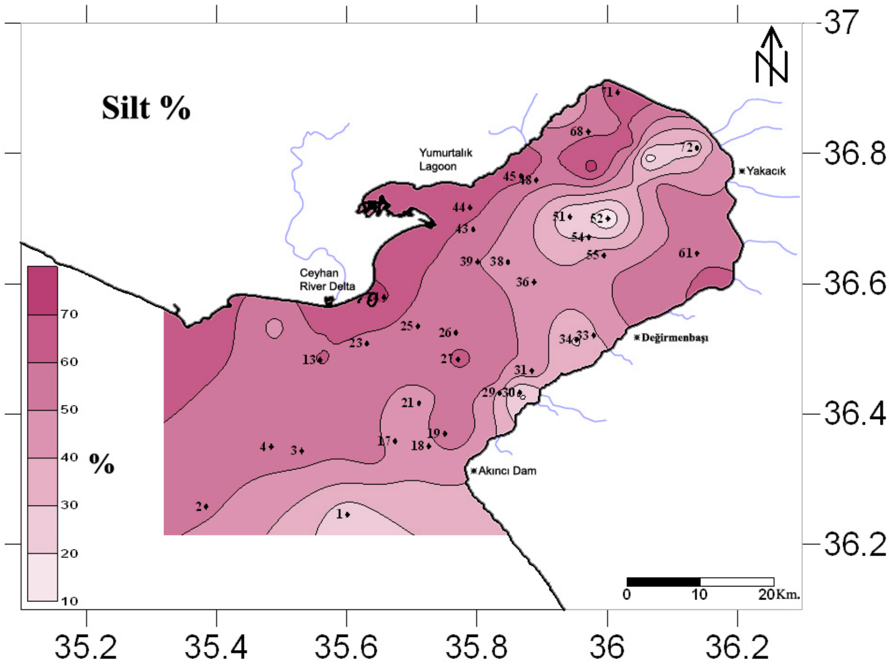


Figure 3-5. Geographical distribution of the silt percentages in the Gulf of İskenderun sediments (Kazan, 1994).

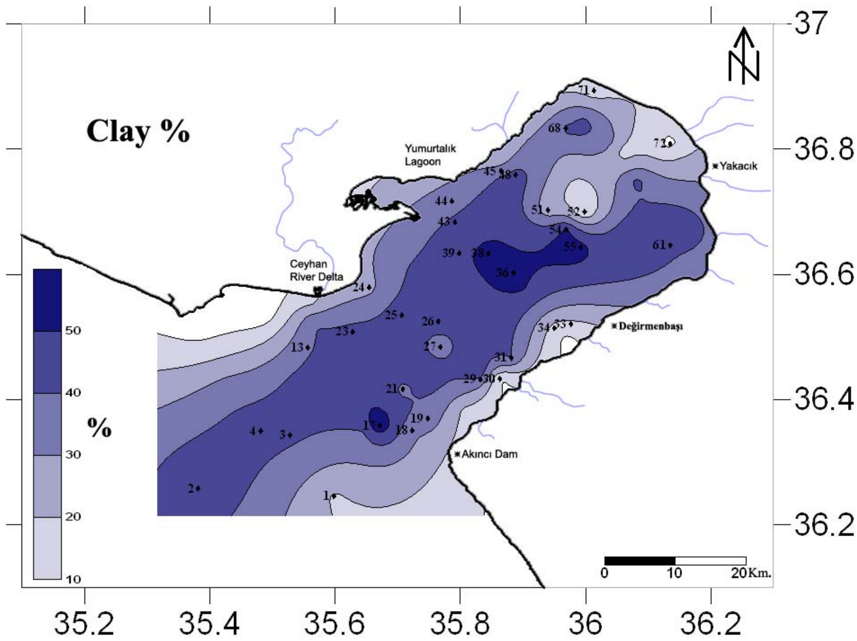


Figure 3-6. Geographical distribution of the clay percentages in the Gulf of İskenderun sediments (Kazan, 1994).

The most parts of the gulf including the studied samples are dominated by silt and clay, referred here as mud. The center part of the gulf is represented by the higher clay (40-71 %) and silt (50-74 %) fractions (Figure 3-4 and Figure 3-5).

In the present study, the distribution of the foraminifera is strongly correlated with the grain sizes of the surface sediment. Especially, the faunas in the southeastern part of the gulf, where the gravel fractions are the highest, are completely different from the mud rich parts. As noted before, the southeastern part of the gulf is flanked by a high topographic relief with no important terrigenous supply that favors the benthic foraminiferal production. This relationship between substrate and distribution patterns of the benthic foraminifera will be discussed in the statistical analyses section.

Another parameter, which affects the distribution patterns of benthic foraminifers, can be defined as **oxygen deficiency**. The Gulf of İskenderun is highly dynamic basin so there is no oxygen deficiency in the bottom of the sea. Furthermore, there is no nutrients deficiency in the gulf, especially near the Ceyhan River, which is the one of the main rivers on the southeastern Mediterranean coasts of the Turkey and discharges nutrient rich waters into the gulf. In the sample 24 located near the Ceyhan River, diversity and density of the species have been expected much higher than the samples 72 and 33, which are situated near another rivers. There may be other factors similar to higher salinity difference in the sample 2, which is more important than nutrient availability.

3.2. The relationship of density and diversity

Diversity and density (or the relative abundance) of species are important indicators of the nature and hostility of an environment. Generally, environments of a relatively hostile nature, such as those with high or low salinities or low oxygen, are characterized by an assemblage, which is low in diversity.

Conversely, abundance of individuals may be high. In these stressed environments, most taxa are excluded, including most predators, so that the available resources are used by a limited number of successful species. This leads to the development of the low diversity but high density of the assemblage. Often, the colonization of such habitats may be rapid, the species concerned being opportunists (Figure 3-7).

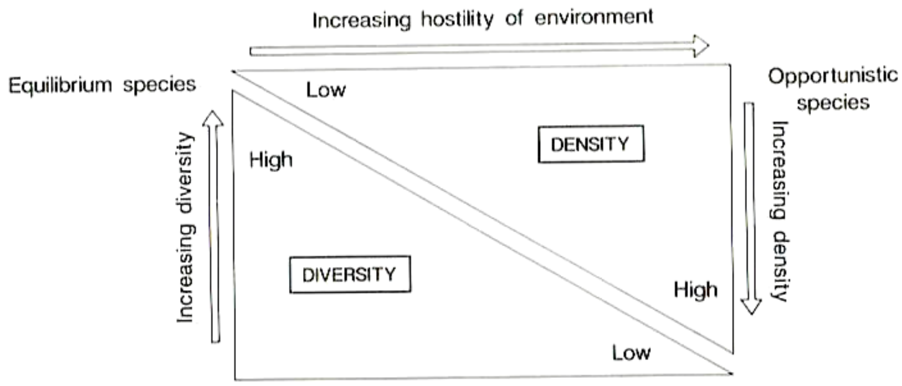


Figure 3-7. The relationship of density and diversity (from Doyle, 1999)

In less limited environments, such as normal marine salinities and fully oxygenated conditions, the diversity of species may be high, but the abundance of individuals may be correspondingly low. This reflects the partitioning of the same resources available to the low diversity assemblage between a greater numbers of species, with a corresponding increase in predators. In such environments, although many species are producing new generations, density is kept low through the competition for resources, and by the action of the predators. Species in these environments are known as equilibrium species, maintained in equilibrium by the quantity of the resource (Doyle, 1999). When an environment deteriorates such as becoming severely oxygen-depleted, the more specialized equilibrium species disappear first whereas the generalists and opportunists survive for long period.

The benthic foraminiferal species richness (number of species) ranges from 22 to 62 in the studied samples. Figure 3-8 shows that overall trend of species diversity decreases from the infralittoral zone to the lower circalittoral zone. The maximum diversity occurs with 62 species at sample 21 (80 meter) and the minimum diversity occurs with 22 species in sample 23 (71 meter). Because of this reason, it can be concluded that the diversity of the species is not related with depth. Moreover, Figure 3-8 represents diversity of the samples is positively correlated with grain sizes. High diversity is generally occurred in gravel rich sediments, while low diversity is recognized in muddy sediments.

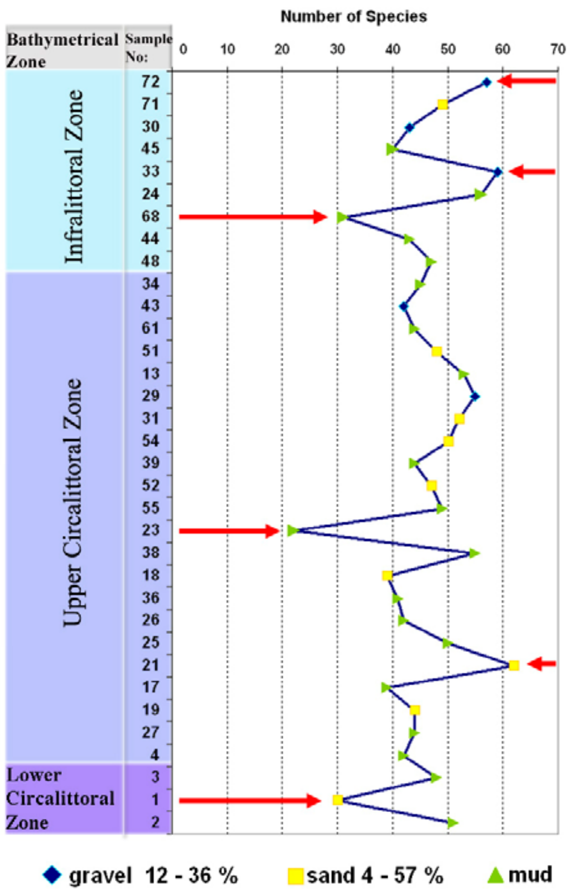


Figure 3-8. Diversity curve of the studied samples.

In this manner, it is obvious that the sample 23 is in a restricted environment due to extremely low diversity. As mentioned earlier, *Valvularina bradyana* is the dominant species (33.4 % and recorded only in the sample 23 and it can be described as an opportunistic species. Figure 3-8 shows that the sample 68 (44 meter) is also represented by low diversity (31 species). The sample 68, unlike the sample 23, is not dominated by only one species. In contrast, there are already the most frequent species of the faunas of the gulf including *Nonion* sp., *Buccella granulata, Textularia bocki, Adelosina pulchella, Reussella spinulosa, Quinqueloculina seminillum* and *Adelosina cliarensis*. Hence, it is difficult to conclude that the sample 68 is restricted environment.

The sample 1 has also relatively low diversity situated at the entrance of the gulf and relatively deeper than other samples. It is dominated by *Peneroplis pertusus, Adelosina cliarensis, Septloculina angulata, Buccella granulata, Quinqueloculina seminillum, Sorites orbiculus, Siphonaperta aspera* and *Ammonia parkinsoniana*. Although individuals of *Peneroplis pertusus* in the sample 1 are not seen as transported or reworked fossil, it is not normal to record this species in deeper zones than the infralittoral zone. Therefore, there may be substrate mobility and turbidity in this location. *Septloculina angulata* may be an opportunistic species that restricted to proximity of the Israel coasts where it is found abundantly.

As previously mentioned, the sample 21 (80 meter depth) is the most diverse (62 species) sample situated in the southeastern entrance of the gulf. In addition, the number of specimens in 1 gr. sediment, which is greater than 250μm, is very high (129 individual > 250 μm / 1 gr.) in the sample 21 (Figure 3-9). Although the samples 17 and 19 are very close to the sample 21 and situated in the same depth, the diversity of the samples 17 and 19 is lower (39 to 44 species) than the diversity of sample 21. The sample 21 with high diversity is represented by sand rich sediments, while the samples 17 and 19 with low diversity are dominated by mud rich sediments.

Therefore, it can be concluded that the diversity of the benthic foraminifers and the grain size of sediments in the studied samples are strongly correlated.

The number of specimens is related mostly to the sediment types than depth (Figure 3-9). Although the number of specimens (> 250 µm / 1 gr.) in the samples increases from the infralittoral zone to the upper circalittoral zone, there are variations of the number of specimens in the same bathymetrical zones. In the infralittoral zone, higher number of specimens is recorded in the gravel rich samples (the samples 72, 30, and 33), while the number of specimens in the mud rich samples (the samples 45, 24, 68, 44 and 48) are lower. However, increase in the number of specimens in the upper circalittoral zone is mainly resulted from the sand rich samples, especially in the samples 21, 52 and 31.

The diversity indexes and dominance of the taxa are determined by means of PAST (Paleontology Statistic program, Hammer *et al.*, 2001) in order to quantify the taxonomical diversity in the studied samples (Figure 3-10). Fisher alpha, Margalef, Shannon H, Menhininck, Simpson, and Equitability are all evenness indexes, while Berger parker is dominancy index. High number of evenness shows relatively diverse sample, represented by high number of species, while high number of dominance (inverse of evenness) shows relatively low diversity, and represented by small number of species. Abrupt increase in dominancy indexes and decrease in evenness indexes are seen in the samples 23 and 1. As notes before, the diversity of benthic foraminiferal species is extremely low in these samples, the former is dominated by *Valvularina bradyana*, and the latter is dominated by *Peneroplis pertusus.* On the contrary, the samples 21 and 38 are represented by the highest evenness and the lowest dominance numbers, both of samples are highly diversified, as mentioned earlier.

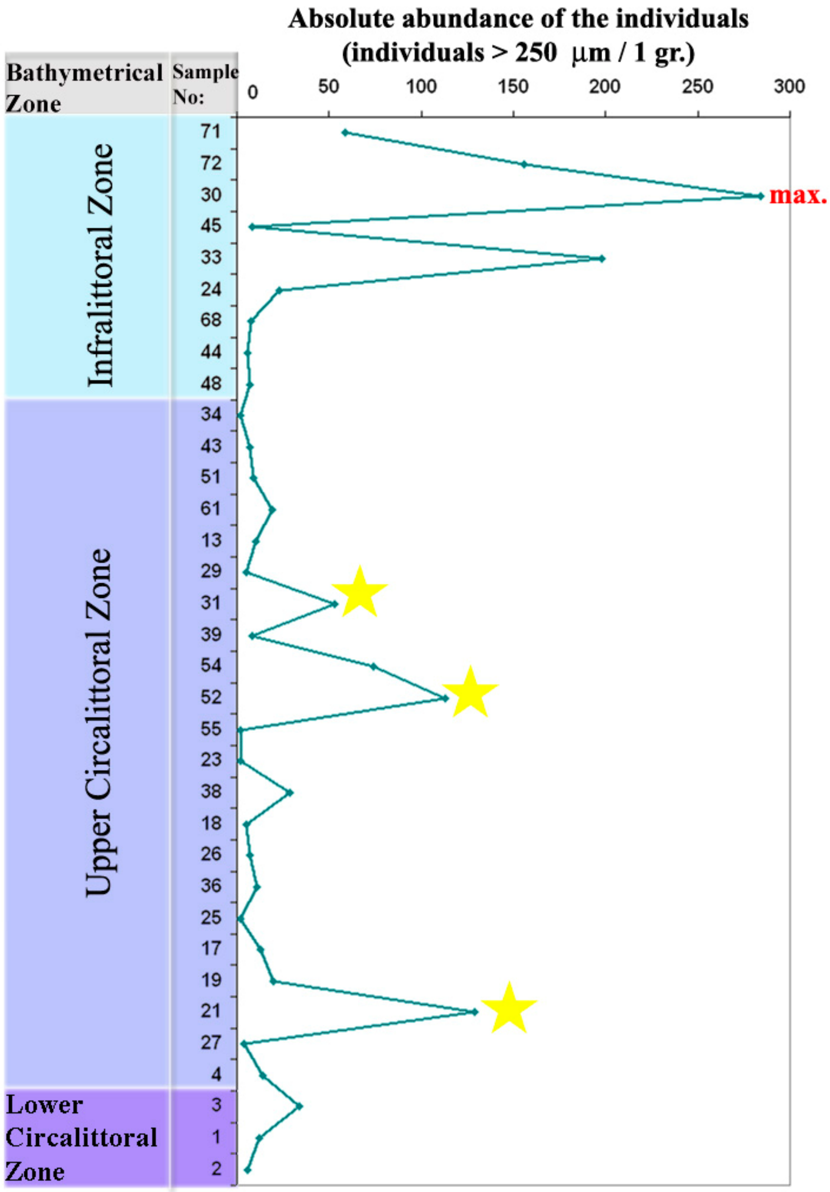


Figure 3-9. Number of specimens of the benthic foraminiferal individuals greater than 250 micron per one gram. Stars show sand rich samples with abrupt increase in the number of specimens of individuals.

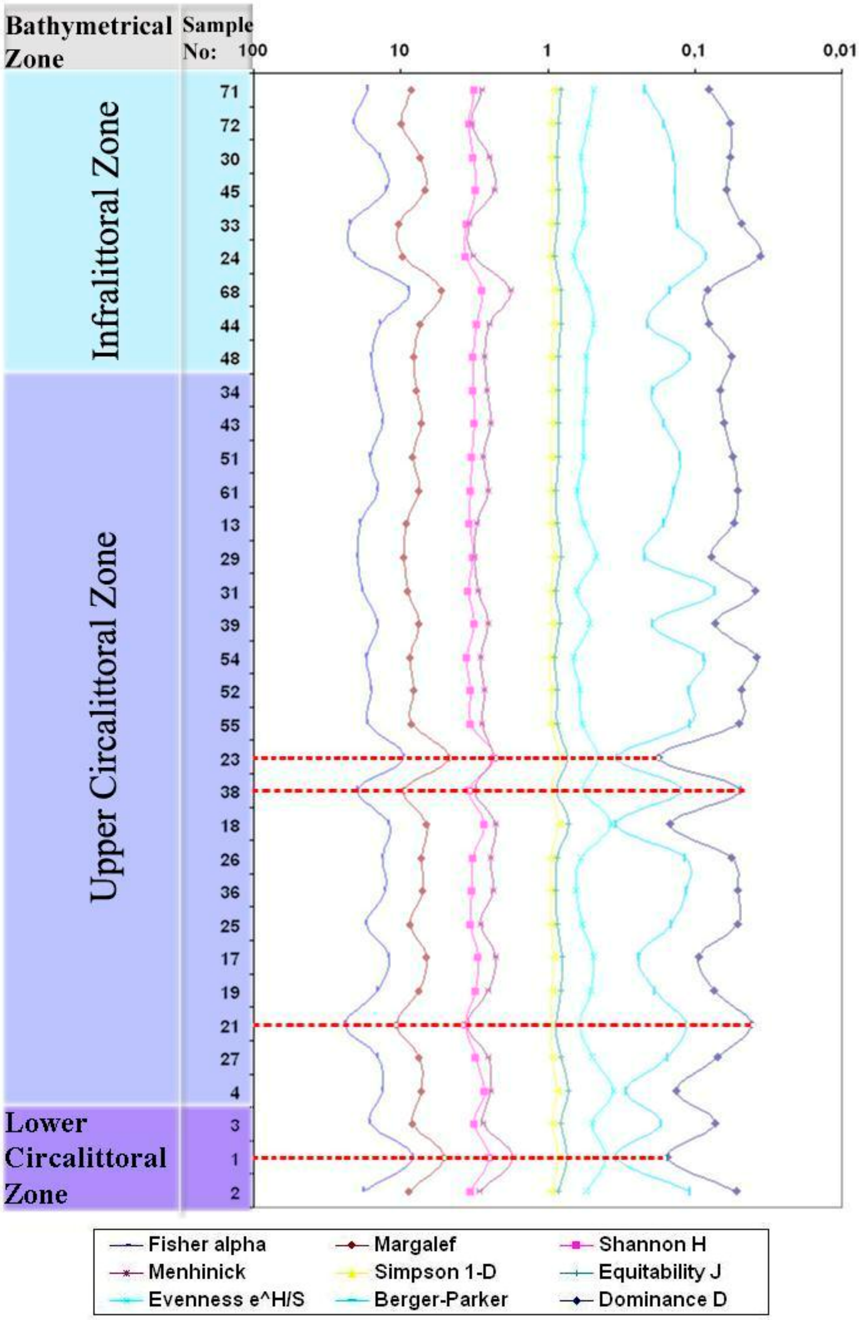


Figure 3-10. Diversity indexes of the samples. Dashed lines show the samples with abrupt increase or decrease in the diversity indexes.

3.3. Statistical Treatment of Data

Nowadays, paleontology becomes a quantitative science and there is a need to know both statistical procedures and analytical methods for paleontological problems. Therefore, this study is concentrated on some statistical methods generally used in ecological data analysis. Indeed, in the present study, the diversity of the benthic foraminifera in each sample is generally extremely high and has very similar value to each other. Moreover, the evenness values are generally high in samples, while dominancy is low. Therefore, it is difficult to recognize any microenvironments owing to too complex distribution scheme of the benthic foraminifers without statistical methods.

These statistical analyses are new for paleontologists and there is a limited use of them. Therefore, there is no unity in the methods. It is not known if raw data is required any transformation or standardization and which methods are appropriate to data. Cluster analysis is much more common than other methods and it is followed by principal coordinate analysis, principal components analysis and non-metric multidimensional scaling (NDMS), all of that give two-dimensional distribution of samples and species. In this study, to cope with this problem, all methods used for ecological data have been established and results have been compared each other.

Three main statistical methods without statistical significance have been applied to counted species. Firstly, the cluster analysis has been used to cope with this problem. The objective of cluster analysis is to sort the most similar kind variables (samples or species) into respective categories. Because the studied samples are highly diversified, it is difficult to recognize the microenvironments. The cluster analysis makes easier to recognize assemblages and their representative species. Cluster analysis is not enough to see environmental factors alone. Therefore, component analysis has been also applied to data.

3.3.1. Hierarchical Cluster Analysis

Hierarchical Cluster Analysis is an explorative technique to identify groups and subgroups in a multivariate data set. It should be emphasized that cluster analysis, unlike a formal statistical technique, is a typical method for data exploration and visualization. It is based on a given distance or similarity measure. Selection of a distance or similarity measure depends on type of data and other considerations (Hammer and Harper, 2006). Hammer and Harper (2006) suggest that "average linkage method" is appropriate for ecological data. Different methods used by different authors are given in Appendix-B. It is very difficult and complicated to select the most suitable method such as similarity matrix, transformation or data selection basis. Therefore, most of the methods, different programs, transformations have been used in this study according to different selection criteria.

Firstly, the raw data have been used giving complicated R-mode clusters. It gives very long clusters combining the accessory species, which have been recorded as only one individual. This is the main reason of the selection of some species according to their relative abundance.

In statistical applications, each method is applied to different situations (Appendix-B). Reasons of selection of type of the method have not been generally given in the papers. Only foraminiferal species that were estimated to be present in statistically significant numbers is used in the Q-Mode cluster analysis. Selection is mostly based on the relative abundance of species having greater than 1 % or greater than 5 %. However, it is very important to emphasize that whether this percentage is gained from total number of species in all samples or it is gained from only one sample. For example, *Valvulineria bradyana* has been recorded only in the sample 23 with high relative abundance (33.3 %), as noted before. Therefore, its relative abundance is 0.29 in the total of the samples since relative abundance of this species is zero in all samples excluding the sample 23. This value is enormously low to add cluster analysis, if selection basis is higher relative abundance of the species (>1 % or >5 %) within the total of samples. As explained earlier, the sample 23 is obviously different from rest of the samples. Because this sample has been represented by dominance of *Valvulineria bradyana*, this species would be added to species of the cluster analysis. Like *Valvulineria bradyana*, some species have been also put into the cluster analysis. Therefore, selection basis is determined as if the species having equal or greater than 5 % of relative abundance within any sample has been used in cluster analysis.

Criteria for selection of species are very important. Appendix-B illustrates that there are different ways to represent data and applying statistical methods.

The studied samples are mainly restricted to the upper circalittoral zone. The grain size of the sediments is commonly dominated by mud in the samples. Therefore, selection of the species has been based on different methods.

Because of the rareness of the most of species recorded in this study, species having greater than 5 % of relative abundance within any sample has been only used in the cluster analysis. From the 151 identified benthic foraminiferal species, 41 taxa have been selected for use in the quantitative analyses based on their frequency of occurrence and relative abundance. Planktonic foraminifers in the samples have been also omitted from calculations. In this manner, 3 main clusters have been obtained from Q-mode cluster analysis using the Ward's method for agglomeration (Figure 3-11). Their representative species resulted from R-mode cluster analysis are given in Figure 3-12. These clusters will be discussed in the following sections.

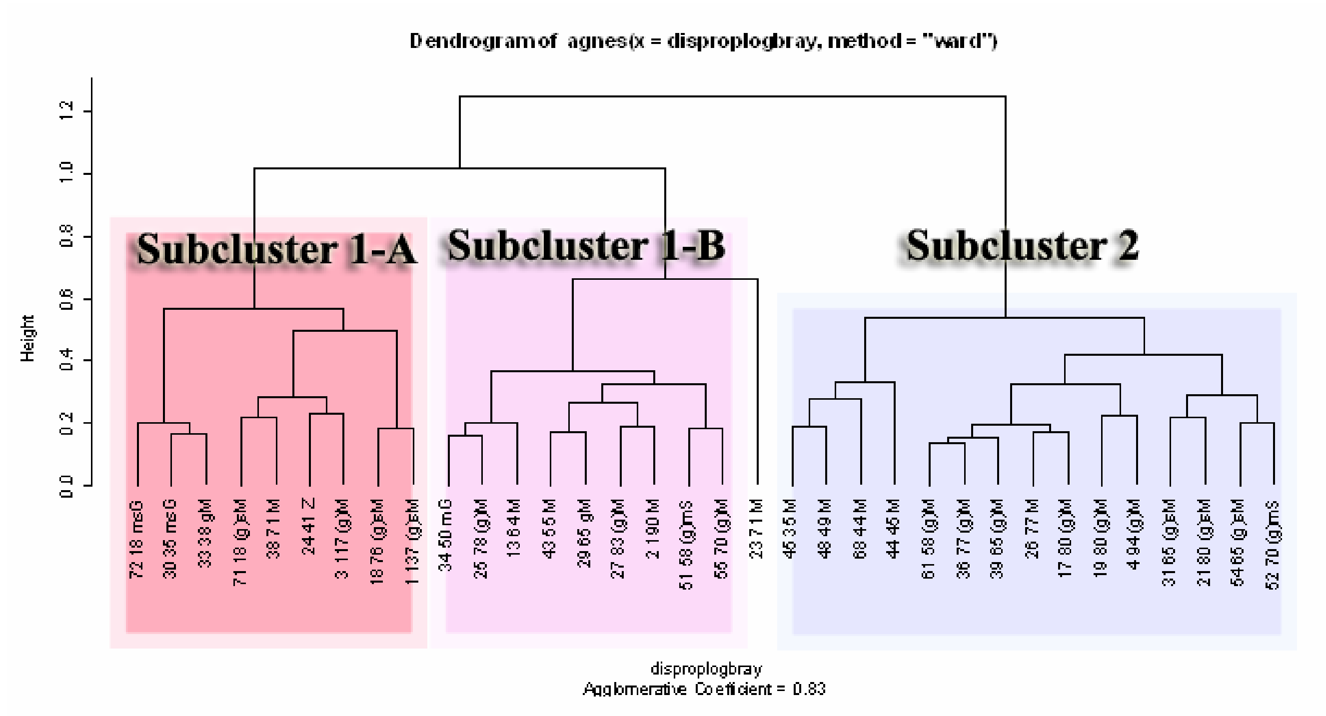


Figure 3-11. Dendrogram resulting from a Q-mode cluster analysis based on the relative abundance of the most frequent taxa in 34 variables (samples), using the Ward's method for agglomeration.

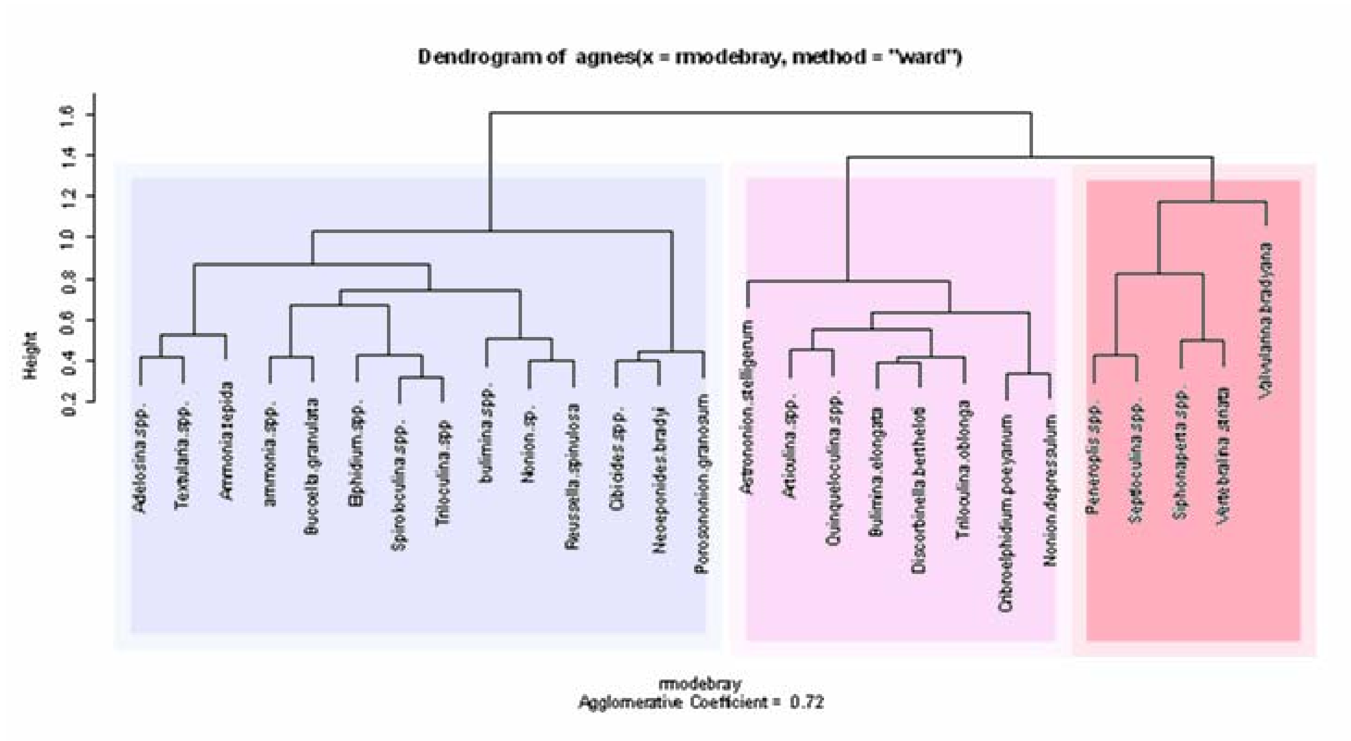


Figure 3-12. Dendrogram resulting from R-mode cluster analysis

3.3.2. Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA)

After obtaining clusters (Figures 3-11 and 3-12), to visualize the samples and their relationships in 2-dimensions, Detrended Correspondence Analysis (DCA) is applied to most abundant taxa. This analysis is an indirect ordination technique of ecological datasets (without a priori) and it represents underlying environmental parameters. If there is no environmental data, this technique is appropriate for ecological datasets. In the present study, there are some environmental parameters including grain size, depth, $CaCO_3$ and Corg, but other parameters like bottom temperature, salinity, dissolve oxygen and primary production are not available. Therefore, this analysis has been applied to dataset of relative abundance of most abundant taxa in 34 samples. This analysis has been shown the reasons of clusters by means of 2 axes (2 different environmental parameters). These 2 environmental parameters could be either 2 different parameters or combination of more parameters. In present study, studied samples have been shown strong correlation with grain size of sediments in axis 1, while axis 2 in have not been correlated well with other environmental factors (Figures 3-13 and Figures 3-14). To recognize easily the relation between clusters of samples (Q-mode) and grain size of sediments in these samples, the clusters analysis have been applied to grain size data in studied samples and 3 main clusters have been obtained including gravel rich cluster 1 (12-36 % gravel), sand rich cluster 2 (4-57 % sand) and mud rich (silt and clay) cluster 3 (Figure 3-16). There have been some irregularities in terms of grain size and these irregularities have been explained by diversity of samples (Figure 3-13). In the mud rich samples (the sample 3, 24, 38 and 13) situated in the left of the axis 1(horizontal), the benthic foraminiferal diversity is higher than other mud rich samples in right of the axis 1. Although diversity is not environmental parameter alone, it shows other environmental parameter underlying of it, which could be nutrient availability or another one. Axis 2 is not correlated any environmental parameters. Therefore, using Multivariate Statistical Package (MVSP), canonical correspondence analysis is applied to analyze the dead foraminiferal data sets and relate them with available environmental data (with priori) (Figure 3-15). It allows to recognize the correlation between constants (samples) and variables (e.g. environmental parameters) and to measure their contribution to the total value of each factor presented simultaneously at a single plot (Teil, 1975; Jongman *et al*., 1995). Canonical correspondence analysis (CCA) is a constrained ordination technique that is an extension of the original correspondence analysis technique (CA). It is a direct gradient analysis method. Environmental parameters are plotted as an arrow. The lengths and positions of the arrows show the relationship between the original environmental variables and the derived axes (Szarek *et al.,* 2006). Arrows, which are parallel to an axis, indicate a correlation, while the length of the arrow reflects the strength of that correlation (Jongman *et al*., 1995). In present study, samples are well correlated with gravel, which is almost parallel to axis 1 in positive direction, and clay, which is also almost parallel to axis 1 in negative direction. Depth is not parallel to axis 2 so the samples are not correlated well in terms of depth; there may be another parameter, which affects to axis 2.

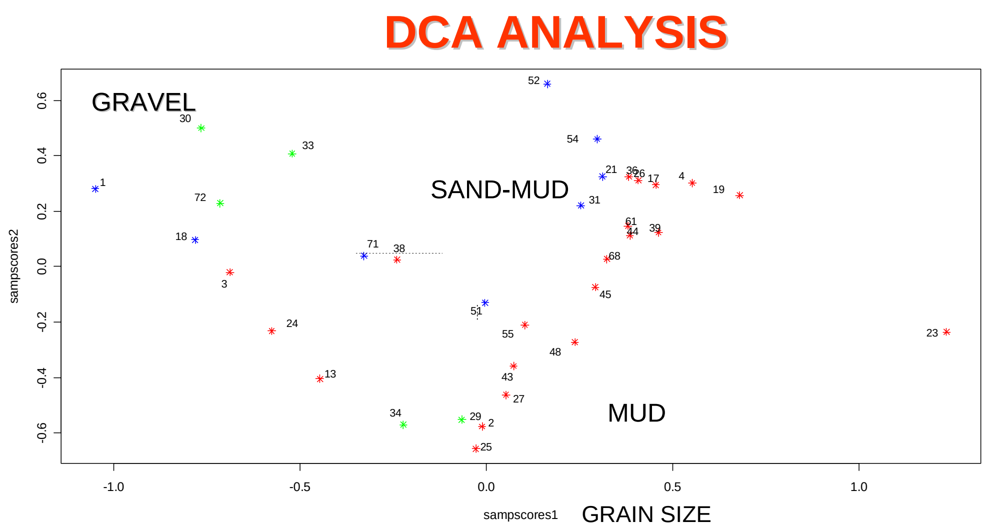


Figure 3-13. Detrended correspondence analysis of studied samples.

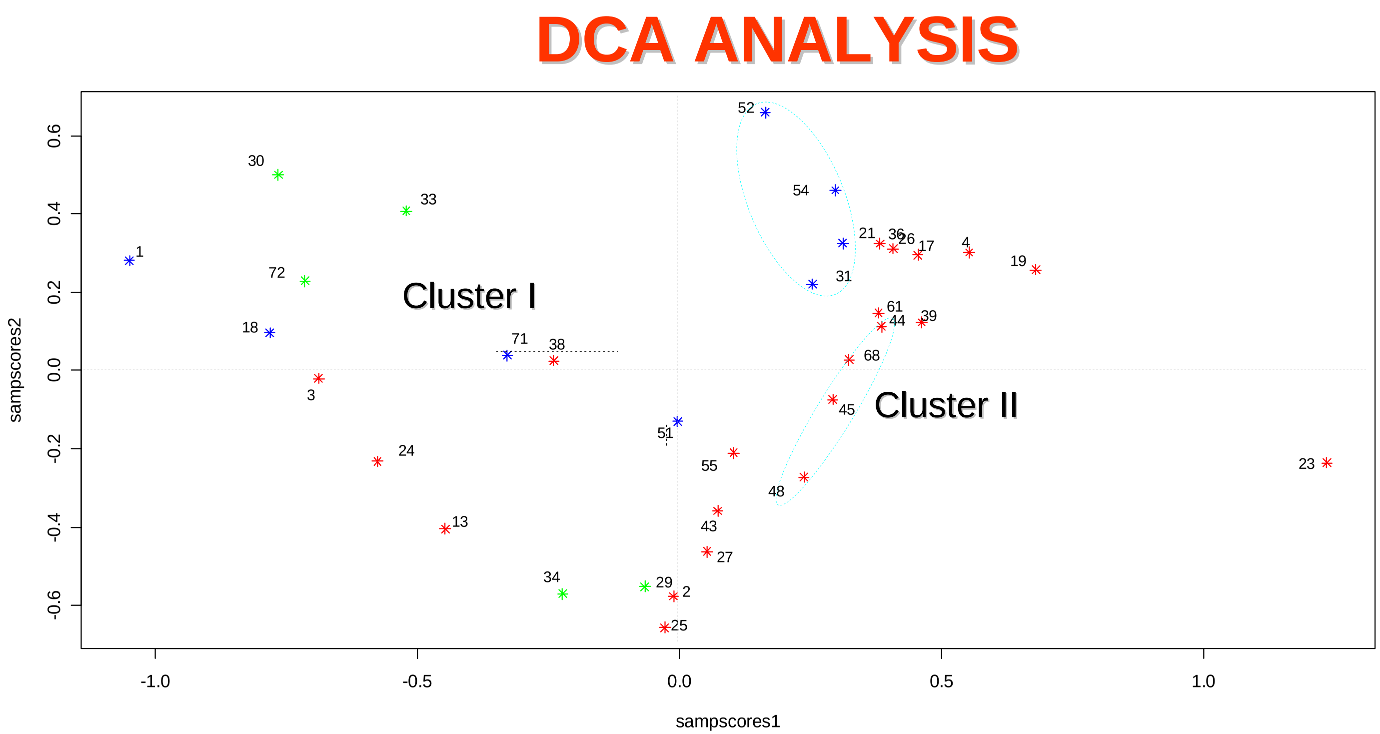


Figure 3-14. Results of DCA analysis according to cluster analysis. Samples show strong correlation in terms of axis 1 (sample score 1) that is strongly related to grain size of sediments. Dashed lines in Cluster II show subclusters.

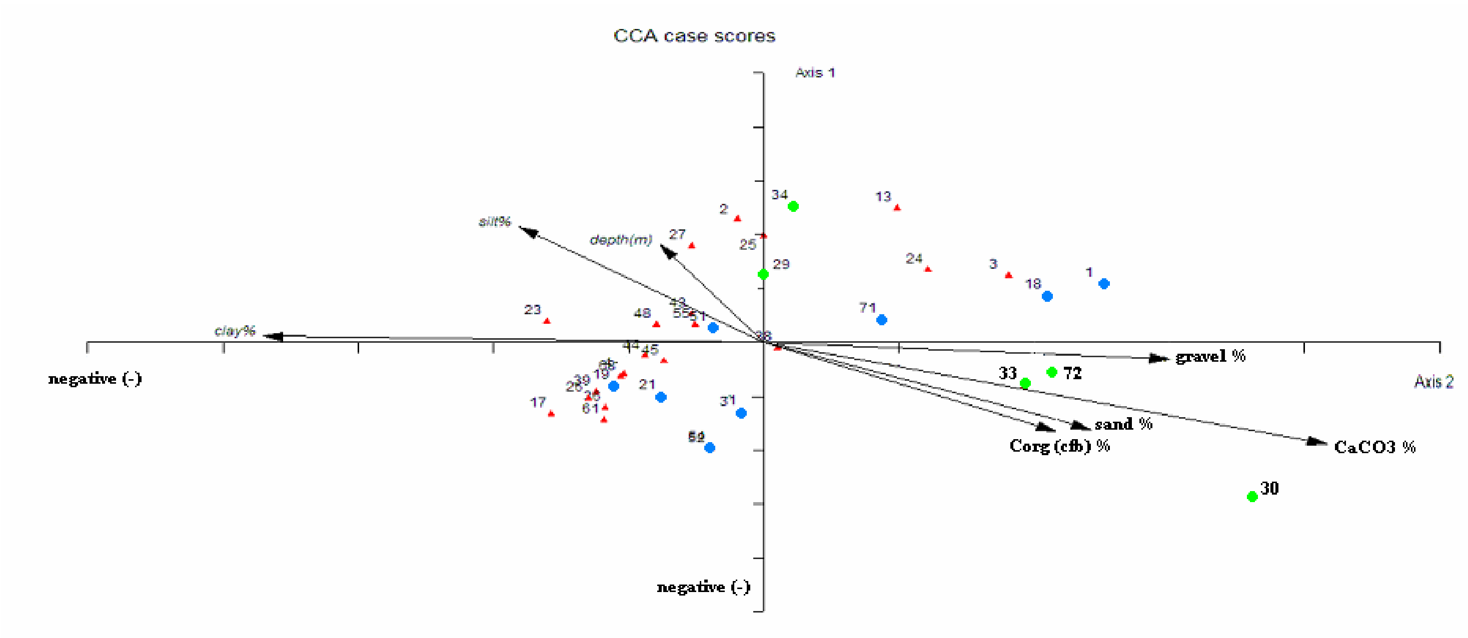


Figure 3-15. CCA plot showing the distribution of: samples in axes 1 and 2 in relation to the environmental parameters.

Clusters analysis in terms of Grain size

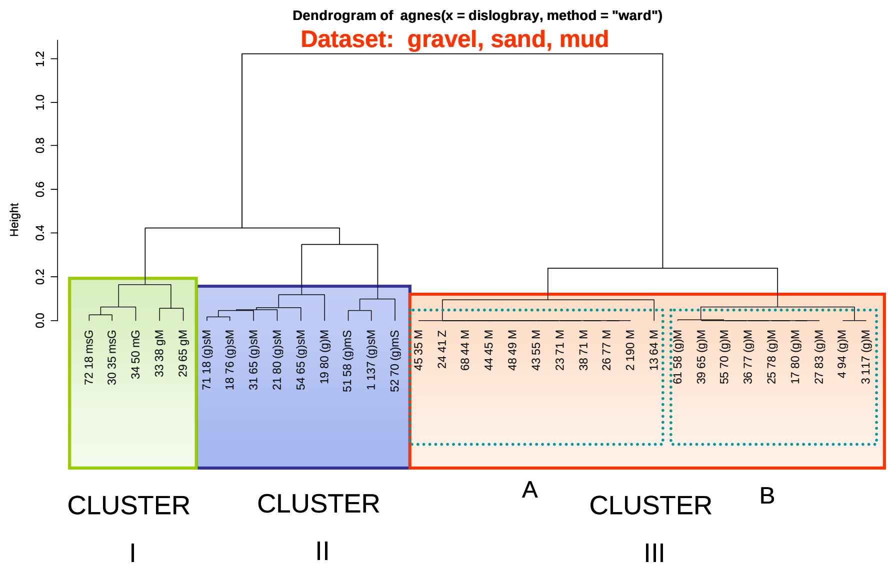


Figure 3-16. Q-mode Cluster analysis of studied samples in terms of grain size.

3.3.3. Bentic foraminiferal associations resulted from analyzing of the clusters

As noted before, there are 2 main clusters obtained from the cluster analysis. The cluster 1 is subdivided into 2 subclusters. There is also another cluster termed as "outlier" and it is composed of only the sample 23 and its representative species *Valvulineria bradyana*, which has been already discussed in previous sections. The main clusters will be discussed in the following section.

Subcluster 1-A

Subcluster 1-A consists of the samples 72, 30, 33, 71, 38, 24, 3, 18 and 1. Depth of the samples varies from 18 to 137 meter depth with median depth of about 41 meter. It is dominated by gravel (12-36 %) and sand (13-43 %) rich sediments. It has the highest $CaCO_3$ content within the clusters. The samples are distributed generally in the coastline of the gulf and vicinity of the rivers (Figure 3-17).

Therefore, there may be a salinity variation due to fresh water inputs. Diversity of this assemblage is extremely high except the samples 1 and 18. As discussed previously, sediments of these two samples may not be autochthonous.

This subcluster is represented by the highest abundance of the Lessepsian migrants (*Peneroplis* spp., *Septloculina* spp. and *Vertebralina striata)*. In addition, the relative abundance of *Siphonaperta* spp. (including *Siphonaperta agglutinants* and *Siphonaperta aspera*) and *Triloculina* spp. are the highest, while the relative abundance of *Textularia* spp. including *Textularia agglutinants, Textularia bocki* and *Textularia truncata* is the lowest in this cluster. *Adelosina* spp. and *Elphidium* spp. are also high in the subcluster 1-A.

This association is very similar to the cluster A of Basso and Spezzaferri (2000), which is represented by living specimens of *Peneroplis* spp., *Sorites orbiculus, Adelosina cliarensis, Triloculina marioni* in the Gulf of İskenderun. In addition, *Sorites orbiculus*, *Coscinospira hemprichii* and *Amphistegina lobifera* (the Lessepsian migrants) are abundant in the cluster A of Basso and Spezzaferri (2000). Although, these species are recorded in the subcluster 1-A, they are omitted in the cluster analyses due to extremely low relative abundance. According to Blanc-Vernet (1969), all these species are recorded in high energy, shallower environments. The median depth of this cluster is about 22 meter. The cluster A is dominated by sand and gravel with sea grasses (Basso and Spezzaferri, 2000). This cluster is distributed only along the southeastern coastline of the gulf including Yakacık.

The subcluster 1-A is also similar to the assemblage-2 of Avşar *et al.* (2001) by having *Peneroplis* spp., *Adelosina cliarensis,* and *Elphidium* spp. This cluster is distributed along the northern and the southeastern coastline of the gulf. It is dominated by sand and gavel in the shallower depths (20-28 meter).

Any relation between the subcluster 1-A and the assemblages of Avşar (1997) has not been recognized. Because the studied samples of Avşar (1997) is only distributed in the northwestern part of the gulf. In the present study, only the sample 24 from the subcluster 1-A is situated in the northwestern part of the gulf and dominated by *Peneroplis* spp. in contrast to assemblages of Avşar (1997).

Subcluster 1-B

Subcluster 1-B consists of the samples 34, 55, 27, 51, 29, 25, 13, 43 and 2. Depth of this subcluster is ranges from 50 to 190 meter with median depth of 65 meter. The $CaCO_3$ content is higher than the cluster 2. The grain size of sediments in this subcluster is varying between gravel and sand with dominance of silt. The diversity of this subcluster is generally higher than the cluster 2. This subcluster is distributed at the inner parts of the gulf and the farthest point of entrance of the gulf (Figure 3-18).

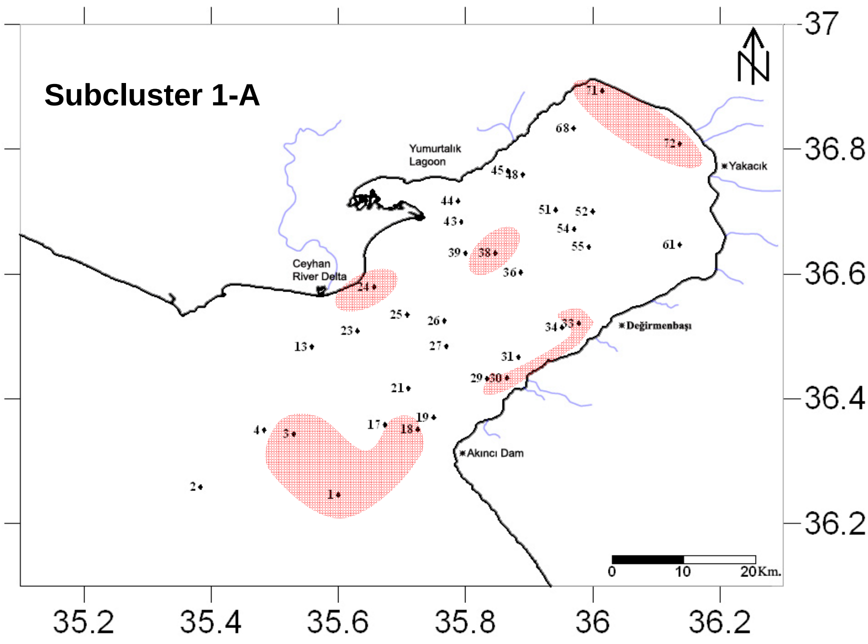


Figure 3-17. Geographical distribution of the subcluster 1-A. Numbers with dots show the samples numbers.

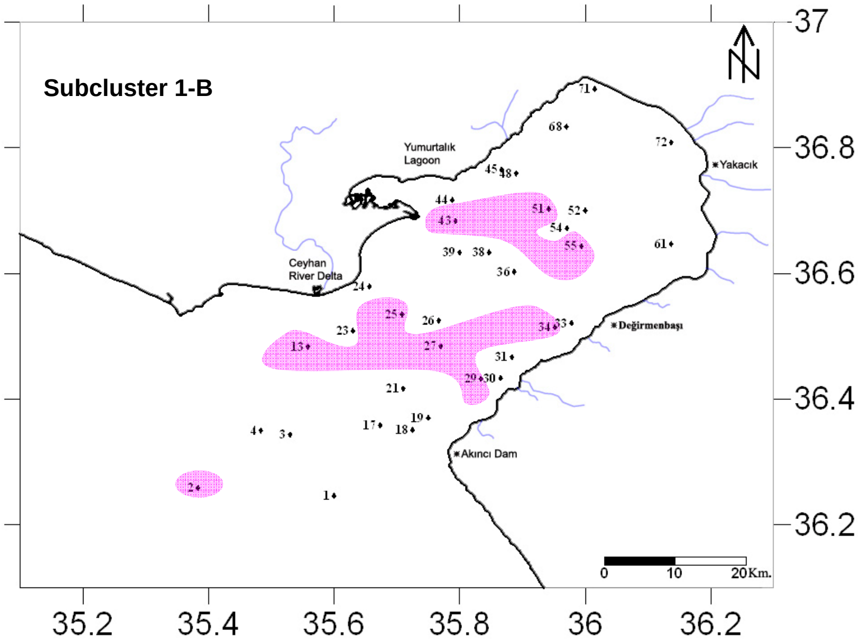


Figure 3-18. Geographical distribution of the subcluster 1-B. Numbers with dots show the samples numbers.

Subcluster 1-B is represented by the most abundance of *Ammonia tepida*, *Astrononnion stelligerum, Articulina* spp., *Quinqeloculina* spp.*, Bulimina elongata, Discorbinella bertheloti, Triloculina oblonga, Cribroelphidium poeyanum*, and *Nonion depressulum*. It is also richer in terms of the Lessepsian migrants than the cluster 2. In addition, *Adelosina cliarensis* is abundant with minor contribution.

Subcluster 1-B is well correlated with the subcluster B2 of Basso and Spezzaferri (2000), which is represented by living specimens of *Ammonia tepida*, *Bulimina elongata* and *Adelosina cliarensis.* In contrast to the present study, *Brizalina striatula* is also abundant in the subcluster B2 of Basso and Spezzaferri (2000). This microenvironment is characterized by shallow (with median depth of 23 meter), low energy waters with muddy bottom including mixture of terrigenous and biogenic input. This subcluster of Basso and Spezzaferri (2000) is distributed in the front of Yumurtalik, the ancient Ceyhan River mouth and along the southeastern coastline of the gulf.

Subcluster 1-B is similar to assemblage 3 of Avşar (1997) by having the most dominantly *Ammonia tepida*. There are also *Bulimina elongata, Cribroelphidium poeyanum, Peneroplis pertusus* and *Adelosina cliarensis.* This assemblage is distributed in sand and mud rich sediments from the Ceyhan River Delta to the Seyhan River in the Mersin coasts. The depth of samples in this assemblage is ranged from 8 to 20 meter.

Cluster 2

Cluster 2 comprises the samples 45, 48, 68, 44, 61, 36, 39, 26, 17, 19, 4, 31, 21, 54, and 52. The Figure 3-19 shows that the samples in this cluster are located in the northwestern, southeastern entrance and center parts of the gulf with 44-94 meter depth (median depth of 65 meter). This cluster is dominated by mud rich sediments and the samples show relatively low diversity.
This cluster is represented by absence of the Lessepsian migrants. The highest relative abundances of *Textularia* spp., *Bulimina* spp., *Nonion* sp.-A, *Reussella spinulosa*, *Cibicides* spp., *Neoeponides bradyi, Buccella granulata* and *Porosononion granosum* are recorded in this cluster. The relative abundances of *Astrononnion stelligerum, Articulina* spp.*, Quinqeloculina* spp.*, Bulimina elongata, Discorbinella bertheloti, Triloculina oblonga, Cribroelphidium poeyanum,* and *Nonion depressulum* are lower than subcluster 1-A.

The cluster 2 is similar to the subcluster B3 of Basso and Spezzaferri (2000), which is represented dominantly by living specimens of *Textularia bocki.* Subcluster B3 is deep environment with median depth of 64 meter and sandy silt rich sediments. The geographical distribution of this cluster is restricted to inner and deeper parts of the gulf.

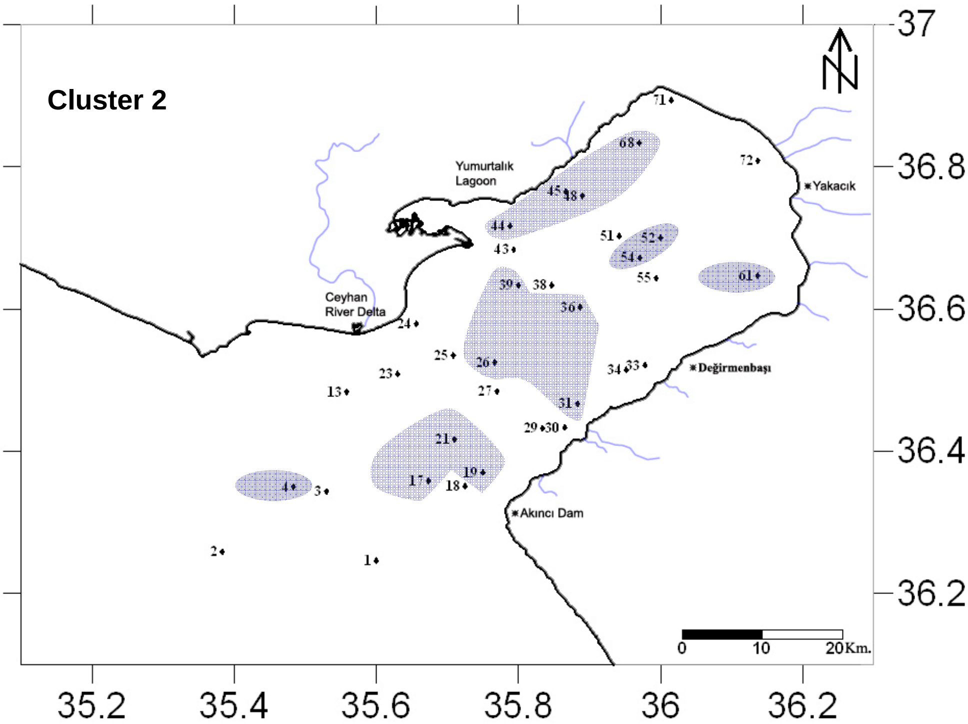


Figure 3-19. Geographical distribution of the cluster 2. Numbers with dots show the samples numbers.

Any relation is not recognized between the cluster 2 of this study and the assemblages of Avşar (1997) and Avşar *et al.* (2001) due to much lower depths of samples than the present study.

3.3.4. Interpretation of the statistical analyses

The summarized scheme of the relative abundances of species and the assemblages is given in the Figure 3-20. The assemblages are not recorded as it expected. In the laboratory work, some species are found with other distinct ones. These species are *Challengeralla bradyii, Siphonaperta aspera, Siphonaperta agglutinans, Spiroloculina ornata, Rosalina floridensis, Rosalina bradyi, Triloculina trigonula, Planorbulina mediterranensis, Textularia agglutinans*

Triloculina oblonga , *Elphidium crispum* , *Parrina bradyi, Triloculina plicata, Quinqueloculina berthelotiana, Miliolinella subrotunda, Asterigerinata mamilla, Neoconorbina terquemi, Eponides concameratus, Ammonia parkinsoniana, Septloculina angulata, Peneroplis pertusus, Peneroplis planatus, Spiroloculina corrugata, Sorites orbiculus, Vertebralina striata, Parahauerinoides bradyi, Articulina carinata, Peneroplis arietinus,* and *Amphistegina lobifera* these species are omitted from calculations of cluster analysis, because of their very low abundance (less than 1%). All these species are discussed as either the Lessepsian species or the depth-controlled species in the Chapter 2. In the contrary, assemblages found by Avşar (1997), Basso and Spezzaferri (2000), and Avşar et al (2001) are generally dominated by these species. The correlation of the clusters with other studies in the Gulf of İskenderun is very difficult. Therefore, the results of the cluster analysis give a different scheme. To show this difference, median grain sizes of samples are plotted given in Figure 3-21.

Figure 3-21 shows that there is a big difference in right of the graph. Selected species for the cluster analysis is collected to left of the graph. There is approximately no difference in the substrate preferences of the dominated species. These species are dominated the entire gulf and they are frequent. As mentioned previously, depth and grain size of most of the samples in the study area is more or less similar so cluster analysis of the dominated taxa gives a distribution pattern according to other parameters including salinity, pollution, fault activity or current direction. Indeed, the results of this study are important, as two of the relatively much important parameters (depth and grain size) are similar most of the samples. Clusters, means assemblages, reflected to effects of other parameters on the distribution of foraminifers.

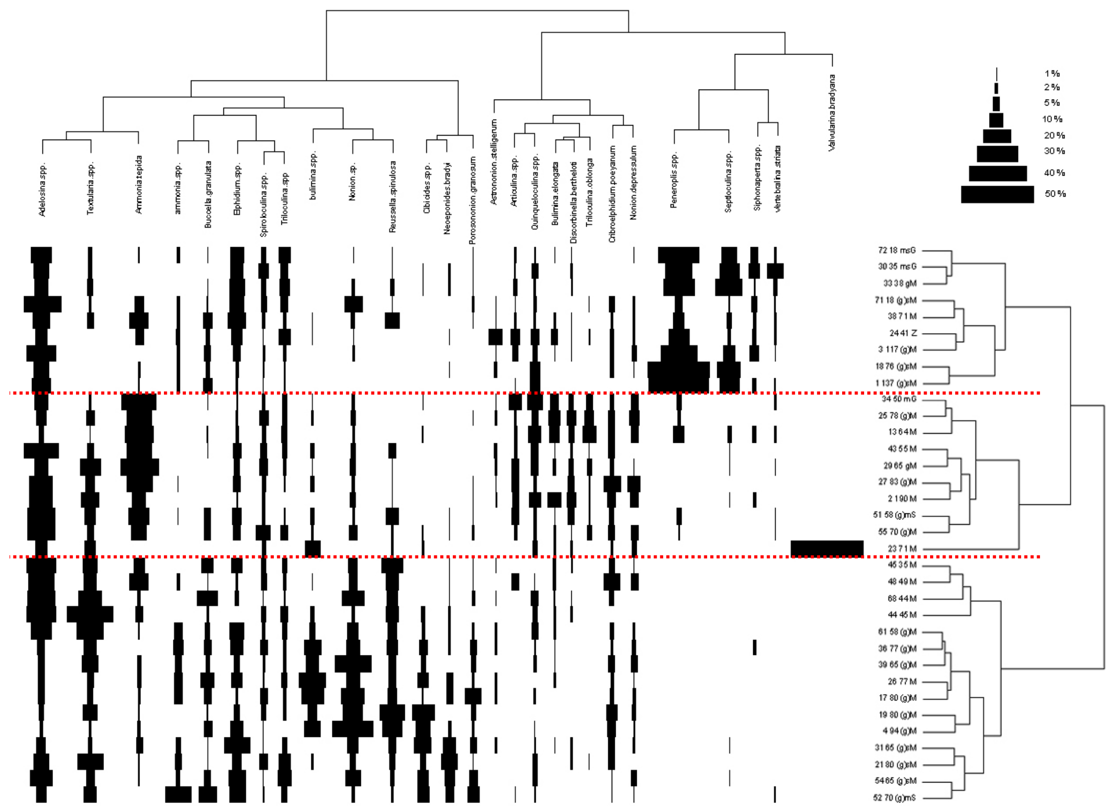


Figure 3-20. Distribution of the relative abundances of species in the R-mode (horizontal) and Q-mode (vertical) clusters. Dashed lines show thecluster boundaries.

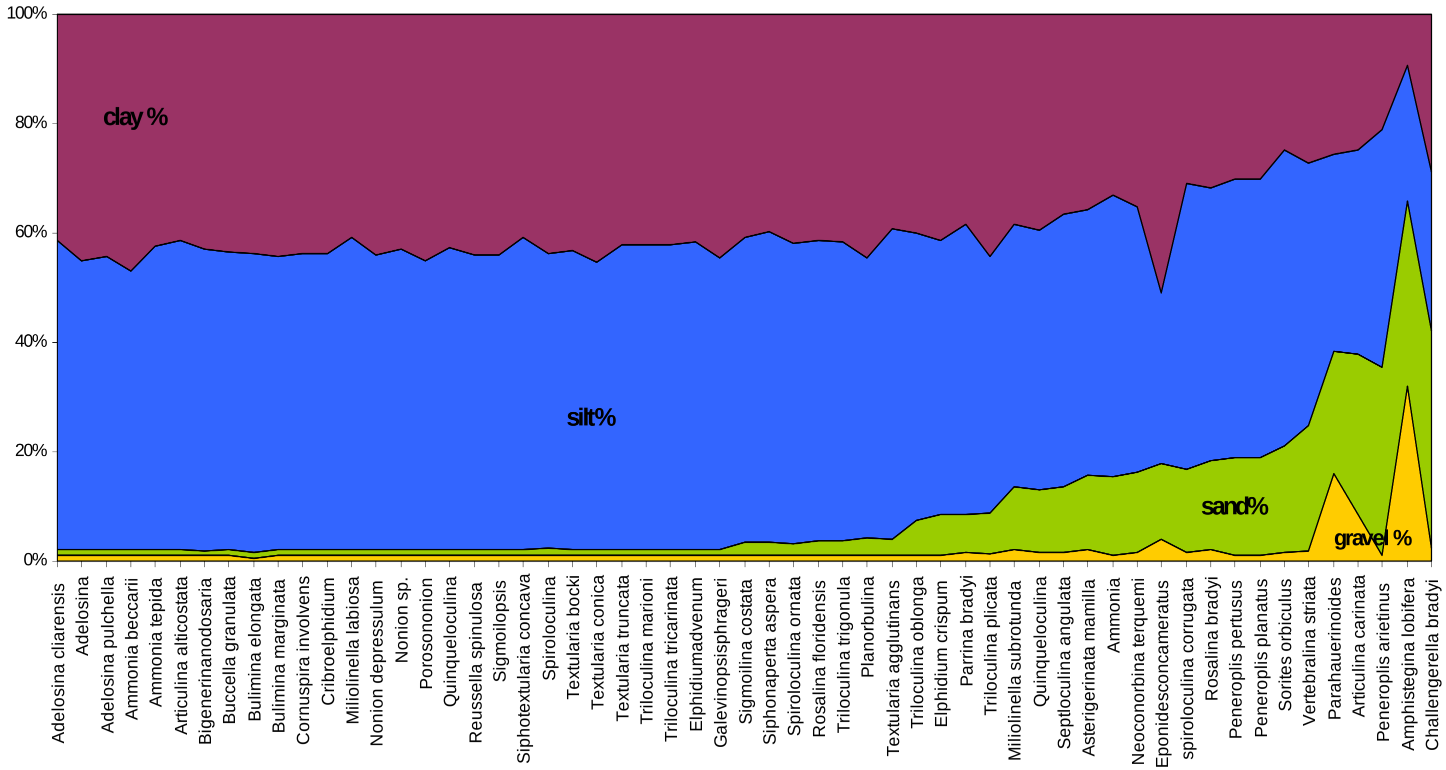


Figure 3-21. Distribution of some selected species according to median grain size

CHAPTER IV

SYSTEMATIC PALEONTOLOGY

4.1. Introduction

This chapter deals with the taxonomy of the 151 benthic foraminiferal species, which have been identified in this study. Identification of benthic foraminiferal species has been completely based on the wall composition and structure, the external morphological features including the shape of test, the arrangement of chambers, the shape of chamber, the number of whorls, the number of chambers per whorl, the shape of periphery, the position and form of aperture, the ornamentation of tests and the modifications of apertures. Internal structures have been not studied due to lack of sufficient material to prepare oriented sections. Therefore, any internal feature of the species has not been given in this chapter.

The classification used in this study is primarily outlined by original descriptions in Ellis and Messina (from 1940). Furthermore, descriptions of Cushman (1931), Murray (1971), Boltovskoy *et al.* (1980), Cimmerman and Langer (1991), and Hottinger *et al.* (1993) emended in order to identify species clearly. Cushman and Parker (1947), Cushman (1939), and Gudmundsson (1994) have been used for identification of the family Nonionidae, *Bulimina* related foraminiferal genera, and superfamily Soriticae, respectively. Generic and suprageneric classifications have been made according to Loeblich and Tappan (1988). In addition, the type specimens of the identified species from the Gulf of Saroz (Altıner *et al.*, 1999) were investigated under the microscope in order to practise the identification of foraminiferal species.

The photographs of most identified and ecologically important individuals having different features from original description have been taken on JSM-6400 Electron Microscope (JEOL) and the reflected light microscope, they are given in the plates (1-11) at the Appendix D.

Avoiding unnecessary repetitions about general features of species within same genera, the description of genera has been given, before the description of species. The systematic definition of each species entails two parts: a restricted synonymy that has at least the original designation followed by the most important synonyms, and diagnostic features that could be observed easily under the stereo microscope at magnifications up to X 100. In the remarks section, the distinguishing features and comparison of species have been done. The occurrences and the bathymetrical distributions of the identified species have been listed in the Appendix A and Appendix C, respectively.

Taxonomical hierarchy and identified species in this study are given as follows.

ORDER **FORAMINIFERIDA** Eichwald, 1830

SUBORDER **TEXTULARIINA** Delage and Herouard, 1896

Superfamily **Astrorhizidae** Brady, 1881

Family Saccamminidae Brady, 1884

Subfamily Saccammininae Brady, 1884

Genus *Lagenammina* Rhumbler, 1911

Test of this form is unilocular, flask shaped with an elongate neck. Its wall is densely covered by agglutinated material. Genus *Lagenammina* has a terminal aperture.

Lagenammina difflugiformis (Brady, 1879)

Pl. 1, fig. 1

1879 *Reophax difflugiformis* Brady, p.51, pl. 4, figs. 3 a, b

1991 *Lagenammina fusiformis* (Wiliamson); Cimerman and Langer, p.15, pl. 1, fig. 4, not 5

1994 *Lagenammina difflugiformis* (Brady); Jones, p. 36, pl. 30, figs. 1-3

2000 *Lagenammina fusiformis* (Wiliamson); Basso and Spezzaferri, p. 375, pl. 1, fig. 2

2004 *Lagenammina fusiformis* (Wiliamson); Meriç *et al.*, p. 23, pl. 1, figs. 3-4

2005 *Lagenammina difflugiformis* (Brady); Licari and Mackensen, p. 207, pl. 1, fig. 4

Diagnostic features:

Wall of this species is composed of coarse agglutinated sand grains and cemented by a brown material. Shape of test is entirely rounded.

Remarks:

Lagenammina difflugiformis can be recognized by its perfectly rounded shape through its test, while the test of *Lagenammina fusiformis* is irregular shaped. The specimen named as *Lagenammina fusiformis* in plate 1, figure 4 of Cimerman and Langer (1991), has a rounded test with perfectly flask shape. Therefore, this form has been defined as *Lagenammina difflugiformis* in this study, Superfamily **Hormosinacea** Haeckel, 1894

Family Hormosinidae Haeckel, 1894

Subfamily Reophacinae Cushman, 1910

Genus *Reophax* de Montfort, 1808

Test is free, rectilinear, uniserial and elongate with few rounded to pyriform chambers in slightly irregular or arcuate series. According to Loeblich and Tappan (1988), the wall consists of thin single layer of agglutinated grains of quartz, mica, sponge spicules, or foraminiferal tests with rough texture. Aperture is terminal and circular to fusiform with a tubular neck.

Reophax scorpiurus Montfort, 1808

1808 *Reophax scorpiurus* Montfort; p. 331 (fide Ellis and Messina, 1940)

1971 *Reophax scorpiurus* Montfort; Murray, p. 19, pl. 2, figs. 5-8

1988 *Reophax scorpiurus* Montfort; Loeblich and Tappan, p. 58, pl. 44, figs. 1-3

1991 *Reophax scorpiurus* Montfort; Cimerman and Langer, p. 17, pl. 4, figs. 1-4

1993 *Reophax scorpiurus* Montfort; Sgarrella and Moncharmont-Zei, p. 158, pl. 2, figs. 3-4

1999 *Reophax scorpiurus* Montfort; Altıner *et al.,* p. 85, pl. 1, fig. 5

Diagnostic features:

Outline of the test of this species is elongated and steplike. Chambers are pyriform or subcylindrical and arranged in a slightly irregular series with 4-6 chambers. Its sutures are distinct and depressed. Its aperture is irregularly ovate.

Superfamily **Spiroplectamminacea** Cushman, 1927

Family Spiroplectamminidae Cushman, 1927

Subamily Spiroplectammininae Cushman, 1927

Genus *Spiroplectinella* Kisel'man, 1972

Test is free with early planispiral stage followed by biserial one. Chambers commonly increase in breadth and may have a marginal keel. Wall is agglutinated and aperture is a low arch at the base of apertural face.

Spiroplectinella sagittula (d'Orbigny, 1839)

Pl. 1, fig. 2

1839 *Textularia sagittula* d'Orbigny; p. 138, pl. 1, figs. 19-21

1971 *Textularia sagittula* Defrance; Murray, p.31, pl. 8, figs. 1-9

1988 *Textularia sagittula* Defrance; Loeblich and Tappan, p. 173, pl. 193, figs. 1-2

1991 *Spiroplectinella sagittula* (d'Orbigny); Cimerman and Langer, p. 19, pl. 1, figs. 19-21

1999 *Textularia sagittula* Defrance; Altıner *et al.*, p. 87, pl. 2, fig. 6

2001 *Textularia sagittula* Defrance; Fiorini and Vaiani, p. 369, pl. 1, fig. 10

2004 *Spiroplectinella sagittula* (d'Orbigny); Meriç *et al.*, p. 24, pl. 1, fig. 13, pl. 2, figs. 1-2

Diagnostic features:

Test of *Spiroplectinella sagittula* is elongated and laterally compressed. Its periphery is subangular to acute. Its peripheral margins are nearly parallel in the biserial adult stage. Sutures of the form are slightly depressed and slightly curved.

Remarks:

The most characteristics feature of this species is nearly rectangular outline of the adult chambers in the lateral view.

Superfamily **Textulariacea** Ehrenberg, 1838

Family Eggerellidae Cushman, 1937

Subfamily Eggerellinae Cushman, 1937

Genus *Eggerelloides* Haynes, 1973

Test of the form is subfusiform and trochospirally coiled with four to five chambers per whorl at least. Number of the later chambers reduces to three chambers per whorl in the stage of triserial arrangement. Wall is coarsely to finely agglutinate with a rough surface. Aperture is interiomarginal, a low slit, and bordered by a lip and a toothplate.

Eggerelloides advenus (Cushman, 1922)

Pl. 1, fig. 3

1922 *Verneuilina advena* Cushman; p. 57, pl. 9, figs. 5, 6

1991 *Eggerelloides advenus* (Cushman); Cimerman and Langer, p. 20, pl. 8, figs. 5-6

1991 *Eggerelloides scabrus* (Williamson); Cimerman and Langer, p. 21, pl. 8, fig. 7

Diagnostic features:

Eggerelloides advenus has an elongated, subconical test. Chambers gradually increase in size. Wall of this species is finely agglutinated.

Remarks:

The specimen in the plate 8, figure 7 named as *Eggerelloides scabrus* by Cimerman & Langer (1991) has elongated test and coarsely agglutinated wall. Being the most important features of *Eggerelloides advenus,* their form is being taken to the synonym list.

Eggerelloides scabrus (Williamson, 1858)

1858 *Bulumina scabra* Williamson; p. 65, pl. 5, figs. 136, 137

1988 *Eggerelloides scabrus* (Williamson); Loeblich and Tappan, p. 170, pl. 189, figs. 5-7

1993 *Eggerella scabra* (Williamson); Sgarrella and Moncharmont-Zei, p. 165, pl. 4, fig. 9

1999 *Eggerella scabra* (Williamson); Altıner *et al.*, p. 85, pl. 1, fig. 57

Diagnostic features:

Test shape of this species is subconical with inflated, subglobular chambers. Its wall is coarsely agglutinated and its aperture can be observed with a curving tooth plate.

Remarks:

Eggerelloides scabrus is differentiated from *Eggerelloides advenus* by its larger and broader chambers and by its coarsely agglutinated wall.

Family Textulariidae Ehrenberg, 1838

Subfamily Textulariinae Ehrenberg, 1838

Genus *Bigenerina* d'Orbigny, 1826

Test is elongate in shape. Early chambers are biserially arranged, then, it becomes abruptly uniserial in its adult stage. Genus *Bigenerina* has an agglutinated and canaliculated wall. While its aperture is basal in the biserial stage, it becomes terminal, rounded and areal in the uniserial stage.

Bigenerina nodosaria d'Orbigny, 1826

Pl. 1, fig. 4

1826 *Bigenerina nodosaria* d'Orbigny; p. 261, pl. 2, figs. 9-10

1988 *Bigenerina nodosaria* d'Orbigny; Loeblich and Tappan, p. 172, pl. 191, figs. 1-2

1988 *Bigenerina nodosaria* d'Orbigny; Jorissen, p. 21, pl. 1, fig. 10

1993 *Bigenerina nodosaria* d'Orbigny; Sgarrella and Moncharmont-Zei, p. 164, pl. 4, fig. 12

1994 *Bigenerina nodosaria* d'Orbigny; Jones, p. 49, pl. 44, figs. 14-18

1999 *Bigenerina nodosaria* d'Orbigny; Altıner *et al.*, p. 87, pl. 2, figs. 1-2

2000 *Bigenerina nodosaria* d'Orbigny; Abu-Zied, pl. 1, figs. 9-11

2000 *Bigenerina nodosaria* d'Orbigny; Sakınç, p. 37, fig. 5

2004 *Bigenerina nodosaria* d'Orbigny; Meriç *et al.*, p. 28, pl. 2, fig. 7

Diagnostic features:

Bigenerina nodosaria has a uniserial stage with rounded to ovate chambers. Its sutures are somewhat distinct and very slightly depressed and aperture is at the end of a short neck.

Remarks:

Bigenerina nodosaria can be distinguished from other species of genus *Bigenerina* by an abrupt change in its chamber arrangement from biserial stage to the uniserial stage, by shape of chamber and by having a short neck. While passing to the uniserial stage, coiling axis of this form is shifted.

Genus *Sahulia* Loeblich and Tappan, 1985

Test of this genus is free, biserial, low cone shaped with a circular outline in the apertural view. Its chambers are very broad and low with nearly horizontal or slightly arched sutures. Wall is finely agglutinated. Aperture is low and straight slit at the base of the apertural face.

This genus differs from genus *Textularia* by its low and conical test rather than an elongate test. Moreover, the aperture of genus *Sahulia* is provided with a flaplike lip, while genus *Textularia* has an open-arched aperture without a bordering lip.

Sahulia conica (d'Orbigny, 1839)

1839 *Textularia conica* d'Orbigny, p. 143, pl. 1, figs. 19, 20

1991 *Textularia conica* d'Orbigny, Cimerman and Langer, p. 22, pl. 10, figs. 7-9

1993 *Textularia conica* d'Orbigny, Sgarrella and Moncharmont-Zei, p. 166, pl. 3, figs. 4,5

1994 *Sahulia conica* (d'Orbigny); Jones, p. 48, pl. 43, figs. 13-14

1999 *Sahulia conica* (d'Orbigny); Altıner *et al.*, p. 87, pl. 2, fig. 3

2000 *Textularia conica* d'Orbigny, Sakınç, p. 39, text fig. 8

2003 *Textularia conica* d'Orbigny, Javaux and Scott, p. 21, figs. 5.10 and 5.11

2004 *Textularia conica* d'Orbigny, Meriç *et al.*, p. 32, pl. 2, figs. 11-12

Diagnostic features:

Sahulia conica has a conical test, subtriangular in the lateral view with subacute peripheral margin. Its chambers are subglobular and its sutures are depressed. Its chamber arrangement is biserial with up to 12 chambers in adult stage, size of chambers gradually increases. Wall is heterogeneously agglutinated.

Remarks:

Sahulia conica can easily be distinguished from the other species observed in this study by its smaller size with low height and by having relatively less number of chambers. Specimens in the Gulf of İskenderun strongly resemble to the forms figured by Sakınç (2000) in text figure 8.

Genus *Textularia* Defrance, 1824

Test of genus *Textularia* is free, elongate and biserial throughout or it may have an adventitious third chamber against the first pair of chambers. It has generally compressed, rarely ovate or circular chambers. Its wall is agglutinated. The aperture of the form is a simple and interiomarginal low arch or slit with rarely a lip.

Textularia agglutinans d'Orbigny, 1835

1835 *Textularia agglutinans* d'Orbigny; p. 136, pl. 1, figs. 17-18, 32-34

1991 *Textularia agglutinans* d'Orbigny; Cimerman and Langer, p. 21, pl. 10, figs. 1-2

1993 *Textularia agglutinans* d'Orbigny; Hottinger *et al.*, p. 36, pl. 13, figs. 1-9

1994 *Textularia agglutinans* d'Orbigny; Jones, p. 48, pl. 43, figs. 1-3

1994 *Textularia agglutinans* d'Orbigny; Loeblich and Tappan, p. 27, pl. 33, figs. 8-12

1995 *Textularia agglutinans* d'Orbigny; Meriç *et al.*, p. 126, pl. 1, fig. 3

2000 *Textularia agglutinans* d'Orbigny; Sakınç, p. 38, text fig. 6

2001 *Textularia agglutinans* d'Orbigny; Fiorini and Vaiani, p. 369, pl. 1, figs.1-4

2003 *Textularia agglutinans* d'Orbigny; Javaux and Scott, p. 21, figs. 5-8, 5-9

Diagnostic features:

Test of *Textularia agglutinans* is stout, large, somewhat elongated, tapering towards base; narrowly triangular in lateral view and suboval to circular in apertural view. Its peripheral margin is compressed. Chamber arrangement is biserial with about 20 chambers in its adult stage. Chambers are gradually increasing in size. Its sutures are distinct and slightly depressed. Wall of this species is coarsely agglutinated.

Remarks:

This species can clearly be differentiated from the rest the species of genus *Textularia* by having a coarsely agglutinated test.

Textularia bocki Höglund, 1947

Pl. 111, fig. 1

1947 *Textularia bocki* Höglund, p. 171, pl. 12, figs. 5, 6

1991 *Textularia bocki* Höglund, Cimerman and Langer, p.21, pl. 10, figs. 3-6

2000 *Textularia bocki* Höglund, Sakınç, p. 39, text fig. 7

2001 *Textularia bocki* Höglund, Fiorini and Vaiani, p. 369, pl. 1, figs. 5-6

2002 *Textularia bocki* Höglund, Kaminski *et al.,* p. 171, pl. 1, figs. 1-2

2004 *Textularia bocki* Höglund, Meriç *et al.*, p. 31, pl. 2, figs. 8-10

Diagnostic features:

Test is wedge-shaped in the lateral view and oval in the apertural view. Chambers are arranged biserially and numbers of chambers are about 20 in the adult. Its chambers are inflated and it has curved and depressed sutures.

Remarks:

Strongly inflated last chambers and the shape of the test are characteristic features for *Textularia bocki*.

Textularia pala Czjzek, 1848

Pl. 1, fig. 5

1848 *Textularia pala* Czjzek, p. 148, pl. 13, figs. 25-27

1991 *Textularia truncata* Höglund; Cimerman and Langer, p. 22, pl. 12, figs. 1-3

1993 *Textularia pala* Czjzek; Sgarrella and Moncharmont-Zei, p. 166, pl. 3, fig. 8

2000 *Textularia pala* Czjzek; Sakınç, p. 40, text fig. 9

2004 *Textularia truncata* Höglund; Meriç *et al.*, p. 34, pl. 3, figs. 1-2

Diagnostic features:

In the lateral view test of the species is isosceles triangular, while it is subrounded in the apertural view. Periphery has a subrounded keel. Its chamber arrangement is biserial with 14-20 chambers in the adult. Its sutures are slightly depressed.

Remarks:

The most characteristic features of *Textularia pala* are slightly inflated to compressed chambers that produce the slightly concave to planar surface in the apertural face.

Subfamily Siphotextulariinae Loeblich and Tappan, 1985

Genus *Siphotextularia* Finlay, 1939

Genus *Siphotextularia* has quadrangular chambers, which are biserially arranged. Chamber arrangement in the initial stage may be rarely triserial. Aperture is areal, rounded or a short slit with a distinct lip or developed on a tubular neck. Its wall is finely agglutinated.

The shape of aperture is the most important feature of Subfamily Siphotextulariinae to distinguish from Subfamily Textulariinae.

Siphotextularia concava (Karrer, 1868)

Pl. 1, fig. 6

1868 *Plecanium concavum* Karrer, p. 192, pl. 1, fig. 3

1991 *Siphotextularia concava* (Karrer); Cimerman and Langer, p. 23, pl. 12, figs. 4-6

1994 *Siphotextularia concava* (Karrer); Jones, 1994, p. 47, pl. 42, figs. 13-14

2004 *Siphotextularia concava* (Karrer); Meriç *et al.*, p. 35, pl. 3, figs. 3-4

Diagnostic features:

Test of this species is triangular in the lateral view and nearly rectangular in the apertural view. Its sutures are nearly straight and slightly depressed.

Remarks:

Siphotextularia concava can be easily differentiated from other species by its almost straight surface in lateral view and by its almost straight sutures.

Suborder Spirillinina Hoheneger and Piller, 1975

Family Spirillinidae Reuss and fritsch, 1861

Genus *Spirillina* Ehrenberg, 1843

Test is discoidal and bilocular. Globular proloculus is followed by a gradually enlarging enrolled, undivided tubular second chamber. Earliest few whorls may be low trochospiral, while later ones are planispiral with four to nine closely coiled whorls. Tubular chamber may not be cylindrical and final part of the last whorl may bend so an umbilical depression may occur. According to Loeblich and Tappan (1988), asexually formed gamont has smaller test and smaller proloculus than those of sexually produced agamont. Wall is calcareous, hyaline with commonly numerous pores or pseudopores on the surface. Aperture is rounded to crescentic, at the open end of the tubular chamber.

Spirillina vivipara Ehrenberg, 1841

Pl. 1, fig. 7, pl-11, fig. 2

1841 *Spirillina vivipara* Ehrenberg; p. 422, pl. 3, fig. 41

1980 *Spirillina vivipara* Ehrenberg; Boltovskoy *et al.*, p. 50, pl. 31, figs. 16-18

1988 *Spirillina vivipara* Ehrenberg; Loeblich and Tappan, p. 34, pl. 318, figs. 4-7

1991 *Spirillina vivipara* Ehrenberg; Cimerman and Langer, p. 24, pl. 14, figs. 4-6

1993 *Spirillina vivipara* Ehrenberg; Sgarrella and Moncharmont-Zei, p. 226, pl. 20, fig. 2 1999 *Spirillina vivipara* Ehrenberg; Altıner *et al.,* p. 87, pl. 2, fig. 8

2003 *Spirillina vivipara* Ehrenberg; Javaux and Scott, p. 21, fig. 5-7

2004 *Spirillina vivipara* Ehrenberg; Meriç *et al.*, p. 38, pl. 3, figs. 11-12

Diagnostic features:

Chamber arrangement of *Spirillina vivipara* is planispiral in the adult stage with perforated surface.

Remarks:

The most characteristic feature of this species is its highly porous hyaline wall. It has glassy and semi-translucent appearance under a light microscope.

Although this species is much more common in the Aegean Sea, only two specimens are recorded in different locations (in the samples 72 and 33) in the studied area. Individual figured in plate 1, figure 7 is very low trochospiral at earlier stage resulting slightly concavo-convex test with large proloculus. The proloculus is elevated above the level of the later whorls. It also has somewhat distinct growth lines. This specimen resembles to the individuals figured by Boltovskoy *et al.* (1980) on plate 31, figures 16-18. However, their specimens are subconical and concavoconvex with prominent growth lines. Moreover, this specimen from the present study resembles to individuals of genus Spirillinid ? sp.A, which are figured by Hottinger *et al.* (1993) on plate 87, figs. 1-6. However, they have spiny projections at their margins and their surface is rough and fairly imperforate. Therefore, this species is different from *Spirillina vivipara* Ehrenberg. Another individual found in Gulf of Iskenderun resemble figured specimens all of the rest in synonym list.

SUBORDER **MILIOLINA** Delage and Hérouard, 1896

To make differentiation among the genera of Miliolina, types of chamber arrangement should be understood clearly. Mainly four coiling types of chamber arrangement are recognized in these forms including quinqueloculine, triloculine, spiroloculine or biloculine, and sigmoiline.

While coiling axis of chambers is rotated, various angles are produced between the median planes of consecutive chambers. If it is 72°, 120°, 180° or that chambers are positioned in an s-shaped curve in one plane, it is called quinqueloculine, triloculine, spiroloculine or biloculine, and sigmoiline, respectively.

It is generally accepted that if five (four are visible from one side and three from opposite side), three, or two chambers are visible at exterior; specimen belongs to the genus quinqueloculine, triloculine, spiroloculine or biloculine, respectively. However, these internal structures could be easily recognized through thin section or X-Ray photographs.

Superfamily Cornuspiracea Schultze, 1854
Family Cornuspiridae Schultze, 1854
Subfamily Cornuspirinae Schultze, 1854

Genus *Cornuspira* Schultze, 1854

This genus strongly resembles to genus *Spirillina* but it is differentiated by having porcelaneous and imperforate wall with occasional transverse growth lines. Aperture is formed at the open end of the last chamber with thickened lip.

Cornuspira involvens (Reuss, 1850)

Pl. 1, figs. 8-9

1850 *Operculina involvens* Reuss, p. 370, pl. 45, fig. 20

1931 *Cornuspira involvens* (Reuss); Cushman, p. 80, pl. 20, figs. 6, 8

1991 *Cornuspira involvens* (Reuss); Cimerman and Langer, p. 25, pl. 15, figs. 4-7

1994 *Cornuspira involvens* (Reuss); Loeblich and Tappan, p. 36, pl. 55, figs. 10-11

2004 *Cornuspira involvens* (Reuss); Meriç *et al.*, p. 39, pl. 4, figs. 3-4

Diagnostic features:

Test of *Cornuspira involvens* is circular in outline. Chamber arrangement is planispiral. Size of second tubular chamber gradually increases and enrolled up to 11 whorls in adult. Surface of the test is slightly corrugated with transverse growth constrictions. Aperture is rarely with rim.

Remarks:

Cornuspira involvens is differentiated from *Spirillina vivipara* by having growth lines and opaque and milky-white porcelaneous appearance under a reflected light microscope.

Cornuspira involvens is common and very abundant relative to *Spirillina vivipara* in the studied samples of the Gulf of İskenderun.

Family Fischerinidae Millet, 1898

Subfamily Fischerininae Millet, 1898

Genus *Planispirinella* Wiesner, 1931

Test is discoidal and flattened. Chamber arrangement is planispiral. Sutures are oblique. Wall is calcareous, imperforate and porcelaneous. Aperture is a narrow slit in the face of the final chamber.

Planispirinella exigua (Brady, 1879)

Pl. 1, figs. 10-11, Pl. 11, fig. 3

1879 *Hauerina exigua* Brady; p. 267, figs. 1-2, 4

1988 *Planispirinella exigua* (Brady); Loeblich and Tappan, p. 317, pl. 329, figs. 13-16

1994 *Planispirinella exigua* (Brady); Jones, p. 27, pl. 12, figs. 1-4

Diagnostic features:

Test of *Planispirinella exigua* is extremely flattened. Proloculus is globular. There are three chambers per whorl. Sutures are obscured by thickened wall. Aperture is slitlike without a lip.

Remarks:

Only last chambers of the last whorl are seen in the reflected light microscope and scanning electron microscope. However, when the test is wet, oblique sutures of former whorls are easily recognized.

Planispirinella exigua is distinguished from *Sigmohauerina bradyi* by its smaller size and having slitlike aperture.

Subfamily Nodobaculariellinae Bogdanovich, 1981

Genus *Vertebralina* d'Orbigny, 1826

Test is flattened, broad and moderately elongated. Chambers are arranged as slightly trochospiral. Early chambers are involute, while last chambers are rectilinear and uniserially arranged. Wall is calcareous, imperforate and porcelaneous with longitudinally costate surface. Aperture is terminal, narrow slit with thickened lip.

Vertebralina striata d'Orbigny, 1826

Pl. 1, fig. 12, Pl. 2, fig. 1, Pl. 11, fig. 4

1826 *Vertebralina striata* d'Orbigny; p. 283, no: 1

1988 *Vertebralina striata* d'Orbigny; Loeblich and Tappan, p. 319, pl. 330, figs. 17-19

1991 *Vertebralina striata* d'Orbigny; Cimerman and Langer, p. 25, pl. 16, figs. 1-5

1993 *Vertebralina striata* d'Orbigny; Sgarrella and Moncharmont-Zei, p. 169, pl. 6, fig. 7

1993 *Vertebralina striata* d'Orbigny; Hottinger *et al.*, p.43, pl. 23, figs. 8-15

2004 *Vertebralina striata* d'Orbigny; Meriç *et al.*, p. 40, pl. 4, figs. 7-8

Diagnostic features:

Test of *Vertebralina striata* is flat with subpoligonal to rectangular appearance in side view and strongly compressed, subelliptical in apertural view. Periphery is rounded. Size of the chambers rapidly increases. Aperture is elongated, subelliptical and asymmetrical slit with a thick everted lip.

Remarks:

This species is characterized by its surface ornamentation and by its peristomal rim around its aperture. In some specimens of study area, like Red Sea specimens of Hottinger (1993), longitudinal, diverging and anastomosing costae are interconnected by transverse ridges so its surface has reticulate pattern.

Family Nubeculariidae Jones, 1875

Subfamily Nodoptalmidiinae Cushman, 1940

Genus *Nodoptalmidium* Macfadyen, 1939

Test is elongate and narrow. Proloculus, which is globular to ovate, is followed by planispirally enrolled second chamber. Then, later chambers are uniserial, rectilinear and tubular. Wall is calcareous, imperforate and porcelaneous. Aperture is terminal.

Nodoptalmidium antillarium Cushman, 1922

1922 *Nodoptalmidium antillarium* Cushman; p. 71, pl. 12, fig. 5

1993 *Nodoptalmidium antillarium* Cushman; Hottinger *et al*., p. 44, pl. 23, figs. 4-7, text fig. 2.

Diagnostic features:

Rectilinearly arranged chambers have flaring distal end. Aperture is rounded and bordered by an everted lip. Test surface is ornamented by several longitudinal and thick costae.

Subfamily Nodobaculariinae Cushman, 1927

Genus *Nubeculina* Cushman, 1924

Test is elongate and narrow. Proloculus is followed by enrolled second chamber. Then, chambers are uniserial, rectilinear to slightly irregular series, which is separated by stolonlike necks. Wall is calcareous, imperforate, porcelaneous and may incorporate some agglutinated particles at the exterior. Aperture is terminal and produced on a neck it has few teeth and lip.

Nubeculina divaricata (Brady, 1879)

Pl. 2, fig. 2

1879 *Sagrina divaricata* Brady; p. 276, pl. 8, figs. 22-24

1988 *Nubeculina divaricata* (Brady); Loeblich and Tappan, p. 321, pl. 331, figs. 13-14

1994 *Nubeculina divaricata* (Brady); Jones, p. 88, pl. 76, figs. 11-16

1991 *Nubeculina divaricata* (Brady); Cimerman and Langer, p. 25, pl. 16, figs. 6-10

Diagnostic features:

Wall is coarsely agglutinated by large grains. Aperture is rounded and bordered by a thickened rim and produced on a non-agglutinated neck.

Remarks:

The most characteristic feature of this species is coarsely agglutinated coating in the test excluding its neck.

Family Ophthalmidiidae Wiesner, 1920

Genus *Edentostomina* Collins, 1958

Test is compressed and ovate in outline. The periphery may be carinate. Chambers are rapidly enlarging and one-coil in length. The chamber arrangement is triloculine. Wall is calcareous, imperforate, and porcelaneous. Surface is smooth, striate or pitted. Aperture is simple, rounded to oval.

Edentostomina cultrata (Brady, 1881)

Pl. 2, fig. 3

1881 *Miliolina cultrata* Brady; p. 45, figs. 1, 2

1988 *Edentostomina cultrata* (Brady); Loeblich and Tappan, p. 325, pl. 334, figs. 6-8

1994 *Edentostomina cultrata* (Brady); Loeblich & Tappan, pl. 63, figs 8-12

2004 *Edentostomina cultrata* (Brady); Meriç *et al*., p. 42, pl. 5, fig. 1

Diagnostic features:

Test is elongated and slender. Periphery of the test is highly carinate. Aperture is simple, oval and produced on a neck. It is bordered by an everted lip.

Remarks:

The most characteristics features of this species are carinate periphery and its lenticular shaped aperture without teeth.

Edentostomina milletti (Wiesner, 1912)

Pl. 2, fig. 5-6

1912 *Miliolina milletti* Wiesner; p. 506

1988 *Edentostomina milletti* (Wiesner); Loeblich and Tappan, p. 325, pl. 334, fig. 9

1994 *Pseudopyrgo milletti* (Wiesner); Loeblich and Tappan, p. 53, pl. 89, figs.10, 11

Diagnostic features:

Test is longer than width and ovate in shape. Periphery is acute. Aperture is simple, oval and produced on a neck. It is bordered by an everted lip.

Remarks:

In the studied samples, test of this species is much more elongated, thinner and exceedingly longer than width.

Superfamily *Miliolacea* Ehrenberg, 1839

Family *Spiroloculinidae* Wiesner, 1920

Genus *Adelosina* d'Orbigny, 1826

Test of the microspheric generation is quinqueloculine in the early stage, while in the megalospheric test, proloculus is followed by flexostyle and involute second chamber, third chamber with a 90° change in plane of coiling, later chambers quinqueloculine in both generations, with planes of coiling 130° to 160° apart (Loeblich and Tappan, 1988). Generally, four chambers are visible from the exterior. Wall is calcareous, imperforate and porcelaneous. Surface is smooth, striate or costate; aperture terminal, rounded, produced on a neck, with a simple or bifid tooth.

Adelosina cliarensis (Heron-Allen and Earland, 1930)

Pl. 2, fig. 7

1930 *Miliolina cliarensis* Heron-Allen and Earland; p. 58, pl. 3, figs. 26-31.

1971 *Adelosina cliarensis* (Heron-Allen and Earland); Murray, p. 60; pl. 22, figs. 1-3

1991 *Adelosina cliarensis* (Heron-Allen and Earland); Cimerman and Langer, p. 26, pl. 18, figs. 1-4;

2001 *Adelosina cliarensis* (Heron-Allen and Earland); Fiorini and Vaiani, p. 371, pl. 2, figs. 12-13;

2001 *Adelosina cliarensis* (Heron-Allen and Earland); Avşar *et al.*, p. 105, pl. 1, figs. 1-3

Diagnostic features:

Test of *Adelosina cliarensis* is elongated with subelliptical to fusiform in lateral view, and subtriangular in apertural view. Peripheral margin is subrounded. Chambers are compressed and sutures are distinct and depressed. Surface of test is smooth. Weakly developed circular rim is developed around aperture with T-shaped tooth.

Remarks:

It is easily differentiated from other *Adelosina* species by having smooth surface and low Wide/Length ratio. Some specimens in this study have indistinct striations at the basal and apertural end. Specimens collected in this study are different from species in plate 22, Figure 1 of Murray (1971). Because forms of Murray (1971) have numerous, continuous, longitudinally arranged costae parallel to the periphery.

Adelosina elegans (Williamson, 1858)

1858 *Miliolina bicornis* Walker and Jacob var. *elegans* Williamson, p. 88, pl. 7, fig. 195

1991 *Adelosina elegans* (Williamson); Cimerman and Langer, p. 27, pl. 20, figs. 5-6

1993 *Adelosina elegans* (Williamson); Sgarrella and Moncharmont-Zei, p. 181, pl. 8, fig. 3

2001 *Adelosina elegans* (Williamson); Fiorini and Vaiani, p. 371, pl. 2, figs. 1-2

Diagnostic features:

Test of *Adelosina elegans* is fusiform in lateral view and subelliptical in apertural view. Peripheral margin is rounded. Sutures are distinct. Surface of test is ornamented by numerous longitudinally arranged, elevated costae which are parallel to the periphery. Weakly developed circular rim is developed around aperture with T-shaped tooth.

Remarks:

The most characteristic feature of this species is its longitudinally arranged, elevated costae on its surface.

Adelosina mediterranensis (Le Calves, J. and Y., 1958)

1958 *Quinqueloculina mediterranensis* Le Calves, J. and Y.; p. 177, pl. 4, figs. 29-31

1991 *Adelosina mediterranensis* (Le Calves, J. and Y); Cimerman and Langer, p. 28, pl. 19, figs. 1-16

1993 *Adelosina mediterranensis* (Le Calves, J. and Y); Sgarrella and Moncharmont-Zei, p. 177, pl. 7, figs. 9-11

2001 *Adelosina mediterranensis* (Le Calves, J. and Y); Fiorini and Vaiani, p. 371, pl. 2, figs. 14-16

Diagnostic features:

Test is subovate to fusiform in lateral view and slightly irregular in apertural view. The periphery of test is carinate in juvenile specimens, while it is truncate in adult specimens. The sutures are distinct and depressed. The surface of test is ornamented by numerous longitudinally arranged curved costae that are parallel to the periphery. The aperture with bifid tooth is surrounded by weakly developed circular rim.

Remarks:

Adelosina mediterranensis is differentiated from *Adelosina elegans* by its irregular appearance in the apertural view and by having thinner costae.

Adelosina partschi (d' Orbigny, 1846)

1846 *Quinqueloculina partschi* d' Orbigny, p. 293, pl. 19, figs. 4-6

1991 *Adelosina partschi* (d' Orbigny); Cimerman and Langer, p. 19, pl. 20

Diagnostic features:

Test of *Adelosina partschi* is fusiform in lateral view with acute periphery. Surface is ornamented by numerous longitudinally arranged costae and striae. Aperture is bordered by weakly developed circular rim. It has a simple tooth and it is developed on the tapering neck.

Adelosina pulchella d' Orbigny, 1846

Pl. 2, figs. 8-10

1846 *Adelosina pulchella* d' Orbigny; p. 203, pl. 20, figs. 25-30

1931 *Quinqueloculina* pulchella (d' Orbigny); Cushman, p. 107, pl. 6, figs. 7-8

1991 *Adelosina pulchella* d' Orbigny; Cimerman and Langer, p. 28, pl. 20, figs. 9-10

2001 *Adelosina pulchella* d' Orbigny; Fiorini and Vaiani, p. 368, pl. 1, figs. 13-15

Diagnostic features:

Test of *Adelosina pulchella* is fusiform in lateral view and irregular in apertural view. Periphery of test is carinate. Surface is ornamented by numerous thick, acute ribs and smaller costae. Aperture with a T-shaped tooth is bordered by weakly developed, circular rim.

Remarks:

Specimens in this study does not resemble to Cushman's (1931) specimens figured in plate 6, figures 7 and 8 by having more coarsely costae on the surface and by irregular appearance in the apertural view.

Adelosina sp. A

Pl. 2, fig. 11

Diagnostic features:

Test of *Adelosina* sp. A is ovate in lateral view and subtriangular in apertural view. Periphery of test is carinated. Chambers are compressed and sutures are distinct and depressed. Surface is ornamented by numerous longitudinally arranged smaller costae. Aperture with short T-shaped tooth is bordered by a circular rim.

Remarks:

The most characteristic features of this species are its broad and carinate peripheral margin and its ornamentation, which is seen obvious especially at the last chamber.

Genus *Spiroloculina* d'Orbigny, 1826

Test is free, laterally compressed, and ovate to fusiform in outline. Periphery of test is truncate with flattened sides. According to Loeblich and Tappan (1988), microspheric proloculus is followed by planispiral tubular second chamber, which is one whorl in length, while chambers one-half coil in length are added in a single plane (spiroloculine coiling) in the later part of microspheric test and all of megalospheric test. Chambers are not embracing. Wall is calcareous, imperforate and porcelaneous. Aperture is at the open end of the final chamber, with simple or bifid tooth and commonly on a short neck.

Spiroloculina angulosa Terquem, 1878

Pl. 11, fig. 5

1878 *Spiroloculina angulosa* Terquem; p. 53, pl. 5, fig. 7

1991 *Spiroloculina angulosa* Terquem; Cimerman and Langer, p. 53, pl. 6, figs. 6-8

Diagnostic features:

Test is fusiform in side view, biconcave and bow tie like shaped in apertural view. The periphery of *Spiroloculina angulosa* is truncated. Number of chambers is up to 11 chambers in adult. Surface of test is slightly rough. Aperture is subovate in shape and bordered by a lip. It has a bifid tooth and it is developed on a short neck.

Remarks:

Spiroloculina angulosa is distinguished from *S. depressa* by having longer neck and its apertural view shape appearing as bow tie.

Spiroloculina corrugata Cushman and Todd, 1944

1944 *Spiroloculina corrugata* Cushman and Todd; p. 61, pl. 8, figs. 22-25

1993 *Spiroloculina corrugata* Cushman and Todd; Hottinger *et al.*, p.46, pl. 26, figs. 5-9

2004 *Spiroloculina corrugata* Cushman and Todd; Meriç *et al.*, p. 55, pl. 6, fig. 9

Diagnostic features:

Test of *Spiroloculina corrugata* is elongated fusiform in lateral view and slightly biconcave. Size of chambers gradually increases. Sutures are indistinct. Surface is ornamented by longitudinally arranged, elongated, irregular and partly anastomosing costae. Aperture on a neck is subcircular in shape and has a lip and bifid tooth.

Remarks:

The characteristic feature of *Spiroloculina corrugata* is its ornamentation on the surface of the test.

Spiroloculina depressa d'Orbigny, 1826

Pl.11, fig.6

1826 *Spiroloculina depressa* d'Orbigny; p. 298, no: 1

1931 *Spiroloculina depressa* d'Orbigny; Cushman, p. 110, pl.9, figs. 8-9

1980 *Spiroloculina depressa* d'Orbigny; Boltovskoy *et al.*, p. 50, pl. 31, figs. 19-20

1988 *Spiroloculina depressa* d'Orbigny; Loeblich and Tappan, p. 33, pl. 340, figs. 2-5

1991 *Spiroloculina depressa* d'Orbigny; Cimerman and Langer, p. 29, pl. 22, figs. 9-12

1999 *Spiroloculina depressa* d'Orbigny; Altıner *et al.,* p. 89, pl. 3, fig. 7

2001 *Spiroloculina depressa* d'Orbigny; Debenay *et al.*, p. 1; fig. 30

2004 *Spiroloculina depressa* d'Orbigny; Meriç *et al.*, p.55, pl. 6, fig. 10

Diagnostic features:

Test of *Spiroloculina depressa* is elliptical in outline and slightly longer than width. It is fusiform in lateral view and flat in apertural view. Peripheral margin is angulated. Sutures are depressed. Surface is rough due to its ornamentation including minute striae. Aperture is elongate, large and almost rectangular in shape and it is developed on an extremely short neck. It has a bifid tooth and bordered by a lip.

Spiroloculina excavata d'Orbigny, 1846

1846 *Spiroloculina excavata* d'Orbigny; p. 271, pl. 16, figs. 19-21

1991 *Spiroloculina excavata* d'Orbigny; Cimerman and Langer, p. 30, pl. 23, figs. 1-3

1993 *Spiroloculina excavata* d'Orbigny; Sgarrella and Moncharmont-Zei, p. 169, pl. 5, fig. 6

1999 *Spiroloculina excavata* d'Orbigny; Altıner *et al.*, p. 89, pl. 3, fig. 8

2001 *Spiroloculina excavata* d'Orbigny; Fiorini and Vaiani, p. 381, pl. 5, figs. 4-5

2004 *Spiroloculina excavata* d'Orbigny; Meriç *et al.*, p. 56, pl. 7, figs. 1-2

Diagnostic features:

Test of *Spiroloculina excavata* is subelliptical in outline, biconcave in apertural view. Peripheral margin is truncated and it has very broad edge. Number of chambers is up to 10 chambers in adult. Aperture on an extremely short neck is subrounded in shape and bordered by a rim. It has a bifid tooth.

Remarks:

Spiroloculina excavata is distinguished from *Spiroloculina depressa* by having its smooth surface, its broad edge and its highly biconcave test.

Spiroloculina ornata d'Orbigny, 1839

1839 *Spiroloculina ornata* d'Orbigny; p. 167, pl. 12, fig. 7

1931 *Spiroloculina ornata* d'Orbigny; Cushman, p. 109, pl.8, fig. 6

1991 *Spiroloculina ornata* d'Orbigny; Cimerman and Langer, p. 30, pl. 23, figs. 8-11

2004 *Spiroloculina ornata* d'Orbigny; Meriç *et al.*, p. 57, pl. 7, figs. 3-4

Diagnostic features:

Test is elongate, compressed, and very slightly biconcave with irregular outline in apertural view. Peripheral margin is bicarinate. Number of chambers is up to 13 chambers in adult and chambers are rapidly increasing in length. Aperture of this species is quadrangular in shape and bordered by a rim. It has a bifid tooth and it is developed on a long neck.

Remarks:

The most characteristic features of *Spiroloculina ornata* are its bicarinate periphery and aperture on a relatively long neck.

Spiroloculina ornata d'Orbigny var. *tricarinata* Le Calvez and Le Calvez, 1958

1958 *Spiroloculina ornata* d'Orbigny var. *tricarinata* Le Calvez, J. and Y.; p. 207, pl. 8, figs. 84-85

1991 *Spiroloculina ornata* d'Orbigny var. *tricarinata* Le Calvez, J. and Y.; Cimerman and Langer, p. 30, pl. 23, figs. 4-7

2001 *Spiroloculina ornata* d'Orbigny var. *tricarinata* Le Calvez, J. and Y.; Fiorini and Vaiani, p. 381 , pl. 4, figs. 17-22

Diagnostic features:

Test is slightly biconcave, elongated and fusiform in lateral view. Peripheral margin is truncated and there is a third carina in the middle of periphery. Number of chambers is up to nine in the adult. Some sutural gaps are recognized between the chambers.

Remarks:

This variety simply differs from its type species (*Spiroloculina ornata***)** by having a third carina in the middle of periphery.

Spiroloculina tenuiseptata Brady, 1884

1884 *Spiroloculina tenuiseptata* Brady; p. 153, pl. 10, fig. 5

1991 *Spiroloculina tenuiseptata* Brady; Cimerman and Langer, p. 31, pl. 24, figs. 6-9

1993 *Spiroloculina tenuiseptata* Brady; Sgarrella and Moncharmont-Zei, p. 169, pl. 7, fig. 5-7

2001 *Spiroloculina tenuiseptata* Brady; Fiorini and Vaiani, p. 381, pl. 5, fig. 6

2004 *Spiroloculina tenuiseptata* Brady; Meriç *et al.*, p. 58, pl. 7, figs. 5-7.

Diagnostic features:

Test is flattened, fusiform in side view and almost rectangular in apertural view. The peripheral margins are elevated in side view. The aperture is rounded in shape and developed on a long and slim neck. It has rim and anvil shaped tooth.

Remarks:

Spiroloculina tenuiseptata is distinguished from the rests of genus *Spiroloculina* by having much longer and thinner neck and its very rough surface.

Family Hauerinidae Schwager, 1876

Subfamily Siphonapertinae Saidova, 1975

Genus *Siphonaperta* Vella, 1957

Test is quinqueloculine and ovate in outline. Chambers are one-half coil in length and five of them are visible on the exterior. Wall is calcareous, imperforate and porcelaneous with agglutinated coating. Aperture is rounded, terminal and it has a rim and simple tooth.

Siphonaperta agglutinans (d'Orbigny, 1839)

Pl. 2, fig. 12

1839 *Quinqueloculina agglutinans* d'Orbigny; p. 195, pl. 12, figs. 11, 12

1931 *Quinqueloculina agglutinans* d'Orbigny; Cushman, p. 103, pl. 1, fig. 1

1991 *Siphonaperta agglutinans* (d'Orbigny); Cimerman and Langer, p. 31, pl. 25 figs. 1-3

2004 *Siphonaperta agglutinans* (d'Orbigny); Meriç *et al.*, p. 60, pl. 7, fig. 8

Diagnostic features:

Test is longer than width and ovate to subelliptical in lateral view. Periphery of this species is broadly rounded. Chambers are rounded and inflated. Sutures are fairly distinct. Surface of the test is heterogeneously and coarsely agglutinated. Aperture is ovate in shape and it has a long bifid tooth.

Siphonaperta aspera (d'Orbigny, 1826)

1826 *Quinqueloculina* aspera, d'Orbigny; p. 301, no: 11

1991 *Siphonaperta aspera* (d'Orbigny); Cimerman and Langer, p. 31, pl. 25, figs. 4-6

1993 *Siphonaperta aspera* (d'Orbigny); Sgarrella and Moncharmont-Zei, p. 185, pl. 6, fig. 12

2004 *Siphonaperta aspera* (d'Orbigny); Meriç *et al*., p. 60, pl. 7, fig. 8

Diagnostic features:

Test is subelliptical in lateral view and length to width ratio of test is nearly same. The chambers are subrounded and elongated. The surface of test is rough and covered by an agglutinated coating. The aperture is subrounded and it has a bifid tooth.

Remarks:

Siphonaperta aspera is differentiated from *Siphonaperta agglutinans* by having more finely agglutinated surface and by its less inflated chambers.

Subfamily Hauerininae Schwager, 1876

Genus *Cycloforina* Luczkowska, 1972

Test is quinqueloculine with chambers having one-half coil in length. Wall of this genus is calcareous, imperforate and porcelaneous. Aperture is terminal and circular in shape with short bifid or simple tooth.

Cycloforina contorta (d'Orbigny, 1846)

Pl. 3, fig. 1

1846 *Quinqueloculina contorta* d'Orbigny; p. 298, pl. 20, figs. 4-6

1988 *Cycloforina contorta* (d'Orbigny); Loeblich and Tappan, p. 33, pl. 342, figs. 4-9

1991 *Cycloforina contorta* (d'Orbigny); Cimerman and Langer, p. 32, pl. 27, figs. 7-11

2001 *Cycloforina contorta* (d'Orbigny); Fiorini and Vaiani, p. 375, pl. 3, figs. 8-10, 13

2004 *Cycloforina contorta* (d'Orbigny); Meriç *et al.*, p. 63, pl. 7, figs. 11-13

Diagnostic features:

Test of *Cycloforina contorta* is elongated, subrectangular in lateral and apertural view. The periphery of test is acute. The chambers are flattened with distinct sutures. The surface is rough and ornamented by numerous microstriae. The aperture has a short bifid tooth and it is produced on a very short neck.

Remarks:

The most characteristic features of *Cycloforina contorta* are its acutely angled chambers and its rough surface of the test.

Genus *Lachlanella* Vella, 1957

Test of this genus is elongate and ovate. Chamber arrangement is quinqueloculine with chambers one-half coil in length. Wall is calcareous, imperforate and porcelaneous. Aperture is large and has subparallel sides. It is bordered by an everted rim and provided with a long slender tooth.

Lachlanella bicornis (Walker and Jacob, 1896)

1896 *Miliolina bicornis* Walker and Jacob, Dezelic, p. 70

1931 *Quinqueloculina bicornis* (Walker and Jacob); Cushman, p. 32, pl. 5, figs. 5-7, pl. 6, figs. 1-2

1971 *Quinqueloculina bicornis* (Walker and Jacob); Murray, p. 57, pl. 20, figs. 1-

5

1991 *Lachlanella bicornis* (Walker and Jacob); Cimerman and Langer, p. 34, pl. 29, figs. 1-3

2004 *Lachlanella bicornis* (Walker and Jacob); Meriç *et al.*, p. 66, pl. 8, figs. 4-7

Diagnostic features:

Test is slightly longer than width, subovate in lateral view and subtriangular in apertural view. Periphery of *Lachlanella bicornis* is broadly rounded. Chambers are somewhat contorted and sinuous. Sutures are distinct and slightly depressed. Surface of the test is strongly ornamented by thick and longitudinally arranged costae, especially on the peripheral margins.

Remarks:

The most characteristic features of this species are its chamber shape and surface ornamentation.

Lachlanella undulata (d'Orbigny, 1826)

1826 *Quinqueloculina undulata* d'Orbigny; p. 302, no: 27

1991 *Lachlanella undulata* (d'Orbigny); Cimerman and Langer, p. 34, pl. 30, figs. 3-6

1999 *Lachlanella undulata* (d'Orbigny); Altıner *et al.*, p. 91, pl. 4, fig. 4

2004 *Lachlanella undulata* (d'Orbigny); Meriç *et al.*, p. 67, pl. 8, fig. 8

Diagnostic features:

Test is ovate to subelliptical in lateral view and ovate to triangular in apertural view.

Chambers are strongly contorted and intensely sinuous in shape. Surface of test is ornamented by longitudinally arranged costae.

Remarks:

Lachlanella undulata is distinguished from *Lachlanella bicornis* by having its extremely contorted surface of test and wavy ornamentation.

Lachlanella variolata (d'Orbigny, 1826)

1826 *Quinqueloculina variolata* d'Orbigny; p. 302, no: 26

1991 *Lachlanella variolata* (d'Orbigny); Cimerman and Langer, p. 35, pl. 31, figs. 1-12

1993 *Quinqueloculina variolata* d'Orbigny; Sgarrella and Moncharmont-Zei, p. 180, pl. 8, fig. 1

2003 *Triloculina bicarinata* d'Orbigny; Javaux and Scott, p. 21, pl. 5, figs. 12-13

2004 *Lachlanella variolata* (d'Orbigny); Meriç *et al.*, p. 69, pl. 8, figs. 9-10, pl 9, figs. 1-3

Diagnostic features:

Test is subelliptical to fusiform in lateral view and ovate to lenticular in apertural view. Peripheral margin of test is rounded to carinate. Surface is ornamented by a reticulate pattern.

Remarks:

The surface ornamentation is characteristic feature of this species.

Genus *Quinqueloculina* d'Orbigny, 1826

Test is free and ovate in outline with chambers one-half coil in length. Chamber arrangement is quinqueloculine or may be cryptoquinqueloculine that depends on the degree of overlap of successive chambers. Wall of this genus is calcareous, imperforate, and porcelaneous. Aperture is ovate and flush with the surface and it has a bifid tooth.

Quinqueloculina berthelotiana d'Orbigny, 1839

Pl. 3, fig. 2

1839 *Quinqueloculina berthelotiana* d'Orbigny; p. 142, pl. 3, figs. 25-27

1991 *Quinqueloculina berthelotiana* d'Orbigny; Cimerman and Langer, p. 36, pl 32, figs. 5-7

1993 *Quinqueloculina berthelotiana* d'Orbigny; Sgarrella and Moncharmont-Zei, p. 170, pl. 6, figs. 1-2

2004 *Quinqueloculina berthelotiana* d'Orbigny; Meriç *et al.*, p. 70, pl. 9, figs. 9-10

Diagnostic features:

Test is ovate to fusiform in lateral view and triangular in apertural view. Peripheral margin of test is acute. Chambers are somewhat contorted and sinuous. Sutures are depressed. Surface of test is very rough and ornamented by rugose ornamentation including anastomosing microstriae. Aperture is circular to ovate in shape and developed on a very short neck. It is bordered by a peristomal rim.

Remarks:

This species is distinguished from *Lachlanella undulata* by having not very distinct ornamentation as much as that of *Lachlanella undulata* and its rounded aperture shape.

Quinqueloculina bosciana d'Orbigny, 1839

Pl. 3, fig. 3

1839 *Quinqueloculina bosciana* d'Orbigny; p. 191, pl. 11, figs. 22-24

1991 *Quinqueloculina bosciana* d'Orbigny; Cimerman and Langer, p. 36, pl. 33,

figs. 5-7

1993 *Quinqueloculina bosciana* d'Orbigny; Sgarrella and Moncharmont-Zei, p. 173, pl. 6, figs. 8-9

2001 *Quinqueloculina bosciana* d'Orbigny; Fiorini and Vaiani, p. 375, pl. 3, figs. 17-18

Diagnostic features:

Test of *Quinqueloculina bosciana* is small and its length is longer than width. Its shape is elongate in lateral view and suboval in apertural view. Chambers are rounded with depressed sutures. Surface of test is smooth. Aperture is circular and bordered by a peristomal rim and provided by primitive bifid tooth.

Remarks:

The most characteristic features of *Quinqueloculina bosciana* are its relatively longer test and its chambers in the center that are always oblique to nearly parallel outer chambers.

Quinqueloculina laevigata d'Orbigny, 1839

1839 *Quinqueloculina laevigata* d'Orbigny; p. 143, pl. 3, figs.32-33

1931 *Quinqueloculina laevigata* d'Orbigny; Cushman, p. 30, pl. 4, fig. 3

1991 *Quinqueloculina laevigata* d'Orbigny; Cimerman and Langer, p. 37, pl. 33, figs. 8-11

2003 *Quinqueloculina laevigata* d'Orbigny; Javaux and Scott, p. 19, fig. 4.11

2004 *Quinqueloculina laevigata* d'Orbigny; Meriç *et al.*, p. 74, pl. 10, figs. 8-9

Diagnostic features:

Test of *Quinqueloculina laevigata* is elongate and its length is longer than width. Outline of test is subovate. Sutures are parallel to the periphery. Surface is smooth. Aperture is subrounded.

Remarks:

This species is differentiated from *Quinqueloculina bosciana* by having sutures parallel to periphery.

Quinqueloculina limbata d'Orbigny, 1826

1826 *Quinqueloculina limbata* d'Orbigny; p. 302, no: 20

1991 *Quinqueloculina limbata* d'Orbigny; Cimerman and Langer, p. 37, pl. 34, figs. 1-5

1994 *Quinqueloculina limbata* d'Orbigny; Loeblich and Tappan, p. 49, pl. 78, figs. 10-12

2004 *Quinqueloculina limbata* d'Orbigny; Meriç *et al.*, p. 77, pl. 10, fig. 12

Diagnostic features:

Test is subelliptical in lateral view and subtriangular in apertural view. Periphery of test is rounded. Surface is ornamented by longitudinally arranged costae. Aperture is circular in shape and bordered by a rim. It has a bifid tooth and it is produced on a very short neck.

Remarks:

The most distinctive characteristics of *Quinqueloculina limbata* is its ornamentation being predominantly on the periphery

Quinqueloculina seminula (Linnaeous, 1758)

1758 *Serpula semiula* Linnaeous; p. 786, pl. 2, fig. 1

1980 *Quinqueloculina seminillum* (Linnaeous); Boltovskoy *et al.*, p. 47, pl. 29, figs. 7-13

1991 *Quinqueloculina semiula* (Linnaeous); Cimerman and Langer, p. 38, pl. 34, figs. 9-12

2001 *Quinqueloculina semiula* (Linnaeous); Fiorini and Vaiani, p. 374, pl. 3, figs.

14-16

2004 *Quinqueloculina semiula* (Linnaeous); Meriç *et al.*, p. 79, pl. 11, figs. 2-4

Diagnostic features:

Test is oval in side view and triangular in apertural view. Chambers are slightly longer than width and 3-4 chambers are visible at the exterior. Surface of this species is very smooth. Aperture is rounded and bordered by a rim. It has a simple tooth.

Quinqueloculina viennensis Le Calvez and Le Calvez, 1958

1958 *Quinqueloculina viennensis* Le Calvez and Le Calvez; p. 187, pl. 5, figs. 42, 44, 45

1993 *Quinqueloculina viennensis* Le Calvez and Le Calvez; Sgarrella and Moncharmont-Zei, p. 176, pl. 7, fig. 8

Diagnostic features:

Test is ovate with acute periphery. Sutures are distinct and depressed. The surface of *Quinqueloculina viennensis* is smooth. The aperture is elongated and bordered by a weak rim. It has a simple tooth.

Genus *Septloculina* El-Nakhal, 1990

Test is free with inflated to compressed chambers. Periphery is rounded to angular. Chambers are added as a seven equally spaced planes called as septloculine coiling so seven chambers are visible from exterior. Sutures of this species are curved. Surface has worn appearance. Aperture is simple and semicircular to triangular at the open end of the final chamber. It has a bifid tooth.

Remarks:

The most characteristic feature of this genus is that sutural regions are filled by secreted calcareous material so the sutures appear as darker than the wall of the test.

Septloculina angulata El-Nakhal, 1990

Pl. 3, fig. 4

1990 *Septloculina angulata* El-Nakhal, p. 91, pl. 1, fig. 1-7

Diagnostic features:

Size of test is 1.3 times longer than width. Chambers are elongate with curved sutures. Last three chambers are compressed with angular periphery. Aperture is semicircular with bifid tooth.

Remarks:

This species is distinguished from other species of genus *Septloculina* by having compressed last chambers and angular periphery.

Septloculina rotunda El-Nakhal, 1990

Pl. 3, fig. 5

1990 *Septloculina rotunda* El-Nakhal, p. 91, pl. 1, fig. 8-11

Diagnostic features:

Size of test is 1.44 times longer than width. Chambers are elongated and inflated with curved sutures. Periphery is rounded. Aperture is semicircular with bifid tooth.

Remarks:

This species is distinguished from other species of genus *Septloculina* by having inflated last chambers and rounded periphery.

Septloculina tortuosa El-Nakhal, 1990

Pl. 3, fig. 6

1990 *Septloculina rotunda* El-Nakhal, p. 91, pl. 2, figs. 4-9

Diagnostic features:

Size of test is 1.23 times longer than width. Chambers are elongated with sigmoid sutures. Last 6 chambers are compressed with angular periphery. Periphery is rounded. Aperture is triangular with bifid tooth.

Remarks:

This species is distinguished from other species of genus *Septloculina* by its smaller test, by having compressed last chambers and sigmoid sutures.

Subfamily Miliolinellinae Vella, 1957

Genus *Biloculinella* Wiesner, 1931

Test is free and discoidal to ovate in shape. Periphery is rounded to carinate. Chambers are one-half coil in length. According to Loeblich and Tappan (1988), early chambers are quinqueloculine, then cryptoquinqueloculine, and finally biloculine in the microspheric generation, while megalospheric forms are biloculine. Therefore, only two chambers are visible from exterior. Chambers are wide and shallow. Wall is calcareous, imperforate and porcelaneous. Aperture is terminal and covered by a broad apertural flap, which leaves only a thin crescentic opening.

Biloculinellla inflata (Wright, 1902)

1902 *Biloculina inflata* Wright; p. 183, pl. 13, figs. 1-4

1993 *Biloculinellla inflata* (Wright); Sgarrella and Moncharmont-Zei, p. 188, pl. 10, fig. 12

2000 *Biloculinellla inflata* (Wright); Sakınç, p. 66, fig. 35

2004 *Biloculinellla inflata* (Wright); Meriç *et al.*, p. 87, pl. 11, figs. 12, 13

Diagnostic features:

Test is subglobular in lateral view and oval in apertural view. Periphery of this species is rounded. Aperture is bordered by a weak peristomal rim and it has a crescentic apertural flap.

Remarks:

Biloculinellla inflata is easily distinguished from *Biloculinellla depressa* that is not recorded in the Gulf of İskenderun. *Biloculinellla depressa* has carinate periphery and its test is lenticular outline in apertural view

Biloculinellla labiata (Schlumberger)

1891 *Biloculina labiata* Schlumberger**;** p. 556, pl. 9, figs. 60-62

1988 *Biloculinellla labiata* (Schlumberger); Loeblich and Tappan, p. 337, pl. 348, figs. 1-4

1991 *Biloculinellla labiata* (Schlumberger); Cimerman and Langer, p. 40, pl. 36, fig. 12

2000 *Biloculinellla labiata* (Schlumberger); Sakınç, p. 67, fig. 36

2004 *Biloculinellla labiata* (Schlumberger); Meriç *et al.*, p. 87, pl. 12, figs. 1-2

Diagnostic features:

Test is ovate in lateral view and lenticular in apertural view. Chambers of this species are inflated and slightly elongated with broadly rounded margins.

Periphery is sharply angled. Aperture is bordered by a weak peristomal rim and provided with crescentic apertural flap.

Remarks:

Biloculinellla labiata is differentiated from *Biloculinellla inflata* by having larger size and its shape of test.

Genus *Miliolinella* Wiesner, 1931

Test is flattened and ovate in outline. Periphery of this genus is broadly rounded. Chamber arrangement is quinqueloculine in early stage, later planispiral. 4-7 chambers are visible at the exterior of test. Wall is calcareous, imperforate and porcelaneous. Aperture is terminal and covered by a broad apertural flap.

Miliolinella elongata Kruit, 1955

Pl. 3, fig. 7

1955 *Miliolinella circularis* (Bornemann) var. *elongata* Kruit; p. 110, pl. 1, fig. 15

1971 *Miliolinella circularis* (Bornemann) var. *elongata* Kruit; Murray, p. 73, pl. 28, figs. 1-4

1993 *Miliolinella circularis* (Bornemann) var. *elongata* Kruit; Sgarrella and Moncharmont-Zei, p. 187, pl. 10, fig. 5

1991 *Miliolinella elongata* Kruit; Cimerman and Langer, p. 41, pl. 37, fig. 8

2001 *Miliolinella elongata* Kruit; Fiorini and Vaiani, p. 381, pl. 5, figs. 19-20

2004 *Miliolinella elongata* Kruit; Meriç *et al.*, p. 86, pl. 12, fig. 3

Diagnostic features:

Test of *Miliolinella elongata* is oval in peripheral view. Periphery of test is subrounded. Last two chambers are planispirally coiled for that reason 3 to 4 chambers are visible at exterior. Surface is smooth. Aperture is bordered by a weak peristomal rim and provided with crescentic apertural flap.

Remarks:

In the Gulf of İskenderun, only two individuals are recorded in the studied samples. Figured individual in plate 3, fig. 2 has slightly elongated test shape relative to other one.

Miliolinella labiosa (d'Orbigny, 1839)

1839 *Triloculina labiosa* d'Orbigny; p. 178, pl. 10, figs. 12-14

1931 *Triloculina labiosa* d'Orbigny; Cushman, p. 60, pl. 15, figs. 2-3

1991 *Miliolinella labiosa* (d'Orbigny); Cimerman and Langer, p. 41, pl. 38, figs. 1-3

2004 *Miliolinella labiosa* (d'Orbigny); Meriç *et al.*, p. 88, pl. 12, fig. 4

Diagnostic features:

Its width is much broader than length. Periphery is rounded. Chambers are inflated and often somewhat irregular. Last two chambers are planispirally coiled so three chambers are visible at exterior. Surface is smooth but it has dull appearance. Aperture is bordered by a weak peristomal rim and provided with crescentic apertural flap.

Remarks:

Miliolinella labiosa is easily differentiated from the other species by having irregular chambers that produce an asymmetrical outline.

Miliolinella subrotunda (Montagu, 1803)

Pl 11, fig. 7

1803 *Vermiculum subrotundum* Montagu; p. 521 (fide Ellis and Messina)

1991 *Miliolinella subrotunda* (Montagu); Cimerman and Langer, p. 42, pl. 38,

figs. 4-9

2001 *Miliolinella subrotunda* (Montagu); Fiorini and Vaiani, p. 381, pl. 5, figs. 21-22

2004 *Miliolinella subrotunda* (Montagu); Meriç *et al.*, p. 88, pl. 12, figs. 9-11

Diagnostic features:

Test is subcircular in lateral view and oval in apertural view. Peripheral margin is rounded. 3-4 chambers are visible at exterior. Surface is smooth, shiny and rarely ornamented by longitudinal striae. Aperture is bordered by a weak peristomal rim and provided with small, crescentic apertural flap.

Remarks:

The most characteristic feature of this species is the subcircular shape of test.

Miliolinella sp. A

Pl. 3, fig. 8

Diagnostic features:

Test is oval, elongated and longer than width. The peripheral margin is rounded. 3-4 chambers are visible at exterior. The surface is smooth and shiny. Aperture is terminal and provided with a spoon-shaped apertural flap.

Remarks:

The most characteristic feature of this species is its spoon-shaped apertural flap.

Genus *Sigmohauerina* S. Y. Zheng, 1979

Test is broadly ovate, discoidal and strongly compressed. In the early stage, chambers are one-half coil in length, biconvex, inflated and sigmoiline. In the later stages, chamber arrangement is planispiral and evolute with shorter chambers. There are generally three chambers at the final whorl. Wall is calcareous, imperforate and porcelaneous. Surface may be ornamented by fine longitudinal striae. Aperture is ovate at the end of the final chamber and it has convex and sieve-like plate with numerous pores, which is called trematophore.

This genus is differentiated from genera *Hauerina* and *Parahauerinoides* by its sigmoiline coiling in the early stage. Genus *Hauerina* is quinqueloculine in early stages and genus *Parahauerinoides* is planispiral throughout, respectively.

Sigmohauerina bradyi (Cushman, 1884)

Pl. 3, fig. 9

1917 *Hauerina bradyi* Cushman; p. 62, pl. 23, fig. 2

1988 *Sigmoihauerina bradyi* (Cushman); Loeblich and Tappan, p. 348, pl. 358, figs. 5-10

1993 *Sigmoihauerina bradyi* (Cushman); Hottinger *et al.*, p. 62, pl. 61, figs. 1-3

1994 *Sigmoihauerina bradyi* (Cushman); Jones, p. 27, pl. 11, figs. 12-13

Diagnostic features:

Test is extremely flat with broadly ovate to polygonal in lateral view. Periphery is subangular. Chambers are strongly compressed. Latter chamber's walls are overlapping to the preceding chambers. Test surface is rough and ornamented by longitudinally arranged by anastomosing microstriae and transverse curved striae. Aperture is elliptical with trematophore.

Remarks:

The most characteristic features of this species are biconvex, inflated early chambers that are sigmoiline and its trematophore.

It is recorded in the Red Sea (Hottinger *et al.*, 1993). This species could be a

Lessepsian migrant (Langer and Hottinger, 2000; Hyams *et al.*, 2002; Meriç *et al.*, 2006) because it is not recorded in the Mediterranean Sea except the Gulf of İskenderun.

Genus *Pseudomassilina* Lacroix, 1938

Test is flattened and subcircular in outline. Chambers are one-half coil in length. Early stage is quinqueloculine followed by planispiral later part. Wall is calcareous, imperforate, thin and translucent with finely pitted surface. Aperture is terminal, very elongate slit without tooth and bordering by a lip.

Pseudomassilina australis (Cushman, 1932)

Pl. 3, fig. 10

1932 *Massilina australis* Cushman, p. 32, pl. 8, fig. 2

1988 *Pseudomassilina australis* (Cushman); Loeblich and Tappan, p. 341, pl. 349, figs. 20-22

1993 *Pseudomassilina australis* (Cushman); Hottinger *et al.*, p. 53, pl. 41, figs. 3-11

1994 *Pseudomassilina australis* (Cushman); Jones, p. 22, pl. 6, figs. 1-2

Diagnostic features:

Test is strongly flattened and sublenticular in apertural view. Periphery is acute to carinate. Chambers of this species are slightly inflated and they slowly increase in width. Wall is penetrated by minute pits.

Remarks:

Pseudomassilina australis has relatively larger size than the other species recorded in the Gulf of İskenderun. The most characteristic feature of this species is its test surface that is covered by curved and oblique to transversal microstriae. Strongly everted lip is easily noticed in both of the aperture and sutures.

Genus *Pseudotriloculina* Cherif, 1970

Test is ovate in outline with broadly rounded periphery. Chambers, one-half coil in length, are cryptoquinqueloculine in early stage and planispiral or very slightly sinuate in later stage. Chambers are broadly overlapping the preceding chambers so 2-3 chambers are visible from the exterior. Wall is calcareous, imperforate and porcelaneous. Aperture is large and rounded. It is bordered by a thick rim and provided with a protruding bifid tooth.

Pseudotriloculina laevigata (d'Orbigny, 1826)

1826 *Triloculina laevigata* d'Orbigny, p. 300, no. 15

1991 *Pseudotriloculina laevigata* (d'Orbigny); Cimerman & Langer, p. 43, pl. 39, figs. 8-12

2004 *Pseudotriloculina laevigata* (d'Orbigny); Meriç *et al.*, p. 94, pl. 13, fig. 3

Diagnostic features:

Test is elongate in lateral view and oval in apertural view. Periphery is subrounded. Three chambers are visible from the exterior. Surface is ornamented by minute microstriae. Aperture is ovate and bordered by a weak peristomal rim. It has a bifid tooth.

Remarks:

Pseudotriloculina laevigata is relatively longer than the other species. This species is differentiated from *Quinqueloculina laevigata* by having nearly parallel sides of chamber margins and oblique inner chambers.

Pseudotriloculina rotunda (d'Orbigny, 1826)

1826 *Triloculina rotunda* d'Orbigny; p. 299, no:4

1931 *Triloculina rotunda* d'Orbigny; Cushman, p. 59, pl. 14, fig. 3

1991 *Pseudotriloculina rotunda* (d'Orbigny); Cimerman and Langer, p. 43, pl. 40, figs. 5-6

2004 *Pseudotriloculina rotunda* (d'Orbigny); Meriç *et al.*, p. 94, pl. 13, figs. 7-9

Diagnostic features:

Test of *Pseudotriloculina rotunda* is fusiform. It is broad, egg-shaped in lateral view and rounded in apertural view. Periphery is broadly rounded. Chambers are rotund and rather longer than width. Sutures are very slightly depressed. Surface is ornamented by anastomosing microstriae. Aperture is rounded and bordered by a thickened lip.

Genus *Pyrgo* Defrance, 1824

Test is free and ovate in outline. Periphery is angular to carinate and compressed through the midpoint of the opposing chambers. According to Loeblich and Tappan (1988), the chambers are one-half coil in length with quinqueloculine to cryptoquinqueloculine in microspheric generation and followed by biloculine in adult. Wall is calcareous, imperforate and porcelaneous. Aperture is terminal and ovate having short bifid tooth.

Pyrgo elongata (d'Orbigny, 1826)

Pl. 3, fig. 11

1826 *Biloculina elongata* d'Orbigny; p. 298, no: 4

1931 *Pyrgo elongata* (d'Orbigny); Cushman, p. 70, pl. 19, figs. 2-3

1980 *Pyrgo elongata* (d'Orbigny); Boltovskoy *et al.*, p. 44, pl. 25, figs. 16-17

1991 *Pyrgo elongata* (d'Orbigny); Cimerman and Langer, p. 44, pl. 41, figs. 6-8

2004 *Pyrgo elongata* (d'Orbigny); Meriç *et al.*, p. 96, pl. 14, figs. 3-5

Diagnostic features:

Test is elongate and tapering toward apertural end. Periphery is rounded. Chambers are slightly inflated chambers with somewhat depressed sutures. Surface is smooth. Aperture is subtriangular with flaplike tooth.

Pyrgo inornata (d'Orbigny, 1826)

1826 *Biloculina inornata* d'Orbigny; p. 266, pl. 16, figs. 7-9

1993 *Pyrgo inornata* (d'Orbigny); Sgarrella and Moncharmont-Zei, p. 183, pl. 9, fig.2

1999 *Pyrgo inornata* (d'Orbigny); Altıner *et al.,* p. 93, pl. 5, figs. 1-3

2004 *Pyrgo inornata* (d'Orbigny); Meriç *et al.*, p. 97, pl. 14, figs. 6-7

Diagnostic features:

Test is nearly circular in lateral view and ovate in apertural view. Periphery is subrounded. Chambers are inflated with somewhat depressed sutures. Aperture is almost rectangular in shape and provided with bifid tooth.

Remarks:

Pyrgo inornata is differentiated from *Pyrgo elongata* by having nearly circular outline and having bifid tooth instead of flaplike tooth as in *Pyrgo elongata*.

Genus *Triloculina* d'Orbigny, 1826

Test is free and ovate in outline. Chamber arrangement is cryptoquinqueloculine in initial chambers, and later chambers are embraced and triloculine. Wall is calcareous, imperforate and porcelaneous. Aperture is terminal, rounded and provided with a short bifid tooth.

Triloculina asymetrica Said, 1949

1949 *Triloculina asymetrica* Said; p. 18, pl. 2, fig. 11

1993 *Triloculina asymetrica* Said; Hottinger *et al.*, p. 64, pl. 66, figs. 4-9

Diagnostic features:

Test is broadly ovate in lateral view and subtriangular in apertural view. Periphery is convex and slightly appressed. Chambers rapidly increase in size and particularly in width. Therefore, test has asymmetrical outline in peripheral view. Aperture is suboval and provided with Y-shaped bifid tooth.

Remarks:

Triloculina asymetrica is differentiated from other species by having asymmetrical outline in the peripheral view.

Triloculina marioni Schlumberger, 1893

Pl. 4, fig. 1

1893 *Triloculina marioni* Schlumberger; p. 204, pl. 1, figs. 38-41

1991 *Triloculina marioni* Schlumberger; Cimerman and Langer, p. 46, pl. 43, figs. 1-5

2004 Triloculina marioni Schlumberger; Meriç *et al.*, p. 101, pl. 15, figs. 3-5

Diagnostic features:

Test of this species is egg-shaped in peripheral view and triangular in apertural view. The periphery is rounded, slightly convex and nearly straight near the sutures with acute shoulders. The chambers are slightly inflated and gradually increased in size. The sutures are distinct and slightly depressed. The surface is faintly striated. The aperture is ovate and surrounded by a peristomal rim. It has a short bifid tooth.

Triloculina oblonga (Montagu, 1803)

Pl. 4, fig. 5

1803 *Vermiculum oblongum* Montagu; p. 522, pl. 14, fig. 9

1980 *Triloculina oblonga* (Montagu, 1803); Boltovskoy *et al.*, p. 52, pl. 33, figs. 11-13

Diagnostic features:

Test is elongate and subrectangular in outline. Periphery is rounded. The chambers are elongate and arcuate. They are widest at the basal end and gradually narrowing towards the apertural end. Sutures are distinct. Wall is shiny and ornamented by weakly striae. Aperture is large, rounded with simple tooth.

Remarks:

This species is differentiated from other species by having large and rounded aperture. In addition, the most characteristic feature is that the last chamber is broadly rounded on its posterior and tapering slightly on each end.

Triloculina plicata Terquem1878

Pl. 4, fig. 3

1878 *Triloculina plicata* Terquem; p. 61, pl. 6, fig. 2

1991 *Triloculina plicata* Terquem; Cimerman and Langer, p. 46, pl. 43, figs. 8-10

1993 *Triloculina plicata* Terquem; Sgarrella and Moncharmont-Zei, p. 186, pl. 10, fig. 2

2004 *Triloculina plicata* Terquem; Meriç *et al.*, p. 102, pl. 15, figs. 6-8

Diagnostic features:

Test is polygonal in apertural view. Peripheral walls are slightly convex and separated by carinate, acutely angled shoulders. Chambers are gradually increasing in size. Surface is smooth. Aperture is circular with peristomal rim and a bifid tooth.

Triloculina tricarinata d'Orbigny

1826 *Triloculina tricarinata* d'Orbigny; p. 299, no:6

1991 *Triloculina tricarinata* d'Orbigny; Cimerman and Langer, p. 46, pl. 44, figs. 3-4

1993 *Triloculina tricarinata* d'Orbigny; Hottinger *et al.*, p. 65, pl. 68, figs. 7-12

Diagnostic features:

Test is broadly ovate in lateral view and nearly equilaterally triangular in apertural view. Peripheral walls are nearly straight with carinated shoulders. Chambers are gradually increasing in size. Sutures are distinct and slightly depressed. Aperture is subtriangular in shape and bordered by an everted peristomal lip. It is provided by a Y-shaped bifid tooth.

Remarks:

According to Cimerman and Langer (1991), the test surface of *Triloculina tricarinata* is covered by extremely faint, minute, and elongated microstriae, though its surface is seen smooth under the reflected light microscope. Carina is visible at the sutures. The most characteristic feature of this species is its perfect triangular shape of the test.

Triloculina trigonula (Lamarck, 1804)

Pl. 4, fig. 4

1804 *Miliolites trigonula* Lamarck; p. 35, pl. 17, fig. 4

1931 *Triloculina trigonula* (Lamarck); Cushman, p. 56, pl. 12, figs. 10-11, pl. 13, figs. 1-2

1993 *Triloculina trigonula* (Lamarck); Hottinger *et al.*, pl. 69, figs. 1 -10

1993 *Triloculina trigonula* (Lamarck); Sgarrella and Moncharmont-Zei, p. 189, pl. 10, fig. 1

1994 *Triloculina trigonula* (Lamarck); Jones, p. 19, pl. 3, figs. 15-16

Diagnostic features:

Test is ovate in lateral view and rounded triangular in apertural view. Periphery is broadly convex. Chambers are slightly convex and gradually increasing in size. Sutures of this species are depressed. Surface is smooth. Aperture is ovate to subtrapezoidal in shape and provided with a somewhat broad bifid tooth.

Remarks:

The most characteristics features of this species are rounded angles of chamber margins and test shape that is longer than width. In the present study, the figured specimen in pl.3, fig. 8 has longer and slender bifid tooth relative to other individuals recorded in the Gulf of İskenderun.

Subfamily Sigmoilinitinae Luczkowska, 1974

Genus *Sigmoilinita* Seiglie, 1965

Test is flattened and ovate to fusiform in outline. The chambers are one-half coil in length. The arrangement of early chambers is sigmoiline, while later chambers are planispirally coiled. Wall is calcareous, imperforate and porcelaneous. The aperture is at the final chamber and has a weakly developed tooth.

Sigmoilinita costata (Schlumberger, 1983)

Pl. 4, fig. 5

1893 *Sigmoilina costata* Schlumberger, 1983; p. 203, pl. 1, figs. 51, 52

1991 *Sigmoilinita costata* Schlumberger; Cimerman and Langer, p. 47, pl. 45,

figs. 1-6

2004 *Sigmoilinita costata* Meriç *et. al*., p. 107, pl. 16, figs. 3-5

Diagnostic features:

Test is fusiform in lateral view. Chambers are one-half coil in length. The coiling axis changes during ontogeny. Surface is ornamented by numerous longitudinally arranged costae. Aperture is produced on a neck and bordered by a rim. It has a short tooth.

Remarks:

The most characteristic feature of this species is the longitudinally arranged costae on its surface. This species is distinguished from *Spiroloculina corrugata* by its sigmoiline to planispiral chamber arrangement.

Subfamily Sigmoilopsinae Vella, 1957

Genus *Sigmoilopsis* Finlay, 1947

Test of this genus is free and ovate in outline. Chambers are one-half coil in length. Early chambers are coiled as sigmoiline with rapidly changing planes, while chambers become gradually planispiral in adult stage. Wall is thick, porcelaneous but coated by a large quantity of agglutinated quartz particles, sponge spicules, and shell fragments (Loeblich and Tappan, 1988). Aperture is terminal and rounded with a small tooth.

Sigmoilopsis schlumbergeri (Silvestri, 1904)

1904 *Sigmoilina schlumhergeri Silvestri*; p. 267(fide Ellis and Messina, 1940)

1988 *Sigmoilopsis schlumbergeri* (Silvestri); Loeblich and Tappan, p. 350, pl. 356, figs. 8-13

1991 *Sigmoilopsis schlumbergeri* (Silvestri); Cimerman and Langer, p.48, pl. 46,

figs. 10-14

1993 *Sigmoilopsis schlumbergeri* (Silvestri); Sgarrella and Moncharmont-Zei, p.185, pl. 9, fig. 4

2000 *Sigmoilopsis schlumbergeri* (Silvestri); Abu-Zied, pl. 4, figs. 9, 10

Diagnostic features:

Chambers are slightly distinct due to agglutinated coating. 4-5 chambers are visible from the exterior. Aperture is rounded and produced on a short neck.

Remarks:

Sigmoilopsis schlumbergeri can be easily differentiated by having agglutinated coating and having a short neck.

Genus *Articulina* d'Orbigny, 1826

Test is elongate. Early ovoid portion is quinqueloculine or cryptoquinqueloculine that has chambers one-half coil in length. Later portion consists of a few cylindrical and ovoid to pyriform rectilinear chambers. Wall is calcareous, porcelaneous with smooth to longitudinally costate surface. Aperture is terminal, rounded to ovate, bordered by a prominent everted lip.

Articulina alticostata Cushman, 1944

Pl. 4, fig. 6

1944 *Articulina alticostata* Cushman; p. 16, pl. 4, figs. 10-13

1994 *Articulina alticostata* Cushman; Loeblich and Tappan, p. 59, pl. 104, figs. 5-10

2004 *Articulina alticostata* Cushman; Meriç *et al.*, p. 112, pl. 16, fig. 10

Diagnostic features:

Chambers are arranged initially in an indistinct quinqueloculine manner. Chambers become cylindrical, slender and rectilinear in later portion. Wall is ornamented by longitudinally arranged costae. Aperture is rounded and bordered by a highly everted lip.

Articulina carinata Wiesner, 1923

Pl. 4, figs. 7-8

1923 *Articulina sagra* d'Orbigny var. *carinata,* Wiesner; p. 74, pl. 19, fig. 188

1980 *Articulina sagra* d'Orbigny var. *carinata,* Wiesner; Alavi, p. 31, pl. 14, fig. 4

1991 *Articulina carinata* Wiesner, Cimerman and Langer, p. 48, pl. 47, figs. 1-5

2004 *Articulina carinata* Wiesner, Meriç *et al.*, p. 112, pl. 16, figs. 11, 12

Diagnostic features:

Test is much compressed with carinate periphery. Chambers are arranged initially in an indistinct quinqueloculine manner and oval in section. Then, chambers become elongated and later portion is post-horn shaped. Surface is ornamented by longitudinally arranged and nearly parallel costae. Aperture is oval with much thickened and everted lip.

Remarks:

The adult tests from the studied samples in the Gulf of İskenderun generally have only one uncoiled chamber or none of it, similar to the specimens from Adriatic and Tyrrhenian Sea (Cimerman and Langer, 1991).

Articulina mayori Cushman, 1922

Pl. 4, fig. 9

1922 *Articulina mayori* Cushman; p. 71, pl. 13, figs. 5

1931 *Articulina mayori* Cushman; Cushman, p. 52, pl. 12, figs. 5

Diagnostic features:

Chambers are arranged initially in an indistinct quinqueloculine manner and then, chambers elongated, slender, flask shaped to fusiform in later portion. Sutures are depressed. Surface of test is faintly striate. Aperture is rounded with not everted lip.

Remarks:

Articulina mayori is clearly distinguished from *A. alticostata* by its chamber shape of later portion, depressed sutures and weak surface ornamentation.

Genus *Parrina* Cushman, 1931

Test of this genus is elongate. In the early stage, the chambers are ovoid and one-half coil in length and the chamber arrangement is quinqueloculine. It is followed by irregular uncoiled chambers in the later stage. Wall is calcareous, porcelaneous and imperforate. Aperture is terminal with one or more openings. It is bordered by a thickened lip and produced on a short neck.

Parrina bradyi (Millett, 1898)

Pl. 4, fig. 10-11

1898 *Nubecularia bradyi* Millett; p. 261, pl. 5, figs. 6 a, b (fide Ellis and Messina, 1940)

1988 *Parrina bradyi* (Millett); Loeblich and Tappan, p. 351, pl. 358, figs. 16-18

1991 *Parrina bradyi* (Millett); Cimerman and Langer, p. 49, pl. 47, figs. 6-7

2004 *Parrina bradyi* (Millett); Meriç *et al.*, p. 111, pl. 16, figs. 13-15

Diagnostic features:

Test is subrounded or irregular in the adult stage. Peripheral margins are broadly rounded. Chambers are inflated and broadest at the base and narrowing toward the aperture. Chambers is planispirally coiled but also irregularly quinqueloculine or irregularly coiled. Wall of this species is smooth. Aperture has 1-3 irregular, slitlike or ovate openings.

Remarks:

Generally, three chambers are visible from exterior and test appears as two joined balls in different size. This species resembles to *Miliolinella labiosa* under the reflected light microscope, except by having aperture on neck.

Superfamily Soritacea (Ehrenberg, 1839)

Family Peneroplidae (Schultze, 1854)

Genus *Peneroplis* de monfort, 1808

Test is compressed with planispirally coiled and involute in early stage. Later chambers are rapidly increased in breadth and strongly arched. This is formed by nearly constant height and it becomes a flaring test. Sutures are slightly depressed. Wall is calcareous, porcelaneous, perforate in juvenile stage, imperforate in adult. Surface is ornamented by numerous striae or grooves alternating with fine ribs aligned parallel to test periphery. There are commonly fine pseudopores in the grooves between surface ribs. In adult, aperture consists of a linear or alternating series of large, circular to oval or irregular pores that are bordered by a distinct elevated lip.

Peneroplis arietinus (Batsch 1791)

1791 *Nautilus (Lituus) arietinus* Batsch; p. 3, pl. VI, figs. 15d-f

1988 *Coscinospira hemprichii* Ehrenberg; Loeblich and Tappan; p. 369, pl. 390, figs. 7-10

1988 *Peneroplis arietinus* (Batsch); Loeblich and Tappan, p.371, pl. 391, figs. 11, 12

1991 *Coscinospira hemprichii* Ehrenberg; Cimerman and Langer, p. 49, pl. 47, figs. 8-11

1993 *Coscinospira hemprichii* Ehrenberg; Hottinger *et al.* , p. 69, pl. 76, figs. 1-12, pl. 77, figs. 1-8

1994 *Peneroplis arietinus* (Batsch); Gudmundsson, p. 113, text-figs. 21, 22, plate 2, fig. 3, plate 3, fig. 2

2000 *Coscinospira hemprichii* Ehrenberg; Basso and Spezzaferri, p. 375, pl. 1, fig. 1

Diagnostic features:

Test is large and nautiloid to crosier-shaped. Chambers are slightly inflated. Early chambers are planispirally coiled with a shallow umbilical depression, while later ones are uncoiled up to 8 rectilinearly arranged chambers. Sutures are depressed and radial in the planispiral stage, whereas they are horizontal in the rectilinear stage. Surface is covered by longitudinally arranged, strong and acute ribs. There is the umbilical depression in both sides of the test. During the ontogeny of this species, the aperture of the species show a continuous change through a single circular aperture, and then crescentic or Y-shaped or X-shaped to multiple and dendritic apertures, and finally circularly arranged apertures in the rectilinear chambers.

Remarks:

There are 16 apertures at most on a single chamber. Some specimens had one, two, or all three of crescentic, Y-shaped or X-shaped apertural types. Multiple and dendritic apertures are always bordered with lips but rarely with protruding teeth. Ornamentation is discontinuous, often irregularly alternating in position from one chamber to the following one (Gudmundsson, 1994).

During the ontogeny of *Peneroplis arietinus*, its different stages with different characteristic features cause to misinterpretation of this species. According to some authors such as Loeblich and Tappan (1988), Cimerman and Langer (1991), Hottinger *et al, (*1993), Basso and Spezzaferri (2000) individuals having uniserial part are called as *Coscinospira hemprichii*. There is no need to proliferation of taxa.

The most characteristic feature of *Peneroplis arietinus* is the thick wall with extremely dense ornamentation and white, opaque appearance under a reflected light microscope.

The specimens from the samples of the Gulf of İskenderun are generally characterized by lack of the rectilinear part of this species.

Peneroplis pertusus (Forskal, 1775)

Pl. 4, fig. 10, pl. 5, figs. 1-3, pl. 11, fig. 8

1775 *Nautilus pertusus* Forskal, p. 125 (fide Ellis and Messina, 1940)

1988 *Peneroplis pertusus* (Forskal); Loeblich and Tappan, p. 371, pl. 391, figs. 7-8

1991 *Peneroplis pertusus* (Forskal); Cimerman and Langer, p. 49, pl. 49, figs. 1-8

2002 *Peneroplis pertusus* (Forskal); Hyams *et al.*, p. 174, pl. 1, fig. 12.

Diagnostic features:

Test has umbilical depressions on the both sides with weakly rounded periphery. Size of the chambers is only weakly increased in height in the adult. Surface is ornamented by parallel-aligned grooves and ribs.

Remarks:

According to Leutenegger (1984), *Peneroplis pertusus* has rhodophycean symbionts so it is found mostly between 0 - 20 m owing to light requirement. The living specimens are generally found as epiphytes on different types of substrates, if there is a vegetation cover. In sciaphile environements, *Peneroplis pertusus* is lacking.

Aperture of *Peneroplis pertusus* is similar to that of *Peneroplis arietinus,* except at late stage. *Peneroplis arietinus* has circularly arranged apertures, while *P. pertusus* has irregularly arranged extremely dendritic apertures in the rectilinear stage. Ornamentation of *P. pertusus* may be confused with that of *P. arietinus.* However, the striations are shallow and the distance between two parallel striations are about equal to the width of one striation in *P. pertusus,* while the striations are deep and the distance between two parallel striations is more closely spaced in *P. arietinus*. *P. pertusus* is differentiated from *P. arietinus* by glassy and semi-translucent appearance under a reflected light microscope, as *P. arietinus* appears opaque and white.

Peneroplis planatus (Fichtel and Moll 1798)
pl. 5, figs. 4-5, pl. 11, fig. 9

1798 *Naatilus planatus* Fichtel and Moll; p. 91-94, pl. 16, figs. a-h
1988 *Peneroplis planatus* (Fichtel and Moll); Loeblich and Tappan, p. 371, pl. 391, figs. 7-8
1991 *Peneroplis planatus* (Fichtel and Moll); Cimerman and Langer, p. 50, pl. 50, figs. 1-6
1993 *Peneroplis planatus* (Fichtel and Moll); Sgarrella and Moncharmont-Zei, p. 190, pl. 10, fig. 14
1993 *Peneroplis planatus* (Fichtel and Moll); Hottinger *et al.*, p. 70, pl. 79, figs 1-16, pl. 80, figs. 1-4
2002 *Peneroplis planatus* (Fichtel and Moll); Hyams *et al.*, p. 174, pl. 1, fig. 13

Diagnostic features:

After 6 to 15 involute planispiral chambers, later ones become evolute and flaring. In the final stage, chambers loose the contact with the periphery of previous whorl and there are up to 17 rectilinear chambers. Surface is ornamented by parallel-aligned ribs and grooves. During the ontogeny of this species, aperture changes from single circular aperture to crescentic, X or Y-shaped and finally multiple and usually dendritic apertures appeared either forming double or single apertural rows.

Remarks:

Peneroplis planatus is differentiated from *Peneroplis pertusus* by its relatively more flattened test. Adult specimens of *P. planatus* have single to triple pit-rows, whereas *P. pertusus* always has three or more pit-rows.

There are microsphric specimens, as the specimen is in the plate 5 figure 5, test of that are appear as a pipe.

Family SORITIDAE Ehrenberg, 1839

Genus *Amphisorus* Ehrenberg, 1839

Test is large, discoidal, and biconcave with thickened rims. Proloculus is followed by flexostyle large secondary chamber. Later chambers are cyclic that has early stage with about six undivided chambers and up to ten additional spiral chambers and then become annular. Wall is calcareous, imperforate and porcelaneous. Aperture is consisting of numerous pores on the peripheral margin. According to Loeblich and Tappan (1988), in the megalospheric test, there are additional supplementary openings in the median plane, while microspheric test may have more elongate and more irregular openings.

Amphisorus hemprichii Ehrenberg, 1840

1840 *Amphisorus hemprichii* Ehrenberg; p. 130

1988 *Amphisorus hemprichii* Ehrenberg; Loeblich and Tappan, p. 380, pl. 417, figs. 1-8

1993 *Amphisorus hemprichii* Ehrenberg; Hottinger *et al.*, p. 71, pl. 81, figs. 1-8, pl. 82, figs. 1-11

1994 *Amphisorus hemprichii* Ehrenberg; Gudmundsson, text-figs. 39-44

Diagnostic features:

Test is circular, biplanar to slightly biconcave. Size of test is large. Chambers in the first 2-4 whorl is cyclic, and then it grows concentric with irregular structure in last chambers. Aperture is elongated across the margin. It is aligned as a single row in earliest growth stage, while it has two alternating rows in later stages.

Remarks:

This species is Indo-Pasific origin and probably a Lessepsian migrant (Langer and Hottinger, 2000; Hyams *et al*., 2002; Meriç *et al*., 2006). It occurs in a great numbers as epiphytes attached to Posidonia leaves in shallow waters (Cushman, 1939).

Genus *Sorites* Ehrenberg, 1839

Test is discoidal with planispiral early stages followed by annular chambers. Wall is calcareous, imperforate and porcelaneous. Aperture of this species is a single row of openings along the periphery.

Sorites orbiculus Ehrenberg, 1839

Pl. 11, fig. 10

1839 *Sorites orbiculus* Ehrenberg; p. 134

1988 *Sorites orbiculus* Ehrenberg; Loeblich and Tappan, p. 382, pl. 419, figs. 4-10

1991 *Sorites orbiculus* Ehrenberg; Cimerman and Langer, p. 50, pl. 51, figs. 1-5

1994 *Sorites orbiculus* Ehrenberg; Loeblich and Tappan, p. 349, pl. 112, figs. 6-8

Diagnostic features:

Test is relatively large and the size of the individuals is up to 2 mm in the Mediterranean Sea (Cimerman and Langer, 1991). It is discoidal and biplanar with slightly thickened margins. Proloculus is followed by an undivided, nearly completely embracing second chamber. Later chambers are cyclical and generally arranged in annular series. Chambers are symmetrical in respect to the equatorial plane. Apertures are multiple and located at the peripheral margin. They are circular to 8-shaped and bordered by a thickened peristomal rim.

Remarks:

The living specimens from the Tyrrhenian Sea are recorded as epiphytes on sea grases like *Posidonia oceanica* and *Sargassum hornschuchii* (Cimerman and Langer, 1991).

Sorites orbiculus is differentiated from *Amphisorus hemprichii* by having smaller tests and its apertures. *Amphisorus hemprichii* has two rows of multiple apertures in the adult, while apertures of *Sorites orbiculus* are aligned as a single row.

SUBORDER **LAGENINA** (Delage and Herouard, 1896)

Superfamily **Nodosariacea** (Ehrenberg, 1838)

Family Nodosariidae (Ehrenberg, 1838)

Subfamily Nodosariinae (Ehrenberg, 1838)

Genus *Dentalina* Risso, 1826

Test is elongate, arcuate and uniserial. Proloculus is apiculate. Chambers are cylindrical to ovate. Wall is calcareous and hyaline. Surface is ornamented by numerous longitudinal costae. Aperture is terminal and radiate.

Dentalina subsoluta (Cushman, 1923)

Pl. 5, fig. 6

1923 *Nodosaria subsoluta* Cushman; p. 74, pl. 13, fig. 1

1994 *Dentalina subsoluta* (Cushman, 1923); Jones, p. 73, pl. 62, figs. 13-16

2004 *Nodosaria subsoluta* Cushman; Eiland and Gudmundsson, p. 8, pl. 1, figs. F, M; Pl. 2, fig. D

Diagnostic features:

Test is robust, straight or arcuate. Chambers are globular and inflated, a little higher than wide. The base of chambers is pointed. The number of chambers is up to 7. Aperture is terminal.

Remarks:

This species is differentiated from *Laevidentalina inflexa* by having more globular chambers and lack of neck.

Genus *Laevidentalina* Loeblich and Tappan 1986

Test is more or less arcuate. Chambers are cylindrical, elongate, moderately embracing and may be apiculate. Sutures may by slightly constricted, horizontal or oblique. Surface is smooth. Wall is calcareous and hyaline. Aperture is terminal.

This genus is differentiated from genus *Dentalina,* which has ornamented surface, by its smooth surface.

Laevidentalina aphelis Loeblich and Tappan 1986

1986 *Laevidentalina aphelis* Loeblich and Tappan; p. 242

1988 *Laevidentalina aphelis* Loeblich and Tappan; p. 396, pl. 439, figs. 22-24

1994 *Dentalina aphelis* (Loeblich and Tappan); Jones, p. 74, pl. 62, figs. 21-22

2000 *Dentalina aphelis* Loeblich and Tappan; Sakinç, p. 84

Diagnostic features:

Test of this species is rectilinear to arcuate. Chambers are cylindrical and size of the chambers gradually increases. Sutures are oblique. Aperture is terminal.

Remarks:

The most characteristic feature of this species is oblique sutures and cylindrical chamber shape.

Laevidentalina inflexa (Reuss, 1866)

1866 *Nodosaria inflexa* Reuss; p. 131, pl. 2, fig. 1

1991 *Dentalina inflexa* (Reuss); Cimerman and Langer, p. 51, pl. 52, figs. 4-6

Diagnostic features:

Test of this species is rectilinear. Chambers are elongated and flask shaped. The height of chambers is longer than width. Surface is smooth. Aperture is produced on a neck.

Remarks:

Its flask shaped chambers are characteristics fro this species. Although, this species refer to *Dentalina* by Cimerman and Langer (1991), surface of this species is not ornamented as genus *Dentalina*. Therefore, this species is named under genus *Laevidentalina*.

Genus *Nodosaria* Lamark, 1812

Test is elongate. The chamber arrangement is uniserial and there are rectilinear and globular to ovate chambers. Wall is calcareous, perforated and hyaline. Aperture is terminal, radiate or rounded and produced on a neck.

Nodosaria subpervesa Cushman, 1917

1917 *Nodosaria subpervesa* Cushman, p. 655, no: 3

Diagnostic features:

Test is subcylindrical. Proloculus is larger than succeeding chambers. All chambers are close to each other. Width of chambers is greater than length. Sutures are deeply constricted. Wall is ornamented by longitudinally arranged fine striations. Aperture is rounded without a neck.

Remarks:

Nodosaria subpervesa is differentiated from *Dentalina subsoluta* by having striations on its surface and its chamber shape that is oval.

According to Ellis and Messina (1940), this species is Pacific originated. Therefore, it may be a lessepsian migrant, which is migrated from the Red Sea via the Suez Canal.

Family Vaginulinidae (Reuss, 1860)

Subfamily Marginulininae Wedekind, 1937

Genus *Amphicoryna* Schlumberger, 1881

Test is free and elongate with commonly apiculate base. In the microspheric generation, early compressed chambers are astacoline coiled and later uncoiled with uniserial and rectilinear chambers of circular transverse section. In the megalospheric generation, there is large globular proloculus that is followed by rectilinear globular chambers. Sutures are flush and oblique in the astacoline coil, straight and constricted in the rectilinear portion. Wall is calcareous, perforate and optically radial. Surface is commonly ornamented by longitudinally striate or with fine costae broken up into rows of small pustules. Aperture is central, terminal and radiate at the end of a pronounced neck with ringlike concentric ridges.

Amphicoryna scalaris (Batsch, 1791)

Pl. 5 fig. 7

1791 *Nautilus (Orthoceras) scalaris* Batsch; p. 91, pl. 2, fig. 4

1980 *Amphicoryna scalaris* (Batsch); Boltovskoy *et al.*, p. 15; pl. 1, figs. 10-12

1988 *Amphicoryna scalaris* (Batsch); Loeblich and Tappan, p. 410, pl. 450, figs. 11-14

1991 *Amphicoryna scalaris* (Batsch); Cimerman and Langer, p. 52, pl. 54, figs. 1-9

1993 *Amphicoryna scalaris* (Batsch); Sgarrella and Moncharmont-Zei, p. 191, pl. 11, figs. 2-3

2004 *Amphicoryna scalaris* (Batsch); Meriç *et al.*, p. 110, pl. 1, figs. 1-13, p. 112, pl. 2, figs. 1-10, p. 114, pl. 3, figs. 1-11

Diagnostic features:

Test has globose chambers with straight, depressed and distinctive sutures. Wall is translucent, shiny and finely perforate. Surface is covered by longitudinal costae, which disappear at the base of long neck. Its neck is surrounded transversely by several ring-like concentric ridges. Aperture is circular. It is bordered by a lip and surrounded by teeth.

Remarks:

All specimens from the studied samples of the Gulf of İskenderun are macrospheric individuals of the *A. scalaris* with four chambers and apiculate spine at the base. Microspheric individual, which has dagger like extention at the base, is not recorded in any location. Furthermore, Meriç *et al.* (2004) emphasized that the microspheric individuals are rare in the Eastern Aegean Sea, as is around the Corsica Island, Gulf of Naples and Adriatic Sea.

Family Lagenidae Reuss, 1862

Genus *Lagena* Walker and Jacob, 1798

Test is unilocular, spherical and ovoid or fusiform. Wall is calcareous and perforate. Surface is smooth or commonly ornamented by costae, pustules or reticulation. Aperture is simple, rounded and produced on a elongate neck. It is bordered by phialine lip.

Lagena striata (d'Orbigny, 1839)

1839 *Lagena striata* d'Orbigny; p. 21, pl. 5, fig. 12

1980 *Lagena striata* (d'Orbigny); Jones, p. 37, pl. 20, figs. 11-14

1991 *Lagena striata* (d'Orbigny); Cimerman and Langer, p. 53, pl. 55, figs. 6-7

1993 *Lagena striata* (d'Orbigny); Sgarrella and Moncharmont-Zei, p. 198, pl. 12, figs. 2-3

2000 *Lagena striata* (d'Orbigny); Sakinç, p. 97, fig. 69

2002 *Lagena striata* (d'Orbigny); Kaminski *et al.*, p. 27, pl. 2, fig. 4

2004 *Lagena striata* (d'Orbigny); Meriç *et al.*, p. 129, pl. 20, figs. 1-2

Diagnostic features:

Test is rarely ovate and semicircular in outline. Wall is ornamented by fine costae, which is cover whole test. Aperture is small and rounded. Neck is ornamented in polygonal patterns.

Lagena strumosa Reuss, 1858

Pl. 5, fig. 8

1858 *Lagena strumosa* Reuss; p. 434

1993 *Lagena strumosa* Reuss; Hottinger *et al.*, p. 79, pl. 90, figs. 18-25

Diagnostic features:

Test is ovoid in shape and apiculate. Test is covered by fine longitudinal striae. Aperture is bordered by a thick lip.

Remarks:

Lagena strumosa is differentiated from *Lagena striata* by having spinose projection in the basal end.

Family Polymorphinidae d'Orbigny, 1839

Genus *Globulina* d'Orbigny, 1839

Test is globular to ovate in shape. Early chambers are added in five planes, while later ones are added in three planes. Sutures are oblique and flush to slightly depressed. Wall is calcareous, translucent and perforate. Surface is smooth or rarely spinose to striate. Aperture is terminal and obscured by fistulose growth.

Globulina minuta (Romer, 1838)

Pl. 5, fig. 9

1838 *Polymorphina minuta* Romer; p. 386, pl. 3, fig. 35

1994 *Globulina minuta* (Romer); Jones, p. 83, pl. 71, fig. 16
2000 *Globulina minuta* (Romer); Sakınç, p. 98

Diagnostic features:

Test is globular. Chambers are strongly overlapping. Surface is smooth. Aperture is terminal, radiated and obscured by fistulose growth.

Genus *Glandulina* d'Orbigny, 1839

Test is elongate and ovate. Chambers increase rapidly in size. Early chambers are biserial, while later chambers are rectilinear and uniserial. Sutures are distinct and flush. Wall is calcareous and hyaline. Surface is smooth and ornamented by finely striae. Aperture is terminal.

Glandulina sp. A

Pl. 5, fig. 10

Diagnostic features:

Test is pyriform to fusiform, tapering at each end. Length of test is longer than width. Chambers are strongly overlapping the previous chambers. Wall is polished and opaque excluding the aperture. Aperture is radiate.

Remarks:

The last chamber of this species is extremely larger than preceding ones. The uniserial part of the test is consisting of only two chambers. The sutures in the uniserial part are straight.

Family Ellisolagenidae

Genus *Oolina* d'Orbigny, 1839

Test is unilocular and globular to ovate. Wall is calcareous and hyaline. Surface is smooth. Aperture is consisting of radiating slits.

Oolina hexagona (Williamson, 1848)

Pl. 5, fig. 11

1848 *Entosolenia squammosa* var. *hexagona* Williamson, p. 20, pl. 2, fig. 23

1980 *Oolina hexagona* (Williamson); Boltovskoy *et al.,* p. 41, pl. 23, figs. 15-17

1991 *Favulina hexagona* (Williamson); Cimerman and Langer, p. 55, pl. 58, figures 8-9

1993 *Oolina hexagona* (Williamson); Sgarrella and Moncharmont-Zei, p. 199, pl. 12, fig. 15

2000 *Favulina hexagona* (Williamson); Sakınç, p.99, fig. 70

Diagnostic features:

Test of this species is globular to egg-shaped and ovate in outline. There is a small boss at the base. Wall is opaque and ornamented by hexagonal reticulate pattern. Aperture is small and circular. It is bordered by a lip and produced on a very small neck.

Remarks:

The most characteristic feature of this species is hexagonal ornamentation in its surface.

Genus *Fissurina* Reuss, 1880

Test is bilaterally symmetrical, rounded to ovate. Periphery has one or more keels. Wall is calcareous, finely perforate and hyaline. Surface is smooth. Aperture is terminal, ovate to slitlike.

Fissurina neptunii (Buncner, 1940)

1940 *Lagena neptunii* Buncner; p.503, pl. 19, figs. 405-406

1993 *Fissurina neptunii* (Buncner); Sgarrella and Moncharmont-Zei, p. 202, pl. 13, fig. 6

Diagnostic features:

Test is ovate and elongated with keeled peripheral margin. Basal part of the test is ornamented by short spines. Aperture is slitlike.

Fissurina alveolata (Brady, 1884)

1884 *Lagena alveolata* Brady; p. 487, pl. 60, figs. 30, 32

1993 *Fissurina alveolata* (Brady); Boltovskoy and Watanabe, pl. 1, figs. 1-2, pl. 5, fig. 1

Diagnostic features:

Test is compressed, ovate in shape and lenticular in side view. Surface is smooth. Periphery is acute. Aperture is terminal and slitlike.

Remarks:

Fissurina alveolata is differentiated from *Fissurina lucida* by absence of horseshoe-shaped white band in aboral margin of the test.

Fissurina lucida (Williamson, 1848)

1848 *Entosolenia marginata* var. *lucida* Williamson; p. 17, pl. 2, fig. 17

1971 *Fissurina lucida* (Williamson); Murray, p. 97, pl. 39, figs. 1-3

1980 *Fissurina lucida* (Williamson); Boltovskoy *et al.*, p. 32, pl. 15, figs. 17-20

Diagnostic features:

Test is compressed, elongate and somewhat pyriform. Peripheral margin is rounded and it has flattened sides. Wall is shiny excluding the opaque horseshoe-shaped white band, which is in aboral margin of the test. Aperture narrow and long.

Remarks:

Its horseshoe-shaped band is more coarsely perforated than remaining part of the test.

Fissurina orbignyana (Seguenza, 1862)

1862 *Lagena orbignyana* Seguenza; p. 66, pl. 2, figs. 19-20

1971 *Fissurina orbignyana* Seguenza; Murray, p. 99, pl. 40, figs. 1-5

1991 *Palliolatella orbignyana* Seguenza; Cimerman and Langer, p. 56, pl. 59, figs. 5-7

1993 *Fissurina orbignyana* Seguenza; Sgarrella and Moncharmont-Zei, p. 204, pl. 13, figs. 2-3

Diagnostic features:

Test is small, flasklike and lenticular. Peripheral margin has 3 strong keels. Surface is irregularly pitted. The wall is finely perforated. Aperture is lenticular opening and produced on a short neck it is bordered by thickened and phialine rim.

Remarks:

The most characteristic features of this species are keels on the peripheral margin and entosolonian tube the internal of the wall.

Genus *Lamarkina* Berthelin, 1881

Test is planoconvex or inequally biconvex. The chamber arrangement is low trochospiral. Chambers are rapidly increased in size. The final chamber is strongly overlapping. Sutures are radial. Periphery is subacute to carinate. Wall is calcareous, aragonitic, and finely perforated. Surface is smooth on the umbilical side, while it may be ornamented by pustules in the spiral side. Aperture is interiomarginal and closed by a thin plate in the umbilical side.

Lamarkiana scabra (Brady, 1884)

Pl. 5, fig. 12

1884 *Pulvinulina scabra* Brady; p. 689, pl. 106, fig. 8

1994 *Lamarkiana scabra* (Brady); Sgarrella and Moncharmont-Zei, p. 242, pl. 26, figs. 3-4

Diagnostic features:

Test is flattened, elongate and subcircular to elliptical. Periphey is lobulate with carina. Sutures are depressed on the umbilical side, while they are limbate in the spiral side. Aperture is large and bordered by a rim.

Remarks:

The most characteristic feature of this species is its more flattened and elongated test compared to other species of genus *Lamarkina.*

Genus *Robertinoides* Höglund, 1947

The chamber arrangement is high trochospiral. Chambers are inflated. Sutures are oblique and depressed. Wall is aragonitic, hyaline and finely perforated. Surface is smooth. Aperture comprises two slitlike openings.

Robertinoides sp.A

Pl. 5, fig. 13

Diagnostic features:

Test is elongated. The initial end is bluntly pointed, whereas apertural end is broadly rounded. Chambers increase rapidly in size. Wall is translucent. One of the apertures is interiomarginal and located at the proximal margin of the chamber. The other aperture is diverging from chamber margin and directed up the apertural face.

Suborder Rotaliina Delage and Hérouard, 1896

Superfamilly Bolivinacea Glaessner, 1937

Family Bolivinidae Glaessner, 1937

Genus *Brizalina* Costa, 1856

Test is elongate, lanceolate, compressed and biserial with acute to carinate periphery. Chambers are broad and low with oblique sutures. Wall is calcareous, hyaline, optically radial and finely perforate. It may be basally apiculate. Surface is smooth or may have low and narrow imperforate longitudinal costae on the early half of the test. Aperture is a basal loop, which extends up the apertural face with bordering lip and internal tooth plate.

Brizalina earlandi (Parr, 1950)

1950 *Bolivina earlandi* Parr; pl. 12, fig. 16

1991 *Brizalina earlandi* (Parr); Cimerman and Langer, pl. 62, figs. 11-13

1994 *Brizalina earlandi* (Parr); Jones, p. 57, pl. 52, figs. 18-19

Diagnostic features:

Test is long, slender and ovate in apertural view. Periphery is subrounded. Size of chambers increases very slowly. There are up to 22 chambers in adult specimens. Sutures are slightly depressed and oblique. Wall of this species is densely perforated. Aperture is elongate, interiomarginal loop and perpendicular to the basal suture with weak peristomal rim on one side.

Remarks:

The long and slender shape of test is very significant morphological features of this species.

Brizalina spathulata (Williamson, 1858)

1858 *Textularia variabilis* Williamson var. *spathulata* Williamson; p. 76, pl. 6, figs 164, 165

1988 *Bolivina spathulata* (Williamson); Jorissen, p. 21, pl. 1, fig. 10

1971 *Brizalina spathulata* (Williamson); Murray, p. 111, pl. 45, figs 1-4

1991 *Brizalina spathulata* (Williamson); Cimerman and Langer, p. 60, pl. 62, figs. 3-5

1993 *Bolivina spathulata* (Williamson); Sgarrella and Moncharmont-Zei, p. 210, pl. 14, fig. 3

1994 *Brizalina spathulata* (Williamson); Jones, p. 57, pl. 52, figs. 20-21

1995 *Brizalina spathulata* (Williamson); Meriç, p. 139, pl. 7, fig. 1

2000 *Brizalina spathulata* (Williamson); Sakınç, p. 105, fig. 76

Diagnostic features:

Test is broad, elongated triangular-shaped in lateral view and lenticular in apertural view with acute periphery. Chambers are up to 32 in the adult stage. Sutures are weakly depressed forming an angle of about 35° with the horizontal and curved backwards. Wall is densely perforated at the outer chamber margin and near the sutures. Surface of its test is ornamented by several, weakly developed longitudinal striae in the lower part of the shell. Aperture is elongated, interiomarginal loop, and perpendicular to the basal suture bordered by a rim.

Remarks:

It is easily distinguished from other species by having triangular shape. Its ornamentation is nearly invisible.

Brizalina striatula (Cushman, 1922)

Pl. 5, fig. 14

1922 *Bolivina striatula* Cushman; p. 27, pl. 3, fig. 10

1991 *Brizalina striatula* (Cushman); Cimerman and Langer, p.60, pl. 62, figs. 6-9

1993 *Bolivina striatula* Cushman; Sgarrella and Moncharmont-Zei, p. 210, pl. 14, fig. 16

Diagnostic features:

Test is gradually tapering from somewhat rounded initial part to broad apertural end. Periphery of this species is subrounded to acutely angle. There are 16-21 chambers in the adult stage. Sutures are weakly depressed and oblique. Wall is densely perforated. Surface is ornamented by several, longitudinal and imperforate costae, extending over the initial two-thirds of the test, final chambers smooth, hardly punctuate. Aperture is elongated, interiomarginal loop, and perpendicular to the basal suture bordered by a rim.

Remarks:

The aperture of *Brizalina striatula* is similar to the aperture of *Brizalina spathulata*. Costate over initial part is the most important feature of this species.

Superdamily Cassidulinacea d'Orbigny, 1839

Family Cassidulinidae d'Orbigny, 1839

Subfamily Cassidulininae d'Orbigny, 1839

Genus *Cassidulina* d'Orbigny, 1826

Test is lenticular to flattened and ovoid with subangular to carinate periphery. Chambers are biserially enrolled, commonly with umbonal boss of clear calcite. Sutures are radial to oblique, straight to curved and flush. Wall is calcareous, hyaline, optically granular, and perforate with smooth and polished surface. Aperture is a narrow arched slit at the base of the apertural face and parallel to the peripheral margin. Apertural plate closes partially the aperture without internal toothplate.

Cassidulina carinata Silvestri, 1896

Pl. 5, fig. 15

1896 *Cassidulina laevigata* d'Orbigny var. *carinata* Silvestri; p. 104, pl. 2, fig. 10

1967 *Cassidulina carinata* Silvestri; Eade, p. 429, pl. 2, figs. 5-9

1971 *Cassidulina carinata* Silvestri; Murray, p. 187, pl. 78, figs. 1-5

1993 *Paracassudilina neocarinata* (Thalmann, 1950); Hottinger *et al.*, p. 95, pl. 116, figs. 1-7.

1993 *Cassidulina carinata* Silvestri; Sgarrella and Moncharmont-Zei, p. 236, pl. 23, figs. 8-9

1994 *Cassidulina laevigata* d'Orbigny var. *carinata* Silvestri; Jones, p. 60, pl. 54, figs. 2-3

1994 *Cassidulina carinata* Silvestri; Loeblich and Tappan, p. 114, pl. 220, figs. 7-12

1995 *Cassidulina carinata* Silvestri; Meriç *et al.*, p. 109, pl. 7, fig. 2

2000 *Cassidulina carinata* Silvestri; Abu-Zied, pl. 6, figs. 1-2

2000 *Cassidulina carinata* Silvestri; Sakınç, p. 106, fig. 78

Diagnostic features:

Test is subcircular in side view and flat to lenticular in edge view. Periphery is carinated and acute angled. Chambers are involute with four pairs in outer whorl. Sutures are weakly depressed on the apertural side, while it is flush on the opposite side. Wall is densely perforated except sutures and carinate margin. Aperture is covered by a weakly perforated apertural plate.

Remarks:

Cassudilina carinata is different from *Cassudilina laevigata* by having definite peripheral keel and four pairs of chambers in the final whorl. *Cassudilina laevigata*, which is not recorded in this study, has five pairs of chambers per whorl.

According to Eade (1967) and Jones (1994), replacement name of *Cassidulina laevigata* d'Orbigny var. *carinata,* Cushman, 1922, which is *Cassudilina neocarinata* Thalmann, 1950, is unnecessary. Because, *Cassidulina laevigata* d'Orbigny var. *carinata* Silvestri, 1896 and *Cassidulina laevigata* d'Orbigny var. *carinata* Cushman, 1922 are homonymous and synonymous. Therefore, *Paracassudilina neocarinata* (Thalmann, 1950) is also synonymous. There is no need to proliferation of taxa even at the generic level.

Genus *Globocassidulina* Voloshinova, 1960

Test is globular to lenticular with rounded to acute or rarely carinate periphery and it has zigzag suture along the periphery. Chambers are biserially enrolled with slightly depressed and radial to oblique sutures. Wall is calcareous, optically granular, and perforate with smooth and polished surface. Aperture is oval, slit like or curved, and it is extending up the apertural face at an angle to the base. Apertural toothplate and crested tooth are also present.

Globular and non-keeled test are the characteristic features of *Globocassidulina. Globocassidulina,* like *Cassidulina,* usually has tightly arranged chambers. However, later chambers of *Globocassidulina* may have a tendency to become uncoiled that gives elongate tests shape (Eade, 1967).

Globocassidulina subglobosa (Brady, 1884)

Pl. 6, fig. 1

1884 *Cassidulina subglobosa* Brady; p. 430, pl. 54, fig. 17

1979 *Globocassidulina subglobosa* (Brady); Hayward and Buzas, p. 59, pl. 17, figs. 219-220

1980 *Cassidulina subglobosa* Brady; Boltovskoy *et al.*, p.23, pl. 7, figs. 18-20

1988 *Globocassidulina subglobosa* (Brady); Loeblich and Tappan, p. 505, pl. 557, figs. 18-23

1991 *Globocassidulina subglobosa* (Brady); Cimerman and Langer, p. 61, pl. 63, figs. 4-6

1994 *Globocassidulina subglobosa* (Brady); Jones, p. 60, pl. 54, fig. 17

Diagnostic features:

Test is globular to ovate with broadly rounded periphery. Chambers are strongly inflated with four pair in final whorl. Wall is very finely perforated. Aperture is subelliptical and partially bordered by a thickened and hook-shaped rim.

Remarks:

Globular to ovate shape of test and shiny appearance under the reflected light microscope are the most characteristic features of this species. It is difficult to observe the sutures of *Globocassidulina subglobosa*. However, when the test is wet, sutures of this species appear as curved lines.

Globocassidulina subglobosa (Brady) var. *producta* Chapman and Parr, 1937

Pl. 6, fig. 2

1937 *Globocassidulina subglobosa* (Brady) var. *producta* Chapman and Parr; p. 82, pl. 2, fig. 12.

Remarks:

This variety differs from the type species by bluntly rounded apex at the final parts of the test. The last few chambers have stronger tendency to become uncoiled and inner margins does not reach the periphery of the last chambers.

Genus *Rectuvigerina* Mathews, 1945

Test is elongated and rounded. Early chambers are triserial and they are followed by rarely biserially-coiled chambers and finally uniserial chambers. Wall is calcerous and perforated. Surface is ornamnented by longitudinally arranged costae. Aperture is rounded and terminal with toothplate.

Rectuvigerina phlegeri Le Calvez, 1959

Pl. 6, fig. 3

1959 *Rectuvigerina phlegeri* Le Calvez; p. 363, pl. 1, fig. 11

1993 *Rectuvigerina phlegeri* Le Calvez; Sgarrella and Moncharmont-Zei, p. 215, pl. 16, figs. 3-4

2000 *Rectuvigerina phlegeri* Le Calvez; Sakınç, p. 109, fig. 80

Diagnostic features:

Test is elongated and slender with subrounded periphery. Sutures are depressed. Aperture is partially bordered by a rim and produced on a neck.

Remarks:

Rectuvigerina phlegeri is differentiated from *Uvigerina perregrina* by having more longer test and by having uniserial part.

Family Buliminidae Jones, 1875

Genus *Bulimina* d'Orbigny, 1826

Test is elongate, ovate to subcylindrical with triserial coiling. However, later chambers may be nearly centered as if tending to become uniserial. Suture is distinct and depressed. Wall is calcareous, finely to coarsely perforate and optically radial. Surface is smooth but it may be carinate, fimbriate, or spinose in lower margin of chambers. Aperture is a loop extending up the face from the base of the last chamber with elevated rim, and an internal folded toothplate.

Bulimina aculeata d'Orbigny, 1826

1826 *Bulimina aculeata* d'Orbigny; p. 269, no:7

1991 *Bulimina aculeata* d'Orbigny; Cimerman and Langer, p. 61, pl. 63, figs. 10

Diagnostic features:

Test is small and tapering towards to aboral part. Chambers are inflated and rapidly increasing in size. Sutures are oblique and depressed. The lower part of the test is ornamented by several long pseudospines. Aperture is a typical buliminid loop.

Remarks:

The most characteristic feature of this species is its long pseudospines, which is located in the basal part of the test.

Bulimina elongata D'Orbigny, 1846

Pl. 6, fig. 4

1846 *Bulimina elongata* D'Orbigny; p. 187, pl. 11, figs. 19, 20

1947 *Bulimina elongata* D'Orbigny; Cushman and Parker, p.108, pl. 25, figs. 14-17

1991 *Bulimina elongata* D'Orbigny; Cimerman and Langer, p. 62, pl. 64, figs.3-8

1993 *Bulimina elongata* D'Orbigny; Hottinger *et al.*, p. 99, pl. 124, figs. 3-7

Diagnostic features:

Test is long and thin. The length of the test is 3 or more times longer than width. The last-formed chambers are inflated. There are 5 or 6 whorls. Chambers are slightly inflated. Sutures are distinct and depressed. Wall is smooth and polished. It is often translucent and very finely perforated. Aperture is a typical buliminid loop.

Remarks:

Bulimina elongata is differentiated from other species of genus *Bulimina* by having not ornamented surface and its more elongated shape of test.

Bulimina marginata d'Orbigny, 1826

Pl. 6, figs. 5-7

1826 *Bulimina marginata* d'Orbigny; p. 269, pl. 12, figs. 10-12

1988 *Bulimina marginata* d'Orbigny; Loeblich and Tappan, p. 521, pl. 571, figs. 1-3

1991 *Bulimina marginata* d'Orbigny; Cimerman and Langer, p. 62, pl. 64, figs. 9-11

Diagnostic features:

Test is small and triangular in side view. Chambers rapidly increase in size. Chambers are inflated in the later parts of the test, while it is angulate in the basal part. Sutures are depressed. Lower edge of the chambers is ornamented by numerous pseudospines, which is blunt. Aperture is a typical buliminid loop.

Remarks:

Bulimina marginata is differentiated from *Bulimina aculeata* by having small bunt pseudospines in the lower edge of the chambers.

Bulumina marginata d'Orbigny var. *biserialis* Millett, 1900

Pl. 6, fig. 8

1900 *Bulumina marginata* d'Orbigny var. *biserialis* Millett; p. 278, pl. 2, fig. 7

1993 *Bulumina marginata* d'Orbigny var. *biserialis* Millett; Hottinger et al., p. 100, pl. 124, figs. 8-11

Remarks:

This variety differs from the type species by sharply undercut chambers, which produce an acute shoulder. Test has zigzag appearance in the side view.

Genus *Trifarina* Cushman, 1923

Test is elongated. The chamber arrangement of this species are triserial in early stage and then later chambers are uniserial and rectilinear. Sutures are slightly depressed to flush. Wall is calcareous and finely perforated. Surface is smooth. Aperture is terminal and rounded with toothplate.

Trifarina bradyi Cushman, 1923

Pl. 6, fig. 9

1923 *Trifarina bradyi* Cushman; p. 99, pl. 22, figs. 3-9

1971 *Trifarina bradyi* Cushman; Murray, p. 125, pl. 52, figs. 1-6

1993 *Trifarina bradyi* Cushman; Sgarrella and Moncharmont-Zei, p. 215

Diagnostic features:

Test is triangular with carinate peripheral margins. Surface is ornamented by raised elongate striae. Aperture is produced on a short neck.

Remarks:

The surface ornamentation of the test is easily seen in the scanning photomicrographs than the reflected light microscope.

Family Reussellidae Cushman, 1933

Genus *Reussella* Galloway, 1933

Test is pyramidal and triserial. Chambers gradually increases in size. Sutures are curved and oblique. Wall is calcareous and coarsely perforated. Surface is smooth to puslose. Aperture is a slit at the base of the final chamber with a toothplate.

Reussella spinulosa (Reuss, 1850)

Pl. 6, fig. 10

1850 *Verneuilina spinulosa* Reuss, p. 374, pl. 47, fig. 12

1988 *Reussella spinulosa* Reuss; Loeblich and Tappan, p. 527, pl. 575, figs. 9-12

1991 *Reussella spinulosa* Reuss; Cimerman and Langer, p. 63, pl. 66, fgs. 5-8

Diagnostic features:

Test is triangular with acute angle in apertural and side view. There are numerous pseudospines, which is project to backwards, along sutures and carinated peripheral margins. Chambers increase gradually in size. Sutures are distinct and hickened. There are numerous pores especially in the chamber margins. Aperture is interiomarginal and ornamented by a few tubercles.

Remarks:

The most characteristic feature of this species is flattened triangular sides and its pseudospines along sutures and carinated peripheral margins.

Superfamily **Fursenkoinacea** Loeblich and Tappan, 1961

Family Fursenkoinidae Loeblich and Tappan, 1961

Genus *Fursenkoina* Loeblich and Tappan, 1961

Test is narrow and elongate. Chambers are slightly inflated. The chamber arrangement is biserial. Surtures are oblique and depressed. Wall is calcareous, very finely perforated and hyaline. Surface is smooth. Aperture is elongate.

Fursenkoina schreibersiana (Czjzek, 1848)

Pl. 6, figs. 11-12

1848 *Virgulina schreibersiana* Czjzek; p. 147, pl. 13, figs. 18-21

1994 *Fursenkoina schreibersiana* (Czjzek); Loeblich and Tappan, p. 131, pl. 257, figs. 1-12

Diagnostic features:

Test is pointed towards the initial part and 8-shaped in horizontal section. Chambers are slightly twisted around the vertical axis. The length of the chambers is longer than width. Aperture is bordered by a weakly developed rim and provided with a toothplate.

Remarks:

This species is differentiated from *Fursenkoina acuta* by having more elongated chambers.

Superfamily **Discorbacea** Ehrenberg, 1838

Family Eponididae Hofker, 1951

Genus *Eponides* de Monfort, 1808

Test is biconvex with angular to carinate periphery. The chamber arrangement is a low trochospiral with 2-3 whorls and 6-7 chambers per whorl. Wall is calcareous and finely perforated. Surface is smooth to faintly pustolose. Aperture is broad interiomarginal arch and bordered by a narrow lip.

Eponides concameratus (Williamson, 1858)

Pl. 7, figs. 1, 2

1858 *Rotalina concameratus* Williamson; p. 52, pl. 4, figs. 101-102

1991 *Eponides concameratus* (Williamson); Cimerman and Langer, p. 64, pl. 67, figs. 11-14

1993 *Eponides concameratus* (Williamson); Sgarrella and Moncharmont-Zei, 232, pl. 22, figs. 4-5

2000 *Eponides concameratus* (Williamson); Sakınç, p. 118, fig. 92

2004 *Eponides concameratus* (Williamson); Meriç *et al.*, p. 161, pl. 22, figs. 13-14

Diagnostic features:

Test is planoconvex to biconvex with evolute spiral and involute ombilical sides. Periphery is carinated. Sutures on the spiral side are thickened and curved backwards, while there are slightly depressed and nearly radial sutures in the umbilical side. Spiral side is ornamented by pustules.

Remarks:

Eponides concameratus is distinguished from *Eponides repandus* by having rapidly increasing chamber size and its pustulose ornamentation in the spiral side.

Family Baggiinidae Cushman, 1927

Genus *Valvulineria* Cushman, 1926

Test is robust and rounded in outline. The chamber arrangement is trochospiral with about 25 whorls. Periphery is rounded. Spiral side is convex; ehile umbilical side has depressed umbilicus. Sutures are straight to gently curved. Wall is calcareous and finely perforated. Surface is smooth. Aperture is interiomarginal, umbilical to extraumbilical arch.

Valvularina bradyana (Fornasini, 1900)

Pl. 7, fig. 3-5

1900 *Discorbina bradyana* Fornasini; p. 393, text-fig. 43

1991 *Valvulineria bradyana* (Fornasini); Cimerman and Langer, p. 64, pl. 67, figs. 8-10

1993 *Valvulineria bradyana* (Fornasini); Sgarrella and Moncharmont-Zei, p. 220, pl. 18, figs. 1-2

1999 *Valvulineria bradyana* (Fornasini); Altıner *et al*, p. 96, pl. 7, fig. 5-8

Diagnostic features:

Periphery is subrounded. Sutures are radial and depressed in the umbilical side, while they are gently curved backwards in the spiral side. Surface is densely perforated except apertural face. Aperture has a large flap, which is covering the umbilicus.

Remarks:

The most characteristic features of this species are apertural flap and densely perforated surface of the test.

Genus *Neoeponides* Reiss, 1960

Peripheral outline is nearly circular. Test is a high trochospiral with 2.5-3 whorls. Periphery is angular to carinate. Chambers are broad and crescentic. Sutures are strongly oblique and elevated in the spiral side, while there are radial and deeply depressed sutures in the umbilical side. Wall is calcareous and thick. Surface is smooth and there are few pustules in the umbilical side. Aperture is interiomarginal arch and bordered by a narrow lip or crescentic flap.

Neoeponides bradyi (Le Calvez, 1974)

1974 *Eponides bradyi* Le Calvez; p. 63

1993 *Neoeponides bradyi* (Le Calvez); Hottinger *et al.,* p. 112, pl .146, figs. 8-12, pl. 147, figs. 1-3

1994 *Neoeponides bradyi* (Le Calvez); Loeblich and Tappan, p. 138, pl. 279, figs. 1-9

2004 *Neoeponides bradyi* (Le Calvez); Meriç *et al.*, p. 162, pl. 24, figs. 1-4

Diagnostic features:

Test is unequally biconvex with strongly convex spiral side. There is a small umbilicus umbilical side. Chambers are slowly increasing in size. Peripheral margin is acute and carinated. Although wall is distinctly perforated, pores is filled by secondary lamination on the spiral side

Remarks:

The most characteristic features of this species are strongly convex spiral side with carinated periphery and pustules in the umbilicus. The umbilicus is obscured by these pustules and strongly thickened sutures on umbilical side.

Superfamily **Discorbacea** Ehrenberg, 1838

Family Rosalinidae Reiss, 1963

Genus *Gavelinopsis* Hofker, 1951

Test is planoconvex to inequally biconvex. Periphery is carinate. The arrangement of the chambers is trochospiral. In the spiral side, chambers are crescentic with thickened sutures. Chambers are triangular with depressed and radial sutures in the umbilical side. Wall is calcareous, hyaline and finely perforated. Aperture is interiomarginal extraumbilical slit.

Gavelinopsis praegeri (Heron-Allen and Earland, 1913)

1913 *Discorbina praegeri* Heron-Allen and Earland; p. 122

1971 *Gavelinopsis praegeri* (Heron-Allen and Earland); Murray, p. 133, pl. 55, figs. 1-5

1988 *Gavelinopsis praegeri* (Heron-Allen and Earland); Loeblich and Tappan, p. 560, pl. 608, figs. 6-12

1993 *Gavelinopsis praegeri* (Heron-Allen and Earland); Sgarrella and Moncharmont-Zei, p. 218, pl. 17, figs. 1-2

Diagnostic features:

There are 2-3 slowly enlarging whorls with 5-6 chambers in the outer whorl. The umbilicus is filled with a large flat boss. Wall pores are confined to the central parts of the chambers on the umbilical side.

Remarks:

This species is easily recognized by having evolute and convex spiral side, and by having involute and strongly flattened umbilical side.

Genus *Neoconorbina* Hofker, 1951

Test is circular in outline and low trochospiral. Final chambers are crescentic and increasing in breadth. Periphery is carinate. Wall is calcareous. Spiral side is densely and finely perforated, while umbilical side is more coarsely perforated. Aperture is interiomarginal extraumbilical slit.

Neoconorbina terquemi (Rzehak, 1888)

Pl. 7, figs. 6-7

1888 *Discorbina terquemi* Rzehak; p. 228

1991 *Neoconorbina terquemi* (Rzehak); Cimerman and Langer, p. 66, pl. 70, figs. 5-7

Remarks:

The most characteristic fearture of this species is the low conical shape of test with broadly crescentic chambers.

Genus *Rosalina* d'Orbigny, 1926

Test is trochospiral. Spiral side is convex and depressed sutures. Chambers are subtriangular in the umbilical side with strongly curved sutures. Wall is calcareous and perforated with smooth surface. Aperture is interiomarginal arch and bordered by a lip.

Rosalina bradyi (Cushman, 1915)

Pl. 7, fig. 8-9

1915 *Discorbis globularis* d'Orbign var. *bradyi* Cushman; p. 12, pl. 8, fig.1

1991 *Rosalina macropora* (Cushman); Cimerman and Langer, p. 67, pl. 71, figs. 6-7

1993 *Rosalina bradyi* (Cushman); Sgarrella and Moncharmont-Zei, p. 218, pl. 17, figs. 4-5

Rosalina floridensis (Cushman, 1922)

Pl. 7, figs 10-11

1922 *Discorbis floridana* Cushman; p. 39, pl. 5, figs. 11-12

2004 *Rosalina floridensis* (Cushman); p. 168, pl. 24, figs. 9-10

Family Sphaeroidinidae Cushman, 1927

Genus *Sphaeroidina* d'Orbigny, 1826

Test is subglobular. Coiling is variable. Chambers are strongly embracing and centered over the preceding chamber. Wall is calcareous and very finely perforated. Surface is smooth. Aperture is interiomarginal, a crescentic arch.

Sphaeroidina bulloides d'Orbigny, 1826

1826 *Sphaeroidina bulloides* d'Orbigny; p. 267

1988 *Sphaeroidina bulloides* d'Orbigny; Loeblich and Tappan, p. 564 pl. 617, figs. 1-6

1993 *Sphaeroidina bulloides* d'Orbigny; Hottinger *et al.*, p. 113, pl. 147, figs. 4-11

1999 *Sphaeroidina bulloides* d'Orbigny; Altıner *et al*, p. 98, pl. 8, figs. 3-4

Diagnostic features:

Test is subglobular to ovate. The chamber arrangement is trochospiral in early parts, later it is streptospiral with 4 strongly embracing chambers per coil. Chambers are inflated and rapidly increasing in size. Sutures are distinct, straight and slightly depressed. Aperture is situated often at the junction of three chambers and bordered by a pustulate lip. It is provided with largee and spathulate basal plate.

Remarks:

This species is differentiated from other species by having extremely finely perforated surface and location of aperture at the junction of three chambers.

Superfamily Glabratellacea Loeblich and Tappan, 1964

Family Glabratellidae Loeblich and Tappan, 1964

Genus *Conorbella* Hofker, 1951

Test is spiroconvex and trochospiral having rapidly enlarging crescentic chambers with rounded to sharply angular peripheral carina. Sutures are oblique, thickened, and depressed on the spiral side, while they are flush and may be obscured by the radial ornamentation on the disc like umbilical side. Wall is calcareous. In the spiral side, surface is strongly rugose, with heavy pustules and spinules that may be aligned concentrically, whilst it is ornamented by radially aligned striae or rows of granules in the umbilical side. Aperture is simple, small, interiomarginal and umbilical slit.

Conorbella imperatoria (d'Orbigny, 1846)

Pl. 8, fig. 3-4

1846 *Rosalina imperatoria* d'Orbigny, p. 176, pl. 190, figs. 16-18

1980 *Glabratella imperatoria* (d'Orbigny, 1846); Alavi, p. 52, pl. 28, figs. 1, 2

1991 *Conorbella imperatoria* (d'Orbigny, 1846); Cimerman and Langer, p. 68, pl. 72, figs. 9-11

1993 *Schackoinella imperatoria* (d'Orbigny, 1846); Sgarrella and Moncharmont-Zei, p. 222, pl. 18, figs. 5-6

Diagnostic features:

Test is high-trochospiral, slightly lobate in apertural view and conical in peripheral view. Chambers are crescentic and gradually increased in spiral side. Sutures are weakly depressed. Umbilical side has a depressed umbilicus. The surface of the spiral side and periphery are heavily ornamented by large pseudospines and pustules, and umbilical side has radially aligned striae and pustules.

Remarks:

This is the largest form of genus *Conorbella* that is recorded in the samples of the Gulf of İskenderun. It is easily distinguished from other *Conorbella* spp. by having pseudospines on the surface.

According to Hottinger *et al.* (1993), genus *Schackoinella* (Weinhandl, 1958) is a small and specialized genus that is still under investigation at the University of Geneva, Switzerland. Therefore, this species is used under the genus *Conorbella* avoiding proliferation of taxa.

Conorbella patelliformis (Brady, 1884)

Pl. 8, fig. 1-2

1884 *Discorbina patelliformis* Brady, p. 647, pl. *88,* fig. 3, pl. 89, fig. 1

1980 *Conorbella patelliformis* (Brady); Alavi, p. 53, pl. 29, figs. 5 and 10

1991 *Conorbella patelliformis* (Brady); Cimerman and Langer, p. 68, pl. 73, figs. 1-3

Diagnostic features:

Test is triangular in peripheral view and rounded in apertural view. There are a pointed juvenile part in spiral side and a depressed umbilicus in umbilical side. The surface of the spiral side is ornamented by rugosity and umbilical side is ornamented by rows of pustules or radially aligned striae.

Remarks:

This species is characterized by its nearly circular outline in umbilical side and pointed part in spiral side.

Conorbella pulvinata (Brady, 1884)

1884 *Discorbina pulvinata Brady*, p. 650, pl. 88, fig. 10

1988 *Conorbella pulvinata* (Brady); Loeblich and Tappan, p. 565, pl. 618, figs. 4-6

1991 *Conorbella pulvinata* (Brady); Cimerman and Langer, p. 68, pl. 73, figs. 4-7

1994 *Conorbella pulvinata* (Brady); Loeblich and Tappan, p. 141, pl. 291, figs. 11-13

1994 *Glabratella pulvinata* (Brady); Jones, p. 94, pl. 88, fig. 10

Diagnostic features:

Test is very low trochospiral, slightly lobate with a subrounded peripheral margin. There are about 4-5 inflated chambers in the last whorl. S tures are indistinct due to high ornamentation. There is a depressed umbilicus in the umbilical side. The surface of the spiral side is heavily ornamented by pustules and spinules and rugose, while the umbilical side has radially arranged ribs and small pustules.

Remarks:

This species is distinguishing from other *Conorbella* spp. by its smaller and nearly flat test.

Family Siphoninidae Cushman, 1927

Genus *Siphonina* Reuss, 1850

Test is lenticular to inequally convex. The chamber arrangement is trochospiral. Sutures are oblique and thickened on the spiral side, while there are radial and depressed sutures on the umbilical side. Umbilicus is closed. Wall is calcareous and coarsely perforated. Aperture is areal and elliptical.

Siphonina pulchra Cushman, 1922

1922 *Siphonina pulchra* Cushman; p. 49, pl. 7, figs. 11-12

1931 *Siphonina pulchra* Cushman; Cushman, p. 69, pl. 14, figs. 2-3

Siphonina reticulata (Czjzek, 1848)

1848 *Rotalina reticulata* Czjzek; p. 145, pl. 13, figs. 7-8

1931 *Siphonina reticulata* (Czjzek); Cushman, p. 68, pl. 14, figs1 a-c

Superfamily Discorbinellacea Sigal, 1952

Family Discorbinellidae Sigal, 1952

Genus *Discorbinella* Cushman and Martin, 1935

Test is ovate to circular in outline. The chamber arrangement is trochospiral with convex spiral side. Periphery is carinate. Wall is calcareous and finely perforated with smooth surface. Aperture is interiomarginal arch.

Discorbinella bertheloti (d'Orbigny, 1839)

Pl. 8, fig. 5-6

1839 *Rosalina bertheloti* d'Orbigny; p. 135, pl. 1, figs. 28-30

1993 *Discorbinella bertheloti* (d'Orbigny); pl.150, figs. 1-4

Diagnostic features:

Test is spiroconvex to concavo-convex and involute. It has small knob in the umbilical side. Peripheral outline is elliptical and slightly lobulated in last chambers with carina. Chambers are gradually increasing in size in earlier stages while they increase very rapidly in last stages.

Superfamily Planorbulinacea (Schwager. 1877)

Family Cibicididae (Cushman, 1927)

Subfamily Cibicidinae (Cushman, 1927)

Genus *Cibicides* (de Montfort, 1808)

Test is commonly attached to a substrate and umbilicoconvex with trochospiral chambers and carinate periphery. Spiral side is flat to concave and evolute with thickened sutures, while umbilical side is strongly convex and involute with depressed sutures and angular apertural face. Wall is calcareous and coarsely and finely perforate in the spiral and the umbilical sides, respectively. Apertural face and peripheral keel are imperforate. Surface is smooth and aperture is a low interiomarginal to equatorial with a lip.

Cibicides refulgens de Montfort, 1808,

Pl. 8, fig. 7

1808 *Cibicides refulgens* de Montfort; p. 122, 123 (fide Ellis and Messina, 1940)

1980 *Cibicides refulgens* de Montfort; Boltovskoy *et al.*, p. 24; pl. 9, figs. 9-11

1988 *Cibicides refulgens* de Montfort; Loeblich and Tappan, p. 582, pl. 634, figs. 1-3

1991 *Cibicides refulgens* de Montfort; Cimerman and Langer, p. 71, pl. 75, figs. 5-9

1994 *Cibicides refulgens* de Montfort; Jones, p. 97, pl. 92, figs. 7-9

1994 *Cibicides refulgens* de Montfort; Loeblich and Tappan, p. 149, pl. 318, figs. 7-9

Diagnostic features:

Test is subcircular in outline and conical in peripheral view. Chambers increases in size gradually with about 2.5 whorls in spiral side and 7-8 chambers in umbilical side. Imperforate sutures are curved backwards in both sides. Wall is irregularly perforate on spiral and umbilical side. Aperture is bordered by a protruding rim continuing into a spiral supplementary aperture.

Remarks:

The most characteristic feature of *Cibicides refulgens* is its conical shape.

Superfamily Asterigerinacea d'Orbigny, 1839

Family Asterigerinatidae Reiss, 1963

Genus *Asterigerinata* Bermudez, 1949

Test is free, compressed, low trochospiral and spiroconvex with three to four whorls on the spiral side. Periphery is acutely angled and carinate. Chambers are increasing rapidly in breadth and they become broad, low, crescentic, and strongly overlapping. The final chamber occupies almost one-half the periphery. Sutures are curved, strongly oblique, thickened, imperforate and flush. Only the five chambers of the final whorl are visible on the umbilical side. The umbilical end of each chamber is covered by a convex ovoid coverplate. Wall is calcareous and coarsely perforate on the spiral side. Coverplates are coarsely perforated on the umbilical side and may be finely pustulose. Aperture is a low interiomarginal arch bordered by short radiating grooves and pustules.

Asterigerinata mamilla (Williamson, 1858)

Pl. 9, fig. 2-3

1858 *Rotalina mamilla* Williamson; p. 54, pl. 4, figs. 109-111

1971 *Asterigerinata mamilla* (Williamson); Murray, p. 141; pl. 59, figs. 1-6

1991 *Asterigerinata mamilla* (Williamson); Cimerman and Langer, p. 73, pl. 82, figs. 1-4

Diagnostic features:

Test is conical in peripheral view and sutures are curved, imperforate and slightly thickened on the spiral side and weakly depressed, curved to sinuate on the umbilical side. Spiral side is perforated with larger pores at the chamber margins. There are several large pores on the umbilical side. Aperture has a thickened lip.

Remarks:

Pores on the spiral margin are very distinctive with large pores close to sutures on umbilical side.

Genus *Amphistegina* d'Orbigny, 1826

Test is low trochospiral, lenticular and inequally biconvex with angular to carinate periphery. It may be bi-involute or partially evolute on the spiral side. Chambers are numerous, broad, and low, strongly curved back at the periphery. It has a distinct umbilical plug. Wall is calcareous and finely perforate. Surface is smooth except the apertural region that has small rounded projections, called as papillae ornamentation. Aperture, bordered by a lip, is an interiomarginal slit on the umbilical side.

Amphistegina lobifera Larsen, 1976

Pl. 9, fig. 4.

1976 *Amphistegina lobifera* Larsen; p. 4, pl. 3, figs. 1 -5, pl. 7, fig. 3, pl. 8, fig. 3

1993 *Amphistegina lobifera* Larsen; Hottinger *et al.*, p. 133, pl. 186, figs. 1 -11, pl. 187, figs. 1 -7, pl. 188, figs. 1-6

2002 *Amphistegina lobifera* Larsen; Hyams *et al.*, p. 174, pl. 1, figs. 3-4

2004 *Amphistegina lobifera* Larsen; Meriç *et al.*, p. 192, pl. 29, figs. 7-10

Diagnostic features:

Test is lenticular to subglobular. Chambers are biinvolute. The peripheral outline is smooth and peripheral margin is rounded. Early chambers have lobes of about equal length, and later adult chambers have lobes of unequal length. Sutures are flush and sharply bent backwards in spiral side, while they are sigmoidal-radial and strongly lobulated in umbilical side. Areal supplementary apertures are irregularly spaced covering the apertural face between pustules.

Remarks:

It is the largest form recorded in the samples of the Gulf of İskenderun.

Superfamily Nonionacea Schultze, 1854

Family Nonionidae Schultze, 1854

Subfamily Nonioninae Schultze, 1854

Genus *Nonion* de Montfort, 1808

Test is laterally compressed, ovate to circular in outline and biumbilicate. The chamber arrangement is planispiral throughout and involute to slightly evolute. Peripheral outline is smooth. Umbilici are ornamented by pustules. Surface is smooth excluding the granules and radial ridges in the umbilical regions. Wall is calcareous Aperture is interiomarginal and equatorial slit.

Nonion depressulum (Walker and Jacob, 1798)

Pl. 7, figs. 4-5

1798 *Nautiulusn depressulus* Walker and Jacob; p.641, pl. 14, fig. 33

1993 *Nonion depressulum* (Walker and Jacob); Sgarrella and Moncharmont-Zei, p. 238, pl. 24, figs. 3-4

Genus *Nonionella* Cushman, 1926

Test is slightly compressed. The chamber arrangement is low trochospiral. Spiral side is partially evolute, while umbilical side is involute. Periphery is rounded. Chambers are broad and low. Sutures are curved and depressed. Wall is calcareous and finely perforated. Surface is smooth. Aperture is small, interiomarginal and nearly equatorial arch.

Nonionella turgida (Williamson, 1858)

1858 *Rotalina turgida* Williamson; p. 50 pl. 4, figs. 95-97

1993 *Nonionella turgida* (Williamson); Sgarrella and Moncharmont-Zei, p. 240, pl. 24, fig. 5

Remarks:

The most characteristic feature of this species is its chambers that are progressively enlarging so it produces a flaring test.

Genus *Nonionoides* Saidova, 1975

Test is slightly asymmetrical and weakly trochospiral. Spiral side is evolute, when umbilical side is involute and deeply umbilicate. Periphery is rounded. Sutures are slightly depressed. Wall is calcareous and finely perforated. Surface is smooth except small pustules in the umbilical rim of the chambers. Aperture is interiomarginal and equatorial arch.

Nonionoides grateloupi (d'Orbigny, 1826)

Pl. 9, figs. 7-8

1826 *Nonionina grateloupi* d'Orbigny; p. 294, no:19

1931 *Nonionoides grateloupi* (d'Orbigny); Cushman, p. 10, pl 3, figs. 9-11, pl. 4, figs. 1-4

Superfamily Rotaliacea Ehrenberg, 1839

Family Rotaliidae Ehrenberg, 1939

Subfamily Ammoniinae Saidova, 1981

Genus *Ammonia* Brünnich, 1772

Test is free, biconvex, coiled in low trochospiral of 3 to 4 volutions with rounded to carinate periphery. Spiral side is evolute having curved slightly backward sutures. Umbilical side is involute having thick, depressed, radial sutures. Umbilical side may have large umbilical plug surrounded by umbilical fissure. Wall is calcareous, and finely perforate with irregular pustules of calcite located along the sutures of the umbilical side as well as on the umbonal area. Both surfaces may be ornamented by pillars. Primary aperture is interiomarginal extraumbilical arch, bordered by a protruding lip at the umbilical end.

Ammonia is one of the most abundant foraminiferal genera worldwide and mainly occurs in sheltered, shallow marine, often slightly brackish, intertidal environments (Murray, 1991). As a result of high morphologic variability of *Ammonia*, there are considerable difficulties in species identification. Recent *Ammonia* has more than 40 species and subspecies (or varieties) worldwide (Hayward *et al.*, 2004). Therefore, the taxonomy of *Ammonia* is in a confused state globally. Many workers have given up trying to differentiate species morphologically such as Alavi (1980). Some taxonomically more rigorous works; like Cimerman and Langer (1991), Hottinger *et al.* (1993) and Loeblich and Tappan (1994); apply formal species names to each different morphological form in the traditional manner. In this study, these formal species names are used.

Ammonia beccarii (Linne, 1758)

1758 *Nautilus beccarii* Linne, p. 710, pl. 1, fig. 1.

1931 *Rotalia beccarii* (Linne); Cushman, p. 58, pl. 12, figs. 1-7 and pl. 13 , figs. 1-3

1971 *Ammonia beccarii* (Linne); Murray, p. 151; pl. 62, figs. 1-7

1988 *Ammonia beccarii* (Linne); Loeblich and Tappan, p. 664, pl. 767, figs. 1-7

1991 *Ammonia beccarii* (Linne); Cimerman and Langer, p. 76, pl. 87, figs. 3-4

2001 *Ammonia beccarii* (Linne); Fiorini and Vaiani, p. 391, pl. 7, figs. 4-5

Diagnostic features:

Test is circular and periphery is rounded. Chambers are slightly inflated, ending in umbilical extension, 9-12 in final whorl. Sutures are imperforate, thickened, flush and limbate in early portion of the spiral side, and interlocular spaces incised on the umbilical side. They are depressed and open in last whorl on both sides. Wall is light yellow or white, highly ornamented, shiny, finely perforate, with large tubercules located along sutures and becoming reduced in last whorl of spiral side. Aperture is a narrow slit at base of apertural face opening into umbilicus.

Remarks:

The umbilicus is sometimes occupied by a calcitic boss.

Ammonia inflata (Seguenza, 1862)

1862 *Rosalina inflata* Seguenza, p. 106, pl. 1, fig-6

1980 *Ammonia beccarii* forma A; Alavi, p. 56, pl. 29, fig. 6, pl. 32, figs. 1-2

1991 *Ammonia inflata* (Seguenza); Cimerman and Langer, p. 76, pl. 87, figs. 5-6

Diagnostic features:

Test is circular. 2.5-3 whorls are visible on the evolute spiral side with 8-9 chambers in the final whorl. The periphery is rounded. Dorsal sutures are deeply incised; umbilicus and the interseptal spaces knobby are ornamented. Spiral side is densely perforated except at thickened sutures. Umbilical side is perforate, while apertural face is imperforate.

Remarks:

This form differs from *A. beccarii* by having larger size, less number of whorls and chambers. *A. beccarii* has 3.5-4 whorls on spiral side and 9-12 chambers in last whorl. In addition, the ornamentation of *A. inflata* that has low frequent umbilical pillars is weaker than the ornamentation of A. *beccarii*.

Ammonia parkinsoniana (d'Orbigny, 1839)

1839 *Rosalina parkinsoniana* d'Orbigny, p. 99, pl. 4, figs. 25-27.

1991 *Ammonia parkinsoniana* (d'Orbigny); Cimerman and Langer, p. 76, pl. 87, figs. 7-9

1993 *Ammonia parkinsoniana* (d'Orbigny); Sgarrella and Moncharmont-Zei, p. 226, pl. 20, figs. 3-4

2001 *Ammonia parkinsoniana* (d'Orbigny); Fiorini and Vaiani, p. 385, pl. 6, figs.14-15

Diagnostic features:

Test is circular to slightly lobulate, spiroconvex, nearly conical in peripheral view. Periphery is rounded. About 2.5 whorls are visible on the evolute spiral side with 8-9 chambers in the final whorl. There are deeply incised interlock spaces and a well-developed knob on the flattened umbilical side. Primary aperture is a semielliptical, interiomarginal opening extending slitlike along the chamber and around the triangular folium.

Remarks:

Except well-developed knob, the species does not have any ornamental features on both sides so this is the most characteristic feature of this species. In relation to *A. beccarii,* this species has a smaller test. Initial whorls on spiral side are somewhat indistinct. While spiral and umbilical sides are nearly equally convex in other species mentioned in this study, this species is planoconvex.

Ammonia tepida (Cushman, 1926)

Pl. 9, fig. 13-15

1926 *Rotalia beccarii* (Linne, 1758) var. *tepida,* Cushman, p. 79, pl. 1 (fide Ellis and Mesina, 1940)

1994 *Ammonia beccarii* (Linne) var. *tepida,* (Cushman); Hayward and Hollis, p. 209, pl. 4, figs. 4-6; Javaux and Scott, 2003, p. 12, pl. 2, figs. 2-3

1991 *Ammonia tepida* (Cushman); Cimerman and Langer, p. 76, pl. 87, figs. 10-

12

1993 *Ammonia tepida* (Cushman); Sgarrella and Moncharmont-Zei, p. 226, pl. 20, figs. 3-4

2001 *Ammonia tepida* (Cushman); Fiorini and Vaiani, p. 385, pl. 6, figs.7-13, 18

Diagnostic features:

Test is very low trochospiral and spiral side is slightly more convex than umbilical side. Periphery is slightly moderately lobulate and broadly rounded. Chambers are slightly oblique, subglobular in spiral side and increasing gradually in size as added. There are 8-9 chambers in the final whorl. Sutures are distinct, limbate and slightly depressed on the spiral side, and more deeply depressed and partly incised on the umbilical side. There is deeply incised umbilicus. It is ornamented by tubercular material at the umbilical region and umbilical extremities of sutures. Aperture is an ovate slit at the base of final chamber.

Remarks:

The small test, lobate periphery, low number of chambers and generally without an umbilical knob is distinctive for this species.

Genus *Challengerella* Billman, Hottinger and Oest Erle, 1980

Test is trochospiral and nearly equally biconvex. With 14-16 chambers at the final whorl, there are 2-3 gradually enlarging whorls visible on the spiral side. Chambers are evolute in spiral side and involute in umbilical side. Periphery is weakly carinate in early part of last whorl and rounded in later chambers. Sutures are limbate, straight to curved, bending slightly backward toward the periphery in spiral side. Umbilical side has radial sutures being deeply incised with elevated margins and finely pustulose. Umbilicus filled with large umbilical plug that is surrounded by an umbilical fissure that becomes a simple spiral canal. Wall is calcareous, finely perforate and smooth. Sutural margins and apertural face is imperforate. Primary aperture is a small interiomarginal slit with an imperforate lip that extends into the umbilicus.

Challengerella bradyi Billman, Hottinger and Oest Erle

1980 *Challengerella bradyi* Billman, Hottinger and Oest Erle; p. 91, text fig. 17, pl. 12, figs. 1 - 6, 8 - 10, 13 - 14, pl. 13, figs. 7, 12

1988 *Challengerella bradyi* Billman, Hottinger and Oest Erle; Loeblich and Tappan, p. 666, pl. 770, figs. 1-9

1993 *Challengerella bradyi* Billman, Hottinger and Oest Erle; Hottinger *et al.*, p. 144, pl. 204, figs. 1-13, pl. 205, figs. 2-7

Diagnostic features:

Test of *Challengerella bradyi* is lenticular to subglobular, biconvex to umbilicoconvex. Peripheral outline is subcircular, smooth except in the last few chambers where they are slightly, then distinctly lobulate. Sutures are depressed and bordered by a narrow, imperforate rim in the last few chambers in spiral side. Umbilical cavity is filled with a compound plug.

Remarks:

It differs from *Ammonia beccarii* by its much larger size and much more elevated sutures on spiral side. In addition, pustulose ornamentation in the umbilical side is characteristics feature of this species.

Family ELPHIDIIDAE Galloway, 1933

Subfamily ELPHIDIINAE Galloway. 1933

Genus *Elphidium* de Montfort, 1808

Test is free, large, equally biconvex, lenticular, planispirally coiled, involute or partially evolute and biumbonate with carinate periphery. In the final whorl, there are 7 to 20 chambers with numerous ponticuli containing retral processes and interseptal bridges. It may have umbilical plug on each side. Deeply incised sutures form interlocular spaces and lined with rows of fossettes. Wall calcareous, radial or granulate and finely perforate. Aperture is a single or multiple interiomarginal pore, and may have additional areal openings.

In this study, all species belonging to genus *Elphidium* is involute.

Elphidium advenum (Cushman, 1922)

1922 *Polystomella advena* Cushman, p. 56, pl. 9, fig. 11, 12.

1994 *Elphidium advenum* (Cushman); Hayward and Hollis, p. 209, pl. 4, figs. 13-15

Diagnostic features:

Test is strongly compressed. Peripheral outline is rounded to slightly lobate, and acute with a blunt keel in periphery. Chambers gradually increases in size. There are 10-15 chambers in the outer whorl. Sutures are curved backwards. There are 7-9 ponticuli in the last chambers of adult specimens. Umbilicus is depressed, rarely with bosses. Aperture is an interiomarginal row of small pores.

Remarks:

Test is smaller compared to other species of the genus. This species is easily distinguished by its keel, smaller number of ponticuli and not protruding bosses if it possess. Subsequently, this species does not seem as biumbonate.

Elphidium craticulatum (Fichtel and Moll)

1798 *Nautilus craticulatus* Fichtel and Moll, p. 51, pl. 5, figs. h, i, k

1939 *Elphidium craticulatum* (Fichtel and Moll); Cushman, p. 56, pl.15, figs. 14-17

1993 *Elphidium craticulatum* (Fichtel and Moll); Hottinger *et al.*, p. 147, pl. 208, figs. 1-10, pl. 209, figs. 1 - 6, pl. 210, figs. 1 -6

Diagnostic features:

Test is subglobose in side view. Peripheral outline is smooth to very slightly lobulate in the last chambers, and peripheral margin is acute with an imperforate, blunt carina. The ratio of diameter to thickness is about 2. There are 22 - 35 chambers in outer whorl with 20 - 22 ponticuli in adult. Chambers are slightly inflated. Apertures are multiple, interiomarginal rounded openings bordered by weak peristomal rims.

Remarks:

Test is moderately large size in the species of the genus. Nearly straight to weakly backward curved chambers and a large imperforate umbilical plug are characteristic features of this species. This species is belonging to Indo-Pacific origin (Cushman, 1939). Therefore, it may be migrated to the Gulf of İskenderun by Lessepsian Migration (Langer and Hottinger, 2000; Hyams *et al.*, 2002; Meriç *et al.*, 2006).

Elphidium crispum (Linne, 1758)

Pl. 11, fig. 11

1758 *Nautilus crispus* Linne, *Systema Naturae,* Ed. 10, Holmiac, p. 709 (fide Ellis and Mesina, 1940)

1939 *Elphidium crispum* (Linne); Cushman, p. 50, pl. 13, figs. 17-21

1971 *Elphidium crispum* (Linne); Murray, p. 155; pl. 64, figs. 1-6

1991 *Elphidium crispum* (Linne); Cimerman and Langer, p. 78, pl. 90, figs. 1-6

1993 *Elphidium crispum* (Linne); Sgarrella and Moncharmont-Zei, p. 227, pl. 20, fig. 11

2001 *Elphidium crispum* (Linne); Fiorini and Vaiani, p. 391, pl. 7, figs. 8, 9, 11.

Diagnostic features:

Test is the largest on among the species of the genus. It is about two and one half times longer than wide in peripheral view. Peripheral margin is angular to acute and carinate, sometimes becoming slightly lobulate and blunter in the last portion. Chambers are long and narrow and there are 22-28 in outer whorl with 12 - 16 ponticuli in adult. Long retral processes occupy about two thirds of the chamber width. Sutures are somewhat sigmoid. The most parts of the surface are covered by a fine granular ornamentation. Aperture consists of a series of interiomarginal pores.

Remarks:

This species is easily differentiated from other species of genus *Elphidium* by having the largest test recorded in the Gulf of İskenderun. It has a large boss with coarse perforations.

Elphidium jenseni Cushman, 1924

1924 *Elphidium jenseni* Cushman; p. 49, pl. 16, figs. 4, 6

1939 *Elphidium jenseni* Cushman; Cushman, p. 62, pl. 17, figs. 14-15

1991 *Elphidium jenseni* Cushman; Cimerman and Langer, p. 78, pl. 90, figs. 1-6

Diagnostic features:

Test is very strongly compressed. Periphery is very slightly keeled. There are 8-

12 chambers, which are not inflated, in the outer whorl. Sutures are distinct, somewhat raised, and retral processes is elongate and thin. Surface is ornamented by large pustules in the umbilical area and small pustules on chamber surface and apertural face. Aperture has a row of openings.

Remarks:

The most characteristic features of this species are surface ornamentation and its compressed test.

Elphidium macellum (Fichtel and Moll)

1798 *Nautilus macellus* var. *beta* Fichtel and Moll, p. 66, pl. 10, figs. h-k

1939 *Elphidium macellum* (Fichtel and Moll); Cushman, p. 51, pl. 14, figs. 1-3, pl. 15, figs. 9, 10

1991 *Elphidium macellum* (Fichtel and Moll); Cimerman and Langer, p. 78, pl. 89, figs. 9

Diagnostic features:

Size of test is medium for the genus. Test is about three and one-half times longer than wide in peripheral view. Periphery is angular, slightly more rounded in the last-formed chambers, slightly keeled and somewhat lobulate. Chambers are numerous with 21-24 in outer whorl. There are 12 - 15 ponticuli in adult. Sutures are slightly depressed. Aperture consists of a row of small openings.

Remarks:

Elphidium crispum (Linne, 1758) and *Elphidium macellum* (Fichtel and Moll) are strongly similar to each other. According to Cushman and Leavitt (1929) and Moulinier (1966), there is a variation in *E. crispum* (Linne, 1758) and *E. macellum* (Fichtel and Moll). Herein, like most authors, *E. crispum is* distinguished by its large size (up to 3 mm diameter) and its umbilical bosses. *E.*

macellum (Fichtel and Moll) has flat umbilical regions, and longer and more widely spreading retral processes relative to *E. crispum.*

Elphidium striato-punctatum (Fichtel and Moll)

1798 *Nautilus striato-punctatus* Fichtel and Moll, p. 61, pl. 9, figs. a-c.

1939 *Elphidium striato-punctatum* (Fichtel and Moll); Cushman, p. 52, pl. 14, figs. 6, 7

Diagnostic features:

The periphery is broadly rounded. Umbilical regions are flat or very slightly concave. There are 16-20 chambers in outer whorl with 22-26 ponticuli in the adult. Later chambers are somewhat wider than the earlier ones. Apertural face is slightly convex, crescentic, and the sides of it end in blunt points.

Remarks:

This species resemble to *Elphidium craticulatum* with all features except relatively smaller size, rounded periphery and sutures partly obscured by the retral processes.

According to Cushman (1939), this species does not seem to occur in the Mediterranean, and its distribution confined to very warm, shallow waters of the Red Sea and adjacent parts of the Indian Ocean. Hence, like *Elphidium craticulatum*, it may migrated to Gulf of İskenderun by the Lessepsian migration (Langer and Hottinger, 2000; Hyams *et al.*, 2002; Meriç *et al.*, 2006).

CHAPTER V

DISCUSSION AND CONCLUSION

Regarding to the scope of the study, the studied 34 samples have been collected as the grab samples from Gulf of İskenderun situated at the eastern Mediterranean Sea. The depth of the samples ranges from 18 m. to 190 m. The main aim is to investigate the foraminiferal assemblages of the recent samples in terms of abundance and diversity, to determine the bathymetrical and the geographical distributions of the foraminiferal assemblages. This study also intends to put forward the responses of foraminifers to environmental factors such as bathymmetry, salinity, substrate, pollution, water currents, etc. on the distribution of foraminifers.

First of all, taxonomical study has been carried out. 151 benthic foraminiferal species belonging to 83 genera and suborders of Textulariina, Spirillinina, Miliolina, Lagenina and Rotaliina have been identified. Accordingly, descriptions, differences from the original definitions of forms and the distinctions of the resembling forms have been discussed in the chapter of systematic paleontology. Special attention has been given to state distinguishing features of species that can be observed under the stereomicroscope.

Concerning the scope of the study, the quantitative analysis has been carried out in order to get the abundance and diversity of foraminiferal species. Total 300 foraminiferal specimens from each sample have been counted, contrary to most of the previous studies in this subject. Thus, changes in diversity and abundance of benthic foraminifers have been documented and discussed in detail in this study.

In this study, by considering the spatial distribution of foraminifers in the neritic zone including the infralittoral, the upper circalittoral and the lower circalittoral zones, benthic foraminifers indicate great diversification and complex distribution patterns. Among the suborders, Suborder Rotaliina has the greatest relative abundance value and it is followed by Suborder Milioliina, Suborder Textulariina, Suborder Lagenina and Suborder Spirillinina, respectively. In the Gulf of İskenderun, the diversity of planktonic species is extremely low and relative abundance of planktonic foraminifers increases towards to the lower circalittoral zone.

In the study area, some species are frequent and very abundant all over the Gulf. There are ten species, whose relative abundance is greater than 2%, including *Ammonia tepida* (Cushman, 1926); *Adelosina cliarensis* (Heron-Allen and Earland, 1930); *Nonion* sp.; *Textularia bocki* Höglund, 1947; *Reussella spinulosa* (Reuss, 1850); *Cribroelphidium poeyanum* (d'Orbigny, 1839); *Adelosina pulchella* d' Orbigny, 1846; *Buccella granulata* (di Napoli Allita, 1952); and *Elphidium advenum* (Cushman, 1922) with decreasing relative abundance. Although species are not generally confined to distinct depth range, the relative abundance of some species increases or decreases in distinct depth zones. These species are *Amphistegina lobifera* and some species of genus *Rosalina* representing the infralittoral zone*; Bigeneria nodosaria, Globocassidulina subglobosa*, some cibicid species and *Eponides concameratus* representing the upper circalittoral zone*; Nodosaria subpervesa* and *Trifarina bradyi* representing the lower circalittoral zone.

In the present study, some lessepsian migrants including *Peneroplis pertusus*, *Septoloculina angulata, Septloculina rotunda, Septoloculina tortuosa, Vertebralina striata,* and *Amphistegina lobifera* are dominant at the southeastern parts of the gulf (nearest parts of the gulf to the Suez Canal). *Edentostomina cultrata, Edentostomina milletti, Nodopthalmidium antillarum*, *Sigmohauerina bradyi, Pseudomassilina australis, Triloculina asymetrica, Articulina alticostata,* *Articulina mayori, Articulina carinata, Peneroplis planatus, Peneroplis arietinus, Amphisorus hemprichii, Sorites orbiculus, Planispirinella exigua* and *Elphidium striatopunctatum* are also other migrants with low relative abundances.

With an abruptly increase importance of quantitative methods in paleontology, the application of statistical procedures and analytical methods become vital. In this manner, some statistical methods generally used in ecological data analysis, such as cluster analysis, etc. have been also used to explain the reason of changes in diversity and abundance of benthic foraminifers in this study. These statistical analyses have been recently applied by paleontologists and there is a limited usage of them. Because there is no unity in the methods, all methods used in similar studies have been applied to the counts of species and results of these analyses have been compared and discussed. In this study, diversity of the benthic foraminifers in each sample is generally extremely high and has very similar value to each other.

In order to visualize foraminiferal assemblages and their representative species, cluster analysis has been applied to counts of species in each sample. Canonical correspondence analysis has been used to relate the faunal data to a set of measured environmental parameters. In Turkey, there were only two applications of cluster analysis on benthic foraminifers (Avşar, 1997 and Basso and Spezzaferri, 2000). Canonical correspondence analysis has not been used in micropaleontological studies in Turkey. Therefore, this study is first application of canonical correspondence analysis and important for this respect.

Cluster Analysis and canonical correspondence analysis have allowed recognizing the correlation between samples and environmental variables. With an aid of these analyses, clear geographical patterns in specific areas and three distinct clusters, which are mainly controlled by $CaCO_3$ and substrate have been determined. It could be concluded that assemblages are not strongly depended on depth as it expected. Douglas (1979) stated that water depth is simply the gradient along which some environmental parameters can vary and it is not a controlling factor itself. If more samples were taken from the bathyal and the infralittoral zones (especially 0-20 meter), the influence of depth on the distribution of benthic foraminifers would be determined accurately by comparing assemblages from the different depth zones.

As a conclusion, this study would be a basis of future studies to detect the responses of foraminifers to environmental conditions in the past. Since modern foraminiferal distributions give clues for their analog ancient marine environments, the results of this study would be used for interpretation of environmental changes in the past. If it is possible to get core samples in the gulf of İskenderun in future, the data would be interpreted by using the results of this study.

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APPENDIX –A

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Adelosina cliarensis*	*Adelosina elegans*	*adelosina ele-med*	*Adelosina mediterranensis*	*Adelosina partschi*	*Adelosina pulchella*	*Ammonia beccarii*	*Ammonia inflata*	*Ammonia parkinsoniana*	*Ammonia tepida*
72	**18**	24	3	8	2	0	2	2	0	6	2
71	**18**	66	1	4	3	0	1	0	1	7	17
30	**35**	6	0	0	3	0	14	0	0	0	0
45	**35**	17	0	6	3	0	30	0	2	0	22
33	**38**	3	0	5	14	0	4	0	0	0	1
24	**41**	16	0	3	1	0	0	0	0	7	13
68	**44**	13	0	6	5	0	30	0	0	0	5
44	**45**	15	0	2	4	3	22	0	1	0	13
48	**49**	28	0	3	3	4	7	5	1	0	32
34	**50**	20	1	0	0	0	3	0	0	0	58
43	**55**	34	0	1	7	0	24	0	0	0	49
61	**58**	4	0	1	13	0	17	16	0	0	3
51	**58**	35	0	5	4	0	8	0	3	0	38
13	**64**	8	0	0	0	0	0	0	0	1	49
29	**65**	15	2	5	2	0	1	0	0	0	66
31	**65**	5	0	0	1	0	10	3	5	0	11
54	**65**	3	0	11	10	0	12	1	7	0	3
39	**65**	2	0	1	0	0	8	6	5	1	8
52	**70**	0	1	0	4	1	14	9	9	28	1
55	**70**	32	0	0	2	2	19	0	0	0	32
23	**71**	4	0	1	0	0	0	0	0	0	0
38	**71**	19	1	0	4	0	9	5	3	0	37
18	**76**	26	0	0	0	0	0	0	0	7	4
36	**77**	3	0	0	2	0	8	16	2	0	1
26	**77**	6	0	0	1	0	4	12	2	0	6
25	**78**	15	0	0	0	0	3	0	0	1	43
21	**80**	4	1	1	1	0	14	2	6	2	2
17	**80**	0	0	0	1	0	6	4	7	0	3
19	**80**	1	0	1	0	0	5	0	1	0	2
27	**83**	37	0	0	0	0	4	3	0	0	46
4	**94**	0	0	0	0	0	4	1	0	0	4
3	**117**	47	2	0	0	0	0	0	0	6	1
1	**137**	33	0	1	0	0	0	0	0	8	3
2	**190**	32	0	3	1	0	5	0	2	0	25

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Amphicoryna scalaris*	*Amphisorus hemrichii*	*Amphistegina lobifera*	*Articulina alticostata*	*Articulina carinata*	*Articulina mayori*	*Asterigerinata mamilla*	*Astrononion stelligerum*	*Bigenerina nodosaria*	*Biloculinella globula*
72	18	0	0	1	3	1	0	7	0	0	0
71	18	0	0	0	2	0	0	2	1	0	0
30	35	0	0	42	0	2	0	14	0	0	0
45	35	0	0	0	0	0	0	1	1	0	0
33	38	0	1	1	6	2	0	5	0	0	0
24	41	0	1	0	4	10	0	2	20	0	0
68	44	0	0	0	0	0	0	0	1	0	0
44	45	0	0	0	0	0	0	0	0	0	0
48	49	0	0	0	13	0	0	0	0	0	0
34	50	0	0	0	15	3	3	0	2	0	0
43	55	0	0	0	8	0	0	0	7	0	0
61	58	0	0	0	0	0	0	0	5	0	0
51	58	0	0	0	13	1	0	0	0	0	0
13	64	0	0	0	3	3	1	0	0	0	0
29	65	0	0	0	11	2	0	3	4	0	0
31	65	0	0	0	0	0	0	21	5	0	0
54	65	0	0	0	0	0	0	4	0	0	0
39	65	2	0	0	0	0	0	0	0	0	0
52	70	0	0	0	1	0	0	6	0	0	0
55	70	0	0	0	8	0	0	1	0	0	0
23	71	0	0	0	0	0	0	0	0	1	0
38	71	0	0	0	5	0	0	1	2	0	0
18	76	0	0	0	0	0	0	1	7	0	0
36	77	0	0	0	0	0	0	0	3	0	0
26	77	0	0	0	0	0	0	0	3	3	0
25	78	0	0	0	5	0	1	1	5	0	0
21	80	1	0	0	0	0	0	0	0	11	0
17	80	0	0	0	0	0	0	0	4	4	0
19	80	0	0	0	0	0	0	0	0	3	1
27	83	0	0	0	14	0	0	0	2	0	0
4	94	1	0	0	0	0	0	0	0	0	0
3	117	0	0	0	9	2	0	2	1	0	0
1	137	0	0	0	0	1	0	0	0	0	0
2	190	0	0	0	11	0	1	0	3	0	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Biloculinellla inflata*	*Biloculinellla labiata*	*Brizalina earlandi*	*Brizalina spathulata*	*Brizalina striatula*	*Buccella granulata*	*Bulimina aculeata*	*Bulimina elongata*	*Bulimina marginata*	*Bulumina marginata biserialis*
72	18	0	0	0	0	0	2	0	2	0	0
71	18	0	0	0	0	0	3	1	0	0	0
30	35	0	0	0	0	0	0	0	0	0	0
45	35	0	0	0	0	0	23	2	7	0	0
33	38	0	0	0	1	0	1	1	0	0	0
24	41	0	0	0	3	0	6	2	11	0	0
68	44	0	0	0	0	1	39	2	3	0	0
44	45	0	0	0	0	0	4	6	3	0	1
48	49	0	0	0	0	0	2	1	6	0	1
34	50	0	0	0	3	0	2	2	15	0	0
43	55	0	0	3	1	0	2	6	2	1	2
61	58	0	0	0	0	0	8	1	3	10	0
51	58	0	0	0	1	1	11	7	2	2	0
13	64	0	0	0	1	0	3	0	18	0	0
29	65	0	0	0	1	0	0	2	7	0	1
31	65	0	0	0	0	0	1	1	2	0	0
54	65	0	0	0	0	0	11	1	0	0	0
39	65	0	2	0	0	0	7	4	1	16	0
52	70	0	0	0	0	0	33	0	0	0	0
55	70	0	0	0	1	0	12	5	4	0	1
23	71	0	0	0	0	0	0	5	1	1	0
38	71	0	0	0	1	0	18	2	6	1	0
18	76	0	0	0	1	0	7	0	0	0	0
36	77	0	0	0	0	0	12	4	1	26	0
26	77	0	0	0	0	0	22	9	4	34	0
25	78	0	0	0	1	0	0	5	21	0	0
21	80	1	3	0	0	0	1	2	0	2	0
17	80	0	0	0	0	0	9	5	0	23	0
19	80	2	0	0	0	0	2	5	0	8	0
27	83	0	0	0	0	0	0	7	0	1	1
4	94	0	0	0	3	0	11	8	0	13	0
3	117	0	0	0	6	0	10	0	2	0	0
1	137	0	0	0	0	0	17	0	0	0	0
2	190	0	0	0	3	0	0	1	23	0	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Cassidulina carinata*	*Challengerella bradyi*	*Cibicides refulgens*	*Cibicides* sp.A	*Cibicides* sp.B	*Conorbella imperatoria*	*Conorbella patelliformis*	*Conorbella pulvinata*	*Cornuspira involvens*	*Cribroelphidium poeyanum*	*Cycloforina contorta*
72	18	0	13	0	0	0	4	0	0	1	0	1
71	18	0	0	0	0	0	2	0	0	0	12	0
30	35	0	0	1	0	0	0	1	0	0	0	0
45	35	0	0	1	0	0	0	0	0	10	12	0
33	38	0	0	1	0	0	0	0	0	2	0	0
24	41	0	0	0	0	0	5	4	4	0	5	2
68	44	0	0	0	0	0	0	0	0	5	11	0
44	45	0	0	7	0	0	2	0	0	31	0	0
48	49	2	0	0	0	0	1	0	0	6	28	2
34	50	0	0	1	0	0	2	1	2	4	6	0
43	55	0	0	0	0	1	0	0	0	4	14	4
61	58	0	5	4	0	3	0	0	0	6	7	3
51	58	0	1	1	0	0	0	0	0	9	11	0
13	64	0	0	2	0	0	0	1	2	3	12	0
29	65	0	0	0	0	0	2	0	0	6	6	1
31	65	0	6	15	1	12	0	0	0	1	11	0
54	65	0	0	13	5	1	3	0	2	4	1	0
39	65	0	0	8	0	1	0	0	0	9	11	1
52	70	0	8	3	7	11	0	0	0	0	2	1
55	70	0	0	3	0	0	1	0	0	8	13	0
23	71	0	0	1	0	0	0	0	0	0	1	0
38	71	0	0	1	0	0	2	2	0	3	4	0
18	76	0	0	0	0	0	9	8	0	0	6	0
36	77	0	0	14	0	1	0	0	0	4	3	0
26	77	0	0	4	0	13	0	0	0	6	5	0
25	78	0	0	0	0	0	1	0	2	4	13	2
21	80	0	0	2	3	4	0	0	0	6	10	1
17	80	0	0	0	2	0	0	0	0	3	6	0
19	80	5	0	7	0	24	0	0	0	8	15	0
27	83	0	0	0	0	0	0	0	1	4	31	1
4	94	3	0	6	1	11	0	0	0	1	11	1
3	117	0	0	0	0	0	4	6	1	2	8	1
1	137	0	0	0	0	0	5	0	4	0	0	0
2	190	0	0	0	0	0	0	0	1	7	15	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Dentalina aphelis*	*Dentalina inflexa*	*Dentalina subsoluta*	*Discorbinella bertheloti*	*Edenstomina cultrata*	*Edentostamina milletti*	*Eggerella advena*	*Eggerella scabra*	*Elphidium advenum*	*Elphidium craticalatum*
72	18	0	0	0	2	0	0	0	0	4	4
71	18	0	0	0	0	0	2	0	0	23	0
30	35	0	0	0	3	0	0	0	0	0	1
45	35	0	0	0	3	0	0	0	0	13	1
33	38	0	0	0	3	0	0	0	0	0	0
24	41	0	0	0	2	0	3	0	3	16	0
68	44	0	0	0	1	0	0	0	0	8	0
44	45	0	0	0	4	0	3	0	0	1	0
48	49	1	2	0	0	0	4	0	3	5	0
34	50	0	0	0	9	0	13	0	4	4	0
43	55	0	0	0	6	0	6	0	0	14	0
61	58	0	0	0	0	0	1	0	0	2	0
51	58	0	0	0	13	0	2	0	0	13	0
13	64	0	0	0	11	1	4	0	2	6	0
29	65	0	0	0	9	0	1	0	2	11	0
31	65	0	0	0	4	0	0	0	0	15	6
54	65	0	0	0	0	0	0	0	0	5	0
39	65	0	0	0	0	0	0	0	0	0	0
52	70	0	0	0	0	0	0	0	0	17	0
55	70	0	0	0	1	0	5	0	2	12	2
23	71	0	0	2	1	0	0	0	0	0	0
38	71	0	0	0	1	0	0	0	0	17	0
18	76	0	0	0	0	0	3	0	0	6	1
36	77	0	2	0	0	0	0	0	0	4	0
26	77	0	0	0	0	0	0	0	0	1	0
25	78	0	0	0	16	0	2	0	1	6	0
21	80	0	0	0	3	0	2	0	0	0	0
17	80	0	0	0	0	0	0	0	0	0	0
19	80	0	0	0	0	0	0	0	0	6	0
27	83	0	0	0	13	0	2	0	3	12	0
4	94	0	0	0	0	0	0	0	0	6	2
3	117	0	0	0	2	0	1	0	0	8	2
1	137	0	0	0	0	0	0	0	0	4	1
2	190	1	0	0	17	0	2	1	3	2	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Elphidium crispum*	*Elphidium jenseni*	*Elphidium macellum*	*Elphidium striopunctatum*	*Elphidium translucens*	*Eponides concameratus*	*Favulina hexagona*	*Fissurina alveolata*	*Fissurina lucida*	*Fissurina neptunii*
72	18	11	0	2	4	0	0	0	0	0	0
71	18	4	0	0	0	0	0	0	0	0	0
30	35	10	0	8	0	0	0	0	0	0	0
45	35	2	0	4	0	0	0	0	0	0	0
33	38	14	1	6	5	0	0	0	0	0	0
24	41	0	0	1	0	0	0	0	0	0	0
68	44	1	0	0	0	0	0	0	0	0	0
44	45	0	0	0	0	0	0	0	0	0	0
48	49	0	0	0	0	0	0	0	0	0	0
34	50	0	0	0	0	0	0	0	0	0	0
43	55	0	0	3	0	0	0	0	0	0	2
61	58	5	0	18	0	0	0	0	0	0	0
51	58	1	0	3	0	0	0	0	0	0	0
13	64	0	0	0	1	0	0	0	0	0	0
29	65	0	0	0	0	0	0	0	0	0	0
31	65	12	0	8	0	0	0	0	0	0	0
54	65	13	3	8	0	0	11	0	0	0	0
39	65	5	1	4	0	0	0	0	0	0	0
52	70	4	1	8	0	0	0	0	0	0	0
55	70	0	0	2	0	0	0	0	0	0	0
23	71	0	0	0	0	0	0	0	0	0	0
38	71	0	7	11	2	0	0	0	0	0	0
18	76	0	0	0	0	0	0	0	0	0	0
36	77	6	0	12	0	0	0	0	0	0	0
26	77	9	2	5	0	0	0	0	0	0	0
25	78	0	0	0	0	0	0	0	0	0	0
21	80	8	0	5	0	0	0	0	1	4	0
17	80	1	2	1	0	0	0	0	0	0	0
19	80	1	0	1	0	0	0	1	0	0	0
27	83	0	0	0	0	2	0	0	0	0	0
4	94	4	4	0	0	0	0	0	0	0	1
3	117	0	0	2	1	0	0	0	0	0	0
1	137	0	0	0	1	0	0	0	0	0	0
2	190	0	0	0	0	2	0	0	0	0	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Fissurina orbignyana*	*Fursenkoina scheibosciana*	*Galevinopsis phrageri*	*Glandulina sp*	*Globocassidulina subglobosa*	*Globocassidulina subglobosa uniserial*	*Globulina minuta*	*Lachlanella bicornis*	*Lachlanella undulata*	*Lachlanella variolata*
72	18	0	0	0	0	0	0	0	0	0	0
71	18	0	0	0	0	0	0	0	0	0	0
30	35	0	0	0	0	0	0	0	0	0	2
45	35	0	1	4	0	0	0	0	0	0	0
33	38	0	0	0	0	0	0	0	2	0	0
24	41	0	0	0	0	0	0	0	0	0	0
68	44	0	0	2	0	0	0	0	0	0	0
44	45	0	1	7	0	0	0	0	0	0	0
48	49	0	0	5	0	0	0	0	0	0	0
34	50	0	0	4	0	0	0	0	0	0	0
43	55	0	0	0	0	0	0	0	0	0	0
61	58	0	0	3	0	0	0	0	0	1	0
51	58	0	0	1	0	0	0	0	0	0	0
13	64	0	0	0	0	0	0	0	0	0	0
29	65	0	1	0	0	0	0	0	0	0	0
31	65	0	0	0	0	0	0	0	0	0	0
54	65	1	0	0	0	0	0	0	0	2	0
39	65	0	0	2	0	1	0	0	0	0	0
52	70	0	0	0	1	0	0	0	0	1	0
55	70	0	0	1	0	0	0	0	0	0	0
23	71	0	0	0	0	0	0	0	0	0	0
38	71	0	0	3	0	0	0	0	0	0	0
18	76	0	0	1	0	0	0	0	0	0	1
36	77	0	0	1	0	3	0	1	0	0	0
26	77	0	0	4	0	22	0	0	0	0	0
25	78	0	2	1	0	0	0	0	0	0	0
21	80	0	0	3	0	5	1	0	0	0	0
17	80	0	0	5	0	26	6	0	0	2	0
19	80	0	0	1	0	6	2	0	0	0	0
27	83	0	2	0	0	0	0	0	0	0	0
4	94	0	0	2	0	3	0	0	0	0	0
3	117	0	0	1	0	0	0	0	0	0	1
1	137	0	0	0	0	0	0	0	0	0	0
2	190	0	0	1	0	0	0	0	0	0	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Lagena striata*	*lagena strumosa*	*Lagenammina diffusiformis*	*Lamarkiana scabra*	*Lobatula lobatula*	*Miliolinella elongata*	*Miliolinella labiosa*	*Miliolinella sp.*	*Miliolinella subrotunda*	*Neoconorbina terquemi*
72	18	0	0	0	0	0	0	0	0	0	2
71	18	0	0	0	0	0	0	0	0	11	0
30	35	0	0	0	0	0	0	0	0	0	2
45	35	0	0	0	0	0	0	0	0	0	0
33	38	0	0	2	0	1	0	1	0	3	4
24	41	0	0	0	1	2	0	0	0	4	2
68	44	0	0	2	0	0	0	0	0	0	0
44	45	0	1	0	0	1	0	0	0	0	0
48	49	0	1	3	0	0	0	0	0	0	0
34	50	0	0	0	0	0	0	0	0	5	0
43	55	0	0	0	0	0	0	0	0	0	0
61	58	0	0	0	0	1	0	0	0	0	1
51	58	0	0	3	0	0	0	0	0	0	0
13	64	0	0	0	0	0	0	6	0	10	0
29	65	1	0	1	0	0	0	0	0	3	0
31	65	1	0	0	0	3	1	0	0	1	5
54	65	0	0	0	0	5	0	0	0	2	7
39	65	0	0	0	0	3	1	0	0	0	0
52	70	0	0	0	0	0	0	0	0	0	6
55	70	0	0	3	0	0	0	0	0	0	0
23	71	0	3	0	0	0	0	0	0	0	0
38	71	0	0	0	0	0	0	0	0	1	0
18	76	0	0	0	0	0	0	0	0	2	1
36	77	0	0	0	0	0	0	0	0	0	0
26	77	0	1	0	0	0	0	0	0	0	0
25	78	1	0	0	0	0	0	2	0	6	2
21	80	1	0	0	0	10	0	0	1	0	1
17	80	0	0	0	0	2	0	0	0	0	0
19	80	0	0	1	0	3	0	0	0	0	0
27	83	1	0	0	0	0	0	0	0	0	1
4	94	0	0	0	0	4	0	0	0	1	0
3	117	0	0	0	0	0	0	0	0	0	0
1	137	0	0	0	0	0	0	0	0	0	0
2	190	0	1	0	0	0	0	0	0	0	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Neoeponides bradyi*	*Nodoptalmidium antillarium*	*Nodosaria subpervesa*	*Nonion depressulum*	*Nonion sp.*	*Nonionella turgida*	*Nonionoides grateloupi*	*Nubeloculina divaricata*	*Parahauerinoides bradyi*	*Parrina bradyi*
72	18	0	0	0	1	1	0	0	0	0	0
71	18	0	0	0	4	34	0	0	0	0	3
30	35	4	0	0	0	0	0	0	0	11	0
45	35	1	0	0	2	17	0	0	0	0	0
33	38	4	0	0	0	6	0	0	0	0	1
24	41	1	0	0	4	1	0	0	0	0	0
68	44	1	0	0	0	44	0	0	0	0	0
44	45	4	0	0	0	5	1	0	0	0	0
48	49	1	0	0	13	15	1	0	0	0	0
34	50	0	0	0	13	5	0	10	0	0	0
43	55	0	0	0	0	11	0	0	0	0	0
61	58	3	0	0	4	19	0	0	0	0	0
51	58	1	0	0	0	4	0	0	0	0	0
13	64	0	0	0	13	4	0	4	0	0	2
29	65	0	1	0	2	11	0	4	0	0	1
31	65	22	0	0	4	18	0	0	1	0	0
54	65	17	0	0	9	26	0	0	0	0	0
39	65	0	0	0	11	58	0	0	0	0	0
52	70	15	0	0	1	6	0	0	0	0	0
55	70	1	1	0	15	17	0	0	0	0	0
23	71	0	0	0	2	0	0	0	0	0	0
38	71	0	2	0	4	9	0	0	1	0	0
18	76	1	0	0	1	0	0	0	0	0	0
36	77	4	0	0	6	23	0	0	0	0	0
26	77	12	0	0	1	23	0	0	0	0	0
25	78	0	0	0	18	9	0	7	0	0	4
21	80	22	0	0	0	8	0	0	0	0	0
17	80	9	0	0	4	29	0	0	0	0	0
19	80	0	0	0	5	28	0	0	0	0	0
27	83	0	11	0	24	5	3	6	0	0	0
4	94	4	0	0	2	53	1	0	0	0	0
3	117	0	0	0	8	4	0	0	0	2	0
1	137	0	0	0	0	0	0	0	0	0	0
2	190	0	0	1	15	11	0	11	0	0	3

Distribution of foraminifers in the studied samples

Sample No:	Depth	Peneroplis arietinus	Peneroplis pertusus	Peneroplis planatus	Planispirinella exigua	Planorbulina acervalis	Planorbulina mediterranensis	Porosononion granosum	Pseudomassilina australis	Pseudotriloculina laevigata
72	18	0	49	27	0	0	0	1	0	0
71	18	0	13	3	0	0	0	6	0	0
30	35	0	23	16	0	0	0	1	0	0
45	35	0	0	0	0	1	0	1	0	0
33	38	3	39	14	0	0	3	2	1	0
24	41	1	25	4	0	0	4	0	0	3
68	44	0	0	0	0	0	0	7	0	0
44	45	0	0	0	0	0	0	0	0	0
48	49	0	0	0	0	0	0	2	0	1
34	50	0	7	0	0	0	1	0	0	0
43	55	0	0	0	0	0	0	0	0	0
61	58	0	0	0	0	0	0	4	0	0
51	58	0	8	0	0	0	1	2	0	0
13	64	0	16	2	2	1	0	0	0	2
29	65	0	0	0	0	1	0	0	0	0
31	65	0	0	0	0	0	8	12	0	0
54	65	0	0	0	0	0	2	14	0	0
39	65	0	0	0	0	0	6	10	0	0
52	70	0	1	0	0	0	2	20	0	0
55	70	0	2	1	0	0	0	4	0	0
23	71	0	0	0	0	0	0	0	0	0
38	71	0	20	1	0	0	1	1	0	0
18	76	0	102	5	0	0	0	0	0	0
36	77	0	0	0	0	0	5	13	0	0
26	77	0	1	0	0	0	2	4	0	0
25	78	0	6	0	0	1	0	1	0	0
21	80	0	0	0	0	0	8	2	0	0
17	80	0	0	0	0	0	1	20	0	0
19	80	0	0	0	0	0	10	8	0	0
27	83	0	1	0	0	0	0	1	0	0
4	94	0	0	0	0	0	2	3	0	0
3	117	0	51	9	9	0	1	0	0	0
1	137	2	103	4	0	0	0	0	0	0
2	190	0	0	0	0	0	0	2	0	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Pseudotriloculina rotunda*	*Pyrgo elongata*	*Pyrgo inornata*	*Quinqueloculina berthelotiana*	*Quinqueloculina bosciana*	*Quinqueloculina laevigata*	*Quinqueloculina limbata*	*Quinqueloculina seminillum*	*Quinqueloculina viennensis*	*Rectuvigerina phlegeri*
72	18	0	0	0	2	2	0	0	0	0	0
71	18	0	0	0	0	0	0	0	5	0	0
30	35	0	0	0	5	2	0	0	1	2	0
45	35	0	0	0	0	0	0	0	1	0	0
33	38	0	0	0	0	0	0	4	0	0	0
24	41	0	0	0	0	9	0	0	4	2	1
68	44	0	0	0	0	0	0	0	16	0	3
44	45	0	0	0	0	1	0	0	7	0	0
48	49	0	0	0	0	0	0	0	1	0	0
34	50	0	0	0	0	24	0	0	1	1	0
43	55	0	0	0	0	2	2	0	12	0	1
61	58	0	0	0	1	0	0	0	9	0	4
51	58	0	0	0	0	2	0	0	3	0	0
13	64	0	0	0	4	14	0	0	3	2	0
29	65	0	0	0	1	5	6	0	1	0	0
31	65	0	0	0	1	1	0	0	0	0	0
54	65	0	0	0	7	0	0	0	1	0	0
39	65	0	0	0	2	0	0	0	3	0	1
52	70	0	0	0	0	0	0	0	3	0	1
55	70	0	0	0	1	0	0	0	5	0	0
23	71	0	0	0	0	0	0	0	2	0	1
38	71	0	0	0	1	0	0	0	4	0	0
18	76	1	0	0	2	1	4	0	8	4	0
36	77	0	0	1	0	0	0	0	3	0	0
26	77	0	0	3	0	0	0	0	0	0	0
25	78	0	0	0	0	3	0	0	3	5	0
21	80	0	1	1	2	0	2	0	3	0	0
17	80	0	1	1	0	0	0	0	3	0	0
19	80	0	0	0	0	0	0	0	0	0	0
27	83	0	0	0	0	3	0	0	2	0	0
4	94	0	1	0	0	1	0	0	0	0	0
3	117	0	0	0	0	1	1	0	3	2	0
1	137	0	0	0	0	6	1	0	14	0	0
2	190	0	0	1	0	12	8	0	1	1	1

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Reophax scorpiurus*	*Reussella spinulosa*	*Robertinoides sp.*	*Rosalina bradyi*	*Rosalina floridensis*	*Rosalina sp.A*	*Sahulia conica*	*Septloculina angulata*	*Septloculina rotunda*	*Septloculina tortuosa*
72	18	0	1	0	2	0	0	2	14	11	5
71	18	1	1	0	5	0	0	0	3	0	0
30	35	0	1	0	4	2	3	6	28	2	0
45	35	0	41	0	1	0	0	4	0	0	0
33	38	0	7	0	10	0	0	1	34	11	2
24	41	0	0	0	2	2	0	0	3	0	2
68	44	0	23	0	0	0	0	1	0	0	0
44	45	0	22	0	0	0	0	3	0	0	0
48	49	0	23	0	0	0	0	5	0	0	0
34	50	0	0	0	0	0	0	1	0	0	0
43	55	0	13	0	0	0	0	0	1	0	0
61	58	0	18	0	0	0	0	7	0	0	0
51	58	0	25	0	0	0	0	6	0	0	0
13	64	0	0	0	0	0	0	0	4	0	2
29	65	0	1	0	0	0	0	11	1	0	0
31	65	0	13	0	4	0	0	0	1	0	0
54	65	0	7	1	1	0	0	1	0	1	0
39	65	0	15	0	0	0	0	3	0	0	0
52	70	0	4	0	1	0	0	2	0	0	0
55	70	0	6	0	0	0	0	1	0	0	0
23	71	0	1	0	0	0	0	0	0	0	0
38	71	0	28	0	1	0	0	2	9	1	0
18	76	0	0	0	1	0	0	0	34	4	3
36	77	0	19	0	0	1	0	8	0	0	0
26	77	0	14	0	0	0	0	2	0	0	0
25	78	0	0	1	0	1	0	1	0	0	0
21	80	0	7	0	0	3	0	6	0	0	0
17	80	0	12	0	0	0	0	0	0	0	0
19	80	0	34	0	1	1	0	9	0	0	0
27	83	0	1	0	0	0	0	2	0	0	0
4	94	0	25	0	0	0	0	4	0	0	0
3	117	0	0	0	0	0	0	0	15	4	0
1	137	0	0	0	0	0	0	0	30	3	4
2	190	0	1	0	0	0	0	4	1	0	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Sigmoilina costata*	*Sigmoilopsis schlumbergeri*	*Siphonaperta agglutinans*	*Siphonaperta aspera*	*Siphonina pulchra*	*Siphonina reticulata*	*Siphotextularia concava*	*Sorites orbiculus*	*Sphaerogypsina globulus*	*Sphaeroidina bulloides*
72	18	2	0	5	10	0	0	1	3	0	0
71	18	3	0	4	8	0	1	0	5	0	0
30	35	0	0	9	7	0	0	0	2	4	0
45	35	0	1	0	0	0	0	8	0	0	0
33	38	3	0	2	2	0	3	0	4	0	0
24	41	12	0	0	7	0	0	1	12	0	0
68	44	0	1	0	0	0	0	0	0	0	0
44	45	1	3	0	1	0	1	2	0	0	0
48	49	3	0	0	0	0	0	2	0	0	0
34	50	2	0	0	0	0	0	0	0	0	0
43	55	5	0	0	0	0	0	0	1	0	0
61	58	0	11	0	0	0	0	0	0	0	0
51	58	3	0	0	1	0	1	2	0	0	0
13	64	9	0	1	8	0	0	0	6	0	0
29	65	3	0	0	0	0	0	1	0	0	0
31	65	2	1	1	0	2	2	2	0	0	0
54	65	0	0	0	0	0	0	0	0	1	0
39	65	0	8	0	1	0	0	1	0	0	0
52	70	1	0	0	0	0	1	0	0	0	0
55	70	1	0	0	0	0	0	0	0	0	0
23	71	0	1	0	0	0	0	3	0	0	0
38	71	4	0	0	5	0	2	0	0	0	0
18	76	9	0	0	1	0	0	0	6	0	0
36	77	0	6	0	6	0	0	0	0	0	0
26	77	0	2	0	0	0	0	0	0	0	0
25	78	5	0	0	0	0	0	0	0	0	0
21	80	0	6	1	0	0	0	2	0	0	0
17	80	0	3	0	0	0	1	1	0	0	0
19	80	0	0	0	0	0	0	2	0	0	0
27	83	3	0	0	1	0	0	1	0	0	0
4	94	0	2	0	1	0	0	1	0	0	0
3	117	7	0	1	15	0	0	0	16	0	0
1	137	9	0	0	9	0	0	0	9	0	0
2	190	6	0	4	3	0	0	2	0	0	1

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Spirillina vivapora*	*Spiroplectinella sagittula*	*Spiroloculina angulosa*	*spiroloculina corrugata*	*Spiroloculina depressa*	*Spiroloculina excavata*	*Spiroloculina ornata*	*Spiroloculina ornata tricarinata*	*Spiroloculina tenuiseptata*
72	18	1	0	1	1	0	2	1	1	5
71	18	0	0	0	3	0	0	4	2	3
30	35	0	0	3	6	2	0	0	0	4
45	35	0	0	0	1	0	0	0	0	9
33	38	1	0	0	1	2	0	3	2	2
24	41	0	0	0	1	0	0	0	1	0
68	44	0	0	0	0	1	0	0	0	0
44	45	0	3	0	0	0	0	2	0	6
48	49	0	0	1	3	2	0	0	0	5
34	50	0	0	0	0	0	0	1	3	3
43	55	0	0	0	0	4	0	0	2	8
61	58	0	0	0	0	2	0	2	0	3
51	58	0	6	0	0	0	0	5	0	2
13	64	0	0	0	2	0	0	1	4	1
29	65	0	2	0	1	4	0	2	1	6
31	65	0	0	0	0	1	1	0	0	0
54	65	0	0	0	0	0	1	0	0	0
39	65	0	0	0	0	3	0	0	0	2
52	70	0	1	0	0	0	4	1	0	0
55	70	0	0	0	0	2	0	6	1	20
23	71	0	0	0	0	0	2	0	0	0
38	71	0	1	0	0	0	0	2	2	3
18	76	0	0	0	2	0	0	0	0	1
36	77	0	0	0	0	8	0	0	0	5
26	77	0	0	0	0	2	1	0	0	0
25	78	0	0	0	2	0	0	4	3	7
21	80	0	3	0	0	2	2	5	0	3
17	80	0	0	0	0	4	0	0	0	6
19	80	0	0	0	0	2	2	0	0	4
27	83	0	0	0	0	0	0	2	0	6
4	94	0	0	0	0	0	0	1	0	0
3	117	0	0	0	0	0	0	1	0	4
1	137	0	0	0	1	0	0	0	0	1
2	190	0	0	0	0	4	0	3	1	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Textularia agglutinans*	*Textularia bocki*	*Textularia truncata*	*Trifarina bradyi*	*Triloculina asymetrica*	*Triloculina marioni*	*Triloculina oblonga*	*Triloculina plicata*	*Triloculina tricarinata*
72	18	0	4	3	0	0	6	0	1	1
71	18	2	1	1	0	0	6	3	2	3
30	35	0	6	0	0	0	7	0	0	4
45	35	0	20	7	0	0	3	0	0	6
33	38	0	10	0	0	0	3	0	0	2
24	41	0	0	0	0	0	10	3	0	2
68	44	0	33	10	0	0	1	0	0	3
44	45	2	63	7	0	0	5	0	0	3
48	49	0	23	1	0	0	0	2	0	5
34	50	0	4	0	0	1	5	11	0	1
43	55	0	13	1	0	0	3	3	0	5
61	58	0	42	6	0	0	0	0	1	1
51	58	0	17	5	0	0	0	5	0	2
13	64	1	1	0	0	0	6	23	0	1
29	65	2	31	2	0	0	0	9	0	1
31	65	0	7	0	0	0	1	2	0	5
54	65	4	8	3	0	0	8	1	9	1
39	65	0	22	4	0	0	2	0	0	2
52	70	12	8	5	0	0	6	0	0	0
55	70	0	11	3	0	0	7	11	2	1
23	71	1	4	0	0	0	0	0	0	0
38	71	0	10	3	0	0	0	0	0	3
18	76	0	0	0	0	0	2	1	0	0
36	77	2	21	0	0	0	2	0	0	4
26	77	0	7	3	0	0	1	0	1	4
25	78	0	16	0	0	0	1	16	0	4
21	80	0	28	6	0	0	6	2	0	2
17	80	0	7	0	0	0	3	0	0	1
19	80	6	6	9	0	0	1	0	0	3
27	83	0	15	3	0	1	2	5	0	1
4	94	2	2	0	0	0	0	1	0	0
3	117	0	0	0	0	0	1	0	0	3
1	137	0	0	0	1	0	0	2	0	2
2	190	0	30	2	0	0	0	5	0	0

Distribution of foraminifers in the studied samples

Sample No:	Depth	*Triloculina trigonula*	*Valvularina bradyana*	*Vertebralina striata*	*Plankton*
72	18	16	0	5	0
71	18	4	0	3	1
30	35	0	0	25	1
45	35	1	0	0	10
33	38	14	0	8	6
24	41	7	0	5	16
68	44	0	0	0	21
44	45	4	0	0	22
48	49	1	0	0	21
34	50	2	0	5	17
43	55	2	0	0	10
61	58	6	0	0	16
51	58	1	0	1	8
13	64	4	0	4	5
29	65	4	0	2	17
31	65	2	0	0	19
54	65	5	0	0	23
39	65	0	0	0	36
52	70	6	0	3	19
55	70	4	0	1	4
23	71	0	29	0	20
38	71	4	0	4	4
18	76	0	0	0	12
36	77	0	0	0	34
26	77	4	0	0	35
25	78	3	0	0	15
21	80	8	0	0	34
17	80	0	0	0	72
19	80	1	0	0	56
27	83	0	0	0	13
4	94	0	0	0	88
3	117	0	0	2	11
1	137	0	0	3	9
2	190	0	0	0	3

APPENDIX B

Some selected studies on the foraminifers for statistical methods

Author	Identified and counted foraminifers in the study	Used foraminifera for statistical analysis	Selection basis	Program	Transformation	Similarity matrix	Method
Basso and Spezzaferri, 2000	120 benthic species	35 benthic species and/or genera	frequency above 3%	PRIMER	double square root (x)	Pearson correlation index	
Burone *et al* ., 2006	not given	not given	Arithmetic Averages	MVPS	log (x+1)	Moristita-Horn	UPGMA
Clemmensen and Thomsen 2005	260 foram species	77 benthic species	frequency above 1%	NCSS97	Minimum variance	not given	Ward's Method
Ding *et al.* , 2006	18 planktonic species	8 planktonic species	similarity	JMP		Weighted average	Ward's Method
Elewa AMT, 2004	16 benthic species	16 benthic species	similarity	BioDiversity Pro	presence/absence	not given	Average linkage method
Ferraro *et al.*, 2006	34 benthic species	8 benthic species and/or genera	frequency above 3%	not given	relative percantage	Pearson correlation index	
Gupta *et al.* , 2006	not given	25 foram species	relative abundance above 2%	SAS	relative percentage	not given	Ward's Method
Haig, 2003	not given	not given	relative abundance	SPSS 1.1	relative abundance	not given	Group linkage and Euclidean distance method
Hammer and Harper, 2006		41 benthic species	frequency of occurrence and relative abundance	PRIMER 5.0.	log(x+1)	The Bray-Curtis	
Hayward *et al.* , 2002	389 benthic species	not given	relative percentage	not given	not given	The Bray-Curtis	not given
Hayward *et al.* , 2004b	244 benthic species	35 benthic species	relative abundance	MVSP	relative abundance	Pearson correlation index	?

Unweighted Pair Group Method: UPGMA

Some selected studies on the foraminifers for statistical methods

Author	Identified and counted foraminifers in the study	Used foraminifera for statistical analysis	Selection basis	Program	Transformation	Similarity matrix	Method
Hromic et al., 2006	175 benthic species	35 foram species	SIMPER analysis	PRIMER	log (x+1)	The Bray-Curtis	complete linkage
Jorissen, 1988	not given	50 benthic species	Most abundant	Balanc and Dendro	relative percantage	not given	
Kawagata, 2001	not given	63 benthic species	relative abundance	SPSS	not given	not given	not given
Martins *et al.* 2006	354 benthic species	not given	relative percentage	STATISTICA 5.1	not given	Pearson correlation index	Ward's Method
Mendes *et al.*, 2004	270 benthic species	22 benthic species	relative abundance	not given	degree of similarity	The Bray–Curtis	UPGMA
Morigi *et al.* , 2005	70 benthic species	24 benthic species	relative abundance	not given	relative percentage	not given	
Osterman, 2003	138 benthic species	93 benthic species	frequency above 1%	SYSTAT 5.2	presence/absence	The Bray-Curtis	Complete linkage method
Platon *et al.* , 2005	not given	not given	relative abundance	Excel and Statistica	not given	not given	Euclidean and Ward's method
Samir *et al.* , 2003	82 benthic species	24 benthic species	abundance above 3%	NTSYS	relative percantage	The Bray-Curtis	UPGMA
Singh and Gupta, 2004	not given	46 benthic species	relative abundance	SAS	minimum variance	not given	Ward's Method
Stefanelli *et al.* , 2005	not given	19 benthic species and/or genera	frequency above 3%	SPSS 9.0	relative percantage		Average linkage (within group)
Szarek *et al.* , 2006	584 benthic species	46 genera "spp."	relative abundance	not given	presence/absence	not given	CCA

UPGMA: Unweighted Pair Group Method

CCA: Canonical correspondence analysis

APPENDIX C

Geographical and bathymetrical distribution of the recorded species

Taxon List	Western Mediterranean Sea: Infralittoral zone	Western Mediterranean Sea: Upper circalittoral zone	Western Mediterranean Sea: Lower circalittoral zone	Levantine Sea: occurence	Red Sea: occurence	Aegean Sea: Infralittoralzone	Aegean Sea: Upper circalittoral zone	Aegean Sea: Lower circalittoral zone	Marmara Sea: Infralittoralzone	Marmara Sea: Upper circalittoral zone	Marmara Sea: Lower circalittoral zone	Western Black Sea: occurence	This Study: Infralittoralzone	This Study: Upper circalittoral zone	This Study: Lower circalittoral zone
Adelosina cliarensis	+	-	-	+		+	+	+	+	+		+	+	+	+
Adelosina elegans	+	+	+	+		+	+		+	+	-	-	+	+	+
Adelosina mediterranensis	+	+	+	+		+	+	+	+	+		+	+	+	+
Adelosina partschi	+	+				+	+	+	+	-	-	-	+	+	+
Adelosina pulchella	+	+	+	+	+	+	+	+	+	+	-	+	+	+	+
Ammonia beccarii	+								+	+		-	+	+	-
Ammonia inflata	-	-	-	+	-	+			+			-	+	+	
Ammonia parkinsoniana	+	+		+		+	+	+	+			+	+	+	+
Ammonia tepida	+	+		+		+	+	+	+			+	+	+	+
Amphicoryna scalaris	+	+	+	+	+	+	+	+	+			-	-	+	-
Amphisorus hemrichii	-	-	-	+	+	+			-	-	-	-	+	-	-
Amphistegina lobifera	-	-	-	+	+	+	+	-				-	+	-	-
Articulina alticostata	-	-	-	+	+	+	-	-	-	-	-	-	+	+	+
Articulina carinata	-	-	-	+	+	+	+	-	-	-	-	-	+	+	+
Articulina mayori	-	-	-	-		-	-	-	-	-	-	-	-	+	+
Asterigerinata mamilla	+	+	+	+		+	+	+				-	+	+	-
Bigenerina nodosaria	+	+	+	+	+	+	+	+	-	+	+	-	+	+	+
Biloculinellla inflata	-	+	+				+	+	-	-	-	-	-	+	-
Biloculinellla labiata	-	+	+			+	+	+			+	-	-	+	-
Bloculinella globula	-		+			+	+	+			+	-	-	+	-
Brizalina earlandi	-	-	-						-	-	-	-	-	+	-
Brizalina spathulata	+	+	+			+	+	+		+	+	-	-	+	-
Brizalina striatula	+					-	+	-			+	-	-	+	-
Buccella granulata	+	+				-	-	-	-	-	-	-	+	+	+
Bulimina aculeata		+	+	+		+	+	+		+	+	-	+	+	+
Bulimina elongata	+	+	+	+	+	+	+	+		+	+	-	+	+	+
Bulimina marginata	+	+	+	+	+	+	+	+	+	+		-	-	+	-
Cassidulina carinata		+	+	+	+	+	+	+				-	-	+	-
Challengerella bradyi	-	-	-	+	+	+	+	+		-	-	-	+	+	-
Cibicides refulgens						+	+	+	-	-	-	-	+	+	-
Conorbella imperatoria						+	+	+	-	-	-	-	+	+	+
Conorbella pulvinata	+	+	-	-	-	-	-	-	-	-	-	-	-	+	+
Cornuspira involvens	+	+	+			+	+	+				-	+		+
Cribroelphidium poeyanum	+	+	+			+	+	+				+	+	+	+
Discorbinella bertheloti	+	+	+									-	+	+	+
Elphidium advenum	+	+	+			+	+	+				-	+	+	+
Elphidium craticalatum				+	+	+	+	+	-	-	-	-	+	+	+
Elphidium crispum	+	+	+	+		+	+	+				+	+	+	+
Elphidium jenseni	+					+	-	-	-	-	-	-	+	+	-
Elphidium macellum	+	+	+	+		+	+	+				+	+	+	+
Elphidium striopunctatum	-	-	-						-	-	-	-	+	+	+
Eponides concameratus	+	+	+	+	-	+	+	+	+	+		-	-	+	-
Galevinopsis phrageri	+	+	+	+		-	+	+	-	-	-	-	+	+	+
Globocassidulina subglobosa		+	+			+	+	+				-	-	+	-
Lachlanella undulata	+	+	+	+		+	+	+		+		+	-	+	-
Lachlanella variolata	+			+		+			-	-	-	-	+	+	+
Lagena striata		+	+	+	+	+	+	+		+	+	-	-	+	-
Lagena strumosa	-	-	-	+	+	-	+	+	-	-	-	-	-	+	+
Lobatula lobatula	+	+	+	+	+	+	+	+				+	-	+	-
Miliolinella subrotunda	+	+	+	+		+	+	+				+	+	+	-
Neoconorbina terquemi	+	+	+			+	+	+	-	+	-	-	+	+	-

+ / - : presence / absence + / +: relative abundance <1 % / >1 %

Geographical and bathymetrical distribution of the recorded species

Taxon List	Western Mediterranean Sea			Levantine Sea	Red Sea	Aegean Sea			Marmara Sea			Western Black Sea	This Study		
	Infralittoral zone	Upper circalittoral zone	Lower circalittoral zone	occurence	occurence	Infralittoralzone	Upper circalittoral zone	Lower circalittoral zone	Infralittoralzone	Upper circalittoral zone	Lower circalittoral zone	occurence	Infralittoralzone	Upper circalittoral zone	Lower circalittoral zone
Neoeponides bradyi				+	+	+	+	+	-	-	-	-	+	+	-
Nodoptalmidium antillarium	-	-	-	+	+	-	-	-	-	-	-	-	-	+	-
Nonion depressulum	+			+		+	+	+				-	+	+	+
Nubeculina divaricata	+	-	-		-	-	-	-	-	-	-	-	-	+	-
Parahauerinoides bradyi	-	-	-	+	+	-	-	-	-	-	-	-	+	+	+
Parrina bradyi		-	-	+	+	+	-	-	-	-	-	-	+	+	+
Peneroplis pertusus	+	-	-	+	+	+	+	+	-	-	-	-	+	+	+
Peneroplis planatus	+	-	-	+	+	+	+	+	-	-	-	-	+	+	+
Planispirinella exigua	-	-	-	-		-	-	-	-	-	-	-	-	+	+
Planorbulina mediterranensis	+	+	+			+	+	+				-	+	+	+
Pseudomassilina austrailis	-	-	-	+	+	-	-	-	-	-	-	-	+	-	-
Quinqueloculina berthelotiana	+					+	+	+				-	+	+	-
Quinqueloculina bosciana	+	+	+			+			+	+		-	+	+	+
Quinqueloculina seminillum	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Reophax scorpiurus	+	+	+			+	+	+	-	-	-	-	+	-	-
Reussella spinulosa	+	+		+		+	+	+	+	+			+	+	+
Rosalina bradyi	+			+	+	+	+	+	+	+		+	+	+	-
Sahulia conica	+	+	+	+	+	+	+	+		+		-	+	+	+
Septloculina angulata	-	-	-	+	+	-	-	-	-	-	-	-	+	+	+
Septloculina rotunda	-	-	-	+	+	-	-	-	-	-	-	-	+	+	+
Septloculina tortusa	-	-	-	+	+	-	-	-	-	-	-	-	+	+	+
Sigmoilina costata				+		+	+	+				-	+	+	+
Sigmoilopsis schlumbergeri	+	+		+	+	+	+	+	+	-	-	-	+	+	-
Siphonaperta agglutinans				+	+	+	+		+			-	+	+	+
Siphonaperta aspera	+	+	+	+	+	+	+	+				+	+	+	+
Siphotextularia concava	+	+	+	+	+	+	+	+	+	+	+	-	+	+	+
Sorites orbiculus	+	-	-	+	+	+	-	-	-	-	-	-	+	+	+
Sphaerogypsina globulus	+	-	-	-	-	+	+	+	+	-	-	-	+	-	-
Spirillina vivipara	+	+	+	+		+	+	+		+		-	+	-	-
spiroloculina corrugata				+	+	+	+					-	+	+	+
Spiroloculina depressa	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Spiroloculina excavata	+	+	+	+	+	+	+	+	+	+		-	+	+	-
Spiroloculina ornata	+			-	-	+	+	+	-	-	-	+	+	+	+
Spiroloculina ornata tricarinata	+	+	+	-	-	-	-	-	-	-	-	-	+	+	+
Spiroloculina tenuiseptata	+	+	+			+	+	+	+	+		-	+	+	+
Textularia agglutinans	+	+	+	+	+	+	+	-	+	+	+	-	+	+	-
Textularia bocki	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Textularia truncata	+	+	+			+	+	+	+	+	+	+	+	+	+
Trifarina bradyi	-	-	+	-	-	-	-	-	-	-	-	-	-	-	+
Triloculina marioni	+	+		+		+	+	+	+	+	-	+	+	+	+
Triloculina oblonga	+	+	-	-	-	-	-	-	-	-	-	-	+	+	+
Triloculina plicata	+			+	+	+	+	+	-	-		-	+	+	-
Triloculina tricarinata	+	+	+			+	+	+				-	+	+	+
Triloculina trigonula	+	-	-	+	+	+	+	-	+	+	-	-	+	+	-
valvularina bradyana	+	+	+	-	-	+	+	+	-	+	+	-	-	+	-
Vertebralina striata	+	+	+	+		+	+	+	-		-	-	+	+	+

+ / - : presence / absence + / +: relative abundance <1 % / >1 %

APPENDIX D

EXPLANATION OF PLATES

From plate 1 to plate 10, the photographs of individuals have been taken on JSM-6400 Electron Microscope (JEOL), while the photographs of individuals have been taken on under reflected light microscope in plate 11.

PLATE 1

(Scale bar = 100 μm)

Figure 1: *Lagenammina difflugiformis* (Brady, 1879) , sample no: 68
Figure 2: *Spiroplectinella sagittula* (d'Orbigny, 1839), sample no: 51
Figure 3: *Eggerelloides advenus* (Cushman, 1922), sample no: 2
Figure 4: *Bigenerina nodosaria* d'Orbigny, 1826, sample no: 21
Figure 5: *Textularia pala* Czjzek, 1848, sample no: 44
Figure 6: *Siphotextularia concava* (Karrer, 1868), sample no: 45
Figure 7: *Spirillina vivipara* Ehrenberg, 1841, sample no: 33
Figure 8: *Cornuspira involvens* (Reuss, 1850), sample no: 44
Figure 9: *Cornuspira involvens* (Reuss, 1850), apertural view, sample no: 44
Figure 10: *Planispirinella exigua* (Brady, 1879); sample no: 3
Figure 11: *Planispirinella exigua* (Brady, 1879); sample no: 3
Figure 12: *Vertebralina striata* d’Orbigny, 1826, sample no: 30

PLATE 1

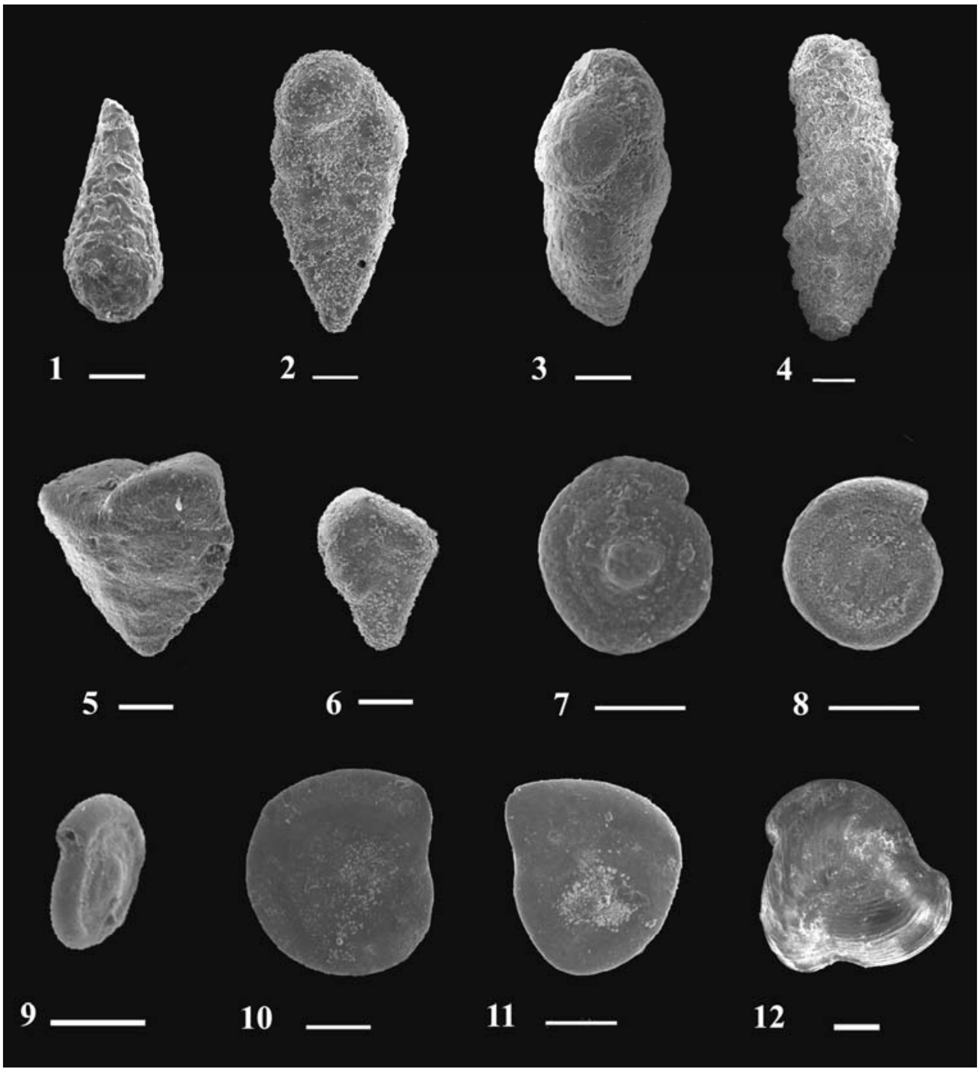

PLATE 2

(Scale bar = 100 μm)

Figure 1: *Vertebralina striata* d'Orbigny, 1826, lateral view, sample no: 30

Figure 2: *Nubeculina divaricata* (Brady, 1879), sample no: 31

Figure 3: *Edentostomina cultrata* (Brady, 1881) sample no: 13

Figure 4: *Edentostomina milletti* (Wiesner, 1912), sample no: 43

Figure 5: *Edentostomina milletti* (Wiesner, 1912), sample no: 43

Figure 6: *Edentostomina milletti* (Wiesner, 1912), apertural view, sample no: 43

Figure 7: *Adelosina cliarensis* (Heron-Allen and Earland, 1930), sample no: 71

Figure 8: *Adelosina pulchella* d' Orbigny, 1846, longitudinal view, sample no: 45

Figure 9: *Adelosina pulchella* d' Orbigny, 1846, apertural view, sample no: 45

Figure 10: *Adelosina pulchella* d' Orbigny, 1846, juvenile specimen, sample no: 43

Figure 11: *Adelosina* sp. A, sample no: 54 (65 meter)

Figure 12: *Siphonaperta agglutinans* (d'Orbigny, 1839), sample no: 72

PLATE 2

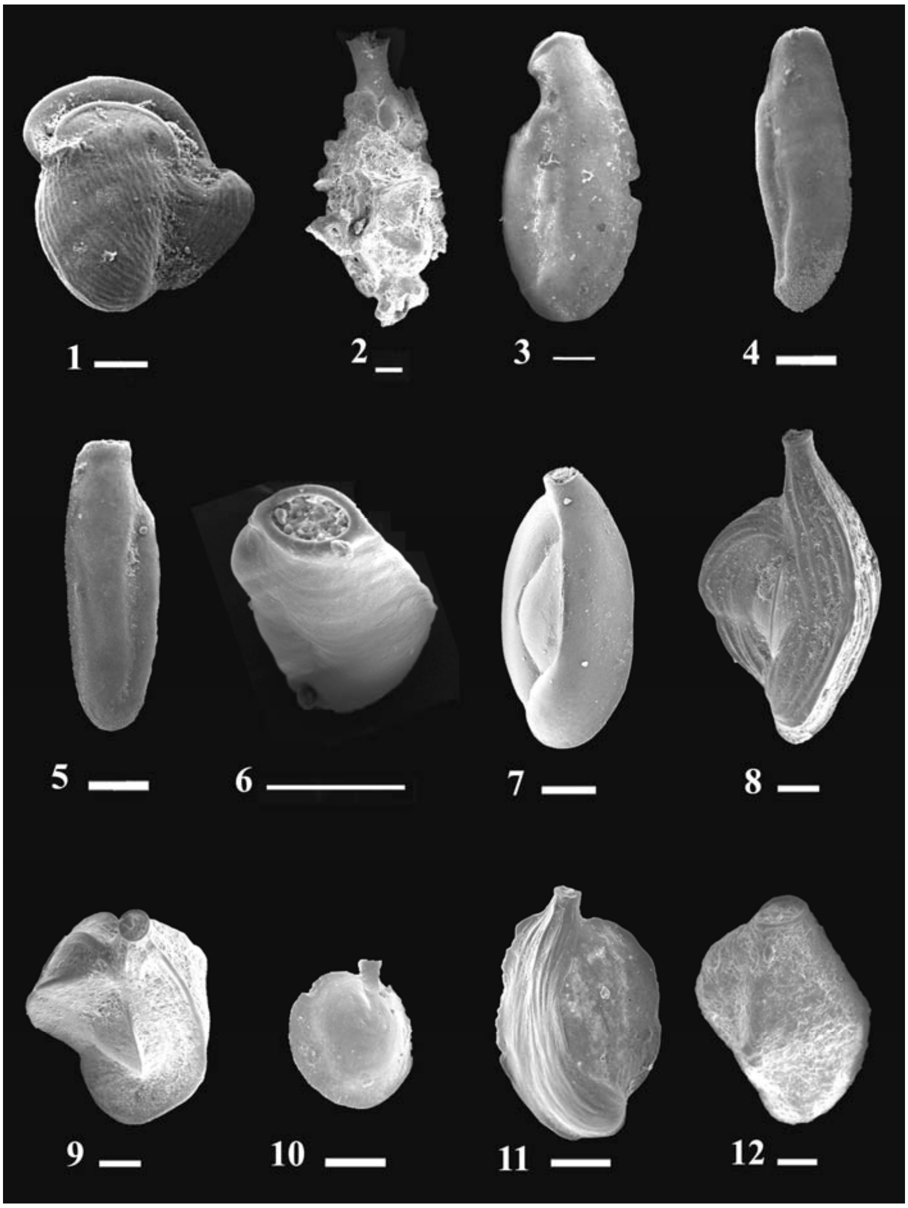

PLATE 3

(Scale bar = 100 μm)

Figure 1: *Cycloforina contorta* (d'Orbigny, 1846), sample no: 43

Figure 2: *Quinqueloculina berthelotiana* d'Orbigny, 1839, sample no: 13

Figure 3: *Quinqueloculina bosciana* d'Orbigny, 1839, apertural view, sample no: 31

Figure 4: *Septloculina angulata* El-Nakhal, 1990, sample no: 18

Figure 5: *Septloculina rotunda* El-Nakhal, 1990, sample no: 72

Figure 6: *Septloculina tortuosa* El-Nakhal, 1990 sample no: 1

Figure 7: *Miliolinella elongata* Kruit, 1955, sample no: 39

Figure 8: *Miliolinella* sp. A, sample no: 21

Figure 9: *Sigmohauerina bradyi* (Cushman, 1884), sample no: 30

Figure 10: *Pseudomassilina australis* (Cushman, 1932), sample no: 33

Figure 11: *Pyrgo elongata* (d'Orbigny, 1826), sample no: 21

PLATE 3

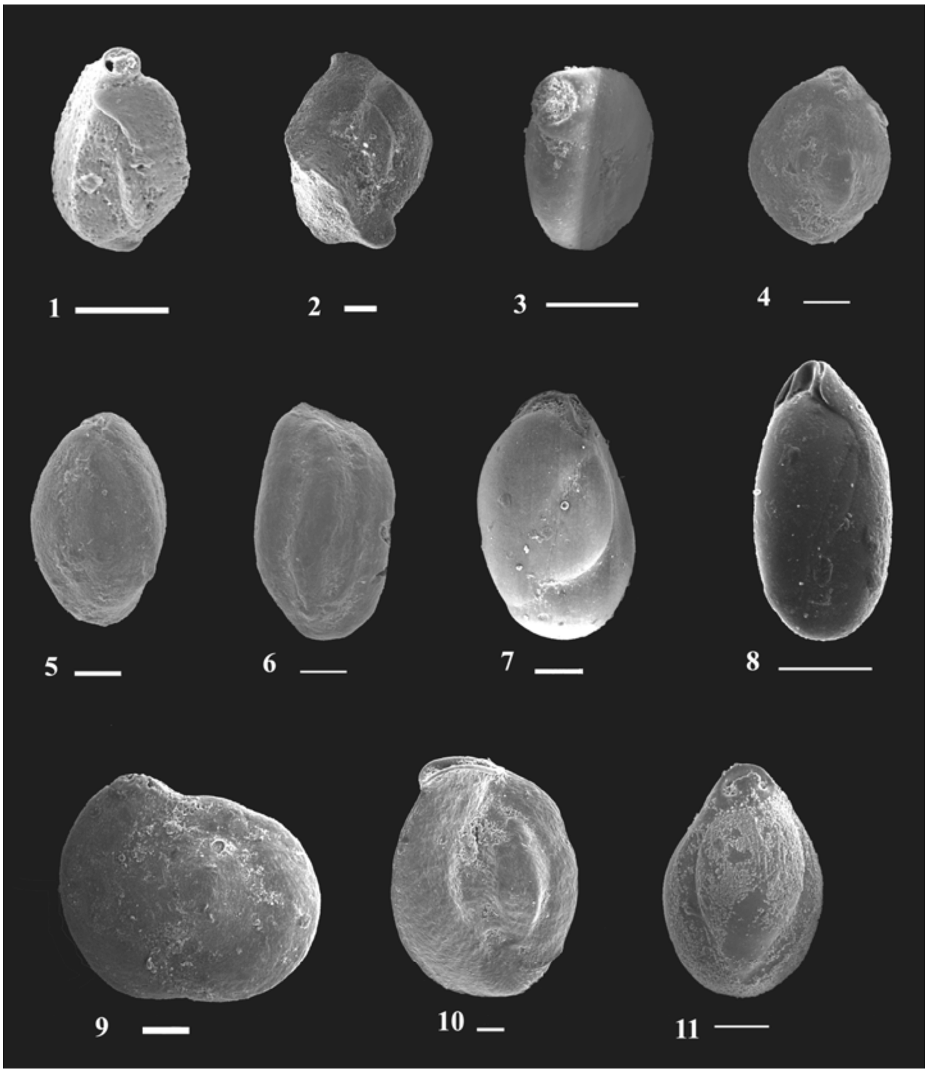

PLATE 4

(Scale bar = 100 μm)

Figure 1: *Triloculina marioni* Schlumberger, 1893, sample no: 55

Figure 2: *Triloculina oblonga* (Montagu, 1803), sample no: 25

Figure 3: *Triloculina plicata* Terquem1878, sample no: 54

Figure 4: *Triloculina trigonula* (Lamarck, 1804) , sample no: 72

Figure 5: *Sigmoilinita costata* (Schlumberger, 1983), sample no: 18

Figure 6: *Articulina alticostata* Cushman, 1944, sample no: 51

Figure 7: *Articulina carinata* Wiesner, 1923, sample no: 13

Figure 8: *Articulina carinata* Wiesner, 1923, sample no: 13

Figure 9: *Articulina mayori* Cushman, 1922, sample no: 34

Figure 10: *Parrina bradyi* (Millett, 1898), sample no:25

Figure 11: *Parrina bradyi* (Millett, 1898), sample no:25

Figure 12: *Peneroplis pertusus* (Forskal, 1775), sample no: 30

PLATE 4

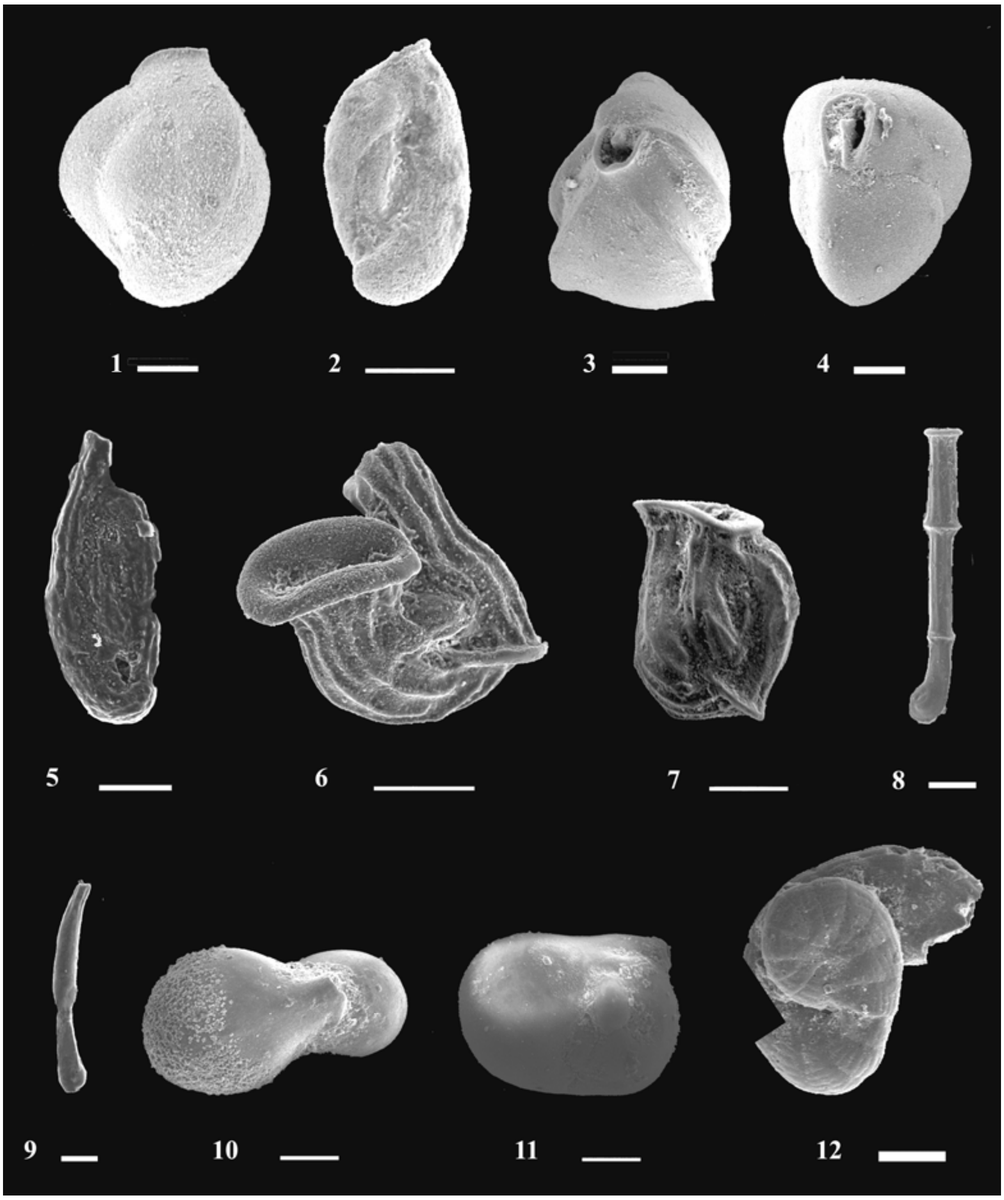

PLATE 5

(Scale bar = 100 μm)

Figure 1: *Peneroplis pertusus* (Forskal, 1775), sample no: 30

Figure 2: *Peneroplis pertusus* (Forskal, 1775), sample no: 30

Figure 3: *Peneroplis pertusus* (Forskal, 1775), sample no: 13

Figure 4: *Peneroplis planatus* (Fichtel and Moll, 1798), sample no:72

Figure 5: *Peneroplis planatus* (Fichtel and Moll, 1798), sample no:72

Figure 6: *Dentalina subsoluta* (Cushman, 1923), sample no: 23

Figure 7: *Amphicoryna scalaris* (Batsch, 1791), sample no: 39

Figure 8: *Lagena strumosa* Reuss, 1858, sample no: 44

Figure 9: *Globulina minuta* (Romer, 1838), sample no: 36

Figure 10: *Glandulina* sp. A, sample no: 52

Figure 11: *Oolina hexagona* (Williamson, 1848), sample no: 19

Figure 12: *Lamarkiana scabra* (Brady, 1884), sample no: 24

Figure 13: *Robertinoides* sp.A, sample no:25

Figure 14: *Brizalina striatula* (Cushman, 1922), sample no: 68

Figure 15: *Cassidulina carinata* Silvestri, 1896, sample no: 19

PLATE 5

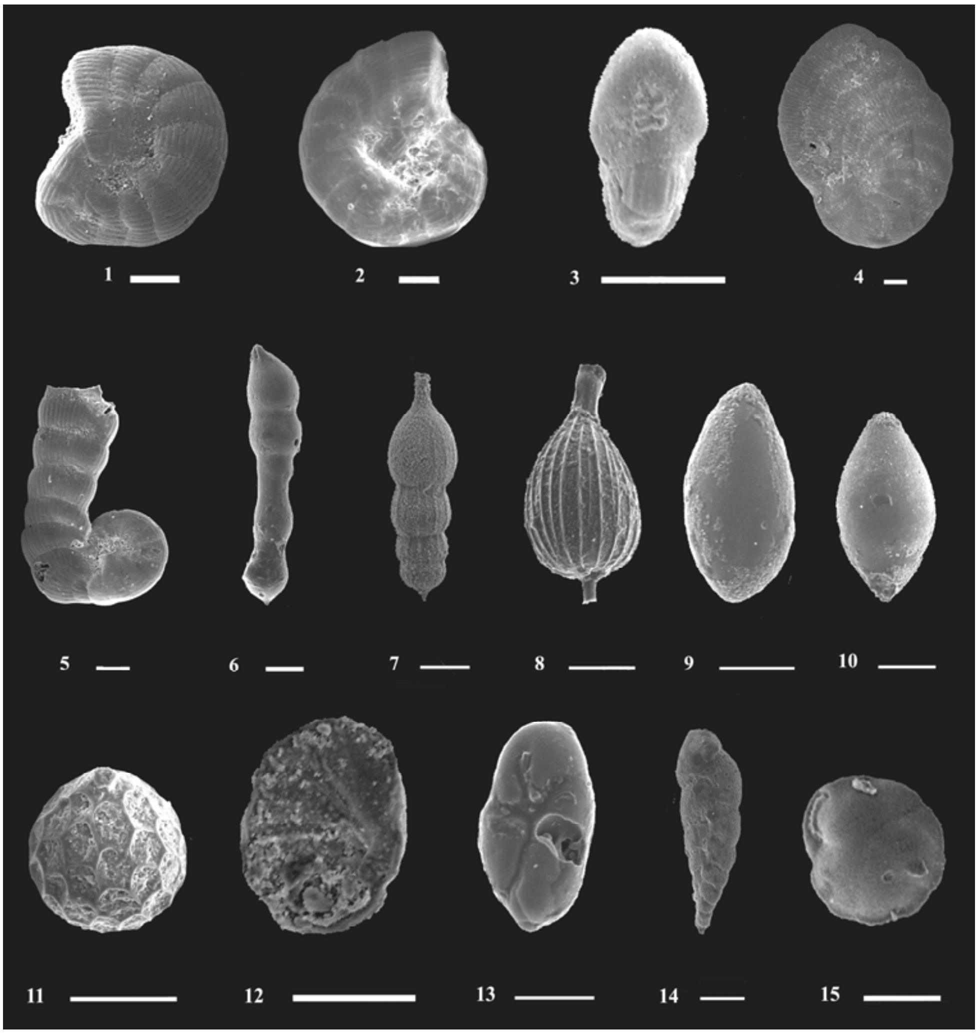

PLATE 6

(Scale bar = 100 μm)

Figure 1: *Globocassidulina subglobosa* (Brady, 1884), sample no: 26

Figure 2: *Globocassidulina subglobosa* (Brady) var. *producta* Chapman and Parr, 1937, sample no: 19

Figure 3: *Rectuvigerina phlegeri* Le Calvez, 1959, sample no: 61

Figure 4: *Bulimina elongata* D'Orbigny, 1846, sample no: 13

Figure 5: *Bulimina marginata* d'Orbigny, 1826, sample no: 39

Figure 6: *Bulimina marginata* d'Orbigny, 1826, sample no: 39

Figure 7: *Bulimina marginata* d'Orbigny, 1826, sample no: 39

Figure 8: *Bulumina marginata* d'Orbigny var. *biserialis* Millett, 1900, sample no: 29

Figure 9: *Trifarina bradyi* Cushman, 1923, sample no: 1

Figure 10: *Reussella spinulosa* (Reuss, 1850), sample no: 4

Figure 11: *Fursenkoina schreibersiana* (Czjzek, 1848) , sample no: 27

Figure 12: *Fursenkoina schreibersiana* (Czjzek, 1848) , sample no: 27

PLATE 6

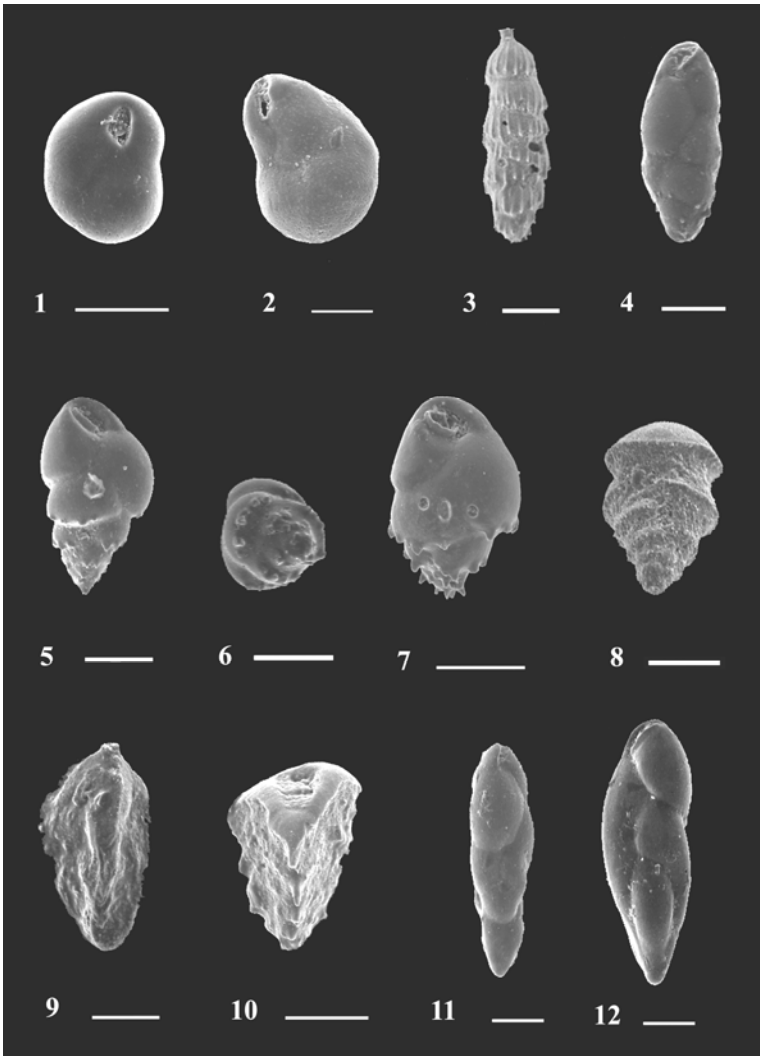

PLATE 7

(Scale bar = 100 μm)

Figure 1: *Eponides concameratus* (Williamson, 1858), sample no: 54
Figure 2: *Eponides concameratus* (Williamson, 1858), sample no: 54
Figure 3: *Valvularina bradyana* (Fornasini, 1900), sample no: 23
Figure 4: *Valvularina bradyana* (Fornasini, 1900), sample no: 23
Figure 5: *Valvularina bradyana* (Fornasini, 1900), sample no: 23
Figure 6: *Neoconorbina terquemi* (Rzehak, 1888), sample no: 52
Figure 7: *Neoconorbina terquemi* (Rzehak, 1888), sample no: 52
Figure 8: *Rosalina bradyi* (Cushman, 1915), sample no: 31
Figure 9: *Rosalina bradyi* (Cushman, 1915), sample no: 31
Figure 10: *Rosalina floridensis* (Cushman, 1922), sample no: 24
Figure 11: *Rosalina floridensis* (Cushman, 1922), sample no:24
Figure 12: *Rosalina* sp. A., sample no: 30
Figure 13: *Rosalina* sp. A., sample no: 30

PLATE 7

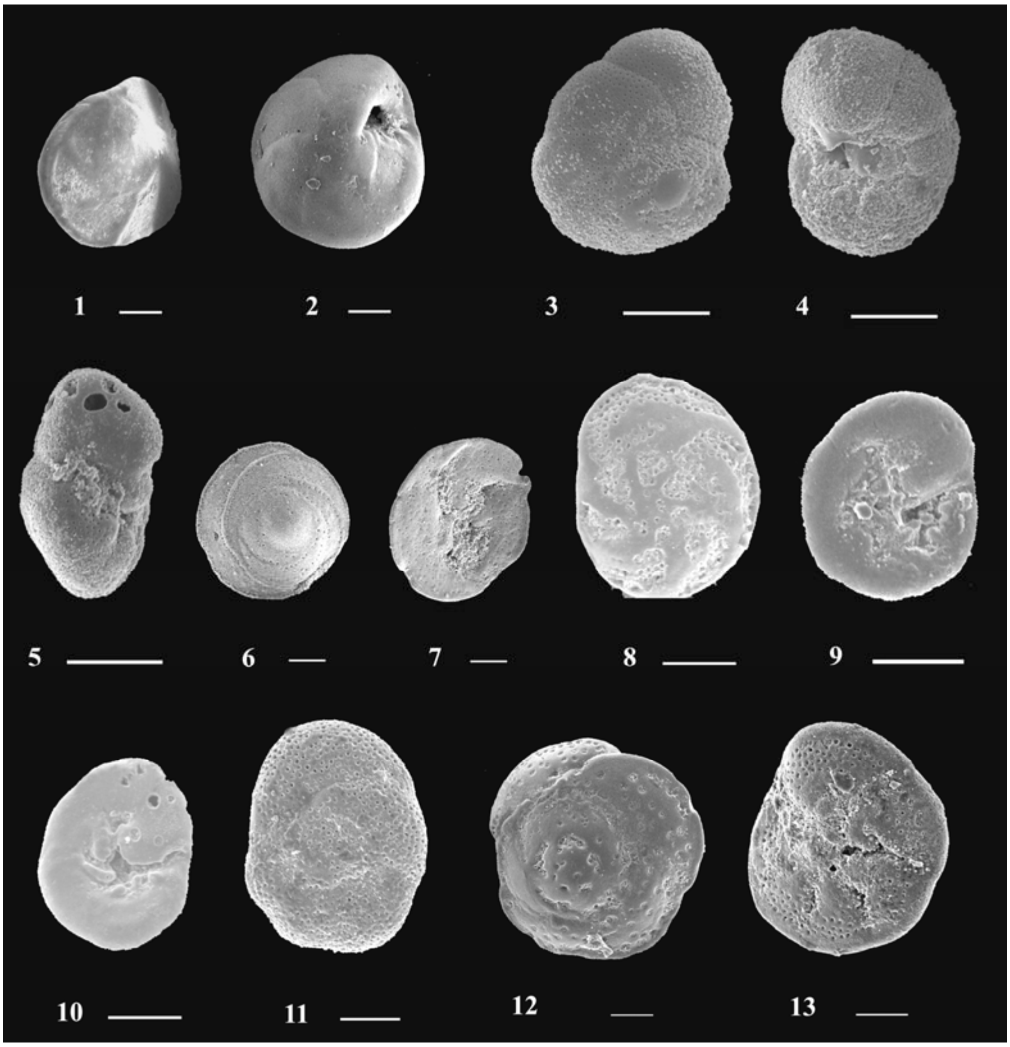

PLATE 8

(Scale bar = 100 μm)

Figure 1: *Conorbella patelliformis* (Brady, 1884)**,** sample no: 18

Figure 2: *Conorbella patelliformis* (Brady, 1884)**,** sample no: 18

Figure 3: *Conorbella imperatoria* (d'Orbigny, 1846), sample no: 54

Figure 4: *Conorbella imperatoria* (d'Orbigny, 1846), sample no: 54

Figure 5: *Discorbinella bertheloti* (d'Orbigny, 1839), sample no: 27

Figure 6: *Discorbinella bertheloti* (d'Orbigny, 1839), sample no: 27

Figure 7: *Cibicides refulgens* Monfort, 1808, sample no: 54

Figure 8: *Cibicides* sp.A, sample no: 54

Figure 9: *Cibicides* sp.A, sample no: 54

Figure 10: *Cibicides* sp.A, sample no: 54

Figure 11: *Cibicides* sp.A, sample no: 54

Figure 12: *Lobatula lobatula* (Walker and Jacob, 1798), sample no: 4

Figure 13: *Lobatula lobatula* (Walker and Jacob, 1798), sample no: 4

Figure 14: *Planorbulina mediterranensis*(d'Orbigny, 1826), sample no: 19

Figure 15: *Planorbulina mediterranensis*(d'Orbigny, 1826), sample no: 19

Figure 16: *Planorbulina acervalis* (Brady, 1884), sample no: 45

PLATE 8

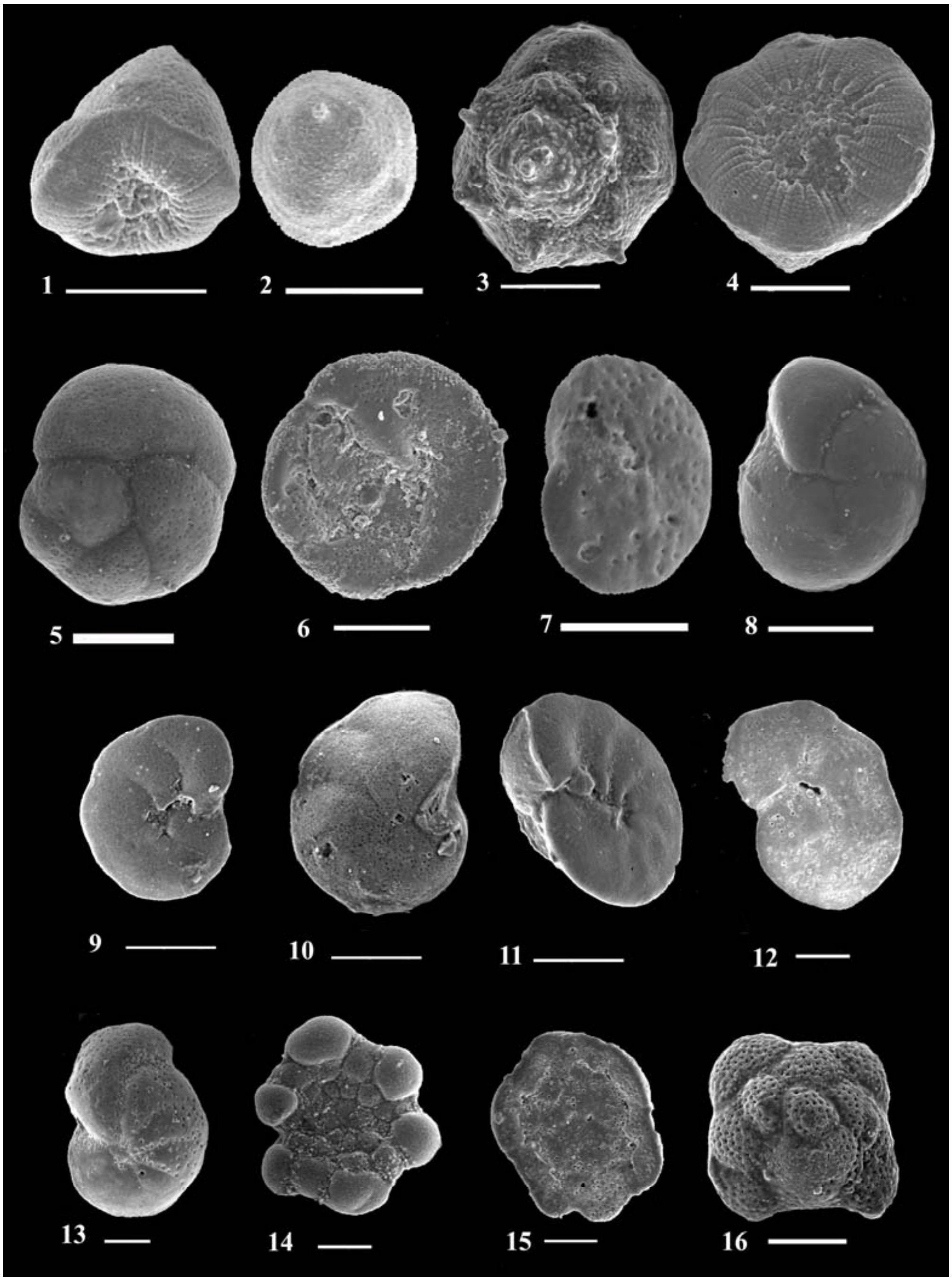

PLATE 9

(Scale bar = 100 μm)

Figure 1: *Sphaerogypsina globulus* (Reuss, 1848)

Figure 2: *Asterigerinata mamilla* (Williamson, 1858), sample no:

Figure 3: *Asterigerinata mamilla* (Williamson, 1858), sample no: 30

Figure 4: *Amphistegina lobifera* Larsen, 1976, sample no: 30

Figure 5: *Nonion depressulum* (Walker and Jacob, 1798), sample no: 25

Figure 6: *Nonion depressulum* (Walker and Jacob, 1798), sample no: 25

Figure 7: *Nonionoides grateloupi* (d'Orbigny, 1826), sample no: 34

Figure 8: *Nonionoides grateloupi* (d'Orbigny, 1826), sample no: 34

Figure 9: *Astrononion stelligerum* (d'Orbigny, 1839), sample no: 43

Figure 10: *Astrononion stelligerum* (d'Orbigny, 1839), sample no: 43

Figure 11: *Buccella granulata* (Di Napoli Alliata,1952), sample no: 68

Figure 12: *Buccella granulata* (Di Napoli Alliata,1952), sample no: 68

Figure 13: *Ammonia tepida* (Cushman, 1926), sample no: 51

Figure 14: *Ammonia tepida* (Cushman, 1926), sample no: 51

Figure 15: *Ammonia tepida* (Cushman, 1926), sample no: 51

Figure 16: *Cribroelphidium poeyanum* (d'Orbigny, 1839), sample no: 55

Figure 17: *Cribroelphidium poeyanum* (d'Orbigny, 1839), sample no: 55

PLATE 9

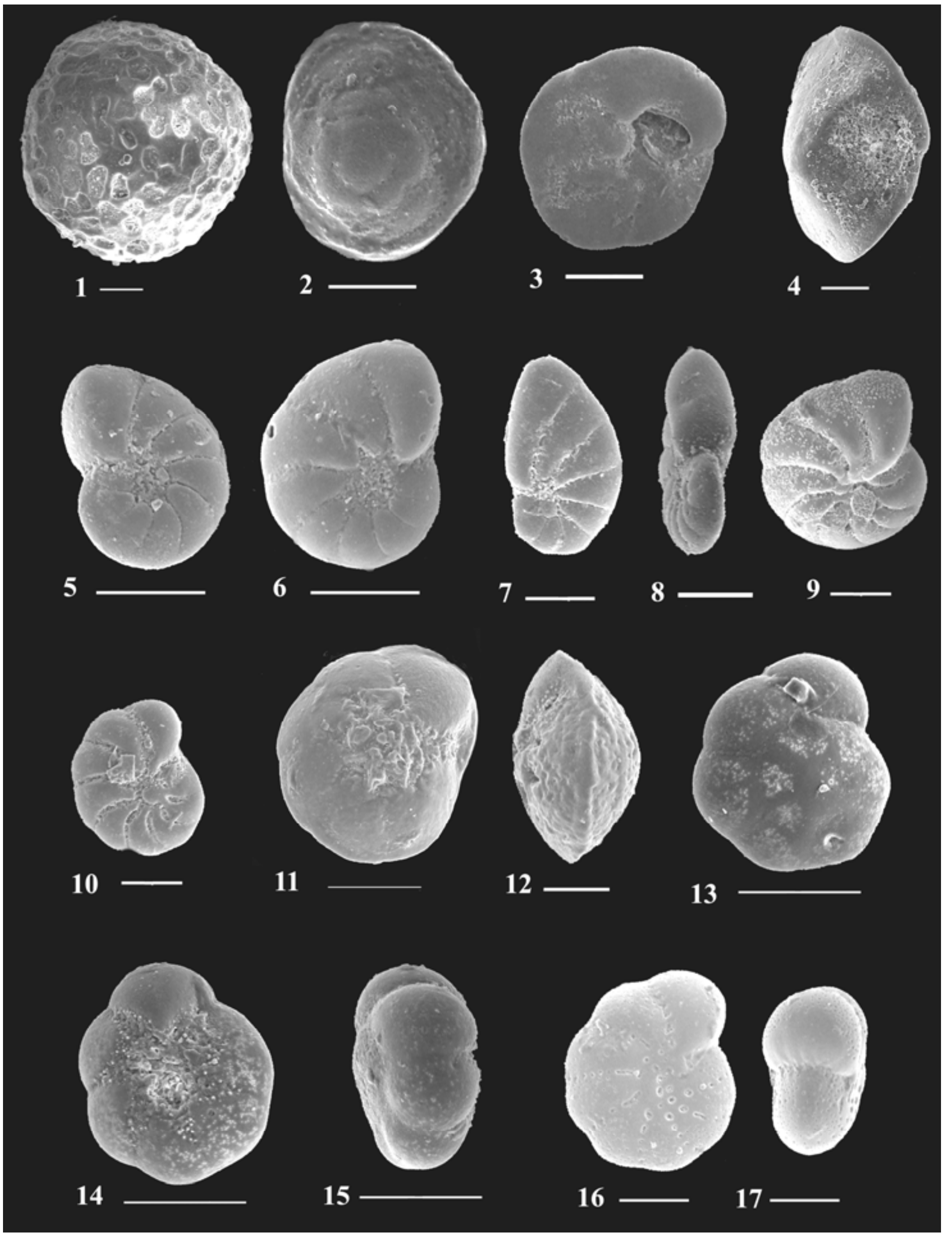

PLATE 10

(Scale bar = 100 μm in figs. 1-2, scale bar = 10 μm in figs. 5-6

Figure 1: *Porosononion granosum* (d'Orbigny, 1846), sample no: 54

Figure 2: *Porosononion granosum* (d'Orbigny, 1846), sample no: 54

Figure 3: *Elphidium translucens* Natland, 1938, sample no: 27

Figure 4: *Elphidium translucens* Natland, 1938, sample no: 27

Figure 5: Details of costae in *Peneroplis pertusus* (Forskal, 1775), sample no: 30

Figure 6: Details of aperture of typical buluminid loop in **:** *Bulimina marginata* d'Orbigny, 1826, sample no: 39

PLATE 10

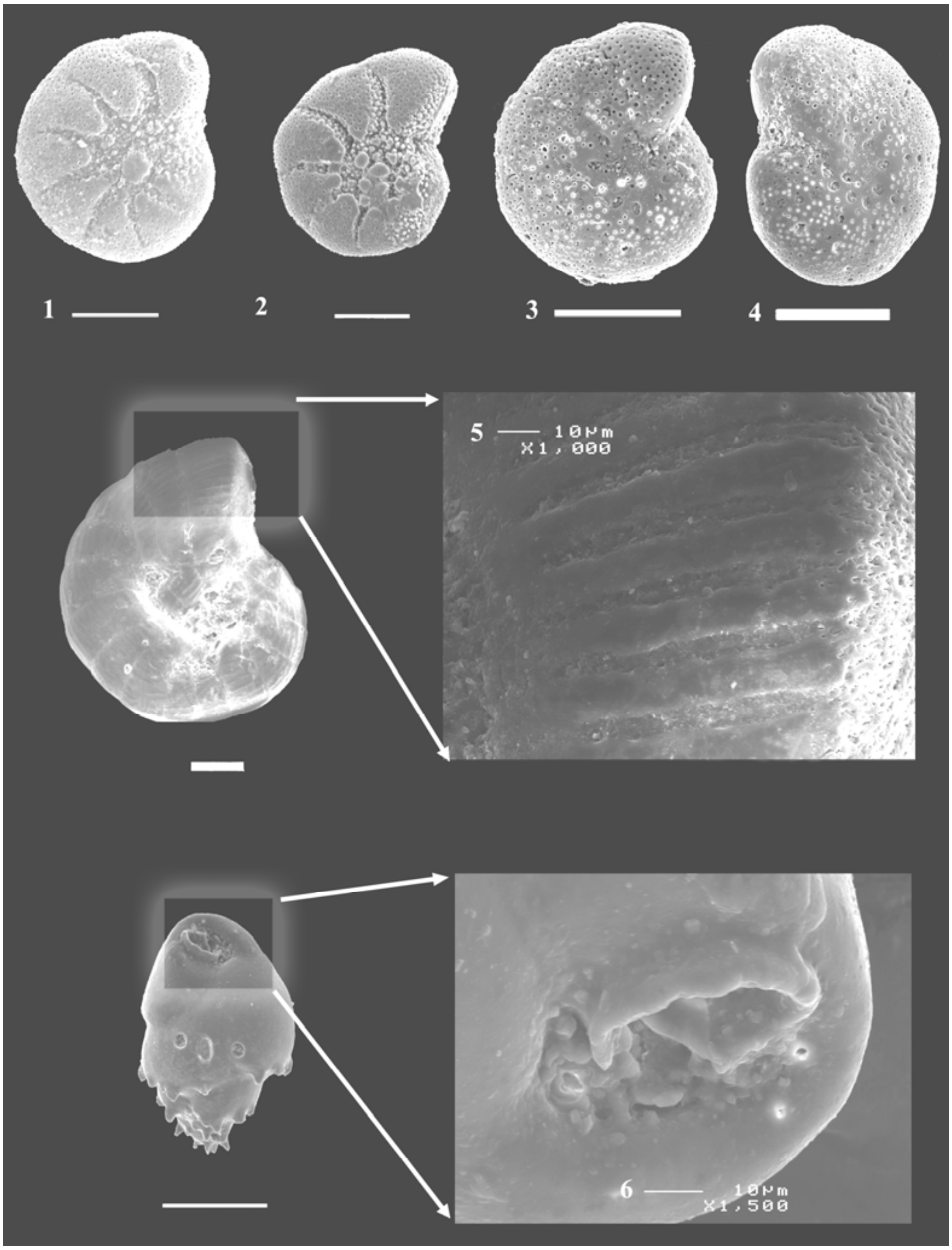

PLATE 11

(Scale bar = 100 μm)

Figure 1: *Textularia bocki* Höglund, 1947, sample no: 2

Figure 2: *Spirillina vivipara* Ehrenberg; sample no: 72

Figure 3: *Planispirinella exigua* (Brady, 1879); sample no: 3

Figure 4: *Vertebralina striata* d’Orbigny, 1826, sample no: 30

Figure 5: *Spiroloculina angulosa* Terquem, 1878, sample no: 30

Figure 6: *Spiroloculina depressa* d'Orbigny, 1826, sample no: 30

Figure 7: *Miliolinella subrotunda* (Montagu, 1803), sample no: 34

Figure 8: *Peneroplis pertusus* (Forskal, 1775), sample no: 30

Figure 9: *Peneroplis planatus* (Fichtel and Moll, 1798), sample no: 24

Figure 10: *Sorites orbiculus* Ehrenberg, 1939, sample no: 3

Figure 11: *Elphidium crispum* (Linne, 1758), sample no: 54

Figure 12: *Nonion* sp. A, sample no: 71

PLATE 11